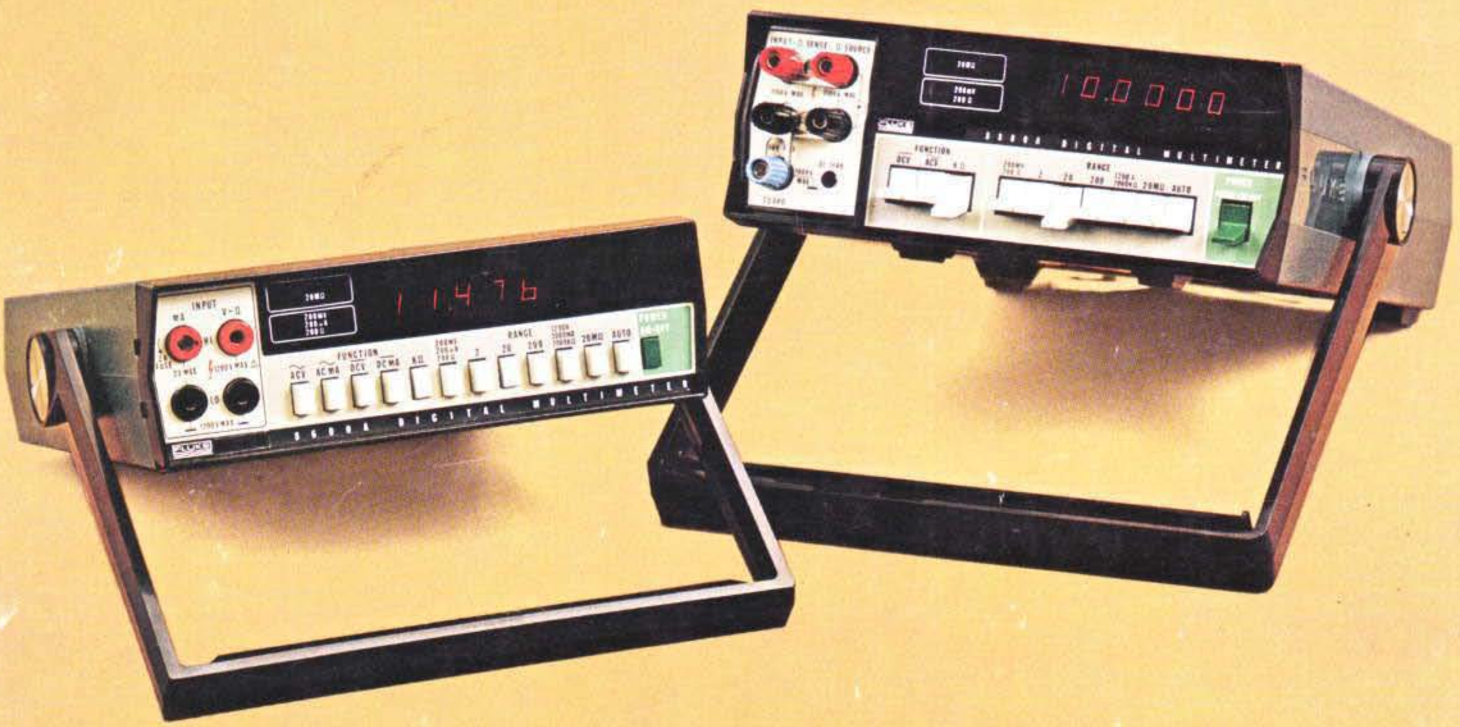
FLUKE®

test and measurement instruments



1974-75 catalog

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[redacted]

domestic representatives

1. **Barnhill Associates, Inc.**
1170 S. Sheridan Blvd.
Denver, CO 80226
Tel. (303) 934-5505

7319 E. Stetson Dr.
Scottsdale, AZ 85251
Tel. (602) 947-7841

1410-D Wyoming N.E.
Albuquerque, NM 87112
Tel. (505) 299-7658

908 Business Parkway
Richardson, TX 75080
Tel. (214) 231-2573

Suite 132
10606 Hempstead Hwy.
Houston, TX 77018
Tel. (713) 688-9971

2. **WKM Associates, Inc.**
16141 Puritas Ave.
Cleveland, OH 44135
Tel. (216) 267-0445

6073 Far Hills Ave.
Dayton, OH 45459
Tel. (513) 434-7500

1474 East Outer Drive
Detroit, MI 48234
Tel. (313) 892-2500

90 Clairton Blvd.
Pittsburgh, PA 15236
Tel. (412) 892-2953

3. **Instrument Representatives Inc.**
109 Massachusetts Ave.
Lexington, MA 02173
Tel. (617) 861-8620

P.O. Box 165
Glastonbury, CT 06033
Tel. (203) 633-0777

4. **Electronic Marketing Assoc., Inc.**
11501 Huff Court
Kensington, MD 20795
Tel. (301) 881-5300, 744-7700

210 Goddard Blvd.
Suite 100
King of Prussia, PA 19406
Tel. (215) 248-5050

5. **Allan Crawford Assoc., Ltd.**
6427 Northam Drive
Mississauga, Ontario, Canada
Tel. (416) 678-1500

1330 Marie Victorian Blvd. E.
Longueuil, P.Q. JHG 1A2
Tel. (514) 670-1212

640 11th Ave. S.W.
Calgary, Alberta
Tel. (403) 261-0780

234 Brooksbank Ave.
N. Vancouver, B.C.
Tel. (604) 980-4831

1299 Richmond Road
Ottawa 3, Ontario
Tel. (613) 829-9651

6. **Industrial Electronics, Inc.**
P.O. Box 135
646 Queen Street
Honolulu, HI 96817
Tel. (808) 533-6095

7. **SBM Representatives, Inc.**
4515 Culver Road
Rochester, NY 14622
Tel. (716) 266-1400

28 Hobby Street
Pleasantville, NY 10570
Tel. (914) 769-1811

1519 Stuyvesant Ave.
Union, NJ 07083
Tel. (201) 687-8737

8. **Instrument Specialists, Inc.**
2000 N. Lincoln Street
Burbank, CA 91504
Tel. (213) 849-7181

2359 De La Cruz Blvd.
Santa Clara, CA 95050
Tel. (408) 244-1505

4805 Mercury St.
Suite One
San Diego, CA 92111
Tel. (714) 565-2555

9. **BCS Associates, Inc.**
P.O. Box 6578
940 N. Fern Creek Ave.
Orlando, FL 32803
Tel. (305) 896-4881
(305) 843-1510

P.O. Box 1273
3322 S. Memorial Parkway
Huntsville, AL 35807
Tel. (205) 881-6220

P.O. Box 6919
1310 Beaman Place
Greensboro, NC 27408
Tel. (919) 273-1918

107 Rich Neck Road
Williamsburg, VA 23185
Tel. (703) 229-5108

2522 Tanglewood Road
Decatur, GA 30033
Tel. (404) 321-0980

4506 Freda Way
Valley Station, KY 40272
Tel. (502) 935-9634

10. **Cozzens & Cudahy, Inc.**
1301 North Rand Road
Des Plaines, IL 60016
Tel. (312) 298-6300

Port O'Call Executive Center
21 Beachway Drive
Indianapolis, IN 46224
Tel. (317) 244-2456

10800 Lyndale Ave. S.
Minneapolis, MN 55420
Tel. (612) 884-4336

P.O. Box 10013
Lambert Field
St. Louis, MO 63145
Tel. (314) 423-1234

4404 Chouteau Traffic Way
Kansas City, MO 64117
Tel. (816) 454-5836

11. **Showalter-Judd, Inc.**
626 S. Alaska St.
Seattle, WA 98108
Tel. (206) 624-9020

13485 S.W. Hargis Road
Beaverton, OR 97005
Tel. (503) 646-3004

12. **Harry Lang & Associates**
1406 W. 47th Ave.
Anchorage, Alaska 99503
Tel. (907) 279-5741

Key to Representatives

AL	9
AK	12
AZ	1
AR	1
CA	8
CO	1
CT	3
DE	4
DC	4
FL	9
GA	9
HI	6
ID	1 or 11
IL	10
IN	10
IA	10
KS	10
KY	9
LA	1
ME	3
MD	4
MA	3
MI	2 or 10
MN	10
MS	9
MO	10
MT	11
NB	10
NV	8
NH	3
NJ	4 or 7
NM	1
NY	7
NC	9
ND	10
OH	2
OK	1
OR	11
PA	2 or 4
PR	9
RI	3
SC	9
SD	10
TN	9
TX	1
UT	1
VT	3
VA	9
WA	11
WV	9
WI	10
WY	1
Canada	5

John Fluke Mfg. Co., Inc.
P.O. Box 7428
Seattle, WA 98113
Tel. (206) 774-2211
TWX. 910-449-2850
TLX: 32-0013, Cable: FLUKE

John Fluke Mfg. Co., Ltd.
P.O. Box 1094
Buffalo, NY 14210
Tel. (716) 842-0311
TWX 610-492-3214

Fluke Trendar Corp.
500 Clyde Avenue
Mountain View, CA 94040
Tel. (415) 965-0350
TWX 910-379-6573

international representatives

Argentina
Coasin S.A.
Virrey del Pino 4071
Buenos Aires, Argentina
Tel. 523185

Australia
Elmeasco Instruments Pty Ltd.
P.O. Box 334
Brookvale, N.S.W. Australia 2100
Tel. 939-7944

Austria
Kontron GmbH & Co. KG
Lederergasse 16
1080 Vienna, Austria
Tel. 425667

Belgium
C.N. Rood S/A
37 Place de Jamblinne de Meux
B-1040 Brussels, Belgium
Tel. 352135

Brazil
Ambriex S.A.
Rue Ceara, 104-2°. e 3°. Andares
ZC-29
Rio de Janeiro GB, Brazil
Tel. 2647406

Ambriex S.A.
Rua Tupi, 535
01233 Sao Paulo, SP Brazil
Tel. 527806

Caribbean
West Indies Sales Co.
606 Calle Aboy
San Juan, Puerto Rico 00907
Tel. (809) 723-3743

Central America
Intermetra Corporation
11 Park Place, Suite 2003
New York, NY 10007
Tel. (212) 349-7630

Chile
Coasin Chile Ltd.
Casilla 14588
Correo 15
Santiago, Chile
Tel. 396713

China, People's Republic of
May Lee Industries, Inc.
31 East 32nd St.
New York, NY 10016
Tel. (212) 532-9200

Colombia
Marones Ltda.
Apartado Aero 90687
Bogota 8, Colombia
Tel. 364731

Cyprus
Chris Radiovision Ltd.
P.O. Box 1989
Nicosia, Cyrpus
Tel. 66121

Denmark
Tage Olsen A/S
Teglvaerksgade 37
2100 Copenhagen Ø, Denmark
Tel. 294800

Ecuador
Proteco Coasin CIA, Ltda.
Apartado 228A
Quito, Ecuador
Tel. 526759

Finland
Oy Findip AB
Teollisuustie 7
02700 Kauniainen, Finland
Tel. 502255

France
M.B. Electronique S.A.
29, Rue Emile Duclaux
92, Suresnes, France
Tel. 7723108

Greece
Marios Dalleggio Representations
2 Alopekis Street
Athens 19, Greece
Tel. 710669

Hong Kong
Gilman & Co. Ltd.
P.O. Box 56
Hong Kong
Tel. 227011

India
Hinditron Services Pvt. Ltd.
69/A L. Jagmohandas Marg
Bombay 400006, India
Tel. 365344

Indonesia
P.T. United Dico-Citas Co., Ltd.
JLN Penjaringan 39A
Jakarta, Indonesia

Iran
Berkeh Company Ltd.
20 Salm Road, Roosevelt Ave.
Tehran, Iran
Tel. 828294

Israel
R.D.T. Electronics Eng'r. Ltd.
P.O. Box 21082
Tel Aviv 61210, Israel
Tel. 456181

Italy
Sistrel S.p.A.
Via Giorgio da Sebenico 11/13
00143 Roma, Italy
Tel. 06-500-1806

Japan
Toyo Trading Company, Ltd.
P.O. Box 5014
Tokyo International
Tokyo 100-31, Japan
Tel. 2790771

Toyo Trading Company, Ltd.
Suzuki Bldg.
2-38 Junkeicho-dori
Minami-ku, Osaka
Tel. (06) 262-3471

Korea
Asis Science & Co.
International P.O. Box 1250
Seoul, Korea
Tel. 241431

Malaysia
O'Connor's (Pte) Ltd.
P.O. Box 1197
Kota Kinabalu, Sabah
East Malaysia
P.O. Box 91
Petaling Jaya, Selangor
West Malaysia

Mexico
Mexitek, S.A.
Eugenia 408
Departments 1 y 5
Mexico 12, D.F.
Tel. 5360910

The Netherlands
C.N. Rood, B.V.
P.O. Box 42
13 - Cort van der Lindenstraat
Rijswijk (Z.H.) 2100
Netherlands
Tel. 996360

Fluke (Nederland) B.V.
P.O. Box 5053
Ledeboerstraat 27
Tilburg, Netherlands
Tel. (13) 673973

New Zealand
Mr. John Groombridge
P.O. Box 30515
Lower Hutt, New Zealand
Tel. 63976

Nigeria
Deemtee Electrotechnics Ltd.
P.O. Box 3073
Lagos, Nigeria

Norway
Morgenstierne & Co. A/S
P.B. 6688 Rodeløkka
Oslo 5, Norway
Tel. 372940

Pakistan
Pak International Operations
P.O. Box 5323
505 Muhammadi House-
McLeod Rd.
Karachi, Pakistan

Peru
Importaciones y Representaciones
Electronicos S.A.
Avda, Franklin D. Roosevelt 105
Lima 1, Peru
Tel. 272078

Portugal
Equipamentos De Laboratorio Lda.
P.O. Box 1100
Lisbon, Portugal
Tel. 976551

Singapore
O'Connor's (Pte) Ltd.
98 Pasir Panjang Road
Singapore 5, Singapore
Tel. 637944

South Africa
Elairco (Pty.) Ltd.
P.O. Box 13091
Northmead 1511
Benoni, Transvaal
Republic of South Africa
Tel. (Durban) 20272

Elairco (Pty.) Ltd.
P.O. Box 2143
Durban
Republic of South Africa
Tel. 20272

Spain
Ataio Ingenieros S.A.
Enrique Larreta 12
Madrid 16, Spain
Tel. 2153543

Sweden
Teleinstrument AB
P.O. Box 490
S-16204 Vallingby-4
Sweden
Tel. 380370

Switzerland
Kontron Electronic A.G.
Bernerstrasse (Sud) 169
8048 Zurich, Switzerland
Tel. 628282

Taiwan - Republic of China
Heighten Trading Co., Ltd.
P. O. 1408
Taipei, Taiwan 104
Republic of China
Tel. 518324

Thailand
G. Simon Radio Ltd.
30 Patpong Ave.
Suriwong
Bangkok, Thailand
Tel. 30991-3

The United Kingdom
Fluke International Corp.
Garnett Close
Watford, WD2 4TT, England
Tel. 33066

U.S.S.R.
Codevintec Pacific Inc.
6263 Variel
Woodland Hills, California 91364
Tel. (213) 348-1719

Uruguay
Coasin Uruguaya S.R.L.
Cerrito 617 4° Piso
Montevideo, Uruguay

Venezuela
Coasin C.A.
APDO Postal 50939
Sabana Grande No. 1
Caracas 105, Venezuela
Tel. 722311

West Germany
Fey Elektronische Messgeräte
8 München 19
Horemannstrasse 28
West Germany
Tel. 089-184041

In Europe contact **Fluke Nederland, B.V., Post Office Box 5053, Industrieterren Noord, Tilburg, The Netherlands.**

product index

how to order

Technical Assistance

Demonstration of a particular instrument may be conveniently arranged with the local **Fluke** representative. Technical assistance in selecting equipment and preparing orders is available from engineering personnel at these local offices supplemented by a highly qualified staff of application engineers at the factory.

Order By Model Number

When ordering, please specify the complete instrument model number and nomenclature. For example, "Model 8600A Digital Multimeter." Note that suffic letter "R" after a model number designates rack mounting version of those instruments available in either a rack or bench mounting configuration. Many **Fluke** instruments use one configuration for both bench and rack mounting.

Special Instrument Service

Many **Fluke** instruments can be supplied with non-standard paint, altered specification ranges, special connectors, or other special features. Please consult the authorized **Fluke** representative in your area or the factory Special-Instrument Service for prices, delivery schedule, and special ordering information.

Where To Send Your Order

Orders should be made out to **John Fluke Mfg. Co., Inc.** or its subsidiaries and sent in care of your local **Fluke** representative (see list of representatives) or directly as follows:

Electronic Counters	**John Fluke Mfg. Co., LTD** P.O. Box 1094 Buffalo, New York 14210
Logic Test Equipment	**Fluke Trendar Corporation** 500 Clyde Avenue Mountain View, CA 94040
All Other Orders	**John Fluke Mfg. Co., Inc.** P.O. Box 7428 Seattle, WA 98133

Shipping Methods

Shipments are made directly from the factory. Unless specifically requested otherwise, express or truck transportation is used, whichever is least expensive and most serviceable to you. Small items may be sent via parcel post. Air freight, air express, or air parcel post will be used when specified on your order.

Terms

U.S. and Canada terms are 30 days net. Unless credit has already been established, shipments will be made C.O.D. or on receipt of cash in advance. Terms for orders from other countries are irrevocable letter of credit or cash in advance unless other terms have been previously arranged.

Prices

Prices are F.O.B. origin, unless otherwise specified. All prices are in U.S. funds and are subject to change without notice.

Quotations and Pro Forma Invoices

Upon request quotations or pro forma invoices will be furnished to you by your local **Fluke** sales representative or by **John Fluke Mfg. Co., Inc., John Fluke Mfg. Co., LTD** or **Fluke Trendar Corporation.**

Certification

Calibration measurements of **Fluke** instruments are traceable to the National Bureau of Standards.

All parts, materials and products on the **Fluke** instrument have been furnished to specifications set out by the manufacturer, the test data for which are available on file at the place of manufacture.

Specifications

Specifications quoted applied at the same time of printing. The Company or its sales representatives can give details of improvements made as part of continuing development.

Warranty

All **Fluke** instruments are warranted against defective materials and workmanship for one year.

customer service

Calibration

The **John Fluke Mfg. Co., Inc.** maintains a set of primary or reference standards which are periodically checked by the National Bureau of Standards, thus assuring direct traceability to the Bureau.

Working standards are checked in this facility and used as a base for calibration throughout the plant. Many instruments and devices in the product line can be supplied with the "**John Fluke Mfg. Co., Inc.** Certificate of Calibration". These calibration reports generally include all numerical values pertaining to the calibration, uncertainties associated with the calibration and statements explaining the calibration.

A modest fee is charged for these services and a standards lab fee schedule is available on request.

Fluke has long established a reputation for accuracy and reliability. This has been made possible by careful attention to design criteria, quality craftsmanship, careful calibrations based on the finest standards facilities available, and a desire to furnish each customer a degree of quality and service which will meet his every need.

Service Organizations

Fluke authorized service centers are located throughout the world, with **Fluke** Technical Centers placed strategically throughout North America. Check the map (page viii) for the nearest Technical Service Center in your area.

All **Fluke** instruments repaired by these facilities are returned to the customer calibrated within the parameters listed in the original specification for that instrument and warranted for 60 days after repair.

Arrangements should be made with the repair agency before sending equipment for repair or calibration. All **Fluke** service agencies will furnish quotes on repair and calibration free of charge. When making arrangements for calibration or repair, please give the model number, name, serial number and as much information as possible concerning the reason for returning the instrument. Non-warranty repairs are made at the cost of labor and materials plus a small service charge.

The factory and the **Fluke** Service Centers stand ready to assist customers in accomplishing their own repair. Should you have a question about servicing your instrument, please feel free to contact either the Customer Service Department at the factory or your nearest **Fluke** Technical Center.

Parts

The factory maintains an extensive supply of parts for all instruments in the line including many instruments that are no longer part of our current production. Replacement parts may be ordered through your nearest **Fluke** Service Center or the factory.

Please identify parts by the **Fluke** stock number and part description as shown in the instruction manual and, if possible, by the schematic diagram circuit reference number. The model number and serial number of the instrument will help us verify the part or parts being ordered.

Carefully observe footnotes on the schematic diagrams and in the parts lists concerning matched components. In some cases parts must be ordered in matched sets in order to maintain the accuracies and capabilities of the instrument after repair. Minimum billing for parts ordered is $20.00. All prices are FOB destination and subject to any applicable federal, state or local taxes.

All prices are in U.S. funds and are subject to change without notice.

Parts may be ordered through our International Representatives listed on page iii. Should you have any further questions about service or parts, please contact the service or sales agency nearest you.

Recommended spare parts lists to support any number of **Fluke** instruments can be obtained by contacting the factory Customer Service Parts Department.

A nominal charge is made for instruction manuals which may be ordered through any of your **Fluke** representatives or Technical Centers.

Fluke Technical Centers

The unique concept of **Fluke** Technical Centers was established approximately two years ago to maximize customer field support and factory feedback. These centers and their personnel are an extension of the Quality & Service Division of the **Fluke** factory. Their further purpose is to be involved in all quality and service situations at the local level enabling the factory to maintain the high standard of quality and service established throughout the years and synonymous with the name **Fluke**.

All Technical Centers are fully staffed and equipped to support the entire **Fluke** product line. Their standards are maintained and directly traceable to N.B.S. and the factory through our "Measurement Agreement Program". All centers have replacement parts inventories to expedite field repairs. Their personnel receive factory training and stand ready with repair and trouble-shooting expertise for all field situations. The **Fluke** Technical Centers stand ready to support you, our customer – please feel free to call upon them for field support.

John Fluke Mfg. Co., Inc.
Bill Fetrow, Tech. Services Supervisor
7001 - 220th S.W.
Mountlake Terrace, WA 98043
Tel: 206 - 774 - 2206
TWX: 910 - 449 - 2850

Fluke Midwestern Technical Center
Bruce Hunt, Service Manager
1287 North Rand Road
Des Plaines, Ill. 60016
Tel: 312 - 298 - 7470
TWX: 910 - 233 - 4978

Fluke Midwestern Technical Center
Bob Wayne, Service Manager
10800 Lyndale Avenue S.
Minneapolis, Minn. 55420
Tel: 612 - 884 - 4541
TWX: 910 - 576 - 3141

Fluke Canadian Technical Center
Herb Duval, Service Manager
6427 Northam Drive
Mississauga, Ontario
Tel: 416 - 678 - 1500
TWX: 610 - 492 - 2119

Fluke N.E. Technical Center
Dick Zemba, Service Manager
109 Massachusetts Ave.
Lexington, Mass. 02173
Tel: 617 - 861 - 8620
TWX: 710 - 326 - 1715

Fluke Western Technical Center
Tom Marshall, Service Manager
4805 Mercury St.
San Diego, CA 92111
Tel: 714 - 565 - 4455
TWX: 910 - 337 - 1273

Fluke Western Technical Center
Mike Nagy, Service Manager
2020 N. Lincoln St.
Burbank, CA 91504
Tel: 213 - 848 - 4641
TWX: 910 - 497 - 2086

Fluke Western Technical Center
Howard McElroy, Service Manager
2359 De La Cruz Blvd.
Santa Clara, CA 95050 Tel: 408 - 244 - 1505
Tel: 408 - 244 - 1505
TWX: 910 - 338 - 0121

Fluke S.E. Technical Center
Dwain Cox, Service Manager
P.O. Box 9619
1310 Beaman Place
Greensboro, N.C. 27408
Tel: 919 - 273 - 1918
TWX: 510 - 925 - 1173

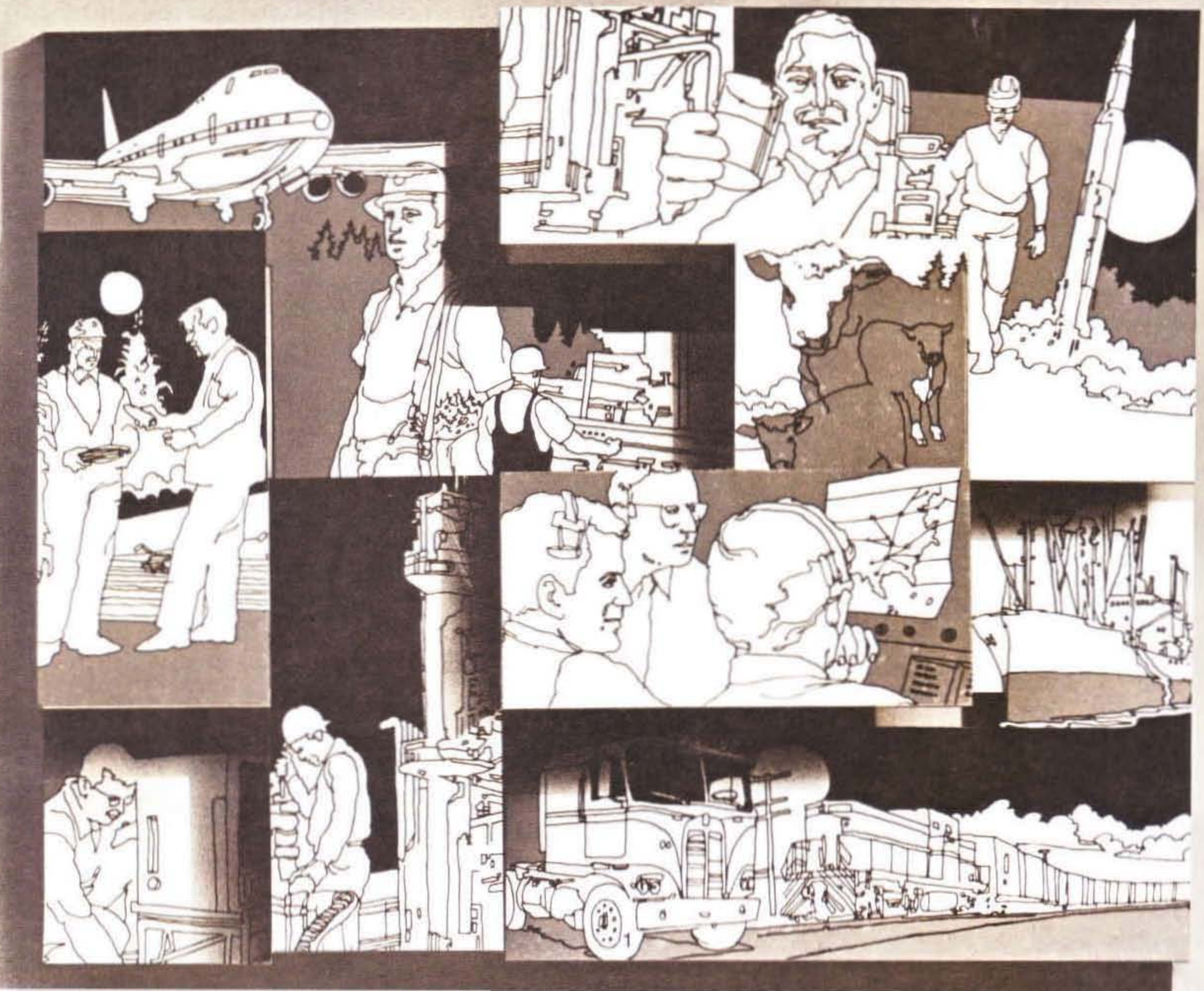
Fluke S.E. Technical Center
Jesse Morse, Service Manager
P.O. Box 6578
940 North Fern Creek Ave.
Orlando, FLA 32803
Tel: 305 - 896 - 2296
TWX: 810 - 850 - 0185

Fluke Mideastern
John Hines, Service Manager
11501 Huff Court
Kensington, MD 20795
Tel: 301 - 881 - 5300
TWX: 710 - 825 - 9645

Fluke Eastern
Bernard Ciongoli, Service Manager
101 Berkshire Ave.
Paterson, N.J. 07502
Tel: 201 - 742 - 3215

section I

digital multimeters and voltmeters



Fluke Features

Performance

Fluke digital voltmeters and multimeters offer the widest possible measurement power in the industry. Ac volts, dc volts, ac current, dc current and resistance measurement capability is standard in the multimeter line. True RMS 4-terminal ohms, AC/DC ratio, isolated data output and remote control are typical of the special functions you can select in a number of models. Basic dc accuracies range from 0.1% to 0.002% depending on model and are specified in terms of time and temperature so you can compare **Fluke** performance with other brands. Range of measurement is broad and in every case includes automatic overranging from 20% to 100% depending on model. **Fluke** DVM's measure microvolts to kilovolts, nanoamps to amps and milliohms to megohms with full overload protection on every function and range. Active filters are employed to ensure noise free performance and optimum accuracy. Guarding is another performance feature built into **Fluke** DVM's to assure the input is fully isolated from ground loops, noise and stray voltage. Exhaustive **Fluke** environmental testing and design evaluation results in MTBF's on the order of 10,000 hours.

Construction

Fluke DVM's are small, tough and reliable. Careful attention to workmanship has resulted in clean, functional layouts and the highest possible degree of servicability. They are field proven to be rugged and able to take a lot of abuse and still work well within specs. Although ideal for bench use, every DVM has a full complement of rack mount kits available for convenient installation in standard EIA racks.

Rechargeable battery packs, available for **Fluke** DVM's, are built in for true convenience and portability. Options are plug-in printed circuit boards and most are field installable, so you can add measurement capability after you buy your DVM.

Design Characteristics

A-to-D Conversion circuitry is designed to suit the particular DVM. **Fluke** uses either its patented Recirculating Remainder system or, in the case of the new 8600A and 8800A, a Dual Slope conversion system in the 4 1/2 and 5 1/2 digit DVM's. The popular Model 8000A employs the industry's most advanced LSI V-to-F converter. Large scale integration (LSI) employed in recent **Fluke** DMM's does more than give an instrument outstanding performance with a limited number of parts. It gives you a clean functional design. An example of advanced designs found in **Fluke** DVM's is the LSI chip used in the new Model 8600A, which contains all the digital controls for an autoranging dual slope DVM. It's a **Fluke** custom C-MOS integrated circuit with the basic timing and counting circuits, analog circuit, switching control, autorange system control, data output timing and control outputs, display system controls, and with the capability of up to 1 MHz clock speeds.

Making a Choice

In making your choice of a **Fluke** DVM, first look at what you want in a basic instrument and then look into the accessories and options designed for that model to give you exactly what you need. The following selection guide will help you quickly locate the **Fluke** DVM most suited to your general requirements. Additional details needed to assist you in making the final choice are contained in the following pages, dealing with each instrument.

DIGITAL VOLTMETER SELECTION GUIDE

MODEL	8000A	8100B	8110A	8120A	8125A[5]	8200A	8300A	8350A	8375A	8400A	8600A	8800A
Digits	3½	4½	4½	4½	4½	4½	5½	5½	5½	5½	4½	5½
Overrange	[8]	20%	20%	20%	20%	60%	20%	20%	20%	20%	[8]	[8]
Basic dc accuracy	0.1%	0.02%	0.01%	0.02%	0.01%	0.01%	0.005%	0.005%	0.002%	0.002%	0.02%	0.005%
dc volts sensitivity	100μV	100μV	100μV	10μV	100μV	1μV	1μV	1μV	1μV	1μV	10μV	1μV
Range — dc volts	200mV to 1200V	1V to 1000V	1V to 1000V	100mV to 1000V	1V to 1000V	10mV[1] to 1000V	100mV[3] to 1000V	100mV to 1000V	100mV to 1000V	100mV to 1000V	200mV to 1200V	200mV to 1200V
Range — ac volts	200mV to 1200V	1V to 1000V	1V to 1000V	100mV to 1000V	1V to 1000V	1V to 1000V	1V to[2] 1000V	1V to 1000V	1V to[4] 1000V	1V to[2] 1000V	200mV to 1200V	2V to 1200V
Range—ac and dc current	200μA to 10A[7]			100μA 1000mA							200μA 2000mA	
Range—Resistance	2Ω to 20MΩ[6]	1KΩ to 10MΩ	1KΩ to 10MΩ	1KΩ to 10MΩ	1KΩ to 10MΩ	100Ω[2] to 10MΩ	1KΩ to[2] 10MΩ	1KΩ to 10MΩ	10Ω to 10MΩ	10Ω to[2] 10MΩ	200Ω to 20MΩ	200Ω to 20MΩ
True RMS option						X			X[4]	X		
Autorange						X	X	X	X	X	X	X
Guarded			X	X	X	X	X	X	X	X		X
Remote control option						X	X		X	X		
DOU option	X	X	X	X	X	X	X		X	X	X	X
Battery pack option	X	X	X	X	X						X	

[1] 10mV & 100mV optional [2] optional [3] 100mV & 1000mV optional [4] true RMS standard [5] militarized
[6] 2Ω and 20Ω optional [7] 10A optional [8] full scale ranges include 100% overrange

Digital Multimeter 8000A

FEATURES

BASIC INSTRUMENT

- 2000 Counts
- 26 Ranges of AC/DC Voltage, Current and Resistance
- 0.1% Basic DC Accuracy
- Full Overload Protection
- Lightweight, Rugged Design
- Wide Range of Accessories

OPTIONS

- 10 Amp AC/DC Current Range
- 2Ω and 20Ω Low Ohms Range
- Rechargeable Battery
- Data Output

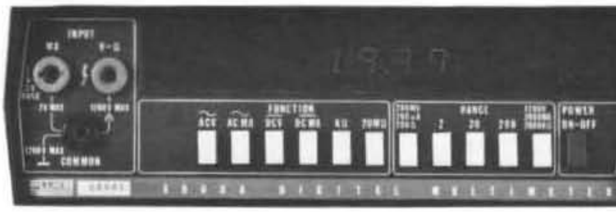
The FLUKE Model 8000A:
2000–COUNT DIGITAL MULTIMETER

The highly successful Fluke 8000A Digital Multimeter brought a new standard of excellence to the low cost field. Today, with expanded capability, the 8000 brings that standard to increased measurement capability through the addition of new options and accessories.

Choose from many options including rechargeable battery power, digital printer output plus the new low ohms and high current options. High voltage and RF probes and a clamp-on ac current probe highlight the list of 8000A accessories.

BASIC INSTRUMENT (8000A)

The Model 8000A gives you more functions for your money. There are 26 ranges, including five ranges each of ac and dc voltage, five ranges each of ac and dc current, and six ranges of resistance. Like the more expensive Fluke digital voltmeters, the Model 8000A offers reliable, error free push button control, and is completely self zeroing. The 8000A is available with a rechargeable battery option, Model 8000A–01, providing 8 hours of operation between charges, or a data output option, Model 8000A–02, for data logging applications.



MODEL 8000A

Specifications (BASIC INSTRUMENT)

DC VOLTAGE

Ranges	±199.9 mV, ±1.999 V, ±19.99 V, ±199.9 V, ±1199 V
Accuracy (1 year, 15°C to 35°C)	±(0.1% of reading + 1 digit)
Temperature Coefficient: (–10°C to 15°C and 35°C to 55°C)	±(0.01% reading/°C + .005% F.S/°C)
Input Impedance	10 MΩ, all ranges
Normal Mode Rejection	Greater than 60 dB @ 50 Hz, 60 Hz
Common Mode Rejection (1 kΩ unbalance)	Greater than 120 dB @ dc and 50 Hz, 60 Hz
Response Time	½ second
Maximum Input Voltage	1200 V rms, all ranges

AC VOLTAGE

Ranges	199.9 mV, 1.999 V, 19.99 V, 199.9 V, 1199V
Accuracy (1 year, 15°C to 35°C)	45 Hz to 10 kHz ±(0.5% of reading + 2 digits) 10 kHz to 20 kHz ±(1% of reading + 2 digits)
Temperature Coefficient: (–10°C to 15°C and 35°C to 55°C)	±(0.01% reading/°C +0.005% F.S./°C)
Input Impedance	10 MΩ in parallel with 100 pf
Common Mode Rejection (1 kΩ unbalance)	Greater than 60 dB @ 50 Hz, 60 Hz
Response Time	3 seconds, worst case
Maximum Input Voltage	1200 V rms, not to exceed 10^7 volt · Hz product on 20, 200, 1200 V ranges. 500 V rms on 200 mV and 2 V ranges.

DC CURRENT

Ranges	±199.9 µA, ±1.999 mA, ±19.99 mA, ±199.9 mA, ±1999 mA
Accuracy (1 year, 15°C to 35°C)	±(0.3% of reading + 1 digit)
Temperature Coefficient: (–10°C to 15° and 35° C to 55°C)	±(0.015% reading/°C +0.005% F.S./°C)
Voltage Burden	0.22V maximum up to 200 mA; 0.45V at 2 amps
Response Time	½ second
Maximum Input	2 amps rms (fuse protected)

AC CURRENT

Ranges	199.9 µA, 1.999 mA, 19.99 mA, 199.9 mA, 1999 mA
Accuracy (1 year, 15°C to 35°C)	45 Hz to 10 kHz ±(1% of reading + 2 digits) except 2000 mA range: 45 Hz to 3 kHz ± (1% of reading +2 digits)
Temperature Coefficient: (–10°C to 15°C and 35°C to 55°C)	±(0.015% reading/°C +0.005% F.S./°C)
Voltage Burden	0.22V maximum up to 200 mA; 0.45 V at 2 amps
Response Time	3 seconds, worst case
Maximum Input	2 amps rms (fuse protected)

RESISTANCE

Ranges	199.9Ω, 1.999 kΩ, 19.99 kΩ, 199.9 kΩ, 1999 kΩ, 19.99 MΩ
Accuracy (1 year, 15°C to 35°C)	±(0.2% of reading +1 digit) all ranges except: ±(0.5% of reading + 1 digit) on 20 MΩ range
Temperature Coefficient: (–10°C to 15°C and 35°C to 55°C)	KΩ ±(0.015% reading/°C +0.005% F.S./°C) 10 Meg ±(0.02% reading/°C +0.005% F.S./°C)
Response Time	½ second, all ranges except: 4 seconds on 20 MΩ range
Current through Unknown	200Ω range, 1 mA 2 kΩ range, 1 mA 20 kΩ range, 100 µA 200 kΩ range, 1 µA 2000 kΩ range, 1 µA 20 MΩ range, 0.1 µA
Maximum Input Voltage	200Ω and 2 kΩ ranges, 130 V rms 20 kΩ through 20 MΩ ranges, 250 V rms

GENERAL

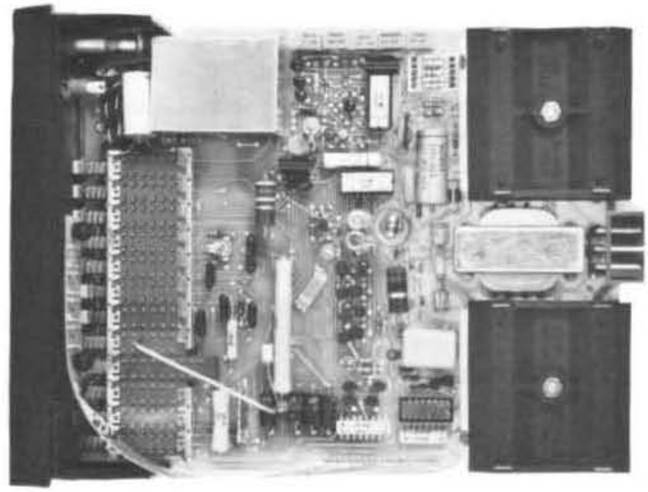
Max. Common Mode Voltage	1200 V peak
Operating Temp. Range	–10°C to +55°C
Storage Temp. Range	–40°C to +75°C (–40°C to +60°C with batteries)
Humidity Range	0 to 80% RH

Display	7 - segment LED 0.30" character height
Size	8½" wide x 2½" high x 10" deep (22 cm x 6 cm x 25 cm)
Weight	2¾ pounds (1.2 kilograms) without batteries 4 pounds (1.8 kilograms) with batteries
Power	100-115-230V ac, 50 to 400 Hz, 2 watts
Battery Option (–01)	8 hour minimum operation on internal rechargeable batteries

OPTIONS

Rechargeable Battery Pack (8000A–01)

The rechargeable battery pack is entirely self-contained within the 8000A package. It is supplied with standard "D" sized nickle-cadmium batteries which provide, under normal conditions, 1000 discharge-charge cycles of operation. The battery pack will provide a minimum of eight hours operation, with recharge requiring less than 14 hours. Recharging is automatic whenever unit is plugged in and does not affect normal bench operation.



Interior View of Model 8000A Equipped with Rechargeable Battery Pack Option

Digital Printer Output (8000A–02)

The data output option provides parallel, buffered BCD data of the digital readout, polarity and overload. It is suitable for driving a digital printer or providing input to systems. The non-isolated buffered output will sink up to 10 mA of current and has a 15 kΩ pull-up resistor. A "Busy" signal is "one" while the DOU output is being updated to the last measurement. This update requires from 0.5 to 16 ms depending on the reading. The data output is available from 110 to 200 ms between busy signals. A single update-readout cycle can be triggered externally. One update cycle with continuous availability occurs after external "date update" command.

High Current Option (8000A-05)

DESCRIPTION

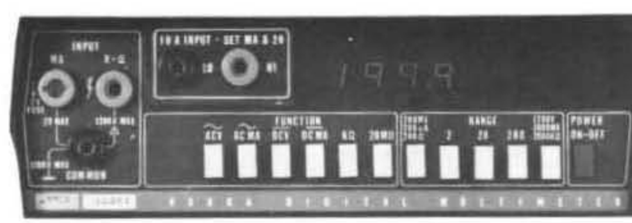
The Fluke 8000A–05 Digital Multimeter offers you extended current measurement capabilities to 20 amps with the –05, line, and –015, battery, options.

Separate high current inputs are provided enabling the new option equipped units to measure up to 10 amps continuously and from 10 to 20 amps for periods of one minute or less.

The standard capabilities of the 8000A DMM have been maintained and include five ranges of AC and DC voltage, five ranges AC and DC current on the 2 amp inputs and six ranges of resistance.

SPECIFICATIONS

All of the specifications for the basic 8000A apply to the 8000A–05, –015 plus the following current specifications:



MODEL 8000A-05

DC CURRENT

Range	10.00A (1 min. operation 10A to 20A)
Accuracy	10A Range ±(0.5% of reading +1 digit)

AC CURRENT

Range	10.00A (1 min. operation 10A to 20A)
Accuracy	10A Range 45 Hz to 3 kHz ±(1% of reading +2 digits)

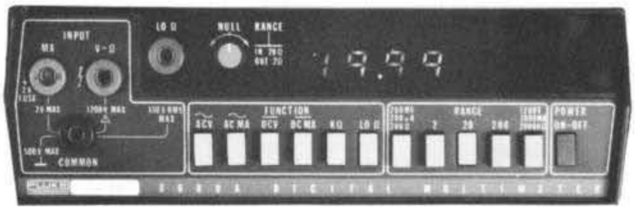
Low Ohms Option (8000A-06)

The Model 8000A–06 features 2 ohm and 20 ohm resistance ranges. The instrument includes a front panel lead resistance cancellation control assuring the user that his measurement of the unknown R does not include the resistance in his test leads. This is important since the model 8000A–06 is capable of resolving 0.001 ohms.

(continued)

LOW OHMS OPTION (8000A-06) *continued*

The low ohms capability of the model 8000A–06 is an invaluable tool when measuring continuity, contact resistance, and shorted circuits. It is ideal for measuring and testing transformers, coils, armatures, fields, heating elements, cables, PCB opens and shorts, small appliances, telephone equipment and office machines.



MODEL 8000A-06

SPECIFICATIONS

All of the specifications for the basic 8000A apply to the 8000A–06 plus the following:

LOW OHMS

Range	1.999Ω, 19.99Ω
Accuracy (1 year, 15°C to 35°C)	1.999Ω range ±(1% of reading +2 digits) 19.99Ω range ±(0.5% of reading +2 digits)

NOTE:
1) 8000A–06 option does not include the 19.99 MΩ resistance range.
2) 8000A–06 is available with line operation only.
3) 8000A–06 and –05 options may not both be installed in the same unit.
4) 8000A–06 not field installable

Accessories

Deluxe Test Lead Kit (A80)

Universal test leads having two color coded leads with insulated, threaded adapters on each end suitable for attachment of the following adapters:

1. Banana Plugs
2. Pin Tips
3. Test Prod Tips
4. Alligator Clips
5. Binding Post Lugs

High Voltage Probe (80K–40)

Voltage Range	1kV–40kV
Input Resistance	1000MΩ
Ratio	1000:1
Overall Accuracy	20–30kV ±2% (Calibrated 1% at 25kV)
Upper Limit	Changes Linearly from 2% at 30kV to 4% at 40 kV
Lower Limit	Changes Linearly from 2% at 20kV to 4% at 1kV (Calibrated for 10MΩ DVM input resistance)

NOTE: Calibrated for 10MΩ DVM input resistance.

RF Probe (80RF–1)

Input Voltage Range: 0.25 to 30V
Response: 100 kHz to 500 MHz, 1 dB accuracy

RF Probe (81RF)

Input Range 0.25V to 30V rms Response: 100 kHz to 100 MHz, 1 dB accuracy

Clamp on AC Current Probe (80I-600)

Ranges, 2 to 600 amps, accuracy +3% 60 to 440 Hz (2" opening)

Carrying Case (C80)

Fitted soft vinyl case, with carrying strap and storage compartment for test leads, power cord and other compact accessories.

Carrying Case (C86)

Rugged moulded case, with handle and storage compartment for test leads, power cord and other compact accessories.

Front Panel Dust Cover (Moo-100-714)

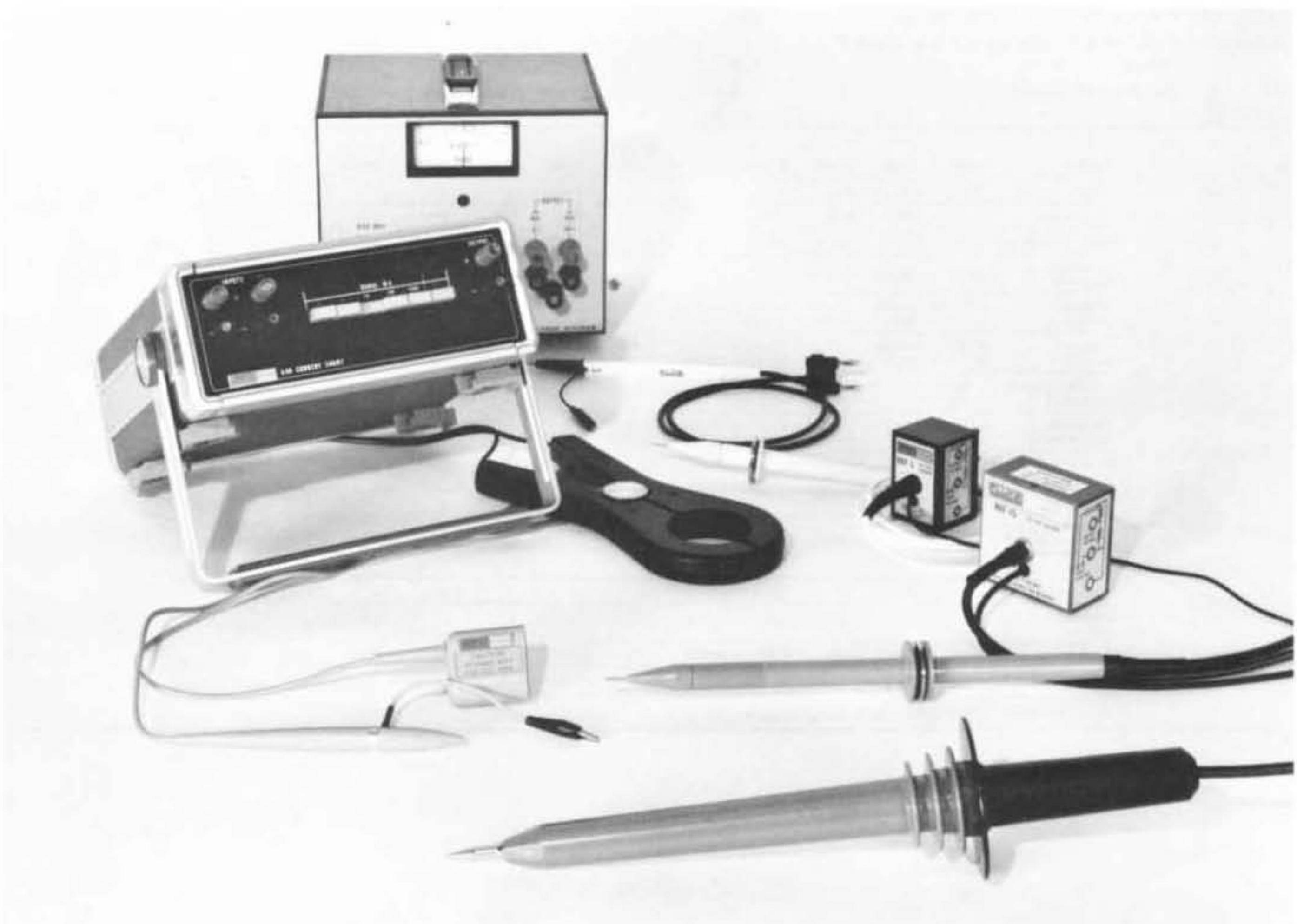
Snap-on dust cover provides protection for front panel and controls.

Rack Mount Kits (M00-200-611/612/613)

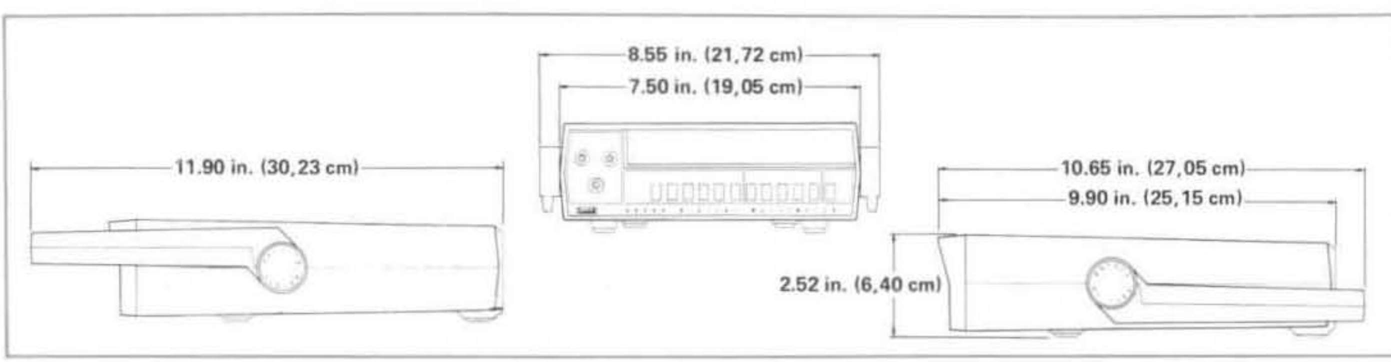
Three rack mount kits provide full width (19 inch E.I.A. standard) panel mounts 3½ inches high. The –611 provides right or left offset mounting of the 8000A, the –612 is a center mount unit and the –613 mounts two units side by side.

DATA LOGGING

Need to log data? The Fluke model 2010A Printer is available with a custom interface cable to the model 8000A when equipped with the data output option. Providing a ready made inexpensive, reliable, data logging system, the printer records up to 10 columns (18 columns with the –01 option) of data per line at the rate of 2.65 lines per second.



MODEL 8000A ACCESSORIES



MODEL 8000A OUTLINE DRAWING

DIGITAL MULTIMETERS

8000A	Digital Multimeter	$ 299
8000A–01	DMM with Rechargeable Battery Pack Option	349
8000A–02	DMM with Data Output Option	374
8000A–025	DMM with Printer Output and 10 AMP Range	399
8000A–015	DMM with 10A Range and Rechargeable Battery Pack	374
8000A–05,	DMM with 10A Range	324
8000A–06	DMM with 2 and 20 Ohm Ranges	350
8000A–026	DMM with Printer Output and 10 AMP Range	424
A80	Deluxe Test Lead Kit	5

80K–40	$ 40
80RF–1, RF Probe	75
81RF, RF Probe	40
80I-600, Clamp-on AC Current Probe	65
C80, Carrying Case, soft vinyl	15
C86, Carrying Case, rugged	15
M00-100-714, Front Panel Dust Cover	8
M00-200-611, Right or Left Offset Rack Mounting Kit	30
M00-200-612, Center Mount Rack Mounting Kit	30
M00-200-613, Dual Unit Mounting Kit	30
2010A Printer 10 column	795
2010A–7001 Cable to 8000A–02	75

MODEL	8000A	8100B	8110A	8120A	8125A[5]	8200A	8300A	8350A	8375A	8400A	8600A	8800A
Digits	3½	4½	4½	4½	4½	4½	5½	5½	5½	5½	4½	5½
Overrange	[8]	20%	20%	20%	20%	60%	20%	20%	20%	20%	[8]	[8]
Basic dc accuracy	0.1%	0.02%	0.01%	0.02%	0.01%	0.01%	0.005%	0.005%	0.002%	0.002%	0.02%	0.005%
dc volts sensitivity	100μV	100μV	100μV	10μV	100μV	1μV	1μV	1μV	1μV	1μV	10μV	1μV
Ranges – dc volts	5-200mV to 1200V	4-1V to 1000V	4-1V to 1000V	5-100mV to 1000V	4-1V to 1000V	6-10mV[1] to 1000V	5-100mV[3] to 1000V	5-100mV to 1000V	5-100mV to 1000V	5-100mV to 1000V	5-200mV to 1200V	5-200mV to 1200V
Ranges – ac volts	5-200mV to 1200V	4-1V to 1000V	4-1V to 1000V	5-100mV to 1000V	4-1V to 1000V	4-1V to 1000V	4-1V to[2] 1000V	4-1V to 1000V	4-1V to[4] 1000V	4-1V to[2] 1000V	5-200mV to 1200V	4-2V to 1200V
Ranges – ac and dc current	6-200μA to 10A[7]			5-100μA 1000mA							5-200μA 2000mA	
Ranges – resistance	8-2Ω to 20MΩ[6]	5-1KΩ to 10MΩ	5-1KΩ to 10MΩ	5-1KΩ to 10MΩ	5-1KΩ to 10MΩ	6-100Ω[2] to 10MΩ	5-1KΩ to[2] 10MΩ	5-1KΩ to 10MΩ	7-10Ω to 10MΩ	7-10Ω to[2] 10MΩ	6-200Ω to 20MΩ	6-200Ω to 20MΩ
True rms option						√			√[4]	√		
Autorange						√	√	√	√	√	√	√
Guarded			√	√	√	√	√	√	√	√		√
Remote control option						√	√		√	√		
DOU option	√	√	√	√	√	√	√		√	√	√	√
Battery pack option	√	√	√	√	√						√	
Basic price	$299	$645	$895	$745	$1995	$995	$1295	$1595	$2195	$2495	$599	$1099

[1] 10mV & 100mV optional [2] optional [3] 100mV & 1000mV optional [4] true rms standard [5] militarized
[6] 2Ω and 20Ω optional [7] 10A optional [8] full scale ranges include 100% overrange

8100B

FLUKE

DIGITAL MULTIMETER

FEATURES:

- *"RECIRCULATING REMAINDER" * A/D CONVERSION*
- *10,000 HOUR MTBF*
- *INTERNAL BATTERY OPERATION OPTIONAL*
- *COMPLETE MULTIMETER*
- *FOUR DIGITS PLUS OVERRANGE*
- *ISOLATED PRINTER OUTPUT OPTIONAL*

APPLICATIONS:

- *MEASURE AC AND DC TO 1200 VOLTS*
- *MEASURE RESISTANCE TO 12 MEGOHMS*
- *COMPLETE PORTABILITY WITH BATTERY OPTION*
- *FULLY ISOLATED MEASUREMENTS*

* Patent Pending

DESCRIPTION

Model 8100B is a compact, lightweight digital multimeter with a 10,000 hour MTBF, displaying four full decades plus a "1" for 20% overrange. It may be operated from line power or optional self-contained rechargeable batteries. AC volts, DC volts and kilohms are standard functions, selection being made via push-button switches. A switched 2-pole active filter and instantaneous, automatic polarity selection and display are additional standard features.

Analog inputs to the 8100B are processed through a buffer amplifier, the output of which is periodically sampled by a unique, Fluke designed, "Recirculating Remainder" analog-to-digital converter. The converter uses only one BCD counter and resistive ladder network to serially determine and display all digits. A unique capacitor register is used to hold the digits of the sample for continuous display between samples. Necessary converter switching is accomplished with field-effect transistors.

The analog circuitry also makes multiple use of scaling resistors and passive components. The combined analog and digital circuitry has low power consumption and a low total parts count, which leads to high reliability and optional battery operation.

High quality wire-wound resistors, polystyrene capacitors and an extremely stable reference amplifier are used in conjunction with the buffer amplifier and a high accuracy comparator to ensure precise, stable, digitizing of the analog input.

Custom packaging of the 8100B combines an attractive appearance with rugged construction. A single fiberglass circuit board is solidly secured to its strong aluminum chassis. Guard shields surround all critical analog and digital circuitry. Tough, scuff resistant plastic covers provide exterior protection. An accessory cover is available to protect the front panel during transit. A locking tilt-up bail is also used as a carrying handle. The line cord is detachable. A concealed slide switch at the rear of the instrument is used for selection of 115V or 230V AC line power.

The optional, rechargeable battery pack may be installed in the field or factory. A meter along side the digit readout is provided to indicate the state of battery charge. The battery is automatically charged when the 8100B is operated from line power. Disconnecting the line cord enables battery operation.

Fully isolated printer output for data logging purposes is a factory installed option. The standard Model 8100B cannot accept the battery option when the printer option is in place, however this combination of options is available as a special version. For full details contact the factory.

SPECIFICATIONS

DC VOLTS

Ranges	±1V, ±10V, ±100V and ±1000V 20% overrange on all ranges.
Resolution	0.01% of range. (100 uv on 1V range maximum)
Accuracy	
30 days, 20°C to 30°C	±(0.02% of input + 0.01% of range)
90 days, 15°C to 35°C	±(0.05% of input + 0.01% of range)
DC Input Resistance	Constant 10 megohms on all ranges.
Filter	Switch selected 2-pole, linear phase active filter.
Response Time to Rated Accuracy (max.) . .	0.5 seconds with filter out. 1.5 seconds with filter in.

SPECIFICATIONS *(Continued)*

Rejection . . . .

		INTERFERENCE FREQUENCY			
		60 Hz		50 Hz	
	DC	FILTER IN	FILTER OUT	FILTER IN	FILTER OUT
COMMON MODE (1K in Low Lead)	120 db	120 db	100 db	120 db	100 db
NORMAL MODE	-----	60 db	20 db	47 db	9 db

NOTE: Common Mode Rejection specifications are not degraded when the isolated printer output option is used and Common Mode Rejection approaches infinity when the instrument is battery operated.

Polarity . . . . Automatic, instantaneous selection and display.

Overload . . . . ±1200 VDC or ±1700V peak AC can be applied continuously to any range without damage.

AC VOLTS

Ranges . . . . 1V, 10V, 100V and 1000V. 20% overrange on all ranges.

Resolution . . . . 0.01% of range. (100 uv on 1V range maximum)

Accuracy	MIDBAND 50 Hz - 10 kHz	EXTENDED 30 - 50 Hz and 10 - 20 kHz
90 days, 15°C to 35°C	±(0.2% of input + 0.05% of range)	±(0.5% of input + 0.1% of range)

Input Impedance . . . . 1 megohm shunted by < 30 pf.

Response Time to Rated Accuracy . . . 3 seconds.

Maximum DC Normal Mode Voltage . . . . ±1200 VDC NOTE: The sum of DC Normal Mode Voltage and peak AC voltage must not exceed ±1700V.

Overload . . . . ±1200 VDC or ±1700V peak AC from 30 Hz to 20 kHz can be applied continuously to any range without damage.

RESISTANCE

Ranges . . . . 1K, 10K, 100K, 1000K and 10M. (20% overrange on all ranges)

Resolution . . . . 0.01% of range (0.1 ohm on 1K range maximum)

Accuracy	1K - 1000K	10M
30 days, 20°C to 30°C	±(0.05% of input + 0.01% of range)	±(0.1% of input + 0.01% of range)
90 days, 15°C to 35°C	±(0.1% of input + 0.02% of range) on all ranges	

Configuration . . . . Two terminal, constant current, +9V across open terminals.

Current in R measured . . . . 0.7 ma. on the 1K range, decreasing by an order of magnitude per range to 0.7 ua on the 1000KΩ range (0.1 ua on the 10MΩ range)

Response Time to Rated Accuracy . . .	1K - 1000K	10M
Filter Out	0.5 seconds	3.0 seconds
Filter In	2.0 seconds	10.0 seconds

Overload

1K Range . . . . 130V RMS may be applied continuously without damage.

10K - 10M . . . . 230V RMS may be applied continuously without damage.

ISOLATED PRINTER OUTPUT (Option 8100B-02, factory installed)

Data Available . . . . Digits, Range, Functions, Polarity, Filter

Coding . . . . 8421 BCD Digits, individual lines for remaining data.

Logic Levels and Definition . . . . . . Logic "1" +3.5V, Logic "0" = 0V from TTL 7400 Series.

Triggering . . . . Two channels provide Logic "1" and Logic "0" triggering.

Trigger to Reading Delay . . . . 400 ms. maximum.

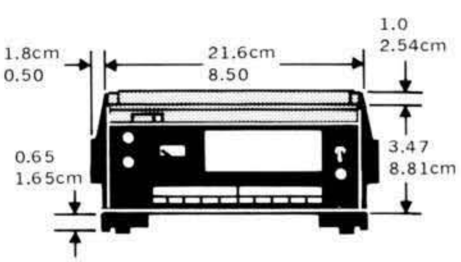
Print Commands . . . . Logic "1" to Logic "0" and complement both provided.

SPECIFICATIONS *(Continued)*

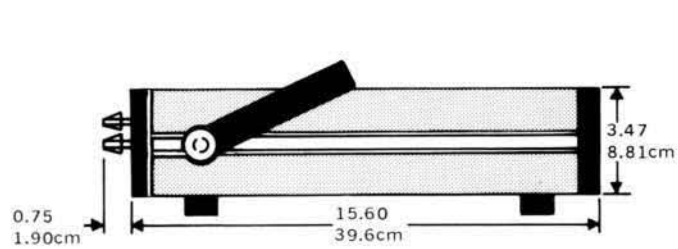
GENERAL

MTBF	10,000 hours
Selection	Manual via mechanically interlocked pushbuttons.
Display	Four decade neon in-line readout with polarity neon for DC volts and fifth digit for 20% overrange. Automatic decimal location.
Sample Rate	3 samples per second.
Maximum Inputs	
"HI" to "LO"	See "Overload" specification by function.
"LO"	1200V DC or 230V RMS at 60 Hz.
Power	8 watts from 115V/230V, ±10%, 50-500 Hz line with internal battery option – 01. 8 hours continuous operation from the rechargeable nickel-cadmium batteries.
Weight	8 pounds without batteries. (3.6 Kg). 10 pounds with batteries. (4.5 Kg).
Storage Temperature	–40°C to +75°C. (–40°C to +60°C with batteries).
Operating Temperature	0°C to +50°C.
Temperature Coefficient (outside limits shown in 30 and 90 day specifications)	DC ±(0.0025% of input +0.001% of range)/°C. AC ±(0.015% of input +0.005% of range)/°C. KΩ ±(0.0035% of input +0.0015% of range)/°C. 10MΩ ±(0.01% of input +0.002% of range)/°C.
Humidity Range	80% R.H. max. at temp.≤ 35°C; 70% R.H. max from 35°C to 50°C.
Shock and Vibration	Meets requirements of MIL-T-21200H and MIL-E-16400F.
Mounting	Tilt down carrying handle detents into custom non-marring feet and serves as a tilt-up bail for bench use.

Price:	Model 8100B	$645 (without battery)
	Model 8100B-01	$745 (factory installed battery option)
	Model 8100B-02	$870 (factory installed printer option – not compatable with battery option)
	8100B-01 Kit	$100 (for field installation of battery option)
Accessories:	80-RF	$75.00 (R.F. Probe, 500 MHz)
	80F-5	$295 (High Voltage Probe, 5 kv)
	80F-15	$350 (High Voltage Probe, 15 kv)
	A-90	$255 (6 Range AC/DC Current Shunt to 10A)
	MO3-203-700	$10.00 (Front Panel Dust Cover)
	M03-200-607	$40.00 (Rack Mtg. Ears -- Single Unit, Right or Left Offset)
	M03-200-606	$25.00 (Rack Mtg. Kit -- Two Units, Side-by Side)
	C-82	$100.00 (Carrying Case)



FRONT



SIDE

FLUKE®

DIGITAL MULTIMETER

FEATURES:

- 25 RANGE, 4 DIGIT MULTIMETER
- 20% OVERRANGE ON ALL RANGES
- OVERLOAD RESISTANT
- "RECIRCULATING REMAINDER" * A/D CONVERSION
- 10,000 HOUR MTBF
- INTERNAL BATTERY OPERATION OPTIONAL
- ISOLATED PRINTER OUTPUT OPTIONAL

APPLICATIONS:

- MEASURE AC AND DC VOLTS FROM 10 UV TO 1200 VOLTS
- MEASURE AC AND DC CURRENT FROM 10 NA TO 1.2 AMPERES
- MEASURE RESISTANCE FROM 0.1 OHMS TO 12 MEGOHMS
- COMPLETE PORTABILITY WITH BATTERY OPTION
- FULLY ISOLATED MEASUREMENTS

*** Patent Pending**

DESCRIPTION

Model 8120A is a complete 25 range digital multimeter that can be used to measure ac and dc voltages, ac and dc currents, plus resistance. Each function has five ranges that all provide 0.01% of range resolution and 20% overranging. Maximum voltage sensitivity is 10uV on the 100 MV ac or dc ranges while maximum current sensitivity is 10nA. The 8120A's in-line, non-blinking readout displays polarity information, an overrange "1" and four full decades of digits.

Custom packaging of the 8120A combines an attractive appearance with rugged but light weight construction. Tough, scuff resistant covers provide exterior protection and a locking tilt-up bail can be rotated for use as a convenient carrying handle.

Severe overloads can be continuously applied to all of the 8120A's voltage and resistance ranges with no damage whatsoever while current ranges are protected with fusing. Large, clearly legible, two color lettering is used to identify each of the interlocked pushbutton selector switches and the decimal point is automatically positioned in the readout. These features reduce the likelihood of an overload being applied through operator error.

Long-lived reliability is centered around the 8120A's use of Fluke developed recirculating-remainder analog-to-digital conversion. This technique utilizes a simple resistive feedback network to serially determine and display all digits. Thus the converters circuits contribute significantly to the reliability enhancing low parts count and low power consumption of the 8120A.

Operating power from sources available virtually everywhere in the world, including shipboard and aircraft power, will energize the 8120A. A slide switch is provided for efficient 115/230VAC changeover while the internal regulating circuits of the 8120A operate equally well at power line frequencies of 50-500 Hz.

Battery operation for eight full hours of multimeter use at sites remote from line power is optionally available. The internally mounted, rechargeable battery option can be ordered installed in the 8120A or easily added by the user in the field. Battery charge is restored by operating the 8120A from line power and disconnecting the line cord provides instantaneous changeover to battery power.

Assured accuracy is maintained in the presence of normal mode noise because a low-pass filter at the input of the 8120A provides positive, broadband rejection. A guard shield prevents common mode errors when the 8120A is line operated and optional battery operation ensures complete freedom from error causing "ground loops" even when the measurement is referenced to a potential elevated more than a thousand volts above power line ground.

Highly Isolated Printer Output is a factory installed option that provides complete measurement information for printers that can accept DTL or TTL logic level inputs. Outstanding isolation between measurement and digital output circuits is obtained because only two guarded toroids are used to serially transfer data from the 8200A's recirculating-remainder analog-to-digital converter into the printer output unit. Data provided is complete and includes polarity, function and range as well as all digits.

SPECIFICATIONS

DC VOLTS

Ranges	±100 MV, ±1V, ±10V, ±100V and ±1000V (20% overrange, all ranges)	
Resolution	0.01% of range. (10 uv on 100 MV range maximum)	
Accuracy	±1V to ±1000V Range	±100 MV Range
90 days, 15°C to 35°C	±(0.02% of input +0.01% of range)	±(0.05% of input +0.02% of range)

DC Input Resistance	Constant 10 megohms on all ranges		
Response Time to Rated Accuracy	1.5 seconds		
Noise Rejection	DC	60 Hz	50 Hz
Normal Mode	–	60 db	47 db
Common Mode (1k in low lead)	120 db	120 db	120 db

NOTE: Common mode rejection specifications are not degraded when the isolated printer output option is used and Common Mode Rejection approaches infinity when the instrument is battery operated.

SPECIFICATIONS

Polarity	Automatic, instantaneous selection and display
Overload (without damage)	±1200 VDC or ±1700V peak AC applied continuously to any range

AC VOLTS

Ranges	100 MV, 1V, 10V, 100V and 1000V. (20% overrange, all ranges)	
Resolution	0.01% of range. (10 uv on 100 MV range maximum)	
Accuracy (all ranges)	50 Hz - 10 kHz	30 - 50 Hz and 10 - 20 kHz
90 days, 15°C to 35°C	±(0.2% of input +0.05% of range)	±(0.5% of input +0.1% of range)
Input Impedance	1 megohm shunted by <50 pf. (100k Ω shunted by <100 pf on 100 MV range)	
Response Time to Rated Accuracy	3 seconds	
DC Normal Mode Voltage	±1200V maximum (±250V on 100 MV range)	
Overload	1V to 1000V Range	100 MV Range
(dc to 20 kHz, without damage)	1200V applied continuously	250V applied continuously

RESISTANCE

Ranges	1k, 10k, 100k, 1000k and 10M. (20% overrange, all ranges)	
Resolution	0.01% of range (0.1 ohm on 1k range maximum)	
Accuracy	1K-1000K Range	10M Range
90 days, 15°C to 35°C	±(0.05% of input +0.01% of range)	±(0.1% of input +0.01% of range)
Configuration	Two terminal, constant current,	
Current in R measured	0.7 ma. on the 1k range, decreasing by an order of magnitude per range to 0.7 ua on the 1000kΩ range (0.1 ua on the 10MΩ range).	
Response Time to Rated Accuracy	2.0 seconds, (10 secs. on the 10MΩ range)	
Overload	10KΩ to 10MΩ Range	1kΩ Range
(without damage)	230V rms applied continuously	130V rms applied continuously

DC CURRENT

Ranges	±100 ua, ±1 MA, ±10 MA, ±100 MA, ±1000 MA (20% overrange, all ranges)
Resolution	0.01% of range (10 na. on 100 ua range, maximum)
Accuracy (all ranges)	
90 days, 15°C to 35°C	±(0.1% of input +0.02% of range)
Burden	100 MV @ 100 ua increasing to 300 MV @ 1200 MA
Response Time to Rated Accuracy	1.5 seconds
Overload	Protected to 2 amp on any range

AC CURRENT

Ranges	100 ua, 1 MA, 10 MA, 100 MA, 1000 MA (20% overrange, all ranges)	
Resolution	0.01% of range (10 na.on 100 ua range, maximum)	
Accuracy (all ranges)	50 Hz - 5 kHz	30 - 50 Hz and 5 - 10 kHz
90 days, 15°C - 35°C	±(0.3% of input +0.05% of range)	±(0.6% of input +0.05% of range
Burden	100 MV @ 100 ua increasing to 300 MV @ 1200 MA	
Response Time to Rated Accuracy	3 seconds	
Overload	Protected to 2 amp on any range	

8120A SPECIFICATIONS

ISOLATED PRINTER OUTPUT (Option 8120A-02, factory installed)

Data Available	Digits, Range, Functions, Polarity
Coding	8421 BCD Digits, individual lines for remaining data
Logic Levels and Definition	Logic "1" = +3.5V, Logic "0" =OV from TTL 7400 Series
Triggering	Two channels provide Logic "1" and Logic "0" triggering
Trigger to Reading Delay	400 ms. maximum
Print Commands	Logic "1" to Logic "0" and complement both provided

GENERAL

MTBF	10,000 hours
Filter	2-pole linear phase filter for dc volts, current and resistance always "in"
Selection	Manual via mechanically interlocked pushbuttons
Display	Four decade neon in-line readout with polarity neon for dc volts and fifth digit for 20% overrange. Automatic decimal location.
Sample Rate	3 samples per second
Maximum Inputs	
"HI" to "LO"	See "Overload" specification by function
"LO" to "GUARD"	100V dc or peak ac
"GUARD" to "CHASSIS"	1200V dc or 230V rms at 60 Hz
Operating Power	8 watts from 115V/230V, ±10%, 50-500 Hz line with internal battery option –01 installed. 8 hours continuous operation from the rechargeable nickel-cadmium batteries.
Weight	8 pounds without batteries. (3, 6 Kg) 10 pounds with batteries. (4, 5 Kg)
Size	3 1/2" H x 8 1/2 W X 15" D (88mm x 216mm x 381mm)
Storage Temperature	–40°C to +75°C (–40°C to +60°C with batteries).
Operating Temperature	0°C to +50°C
Temperature Coefficients (Apply outside of temperature limits of "Accuracy" specifications)	
DC volts except 100 MV	±(0.0025% of input +0.0005% of range)/°C
DC Current and 100 MV	±(.0035% of input +0.005% of range)/°C
AC, Volts and Current	±(0.015% of input +0.005% of range)/°C
KΩ ranges	±(0.0035% of input +0.001% of range)/°C
10 MΩ Range	±(0.01% of input +0.002% of range)/°C
Humidity Range	80% R.H. max. at temp. ≤15°C, 70% R.H. max. from 35°C to 50°C
Shock and Vibration	Meets requirements of MIL-T-21200H and MIL-E-16400F
Mounting	Tilt down carrying handle detents into custom non-marring feet and serves as a tilt-up bail for bench use.

Price:	Model 8120A	$745 (without battery)
	Model 8120A–01	$845 (factory installed battery option)
	Model 8120A–02	$870(factory installed printer option - not compatible with battery option
	8120A–01 Kit	$100 (for field installation of battery option)
Accessories:	80-RF	$75.00 (R. F. Probe, 500 MHz)
	80F-5	$295 (High Voltage Probe, 5 kv)
	80F-15	$350 (High Voltage Probe, 15 kv)
	M03-200-607	$40.00 (Rack Mounting Kit - - Single Unit, Right or Left Offset)
	M03-200-606	$25.00 (Rack Mounting Kit - - Two Units, Side-by-Side)
	M03-203-700	$10.00(Front Panel Cover)
	C-82	$100.00 (Carrying Case)

FLUKE

Militarized DMM 8125A

FEATURES:

- **MIL-T-21200L, Class 2 (Flight Line)**
  Specifications:
  - *DESIGN AND CONSTRUCTION*
  - *COMBINATION CASE*
  - *TEMPERATURE, OPERATING & NON-OPERATING*
  - *ALTITUDE, OPERATING & NON-OPERATING*
  - *HUMIDITY, OPERATING*
  - *ELECTROMAGNETIC INTERFERENCE*
  - *SHOCK*
  - *VIBRATION*
  - *SAND AND DUST*
  - *SALT ATMOSPHERE*
- **Complete Ruggedized Multimeter**
- **Four Full Digits Plus Overrange**
- **Optional Self-Contained Battery Power**
- **Protected Against Damage From Overload**

DESCRIPTION

Fluke Model 8125A is a compact, rugged, truly portable militarized digital multimeter with extreme reliability and recalibration intervals as long as one year. It meets the stringent Class 2 environmental requirements (except "explosive conditions") of MIL-T-21200L when operated from 50 - 500 Hz, 115V/230V line power. If line power is not available, optional, self-contained, rechargeable batteries provide for eight hours of continuous operation while maintaining the 8125A's ability to perform in the same Class 2 environments over a 0°C to +55°C temperature range.

A MIL combination case completely encloses the instrument. Its detachable cover protects the front panel while serving as a storage space for accessories, test leads and the line cord. A recessed carrying handle is attached to the cover's exterior.

The multimeters standard functions include four ranges of AC volts, four ranges of DC volts with automatic polarity selection and display, five ranges of resistance and switched filtering for dependable broadband normal mode noise rejection. A guard provides for high common mode rejection when the 8125A is line power operated while battery operation allows complete immunity from common mode errors due to "floating" voltages or "ground-loop" currents.

An in-line readout displays polarity, a "1" for 20% overrange and four full decades of digits with automatic decimal positioning. Sealed pushbutton switches select ranges and functions while a sealed toggle switch applies line power. Internal heaters automatically energize at ambient temperatures below 0°C when the instrument is line-powered. The "LOW TEMP" lamp indicates that the heaters are "ON".

All analog inputs are scaled for processing through the same operational amplifier prior to digitization in the unique, Fluke designed, "Recirculating Remainder" analog-to-digital converter. The converter uses only one decade of BCD counter and resistive ladder network to sample the input and serially determine and display all digits. A unique capacitor register is used to hold the digits between samples. A low parts count and low instrument power consumption result from the efficient use of analog circuitry combined with the digitizing technique.

Line power is applied through the front panel of the instrument. All fuses and indicator lamps are front panel mounted. A concealed slide switch at the rear of the instrument's chassis is used for selection of 115v or 230v AC line power. The optional battery pack may be installed in the field or factory. A meter along side of the digit readout indicates the state of battery charge. The battery is automatically charged when the 8125A is operated from line power. Disconnecting the line cord enables battery operation when the ambient temperature is greater than 0°C. Thermostat interlocks provide for line operation only with energized heaters from 0°C to –40°C.

SPECIFICATIONS

DC VOLTS

Ranges	±1V, ±10V, ±100V and ±1000V, 20% overrange all ranges
Resolution	0.01% of range (100 uv on 1V range maximum)
Accuracy:	
90 days, 20°C to 30°C	±(0.01% of input + 0.01% of range)
6 months, 15°C to 35°C	±(0.01% of input + 0.02% of range)
1 year, 15°C to 35°C	±(0.02% of input +0.02% of range)
Temperature Coefficient	±(0.0015% of input + 0.001% of range)/°C
DC Input Resistance	Constant 10 megohms on all ranges.
Filter	Switch selected 2-pole, linear phase active filter.
Settling Time to Rated Accuracy	0.25 seconds with filter out. 1.2 seconds with filter in.

Rejection . . . .

	DC	INTERFERENCE FREQUENCY 60 Hz FILTER IN	60 Hz FILTER OUT	50 Hz FILTER IN	50 Hz FILTER OUT
COMMON MODE (1 KΩ in Low Lead)	120 db	120 db	100 db	120 db	100 db
NORMAL MODE	------	60 db	20 db	47 db	9 db

NOTE: Common Mode Rejection approaches infinity when instrument is battery operated with line cord disconnected.

Polarity . . . . Automatic, instantaneous selection and display.

Overload . . . . ±1200 VDC or ±1700V peak AC can be applied continuously to any range without damage.

AC VOLTS

Ranges . . . . 1V, 10V, 100V and 1000V. 20% overrange on all ranges.

Resolution . . . . 0.01% of range. (100 uv on 1V range maximum)

Accuracy:	50Hz - 10 kHz	30 - 50 Hz and 10 - 20 kHz
90 days, 15°C to 35°C	±(0.2% of input + 0.05% of range)	±(0.5% of input +0.1% of range)
6 months, 15°C to 35°C	±(0.2% of input + 0.08% of range)	±(0.5% of input +0.1% of range)
1 year, 15°C to 35°C	±(0.2% of input + 0.1% of range)	±(0.5% of input + 0.15% of range)

Input Impedance . . . . 1 megohm shunted by < 150 p.f.

Settling Time to Rated Accuracy . . . . . 2.8 seconds

Maximum DC Normal Mode Voltage . . . . . ±1200VDC NOTE: The sum of DC Normal Mode Voltage and peak AC voltage must not exceed ±1700V.

Overload . . . . ±1200 VDC or ±1700V peak AC from 30 Hz to 20 kHz can be applied continuously to any range without damage.

RESISTANCE

Ranges . . . . 1K, 10K, 100K, 1000K and 10M. 20% overrange on all ranges

Resolution . . . . 0.01% of range (0.1 ohm on 1K range maximum)

Accuracy	1K - 1000K	10 M
90 days, 20°C to 30°C	±(0.02% of input + 0.01% of range)	±(0.05% of input +0.01% of range)
6 months, 15°C to 35°C	±(0.02% of input +0.02% of range)	±(0.07% of input +0.02% of range)
1 year, 15°C to 35°C	±(0.02% of input +0.03% of range)	±(0.07% of input +0.03% of range)

Configuration . . . . Two terminal, constant current

Current in R measured . . . . 0.7 ma on the 1K range, decreasing by an order of magnitude per range to 0.7 ua on the 1000KΩ range (0.1 ua on the 10MΩ range)

Settling Time to Rated Accuracy	1K - 1000K	10 M
Filter Out	0.25 seconds	2.8 seconds
Filter In	1.8 seconds	10.0 seconds

Overload:

1K Range . . . . 130V RMS may be applied continuously without damage.

10K - 10M Range . . . . 230V RMS may be applied continuously without damage.

Open Terminal Voltage . . . . +5V maximum on any range (Isolated by source resistances increasing in decade steps from 10k Ω to 10M Ω with increasing range).

ENVIRONMENTAL

Operating Temperature . . . . –40°C to +55°C (Line operation only below 0°C and intermittant operation to +71°C)

NOTE: Internal temperature remains above 0°C on line operation.

ENVIRONMENTAL (Cont.)

Storage Temperature	$-62^{\circ}C$ to $+85^{\circ}C$. ($-62^{\circ}C$ to $+60^{\circ}C$ with battery option installed)
Humidity Range	0 to 100% R.H. (Meets paragraph 3.2.19.2 of MIL-T-21200L)
Altitude	Operating; 10,000 feet. Non-Operating; 50,000 feet.
Vibration	Withstands continuous vibration along each of the mutually perpendicular axes as follows:

Frequency Range	Double Amplitude
5 to 15 Hz	0.06 inch
15 to 25 Hz	0.04 inch
25 to 55 Hz	0.02 inch

Shock	Withstands 18 impact shocks of 20G - 3 shocks in opposite directions along each of the mutually perpendicular axes.
Electromagnetic Interference	Meets MIL STD 461A Class B Notices 1-3
Sand and Dust	Meets paragraph 3.2.19.6 of MIL-T-21200L
Salt Atmosphere	Meets paragraph 3.2.19.8 of MIL-T-21200L

GENERAL

Selection	Manual via mechanically interlocked pushbuttons.
Display	Four decade neon in-line readout with polarity neon for DC volts, and fifth digit for 20% overrange. Automatic decimal location.
Sample Rate	3 samples per second.
Maximum Inputs:	
"HI" to "LO"	See "Overload" specification by function.
"LO" to "GUARD"	100V DC or peak AC.
"GUARD" to "CHASSIS"	1200V DC or 230V RMS at 60 Hz.
Temperature Coefficients (Apply outside of temperature ranges of "accuracy" specifications.)	DC ±(0.0015% of input + 0.001% of range)/°C AC ±(0.015% of input + 0.005% of range)/°C KΩ ±(0.003% of input + 0.001% of range)/°C 10 MΩ ±(0.008% of input + 0.001% of range)/°C
Power	3 watts during 8 hours of continuous operation from rechargeable nickel-cadmium batteries. 8 watts line operated, with heater "off" and batteries charging. Line voltage is 115/230V AC, ±10%, 50 - 500 Hz.
Heater Power	125 Watts Maximum
Weight	$<$ 20 lbs. without batteries (9,08 Kg) $<$ 22 lbs. with batteries. (9,988 Kg)
Size:	
Linear dimensions	20.19" long (with cover on) x 6.63" high x 9.84" wide (512,8 mm x 168,4 mm x 249,9 mm)
Volume	0.762 cu ft.
Prices:	
Model 8125A	$1995
Model 8125A - 01	$2195 (Factory installed battery option).

FLUKE®

Digital Voltmeter 8200A

FEATURES:

- 0.01% ACCURACY with FULL AUTORANGING
- 4½ Digit DVM with 60% OVERRANGING
- Fast 400 Readings Per Second Systems Capability
- 6 Ranges of DC Volts with 1 uV resolution
- 4 Ranges of True RMS AC Volts, AC or DC Coupled
- 6 Ranges of Resistance
- Isolated Data Output
- Isolated Remote Control
- Isolated 4 Terminal Ratio
- Low parts count due to FLUKE's Patented Recirculating Remainder A-to-D Conversion
- Switch Selectable filter
- Overload Protected on all functions
- 10,000 hour MTBF

The 8200A Offers You:

Basic

The Model 8200A is a four range dc DVM that can easily be expanded into a 400 readings per second systems multimeter by installing a family of plug-in options. Standard features of the basic instrument include 60% overrange, a switched filter for assured broadband noise rejection, all push button selection, autoranging, automatic polarity selection and display as well as full guarding. The in-line, non-blinking readout displays polarity, the overrange digit and four full decades of digits with automatic decimal point location. Illuminated indicators designate the function selected.

Analog Options

Multimeter options include 2 ranges of dc millivolts (option -02), 4 ranges of True RMS ac volts (option -09) or 4 ranges of average responding ac volts (option -01), 6 resistance ranges (option -03) and an isolated external reference-ratio input (option -04). The extremely well isolated system options are the Data Output Unit (option -07) or the Printer Output Unit (option -06) and the Remote Control Unit (option -08). All options may be added in the field by the user at any time.

1 microvolt to 1200V dc voltage measurement capability with complete, 6 range autoranging is obtained by adding the two range millivolts option. A true 400 readings per second speed can be maintained on the 100 mV through 1000V ranges even when using an input switching scanner and externally triggered. The filter can be selected for positive noise rejection on all 6 resistance ranges.

Correct, fast digital readings of waveforms rich in harmonics and/or possessing high crest factors are assured when the True rms ac volts option 09 is utilized. 60% overrange capability and overload immunity are built-into this option to complement its very fast 500 millisecond response time and its superb low level accuracy.

AC voltages of any waveshape from 20 Hz to 300 kHz with crest factors up to 7 (2% duty cycle pulse) can be measured using the true RMS option -09. It may be DC coupled via a panel switch or a program line on remote control option -08 for inclusion of the DC component.

10 milliohm to 16 megohm resistance inputs with Ω/kΩ/MΩ autoranging can be digitized by the 8200A when it is equipped with its ohms converter option 03.

Overload protection prevents damage to the option or DVM even if 120 VAC line voltage is misapplied to the input.

True four-terminal, real-time dc/dc, mV/dc or ac/dc ratio determinations are made in conjunction with the isolated External Reference option -04. Direct resistance measurements with greately reduced power dissipation in the unknown resistor are also implemented by it.

Systems Options

Isolated Printer Output option -06 is available which provides isolated and buffered data transfer for the low-priced data logging systems. Grounded printers may be used without compromising any of the common mode specifications for Model 8200A. Output is DTL/TTL compatible 8421 BCD for parallel acquisition. The 8200A may be triggered up to 400 times a second via this option.

Isolated Data Output, option -07, and Isolated Remote Control, option -08, use guarded toroids to transfer data and commands from and to the 8200A without degrading any of its outstanding common mode rejection specifications. These options are also DTL/TTL compatible and are designed to permit the multiplexing of several 8200A's on common sets of control and data output lines. Moreover they are buffered to prevent interaction between the DVM and the Acquisition/Control devices.

External triggering of the 8200A is accomplished via its Data Output Unit and the resulting data may be acquired fully in parallel BCD format or serially by character in multiples of four-bit words. A single control line enables automatic time delays that allow for full setting of the analog input prior to digitization of the data transferred. Two flags provide continuous measurement status information for the acquisition device.

Remote Control is exerted by contact closure or logic levels. The 8200A's unique "Control Command Storage" feature permits the 8200A to "latch" on commands which may be later removed while the 8200A retains the commanded function and range in internal storage. Logical interlocks are a further important systems feature of this option because they prevent incompatible calls.

For further information on system options, request Application Bulletin AB-10.

INPUT

Ranges	Input Impedance *
±1V	10^{10} ohms
±10V	10^{7} ohms
±100V	10^{7} ohms
±1000V	10^{7} ohms

*Shunted by less than 130 pF.

Resolution: 0.01% of range (100 uV on 1V range).

Overrange: 60% (±1200V max on ±1000V range)

Overload: ±1200V dc or 1100V rms may be continuously applied to any range without damage.

Input Offset Current: Less than 50 pA.

ACCURACY ±(% of input + % of range)

	±1V thru ±1000V ranges
90 day, 23°C ±5°C	(0.01 + 0.01)
1 year, 23°C ±5°C	(0.02 + 0.03)
(To 160% of range)	
Temperature Coefficient (−10°C to 18°C and 28°C to 50°C)	±(0.001 + 0.001)/°C

Response Time

Filter Out: 2.25 msec (series of steps on same range) (1) (2)

3.75 msec (Single reading and first reading of a series) (1)

Filter In: 500 msec (single reading or a series of steps) (1)

(1) To a reading within 0.01% of range when measuring step change inputs and using external trigger.

(2) Includes Buffer Amplifier Settling time of 2 msec maximum to within 0.01% of input step, see "Timeouts Disabled" time diagram on Page 9.

NOISE REJECTION	DC	Filter In	Filter Out
Common Mode: (3) (4)	> 140 dB	> 140 dB up to 60 Hz	> 110 dB or 1 digit whichever is greater
Unbalance Resistance:	1 kΩ	1 kΩ	100Ω
Normal Mode: (3)		> 60 dB at 50 Hz > 65 dB at 60 Hz > 100 dB 200 Hz & above	

(3) The normal mode and common mode rejection are not line frequency harmonic oriented due to the broad band response of an active 4 pole filter and, therefore, will reject random noise at most frequencies.

(4) Common mode rejection specifications are maintained with any combination of options installed and are unchanged with the use of grounded devices with the remote control, data output or printer output options.

Specifications/General

A/D Conversion Technique: Recirculating Remainder

Digitizing Time: 2.5 milliseconds

Sample Aperature: 500 microseconds (at A/D converter input)

Sample Rate,

External Trigger: 400 readings per second maximum for all functions (1)

Internal Trigger: 4 readings per second, basic DVM

Autorange Time (Per range change)

External Trigger: 25 milliseconds: MV/VDC and Ω/kΩ/MΩ, Filter "out"
250 milliseconds all other combinations. (1)

Internal Trigger: 250 milliseconds

(1) External triggering is accomplished via Data Output or Printer Output Options.

Filters: 4 pole active filter for dc volts and resistance measurements, 3 pole active filter for millivolt measurements.

Range Selection: Manual, Automatic (standard), Remote (optional)

Function Selection: Manual, Remote (optional), Autorange, MVDC/VDC, Ω/kΩ/MΩ, VAC, FILTER, EXT, REF. (optional)

Function Annunciator: Lamp indicator for each function selected.

Display: In-line, neon-tube display of polarity, overrange digit and 4 full decades of digits with automatic decimal placement.

Overload Limits:
(Maximum voltage that may be continuously applied without damage)

"Hi" to "Lo": See individual functions under "Overload"

"Lo" to "Guard": ±100V dc or peak ac (2)

(2) A protection circuit causes a warning lamp to illuminate when this limit is exceeded.

"Guard" to "Chassis": ±1000V dc or peak ac, maximum common mode voltage for any function.

	Operating	Storage
Temperature:	−10°C to +50°C	−40°C to +75°C
Altitude:	10,000 feet	50,000 feet
Humidity:	Up to 90% RH −10°C to +25°C Up to 80% RH +25°C to +50°C	
Power: (Including options)	115V/230V ±10% 50 to 440 Hz Less than 25W	

Shock and Vibration: Meets MIL-T-21200L and MIL-E-16400F

Weight: Less than 15 lbs (7, 8 kg)

Size: 3½" H X 8½" W X 15"D
(88 mm X 216 mm X 381 mm)

Warm-up Time: 20 minutes to 1 year accuracy, 1 hour to full accuracy.

Specifications/DC Millivolts/Option 02

INPUT

Ranges (1)	Input Impedance
±10 mV	10^{10} ohms
±100 mV	10^{10} ohms

(1) Autoranges between dc millivolts and dc volts.

Resolution: 0.01% of range (1 uV on 10 mV range)

Overrange: 60%

Overload: ±1200V dc or 1100V rms for 15 seconds
±300V dc or rms continuously

Zero Stability: Less than 10 uV, not using zero control for 90 days

Input Offset Current: Less than 10 pA

Response Time

Filter Out:	2.25 msec (Series of steps on 100 mV range) (2) (3) 3.75 msec (single reading and first reading of a series on 100 mV range) (2) 100 msec (single reading or series of steps on 10 mV range) (2)
Filter In:	2 sec (single reading or series of steps on either range) (2)

(2) To a reading within 0.01% of range when measuring step change inputs and using external trigger.

(3) Includes Buffer Amplifier Settling time of 2 msec maximum to within 0.01% of input step, see "Timeouts Disabled" time diagram on Page 9.

ACCURACY (% of input + % of range)

	±10 mV range	±100 mV range
90 days, 23°C ±5°C (To 160% of range)	(0.01 + 0.02)	(0.01 + 0.01)
Temperature Coefficient −10°C to 18°C and 28°C to 50°C	(0.0 + 0.02)/°C	(0.0015 +0.002)/°C

NOISE REJECTION

	DC	Filter In	Filter Out
Common Mode: (4) (5)	>180 dB	>180 dB up to 60 Hz on either range	>140 dB up to 60 Hz on 10 mV range >130 dB up to 60 Hz on 100 mV range
Unbalance Resistance:	1 kΩ	1 kΩ	1 kΩ (1Ω max between lo and guard)
Normal Mode:		>75 dB at 50 Hz >80 dB at 60 Hz on 10 mV range >55 dB at 50 Hz >60 dB at 60 Hz on 100 mV range	

(4) The normal mode and common mode rejection are not line frequency harmonic oriented due to the broad band response of an active 3 pole filter and, therefore, will reject random noise at most frequencies.

(5) Common mode rejection specifications are maintained with any combination of options installed and are unchanged with the use of grounded devices with the remote control, data output or printer output options.

Specifications/True RMS AC Volts/Option 09

INPUT

Ranges
1V ac or ac + dc
10V ac or ac + dc
100V ac or ac + dc
1000V ac or ac + dc

Conversion: True rms responding

Response Time: 500 milliseconds maximum to within 0.1% for reading greater than 10% of range. Double indicated time for readings less than 10% of range.

Resolution: 0.01% of range (100 uV on 1V range)

Overrange: 60% (1100V rms max. input on 1000V range)

Overload: 1100V rms or 1500V peak may be continuously applied to any range without damage.

Superimposed DC: ±1100V dc (peak ac plus dc not to exceed ±1500V) maximum

Input Impedance: 1.0 Megohm shunted by <130 pF

Crest Factor: 7 at Full Scale, increasing downrange per

$$7X\sqrt{\frac{V\ range}{V\ input}}$$

Noise Rejection: Common mode with 100Ω unbalance in either lead, dc to 60 Hz, 120 dB minimum

ACCURACY (% of input + % of range) From 0.001V to 1100V (1)

		AC Only Mode (2)	AC + DC Mode (2)
90 days, 23°C ±5°C (To 160% of Range)	DC	———	(0.1 + 0.04)
	20 Hz - 50 Hz	(0.5 + 0.02)	(0.5 + 0.04)
	50 Hz - 10 kHz	(0.1 + 0.02)	(0.2 + 0.04)
	10 kHz - 30 kHz (3)	(0.2 + 0.04)	(0.2 + 0.06)
	30 kHz - 50 kHz (3)	(0.3 + 0.1)	(0.3 + 0.12)
	50 kHz - 100 kHz (3)	(1.0 + 0.3)	(1.0 + 0.3)
	100 kHz - 300 kHz (3)	(2.0 + 0.5)	(2.0 + 0.5)
Temperature Coefficients DC, 20 Hz -10 kHz −10°C to 18°C and 28°C to 50°C		(0.004 + 0.001)/°C	(0.004 + 0.004)/°C

(1) With inputs above 500V, mulitply accuracy by $\frac{2000V + V\ input}{2000V}$

(2) Direct coupled – FILT/RMS button in
AC coupled – FILT/RMS button out
Programmable using Filter program Line in Remote Control Option.

(3) Input volt X hertz product should not exceed 2 X 10^7.

Specifications/Resistance/Option 03

INPUT

Ranges (1)	Forcing Current
100Ω	10 mA
1 kΩ	1 mA
10 kΩ	100 uA
100 kΩ	10 uA
1000 kΩ	1 uA
10 MΩ	100 nA

(1) Autoranges between all resistance ranges.

Resolution: 0.01% of range (10 mΩ on 100 Ω range)

Overrange: 60% (16 MΩ on 10 MΩ range)

Overload:
100Ω: 30V rms (fused-spare supplied)
1 kΩ–10MΩ: 130V rms maximum without damage. Overload in excess of 130V to 1000V will not damage active circuit components.

Configuration: Two Terminal

Voltage Across Unknown R_X: 1.0 Volts at 100% of range
1.6 Volts at 160% of range

Open Terminal Voltage: +10 Volts maximum

ACCURACY (% of input + % of range)

Ranges:	100Ω	1kΩ – 100 kΩ	1000 kΩ	10 MΩ
90 days, 23°C ±5°C (To 160% of range)	(0.03 + 0.02)	(0.01 + 0.01)	(0.02 + 0.02)	(0.1 + 0.02)
Temperature Coefficients −10°C to 18°C and 28°C to 50°C	(0.002 + 0.001)/°C	(0.001 + 0.001)/°C	(0.005 + 0.002)/°C	(0.015 + 0.01)/°C

RESPONSE TIME (2)

Ranges:	100Ω – 10 kΩ	100 kΩ	1000 kΩ	10 MΩ
Filter Out(3) (Series of steps on same range)	2.25 msec	2.25 msec	4.5 msec	30 msec
Filter Out (Single reading and first reading of series)	3.75 msec	3.75 msec	5.75 msec	30 msec.
Filter In (Single reading or a series of steps)	500 msec	550 msec	1.2 sec	7.0 sec

(2) To a reading within 0.01% of range when measuring step change inputs and using external trigger.

(3) Includes Buffer Amplifier Settling time of 2 msec maximum to within 0.01% of input step, see "Timeouts Disabled" time diagram on Page 9.

Specifications/AC Volts/Option 01

INPUT

	Ranges
	1V ac
	10V ac
	100V ac
	1000V ac

Conversion: Average responding, calibrated for RMS

Resolution: 0.01% of range (100 uV on 1V range)

Overrange: 60% (1100V rms max. input on 1000V range)

Overload: 1100V rms or 1500V peak may be continuously applied to any range without damage.

Superimposed DC: ±1100V dc (peak ac plus dc not to exceed ±1500V) maximum

Input Impedance: 1.11 Megohm ±0.2%, shunted by <130 pF

Response Time: 500 milliseconds maximum to within 0.1%.

Noise Rejection: Common mode with 100Ω unbalance in either lead, dc to 60 Hz, 120 dB minimum.

ACCURACY (% of input + % of range)

		0.001V to 500V	500V to 1100V
90 days, 23°C +5°C (To 160% of range)	30 Hz – 50 Hz	(0.5 + 0.02)	(0.5 + 0.0)
	50 Hz – 20 kHz	(0.1 + 0.02)	(0.15 + 0.0)
	20 kHz – 50 kHz	(0.2 + 0.02)(1)	(0.2 + 0.0)(1)
	50 kHz – 100 kHz	(0.5 + 0.02) (1)	———
Temperature Coefficients −10°C to 18°C and 28°C to 50°C		(0.004 + 0.004)/°C	(0.004 + 0.004)/°C

(1) Input volt X hertz product should not exceed 2×10^7.

Specifications/Isolated DC External Reference/Option 04

MAIN INPUT

Ratio Range	Corresponding DC Voltage Range
±0.1:1	±1V
±1.0:1	±10V
±10:1	±100V
±100:1	±1000V

(1) Requires Rear Input, Option -05

Resolution: 0.01% of dc voltage range

Overrange: 60% (1200V maximum on ±100:1 Ratio Range) (2)

(2) $\frac{\text{\% Input Voltage Range}}{\text{\% Ref Voltage Range}}$ must be less than 1.6 for non-overrange reading.

Overload: $\pm$1200V dc or 1100V rms may be continuously applied to any range.

Reading vs Ratio: 10 X Ratio

Other Modes: DC mV/DCV, ACV/DCV and Ω/DCV are available when corresponding main input options are installed.

REFERENCE INPUT

Type: Isolated 4 -wire

Sample Time: 500 usec period just prior to 500 usec main input aperature

Voltage Range: +1V to +11V

Impedance: 1 Megohm $\pm$0.1%

Isolation: Input Lo and Reference Lo difference not to exceed +8V and -6V

Overload: Absolute value of V Reference plus difference in potential of Reference Lo and Input Lo must not exceed 25V

Noise Rejection:

Normal Mode: 25 dB at 60 Hz

Common Mode: 80 dB with +10V reference and up to 1 kΩ unbalance

Settling Time: 1 second maximum to 0.01% of reference range for step change of reference voltage.

ACCURACY

90 days, 23°C $\pm$5°C	$\pm$(0.01% of reading + 0.01% $\left(\frac{10V}{V_{ref}}\right)$ of dc voltage range)
Temperature Coefficient −10°C to 18°C and 28°C to 50° C	$\pm$(0.001% of reading +0.001% $\left(\frac{10V}{V_{ref}}\right)$ of dc voltage range)/° C

Specifications/System Options

Isolated Data Output Unit, Option 07

Data Available: Digits, polarity,range, functions

Coding: 8421 BCD, Digits and range

Logic Levels: 1 = +5V, 0 = 0V (Series 930 DTL with 6k pull up)

Maximum Trigger Rate: 400 per second

Flags: Ready, overload

Acquisition: Full parallel or serial by character in multiples of 4 bits

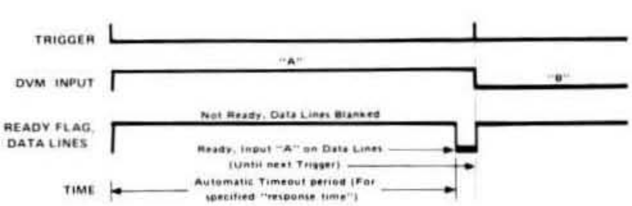
Automatic Adaptive Timeouts Automatic delays to allow for settling time of all analog inputs are enabled via a single logic line.

Data Lines: Blanked during digitizing time

Serial Output: Serial by 4 bit or multiples of 4 bits. Requires external sequencer.

TIMEOUT ENABLED MODE

Operation of the 8200A's D.O.U. in this mode provides a "Timeout" that prevents the 8200A from providing digital outputs until the specified input "response time" has elapsed. An external trigger initiates the delay whose duration is internally determined by the 8200A. At the conclusion of the delay, the 8200A automatically reads the settled input and transfers the reading to the Data Lines.



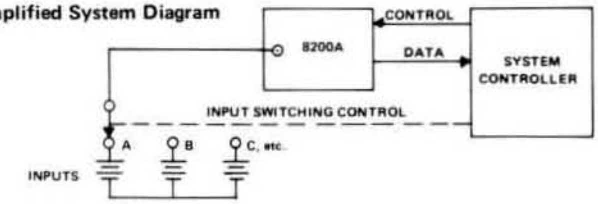
FUNCTION/RANGE (1)	TOTAL TIMEOUT MEASURED AT READY FLAG OUTPUT ALL TIMES
VDC WITHOUT FILTER 1, 10, 100, 1000	15 MSEC
VDC WITH FILTER 1, 10, 100, 1000	530 MSEC
MVDC WITHOUT FILTER 10, 100	120 MSEC
MVDC WITH FILTER 10, 100	2.1 SEC
VAC 1, 10, 100, 1000	850 MSEC
Ω WITHOUT FILTER 100	17 MSEC
Ω WITH FILTER 100	560 MSEC
kΩ WITHOUT FILTER 1, 10, 100, 1000	17 MSEC
KΩ WITH FILTER 1, 10, 100, 1000	1.3 SEC
10 MΩ WITHOUT FILTER	45 MSEC
10 MΩ WITH FILTER	7.4 SEC
RANGE CHANGES ADD TO TIMEOUTS	
VDC, MVDC, Ω, KΩ, MΩ WITHOUT FILTER CALLED	20 MSEC/RANGE CHANGE
ALL OTHER CONDITIONS	250 MSEC/RANGE CHANGE

(1) A timeout is not provided for the 1.0 second setting time at the External Reference input.

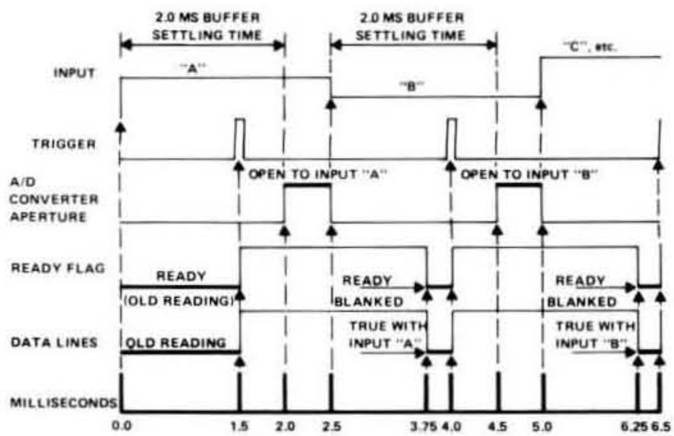
TIMEOUT DISABLED MODE

The unique Fluke Recirculating Remainder A-to-D conversion technique permits the 8200A to maintain its 400 readings per second speed while measuring switched inputs. As the diagram below shows, the 2 ms settling time for 8200A's Buffer Amplifier used on the 100 MV – 1000V and 100Ω-100kΩ ranges (filter "OUT") can be timed to occur during the 2 milliseconds interval between the end of one "sample aperture" and the beginning of the next. The slower ranges and functions may also be sampled at 400 readings per second but may not be switched or be widely varying in amplitude.

Simplified System Diagram



TIMING



SERIAL OUTPUT CAPACITY

Data on the output lines is normally present in parallel. However, parallel bit, serial-character data transfer in multiples of four bits, is achieved by appropriate addressing of eight D. O. U. control lines.

Figure A indicates how independent addressing of these lines can provide all data on only four lines to simplify the interface required for ASCII formating or card punch operation.

Figure B illustrates grouped addressing of the control lines to serially provide a computer with all 8200A data on two sixteen bit words.

FIGURE A

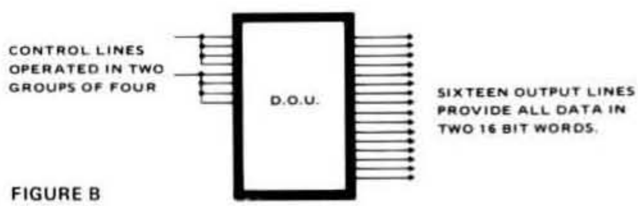


FIGURE B

Isolated Remote Control Unit, Option 08[(1)]

Control Levels: 0 = function called, 1 = function inactive

Logic Levels: 0 = contact closure or 0V, 1 = open or +5V

Input Definition: Series 930 DTL

Control Command Storage Storage: Continuous or addressed remote control of instrument. Triggered address control allows the 8200A to "latch" to input commands. Following latch, the commands may be removed but the functions and ranges commanded will continue to be in effect until the next address trigger.

Interlocks: Incompatible functions or simultaneous ranges cannot be called.

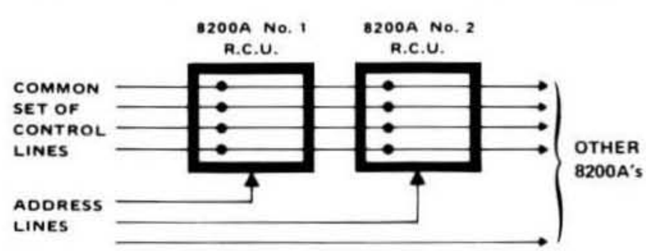
No Call: Volts DC and autorange called.

Flag: +5V through 6kΩ when the Remote button is depressed.

(1) Remote Control Unit requires +5V power (105 mA) from Data Output Unit or external power supply which can be supplied as a special item. Contact factory for further details.

MULTIPLEXED REMOTE CONTROL CAPACITY

The "control command storage" mode of operation permits several 8200A's to be controlled via a common set of 12 lines. The simplified diagram indicates how address lines are used to route the commands into the appropriate DVM's R. C. U. The command is entered when the address line is energized and ignored when the address line is de-energized.

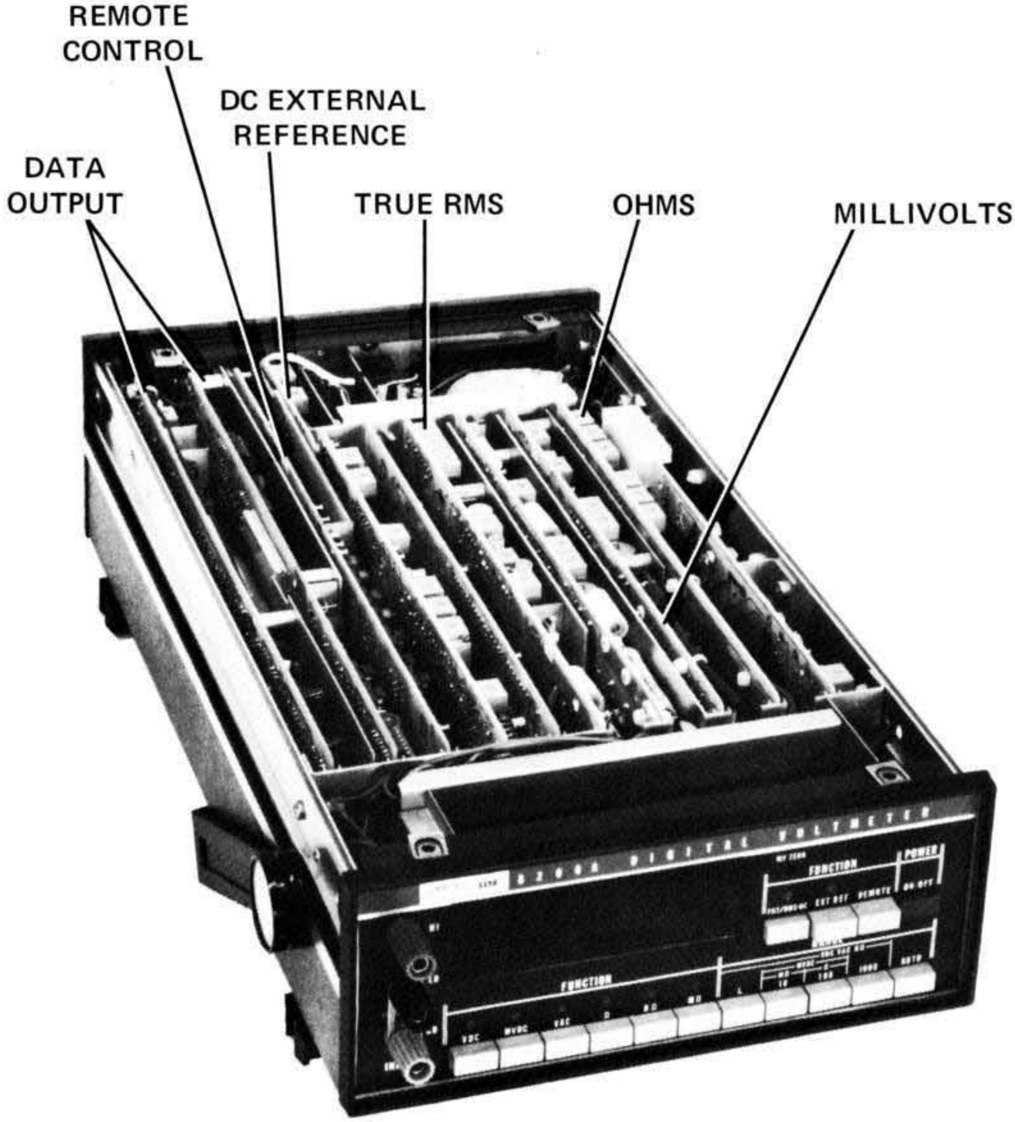


Isolated Printer Output, Option 06

Data Available:	Digits, polarity, range
Coding:	8421 BCD digits and range
Logic levels:	1 = +5V, 0 = 0V (Series 930 DTL with 6k pull up)
Maximum Trigger Rate:	400 per second (Timeout Disabled mode diagram on Page 9. applies.)

Rear Input, Option 05

Connector:	5 pin located on rear panel.
Connections:	In parallel with front panel input terminals.
Capacitance:	Adds less than 75 pF.



FLUKE 8200A WITH FIELD INSTALLABLE OPTIONS

Prices

OPTIONS		PRICES
8200A	Four Range DC DVM	$995
8200A–01	AC Converter (4)	295
8200A–02	MV Converter	250
8200A–03	Ohms Converter	200
8200A–04	External Reference (3)	150
8200A–05	Parallel Rear Input (6)	40
8200A–06	Printer Output (2) (6)	200
8200A–07	Data Output (2) (6)	400
8200A–08	Remote Control (6)	200
8200A–09	True RMS Converter (4)	595

ACCESSORIES	PRICES
2010A, Digital Printer, 10 column	$795
2010A-7004, Interface cable for option –06	125
2010A-7005, Interface cable for option –07	150
A90, AC/DC current shunts, 6 ranges to 10A(5)	255
80F-5, 5 kV dc probe, 0.01% ratio	295
80F-15, 15 kV dc probe, 0.05% ratio	350
80K-40, 40 kV dc probe, 2%/4% ratio	40
80RF, RF probe, 100 kHz to 500 MHz (7)	75
81RF, RF probe, 100 kHz to 100 MHz (7)	40
M03-200-607, Offset-Rack Mount	40
M03-203-700, Dust Cover	10
8200A-4017, Extender Board	25
C-82, Carrying Case	100

(1) Order options for field installation by suffixing option number with a "k" e.g. 8200A–01k. Prices are the same as above. All options are field installable and take approximately 10 minutes (30 minutes for option –05) and can be done with the use of only a phillips screwdriver.

(2) Options –06 and –07 may not be installed simultaneously.

(3) Option –04 requires option –05.

(4) Option –01 and –09 may not be installed simultaneously.

(5) 100 mV output at full scale. Contact factory for rack moutning information.

(6) Mating connector (s) are supplied.

(7) Requires 10 Megohm Shunt.

FLUKE 8200A, WITH FLUKE 2010A DIGITAL PRINTER

Digital Voltmeter 8300A

FEATURES:

GENERAL:

- Most flexible family of DVM's:
  - 8300A—with 3 ranges of D.C. Volts at $1295
  - 8300A—with 5 ranges of D.C. Volts at $1395
  - 8300A—with 5 ranges of D.C. Volts plus 5 ranges of OHMS at $1590
- 10,000 hour demonstrated MTBF with "Recirculating Remainder"* A/D conversion
- Auto range and auto polarity
- Full 5 digits + "1" for 20% overranging
- Active 3-pole switchable filter with 60 Hz notch
- 40 full 5½ digit readings per second for systems application

OPTIONS:

- AC voltage measurements in 4 ranges from 0 to 1100 Volts
- Four terminal OHMS
- Isolated external reference allowing 4-wire bipolar ratio measurement
- Isolated digital data output in serial or parallel format
- Isolated remote control

The 8300A Offers You:

DESCRIPTION

The 8300A is a versatile digital voltmeter with five full decades of digits plus a 6th digit for 20% over-range. Its mainframe will accept options in any sequence for expansion from a bench DVM into a bench or systems multimeter.

The 8300A uses the Fluke developed Recirculating Remainder* A-to-D conversion system which determines the most significant digit by a very accurate direct comparison process, stores a sample of the remaining input voltage, and serially determines the value of succeeding digits from this sample.

This process requires only one decade of BCD counter and one decade of precision resistive ladder network for five complete decades of conversion. Multiple use of components results in low parts count, and low power consumption, thus ensuring high reliability. Complete isolation of digital data outputs is yet another outstanding characteristic of this Fluke developed technique.

The basic instrument offers 3 ranges of DC voltage measuring capability including autorange, auto-polarity, and switchable active filtering. In addition, the 8300A-10 configuration offers 5 ranges of DC Volts, and the 8300A-02 version offers both 5 ranges of DC Volts and 5 ranges of ohms measurements.

The 8300A's sample rate can be manually varied from the front panel or it can be remotely controlled (optional).

Full guarding is accomplished by box-in-a-box construction and use of a FLUKE custom-designed isolating power transformer. Guarding is not compromised when the isolated Data Output and Remote Control units are added.

Calibration is accomplished through the guard via labelled ports.

ANALOG OPTIONS

All optional functions may be installed in the field. The analog options are fully within the guard, their installation automatically enables the appropriate function light of the display. Options may be field installed.

AC volts features a 50 Hz to 20 kHz midband with excellent accuracy to 30 Hz and 100 kHz.

Mv function extends the DC capability of the 8300A to 100 mv at full range with 1 uv of resolution. The ohms function includes 5 resistance ranges, using a modified four-terminal configuration on the two lowest.

DC External Reference can be used for true four-terminal ratio or for systems measurements related to a master reference.

DIGITAL OPTIONS

Data Output is completely isolated from the analog input and is available in a 8-4-2-1 BCD logic level format. Data is transferred serially via guarded toroids from the 8300A to the Data Output unit. Single decade code conversion and serial-character, parallel-bit acquisition are unique capabilities in addition to standard full parallel output.

Remote Control is fully isolated from analog input and may be fully isolated from the Data Output unit but is normally used in conjunction with it. Control is exerted by logic levels or contact closures. Isolation from analog circuitry is accomplished through the use of light-emitting diodes and photo-transistors.

*Patent Pending

Specifications

DC VOLTS

RANGES . . . ±10V, ±100V and ±1000V. 20% overrange capability (1100V maximum)

POLARITY . . . Automatic, instantaneous selection and display.

RANGE SELECTION . . . Manual and autorange standard (Remote optional)

RESOLUTION . . . 0.001% of range (1 uv on 0.1V range)

ACCURACY:

24 hours, 23°C ±1°C . . . ±(0.005% of input + 0.001% of range)
30 days, 20°C to 30°C . . . ± (0.008% of input + 0.002% of range)
90 days, 20°C to 30°C . . . ±(0.01% of input + 0.002% of range)
6 months, 20°C to 30° . . . ±(0.01% of input + 0.004% of range)
1 year, 20°C to 30°C . . . ±(0.015% of input + 0.005% of range)

TEMPERATURE COEFFICIENT:

0°C to 20°C, 30°C to 50°C . . . ±(0.0007% of input + 0.0003% of range/°C

INPUT RESISTANCE . . . 10V: 10,000 megohms minimum, 100V & !000V: 10 megohms

FILTER . . . Switch selected 3 pole active filter standard (remote control optional.)

RESPONSE TIME . . . To within 0.01% of step function change including polarity change.
25 ms maximum unfiltered. (No settling time required for input applied coincident with read command. Time given is digitizing time only.)

500 ms maximum filtered.

NOTE: Filter settling time unaffected by source impedance.

REJECTION:	DC	AC	NOTE
Normal Mode (Filtered)	—	>60 db, above 50 Hz	150% of Range sum of Input Peak AC Normal Mode Voltage plus DC/Voltage
Common Mode (Unfiltered) 1 KΩ unbalance in either lead 100Ω unbalance in either lead	 >140 db >160 db	 >100 db, 60 Hz and above >120 db, 60 Hz and above	1000V DC or peak AC maximum common mode voltage.
Common Mode (Filtered) 1 KΩ unbalance in either lead	>140 db	>140 db, 60 Hz and above	

ADDITIONAL SPECIFICATIONS BASIC DC UNIT 1100V DC or RMS (1500V peak AC) overload with no damage (any range).
Input capacitance < 100 pf.
Input offset current less than 50 pa on any range.

DC MILLIVOLTS (USING MV OPTION 8300A-10 OR MV/OHMS OPTION 8300A-02)

RANGES . . . ±100 mv and ±1000 mv. 20% overrange capability (Up to 1100V overload with no damage)

POLARITY . . . Automatic, instantaneous selection and display.

RANGE SELECTION . . . Manual and autorange standard (Remote optional)

RESOLUTION . . . 0.001% of range (1 uv on 100 mv range)

ACCURACY Using millivolts zero control	1000MV RANGE	100MV RANGE
24 hrs, ± 1°C	±(0.005% of input + 0.001% of range)	±(0.005% of input + 0.004% of range)
90 days and 6 mos 20°C-30°C	±(0.01% of input + 0.002% of range)	±0.01% of input + 0.005% of range)
1 year 20°C-30°C	±(0.015% of input + 0.002% of range)	±(0.015% of input + 0.005% of range)

ZERO STABILITY (After 30 minute warmup) Better than 8 uv for 90 days. (Front panel millivolt zero control provided to compensate for external thermal EMF's etc.

8300A Specifications Continued

TEMPERATURE COEFFICIENT:

$0^\circ C$ to $20^\circ C$, $30^\circ C$, to $50^\circ C$ . . . . 1000 mv range ±(0.0007% of input + 0.0003% of range)/°C
100 mv range ±(0.0007% of input + 0.0005% of range)/°C

INPUT RESISTANCE . . . . 100 mv: 100 megohms min. 1000 mv: 1000 megohms min.

RESPONSE TIME: . . . . (Including polarity change, to within 0.01% of step function change)
1000 mv Range . . . . 1 second maximum.
100 mv Range . . . . 3 seconds maximum.
NOTE: Response time figures applicable for source resistance up to 50 KΩ

REJECTION

	DC	INTERFERENCE FREQUENCY	
		50 Hz	60 Hz
Normal Mode	–	>55 db	>60 db, 60 Hz and above
Common Mode 1 KΩ unbalance in either lead	>140 db, DC to 60 Hz		

MAXIMUM INPUT VOLTAGE . . . . 1100 VDC or RMS (1500V peak AC) overload with no damage (any range)

AC VOLTS (USING AC OPTION 8300A-01)

RANGES: . . . . 1V, 10V, 100V and 1000V
20% overrange capability (1100V RMS maximum)**

RANGE SELECTION . . . . Manual and autorange standard (Remote Optional)

RESOLUTION. . . . . 0.001% of range (10 uv on 1V range)

ACCURACY:
$20^\circ C$ to $30^\circ C$

FREQUENCY RANGE	INPUT VOLTAGE .001V – 500V		INPUT VOLTAGE 500 – 1100V
50 Hz - 20 kHz	±(0.1% of input	+0.005% of range)* +0.02% of range) 30 days +0.03% of range) 90 days +0.035% of range) 6 months +0.04% of range) 1 Year	±0.15% of input
20 kHz - 50 kHz	±(0.2% of input	+0.005% of range)* ** +0.02% of range) 30 days +0.03% of range) 90 days +0.035% of range) 6 months +0.04% of range) 1 Year	±0.2% of input **
30 - 50 Hz and 50 kHz - 100 kHz	±(0.5% of input	+0.005% of range)* ** +0.02% of range) 30 days +0.03% of range) 90 days +0.035% of range) 6 months +0.04% of range) 1 Year	±0.5% of input **

* "±0.005% of range" accuracy can be obtained at any time during a six month period via front panel AC zero. ±0.005% accuracy is typically maintained for 24 hours following zero adjustment. 30 day, 90 day and 6 mos intervals start after the last use of the AC zero.

** Input Volt-Hertz product should not exceed 2×10^7.

TEMPERATURE COEFFICIENT

$0^\circ C$ to $20^\circ C$, $30^\circ C$ to $50^\circ C$ . . . . ±(0.002% of input + 0.001% of range)/°C.

INPUT IMPEDANCE

(All Ranges) . . . . 1 megohm shunted by < 100 pf.

RESPONSE TIME:
(To within 0.1% of step function change) . . . . 500 ms maximum.

MAXIMUM INPUT VOLTAGE. . . . . 1100V RMS
(Up to ±1100V superimposed DC is allowed if the peak voltage does not exceed 1500V).

REJECTION:

Common Mode (DC to 60 Hz) . . . . 100Ω unbalance in either lead. $>$ 120 db
Maximum Common Mode Voltage. . . . . 1000V DC or peak AC.

OHMS (USING MV/OHMS OPTION 8300A–02)

RANGES . . . . 1KΩ, 10KΩ, 100KΩ, 1000KΩ, 10MΩ, 20% overrange capability all ranges.

RANGE SELECTION . . . . Manual and autorange 1 KΩ through 1000KΩ ranges. 10 MΩ range selected manually. (Remote selection optional all ranges).

RESOLUTION . . . . 0.001% of range (10 milliohms on 1 K range)

ACCURACY:

	1K – 1000K	10M
24 hours, 22°C to 24°C	± (0.008% of input + 0.002% of range)	± (0.04% of input + 0.002% of range)
90 days, 20°C to 30°C	±(0.01% of input + 0.002% of range)	±(0.05% of input + 0.002% of range)
6 months, 20°C to 30°C	±(0.01% of input + 0.004% of range)	±(0.05% of input + 0.004% of range)
1 year, 20°C to 30°C	±(0.015% of input + 0.005% of range)	±(0.06% of input + 0.005% of range)

TEMPERATURE COEFFICIENT:

0°C to 20°C, 30°C to 50°C . . . . KΩ Ranges
±(0.0007% of input + 0.0003% of range)/°C
10 MΩ Range
±(0.003% of input +0.0003% of range)/°C

MEASUREMENT CURRENT:
(And Mode)

Range (KΩ)	1	10	100	1000	10 MΩ
Current (ua)	1.1 ma	110	100	10	1
Mode	4 terminal		2 terminal		

NOTE: Power dissipated in unknown resistor is only 1.2 milliwatts at 1 KΩ

RESPONSE TIME:
(To within 0.01% of step function change)

RANGE	UNFILTERED	FILTERED
1 KΩ 10KΩ	1 sec.	1.5 sec
100 KΩ 1000 KΩ	15 ms*	
10 MΩ	50 ms*	

* Includes 25 ms digitizing time - No settling time required on 100K & 1000K ranges for input applied coincident with read command.

MAXIMUM INPUT VOLTAGE . . . . 30V RMS opens protective fuse. (spare supplied)

4–WIRE RATIO (USING ISOLATED REFERENCE OPTION 8300A-05)

RANGES:

MODE	RATIO RANGE $(\frac{A}{B})$	READING	V INPUT (A)	V REF. (B)
DC/DC	0 ± 1.0 0 ± 10 0 ± 100	0 ± 10.0000 0 ± 100.000 0 ± 1000.00	0 ± 10V 0 ± 100V 0 ± 1000V	+2V to +10.5V Standard
MV/DC (OPTIONAL)	0 ± 0.01 0 ± 0.1	0 ± 100.000 0 ± 1000.00	0 ± 100 mv 0 ± 1000 mv	
NOTE: DC External Reference may also be used for AC measurements.				

20% overranging, autorange and autopolarity operation apply to V input for all modes above as applicable.

$\frac{\text{\% Input Voltage Range}}{\text{\% Reference Voltage Range}}$ must be less than 1.2 for a non-overrange reading.

ACCURACY: 90 days 20°C-30°C	RATIO RANGE	
	0 ± 0.1, 0 ± 1, 0 ± 10, 0 ± 100	±(0.01% of Reading + 0.002% X (10V/E_{ref}) of DC Voltage range)
	0 ± 0.01	±(0.01% of Reading + 0.005% X (10V/E_{ref}) of DC Voltage range)*

NOTE! 24 hr, 6 mos & 1 year accuracy and temperature coefficient same as basic DC & MV specifications except multiply "% of range" by 10V/Eref.

* Using MV zero

EXTERNAL REFERENCE INPUT SPECIFICATIONS:

Input Impedance . . . . 1 megohm.
Response Time . . . . To within 0.01% of step function change (2 seconds)

NORMAL MODE REJECTION: . . . . > 30 db at 60 Hz.

COMMON MODE REJECTION: . . . . 120db at 10V reference with 1k Ω unbalance

ISOLATION: . . . . Difference between "INPUT HI" and EXT. REF. "LO" may not exceed ±13V peak on 10V, and mV DC voltage ranges.
(Input & reference commons)

GENERAL

DEMONSTRATED MTBF . . . . 10,000 hours

DISPLAY . . . . Function/polarity display block plus six digit in-line neon readout.

DIGITIZING TIME . . . . 25 ms maximum.

SAMPLE RATE . . . . Front panel variable from 10 readings/sec to 1 reading/3 sec + "EXT" (External Control) position.
40 reading/sec under external control through the Data Output Unit.

MAXIMUM INPUTS:
"HI" to "LO" . . . . See individual function specifications.
"LO" to "GUARD" 100V
"GUARD" to "GROUND" . . . . 1000V DC or peak AC.

TEMPERATURE RANGE . . . . Operating 0°C to 50°C
Storage −40°C to +75°C

HUMIDITY RANGE . . . . Operating
<80% relative humidity; 0°C to 25°C
<70% relative humidity; 25°C to 50°C

ALTITUDE . . . . Operating 10,000 Feet. (3,048 Km)
Non Operating 50,000 Feet (15,24 Km)

SHOCK & VIBRATION . . . . Meets requirements of MIL–T-21200L and MIL-E-16400F.

POWER . . . . 115/230V, ±10%, 50-440 Hz line, 20 watts with all options.

WARMUP TIME . . . . 30 minutes to meet all specifications.

WEIGHT . . . . 15 lbs basic (6,81 Kg)
19 lbs with all options (8,63 Kg)

SIZE . . . . 3.5" high by 17.5" wide by 15" deep (see outline drawing.)
(88,9 mm H X 444,5 mm W X 381 mmD)

PRICE:

8300A Basic DC Instrument	$1,295.00
8300A-01 AC	$ 495.00
8300A-02 MV/Ω (factory installed only)	$ 295.00
8300A-03 Data Output Unit (2)	$ 500.00
8300A-04 Remote Control Unit (1) (2)	$ 200.00
8300A-05 DC-DC Ratio (Requires -06) (3)	$ 200.00
8300A-06 Rear Input (3)	$ 40.00
8300A-10 MV (factory installed only)	$ 100.00

ACCESSORIES:

2010A Digital Printer, 10 column	$795.00
2010A-7006, Printer Interface Cable	$125.00
8300A-4013 Option Extender (MV/Ω, AC)	$ 25.00
8300A-4015 Buffer Extender	$ 25.00
8300A-701 Digital Option Enclosure	$ 25.00
MEE-7001 19" Rack Mounting Brackets	$ 15.00
MEE-8078 18" Rack Slides	$ 50.00
MEE-8079, 24" Rack Slides	$ 50.00
A90, AC/DC current shunts, 6 ranges to 10A	$255.00
80F-5-02, 5 kV dc probe, 0.01% ratio	$295.00
80F-15-02, 15 kV dc probe, 0.05% ratio	$350.00
80RF, 100 kHz to 500 MHz RF probe (4)	$ 75.00
81RF, 100 kHz to 100 MHz RF probe (4)	$ 40.00
A80, Test leads, red and black, 5 assorted screw-on tips	$ 5.00

KITS:

(for field installation) Order options for field installation by suffixing option number with a "K", e.g. 8300A–01K.

8300A-10K, MV (for field installation) . . . $ 225.00
8300A-02K, MV/Ω (for field installation) . . $ 395.00
All other kits as priced under option listing.

NOTES:

1) 8300A-701 Digital Option Enclosure required when –04 option ordered without –03 Data Output.

2) Mating connectors supplied

3) Binding post input terminals

4) Requires 10 MΩ load resistor.

DATA OUTPUT UNIT (USING ISOLATED DATA OUTPUT OPTION 8300A–03)

OUTPUTS	LINES	LOGIC LEVELS	
		0 to +0.5V	+5V
FUNCTION: DCV, MV, ACV, KΩ, MΩ Filter, Ext. Ref.	7	Function inactive.	Function called.
RANGE (Coded): 1 = 00 10 = 01 100 = 10 1000 = 11	2	Logic 0	Logic 1
POLARITY:	1	Negative	Positive
6 DIGITS (Including "Overrange "1") Binary-Coded Decimal 8-4-2-1	21	Logic 0	Logic 1
DATA READY (Print) COMMAND	1	Data Ready	Data
OVERLOAD FLAG	1	No Overload	Overload
+5V REF & RETURN (TO POWER RCU)	2	---------	---------
INPUTS		0 to +0.5V (or short)	+5V (or open)
EXT. TRIGGER (Read Command)	1		+5V pulse >1 usec
SAMPLE DELAY (Internally programmed timeout delays sample until the Analog functions specified settling time has elapsed.)	1	No Delay (FAST)	Settling delay enabled (NORMAL)
INHIBITS (Address Lines for Serial Acquisition)	10	Inhibit	Normal
NOTE: 8 additional output lines and 4 input lines provided for code conversion of output data -- contact factory. Output is series 930 DTL with 6K collector resisitors.			

OUTPUT FORMAT . . . . Complete parallel and addressable for parallel bit-serial character in multiples of 4 bits.

BLANKING . . . . All outputs are high during conversion and programmed time outs. Outputs enabled at time "Data Ready" flag appears.

POWER . . . . +5V DC available as output to power remote control unit if desired.

ISOLATION . . . . All CMRR specifications apply with DOU installed. 1000 VDC or peak AC may be applied between DOU common and input "LO".

NOTE: For further details, request Application Bulletin #6

REMOTE CONTROL (USING ISOLATED REMOTE CONTROL OPTION 8300A–04)

INPUTS		LINES	LOGIC LEVELS	
Function:	DCV, MV, ACV, KΩ, MΩ Filtered, External Reference	7	0 to +0.5V (or contact closure)	+5V (or open)
			Function Called	Function inactive
Range:	1, 10, 100, 1000 uncoded	4	Range Called	All lines open Autorange

Input is series 930 DTL

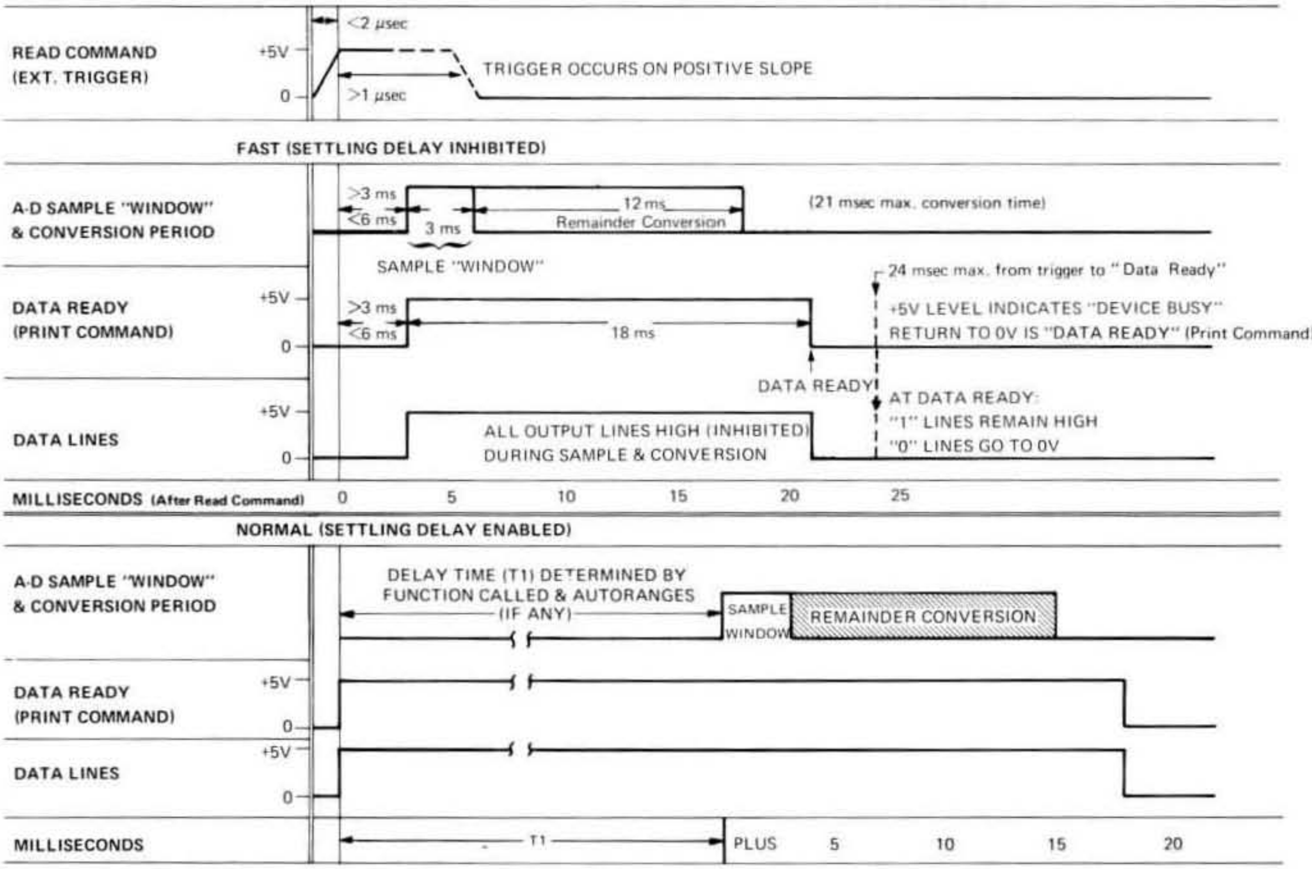
INTERLOCKS . . . . Interlocks are provided to disallow multiple function or range calls for incompatible combinations.

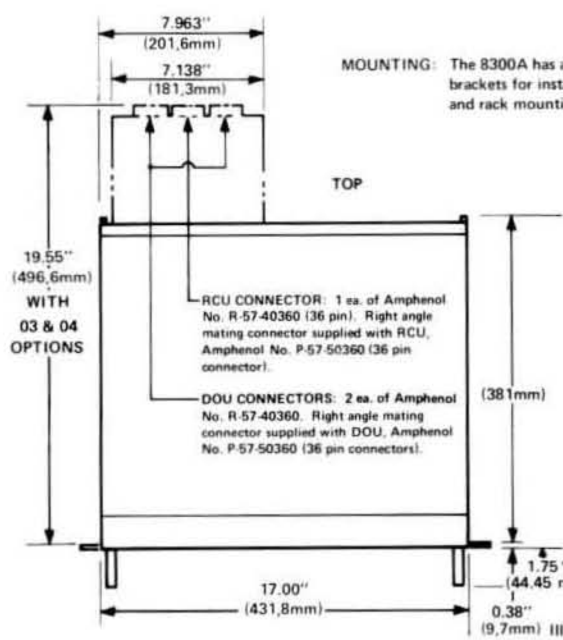
POWER . . . . +5V power available from Data Output Unit (May be externally powered, 5V DC at 150 ma required.)

ISOLATION . . . . All CMRR specifications apply with RCU installed. 1000 VDC or peak AC may be applied between RCU common and input "LO".

NOTE: For further details, request Application Bulletin #6

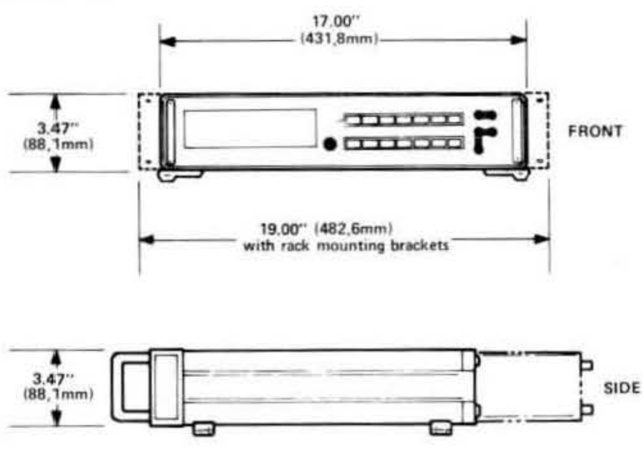
DATA OUTPUT TIMING DIAGRAMS





Illustrated with DOU and RCU installed.

MOUNTING: The 8300A has a tilt-up bail for bench use. Mounting brackets for installation in a standard EIA relay rack and rack mounting slides are available as accessories.



FLUKE®

Digital Multimeter 8350A

FEATURES:

- 5½ Digits
- 0.005% Accuracy
- 5 Ranges DC Volts
- 5 Ranges of Ohms
- 4 Ranges AC Volts
- $1,495, Complete DMM
- 10,000 Ar. MTBF

The 8350A Offers You:

Unsurpassed reliability, performance and low cost of ownership

The Fluke 8350A offers you maximum performance and quality in a 5-½-digit multimeter. Included in the standard 8350A multimeter is the ability to measure accurately DC volts from 1 microvolt to 1100 volts, AC volts from 10 microvolts to 1100 volts rms, and resistance from 10 milliohms to 12 megohms. These measurements are made with full-scale 120,000-count resolution, and accuracies of up to 0.005%. Autoranging and autopolarity are standard.

The 8350A utilizes the Fluke patented Recirculating Remainder A-to-D conversion technique, with autozero circuit, which reduces the number of parts and decreases power consumption. It results in outstanding reliability and increased ease of servicing.

Lower cost of ownership

The initial purchase price of $1,495 includes complete measurement capability—DC volts, AC volts and ohms. The 8350A can lower your costs by providing all of these measurement functions in one unit at one low price. The very low parts count increases reliability and provides easier troubleshooting.

More performance

- Five ranges of DC volts
- Four ranges of AC volts
- Five ranges of ohms, with four-terminal measurement below 12Kohms
- Autoranging, autopolarity, and fully-annunciated read-out.
- Rugged environmental capability

Better reliability

- The basic 8350A design has a demonstrated MTBF (mean time between failure) of over 10,000 hours. This represents years of normal operating time.

Specifications /DC Volts

INPUT	Ranges	Input Impedance
	±100mV	10^8 ohms
	±1000mV	10^9 ohms
	±10V	10^{10} ohms
	±100V	10^7 ohms
	±1000V	10^7 ohms
		< 100 pf

Noise Rejection	DC	AC
Common Mode 1KΩ in either lead	>140 db	>140 db, 60Hz and above
Normal Mode		>60 db, 50Hz and above

Range Selection: Manual or automatic within millivolts or volts ranges

Resolution: 0.001% of range (1μV on ± 100MV range)

Overrange: 20% (±1100V maximum on ± 1000V range)

Overload: 1100V DC or RMS 1500V peak may be continuously applied to any range without damage

Zero Stability: Better than 8μV for 90 days (after 30 minutes warm up)

Offset Current: Less than 50 pA on any range

Response Time:

10V, 100V, 1000V ranges	500 milliseconds maximum to within 0.01%
1000 mV range	1 second *maximum to within 0.01%
100 mV range	3 seconds *maximum to within 0.01%

*Applicable for source resistance up to 50 kΩ.

Superimposed ac voltage: 50% of range peak ac, maximum

ACCURACY ±(% input + % range)

	±10V, ±100V, ±1000V ranges	±1000mV Range	±100mV Range
24 Hour 23°C ± 1°C	±(0.005 + 0.001)	±(0.005 + 0.001)	±(0.005 + 0.004)
30 days, 25°C ± 5°C	±(0.008 + 0.002)	±(0.008 + 0.002)	±(0.008 + 0.005)
90 days, 25°C ± 5°C	±(0.01 + 0.002)	±(0.01 + 0.002)	±(0.01 + 0.005)
6 months, 25°C ± 5°C	±(0.01 + 0.004)	±(0.01 + 0.002)	±(0.01 + 0.005)
1 year 25°C ± 5 °C	±(0.015 + 0.005)	±(0.015 + 0.002)	±(0.015 + 0.005)
Temperature Coefficient 0°C to 20°C and 30°C to 50°C	±(0.0007 + 0.0003)/ °C	±(0.0007 + 0.0003)/ °C	±(0.0007 + 0.0005)/ °C

Specifications /AC Volts

INPUT

Ranges	Input Impedance
1V 10V 100V 1000V	1 Megohm shunted by <100pf

Range Selection: Manual or automatic

Resolution: 0.001% of range (10μV on 1V range)

Noise Rejection: DC to 60Hz, >120db Common mode with up to 100Ω unbalance in either lead

Response Time: 500 Milliseconds, maximum to within 0.1%

Maximum Common Mode Voltage: 1000V DC or peak AC

Overload: 1100V RMS on any range, 1500V peak AC + DC

Conversion: Average responding corrected to indicate RMS value

Overrange: 20%, 1100V maximum on 1000V range

ACCURACY 25°C ± 5°C ±(% of input + % range) from 0.001V to 1100V (2) (3)

	24 Hour	30 Days (1)	90 Days (1)	6 Months (1)	1 Year (1)
50Hz - 20kHz	±(0.1 + 0.005)	±(0.1 + 0.02)	±(0.1 + 0.03)	±(0.1 + 0.035)	±(0.1 + 0.04)
20kHz - 50kHz	±(0.2 + 0.005)	±(0.2 + 0.02)	±(0.2 + 0.03)	±(0.2 + 0.035)	±(0.2 + 0.04)
30Hz - 50Hz 50kHz - 100kHz	±(0.5 + 0.005)	±(0.5 + 0.02)	±(0.5 + 0.03)	±(0.5 + 0.035)	±(0.5 + 0.04)

Temperature Coefficient 0°C to 20°C and 30°C to 50°C: ±(0.002 + 0.001)/ °C

(1) Accuracies stated without front panel AC zero adjustment for intervals indicated. With adjustment, floor accuracy of ± 0.005% of range may be obtained at any time throughout a one year period.

(2) Input volt x hertz product should not exceed $2x10^7$.

(3) At 50Hz to 20kHz between 500V and 1100V, accuracy = ± 0.15% of input.

Specifications /Resistance

INPUT

Ranges	Source Current
1k Ω	1.1mA
10k Ω	110μA
100k Ω	100μA
1000k Ω	10μA
10M Ω	1μA

ACCURACY ± (% of input + % of range)

	1k-1000kohm Ranges	10 megohm Range
24 Hour 23°C ± 1°C	±(0.008 + 0.002)	±(0.04 + 0.002)
90 Day 25°C ± 5°C	±(0.01 + 0.002)	±(0.05 + 0.002)
6 months 25°C ± 5°C	±(0.01 + 0.004)	±(0.05 + 0.004)
1 Year	±(0.015 + 0.005)	±(0.06 + 0.005)
Temperature Coefficient 0°C to 20°C and 30°C to 50°C	±(0.0007 + 0.0003)/ °C	±(0.003 + 0.0003)/ °C

Response Time: 1.5 seconds maximum to within 0.01%

Range Selection: Manual or automatic, 10M Ω range selected manually

Resolution: 0.001% of range, 10 milliohms maximum on 1K range.

Configuration: 4 terminal through 10k Ω range

Maximum Voltage on input: 30V RMS fuse protected, spare supplied

8350A Specifications /General

	Operating	Storage
Temperature:	0°C - 50°C	–40°C to +75°C
Altitude:	10,000 feet	50,000 feet
Humidity:	0 to +25°C up to 80% RH +25°C to 50°C up to 70% RH	
Shock and Vibration:	Meets MIL-T-21200K and MIL-E-16400F	
Warm up time:	30 minutes to meet all specifications	
Sample aperature:	3 milliseconds	
Sample Rate:	Set at 4 readings per second for easy viewing	
Filter:	3-pole active notch filter	
MTBF:	10,000 hours demonstrated	
Maximum Inputs:	Hi to Lo: See individual specifications Lo to Guard: 100V Guard to chassis 1000V DC or Peak AC	
Power:	115/230V ± 10% 50 - 440Hz Less than 20w	
Weight:	16 lbs (7, 3kg)	

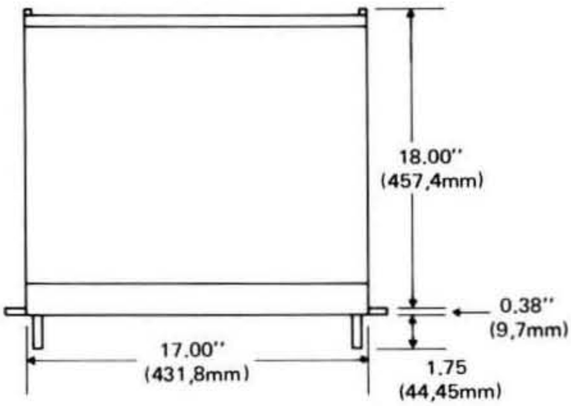
Price

8350A Multimeter	$1,595

Accessories

M03-205-600 19" Rack Mounting Brackets	$ 15
M00-280-610 24" Rack Slides	50
A-90, AC/DC current shunts, 6 ranges to 10A	255
80F-5-02, 5 kV dc probe, 0.01% ratio	295
80F-15-02, 15 kV dc probe, 0.05% ratio	350
80RF, 100 kHz to 500 MHz RF probe	75
A80, Test Leads, red and black, 5 assorted screws on tips	5

MOUNTING:
Mounting brackets for installation in a standard EIA relay rack and rack mounting slides are available as accessories.



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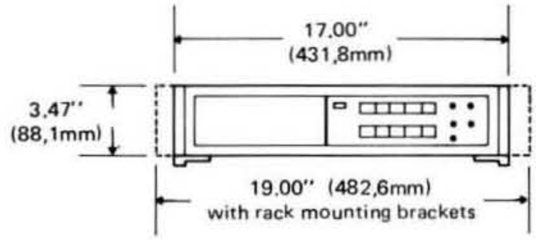


FRONT

Digital Multimeter 8375A

FEATURES:

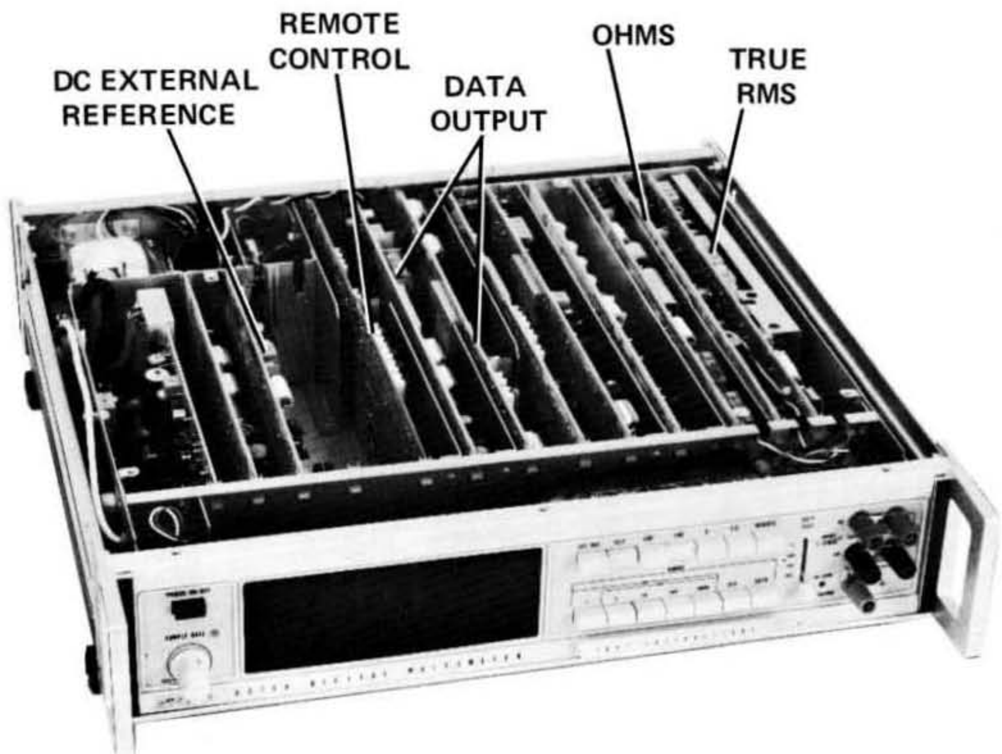
- 5½ Digits
- 0.003% Accuracy
- 5 Ranges DC Volts
- 4 Ranges True RMS AC Volts
- 7 Ranges of Ohms
- Functional Self-Test
- Powerful Systems Options
- 10,000 Hour MTBF

The 8375A Offers You:

The 8375A offers unusual capability in a 5½ digit multimeter. At a very low cost, its standard configuration combines highly accurate measurement of dc volts, true-rms ac volts and broad ranges of resistance, together with a unique self-test feature that permits rapid check-out of all measurement functions. In addition, a powerful set of systems-oriented options are available, all of which can be easily installed in any desired sequence in the field.

The 8375A offers 120,000-count full-scale resolution, together with full autoranging on all functions and auto-polarity. General features include:

- Fluke's patented Recirculating Remainder A-to-D conversion technique with autozero circuit: improves long-term accuracy and linearity with increased reliability over conventional A-to-D techniques.
- Self-test feature provides rapid check out of all functions without additional gear, assuring the user his DMM is ready for use.
- Measure from 1 μvolt to 1100 volts in five ranges with accuracies up to 0.003%, with excellent linearity and temperature coefficients.
- Two unusual features of the Fluke True RMS converter are exceptional low-level accuracy and rapid response time, providing accurate measurement of distorted waveforms from 1m volts to 1100 volts in four ranges.
- Resistance measurements from 100μ ohms to 12 megohms are made in seven ranges, with full four-terminal mode on the lower ranges. Low power dissipation in the resistor under test and fast response time are also features.
- Range and function are push-button selectable, with complete interlocks.
- Variable sample-rate provides complete control of reading rate.
- Switched four-pole filter with true broad-band noise rejection eliminates the possibility of integrating offset errors into the reading.



FLUKE 8375A, WITH FIELD INSTALLABLE OPTIONS

Specifications/DC Volts

INPUT

Range	Input Impedence
± 0.1V	10^8 ohms
± 1V	10^9 ohms
± 10V	10^{10} ohms
±100V	10^7 ohms
±1000V	10^7 ohms

Range Selection: Manual, automatic, or optional remote

Resolution: ± 0.001% of range (1μV on ± 0.1V range)

Overrange: 20% (±1100V maximum input on 1000V range)

Overload: 1100V DC or RMS ±1500V peak may be continuously applied to any range without damage

Superimposed AC Voltage: 50% of range peak AC, maximum

Noise Rejection	DC	Filtered at 60 Hz	Unfiltered to 60 Hz
Common Mode 1KΩ In Either Lead:	>140db	>140db	>100db
Normal Mode:		>65db @ 60 Hz >60db @ 50 Hz	

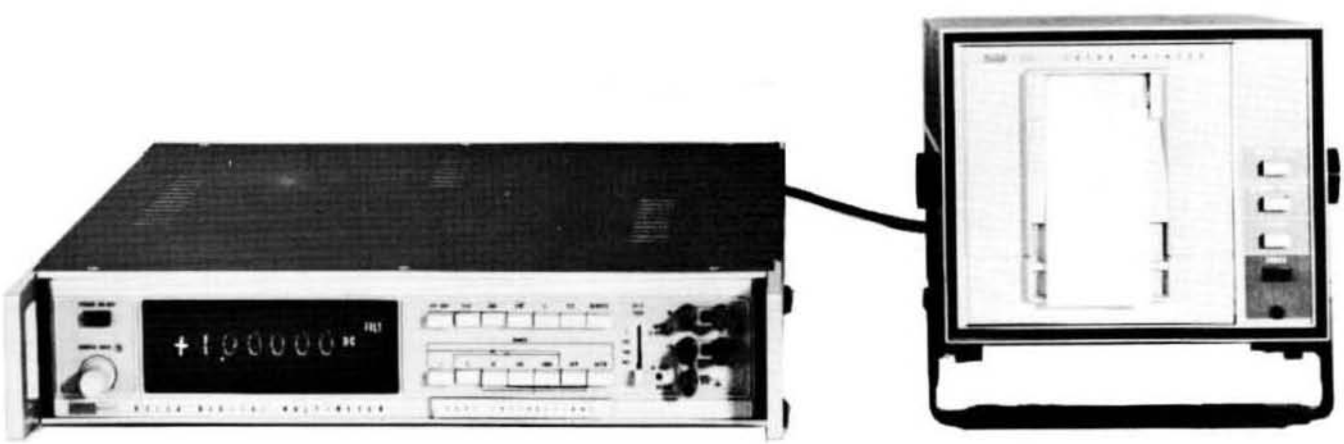
Zero Stability: Better than 5μV for 90 days after one hour warmup.

Offset Current: Less than ±5pa on any range. Temperature coefficient of ±1 pa/°C

Response Time: (To within 0.005%)
Filter out: 33 milliseconds, maximum
100 milliseconds on 0.1V range, maximum
Filter in: 500 milliseconds, maximum

ACCURACY ±(% of input + % of range)

	±10V, ±100V ±1000V Ranges	±1V Range	±0.1V Range
24 hour 23°C ±1°C	±(0.003 + 0.001)	±(0.004 + 0.002)	±(0.004 + 0.005)
90 day 23°C ± 5°C	±(0.005 + 0.001)	±(0.006 + 0.002)	±(0.006 + 0.005)
1 year 23°C ±5°C	±(0.01 + 0.002)	±(0.02 + 0.003)	±(0.02 + 0.006)
Temperature Coefficient 0°C to 18°C and 28°C to 50°C	±(0.0003 + 0.0001)/°C	±(0.0004 + 0.0002)/°C	±(0.0005 + 0.0006)/°C



FLUKE 8375A , WITH FLUKE 2010A PRINTER ACCESSORY

Specifications/True RMS AC Volts

INPUT

Ranges:
1V AC, or AC + DC
10V AC, or AC + DC
100V AC, or AC + DC
1000V AC, or AC + DC

Conversion: True RMS

Range Selection: Manual, automatic or optional remote

Resolution: 0.001% of range (10μV on 1V range)

Input Impedence: 1 megohm shunted by <150 pf

Overrange: 20% (1100V RMS maximum on 1000V range)

Coupling: DC + AC or AC only. Switch selectable. Located on P.C. Board. Accessable through guard cover.

Noise Rejection: Common mode with up to 100Ω unbalance in either lead, DC to 60 Hz, 120 db minimum

Response Time: (To within 0.1%)
Filter out: 100 milliseconds maximum (above 400 Hz for rated accuracies)
Filter in: 500 milliseconds maximum (for readings less than 10% of range, double indicated times)

Overload: 1100V RMS, 1500V peak AC any range

Superimposed DC (AC only): 1100V DC (peak AC plus DC must not exceed $\pm$1500V)

Crest factor: 7 at full scale, increasing down scale per:

$$7X \sqrt{\frac{\text{V Range}}{\text{V Input}}}$$

ACCURACY 23°C $\pm$5°C, $\pm$(% of input + % of range) from 0.001V to 1100V *(1)*

	AC + DC (90 days)	AC Only (90 days)	AC + DC (1 year)	AC Only (1 year)
DC	$\pm$(0.1 + 0.03)		$\pm$(0.13 + 0.07)	
10Hz - 20Hz	$\pm$(I.0 + 0.06)	$\pm$(I.0 + 0.04)	$\pm$(1.3 + 0.1)	$\pm$(1.3 + 0.06)
20Hz - 50Hz	$\pm$(0.5 + 0.03)	$\pm$(0.5 + 0.012)	$\pm$(0.65 + 0.07)	$\pm$(0.65 + 0.032)
50Hz - 10kHz	$\pm$(0.1 + 0.03)	$\pm$(0.1 + 0.02)	$\pm$(0.13 + 0.07)	$\pm$(0.13 + 0.04)
10kHz - 30kHz (2)	$\pm$(0.2 + 0.06)	$\pm$(0.2 + 0.04)	$\pm$(0.26 + 0.1)	$\pm$(0.26 + 0.06)
30kHz - 50kHz (2)	$\pm$(0.3 + 0.12)	$\pm$(0.3 + 0.1)	$\pm$(0.39 + 0.16)	$\pm$(0.39 + 0.12)
50kHz - 100kHz (2)	$\pm$(1.5 + 0.4)	$\pm$(1.5 + 0.4)	$\pm$(1.95 + 0.4)	$\pm$(1.95 + 0.4)
100kHz - 300kHz (2)	$\pm$(4.0 + 1.0)	$\pm$(4.0 + 1.0)	$\pm$(5.0 + 1.0)	$\pm$(5.0 + 1.0)
Temperature Coefficients (0°C to 18°C and 28°C to 50°C) to 10 kHz	$\pm$(0.004 + 0.004)/°C	$\pm$(0.004 + 0.001)/°C	$\pm$(0.004 + 0.004)/°C	$\pm$(0.004 + 0.001)/°C

(1) With inputs above 500V multiply accuracy by $\frac{2000V + V\,input}{2000V}$

(2) Input volts x hertz, product should not exceed 2×10^7

Specifications/Resistance

INPUT

Ranges	Source Current
10Ω	10mA
100Ω	10mA
1000Ω	1mA
10,000Ω	100μa
100kΩ	100μa
1000kΩ	10μa
10,000kΩ	1μa

Range Selection: Manual, autorange, or optional remote

Resolution: 0.001% of range (100 uΩ maximum on 10Ω range).

Overrange: 20% (12 megohms maximum on 10,000k range)

Overload: 10Ω - 10,000Ω 20V RMS, fused-spare supplied

100kΩ - 10,000kΩ 250V continuous

Configuration: 4 terminal through 10,000Ω range

Response time: (To within 0.01%) Filter out: 33 milliseconds, maximum; 100 milliseconds on 10Ω range, maximum

Filter in: 500 milliseconds, maximum

Maximum Lead Resistance: (For less than 0.001% of range effect on accuracy.)

4 terminal: 10Ω on 10Ω range, 100Ω on all other ranges for source leads, 1 kΩ in either lead for sense leads.

2 terminal: Less than 0.001% of range lead resistance.

ACCURACY ±(% input + % range)

	10Ω	100Ω - 10,000Ω	100kΩ - 1000kΩ	10,000kΩ
90 days 25°C ±5°C	±(0.01 + 0.01)	±(0.01 + 0.003)	±(0.01 +0.002)	±(0.05 + 0.002)
Temperature Coefficient (0°C to 18°C and 28°C to 50°C	±(0.001 + 0.0005)/°C	±(0.001 + 0.0002)/°C	±(0.0007 + 0.0001)/°C	±(0.003 + 0.0001)/°C

Specifications/Isolated DC External Reference/Option-05

MAIN INPUT

Ratio Ranges

±0.01	:1	±1	:1
±0.1	:1	±10	:1
		±100	:1

Type: True 4-wire, real time

Resolution: 0.001% of DC Voltage Range

Overrange: 20%, 110: 1 maximum input on 100: 1 Range

NOTE: $\dfrac{\textit{\% Input Voltage Range}}{\textit{\% Reference Voltage Range}}$ *must be less than 1.2 for a non-overrange reading.*

Overload: ±1100VDC or RMS, ±1500V peak, continuous.

Reading vs Ratio: 10 x ratio

REFERENCE INPUT

Voltage Range: +1V to +10.5V

Input Resistance: 1 megohm ± 0.1%

Noise Rejection: Normal mode 30db at 60 Hz

Common mode 1k lead unbalance 120db with a +10V reference

Settling time: 2 seconds (to within 0.01%)

Isolation: Input Hi to Input Lo voltage plus Input Lo to Reference Lo voltage not to exceed ± 13V on 10V and lower DC voltage ranges.

ACCURACY $\pm$(% of reading +% $\left(\frac{10V}{V\ Ref}\right)$ X DC Voltage Range)

	0.1V Range	1V Range	10V, 100V, 1000V Ranges
90 days 23°C ±5°C	±(0.005 + 0.01)	±(0.005 + 0.004)	±(0.005 +0.002)
Temperature Coefficient (0°C to 18°C and 28°C to 50°C)	±(0.0005 + 0.0006)/°C	±(0.0004 + 0.0002)/°C	±(0.0003 +0.0001)/°C

Specifications/Systems (Ask for 8375A Systems Applications Bulletin #11)

ISOLATED DATA OUTPUT UNIT
OPTION –03

Data available: Digits, polarity, range and functions

Acquisition: Parallel or Serial 8421 BCD

Maximum Trigger Rate: 30 per second

Logic Levels– 6k pull-up: 1 = +5V; 0 = 0V

Timeouts: Programmable Automatic settling time delays.

Flags: Busy, overload, remotely controlled, remotely triggered, and sample.

ISOLATED REMOTE CONTROL UNIT
OPTION –04

Control Commands: All front panel modes

Flags: Remotely called flags in data output unit

Logic Levels – DTL: 1 = +5V or open contact (function inactive); 0 = 0V or closed contacts (function called)

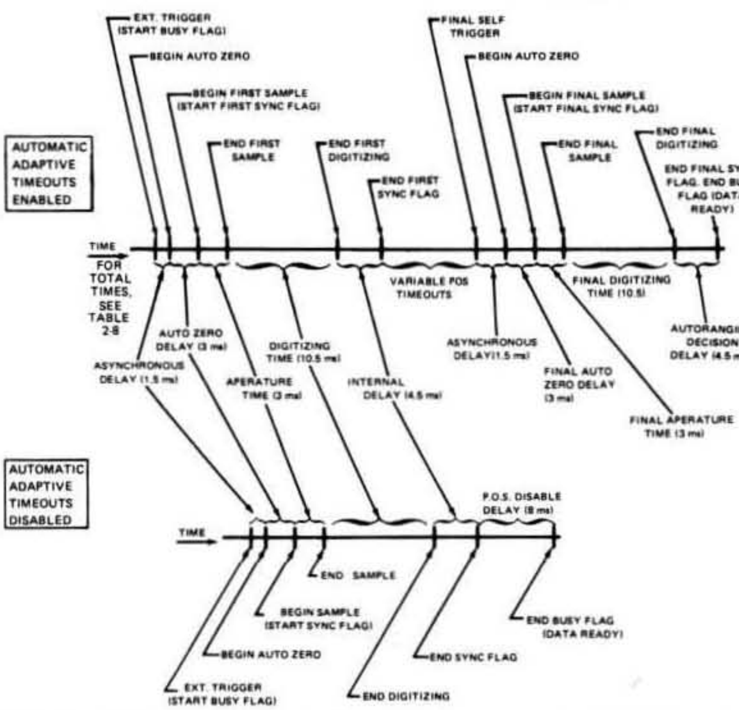
Command Modes: Continuous or stored for addressing applications.

No Call: Volts dc and autorange

Interlocks: Automatically locks out incompatable functions and ranges.

NOTE: Requires +5V power (150 mA) from Data Output unit or external power supply which can be supplied as a special item. Contact factory for further details.

TIMING DIAGRAMS VIA DATA OUTPUT UNIT, OPTION 03



TOTAL TIMEOUT CHART
(Automatic Adaptive Timeouts Enabled)

FUNCTION/ RANGE	TOTAL TIME (MS)	
	Filter Out	Filter In
VDC-10,100 1000	54 ±3	523 ±42
VDC - 0.1, 1.0	123 ±10	523 ±42
VAC - all ranges	123 ±10	523 ±42
Ω - all ranges	123 ±10	523 ±42
KΩ - all ranges	73 ± 6	523 ±42
Autorange-per range change	add 50	add 280

Specifications/General

	Operating	Storage
Temperature:	0°C to +50°C	−40°C to 75°C
Altitude:	10,000 feet	50,000 feet
Humidity:	0°C to +25°C Up to 80% RH +25°C to 50°C Up to 70% RH	
Shock and Vibration:	Meets MIL-T-21200L & MIL-E-16400F.	

Warm Up Time:	20 minutes to 1 year accuracy. 1 hour to full accuracy.
MTBF:	10,000 hours.
Sample Rate:	Variable from 13 per second to one per 4.5 seconds and hold.
Autorange Time:	50 milliseconds per range change, filter out. 280 milliseconds per range change, filter in.
Filter:	Switch selected 4-pole active for dc volts, ac volts and resistance.

PRICES

8375A Digital Multimeter DC, AC, Ω	$2,195
8375A-03 Data Output . . . . (Mating connectors supplied)	500
8375A-04 Remote Control . . . . (Mating connector supplied)	200
8375A-05 DC Reference . . . . (Requires Option -07, Mating connector supplied)	200
8375A-07 Rear Input . . . . (Mating Connector supplied)	45

(For field installed options, add "k" suffix to Option Number. Same price as above. Installation takes approximately 10 minutes (30 for option 07) and only requires use of Screw-Driver.)

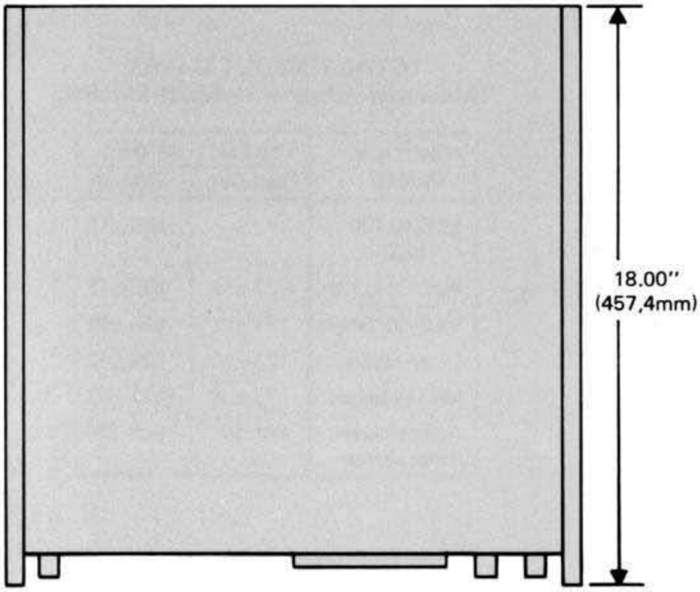
ACCESSORIES

2010A Digital Printer, 10 column	$795
2010A-7007 Printer Interface Cable	150
A90, AC/DC Current Shunts, 6 ranges to 10A . .	255
80F-5-02, 5 kV dc Probe, 0.01% Ratio	295
80F-15, 15 kV dc Probe, 0.05% Ratio (1)	350
80RF, 100 kHz to 500 MHz RF Probe (2)	75
81RF, 100 kHz to 100 MHz RF Probe (2) . . .	40
M03-205-600, 19" Rack Ears	15
298265 Extender Board	25
M00-280-610, 24" Rack Slides	50
A80, Test Leads, Red and Black, 5 assorted screw-on tips	5

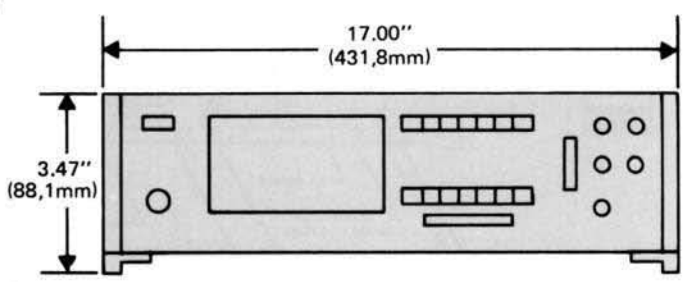
(1) Requires 10 MΩ shunt for voltages below 12 kV. IF voltage to be measured is always below 12 kV, order option 80F-15-02.

(2) Requires 10 MΩ shunt.

OUTLINE DIMENSIONS



TOP



FRONT

FLUKE

Digital Voltmeter 8400A

FEATURES

- 0.002% ACCURACY
- Four Ranges of Fast-Responding True-RMS AC
- Low Power Consumption
- Five Ranges of DC with autopolarity and autoranging
- 20% overrange and 0.001% resolution
- Overload Resistant, 1500V Peak Overload Protection
- Rugged Environmental Specifications
- Plug-in AC, Resistance and Ratio options
- Switched Filter for DC, AC, Resistance and Ratio
- Extremely well isolated and buffered systems options
- Automatic Settling Time Delays
- Serial or Parallel Data Output
- Analog Input, Data Output, Remote Control can be individually multiplexed
- Recirculating Remainder A-to-D Conversion*
- 10,000 Hour MTBF

DESCRIPTION

BASIC

The Fluke Recirculating-Remainder * A-to-D conversion technique used in the Model 8400A provides a reliable DVM with long-term accuracy and linearity plus superior environmental characteristics.

The 8400A's outstanding accuracy is complemented by numerous and versatile functional capabilities. DC voltages are measured on five ranges with resolution to 1 microvolt. Overrange is 20% on all ranges except on the ±1,000V range. 1100V can be applied to any range without damaging the unit.

A non-blinking readout contains an in-line neon tube display of polarity, overrange digit and five full decades of digits followed by a lighted function annunciator. The speed at which the readout updates is controlled by a variable "Sample Rate" control on the front panel. A switched four-pole filter has true broad-band noise rejection which eliminates integrated offset errors in the reading, a characteristic of dual slope DVM's. The filter may be used with all analog options.

Features like pushbutton selection, thousand volt guarding, full autoranging, instantaneous auto polarity and calibration of all standard and optional functions through the top guard cover make the 8400A dependable and easy to use.

The basic DVM will readily accept a family of rugged plug-in option cards that allow it to measure AC volts, resistance and DC/DC or AC/AC ratios. System options plug directly into the 8400A mainframe. The Data Output is highly isolated and the 8400A can be operated by Remote Control. The options may be easily installed in the field at any time in any desired sequence. The result is a full systems multimeter that is highly overload resistant which can be built up from the basic 8400A as requirements dictate.

ANALOG OPTIONS

Accurate, fast digital readings of distorted waveforms are assured with the True RMS AC Converter. Fluke's computing technique provides a genuine RMS to DC transfer function for measurement of waveforms with high distortion, high crest factor characteristics. In addition, this true RMS converter features very fast response time and excellent low-level accuracy. If ac measurements are always sinusoidal, the lower-priced average responding ac converter may be used.

True four terminal resistance measurements on the four "Ohms" ranges are made with very low power dissipation in the unknown resistor and full "Ohms" to "Kilohms" autoranging spans resistance measurements from 100 microhms to 12 megohms.

Real-time four terminal DC/DC ratios are measured via the Isolated External Reference option. The Reference input "LO" terminal may be elevated by as much as ±13V from the input "HI" terminal without loss of ratio accuracy. Furthermore, the standard reference voltage span of +1V to +10.5V permits measurement of ratios from a wide number of sources. Special reference voltages are available on request.

Three terminal AC/AC ratio measurements does not require use of the DC Isolated External Reference Option. Reference voltages from 0.1V to 105V may be applied on three ranges for highly accurate ratio determinations over a broad range of frequencies.

SYSTEM OPTIONS

Isolated Data Output and Isolated Remote Control options use guarded toroids to transfer data and commands from and to the 8400A without degrading any of its outstanding common mode rejection specifications. These options are also DTL/TTL compatible and are designed to permit the multiplexing of several 8400A's on common sets of control and data output lines. Moreover, they are buffered to prevent interaction between the DVM and the Acquisition/Control devices.

External Triggering of the 8400A is accomplished via its Data Output Unit and the resulting data may be acquired fully in parallel BCD format or serially by character in multiples of four-bit words. A single control line enables automatic time delays that allow for full settling of the analog input prior to digitization of the data transferred. Five flags provide continuous measurement status information for the acquisition device.

Remote Control is exerted by contact closure or logic levels. The 8400A's unique "Control Command Storage" feature permits the 8400A to "latch" on commands which may be later removed while the 8400A retains the commanded function and range in internal storage. Logical interlocks are a further important systems feature of this option because they prevent incompatible calls.

Patent Pending

MAINFRAME

DC VOLTS

RANGES . . . . ±0.1V, ±1V, ±10V, ±100V, ±1000V (automatic polarity selection)

NOTE: The 8400A will autorange through all voltage ranges.

Resolution	±0.001% of range, (1µV maximum on ±0.1V range)
Overrange	20% ±1100V maximum input on ±1000V range
Overload	±1100V DC or RMS (±1500V peak) may be continuously applied to any range without damage.

ACCURACY (To 120% of range or ±1100V maximum input)

24 hours (23°C ± 1°C)	±10V, ±100V, ±1000V ranges	±(0.002% of input + 0.001% of range)
	±1V range	±(0.003% of input + 0.002% of range)
	±0.1V range	±(0.003% of input + 0.005% of range)
90 days (18°C to 28°C)	±10V, ±100V, ±1000V ranges	±(0.004% of input + 0.001% of range)
	±1V range	±(0.005% of input + 0.002% of range)
	±0.1V range	±(0.005% of input + 0.005% of range)
1 year (18°C to 28°C)	±10V, ±100V, ±1000V ranges	±(0.01% of input + 0.001% of range)
	±1V range	±(0.02% of input + 0.002% of range)
	±0.1V range	±(0.02% of input + 0.005% of range)

Temperature Coefficients (0°C to 18°C and 28°C to 50°C)

±10V, ±100V, ±1000V ranges	±(0.0003% of input + 0.0001% of range)/°C
±1V range	±(0.0004% of input + 0.0002% of range)/°C
±0.1V range	±(0.0005% of input + 0.0006% of range)/°C

Input Impedances	±10V range	10,000 megohms	shunted by less than 100 p.f.
	±1V range	1000 megohms	
	±0.1V range	100 megohms	
	±100V, ±1000V range	10 megohms	

Offset Current at 23°C ± 1°C	Less than ±5 pa. on any range
Temperature Coefficient	Less than ±1 pa./°C on any range
Zero Stability	Better than 5µV for 90 days after a one hour warmup

NOISE REJECTION

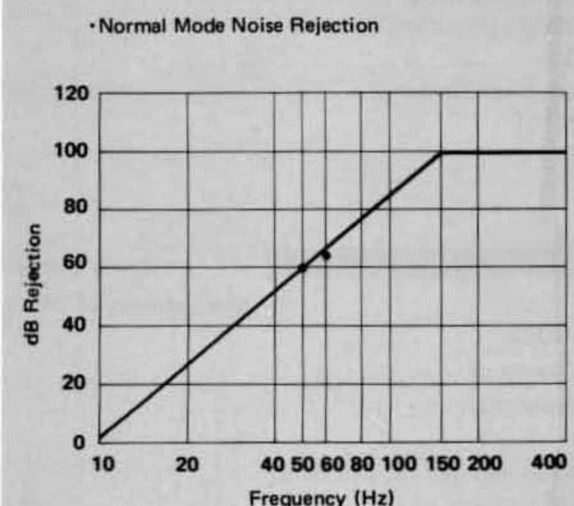
Normal Mode (filtered)	Greater than 65 db @ 60 Hz (60 db @ 50 Hz)
Maximum superimposed AC Voltage	50% of range peak AC, maximum

NOTE: The Normal Mode and Common Mode Rejection are not 60 Hz harmonic oriented due to the broadband response of the active 4 pole filter (80 db per decade attenuation) and therefore will reject random noise at any frequency.

Common Mode (with up to 1K unbalance in either lead)

DC	Greater than 140 db
AC to 60 Hz, Filter "in"	Greater than 140 db
Filter "out"	Greater than 100 db

Typical 8400A, Filter In



The Fluke 8400A is not dependent on 60 Hz harmonics and therefore will reject random noise at any frequency. The same applies to Common Mode Rejection.

NOTE: Common Mode Rejection specifications are maintained with any combination of options installed and are unaffected when grounded devices are used in conjunction with the remote control or data output options.

RESPONSE TIME (from an input step change to a completed reading within 0.005% of the change when externally triggered)

Filter "out"	Less than 33 milliseconds, 100 milliseconds on 0.1V range
Filter "in"	500 milliseconds

GENERAL

Total Digitizing Time	18 milliseconds
Sample Aperture	3 milliseconds
Autozero	3 milliseconds
Sample Rate	Up to 30 readings per second, when externally triggered via Data Output Option, 8400A-03. Manually variable from 13 per second to one per 4.5 seconds via front panel sample rate control.
Autorange Time Filter "out"	50 milliseconds per range change
Filter "in"	280 milliseconds per range change
Filter	4-pole active filter for use with DC volts, AC volts, and Resistance measurements
Range Selection	Manual, Automatic Standard; Remote Optional
Function Selection	Manual Standard, Remote Optional, Autoranges from Ω to KΩ
Display	In-line neon-tube display of polarity, overrange digit and 5 full decades of digits, with automatic decimal placement plus an illuminated function annunciator.
Overload Limits (Maximum voltage that may be continuously applied without damage)	
"Hi" to "Lo"	See individual functions under "range", & "overload"
"Lo" to "Guard"	±100V DC or peak AC
"Guard" to "Chassis"	±1000V DC or peak AC maximum Common Mode Voltage
Temperature Range, Operating	0°C to +50°C
Non-Operating	−40°C to +75°C
Humidity Range 0°C to +25°C	Less than 80% relative Humidity
+25°C to +50°C	Less than 70% relative Humidity
Altitude Range Operating	To 10,000 feet (3,048 kM)
Non-Operating	To 50,000 feet (15,25 kM)
Shock and Vibration	Meets requirements of MIL-T-21200H and MIL-E-16400F
Operating Power (including Options)	115/230 VAC ± 10%, 50 to 440 Hz, Less than 25W
Weight (including Options)	Less than 20 pounds (9,08 kg)
Size	3½" H x 17" W x 18" D (88, 1 mm x 432 mm x 457, 4 mm)
Warm-up Time	20 minutes to 1 year accuracy, 1 hour to full accuracy.
MTBF	10,000 hours

OPTIONS

TRUE RMS CONVERTER

(Using Option 8400A-09)

For Measurement of DC-Coupled (AC+DC) Voltages or AC-Coupled (AC Only) Voltages(3)

RANGES	1, 10, 100, 1000 VAC
Overrange	20%, 1100V RMS maximum on 1000V range
Resolution	0.001% range (10 μV on 1V range)
Overload	1100V RMS any range (1500V peak AC)
Superimposed DC (AC only)	1100V DC (Peak AC plus DC may not exceed ± 1500V)
Max. Crest Factor	7 at full-scale and increasing down scale per: $7X\sqrt{\frac{\text{V Range}}{\text{V Input}}}$

ACCURACY

		AC+DC (3)	AC ONLY
	D.C.	±(0.1% of input + 0.03% of range)	
	50Hz-10kHz	±(0.1% of input + 0.03% of range)	±(0.1% of input + 0.012% of range)
90 days,	10kHz-30kHz(2)	±(0.2% of input + 0.06% of range)	±(0.2% of input + 0.04% of range)
(18°C to 28°C)	30kHz-50kHz(2)	±(0.3% of input + 0.12% of range)	±(0.3% of input + 0.1% of range)
(0.001V-1100V(1))	20Hz-50Hz	±(0.5% of input + 0.03% of range)	±(0.5% of input + 0.012% of range)
	10Hz-20Hz	±(1.0% of input + 0.06% of range)	±(1.0% of input + 0.04% of range)
	50kHz-100kHz(2)	±(1.0% of input + 0.3 % of range)	±(1.0% of input + 0.3% of range)
	100kHz-300kHz(2)	±(2.0% of input + 0.5 % of range)	±(2.0% of input + 0.5% of range)

(1) With inputs above 500V multiply accuracy by $\left[\frac{2000V + V\,input}{2000V}\right]$

(2) Input volt x hertz, product should not exceed 2×10^7

(3) Switch selectable. Located on P.C. Board. Accessable through guard cover.

Temperature Coefficients (0°C to 18°C and 28°C to 50°C)

DC and 10 Hz - 10 kHz (AC+DC)	±(0.004% Inp. +0.004% Range) /°C
10 Hz - 10 kHz (AC only)	±(0.004% Inp. + 0.001% Range) /°C
Input Impedance	1 Megohm, shunted by less than 150 pf.

NOISE REJECTION

Common Mode (with up to 100Ω unbalance in either lead)

DC to 60 Hz. . . . . Greater than 120 db

RESPONSE TIME (to a reading within 0.1% of range when measuring step change inputs and using external trigger).

Filter "out"	100 milliseconds maximum(4)
Filter "in"	500 Milliseconds maximum

(For readings less than 10% Range, double indicated times).

(4) Above 400Hz for rated accuracies.

RESISTANCE (Using Option 8400A-02)

RANGES. . . . . 10Ω, 100Ω, 1000Ω, 10,000Ω, 100 KΩ, 1000 KΩ, 10,000KΩ

NOTE: Model 8400A will autorange through all resistance ranges.

Resolution		0.001% of range, (100 uΩ maximum on 10 Ω range)
Overrange		20%, 12 megohms maximum on 10,000K range
Overload,	10Ω - 10,000Ω ranges	20V RMS (fused-spare supplied)
	100KΩ - 10,000 KΩ ranges	Up to 250V RMS may be continuously applied without damage.

ACCURACY (To 120% of range)

90 days,	100kΩ - 1000kΩ ranges	±(0.01% of input +0.002% of range)
(18°C to 28°C)	100Ω - 10,000Ω ranges	±(0.01% of input +0.003% of range)
	10Ω range	±(0.01% of input +0.01% of range)
	10,000kΩ range	±(0.05% of input +0.002% of range)

Temperature Coefficients (0° to 18°C and 28° to 50°C)

100kΩ, 1000kΩ ranges	±(0.0007% of input +0.0001% of range)/°C
10,000kΩ range	±(0.003% of input +0.0001% of range)/°C
100Ω - 10,000Ω range	±(0.001% of input +0.0002% of range)/°C
10Ω range	±(0.001% of input +0.0005% of range)/°C

CONFIGURATION . . . . True 4-terminal through 10,000Ω range and 2 terminal on the 100 KΩ through 10,000 KΩ ranges.

Current through R measured

Range	10Ω, 100Ω,	1000Ω,	10,000Ω,	100KΩ	1000KΩ, 10,000 KΩ
Current	10 ma	1 ma	100 μa	10 μa	1 μa

Maximum Lead Resistance (for less than 0.001% of range effect on accuracy)

4 terminal mode, Current leads	10Ω in both leads on 10Ω range and 100Ω on all other ranges
Voltage leads	1 KΩ in either lead on all ranges.
2 terminal mode	Less than 0.001% of range lead resistance.

RESPONSE TIME (from an input step change to a completed reading within 0.01% of the change when externally triggered).

Filter "out"	33 milliseconds, 100 milliseconds on 10Ω range
Filter "in"	500 milliseconds

ISOLATED DC EXTERNAL REFERENCE (4-Wire DC/DC Ratio using Options 8400A-05 and 8400A-07)

NOTE: Mating connector is supplied.

REFERENCE INPUT

Type	True 4-Wire, Real Time
Voltage Range	+1V to +10.5V
Input Resistance	1 megohm ±0.1%
Isolation of Reference and Input Commons *NOTE: Fused to prevent damage.*	Input Hi to Input Lo voltage plus Input Lo to Reference Lo voltage, not to exceed ± 13V on 10V and lower DC Voltage ranges.
RATIO RANGES	±0.01:1, ±0.1:1, ±1:1, ±10:1, ±100:1
Resolution	±0.001% of DC Voltage range, (0.000001: 1 maximum on ±0.01: 1 ratio range)
Overrange	20%, 110: 1 maximum input on 100: 1 range

NOTE: $\frac{\%\ \text{Input Voltage Range}}{\%\ \text{Reference Voltage Range}}$ *must be less than 1.2 for a non-overrange reading.*

Overload	±1100V DC or RMS (±1500V peak) may be continuously applied to the numerator (input) terminals without damage.
Reading vs. Ratio	10 x Ratio

ACCURACY (To 120% of ratio range)

90 days (18°C to 28°C)	±1:1, ±10:1, ±100:1 ratio ranges	±(0.005% of Reading + 0.002% x $\left(\frac{10V}{Vref}\right)$ of DC Voltage range)
	±0.1:1 ratio range	±(0.005% of Reading + 0.004% x $\left(\frac{10V}{Vref}\right)$ of DC Voltage range)
	±0.01:1 ratio range	±(0.005% of Reading + 0.01% x $\left(\frac{10V}{Vref}\right)$ of DC Voltage range)

NOTE: 24 hour and 1 year specifications available upon request.

Temperature Coefficients (0°C to 18°C and 28°C to 50°C)

±1:1, ±10:1, ±100:1 ratio ranges	±(0.0003% of Reading + 0.0001% x $\left(\frac{10V}{Vref}\right)$ of DC Voltage range)/°C
±0.1:1 ratio range	±(0.0004% of Reading + 0.0002% x $\left(\frac{10V}{Vref}\right)$ of DC Voltage range)/°C
±0.01:1 ratio range	±(0.0005% of Reading + 0.0006% x $\left(\frac{10V}{Vref}\right)$ of DC Voltage range)/°C

NOISE REJECTION (At Reference Input)

Normal Mode	30 db @ 60 Hz
Common Mode (with up to 1K unbalance)	120 db with a +10V Reference
REFERENCE SETTLING TIME	2 seconds

(To 0.01% of range following a step change of reference voltage. Numerator response time same as "dc volts".)

AC EXTERNAL REFERENCE (3-Wire AC/AC Ratio using Options 8400A-01, 8400A-06, and 8400A-07).

NOTE: Mating connector is supplied.

REFERENCE INPUT

Type	3-Wire, Real Time
Reference Ranges	1V, 10V, 100V (internal selection)
Reference Voltage	10% to 105% of Reference Range
Input Impedance	1 megohm shunted by less than 100 pf.

RATIO RANGES

Reference Range	1V	1:1, 10:1, 100:1, 1000:1
	10V	0.1:1, 1:1, 10:1, 100:1
	100V	0.01:1, 0.1:1, 1:1, 10:1
Resolution		0.001% of AC Voltage range, 0.000001: 1 maximum
Overload		130V RMS at Reference Input
Reading vs. Ratio,	1V Ref. Range	1 x Ratio
	10V Ref. Range	10 x Ratio
	100V Ref. Range	100 x Ratio

ACCURACY (90 days at 18°C to 28°C and to 120% of ratio range)

50 Hz - 10 kHz *

1:1 Ratio Range and Reference and Input at the same frequency . . . . ±(0.05% of Reading + 0.005% x (Ref. Range/V_{ref})of AC Voltage range)

**NOTE:* *Specifications from 10 Hz - 50 Hz and 10 kHz - 100 kHz available on request.*

Input and Reference not at the same frequency or not on the 1:1 ratio Range . ±(0.1% of Reading + 0.005% x (Ref. Range/V_{ref})of AC Voltage range)

Temperature Coefficient

(0°C to 18°C and 28°C to 50°C) . . . . $\pm$(0.004% of Reading + 0.001% x (Ref Range/V_{ref}) of AC Voltage range)

REFERENCE SETTLING TIME . . . . 500 milliseconds

(To 0.05% of range following a step change of reference voltage. Numerator response time same as "ac volts").

AC VOLTS (Average responding converter using Option 8400A-01)

RANGES 1V, 10V, 100V, 1000V

Resolution	0.001% of range, (10μV maximum on 1V range)
Overrange	20%, 1100V RMS maximum input on 1100V range
Overload	1100V RMS may be continuously applied to any range without damage
Superimposed DC	$\pm$1100V DC (Peak AC plus DC may not exceed $\pm$1500V)

ACCURACY (To 120% of range or 1100V maximum input)

0.001V to 500V,	50 Hz - 10 kHz	$\pm$(0.05% of input + 0.005% of range)
(90 days,	10 kHz - 50 kHz	$\pm$(0.1% of input + 0.005% of range)
18°C to 28°C)	20 Hz - 50 Hz and 50 kHz - 100 kHz	$\pm$(0.5% of input + 0.005% of range)*
	10 Hz - 20 Hz	$\pm$(1.0% of input + 0.01% of range)
500V to 1100V,	50 Hz - 10 kHz	$\pm$0.1% of input
90 days	10 kHz - 50 kHz	$\pm$0.15% of input *
(18°C to 28°C)	20 Hz - 50 Hz	$\pm$(0.5% of input + 0.005% of range)
	10 Hz -20 Hz	$\pm$(1.0% of input + 0.01% of range)

**NOTE:* *Input Volt - Hertz product should not exceed 2×10^7*

Temperature Coefficients (0°C to 18°C and 28°C to 50°C)

10 Hz - 50 kHz	$\pm$(0.002% of input + 0.0005% of range)/°C
50 kHz - 100 kHz	$\pm$(0.01% of input + 0.0005% of range) / °C

Input Impedance . . . . 1.11 megohm, $\pm$0.1%, shunted by less than 100 pf.

NOISE REJECTION

Common Mode (with up to 100Ω unbalance in either lead)

DC to 60 Hz . . . . Greater than 120 db

RESPONSE TIME (from an input step change to a completed reading within 0.05% of the change when externally triggered).

Filter "out"	100 milliseconds **
Filter "in"	500 milliseconds

***NOTE:* *Above 400 Hz for rated accuracies*

ISOLATED REMOTE CONTROL (Using Option 8400A-04)

NOTE: Mating connector is supplied

Control Levels	0 = function called, 1 = function inactive
Logic Levels	0 = contact closure or 0V, 1 = open or +5V
Input Definition	Series 930 DTL
Control Command Storage	Continuous or addressed remote control of instrument. Triggered address control allows the 8400A to "latch" to input commands. Following latch, the commands may be removed but the functions and ranges commanded will continue to be in effect until the next address trigger.
Interlocks	Incompatible functions or simultaneous ranges cannot be called.
No Call	Volts DC and autorange called
Flag	Remotely control Flag in Data Output Unit.

NOTE: Requires +5V power (150mA) from Data Output Unit or external power supply which can be supplied as a special item. Contact factory for further details.

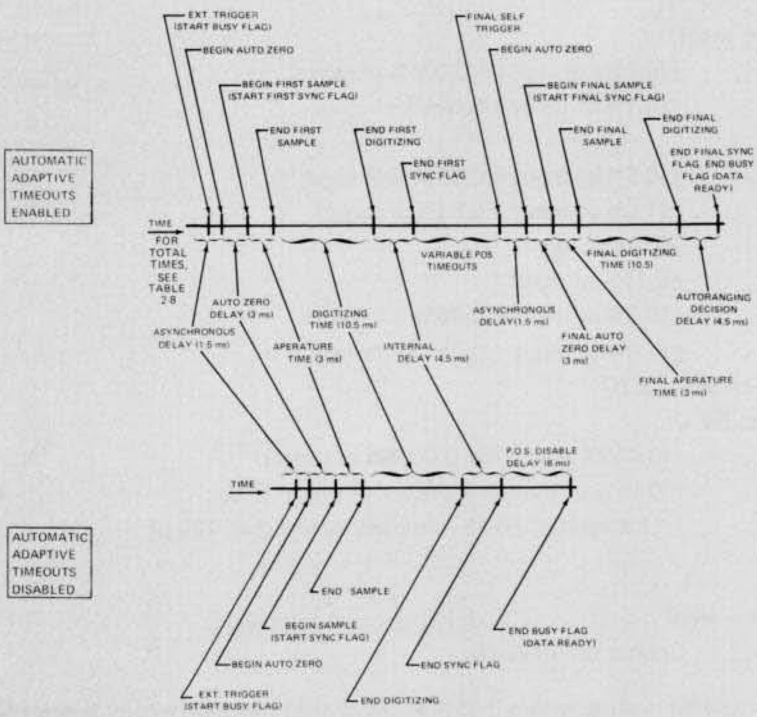
8400A Specifications

ISOLATED DATA OUTPUT (Using Option 8400A-03)

Note: Two mating connectors are supplied.

Data Available	Digits, polarity, range, functions
Coding	8, 4, 2, 1 BCD, digits and range
Logic Levels	1 = +5V, 0 = 0V (Series 930 DTL with 6K pullup)
Maximum Trigger Rate	30 per second
Flags	Digitizing, Remotely Controlled, Remotely Triggered, Busy, Overload, sample sync.
Acquisition	Full parallel or serial by character in multiples of 4 bits.
Automatic Adaptive Timeouts	Automatic delays to allow for settling time of all analog inputs are enabled via a single logic input line.

Timing Diagrams



TOTAL TIMEOUT CHART
(Automatic Adaptibe Timeouts Enabled)

FUNCTION/ RANGE	TOTAL TIME (MS) Filter Out	Filter In
VDC- 10, 100 1000	54±3	523±42
VDC- 0.1, 1.0	123±10	523±42
VAC-all ranges	123±10	523±42
Ω-all ranges	123±10	523±42
KΩ-all ranges	73±6	523±42
Autorange-per range change	add 50	add 280

NOTE: For further details request Application Bulletin #11.

PARALLEL REAR INPUT (Using Option 8400A-07)

PRICES: Basic 8400A and Options

8400A	$2495
8400A-01 AC Converter (1)	$ 695
8400A-02 Resistance Converter	$ 300
8400A-03 Data Output (3)	$ 500
8400A-04 Remote Control (3)	$ 200
8400A-05 DC Ext. Reference (2)(3)	$ 200
8400A-06 AC Ext. Reference (2)(3)	$ 700
8400A-07 Rear Input (3)	$ 75
8400A-09 True RMS Converter (1)	$ 750

ACCESSORIES

A-90 Shunts, 6 Ranges to 10A	$255
80F-5 H-V Probe, 5k VDC, .01% Ratio	$295
80F-15 H-V Probe, 15 k VDC, .05% Ratio	$325
80 RF R-F Probe, 10kHz to 700 MHz	$ 75
M03-205-600 Rack Ears	$ 15
298265 Extender Board	$ 25
M00-280-610 Rack Slides	$ 50
2010A Digital Printer, 10 col.	$795
2010A-7007 Printer Interconnecting Cable	$100

NOTES: (1) Option 8400A-01 and 8400A-09 may not be installed simultaneously
(2) Requires 8400A-07 Option
(3) Mating connectors supplied

The Fluke 8600A 20,000-count digital multimeter

We are proud to introduce a DMM with a 4½ digit LED readout featuring five ranges of dc volts, five ranges of ac volts, five ranges of dc current, five ranges of ac current and six ranges of resistance. With 26 ranges, the instrument offers more measure power than any other instrument available. **Autorange** and **autozero** are standard. Fluke engineers designed it especially to meet the widest possible applications of bench, field and laboratory.

High accuracy

The Fluke 8600A offers a basic dc accuracy of 0.02% for 90 days over a temperature span from 15° C to 35° C. AC provides ±0.2% accuracy at mid band and operates over a 30 Hz to 100 KHz dynamic range. This is the best price and performance you can get anywhere.

Complete protection

All dc voltage ranges from 200 mv through 1200 volts are continuously protected to ±1200 vdc or 1700 volts peak ac. On all resistance ranges from 200 ohms full scale through 20 megohms full scale, the 8600A takes a continuous 250 v rms or dc. A 2-amp front panel fuse protects all ac and dc current ranges.

True portability

Use the Fluke 8600A anywhere for up to 8 hours offline by ordering the rechargeable battery pack with the charger built in. Weight of the 8600A with battery pack is only 4.5 pounds (2.1 kg.). So you really get a portable machine.

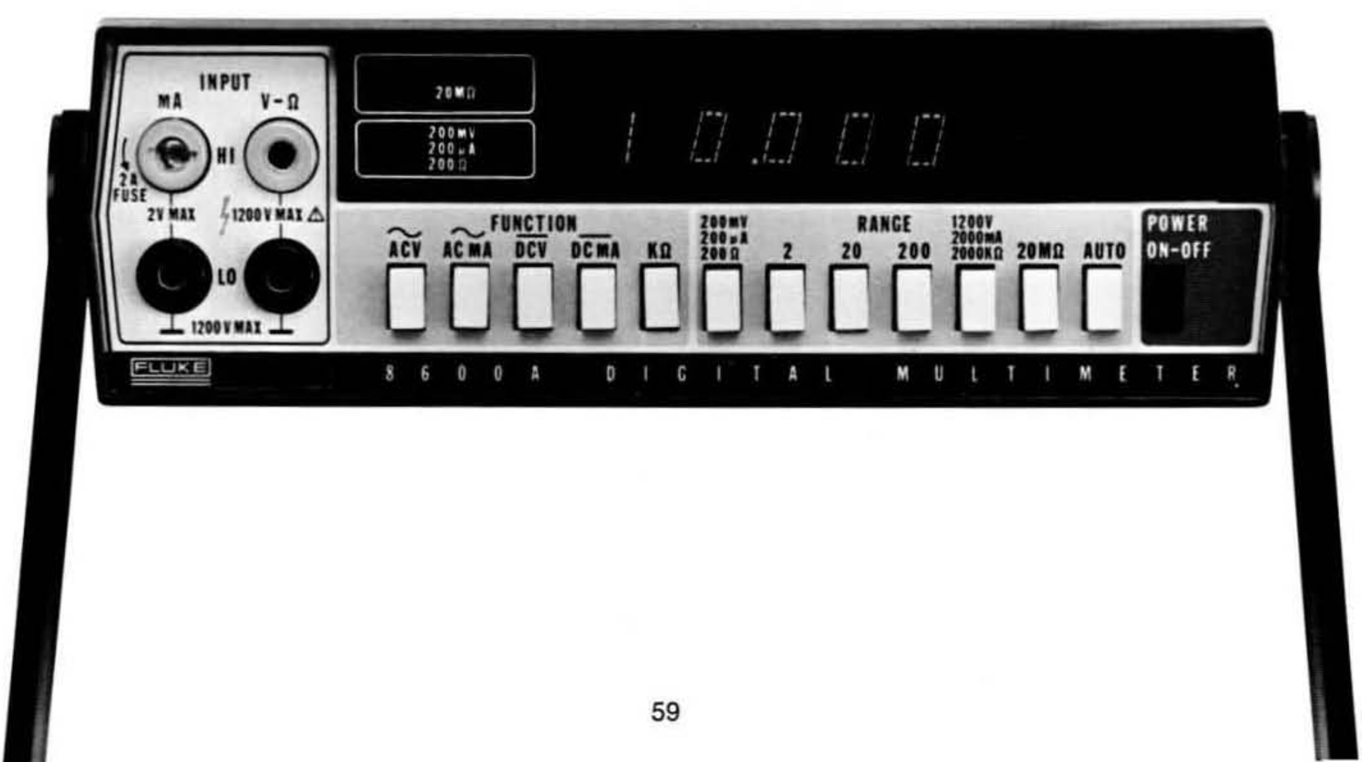
Drive a printer

Another low cost option, TTL/DTL-compatible isolated printer output lets you use the 8600A in data logging applications.

Fluke's 2010A Digital Printer.

The Model 2010A is available with 10 or optionally 18 columns. Printing is at a rate of 2.65 lines per second in black and 2.5 in red. Fan fold paper stacks neatly in the front panel drawer. Standard 2¼" adding machine paper rolls can also be used.

A built-in memory and busy flag enable the 2010A to be connected to instruments with higher sampling rates than the printer's output. The printer can also be placed in a **Standby** mode where the memory continues to be updated but a printout will only occur with a front panel **Manual Print** command.



Specifications

DC VOLTS

Ranges: ±200 mV, ±2V, ±20V, ±200V, ±1200V
Ranging: Full autoranging or manual ranging
Polarity: Automatic bipolarity, + or − display
Resolution: 10 microvolts on 200 mV range
Accuracy: (90 days— 15°C to 35°C) ±(0.02% of input +0.005% of range) for 2, 20, 200V ranges
±(0.02% of input + 0.008% of range) for 1200V range
±(0.04% of input + 0.01% of range) for 200 mV range
DC Input Resistance: >1000 MΩ, 200 mV, 2V, 10 MΩ 20V, 200V, 1200V
Zero Stability: Auto zeroed on all ranges
Overload Protection: ±1200V dc or ±1700V peak ac applied continuously to any range
Normal Mode Noise Rejection: 60 dB minimum at 50 Hz and 60 Hz
Common Mode Noise Rejection: 120 dB minimum (with 1 kΩ in either lead) at DC, 50 Hz and 60 Hz
Response Time To Rated Accuracy Within Range: 1 second maximum to displayed input

AC VOLTS

Ranges: 200 mV, 2V, 20V, 200V, 1200V
Ranging: Full autoranging or manual ranging
Resolution: 10 microvolts on 200 mV range
Accuracy: 90 Days (15°C to 35°C)

200 mV Range: (100% to 1% of range)
±(0.2% of input + 0.08% of range) 50 Hz—10 kHz
±(0.5% of input + 0.10% of range) 30 Hz—50 Hz and 10 kHz—50 kHz
±(0.5% of input + 0.5% of range) 50 kHz—100 kHz

2V Range—200V Range: (100% to 1% of range)
±(0.2% of input +0.015% of range) 50 Hz—10 kHz
±(0.5% of input + 0.025% of range) 30 Hz—50 Hz and 10 kHz—50 kHz
±(1.0% of input + 0.05% of range) 50 kHz—100 kHz

1200V Range: (100% to 1% of range)
10V to 500V
±(0.2% of input + 0.03% of range) 50 Hz—10 kHz
500V to 1200V
±(0.37% of input + 0.03% of range) 50 Hz—10 kHz
10V to 1200V
±(0.5% of input + 0.08% of range) 30 Hz—50 Hz and 10 kHz—20 kHz

AC Input Impedance: 2MΩ shunted by less than 100 pF
Overload Protection: 1200V rms maximum, not to exceed $2(10^7)$V Hz product
Response Time To Rated Accuracy Within Range: 1.5 second maximum to displayed input

DC CURRENT

Ranges: 200 μA, 2 mA, 20mA, 200 mA, 2000 mA
Ranging: Manual ranging
Resolution: 10 nA on 200 μA range
Accuracy (90 Days—15°C to 35°C): ±(0.1% of input +0.01% of range) on all ranges
Voltage Burden: 0.5V maximum at 2 Amps, 0.25V to 200 mA
Overload: Protected to 2 Amps on any range; fused above 2A
Response Time To Rated Accuracy Within Range: 1 second maximum to displayed input

AC CURRENT

Ranges: 200 μA, 2 mA, 20 mA, 200 mA, 2000 mA
Ranging: Manual Ranging
Resolution: 10 nA on 200 μA range
Accuracy: 90 Days (15°C to 35°C) ±(0.3% of input + 0.08% of range) 50 Hz—10 kHz
All ranges (except 2000 mA range 50 Hz—5 kHz)
±(0.6% of input + 0.1% of range) 30 Hz—50 Hz
All ranges
Voltage Burden: 0.5V maximum at 2 Amps, 0.25V to 200 mA
Overload: Protected to 2A on any range; fused above 2A
Response Time To Rated Accuracy Within Range: 1 second maximum to displayed input

OHMS

Ranges: 200Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, 20 MΩ
Ranging: Full autoranging or manual ranging
Resolution: 10 milliohm on 200 ohm range
Configuration: 2 wire
Accuracy: (90 Days— 15°C to 35°C) ±(0.1% of input + 0.015% of range) 200Ω range
±(0.1% of input + 0.005% of range) 2 kΩ range
±(0.05% of input + 0.005% of range) 20 kΩ to 2000 kΩ range
±(0.2% of input + 0.005% of range) 20 MΩ range

Maximum Open Circuit Voltage: 5 volts
Overvoltage Protection: 250V rms or dc, applied continuously
Response Time To Rated Accuracy Within Range: 1.0 second maximum to displayed input (200Ω range to 2000kΩ range)
4 seconds maximum to displayed input (20 MΩ range)
Current Through Unknown:

200Ω	2 kΩ	20 kΩ	200 kΩ	2000 kΩ	20 MΩ
1 mA	1 mA	100 μA	10 μA	1 μA	.1 μA

GENERAL

Function: Selected via front panel controls
Range: Automatic or manual selected via front panel controls
Autorange Rate: 600 ms maximum per range change
Display: 7 segments 0.3" LED display, automatic decimal location
Reading Rate: 2½ samples/second within range
Overload Indication: Flashing display of +18888 (built-in segment test of LED display) for out of range indication
Operating Temperature: 0°C to +50°C
Temperature Coefficients: (0°C to 15°C and 35°C to 50°C)
DC Volts Except 200 mV: ±(0.001% input + 0.0005% range)/°C
DC Current and 200 mV: ±(0.003% input + 0.001% range)/°C
AC Volts Except 200 mV: ±(0.01% input + 0.002% range)/°C
AC Current and 200 mV: ±0.015% input + 0.005% range)/°C
kΩ Except 200Ω and 20 MΩ: ±(0.003% input + 0.0005% range/°C
200Ω and 20 MΩ: ±(0.005% input + 0.001% range)/°C
Storage Temperature: −40°C to +75°C (−40°C to +60°C with batteries)
Humidity Range: 80% R.H., +5°C to +35°C
70% R.H., +35°C to +50°C
Shock and Vibration: Meets pertinent requirements of MIL-T-21200L and MIL-E-16400F
MTBF: 10,000 hours calculated, minimum
Maximum Common Mode Voltage: 1000V dc or peak ac
Power: 115/230V ac ±10%, 50 or 60 Hz, 7 watts line 10 watts battery
Size: 8½" W x 2½" H x 10" D
216 mm W x 64 mm H x 254 mm D
Weight: 3.5 lbs. (1.6 kg) line; 4.5 lbs. (2.1 kg) w/batteries

OPTIONS

-01, Battery Pack: Rechargeable battery pack, capable of 8 hours typical (6 hours minimum) operation, rechargeable in 16 hours maximum
-02, DOU: Isolated BCD output, TTL/DTL compatible levels (not compatible with option -01)
Available Data: Digits, polarity (both logic senses) and range
Data Coding: 8-4-2-1 BCD positive true parallel (negative true easily obtained by changing output buffers)
Logic Levels: "1" = +5V, "0" = 0V
Drive Capability: All outputs can drive a minimum of two TTL loads (i.e., sink 3.2 mA)
Flags: Busy, not busy, and overload
Controls: External trigger (negative-going edge triggers); External trigger enable (Logic "1" enables external trigger, Logic "0" causes data update at the internal sample rate of approximately 2.5/second); +5V reference

ACCESSORIES

High Voltage Probe: (80K-40) Voltage Range: 1 kV to 40 kV
Input Resistance: 1000 MΩ
Ratio: 1000:1
Overall Accuracy: 20 kV to 30 kV ±2% (Calibrated 1% at 25 kV)
Upper Limit: Changes Linearly from 2% at 30 kV to 4% at 40 kV
Lower Limit: Changes Linearly from 2% at 20 kV to 4% at 1 kV (Calibrated from 10 MΩ DVM input resistance)
RF Probe: low cost (81RF)
Range: 0.25V to 30V rms, 12 MΩ input Z, 350V dc maximum
Response: 100 kHz to 100 MHz ±1 dB. Useable from 20 kHz to 250 MHz
RF Probe: (80RF—1) Input Voltage Range: 0.25V to 30V. Response: 100 kHz to 500 MHz ±1 dB accuracy. Useable from 1 kHz to 1 GHz
Clamp-on AC Current Probe: (80I-600) Range: 2 Amps to 600 Amps
Accuracy: ±3%
Deluxe Test Lead Kit: (A80) Universal test leads having two color coded leads with insulated, threaded adapters on each end suitable for attachment of the following adapters: 1. Banana plugs, 2. Pin Tips, 3. Test Prod Tips, 4. Alligator Clips, 5. Binding Post Lugs
Carrying Case (C-80) Soft vinyl case formed to carry the Model 8600A and accessories with convenient viewing window and shoulder strap
Carrying Case (C-86) Rugged polyethylene case, with handle and storage compartment for test leads, power cord and other compact accessories
Front Panel Dust Cover: MOO-100-714
Rack Mount Kits: MOO-200-611 (Offset); MOO-200-612 (Center); MOO-200-613 (Dual)

The Fluke 8800A 200,000-count digital multimeter

This extraordinary DVM offers a basic dc accuracy of 0.005% with full autoranging. There are fifteen ranges which include five dc, four ac, and six resistance. Complete isolated four terminal ohms measurements are provided on all ranges. Separate current and voltage inputs are available to provide the ultimate in ohms accuracy by eliminating errors caused by input lead resistance. LED readout is bright and readable.

Fluke engineers designed the 8800A especially for your most exacting laboratory and bench applications. And then we used our LSI technology to build in performance at a price heretofore impossible.

Fully guarded, completely isolated

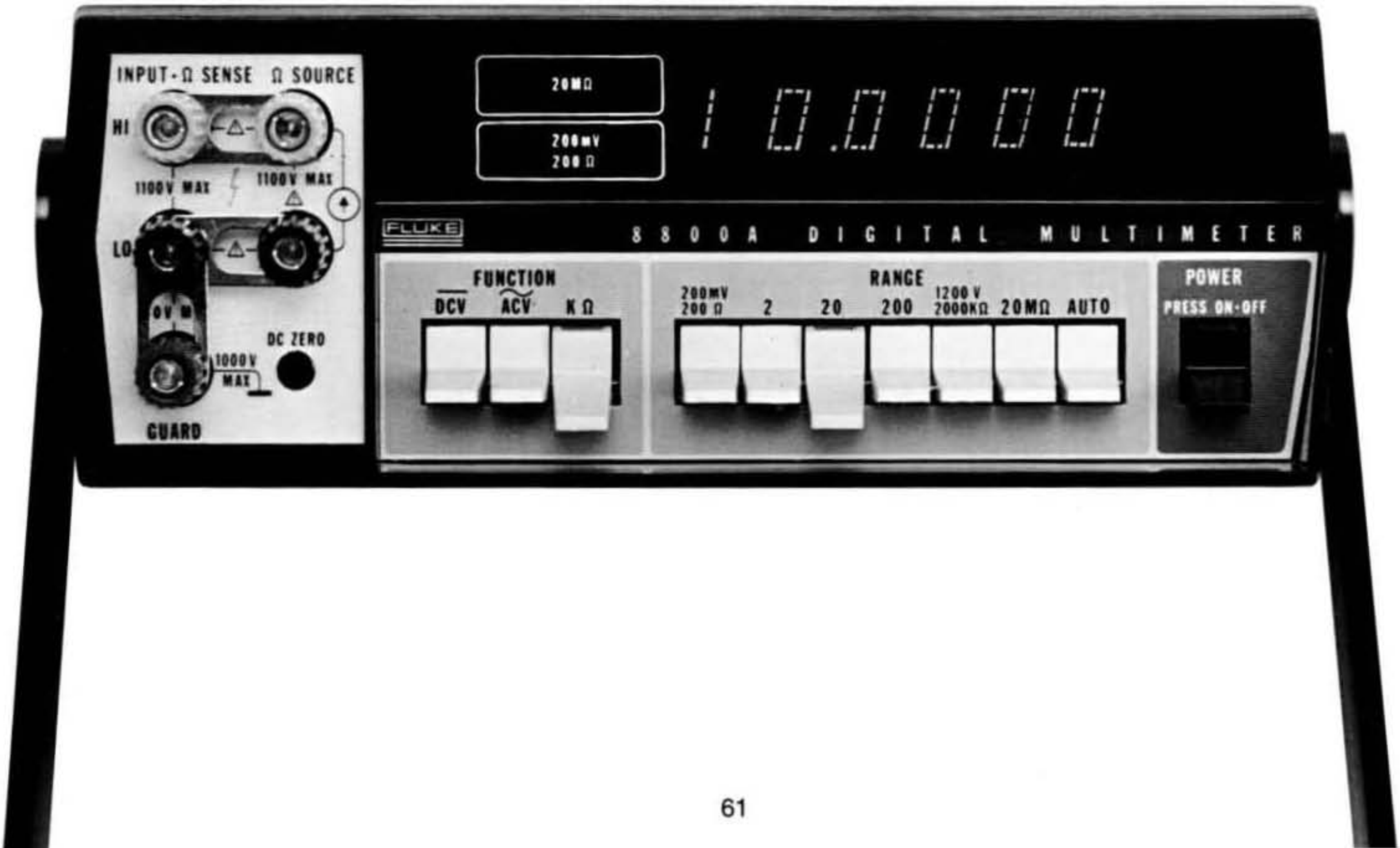
The Fluke 8800A has an input resistance better than 1,000 megohms on the 200 mV, 2 V, and 20 V ranges and 20 megohms on the 200 V and 1200 V ranges. Common mode rejection is better than 120 dB dc to 60 Hz. Normal mode rejection is better than 60 dB at 50 and 60 Hz. Your load is fully isolated from ground loops, noise and stray voltages. You get the accuracy you paid for under a wide variety of ambient environments.

Overload protection

No voltmeter around offers better overload protection. After we engineered in all the overload protection you would possibly want, we thought about cost-performance tradeoffs. The Fluke 8800A offers you protection on the most sensitive ranges from continuous applications of up to 1000 VDC or 1400 VAC peak. Resistance protection from a continuous 250 V rms or dc is offered from 200 ohms through 20 megohms.

Strength without weight

Electronics technology is one major breakthrough of the century, materials technology another. All of the new Fluke portable voltmeters take advantage of this progress. The Fluke 8800A case is molded from some of the toughest plastics available with all electronic boards, IC chips and components securely fastened within. In fact, the voltmeter will take a lot of abuse and still operate well within specifications. Yet with all this, the Fluke 8800A weighs less than 7 pounds or less than half the amount of comparable instrumentation.



Specifications

DC VOLTS

Ranges: ±200 mV, ±2V, ±20V, ±200V, ±1200V
Ranging: Full autoranging or manual ranging
Polarity: Automatic bipolarity, + or − display
Resolution: 1 μV on 200 mV range
Accuracy:

	24 Hour, 23°C ±1°C	90 Day, 18°C −28°C
200 mV Range	±(0.008% input + 0.0025% range)	±(0.01% input + 0.005% range)
2V−200V Range	±(0.005% input + 0.001% range)	±(0.01% input + 0.0015% range)
1200V Range	±(0.005% input + 0.002% range)	±(0.01% input + 0.003% range)

Temperature Coefficient: (0°C−18°C, 28°C−50°C) ±(0.0007% input + 0.0013% range)/°C, 200 mV range
±(0.0007% input + 0.0003% range)/°C, 2V range
±(0.0007% input + 0.0002% range)/°C, 20V, 200V range
±(0.0007% input + 0.0003% range)/°C, 1200V range
DC Input Resistance: ≥1000 MΩ on 200 mV, 2V, and 20V ranges
10MΩ on 200V and 1200V ranges
Offset Current (at 23°C): Less than 15 pA on any range. Temperature Coefficient of ±5 pA/°C
Zero Stability: Better than 10 μV for 90 days after one hour warmup
Overload Protection: 200V, 1200V range, ±1200V dc, 1700V peak ac
200 mV, 2V, 20V range, ±1000V dc, 1400V peak ac
Normal Mode Noise Rejection: ≥60 dB at 50 Hz and 60 Hz
Common Mode Noise Rejection: ≥120 dB at dc to 60 Hz (with 1 kΩ in either lead)
Response Time To Rated Accuracy Within Range: 1 second maximum to displayed input

AC VOLTS

Ranges: 2V, 20V, 200V, 1200V
Ranging: Full autoranging or manual ranging
Resolution: 10 μV on 2V range
Accuracy:

2V−200V ranges (100% to 0.1% of range)

Frequency:	24 Hour, 23°C ±1°C	90 Day, 18°C −28°C
100 Hz−10 kHz:	±(0.05% input + 0.005% range)	±(0.1% input + 0.005% range)
50 Hz−100 Hz, 10 kHz−20 kHz:	±(0.1% input + 0.01% range)	±(0.25% input + 0.01% range)
30 Hz−50 Hz, 20 kHz−100 kHz:	±(1.0% input + 0.03% range)	±(1.0% input + 0.03% range)

1200V range (100% to 0.1% of range) 90 days 18°C −28°C

	1V to 500V	500V to 1200V
100 Hz−10 kHz:	±(0.15% input + 0.01% range)	±(0.3% input + 0.01% range)
30 Hz−100 Hz, 10 kHz−20 kHz:	±(0.25% input + 0.02% range)	±(0.5% input + 0.02% range)

Temperature Coefficient: (0°C−18°C, 28°C−50°C) ±(0.008% input + 0.001% range)/°C, 2V−200V ranges
±(0.008% input + 0.002% range)/°C, 1200V range
AC Input Impedance: 2 MΩ shunted by less than 100 pF
Overload Protection: 1200V rms maximum, not to exceed 2×10^7V Hz product. 20 kHz maximum on 1200V range.
Response Time To Rated Accuracy Within Range: 1.5 second maximum to displayed input

OHMS

Ranges: 200Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, 20MΩ
Ranging: Full autoranging or manual ranging
Configuration: 4-terminal measurement on all ranges
Resolution: 1 mΩ on 200 ohm range
Accuracy:

	Temp. Coef.	24 Hour, 23°C ±1°C	90 Day, 18°C −28°C
200Ω:	±(0.001% + 0.0013%)/°C	±(0.01% input + 0.0025% range)	±(0.02% input + 0.005% range)
2 kΩ− 200 kΩ:	±(0.001% + 0.0003%)/°C	±(0.008% input + 0.001% range)	±(0.01% input + 0.0015% range)
2000 kΩ:	±(0.005% + 0.0003%)/°C	±(0.02% input + 0.001% range)	±(0.05% input + 0.0015% range)
20 MΩ	±(0.02% + 0.0003%)/°C	±(0.05% input + 0.001% range)	±(0.2% input + 0.0015% range)

Current Through Unknown:

Range:	200Ω	2 kΩ	20 kΩ	200 kΩ	2000 kΩ	20 MΩ
Maximum Current through Unknown:	1 mA	1 mA	250 μA	25 μA	2.5 μA	0.25 μA

Maximum Open-Circuit Voltage: 3.3 volts
Overvoltage protection: 250V rms or dc, applied continuously to any range
Response Time: 1.0 second maximum to displayed input (200Ω through 200 kΩ range)
3.0 seconds maximum to displayed input (2000 kΩ and 20 MΩ range)

GENERAL

Function: Selected via front panel controls
Range: Automatic or manual selected via front panel controls
Autorange Rate: 600 msec maximum per range change.
Display: 7 segment, 0.3" LED display, automatic decimal location
Reading Rate: 2.5 readings/second within range
Overload Indication: Flashing display of +188888 (built-in segment test of LED display) for out of range indication
Operating Temperature: 0°C to +50°C
Storage Temperature: −40°C to +75°C
Humidity Range: 70% RH, 35°C to 50°C
80% RH, +5°C to +35°C
Shock and Vibration: Meets pertinent requirements of MIL-T-21200L and MIL-E-16400F
MTBF: 10,000 hours calculated, minimum
Maximum Common Mode Voltage: 1000V dc or peak ac
Maximum LO to GUARD Voltage: 100V dc or peak ac
Power: 110/230V ac ±10%, 50 or 60 Hz, 8 watts
Size: Maximum dimensions: 3½" H x 9" W x 12½" D
89 mm x 229 mm x 318 mm
Weight: 6.5 lbs. (3.0 kg)

ACCESSORY

Rack Mount Kit (center): MOO-200-625

OPTION

-02 (DOU): Isolated BCD output, TTL/DTL compatible levels
Available Data: Digits, polarity (both logic senses), and range
Data Coding: 8-4-2-1 BCD positive true parallel (negative true easily obtained by changing output buffers)
Logic Levels: "1" = +5V, "0" = 0V
Drive Capability: All outputs can drive a minimum of two TTL loads (i.e., sink 3.2 mA)
Flags: Busy, not busy, and overload
Controls: External trigger (negative-going edge triggers); External trigger enable (Logic "1" enables external trigger, Logic "0" causes data update at the internal sample rate of approximately 2.5/second); +5V reference

Prices for basic

Model 8600A

Basic unit, $599.

Options

Option -01, battery pack, $100.
Option -02, digital output unit (DOU), $150.

Accessories

High voltage probe, Model 80K40, $40.
RF probe, Model 80RF-1, $75.
RF probe, Model 81RF, $40.
High current probe, Model 801600, $50.
Deluxe test leads, Model A80, $5.
Carrying cases,
C80, soft vinyl, $15.
C86, rugged polyethylene, $15.
Rack mount kits,
offset, Model MOO-200-611, $30.
center, Model MOO-200-612, $30.
dual, Model MOO-200-613, $30.

Model 8800A

Basic unit, $1099.

Options

Option -02, digital output unit (DOU), $150.

Accessories

High voltage probe, Model 80K40, $40.
RF probe, Model 80RF-1, $75.
RF probe, Model 81RF, $40.
Deluxe test leads, Model A80, $5.
Rack mount kit, center, MOO-200-625, $30.

Voltmeter Accessories

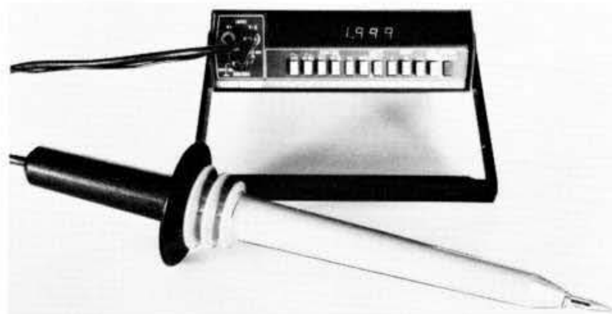
- High Voltage Probes
- Precision Dividers
- Current Probes
- Shunts
- RF Probes
- Physical Accessories

High Voltage Measurements

1000V to 40,000V

High Voltage Probe 80K - 40

A wide range of high voltage dividers are available from Fluke to satisfy your measurement requirements including voltage range, accuracy, input resistance and impedance matching.



FLUKE MODEL 80K–40 WITH 8000A

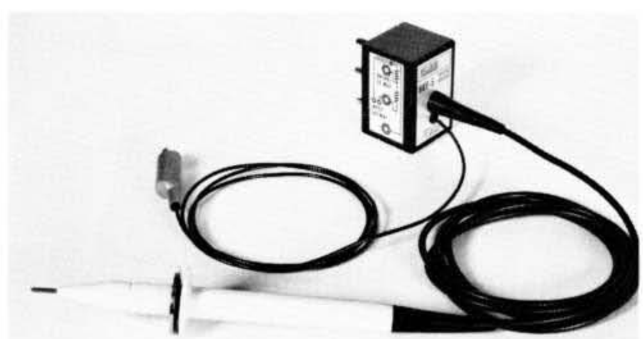
High Voltage Probe: (80K-40) Voltage Range: 1 kV to 40 kV
Input Resistance: 100 MΩ
Ratio: 1000 : 1
Overall Accuracy: 20 kV to 30 kV ±2% (Calibrated 1% at 25 kV)
Upper Limit: Changes Linearly from 2% at 30 kV to 4% at 40 kV
Lower Limit: Changes Linearly from 2% at 20 kV to 4% at 1 kV
Calibrated into 10 MΩ DVM input resistance

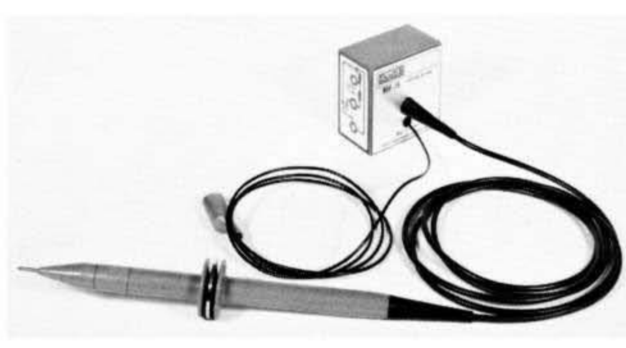
Precision High Voltage Probes 80F–5 and 80F–15

80F-5, 80F-15 HIGH VOLTAGE PROBES (Compatible with most models of Fluke Voltmeters)

	80F-5	80F-15
INPUT VOLTAGE RANGE	500 - 5000V	1000 - 15,000V
INPUT RESISTANCE	50 MΩ	100 MΩ
DIVISION RATIO	1000:1	1000:1
RATIO ACCURACY (23°C ± 1°C) (into 10 MΩ ±0.1% voltmeter input)	±0.05% of input	±0.05% of input
STABILITY OF RATIO	±0.01%/month; 0.05%/year (recalibrated by internal adjustment)	
OPERATING TEMPERATURE RANGE	0°C to 50°C	
TEMPERATURE COEFFICIENT	0.001%/°C	
HUMIDITY RANGE	0 to 80% relative humidity	
CABLE LENGTH	5 ft. min. (1.5m)	
WEIGHT	12 oz. (340 grams)	24 oz. (680 grams)
OPTIONS: –01	Calibrated for output into 11MΩ ±0.1%	
–02	Calibrated for output into $> 10^{10}\Omega$	

Note: 80F-5 or 80F-15 without option –01 or –02 is calibrated for output into 10 megohms.





80F–5, 80F–15 HIGH VOLTAGE PROBES

MODEL	MAXIMUM INPUT VOLTAGE	DC ACCURACY	INPUT RESISTANCE	DIVISION RATIO	CALIBRATED FOR VOLTMETER INPUT RESISTANCE
80K–40	40 KV	2% (nom.)	1000 MΩ	1000 : 1	10 MΩ
80F–5	5 KV	0.05%	50 MΩ	1000 : 1	10 MΩ
80F–5–01	5 KV	0.05%	50 MΩ	1000 : 1	11 MΩ
80F–5–02	5 KV	0.05%	50 MΩ	1000 : 1	10^{10} MΩ
80F–15	15 KV	0.05%	100 MΩ	1000 : 1	10 MΩ
80F–15–01	15 KV	0.05%	100 MΩ	1000 : 1	11 MΩ
80F–15–02	15 KV	0.05%	100 MΩ	1000 : 1	10^{10} MΩ
80E–10	10 KV	0.01%	10 MΩ	1000 : 1 & 10000 : 1	10^{10} MΩ

HIGH VOLTAGE DIVIDER SELECTION GUIDE

High Voltage Divider 80E–10

MODEL 80E–10 HIGH VOLTAGE DIVIDER

Accuracy: ±0.01% for both division ratios over a temperature range from 18°C to 28°C and for any input voltage up to rated maximum. Derate at 2 ppm/°C outside this temperature range to 0°C and 50°C.

Maximum Input Voltage: 10,000 VDC

Divider Current: 1 milliampere nominal at rated input.

Input Resistance: 10 megohms, nominal

Division Ratios: 1,000:1 (10V output at maximum input)
10,000:1 (1V output at maximum input)

Stability of Division Ratio: ±0.01% per year (recalibrated by internal adjustment).

Input Connector: MS3102A-18-16S on front panel (mating connector supplied).

Output Connectors: Two binding posts on ¾" centers for each of two outputs. One side of each output is common to chassis. Separate binding post for grounding case. All output connectors located on front of instrument.

Altitude: 10,000 feet (operating)
50,000 feet (non-operating)

Humidity: 0 to 80% (to 28°C)
0 to 60% (to 50°C)

Panel Meter: 10 - 0 - 10 kV

Input Power: None required

Mounting: Resilient feet provided for bench and portable use. For side-by-side EIA rack mounting with solid-state Fluke Differential Voltmeters, use Adapter Kit 881A-103 (includes handle-bracket and key plate). For EIA Rack Mounting of a single unit, use Adapter Kit 881A-102 (includes brackets with handles).

Size: 7" high x 8½" wide x 8" deep. (17.75 cm x 21.5 cm x 20.4 cm) (19" wide in rack configurations)

Weight: 6 pounds (2.7 kilograms)

Current Measurements

AC Current Clamp-On Probe 801600

The Model 801–600 AC current probe is a true current transformer which is designed to clamp around the current carrying conductor to be measured. This conductor becomes the primary of the current transformer probe. Windings in the probe are the secondary. The current flow in the secondary is measured by placing a known small value of resistance across the probe's output. The voltage across this resistor may then be precisely measured.

MODEL 801-600 CLAMP-ON CURRENT PROBE

CURRENT RANGE	ACCURACY	FREQUENCY RESPONSE	DIVISION RATIO	INSULATION	MAXIMUM CONDUCTOR SIZE
2A-600A	±3%	30 Hz - 1 kHz	1000:1	5 kV	2" diameter

Switched Current Shunt A-90

The Model A–90 current shunts may be used for both DC and AC current measurements over a wide range of currents and frequencies. Voltage may be sensed across the shunts with virtually any voltmeter.

A90 CURRENT SHUNT

RATED CURRENT RANGE	E BURDEN (APPROX.)	SHUNT R	"OUTPUT" AT RATED CURRENT	ACCURACY – WITH VOLTMETER INPUT RESISTANCE ⩾ 10MΩ ±(% OF INPUT + % OF RANGE)	
				DC	**AC (30 Hz - 10 kHz)**
0.1 mA	100 mV	1 kΩ	100 mV	±(0.15 + 0.1)	±(0.3 + 0.5)
1.0 mA	100 mV	100 Ω	100 mV	±(0.15 + 0.1)	±(0.3 + 0.5)
10 mA	100 mV	10 Ω	100 mV	±(0.15 + 0.1)	±(0.3 + 0.5)
100 mA	102 mV	1 Ω	100 mV	±(0.15 + 0.1)	±(0.3 + 0.5)
1 A	120 mV	0.1 Ω	100 mV	±(0.15 + 0.1)	±(0.4 + 0.5)
10 A	300 mV	0.01 Ω	100 mV	±(0.25 + 0.1)	±(0.5 + 0.5) to 4 kHz

RF Measurements

RF Probe 80RF-RF Probe 81RF


MODELS 80RF & 81RF PROBE

High frequency RF probes convert frequencies up to 1 GHz to a DC level proportional to the RMS value of the input. Select either the Model 80RF or the low cost Model 81RF from the specification chart below.

	81 RF	80 RF
Frequency Response	100 kHz to 100 MHz; ±1 dB	100 kHz to 500 MHz; ±1 dB 10 kHz to 500 MHz; ±3 dB
Extended Response (Useful for relative readings)	20 kHz to 250 MHz	1 kHz to 1 GHz
Voltage Range	0.25V to 30V RMS 350V DC Max.	0.25V to 30V RMS 200V DC Max.
Input Impedance	12 MΩ / / 15 pF	4 MΩ / / 2 ±0.5 pF
Voltmeter Input Resistance	10 MΩ ±10%	10 MΩ ±10%

Note: Order 80RF–1 for Models 8000A & 8600A (includes compatible mating connector)

Physical Accessories

Carrying Cases, Dust Covers, Rack Mounting Hardware, Chassis Slides, Test Leads

A complete line of physical accessories are available to protect or enhance the convenience of your Fluke instrument.

	Vinyl Case	Rugged Case	Single Rack	Dual Rack	Offset Rack	Deluxe Test Leads	Chassis Slides	Dust Cover	Extender Boards
8000A	C-80	C-86	M00-200-612	M00-200-613	M00-200-611	A-80	–	M00-100-714	–
8000A–05	C-80	C-86	M00-200-612	M00-200-613	M00-200-611	A-80	–	M00-100-714	–
8000A–06	C-80	C-86	M00-200-612	M00-200-613	M00-200-611	A-80	–	M00-100-714	–

Carrying Cases, Dust Covers, Rack Mounting Hardware, Chassis Slides, Test Leads

	Vinyl Case	Rugged Case	Single Rack	Dual Rack	Offset Rack	Deluxe Test Leads	Chassis Slides	Dust Cover	Extender Boards
8000A	C-80	C-86	M00-200-612	M00-200-613	M00-200-611	A-80	–	M00-100-174	–
8100B	–	C-82	M03-200-607	M00-200-606	–	A-80	M00-260-610	M03-203-700	–
8110A	–	C-82	MEE-7006	MEE-7014	MEE-7013	A-80	–	MEE-4008	–
8120A	–	C-82	M03-200-607	M03-200-606	–	A-80	M00-260-610	M03-203-700	–
8200A	–	C-82	–	M03-200-606	M03-200-607	A-80	M00-260-610	M03-200-700	8200A-4017
8300A	–	–	MEE-7001	–	–	A-80	MEE-8078 & 8079 (18") (24")	–	8300A-4013 8300A-4015
8350A	–	–	M03-205-600	–	–	A-80	M00-280-610	–	–
8375A	–	–	M03-205-600	–	–	A-80	M00-280-610	–	298265
8400A	–	–	M03-205-600	–	–	A-80	M00-280-610	–	8400A-7014
8600A	C-80	C-86	M00-200-612	M00-200-613	M00-200-611	A-80	–	M00-100-174	**8600A-7001**
8800A	–	–	M00-200-625	–	–	A-80	–	–	**8800A-7001**

ELECTRICAL ACCESSORY PRICES

80K–40	$ 40
80F–5	295
80F–5–01	295
80F–5–02	295
80F–15	350
80F–15–01	350
80F–15–02	350
80E–10	395
80I–600	65
A–90	255
80RF	75
80RF–1	75
81RF	40

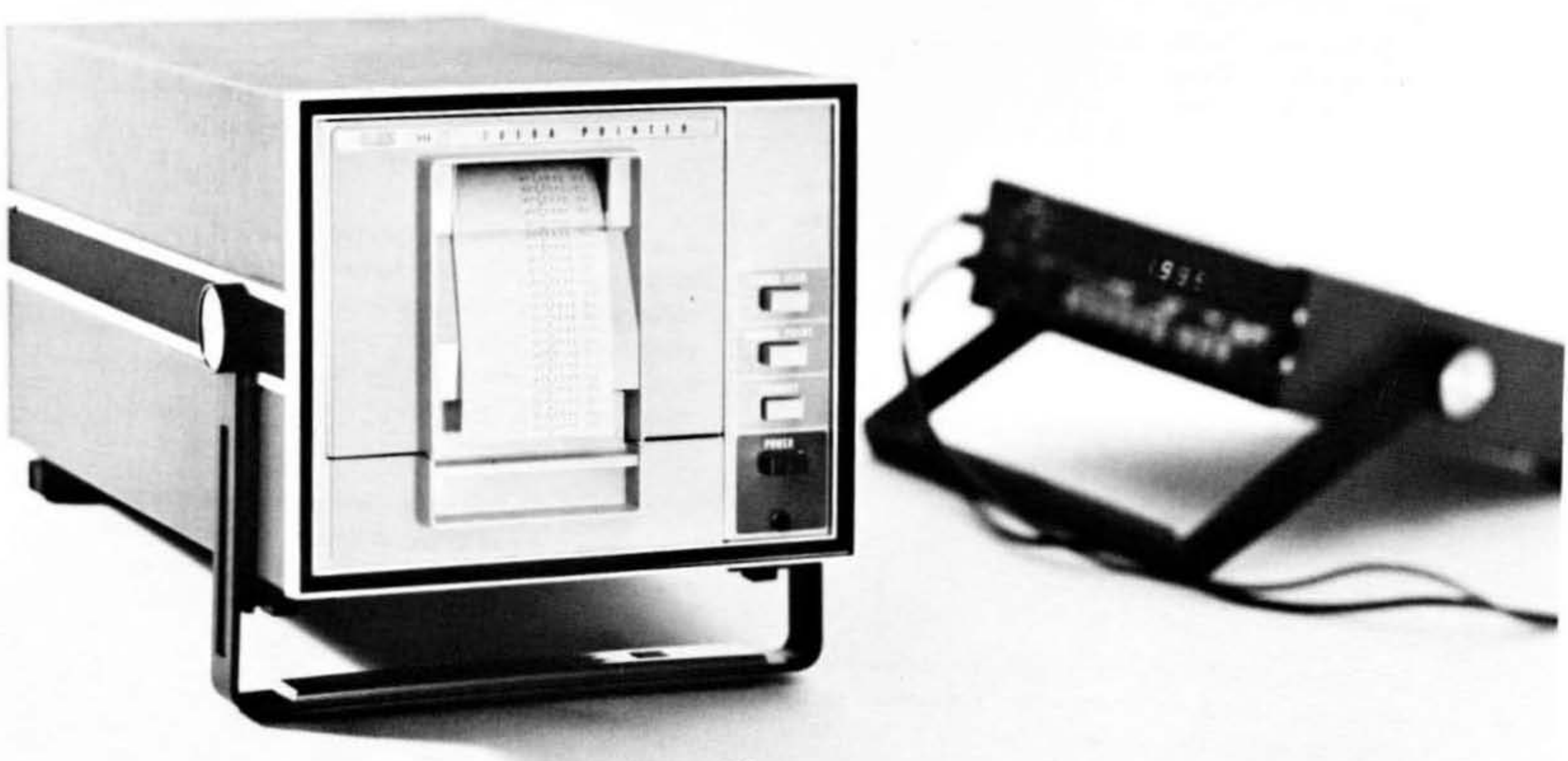
PHYSICAL ACCESSORY PRICES

A–80	$ 5
C–80	15
C–82	100
C–86	15
M00-100-714	8
M00-200-611	30
M00-200-612	30
M00-200-613	30
M00-200-625	30
M00-260-610	50
M00-280-610	50
M03-200-606	25
M03-200-607	40
M03-203-700	10
M03-205-600	15
298265	25
MEE-4008	10
MEE-7001	15
MEE-7006	40
MEE-7013	40
MEE-7014	25
MEE-8078	50
MEE-8079	50
8200A-4017	25
8300A-4013	25
8300A-4015	25
8400A-7014	25
8600A-7001	**50**
8800A-7001	**50**

Digital Printer 2010A

FEATURES

- Complete Instrument Compatibility
- 10 or 18 Column Capability
- Data Storage Standard
- Easy Front Panel Paper Access
- High Reliability



The 2010A Offers You:

GENERAL

The Fluke Model 2010A Printer is a versatile, highly compatible, low cost performer specifically designed for instrumentation requirements. The basic printer records 10 columns, sufficient for recording data from most digital multimeters and counters. For data sources with a larger number of outputs the 2010A is optionally available with 18 columns.

COMPATABILITY

The compatability of the 2010A printer with digital instruments is a key advantage. Many printers require a variety of options to modify programming codes for each digital source. In some cases the user must fabricate external electronic circuits in order to interface a printer.

Because the 2010A has been designed to accept either coded or discrete range and function information, the need for special decoding and encoding circuitry has been eliminated. Cables available from Fluke let the user simply plug-in the printer to Fluke Digital Multimeters or Counters. A general purpose cable is also available to connect the 2010A to other digital sources.

PRINTOUT

The 2010A prints at a rate of 2.65 lines per second in black and 2.5 in red on 2¼" fan fold paper. The fan fold format has been chosen because it is superior to roll paper when data is to be stored for documentation purposes or later evaluation. The fan fold paper self stacks in the front panel drawer of the 2010A.

While fan fold paper is more useful and convenient than roll paper, it is conceivable that situations might dictate user preference for roll paper. For these applications the 2010A can be used with a standard 2¼" roll of adding machine paper. The roll paper adapter is supplied at no charge.

Printing is by ink impression with a standard two color, black and red nylon ribbon (Columbia Model 212PVL015). The hinged front panel of the 2010A allows the ribbon to be changed quickly and easily.

DATA PRESENTATION

Because the 2010A has been designed for instrumentation applications, particular attention has been given to the generation of function characters. Columns 17 and 18 at the extreme right of the printout are used for printing these units of measurement.

In the standard printer these two columns are encoded in four line binary format. See print drum layout below for function characters available and coding for each. In the accessory list are diode matrices that enable the calling of a two column function with a single line. There are three available, the multimeter version calling DCV, ACV, mV, ACmA, DCmA, Ω, kΩ, and MΩ, the counter version calling Hz, kHz, MHz, μs, ms, and s, and the thermometer version calling $^\circ$F, $^\circ$C and mV.

Columns 9 through 16 in the standard unit and columns 1 through 16 in the option 01 are used for printing data. Columns 2 and 9 contain + and – symbols to identify bipolar data.

A convenient and unique feature of the 2010A printer is that when connected with the appropriate interconnecting cable to a Fluke Digital Multimeter that is overloaded, the printer automatically prints in red.

PRINT DRUM LAYOUT

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	BINARY CODE	
>	–	–	:	–	–	:	>	–	:	–	–	:	–	–	>	Kg	mA	1 1 0 0	12
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	H	1 0 1 1	11
<	+	•	•	•	•	•	<	+	•	•	•	•	•	•	<	G	A	1 0 1 0	10
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	u	W	1 0 0 1	9
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	dB	F	1 0 0 0	8
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	$^\circ$F	si	0 1 1 1	7
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	$^\circ$C	%	0 1 1 0	6
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	p	c^2	0 1 0 1	5
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	m	s	0 1 0 0	4
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	M	Hz	0 0 1 1	3
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	K	1b	0 0 1 0	2
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	AC	Ω	0 0 0 1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	DC	V	0 0 0 0	0
																		8 4 2 1	

Spaces may be generated by binary 13, 14 or 15 in any column.

DECIMAL POINT

A decimal point may be printed in any column of the 2010A to the right of the digit on the same column. Most digital sources provide range information in a coded format while many printers require this information on discrete lines. A key advantage of the 2010A is that range information can be on coded or discrete lines.

The decimal information is accepted in four line binary format and is decoded to one of sixteen, number one being to the right of column sixteen and numbered to the left from there. Special decimal jumper boards are provided in the interface kits to decode range information from particular instruments. There is a general purpose board in the accessory list that can be jumpered as desired.

CONTROL INPUT SIGNALS

For measuring instruments such as digital voltmeters and digital multimeters, the 2010A has a built-in inverter circuit which can be used for either positive high or positive low polarity signals. Parallel data entry is standard with the printer accepting a DTL/TTL compatible binary code 1, 2, 4, 8 for each column 1 through 18.

Because the 2010A printer has a built in memory and busy flag signal, it can be used in systems with sampling rates faster than the printers output.

The memory accepts and stores one complete set of data to be printed. While printing, the output is not changed by additional data being supplied by the measuring instrument. The busy flag indicates that the printer is printing and additional inputs are ignored until the completion of the print cycle. Nominal duration of the print cycle is 375 msec for black printout, extending to 400 msec for red. As a result, the measuring instrument is not limited to a sampling rate the same as the printers printing rate.

STANDBY

The standby control is a useful feature of the 2010A printer when making calibrations or adjustments that require individual sets of data recorded at specific times.

While the 2010A is in Standby, the last complete set of data in the memory can be printed by a manual print command from the front panel. The memory continues to be updated with new data at the measuring instrument's rate, up to once every 4μsec.

REMOTE CONTROL

The 2010A Printer has remote operation of Paper Feed and Standby for applications in small scale data acquisition systems.

For more details on the interface and operation of the 2010A Digital Printer ask for Applications Bulletin AB16, titled "Data Acquisition with the 2010A Printer".

Specifications

ACCURACY: Identical to input device used.

PRINTING RATE: 2.65 lines/second - Black (375ms)
2.5 lines/second - Red (400ms)

LINE SPACING: Six lines/inch

COLUMN SPACING: Ten columns/inch

COLUMN CAPACITY: Standard printer supplied with columns 9 through 18 providing 8 data columns and 2 function columns.

Option –01 provides full 18 columns printing capability.

PRINTING DRUM: 13 characters per column plus space. Numeral 0 through 9, decimal point and two other characters for columns 1 through 16. Two columns of 13 characters each for printing units of measurement.

PAPER: 2¼" wide fan-fold or standard 2¼" wide roll paper.

RIBBON: Standard black/red, ½" wide, automatically reversed.

FRONT PANEL CONTROLS: POWER SWITCH and LED indicator.
STANDBY, Interrupts print command pulse, data memory continues to be up-dated.
MANUAL PRINT, initiates a single printout of data in memory.
PAPER FEED feeds paper continuously while push button is pressed.

DATA INPUT: Code: 1, 2, 4, 8 binary code for each data column 1 through 18.

Data Entry: Parallel data entry standard.

Logic Level: DTL/TTL compatible, positive true logic.
Logic "1" = +3.5V minimum (or an unloaded TTL output) to +5V maximum or open

2010A Specifications Continued

Logic "0" = +0.8V at 0.5 mA maximum sink current.

Red Ribbon Selection. Logic "1" or open circuit.

Decimal Point. Floating decimal point from either coded or uncoded range data.

Data Transfer Time. All data decimal point and function information must be present for a minimum of 4μs after print command.

CONTROL INPUT AND OUTPUT SIGNALS

Print Command Input –: The print cycle is initiated by a transition from Logic "1" to Logic "0". This command is ignored if it occurs during the print cycle. Duration of pulse is 4 μsec minimum.

Print Command Input +: Inverse of Print Command Input –

Busy Signal The "Busy Flag" transitions to Logic "1" at the command to print and remains at this level until the end of the entire print cycle when it returns back to Logic "0". The complement is also available.
Logic "0" = +0.4V with maximum sink current of 4.8 mA.
Logic "1" = +2.5V with maximum source current of 2 mA.

Memory Update Complete: Input data may be removed on transition of this pulse from Logic "1" to Logic "0".
Logic "0" = +0.4V with maximum sink current of 2.4 mA.
Logic "1" = +2.5V with maximum source current of 1 mA.

POWER: 115V or 230V ± 10% selectable by rear panel switch. 48 - 440 Hz 15 VA power dissipation.

DIMENSIONS: 7" high, 8½" wide, 16" deep. Case includes carrying handle/tilt stand. 17.8 cm x 21.6 cm x 40.6 cm

WEIGHT: 15 pounds 6,75 kg

ENVIRONMENT: 0 to 50°C 0 to 80% RH

Designed to meet I.E.C. Specification 348.

PRICES

Digital Printer, 10 columns, Model 2010A	$ 795.00
Digital Printer, 18 columns, Model 2010A–01 . . .	875.00

(Prices include 1 ribbon and 1 pack of fan fold paper. Input Connector, Input Cable or Interface Kits are listed below.)

ACCESSORIES

Fan fold paper, 2010A–7013 (per dozen)	25.00
Ribbon, 2010A–7014 (per dozen)	18.00
Input mating connector, 2010A–7008	15.00
General purpose input cable, 2010A–7000 . . . . (6' long, mating connector 2010A–7008 one end, other end is 50 wires unterminated)	75.00
General purpose decimal jumper board, 2010A–7012 .	10.00
Rack mounting kit, 19" relay rack, 2010A–7010 . .	50.00
Diode matrix, DMM functions, 2010A–7019 . . .	17.50
Diode Matrix, counter functions, 2010A–7020 . . .	17.50
Diode Matrix, Thermometer functions, 2010A–7021 .	17.50
Dust Cover, M07-203-546	15.00
Extendor Card, 2010A–4006	25.00

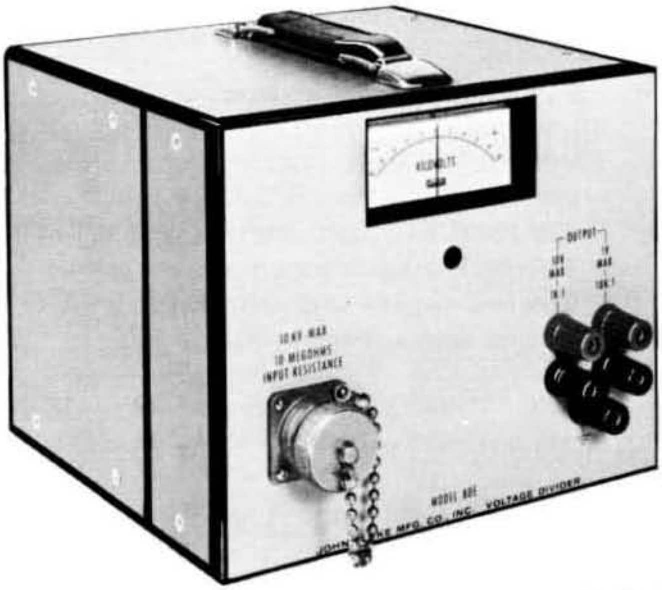
INTERFACE KITS

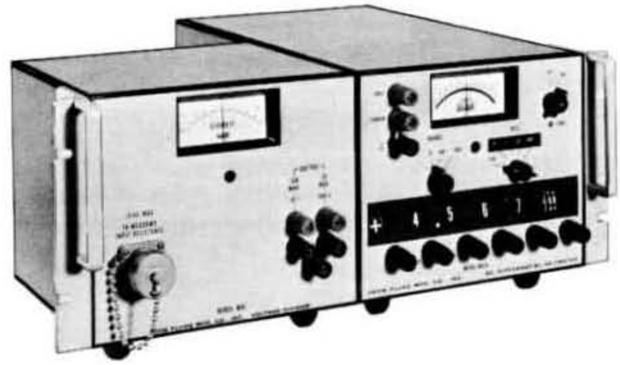
(Include Complete Cable, Diode Matrix, and Decimal Jumper Board as required)

Digital Multimeters	Kit Model No.	
8000A–02	2010A–7001	75.00
8100A–02	2010A–7002	75.00
8100B–02	2010A–7002	100.00
8110A–02	2010A–7002	100.00
8120A–02	2010A–7003	100.00
8200A–06	2010A–7004	125.00
8200A–07	2010A–7005	150.00
8300A–03	2010A–7006	125.00
8375A–03	2010A–7007	150.00
8400A–03	2010A–7007	150.00
8600A–02	2010A–7015	100.00
8800A–02	2010A–7015	100.00
Digital Counters		
1941A–02	2010A–7009	75.00
1950A–02	2010A–7009	75.00
1952A–02	2010A–7011	100.00
1952B–02	2010A–7016	150.00
1900A–02	2010A–7022	100.00
Digital Thermometers		
2100A–03	2010A–7017	100.00
2100A–06	2010A–7017	100.00
2100A–10	2010A–7018	150.00

FLUKE

VOLTAGE DIVIDER





FEATURES

- SPECIAL FLUKE PRECISION WIREWOUND RESISTORS
- ±0.01% DIVISION RATIO ACCURACY FOR ANY INPUT.
- 10V AND 1V TAPS
- MEETS SEVERE ENVIRONMENTAL REQUIREMENTS
- ZERO CENTER PANEL METER

Fluke Model 80E –10 Voltage Divider provides a highly stable, accurate means of measuring voltages to 10kV in conjunction with Fluke Differential Voltmeters, Digital Voltmeters and conventional potentiometers. 10V and 1V outputs are provided with 10 kV inputs for 1000: 1 and 10,000:1 division ratios. It is important to note that the ±0.01% division ratio accuracy applies to both division ratios and holds for any input voltage up to rated maximum.

Design of the 80E-10 includes the use of Fluke manufactured precision wirewound resistors mounted on glass-epoxy printed circuit boards. These resistors are specially processed for excellent stability, and selected for extremely low temperature coefficient of resistance.

Model 80E-10 instruments are equipped with resilient feet for bench use. They may be rack mounted side-by-side with Fluke 880 or 890 series solid-state Differential Voltmeters using the 881A-103 Rack Adapter Kit. For single rack mounting, side panels and handles are available as the 881A-102 Rack Adapter Kit.

ACCURACY: ±0.01% for both division ratios over a temperature range from 18°C to 28°C and for any input voltage up to rated maximum. Derate at 2 ppm/°C outside this temperature range to 0°C and 50°C.

MAXIMUM INPUT VOLTAGE: 10,000 VDC

DIVIDER CURRENT: 1 milliampere nominal at rated input.

INPUT RESISTANCE: 10 megohms, nominal

DIVISION RATIOS:

1,000:1 (10V output at maximum input)
10,000: 1 (1V output at maximum input)

STABILITY OF DIVISION RATIO: ±0.01% per year (recalibrated by internal adjustment).

INPUT CONNECTOR: MS3102A-18-16S on front panel (mating connector supplied).

OUTPUT CONNECTORS: Two binding posts on ¾" centers for each of two outputs. One side of each output is common to chassis. Separate binding post for grounding case. All output connectors located on front of instrument.

SHOCK: Meets half sine (20g, 11 milliseconds) shock and bench handling requirements of MIL-E-4970A.

VIBRATION: Meets requirements of MIL-T-945A.

OPERATING TEMPERATURE: 0°C to 50°C.

STORAGE TEMPERATURE: −35°C to +70°C (MIL-E-4970A).

ALTITUDE: 10,000 feet (operating)
50,000 feet (non-operating)

HUMIDITY: 0 to 80% (to 28°C)
0 to 60% (to 50°C)

METER: 10 - 0 - 10 kV

INPUT POWER: None required.

MOUNTING: Resilient feet provided for bench and portable use. For side-by-side EIA rack mounting with solid-state Fluke Differential Voltmeters, use Adapter Kit 881A-103 (includes handle-bracket and key plate). For EIA Rack Mounting of a single unit, use Adapter Kit 881A-102 (includes brackets with handles).

SIZE: 7" high x 8-1/2" wide x 8" deep. (19" wide in rack configurations). (17.8 x 21.6 x 20.3cm)

WEIGHT: Approximately 6 pounds. (2.72 kg)

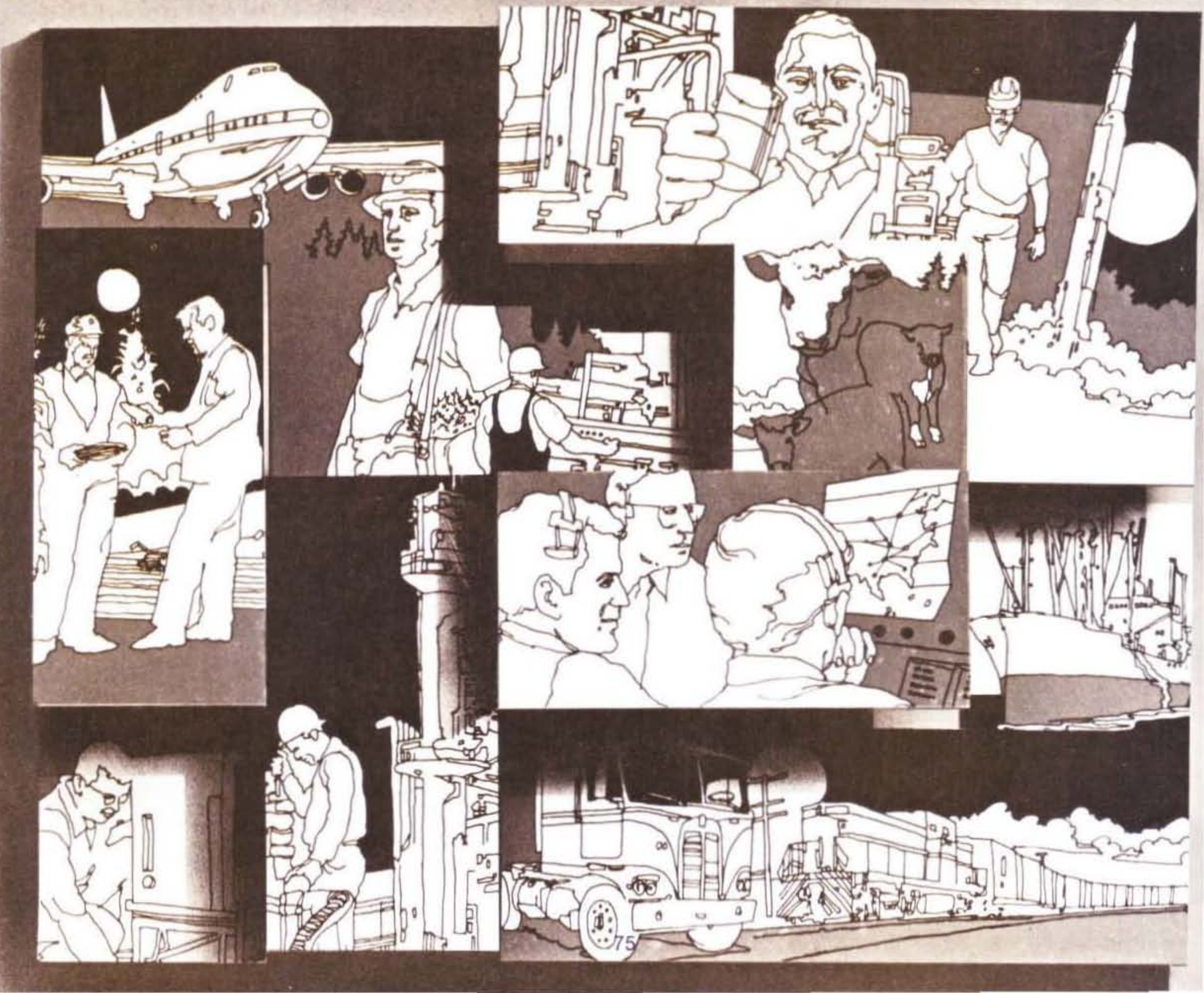
PRICE:

80E - 10, $395.00
881A - 103 Rack Adapter Kit, $15.00
881A - 102 Rack Adapter Kit, $25.00

NOTE: Special models of 80E-10 Voltage Dividers are available with maximum input voltages in 1000V steps from 1 kV to 9 kV. Information supplied upon request.

section 2

electronic counters



The Record

Fluke entered the frequency measurement market through the acquisition of Analog Digital Research in July, 1973. Since that date, the products of the new subsidiary, **Fluke Ltd.**, have demonstrated the **Fluke** tradition of quality and reliability. In the first year, **Fluke Ltd.** has introduced two new counters which include LSI MOS devices for improved reliability and cost savings. It is expected that high quality and an earnest desire to serve our customers more fully will ensure a place for **Fluke** frequency counters.

Features

LSI/MOS Circuits The use of MOS circuits has revolutionized the DMM business in the last two years. The advent of low power miniaturization is having far reaching effects and is today the major factor in the price erosion witnessed in general purpose test instrumentation. The 1900A attests to this progression in counter type instruments. The benefits of such progression are simply lower cost to the consumer, high reliability and vastly reduced power consumption.

Display **Fluke** provides light emitting diode displays to reduce power consumption and enable long life battery operation. Leading zero suppression assures easy reading and automatic units annunciation provides measurement units at a glance. For economic reasons, an overflow indicator is located directly above the most significant digit. The 1941A provides a six-digit gas-discharge type display for bright, distant viewing in industrial environments.

Autoranging The 1900A low cost multi-counter provides high speed frequency measurements and single and multiple period measurements without gate time selection. When in autoranging mode, the 1900A will fill all six digits to a maximum resolution of 1 Hz for frequency measurement or 1 nanosecond for period measurement. All **Fluke** counters offer a full selection of gate times providing the user with the desired resolution.

Filter and Attenuator **Fluke** counters provide the user with effective circuitry for eliminating noisy readings resulting from high amplitude signals and high RF signals.

Trigger Level Controls **Fluke** counter/timers provide trigger level controls for locating the correct trigger point on a waveform. Excessive ringing can produce double or triple counting and can be avoided with the correct use of the trigger level control.

Trigger Status Lamps **Fluke** counters provide trigger status lamps which, when balanced, provide quick, easy location of the triggering point of low amplitude waveforms.

COUNTER SELECTION GUIDE

MODEL	1900A	1941A	1950A	1952A	1980A
Frequency	5 Hz – 80 MHz	5 Hz – 40 MHz	5 Hz – 50 MHz	DC – 80 MHz 25 MHz – 515 MHz (Opt.)	5 Hz – 50 MHz 25 MHz – 515 MHz (Opt.)
No. of Digits	6	6	6	7 (9 Opt.)	6
Gate Times	10 ms, 0.1 sec, 1 sec, 10 sec	1 ms to 1 sec	0.1 ms to 10 sec	0.1 ms to 10 sec	1 ms to 10 sec
Sensitivity	25 mV	40 mV	50 mV	50 mV DC – 50 MHz	50 mV
Functions Frequency	X	X	X	X	X
Frequency Ratio			X	X	
Period	X		X	X	
Period Average	X		X	X	
Totalize	X	X	X	X	
Time Interval				X	
RPM		X		X	
Autoranging	X				
Power 115/230V	X	X	X	X	X
12V DC			X		X
Rechargeable Battery Option	X				X
BCD Output Option	X	X	X	X	
Programmable Range and Function					
Programmable Trigger Levels					

1900A MULTI-COUNTER

this Counter is available with high stability time-base, is the same type as used on higher price Counter (~~since~~ this is new & only factory knows of availability 3/76

FEATURES:

- *AUTORANGING IN FREQUENCY AND PERIOD MODES*
- *20% HYSTERESIS*
- *5Hz TO 80MHz*
- *SINGLE AND MULTIPLE PERIOD*
- *25mV SENSITIVITY, TYPICAL 15mV OVER THE ENTIRE RANGE*
- *6 DIGIT LED DISPLAY WITH AUTOMATIC ANNUNCIATION*
- *AUTO RESET ON ALL MODES, GATE TIMES, ATTENUATOR AND FILTER*
- *INPUT CONDITIONING – ATTENUATOR AND 1MHz LOW PASS FILTER*
- *OPTIONAL BATTERY OPERATION AND DATA OUTPUT*

The 1900A is a breakthrough in the price of multi-function counters.

This new, autoranging, 80MHz multi-counter features advanced L.S.I./M.O.S. circuitry providing greater reliability with much reduced power consumption.

In addition to autoranging the 1900A provides manual selection of gate times from 10msec to 10 seconds, .1Hz resolution. Autoranging seeks to fill all display digits with a maximum resolution of 1Hz or for period measurements, 10^2 periods. The autoranging circuitry provides a unique 20% hysteresis which prevents ambiguous readings caused by up range and down range commands. A simple example is seen when the input signal is approximately 10MHz.

Signal conditioning is provided with a 1MHz low pass filter and a times ten attenuator. These features are necessary when measuring signals in the presence of high level RF or when the signal amplitude is so high that a noisy reading results.

The dynamic range of the 1900A in the frequency mode is 5Hz to 80MHz and 5Hz to 1MHz in the period mode. In totalizing operations the 1900A will accept frequencies of 5Hz to 80MHz.

Sensitivity over the range of 5Hz to 80MHz is 25mV and typically will respond to a 15mV input.

The 1900A provides a six digit LED display with automatic decimal point positioning and automatic units annunciation of MHz, kHz, msec and usec.

In addition to a standard reset control all functions, gate times and signal conditioning buttons activate auto reset. This means that when functions are changed the counter logic and display are reset to zero and the next reading is correct. The most illustrative example is when selecting the ten second gate time. The auto reset assures the operator that he will not have to wait twenty seconds for correct reading.

The 1900A utilizes highly sophisticated packaging concepts. The result is a very durable package that will provide years of dependable service.

Options available for the 1900A include an rechargeable NiCad battery and a data output option.

The rechareable battery mounts internally and provides the operator with a light weight field operable multi-function counter. The convenient carrying handle makes it ideal for field service applications.

The data output option provides parallel BCD information in 8.4.2.1 code. The information provided includes six digits, decimal point, units annunciation and overflow indication.

Standard in the 1900A is full leading zero suppression and automatic decimal position.

In addition to the automatic units annunciation, the control panel is colour keyed for ease in descrimination between frequency and period units.

Operating Ranges

Frequency:
5 Hz to 80 MHz

Period:
5 Hz to 1 MHz single and multiple period averages

Totalize:
1 count to 999999 counts

Input Characteristics

Sensitivity:
25 mV, typically 15mV rms sine wave, 5 Hz to 80 MHz
Frequency and totalize: 200 mV P-P pulse amplitude with minimum pulse width of 20 nsec. Duty cycle $>10\%$.
Period: 200 mV P-P pulse amplitude with minimum pulse width of 200 nsec. Duty cycle $>10\%$.

Impedance:
1 MΩ shunted by less than 30 pf

Filter:
1 MHz (3dB point) lowpass

Attenuator:
Decreases sensitivity by 10

Overload:
150 V rms 5 Hz to 1 kHz decreasing to 20 V at 80 MHz

Resolution

Frequency:
Four manually selected gate times of:
10 ms (100 Hz resolution)
100 ms (10 Hz resolution)
1 s (1 Hz resolution)
10 s (0.1 Hz resolution)
Autorange position will automatically seek to fill all 6 digits but will not select a gate time greater than 1 second (1 Hz resolution)

Period:
Manual selection of single period or 3 period averaging ratios:
10^0 single period (100 ns resolution)
10^1 periods averaged (10 ns resolution)
10^2 periods averaged (1 ns resolution)
10^3 periods averaged (100 ps resolution)
Autorange position will automatically seek to fill all 6 digits. Autoranging will not select a period average of greater than 10^3 averages.

Totalizing:
Accumulates up to 999999 counts, then activates overflow indicator.

Time Base Characteristics

Frequency: 10 MHz

Stability:
Aging Rate: $<\pm 5 \times 10^{-7}$ month
Short Term: $<\pm 5 \times 10^{-8}$ rms over 1 second
Temperature: $<\pm 5 \times 10^{-6}$ 0°C to 50°C
$<\pm 2 \times 10^{-6}$ (typical) 20°C to 30°C

Line Variation:
$<\pm 1 \times 10^{-7}$ for $\pm$ 10% variation in line voltage

improved time base 126 option / option 03
same as for 1920A

General

Display:
6 digit LED, leading zero suppression
Time between successive measurements is 200 ms plus measurement time

Annunciation:
MHz, kHz, msec, μsec
overflow

Automatic Features:
AUTORANGE:
In both frequency and period modes, autoranging includes a unique 20% hysteresis in its switching thresholds, to eliminate redundant up range/down range commands. This allows measurements to be made on signals containing large amounts of FM and PM.
Hysteresis memory can be reset by depressing the reset button.
AUTORESET . . .
A new measurement sequence is started every time a front panel button is activated.

Operating Temp: 0°C to +50°C

Storage Temp: −40°C to +60°C

Power Requirements:
115/230 VAC ± 10%
100 VAC available
50, 60, 400 Hz
6.5 watts line model
8.5 watts battery model

Fuses:
⅛ amp AC-line version
½ amp slow-blow battery version

Dimensions

Width:	8.55 inches	21.72 mm
Height:	2.52 inches	6.40 mm
Depth:	10.65 inches	27.05 mm
Weight:	2.75 lbs.	1.2 Kg

Data Output Option

8-4-2-1 BCD output from each digit, plus encoded decimal point and units annunciation information. All outputs CMOS/Low Power TTL compatible, high true. Print command is provided.

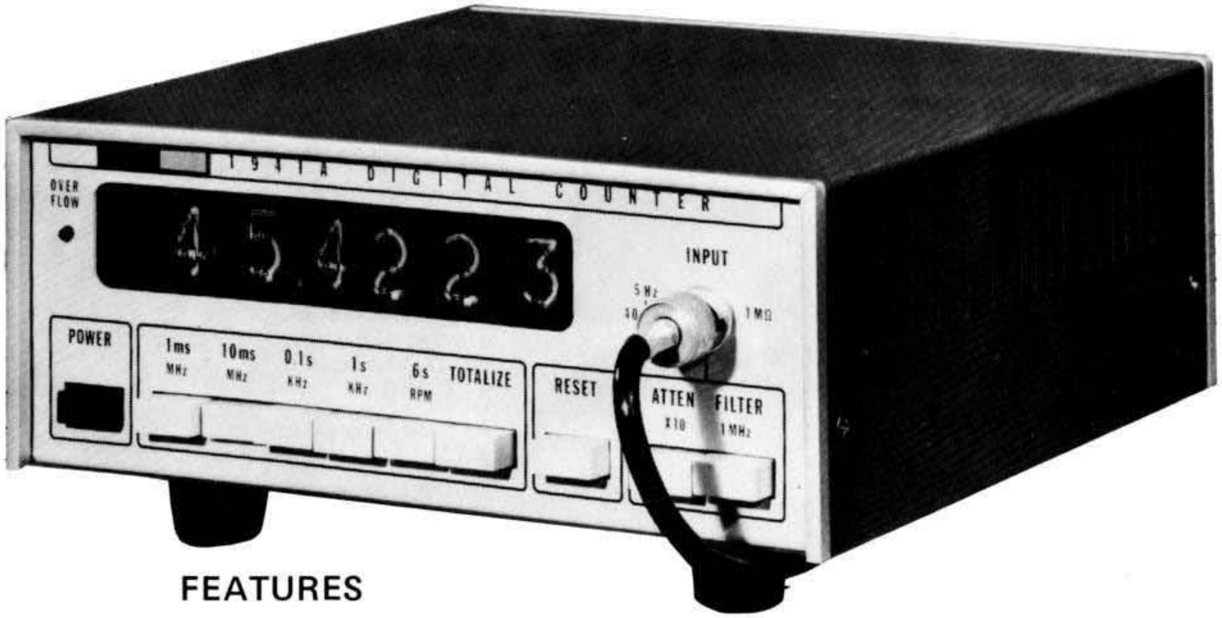
Battery

NICAD rechargeable
discharge time 5 hours
charge time 14 hours with unit inoperative

Ordering Information

1900A	$349.00
Rechargeable battery option	$125.00
Data output option	$150.00

1941A INDUSTRIAL COUNTER/TOTALIZER



FEATURES

- *FREQUENCY MEASUREMENT, 5Hz TO 40MHz*
- *40mV SENSITIVITY*
- *TOTALIZE MEASUREMENTS TO 999999 UNITS*
- *PRESETTABLE DISPLAY*
- *RPM MEASUREMENT*
- *LOW COST*

THE 1941A INDUSTRIAL COUNTER/TOTALIZER

The 1941A frequency and rpm counter/totalizer offers several very unique features not found in counters in the same price range. This counter provides input conditioning and normalizing. A 1MHz low pass filter will prevent erroneous readings caused by the presence of high level R.F. An input attenuator can be engaged to immunize the counter logic from high amplitude transients and spikes.

A display offset option permits the 1941A to be used in applications where the desired reading is something other than the frequency input. As an example, the I.F. of a receiver may be subtracted from the frequency input. This is accomplished by subtracting a number equal to the receiver IF from the display, the result will enable the operator to track the actual received frequency. In many instances where unskilled operators are using counters it is considerably easier to reduce the reading to zero thus reducing eye fatique. A negative offset of the desired reading will provide a reading of 000000.

The "count" or totalize mode will provide unit counting up to 999999 then will activate an overflow indicator. Using the 1941A's preset capability, this counter will provide a TTL signal at a predetermined number. An example of using the complementary offset in the totalize mode would be counting "N" bearings during the packaging stage and providing a TTL pulse to a conveyor controller. The result is simply "N" bearings per box.

The 1941A preset can be hard wired for dedicated applications or varied easily by interfacing the rear panel connector to a commercially available, 6 digit thumbwheel switch. Thus the offset amount can be adjusted within seconds.

This instrument also provides an RPM mode, and, depending on the type of tranducer used, can provide resolution to a single RPM in 600 milliseconds.

The large, 1/2", gas discharge type display offers easy viewing of six digits from distances in excess of 20 feet away.

The 1941A enables frequency measurements to be made from 5Hz to 40MHz, providing a choice of four gate times for resolution selection. A reset command will return the counter's logic and display to zero and will initiate a new measurement.

An external clock input will permit this counter to be tied to an in plant standard.

FUNCTIONS

FREQUENCY MEASUREMENTS

RANGE	5Hz to 40MHz (filter out) 5Hz to 1MHz (filter in)
GATE TIMES	1 msec, 10msec, 100 msec, 600 msec, 1 sec
RESOLUTION	1 Hz at 1 sec gate time decreasing to 1 kHz at 1 msec gate time
ACCURACY	$\pm$ count + timebase accuracy
TOTALIZING	Counts to 999,999 then activates overflow indicator
RPM	Determined by pulses per revolution from source. 5 pulses/sec. to 40 million pulses /sec. limits, with 999,999 display capacity Decimal placed for 100 pulses per revolution tachometer, giving reading directly in RPM.

SIGNAL INPUTS

SENSITIVITY

SINEWAVE	40mV rms (attenuator out) 400mV rms (attenuator in)
PULSE	150mV p-p (attenuator out) at minimum pulse width of 15nsec. 1.5V p-p (attenuator in)
IMPEDANCE	1M in parallel with 30pF typical (attenuator out)
ATTENUATOR	Sensitivity is decreased by a factor of 10 in the X10 position.
FILTER	1MHz low pass filter activated by front panel push button.
OVERLOAD CAPABILITY	DC + Peak AC must not exceed 250V 150V rms to 1kHz decreasing to 20V rms to 40MHz

TIMEBASE

AGING RATE	$\langle \pm 2 \times 10^{-6}$ /month
TEMP DEPENDENCE. $20^{o}C$ to $30^{o}C$ $0^{o}C$ to $40^{o}C$	 $\langle \pm 1 \times 10^{-6}$ /typical $\langle \pm 5 \times 10^{-6}$
LINE VOLTAGE ($\pm$ 10% Change)	$\langle \pm 2 \times 10^{-7}$

FREQUENCY	10MHz
STABILITY AGING	$\langle \pm 2 \times 10^{-6}$ /month

EXTERNAL TIMEBASE INPUT

FREQUENCY	10MHz
SENSITIVITY	500mV rms
IMPEDANCE	20 k shunted with 50 pF

BCD OUTPUT/OFFSET INPUT

OPTIONAL BCD OUTPUT	4 line 8-4-2-1 for each digit, high true. Print command is low true. All outputs are TTL compatible.
OPTIONAL BCD OFFSET	4 line 8-4-2-1 for each digit. TTL Compatible

GENERAL

DISPLAY	6 digit in-line display incorporating long-life gas-discharge tubes. LED overflow indicator.
CYCLE RATE	200 msec plus gate time
STORAGE TEMP. RANGE	$-40^{\circ}C$ to $+75^{\circ}C$
OPERATING TEMP. RANGE	$0^{\circ}C$ to $+40^{\circ}C$
POWER REQUIREMENTS	50, 60, 400Hz; 115/230V $\pm$ 10% (100V operation available) 14 watts
FUSE	1 Amp (115V) or 1/2 Amp (230V)

GENERAL

DIMENSIONS

HEIGHT	3.00" – 7, 6 cm
WIDTH	7.75" – 19.7 cm
DEPTH	9.40" – 23, 9 cm
WEIGHT	6 Pounds – 2, 7 kg

ORDERING INFORMATION

1941A	**$339.00**
OPTION 02 BCD OUTPUT	**$ 45.00**
OPTION 05 DISPLAY PRESET	**$ 45.00**

1950A MULTI-FUNCTION COUNTER

FEATURES

- *5 Hz TO 50 MHz WITH 50mV SENSITIVITY*
- *FIVE FUNCTIONS*
  1. *FREQUENCY*
  2. *FREQUENCY RATIO*
  3. *SINGLE PERIOD*
  4. *MULTIPLE PERIOD AVERAGE*
  5. *TOTALIZE*
- *6 DIGIT LED DISPLAY WITH UNITS ANNUNCIATION*
- *TRIGGER LEVEL CONTROL WITH STATUS LAMPS*
- *12 V DC OPERATION FOR PORTABILITY*

As a 50 MHz counter, the 1950A offers superb performance in the low-priced general-purpose counter market. Operating from line voltage or 12 Vdc the 1950 A is a rugged and versatile performer.

The 1950A performs frequency, frequency ratio, period, multiple period average and totalizing measurements. Input sensitivity over the entire range of 5 Hz to 50 MHz is 50 mVrms. For improved noise rejection in electrically noisy environments an input attenuator on Channel "A" desensitizes the input by a factor of 10. Both channels have an overload capability to withstand 150 Vrms without damage.

A variable trigger level control with trigger status lamps enables the operator to quickly establish proper triggering. This feature is extremely useful for measuring waveforms contaminated by ringing and noise spikes that can cause erroneous readings on counters with preset trigger levels.

With optional temperature compensated crystal oscillators, the 1950A will meet or exceed FCC spec fications. When the instrument is turned on, there is no need to wait for an oven controlled oscillator to stabilize.

For users who require a BCD output or envision future needs for recorded data, Fluke provides an inexpensive field installable BCD output, Option -02, providing 8-4-2-1 parallel TTL compatible logic with print command. The 1950A-02 can be easily mated with digital printers, and an interface kit to the Fluke 2010A printer is available as an accessory.

FUNCTIONS

FREQUENCY MEASUREMENTS

RANGE	5 Hz to 50 MHz
GATE TIME	0.1 ms to 10 s in 6 decade steps
RESOLUTION	0.1 Hz at 10s gate time to 10kHz at 0.1 ms
ACCURACY	± 1 count + timebase accuracy
READOUT	kHz or MHz automatically displayed with decimal point

RATIO MEASUREMENTS

DISPLAYS	f_1/f_2 where f_1 and f_2 are applied separately at the two input channels, A and B.
RANGE f_1	5 Hz to 50 MHz
f_2	1 kHz to 10 MHz
ACCURACY	± 1 count of signal in input A, plus trigger error of signal on input B. (Input B trigger error is ±0.4% ÷ periods averaged for signals with better than 40 dB S/N ratio, and greater than 500 mV rms amplitude).

PERIOD MEASUREMENTS

RANGE	5 Hz to 10MHz
PERIODS AVERAGED	1 period to 10^5 periods in decade steps
FREQUENCY COUNTED	100 kHz
RESOLUTION	0.1 ns at 10^5 periods to 10_us at 1 period
ACCURACY	± 1 count + timebase stability + trigger error of signal on input A. (Input A trigger error is ± 0.3%÷ periods averaged for signals with better than 40 dB S/N ratio and greater than 100mV rms amplitude. Error decreases as S/N and amplitude increase.)
READOUT	ms or µs automatically displayed with decimal point.

TOTALIZING

RANGE	5 Hz to 50 MHz
CAPACITY	Counts up to 999999, then activates overflow indicator

SIGNAL INPUTS

SENSITIVITY

INPUT A	Sinewave: 50mV rms over entire frequency range of 5 Hz to 50 MHz
	Pulse: 175 mV p-p pulse amplitude at minimum pulse width of 15 ns.
INPUT B	600 mV rms sinewave 1 kHz to 10 MHz

IMPEDANCE

INPUT A . . . . 1M in parallel with 30 pF

INPUT B . . . . 100k in parallel with 35 pF

ATTENUATOR

. . . . Input A sensitivity is reduced 10 times when attenuator is in X10 position

TRIGGER LEVEL . . . . Front panel control has ± 0.2V range when attenuator is in X1 position and ± 2V range when the attenuator is in the X10 position

OVERLOAD CAPABILITY

INPUT A . . . . DC + Peak AC must not exceed 250V. Can withstand signals of up to 150V rms for frequencies up to 1kHz. This value decreases to 5V rms (attenuator X1) or 50V rms (attenuator X10) at 50 MHz.

INPUT B . . . . Can withstand signals of up to 150V rms for frequencies up to 1 kHz decreasing to 5V rms at 10 MHz.

TIMEBASE

	STANDARD	OPTION -03	OPTION -04
AGING RATE (Constant temp.)	$\pm 2 \times 10^{-6}$ / mo.	$\pm 3 \times 10^{-7}$ /mo.	$\pm 3 \times 10^{-7}$ /mo.
SHORT TERM STABILITY (RMS OVER 1s)	$\pm 1 \times 10^{-7}$	$\pm 5 \times 10^{-8}$	$\pm 2 \times 10^{-8}$
TEMP. DEPENDENCE			
$20^{\circ}C$ to $30^{\circ}C$	$\pm 2 \times 10^{-6}$	$\pm 5 \times 10^{-7}$ typical	$\pm 2 \times 10^{-7}$ typical
$0^{\circ}C$ to $50^{\circ}C$	$\pm 5 \times 10^{-6}$	$\pm 2 \times 10^{-6}$	$\pm 5 \times 10^{-7}$
LINE VOLTAGE (± 10% Change)	$\pm 1 \times 10^{-7}$	$\pm 5 \times 10^{-8}$	$\pm 2 \times 10^{-8}$

EXTERNAL TIMEBASE INPUT

FREQUENCY REQUIRED . . . . 10 MHz

SENSITIVITY . . . . 500 mV rms

IMPEDANCE . . . . 1M shunted by 30pf typical

OUTPUTS

GATE . . . . Level goes to "1" state during actual sampling interval: "1" and "0" states are TTL compatible.

CLOCK . . . . 10 MHz square wave output derived from the counter's timebase. Output impedance 500 ohms; output level 4.5 volts peak-to-peak BNC connector.

BCD (OPTIONAL) . . . . 4 line 8-4-2-1 for each digit TTL compatible, high true. High true print pulse. Connector is Amphenol 57-40360.

GENERAL

DISPLAY . . . . 6 digit LED disply incorporating 0.27" high solid state, seven segment characters. Full leading zero suppression.

CYCLE RATE . . . . The time interval between successive measurements can be varied between approximately 0.2 to 2.0 seconds by the cycle rate control.

STORAGE TEMP. RANGE . . . . $-40^{\circ}C$ to $+75^{\circ}C$

OPERATING TEMP. RANGE . . . . $0^{\circ}C$ to $+ 50^{\circ}C$

POWER REQUIREMENTS.	50, 60, 400 Hz; 115/230V ± 10% (100V operation available) 11.5 to 14 V dc at 1.5 amps 16 watts
FUSES	AC – 1A (115V), 0.5A (230V) DC – 2A
DIMENSIONS	
WIDTH	9.26" – 23.5 cm
HEIGHT	2.95" – 7.5 cm
DEPTH	8.60" – 21.8 cm
WEIGHT	5 pounds – 2.27 kg

PRICE

BASIC MODEL	$495.00
OPTION 02: BCD Parallel 8-4-2-1 Output	$ 45.00
OPTION 03: TCXO (Temperature compesnated timebase)	$ 85.00
OPTION 04: TCXO (Temperature compensated timebase)	$225.00
RACK MOUNTING HARDWARE	$ 50.00

FLUKE

1952A UNIVERSAL COUNTER / TIMER

FEATURES

D C TO 80 MHz, EXPANDABLE TO 515 MHz.

- *SIX FUNCTIONS*
  1. *FREQUENCY*
  2. *FREQUENCY RATIO*
  3. *SINGLE PERIOD*
  4. *MULTIPLE PERIOD AVERAGE*
  5. *TIME INTERVAL MEASUREMENT*
  6. *TOTALIZE, AND GATEABLE TOTALIZE*
- *7 DIGIT LED DISPLAY, 8 AND 9 DIGITS OPTIONAL*
- *MATCHED INPUT CHANNELS FEATURING FULL CONTROL OF COUPLING, ATTENUATION, SLOPE, AND TRIGGER LEVEL*
- *UNITS ANNUNCIATION, OVERFLOW & GATE LAMPS AND TRIGGER LEVEL STATUS LAMPS*

The versatile one from Fluke. Counting from DC to 80 MHz in the standard version, this precision counter can be expanded in the field to cover telecommunications applications to 515 MHz. Capabilities include frequency, frequency ratio, single period, multiple period averaging, time interval measurement, totalize and gateable totalize.

Standard features include a highly stable temperature compensated cyrstal oscillator (TCXO), matched input channels, a seven digit LED display, self check, together with variable and preset trigger level controls with status indicators. Options available include eight or nine digit displays, a prescaler for frequency capabilities to 515 MHz, BCD output, and a TCXO with improved temperature dependence and stability.

The 1952A also provides a marker output which enables an operator to set the start and stop triggering points accurately. The output, a 5V signal, connected to an oscilloscope Z axis input will intensity modulate the portion of the waveform displayed during the time interval being measured.

For users who require a BCD output or envision future needs for recorded data, Fluke provides an inexpensive field installable BCD output, Option -02, providing 8-4-2-1 parallel TTL compatible logic with print command. The 1952A-02 can be easily mated with digital printers, and an interface kit to the Fluke 2010A printer is available as an accessory.

FUNCTIONS

FREQUENCY MEASUREMENTS

RANGE	DC to 80 MHz (dc coupled) 5Hz to 80 MHz (ac coupled) 25 MHz to 515 MHz, prescaled by 10 (optional)
GATE	0.1 ms to 10s in 6 decade steps (increased by 10 when input C optional prescaler is installed)
RESOLUTION	0.1 Hz at 10s gate time to 10 kHz at 0.1 ms gate
ACCURACY	± 1 count + timebase accuracy
READOUT	kHz or MHz automatically displayed with decimal point

RATIO MEASUREMENTS

DISPLAYS	f_1 / f_2 where f_1 and f_2 are applied at the two input channels, A & B
RANGE f_1	DC to 80 MHz (dc coupled) 5 Hz to 80 MHz (ac coupled)
f_2	DC to 10 MHz
ACCURACY	± 1 count of signal on input A, ± trigger error of signal on input B*

PERIOD MEASUREMENTS

RANGE	DC to 10 MHz (dc coupled) 5 Hz to 10 MHz (ac coupled)
PERIODS AVERAGED	1 period to 10^5 periods
FREQUENCY COUNTED	100 kHz
RESOLUTION	0.1 ns at 10^5 periods to 10μs at 1 period
ACCURACY	± count + timebase accuracy, ± trigger error of signal on input A*
READOUT	ms or us automatically displayed with decimal point

TIME INTERVAL MEASUREMENT

RANGE	0.1 μs to 10^6 s (with 7 digit display) 0.1 μs to 10^8 s (with 9 digit display)
INPUT	Channels A and B; common, separate
RESOLUTION	0.1 us to 10 msec in 6 decade steps
ACCURACY	± 1 count + timebase accuracy ± trigger error**

TOTALIZING (A GATED BY B)

RANGE	DC to 80 MHz (dc coupled) 5 Hz to 80 MHz (ac coupled)
CAPACITY	10^7 standard, up to 10^9 with 9 digit display

*Trigger error is less than $\pm 0.3\% \div$ periods averaged for signals with better than 40 dB S/N ratio and greater than 100 mV rms amplitude.

**Trigger error is less than ± 0.0025V /Signal Slope (V/us) in us

SIGNAL INPUTS

SENSITIVITY

INPUT A or B	Sinewave: 50 mV rms from dc to 50 MHz, increasing to 75mV rms at 80 MHz Pulse: 100 mV pulse amplitude with minimum pulse width of 20 ns.
INPUT C (PRESCALED)	50 mV from 25 MHz to 515 MHz

IMPEDANCE

INPUT A or B	1M in parallel with 30pf
INPUT C (PRESCALED)	50 ohms VSWR typically less than 2:1

ATTENUATOR

INPUT A and B ONLY	Sensitivity is decreased by a factor of 10 in the X10 position

TRIGGER SLOPE

INPUT A and B ONLY	Front panel slide switch selects positive or negative slope triggering

TRIGGER LEVEL

INPUT A and B ONLY	Front panel control has $\pm$ 1V range when attenuator is in X1 position and $\pm$ 10V in the X10 position. Preset position is fully counterclockwise.

OVERLOAD CAPABILITY

INPUT A or B	DC + Peak AC must not exceed 250V 150V rms to 1 kHz (decreasing to 5V rms at 80 MHz)
INPUT C (PRESCALED)	5V rms, fuse protected

TIMEBASE

	STANDARD	OPTION - 04
AGING RATE (Constant Temp.)	$< \pm 3 \times 10^{-7}$/mo.	$< \pm 3 \times 10^{-7}$/mo.
SHORT TERM STABILITY (rms over 1 sec.)	$< \pm 6 \times 10^{-8}$	$< \pm 2 \times 10^{-8}$
TEMP. DEPENDENCE		
20°C to 30°C	$< \pm 5 \times 10^{-7}$	$< \pm 2 \times 10^{-7}$
0°C to 50°C	$< \pm 2 \times 10^{-6}$	$< \pm 5 \times 10^{-7}$
LINE VOLTAGE ($\pm$ 10% Change)	$< \pm 5 \times 10^{-8}$	$< \pm 2 \times 10^{-8}$

EXTERNAL TIMEBASE INPUT

FREQUENCY REQUIRED	10 MHz
SENSITIVITY	100 mV
IMPEDANCE	1M in parallel with 15pf

OUTPUTS

GATE	Level goes to "1" state during actual sampling interval: "1" and "0" states are TTL compatible
CLOCK	TTL Compatible. 10 MHz square wave derived from the counter's timebase
BCD (OPTIONAL)	4 line 8-4-2-1 for each digit TTL compatible, high true. High true print pulse.
MARKER OUTPUT	A TTL compatible output is available for the duration of a time interval measurement by means of a rear panel BNC connector. 5 Volt.

GENERAL

DISPLAY	7 digit LED display incorporating 0.27" high, seven segment characters. Up to 9 digits available optionally. Full leading zero suppression.
CYCLE RATE	When in the "CONT" mode the time interval between successive measurements can be varied by means of a cycle rate control between 0.2 and 2.0 seconds. "Reset" button clears display and activates a new measurement.
RESET	In "TRIG" mode the readings may be updated by pushing the "Reset" button or applying a TTL compatible pulse to the external reset connector on the rear panel.
SELF CHECK	A timebase-derived 100 kHz signal is internally connected to the Channel A preamplifier output.
STORAGE TEMP. RANGE	$-40^{\circ}C$ to $+75^{\circ}C$
OPERATING TEMP. RANGE	$0^{\circ}C$ to $+50^{\circ}C$
POWER REQUIREMENTS	50, 60, 400Hz; 115/230V $\pm$ 10% (100V operation available) 20 watts.

DIMENSIONS

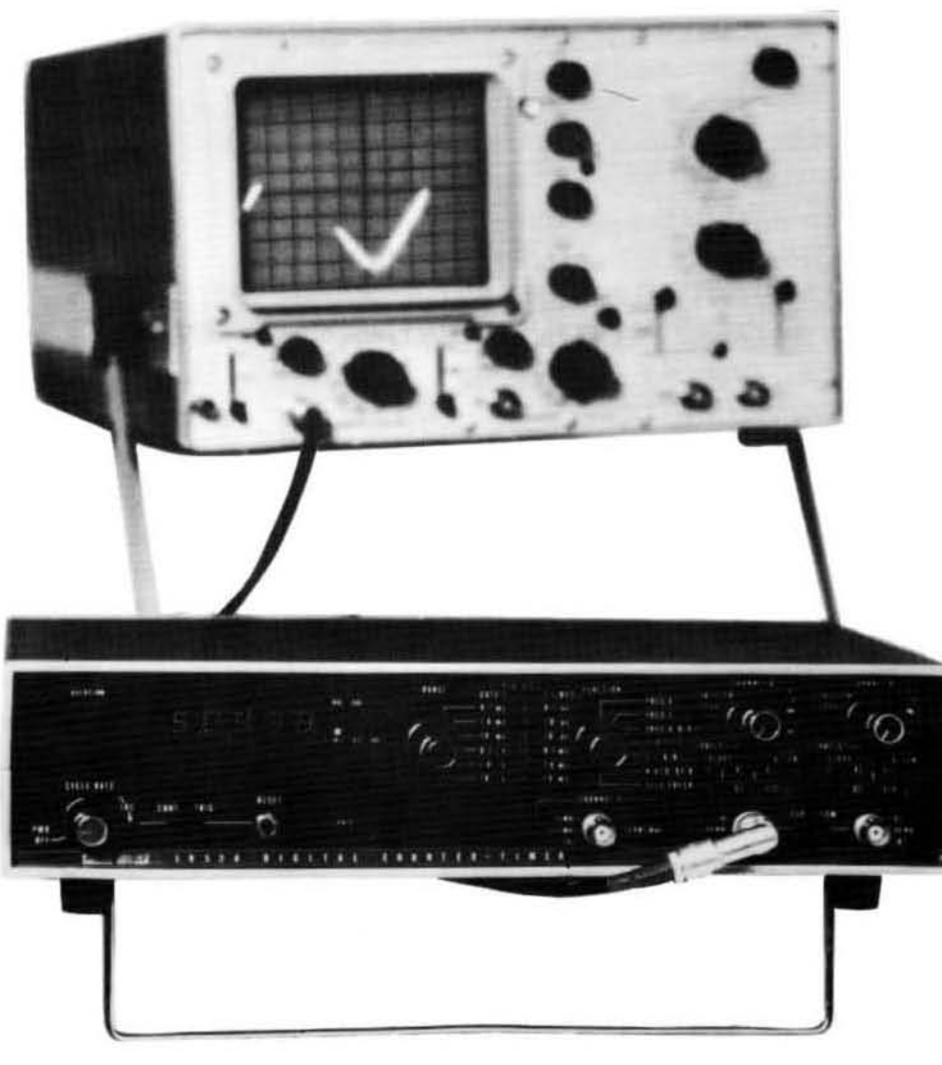
WIDTH	12.98" – 32,9 cm
HEIGHT	2.94" – 7, 5 cm
DEPTH	9.95" – 25, 3 cm
WEIGHT	8 pounds . – 3, 63 kg.

PRICE

BASIC MODEL	$749.00
OPTION 02: BCD PARALLEL 8-4-2-1 OUTPUT	$ 55.00
OPTION 04: TCXO (temperature compensated timebase)	$185.00
OPTION 07: 515 MHz Prescaler - 50mV sensitivity	$300.00
OPTION 08: 8th LED digit	$ 45.00
OPTION 09: 8th and 9th LED digits	$ 90.00
STANDARD RACK MOUNT	$ 50.00

1952A REAR PANEL

1952A MEASURING TIME INTERVAL.
WAVE FORM INTENSIFIED BY Z AXIS MARKER OUTPUT



1980A VHF, UHF TELECOMMUNICATIONS FREQUENCY COUNTER

FEATURES

- *5 Hz TO 515 MHz*
- *50 mV SENSITIVITY OVER THE ENTIRE RANGE*
- *SNAP-ON BATTERY PACK AND CARRYING CASE (OPTIONAL)*
- *6 DIGIT LED DISPLAY*
- *12Vdc OPERATION*

In the lab, in a van, or strapped to a technician's side, the 1980A VHF, UHF Telecommunications Counter can be used to service mobile land, sea and air communications systems quickly, accurately and dependably. Ready to use when it is turned on, this performance engineered counter operates under conditions of 0°C to 50°C. The standard TCXO in the 1980A will provide specifications that meet or exceed FCC requirements, from 0°C to +50°C! An optional TCXO further improves the 1980A's temperature dependence.

A standard 1980A will operate from line voltages, 115/230 Vac or 100 Volt at request. For mobile applications a 12Vdc external power source may be used. When total portability is required an optional battery pack and carrying case provide approximately 5 hours of continuous operation. Because of built-in protection circuitry, recharging can be accomplished while operating the 1980A-01 on line current without fear of over-charging. The instrument can be used while charging the battery.

Sinewaves with noise spikes and ringing square waves can cause erroneous readings on counters with fixed positive or negative trigger levels. To help eliminate this problem the 1980A provides a variable trigger level control on the direct input. With this control proper triggering can be quickly and easily established.

The 1980A, used with a sniffer antenna or inductive loop can be used to quickly measure RF carrier frequencies, squelch tones, beeper tones and local oscillator frequencies. RF carriers can be measured to a resolution of 1Hz and frequencies below 50MHz to .1Hz.

FUNCTIONS

RANGE	5 Hz to 50 MHz (direct input) 25 MHz to 515 MHz (prescaled input)
GATE TIMES	1 ms to 10s in 5 decade steps
RESOLUTION	0.1 Hz for 10s gate time to 1 kHz at 1msec gate (prescaled input decreased resolution by a factor of 10)
ACCURACY	$\pm$ 1 count $\pm$ timebase accuracy
READOUT	kHz or MHz automatically displayed with decimal point

SIGNAL INPUTS

SENSITIVITY

SINEWAVE	50 mV rms over entire frequency range of 5 Hz to 50 MHz 50 mV rms from 25 MHz to 515 MHz (prescaled input)

IMPEDANCE

DIRECT INPUT	1M in parallel with 30 pF
PRESCALED INPUT	50 ohms, VSWR typically 2:1
TRIGGER LEVEL	Front panel control has $\pm$0.15V range. (Direct Input only)

OVERLOAD CAPABILITY

DIRECT INPUT	150 V rms up to 1kHz decreasing to 5V rms at 50 MHz, dc + peak VAC must not exceed 250V
PRESCALED INPUT	5V rms, fuse protected

TIMEBASE

	STANDARD	OPTION -04
AGING RATE (constant temp.)	$< \pm 3 \times 10^{-7}$/mo.	$< \pm 3 \times 10^{-7}$/mo.
SHORT TERM STABILITY (rms over 1 sec)	$< \pm 5 \times 10^{-8}$	$< \pm 2 \times 10^{-8}$
TEMP. DEPENDENCE 20°C to 30°C 0°C to 50°C	 $< \pm 5 \times 10^{-7}$ typical $< \pm 2 \times 10^{-6}$	 $< \pm 2 \times 10^{-7}$ typical $< \pm 5 \times 10^{-7}$
LINE VOLTAGE ($\pm$10% Change)	$< \pm 5 \times 10^{-8}$	$< \pm 2 \times 10^{-8}$

GENERAL

CYCLE RATE	Variable between 0.2 and 2.0 seconds
DISPLAY	6 digit LED display, 0.27" character height. Measurement units and decimal point automatically indicated
STORAGE TEMP.	-40°C to $+75^{\circ}$C
OPERATING TEMP.	0°C to $+50^{\circ}$C
POWER REQUIREMENTS	50, 60, 400 Hz; 115/230V $\pm$ 10% (100V operation available) 11.5V dc to 14V dc
BATTERY LIFE	4.8 hours when using direct input. 4 hours using prescaled input. An undervoltage trip circuit prevents battery from being drained below 10 volts if accidently left on.

DIMENSIONS

		With Battery Option and Case
HEIGHT	2.94" – 7, 5 cm	3.50" – 8.9 cm
WIDTH	6.51" – 16, 6 cm	7.00" – 17, 7 cm
DEPTH	7.85" – 19, 9 cm	12.50" – 31, 9 cm
WEIGHT	4.75 lbs. – 2, 16 kg	10.5 lbs. – 4, 76 kg

PORTABILITY

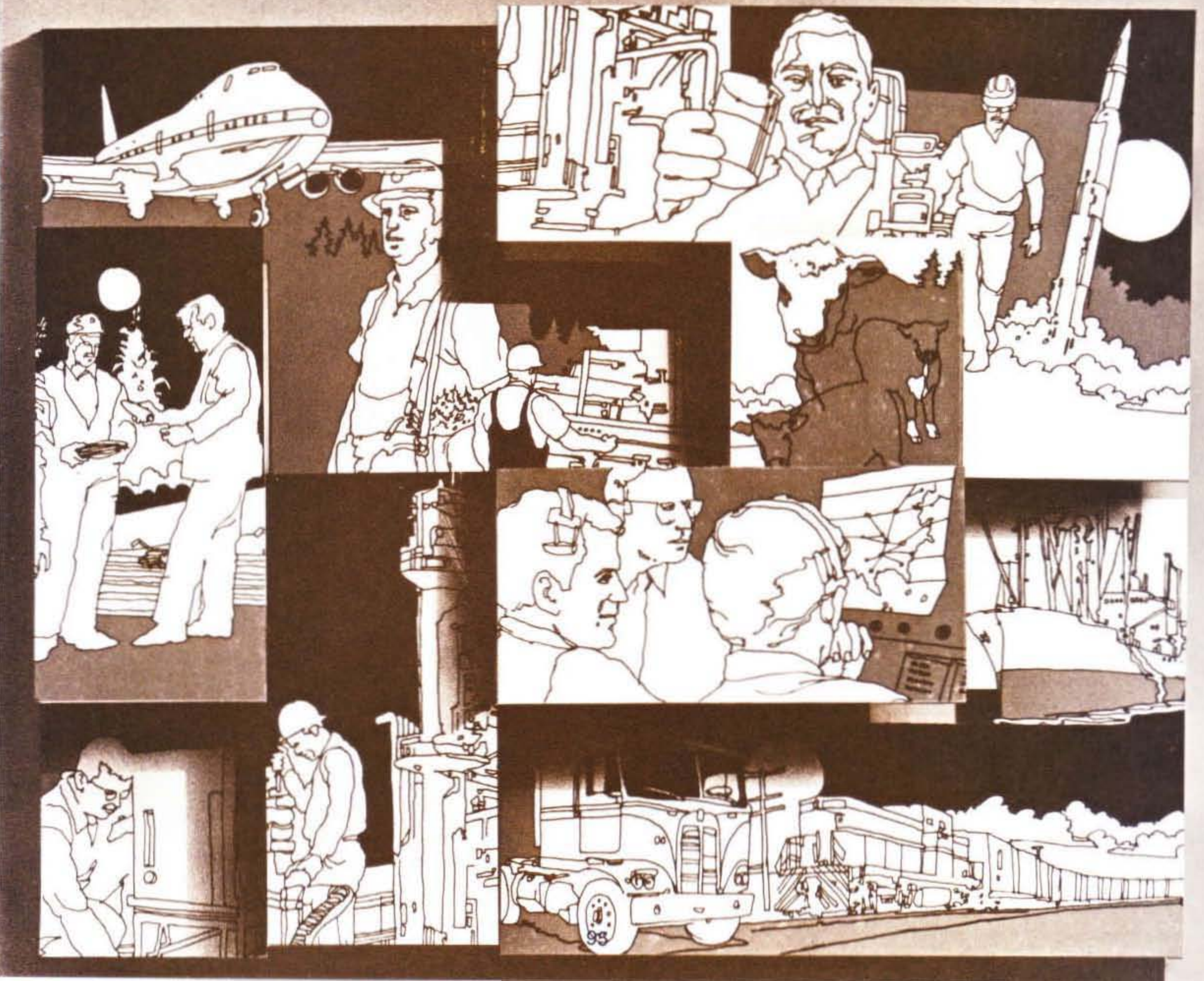
Shown below is the Model 1980A with the field installable -01 option, a rechargeable battery pack and carrying case. In this configuration the 1980A-01 is totally portable and provides approximately 5 hours of battery operation. The internal battery charger incorporates overcharge protection circuitry enabling the unit to be recharged whenever connected to or operated from the line.

PRICE

BASIC 1980A MODEL	$849.00
OPTION 01: Rechargeable Battery Pack with Leather Carrying Case	$199.00
OPTION 04: TCXO (temperature compensated timebase)	$185.00

section 3

digital thermometers



Types of Temperature Transducers

Two types of temperature transducers in common use today are the thermoelectric transducer and the resistance thermometer.

Thermoelectric transducers (thermocouples) consist of two metallic conductors of dissimilar chemical composition joined together at each end. One end is referred to as the measuring junction and the other as the reference junction. This transducer generates a current in proportion to the temperature difference between the two junctions. Thermocouples are selected according to the temperature to be measured. Besides the sensitivity, which varies with type of material, error at different temperatures should also be considered. Table 1 shows the range, sensitivity and limits of error for common thermocouples. Thermocouples are very rugged and find a wide range of applications due to their small size and low cost.

Resistance thermometers are electrical resistors that vary in resistance with temperature according to predictable values. Resistance thermometers are more stable, more sensitive and more accurate than thermocouples although generally more expensive. Copper, nickel, and platinum are generally used, in a pure or alloy state, to produce thermometers having consistently reproducible temperature coefficients. Copper thermometers operate in the range of -325° to 300°F. Nickel is employed at temperatures up to 600°F. Platinum thermometers offer the widest coverage, -325° to 1600°F. Table 2 compares thermocouple and resistance thermometer characteristics.

Fluke Digital Thermometer Line

Three basic instruments make up the digital thermometer series, although many parts are common and instruments can easily be converted from one type to another. Temperature range covered is -320°F to +3200°F, depending on thermocouple type. The 2100A-03 measures the temperature of a single thermocouple of a predetermined type. The complete temperature span of each thermocouple is covered. The 2100A-06 measures the temperature of a single thermocouple of any type. Selection of thermocouple is via front panel pushbuttons which also permit selection of two direct voltage ranges. The 2100A-10 allows ten thermocouples of a predetermined type to be switched through to the measuring instrument. Selection of the point to be monitored is by front panel pushbuttons and all ten thermocouples are connected to an isothermal reference junction ahead of the switches.

Options are available for each instrument in the series, including rechargeable battery pack for portable or field use, data output, printer cable and thermocouple probe.

The Fluke 2150A, an accessory to the 2100A series thermometers, permits up to thirty thermocouples to be individually selected via point-select pushbutton switches.

TABLE ONE COMMON THERMOCOUPLE RANGE, SENSITIVITY & ERROR

ISA Code	Thermocouple	Range ($^{\circ}$F)	Avg. Sensitivity in μV/$^{\circ}$F	± Error Limits: Standard Grade	± Error Limits: Special Grade
J	Iron-Constantan	32 to 530 530 to 1400	30 32	4°F 3/4%	2°F 3/8%
T	Copper - Constantan	−300 to −75 −150 to −75 75 to 200 200 to 700	14 17 22 30	— 2% 1-1/2°F 3/4%	1% 1% 3/4°F 3/8%
K	Chromel - Alumel	32 to 530 530 to 2300	23 22	4°F 3/4%	2°F 3/8%
E	Chromel - Constantan	32 to 600 600 to 1600	39 44	3°F 1/2%	— —
S,R	Platinum Rhodium - Platinum	32 to 1000 1000 to 2700	5 7	5°F 1/2%	2.5°F 1/4%

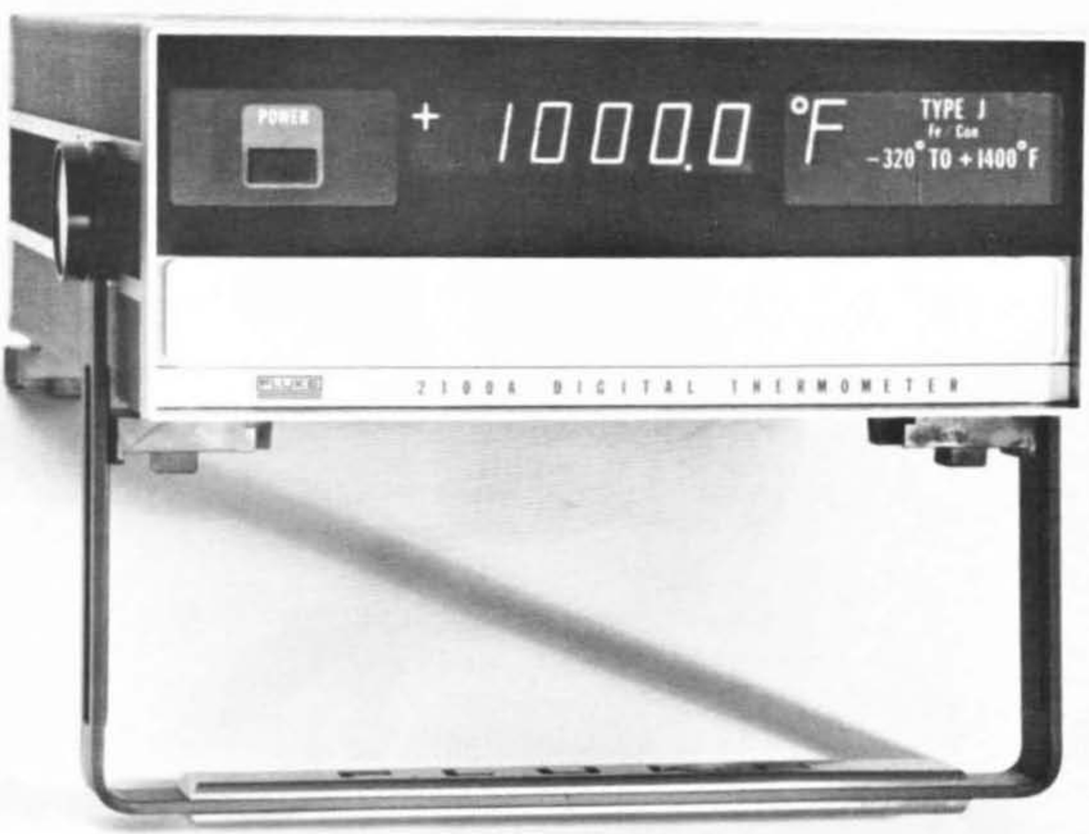
TABLE TWO COMPARISON OF THERMOCOUPLE & RESISTANCE THERMOMETER CHARACTERISTICS

Characteristic	Thermocouple	Resistance Thermometer
Interchange-Ability	±0.75%	±0.5%
Minimum Size	0.015 in. dia.	9/32 in. dia. x 1/4 in. long
Repeatability	0.2 to 15°F	0.05 to 0.1°F
Sensitivity	10 to 50μV/$^{\circ}$C	0.2 to 10Ω/$^{\circ}$C
Signal Output	0 to 60 mV	0.02 to 0.5V
Stability	1° to 2° drift per year	less than 0.10% drift/5 yrs.
Temperature Range	−300°F to 3100°F	0° to 1600°F
Best Features	Low cost Wide temperature range Small size Not easily damaged	High accuracy over wide range Highly stable

Digital Thermometer 2100A

FEATURES:

- All Thermocouple Types, J, K, E, T, R, S
- Inputs Isolated, 2 Wire With Guard
- Dual Slope Integration With Auto Zero
- Linearization By ROM Programs
- Bright ½ inch Gas Discharge Readout
- Automatic Reference Junction Compensation
- Covers a Total Range Of –320° F (–190° C) to +3200° F (+1760° C)
- 12 Volt Battery Operation
- Digital Data Output
- Open Circuit Detection
- Pushbutton Selection Of Up To 100 Thermocouples Of Mixed Types



BASIC

The 2100A Digital Thermometer is not just a single instrument, it is a whole series of instruments designed to satisfy a wide variety of temperature measuring applications. Its versatility ranges from a systems instrument capable of monitoring up to 100 different thermocouples and outputting the data to a digital recorder or computer, to a fully portable battery operated instrument able to take measurements from any type of thermocouple as well as having two direct mV ranges. All of this with a resolution of 0.1 degrees.

Four basic instruments make up the series, although many of the parts are common and instruments can easily be converted from one type to another. The 2100A–03 is used to measure the temperature of a single thermocouple of a predetermined type. The complete temperature span of each thermocouple is covered and the reading is displayed in either degrees Celsius or degrees Fahrenheit. The 2100A–06 is used to measure the temperature of a single thermocouple of any type. Selection of the correct type of thermocouple is by front panel push buttons which also allow the selection of the two direct mV ranges. The 400 mV range and 40 mV range have sensitivities of 10 uV and 1 uV, respectively. The 2100A–10 allows ten thermocouples of a predetermined type to be switched through to the measuring instrument. Selection of the point to be monitored is by front panel push buttons and all ten thermocouples are connected to an isothermal reference junction before the switches. An ACTIVE LED and CANCEL button allow more than one set of switches to be used. The last of the four instruments, the 2150A is a multi-point switch unit. It consists of up to three sets of ten point-select push button switches and can be used with any of the three measuring instruments. Up to 30 thermocouples can be connected to each unit and units can be connected in series to allow up to 100 points to be monitored by one measuring instrument.

THERMOCOUPLE TYPES

All of the instruments can operate with any of the standard types of thermocouples; J, K, E, T, R, S, and will measure the specified temperature span of each thermocouple without the need for range changing. For example, with a K couple, the temperature range is -320°F to $+2400^\circ$F and for a R couple, the temperature range is 0°F to 3200°F. The resolution is either 0.1°F or 0.1°C for the J, K, E and T thermocouples and either 0.2°F or 0.1°C for the R and S thermocouples. A unique feature of the design is that the linearizing data for all six types of thermocouple is contained in a single ROM of 4k bits which allows the user to easily change from one type of couple to another. The curve of each thermocouple is subdivided into 64 straight line segments which gives the 2100A digital thermometer excellent conformity to the NBS tables.

DUAL SLOPE INTEGRATION

Because of the low output of thermocouples (less than 1 uV per digit at some temperatures), the complete instrument is mounted in a fully isolated guard box. This, together with a dual slope integration technique, provides excellent noise rejection. The integration period is 100 milliseconds and the reading rate is 2.5/second. The common mode rejection is 150 dB at 50 or 60 Hz and the normal mode rejection is 90 dB at 50 or 60 Hz. Zero drift correction is automatic which obviates the need for continual adjustment necessary in so many instruments. Protection of the input circuit up to 250V dc or ac rms ensures that the instrument is well protected and allows the thermocouple to come into contact with the line voltage.

The complete digital circuit for the A to D converter is contained in a single custom LSI chip which plugs into the main board. This chip allows a maximum count of 40,000, more than sufficient for the maximum temperature of 3200.0 degrees. A half inch Sperry planar display provides an extremely bright unambiguous readout. Leading zero suppression, a feature not normally included in an instrument of this type, adds considerable to the clarity of the display.

OPEN CIRCUIT DETECTION

All instruments are equipped with a circuit which detects a broken or bad thermocouple. The instrument detects the loading by the thermocouple on a 10 kHz signal generated internally. When the source impedence of a thermocouple becomes greater than approximately 1.5kΩ the input is assumed to be open and this is indicated by blanking the display. This method always gives a positive indication of a bad thermocouple and is superior to the commonly used technique which introduces an increasing amount of error as the thermocouple increases in resistance.

REFERENCE JUNCTION COMPENSATION

In the two multipoint units, 2100A–10 and the 2150A, all thermocouples are connected to the isothermal reference unit. This consists of an anodized aluminum block which contains 30 threaded studs to which the ten thermocouples (High, Low and Guard) are connected. These studs are electrically isolated but thermally coupled to insure their being at the same temperature. The temperature of the block is detected by a transistor whose base emitter current has been calibrated with temperature. This method of referencing all thermocouples is the only acceptable one for an instrument of this class and introduces a additional error of less than 0.1° over the complete ambient temperature range of the instrument. The majority of instruments in use at the moment do not have a multipoint reference junction, but instead rely on the geometric spacing of the input connections to produce a pseudo isothermal reference. This method can produce large errors due to temperature gradients in the box and ambient conditions and is not recommended.

An additional benefit in using a true multi-point reference junction is that types of thermocouples can be mixed instead of having to dedicate an instrument to just one type of thermocouple. As an example of this, a 2100A–06 digital thermometer and a 20 point 2150A–20 multi-point switch unit would allow the user to monitor for instance eight J (iron-constantan) couples, six K (chromel-alumel) couples, two R (platinum-rhodium/platinum) couples as well as four voltages in the 40 mV and 400 mV ranges.

OPTIONS

The two options which can be fitted to each of the three measuring instruments are the rechargeable battery pack –01 and the digital output unit –02. Both fit inside the unit but are mutually exclusive. The battery pack contains rechargeable Ni-Cad cells with a continuous operating time of eight hours. To minimize the current drain from the batteries, the linearizing circuitry is switched off during the auto zero and integrate periods when it is not required. This power conservation has enabled the battery life to be extended 35%. An added advantage is that the instrument now runs cooler which in turn results in a more reliable instrument. The cells charge only when the instrument is switched on. The digital output unit provides isolated buffered outputs for data, point identity, polarity and functions. An interface kit for connection to the 2010A printer is another option that enables the units to be converted to a low cost manual data recording system.

Specifications/Mainframe

2100A–03 Digital Thermometer for one type of thermocouple

Types of Thermocouple:	J, K, E, T, R, S
Input Circuit:	Two wire with guard, isolated
Input Connections:	Three screw terminals on isothermal block at rear
Measurement Method:	Dual slope integration over 100 ms period with automatic zero
Response Time to Rated Accuracy:	< 1.0 seconds
Reading Rate:	2.5 readings per second fixed
Type of Display:	5 digit 0.5 inch Sperry display, non-flickering with leading zero suppression
Linearization:	Digital with six programs stored in ROM
Number of Segments:	64 segments to each program for negative and positive temperatures
Resolution:	0.1°F or 0.1°C for J,K,E,T 0.2°F or 0.1°C for R,S
Conformity to NBS Tables:	< ±0.2°C (±0.3°F) for J,K,E,T < ±0.3°C (±0.5°F) for R,S NOTE: Below –50°C (–58°F) E type is ±0.3°C (±0.5°F) Below –150°C (–238°F) E type is ±0.4°C (±0.7°F) and J, K, T types are ±0.3°C (±0.5°F) Below +35°C (+95°F) R,S, types are ±0.5°C (±0.9°F)
Reference Junction Compensation:	0.02° per ° over total ambient temperature range 0.01° per ° over temperature range +20°C to +30°C (+68°F to +86°F)
Conversion Accuracy:	
90 days at 25°C ±5°C: (77°F±9°F)	±0.015% reading ±0.2°F or ±0.1°C for J, K, E, T ±0.015% reading ±0.4°F or ±0.2°C for R, S
1 year at 25°C ±10°C: (77°F ± 18°F)	±0.03% reading ±0.3°F or ±0.2°C for J, K, E, T ±0.03% reading ±0.8°F or ±0.5°C for R, S
Temperature Coefficient:	±(15 ppm±0.1 uV)/°C
Repeatability:	±0.1°F or ±0.1°C for J,K,E,T ±0.2°F or ±0.1°C for R, S
Input Impedance:	1000 MΩ
Input Current:	< 200 pA
Maximum Source Impedance:	1.5 kΩ source impedance causes less than 0.1°C error for J, K, E, T
Overload:	Continuous 250V dc or ac rms across input will not cause damage
Common Mode Rejection:	150 dB at 50/60 Hz ±0.1% with 1 kΩ unbalance. A common mode voltage of 250V will cause an error of less than 0.1°C using a K couple.
Common Mode Voltage:	Maximum of 250V dc or ac rms

Normal Mode Rejection: 90 dB at 50/60 Hz ±0.1%. A normal mode 50/60 Hz voltage of 100 mV will cause an error of < 0.1°C using a type K couple.

Zero Drift: None. Automatic zero correction.

Open Circuit Detection: A source impedance of greater than 1.5 kΩ ±500Ω or capacitance less than 0.01uF ±0.005 uF is defined as open-circuit. An open circuit input is indicated by blanked display.

Calibration: Zero and full scale

Selection of Thermocouple Type: By selected components on a small plug-in circuit board. One thermocouple type only in any one instrument.

Selection of Temperature Units: One ROM program provides for measurement in degrees Fahrenheit, and a different ROM for degrees Centigrade. Only one ROM can be fitted.

Specifications/Options

2100A–01 - Rechargeable Battery Pack

Type of Cell: Rechargeable Ni Cad

Size: "HALF D"

Number: 9 cells providing 11 volts

Operating Time: Typically, 8 hours continuous operation.

Charge-Discharge Cycles: Minimum of 500

Additional Weight: 2 pounds (0,91Kg)

2100A–02 - Digital Output Unit

Type of Output: Fully isolated, buffered, parallel bcd.

Available Data: 18 bits data, 8 bits of channel identity, polarity, open circuit, function.

Flags: Busy, not busy

Control Inputs: EXTERNAL TRIGGER. (Negative going edge trigger.)

This allows external control of DOU update.

EXTERNAL TRIGGER ENABLE.

In the "1" state this allows the DOU to be updated by an external trigger. In the "0" state it allows the DOU to be updated at the instrument reading rate of 2½ readings per second.

Data Coding: 1-2-4-8 bcd positive true parallel.

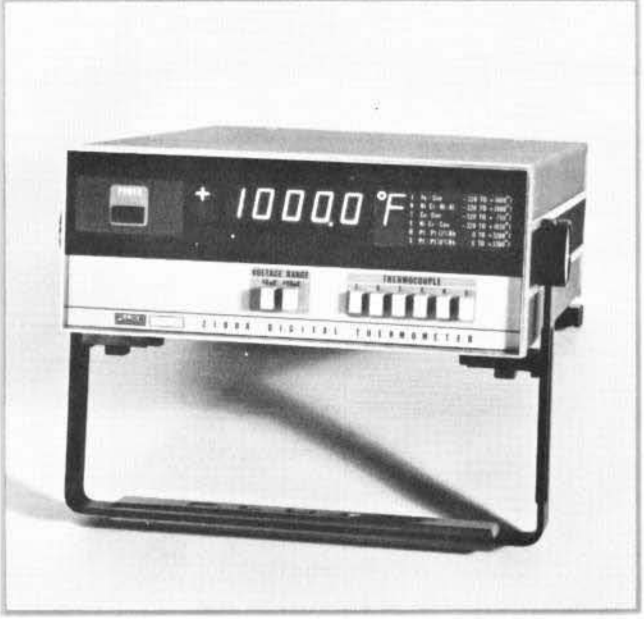
Logic Levels: "1" = +4V, "0" = +0.4V

Drive Capability: All outputs can drive one standard TTL load (i.e., sink 2.1 mA).

Isolation: Fully isolated to 250V dc or rms ac.

2100A–06 - Digital Thermometer for six types of thermocouples

This is the same basic unit as the 2100A–03 but with the addition of 8 select switches on front panel. Any one of



2100A–06

the six available thermocouple types can be selected by means of the switches, but only one type of thermocouple can be connected at one time. Two additional ranges for dc voltages of 40 mV and 400 mV are provided.

Accuracy:

90 days 25°C ±5°C (77°F ± 9°F)	400 mV range ±(0.015% of reading + 1 digit) 40 mV range ±(0.01% of reading +2 digits)
1 year 25°C ± 10°C (77°F ± 18°F)	400 mV range ±(0.03% of reading +2 digits) 40 mV range ±(0.03% of reading +3 digits)

2100A–10 - Digital Thermometer for ten thermocouples of the same type

This is the same basic unit as the 2100A–03 but with the addition of 11 manual switches on front panel. This allows up to 10 thermocouples (all of the same type) to be con-

2100A–10

nected to the rear of the instrument and then switched, one at a time, into the measuring instrument. An error of 0.1°F or 0.1°C is added to the existing errors in the 2100A–03 specifications. A separate switch on the front panel isolates this bank of ten switches from external inputs when the 2150A is used. Channel identity of the selected thermocouple is available when the DOU is fitted.

2150A–10 - Ten point selector switch unit.

This is a separate unit containing 10 manual selector switches on the front panel and a separate switch for isolating the switches. When used with any of the above instruments, the specification will be the same as the 2100A–10. When used with the 2100A–06, any combination of thermocouples can be connected to the unit. Channel identity can be recorded as in the 2100A–10.

2150A–20 - Twenty point selector switch unit

Same as 2150A–10, but with two rows of 10 selector switches.

2150A–30 - Thirty point selector switch unit.

Same as 2150A–10, but with three rows of 10 selector switches.

2150A–30

Specifications/Thermocouple

	Type of Couple	Temperature Range	Resolution	Maximum Error 90 Days 77°F ±9°F 25°C ±5°C	Maximum Error 1 Year 77°F ±18°F 25°C ±10°C
E	Nickel Chromium/	–320°F to +1830°F	0.1°F	(1) ±0.015% rdg ±.55°F	(1) ±.03% rdg ±0.8°F
	Constantan	–200°C to +960°C	0.1°C	±0.015% rdg ±.35°C	±.03% rdg ±0.5°C
J	Iron/Constantan	–320°F to +1400°F	0.1°F	(2) ±.015% rdg ±.55°F	(2) ±.03% rdg ±0.8°F
		–200°C to +760°C	0.1°C	±.015% rdg ±.35°C	±.03% rdg ±0.5°C
K	Nickel Chromium/	–320°F to +2400°F	0.1°F	(2) ±.015% rdg ±.55°F	(2) ±.03% rdg ±0.8°F
	Nickel Aluminum	–200°C to +1370°C	0.1°C	±.015% rdg ±.35°C	±.03% rdg ±0.5°C
T	Copper/Constantan	–320°F to +750°F	0.1°F	(2) ±.015% rdg ±.55°F	(2) ±.03% rdg ±0.8°F
		–200°C to +400°C	0.1°C	±.015% rdg ±.35°C	±.03% rdg ±0.5°C
R	Platinum 13%	0°F to +3200°F	0.2°F	(3) ±.015% rdg ±1.0°F	(3) ±.03% rdg ±1.4°F
	Rhodium/Platinum	0°C to +1760°C	0.1°C	±.015% rdg ±0.6°C	±.03% rdg ±0.8°C
S	Platinum 10%	0°F to +3200°F	0.2°F	(3) ±.015% rdg ±1.0°F	(3) ±.03% rdg ±1.4°F
	Rhodium/Platinum	0°C to +1760°C	0.1°C	±.015% rdg ±0.6°C	±.03% rdg ±0.8°C

(1) Added error of ±0.1°C (±0.2°F) for temperatures below –50°C (–58°F) and ±0.2°C (±04°F) for temperatures below –150°C (–238°F)

(2) Added error of ±0.1°C (±0.2°F) for temperatures below –150°C (–238°F)

(3) Added error of ±0.2°C (±0.4°F) for temperatures below +35°C (+95°F)

Specifications/General

Size: Maximum of 3 ½" high x 8½" wide x 12" deep.

Weight: 8 pounds (3,63Kg)

Power: 100, 115 or 230V ac ±10% 50 to 440 Hz. Also, 12.5V ±2V external dc battery supply.

Operating Temperature: 0 to +50°C (+32 to +122°F)

Storage Temperature: –40 to +75°C (–40 to +167°F) Line operated
–40 to +60°C (–40 to +140°F) Battery operated

Humidity: 80% non-condensing over operating temperature range. 90% up to 35°C (95°F)

PRICES

2100A–03 Digital Thermometer for Single Thermocouple . . .	$749
2100A–06 Digital Thermometer for Multi-Type Thermocouples . . .	995
2100A–10 Digital Thermometer for Multi-Point Thermocouples . . .	895
2150A–10 Multi-Point Switch Unit for up to 10 Thermocouples . .	250
2150A–20 Multi-Point Switch Unit for up to 20 Thermocouples . .	350
2150A–30 Multi-Point Switch Unit for up to 30 Thermocouples . .	450

OPTIONS

2100A–01 Rechargeable Battery Pack for 2100A .	$150
2100A–02 Data Output Unit for 2100A	150

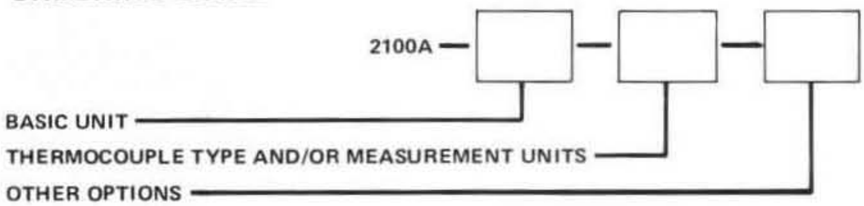
ACCESSORIES

2010A–7017	Interface Kit to Fluke 2010A Printer from 2100A–03 and 2100A–06	$ 100
2010A–7018	Interface Kit to Fluke 2010A Printer from 2100A–10	150
M00-200-618	Side-By-Side Rack Mount	30
M00-200-619	Offset Rack Mount	35
M00-200-620	Panel Mounting Frame	25
M03-203-700	Front Panel Cover	10
C81	Carrying Case	100
P20J	Thermocouple Probe - J Type	20
P20K	Thermocouple Probe - K Type	20
P20T	Thermocouple Probe - T Type	20

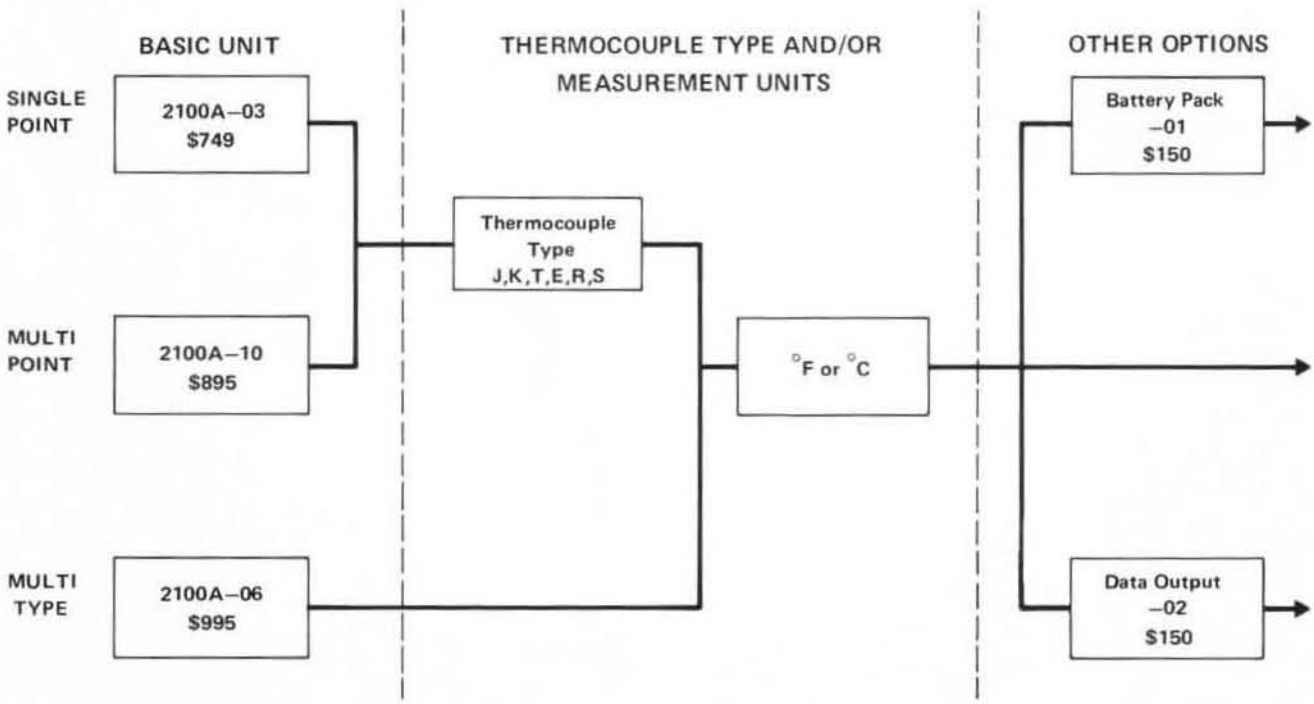
KITS FOR FIELD INSTALLATION

2100A– _ _ K	Conversion Kit to a different type of thermocouple. Specify new type of thermocouple and measurement units; e.g., 2100A–TFK for T type in Fahrenheit degrees	$ 20
2100A–F2CK	Conversion Kit °F to °C	60
2100A–10K	Ten Point Selector Switch for Field Installation in 2100A–03	150
2150A–10K	Ten Point Selector Switch for Field Installation in 2150A–10 and 2150A–20	150

ORDERING GUIDE



NOTE:
LINE VOLTAGE MUST BE SPECIFIED IF DIFFERENT FROM 115V ±10% 50 to 440 Hz



ORDERING EXAMPLES:

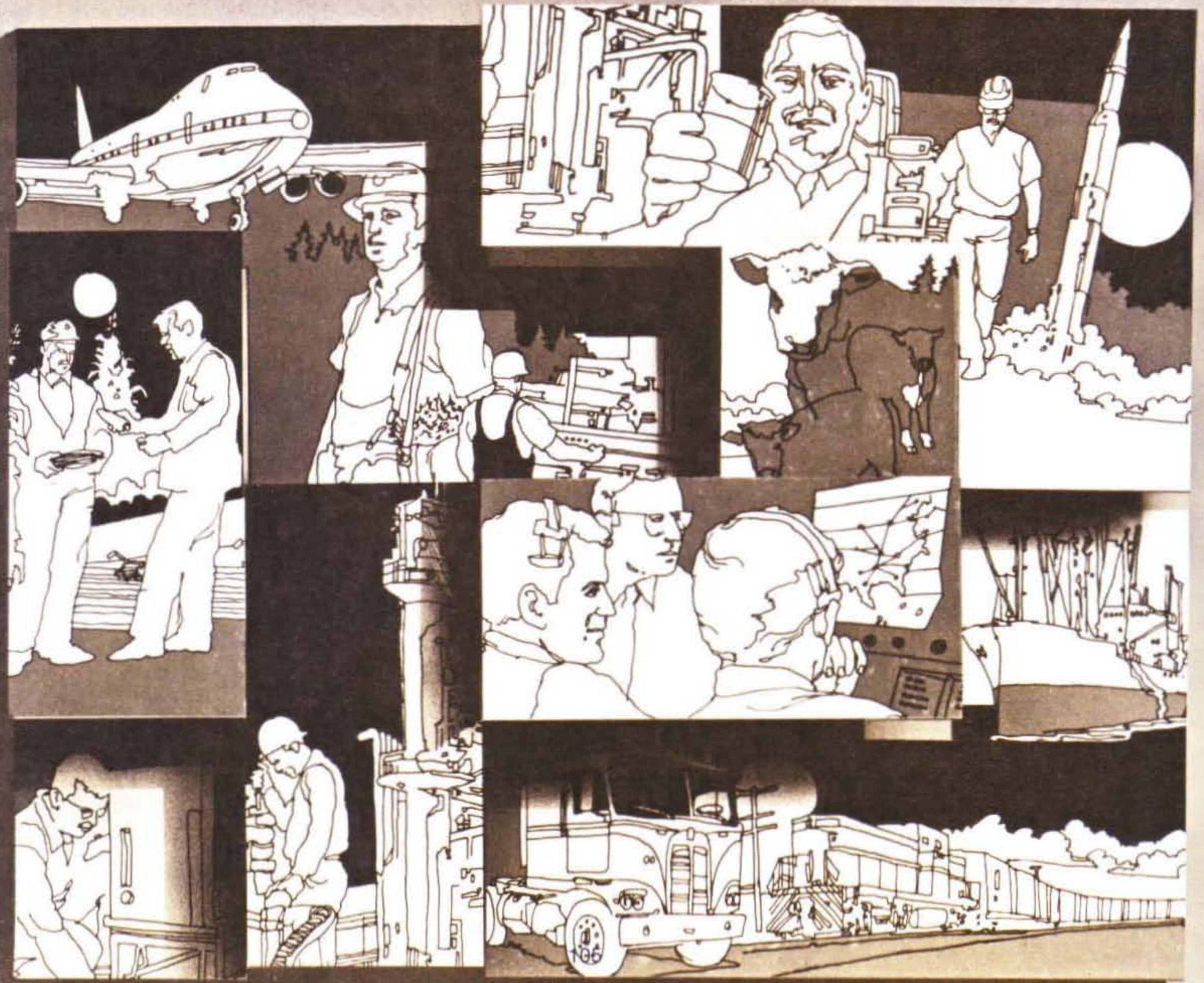
2100A–03–JF	Single point, J type in °F	Price $ 749.00
2100A–10–EC–02	Multi-point, E type in °C with data output	Price $1045.00
2100A–06–F–01	Multi type, in °F with battery pack	Price $1145.00

SUGGESTED SOURCES OF THERMOCOUPLES:

California Alloy Co., 1475 Potrero Ave., South El Monte, CA 91733, 213-579-3230
Pyco, 600 E. Lincoln Hwy., Penndel, PA 19047, 215-757-3709
Thermo Electric, 109 Fifth Street, Saddle Brook, NJ 07662, 710-990-5108
Omega Eng. Inc., Box 4047, Springdale Station, Stamford, CN 06907, 203-359-1660
Rosemount Eng. Inc., P.O. Box 35129, Minneapolis, MN 55435, 612-941-5560
Marlin Manufacturing Corp., 12402 10 Triskett Road, Cleveland, OH 44111, 216-941-6200
Hy-Cal Engineering Co. Inc., 12105 East Los Nietos Road, Sante Fe Springs, CA 90670, 213-698-7785
Syscon International Inc., 205 Sycamore Street, South Bend, IN 46622, 219-287-5916

section 4

differential voltmeters



Long the industry leader in the differential voltmeter field, the **John Fluke Mfg. Co., Inc.** continues to offer a selection of high quality models that give you the option of building a differential measurement system to suit your needs.

All **Fluke** models are solid state DC, AC/DC or True RMS instruments. Optional built-in rechargeable battery packs make them fully portable and suitable for bench or field use. They have been designed and tested to take rough usage under adverse environmental conditions.

The **Fluke** models also are designed with overload protection, single meter scales to handle various modes and ranges and annual calibration intervals.

Put these factors together, and you will find the **Fluke** differential voltmeter will give you the accuracy, reliability, and versatility that no other instrument of this type can match.

Principles of Operation

Here are the basic principles of operation of the **Fluke** differential voltmeters:

> An 1100V DC reference supply prevents loading the circuit under test. This is regulated by comparing a sample of its potential with that of aged and matched zener diodes using a high gain, very stable amplifier.

The reference voltage is applied across a Kelvin-Varley voltage divider with decades of **Fluke**-manufactured precision wirewound resistors plus a high resolution interpolating potentiometer.

The voltmeter input voltage is compared directly to the Kelvin-Varley divider output voltage by means of a high input impedance detector. The instrument therefore operates potentiometrically over its entire range with infinite input resistance at null, thereby eliminating source loading error.

Selecting a Model

The **Fluke** differential voltmeter product line includes eight instruments from which you will be able to choose the one most suited to your requirements. Refer to the following Differential Voltmeter Selection Guide to identify the **Fluke** differential voltmeter closest to your needs. Then find all the details on the instrument of your choice in the following pages.

DIFFERENTIAL VOLTMETER SELECTION GUIDE

Model	883AB	885AB	887AB	891A	893A/AR	895A	931B
Function	AC/DC	DC	AC/DC	DC	AC/DC	DC	True RMS
Basic Accuracy	0.005% dc 0.1% ac	0.0025%	0.0025% dc 0.05% ac	0.01%	0.01% dc 0.05% ac	0.0025%	0.05%
Range	0-1100V	0-1100V	0-1100V	0-1100V	0-1100V	0-1100V	10mV-1100V
Frequency Range – AC	20Hz-5kHz	—	20Hz-5kHz	—	5Hz-100kHz	—	2Hz-2MHz Bandwidth
DC Input Resistance	10MΩ above 11V[1]	10MΩ above 11V[1]	10MΩ above 11V[1]	Infinite[2]	Infinite[2]	Infinite[2]	—
AC Input Impedance	1MΩ, 40pF	—	1MΩ, 40pF	—	1MΩ, 20pF	—	1MΩ, 8pF
Resolution	1μV max	1μV max	1 ppm of range	10μV max	10μV max	1μV max	—
Stability of Reference Supply	5 ppm/hour	5 ppm/hour	5 ppm/hour	10 ppm/hour	10 ppm/hour	5 ppm/hour	50 ppm/hour
Rechargeable Battery Pack Available	X	X	X	X	X	—	X
Recorder Output Available	X	X	X	X	X	X	X

[1] Infinite at null from 0-11V [2] Infinite at null from 0-1100V

FLUKE

SOLID-STATE AC/DC DIFFERENTIAL VOLTMETER

FEATURES

- All-Solid-State
- 100 uv Full Scale Null Sensitivity
- Rechargeable Battery Power
- ±0.005% of Input DC Accuracy
- ±0.1% of Input AC Accuracy
- 0 - 1100 VAC and DC
- Large, In-line Readout
- Less than 14 lbs.

Fluke Model 883AB is an all-solid-state AC/DC Differential Voltmeter that is combination line- or battery-powered. Batteries in Model 883AB are compact, rechargeable nickel-cadmium units which operate the voltmeter for more than 30 hours after recharge. Battery power makes the instrument truly portable as well as offering complete isolation from the power line, eliminating error from measurements where ground loops contribute to inaccuracy.

DC accuracy of the 883AB is an extreme ±(0.005% of input voltage + 0.0002% of range + 5 uv) from 0 to 1100 VDC, complemented by AC accuracy of ±(0.1% of input + 25 uv) from 0.001 to 1100 VAC. Basic frequency range is 20 Hz to 5 kHz, with reduced accuracy to 5 Hz and 100 kHz.

Internal reference voltage of the Model 883AB is derived from a temperature-compensated zener diode, developing more than 11 volts. Each zener is Fluke-processed for determination and historical documentation of temperature coefficient and stability parameters. Overall temperature coefficient of the reference is less than 2 ppm/°C, with stability better than 25 ppm peak-to-peak per year.

The zener voltage is applied across a Kelvin-Varley type voltage divider with four decades of Fluke-manufactured precision wirewound resistors plus high-resolution interpolating vernier for six-digit readout. Critical resistors in the divider are temperature coefficient matched to within 1.5 ppm/°C. Ratio stability of the resistors in each decade is better than 10 ppm per year.

The divider output voltage is compared to the unknown input voltage by the null detector, a high input resistance, chopper-stabilized DC amplifier which drives the taut-band suspension panel meter. Taut-band suspension eliminates meter stickiness inherent in jewel-pivoted movements. Full scale null deflection (difference between unknown input voltage and Kelvin-Varley output voltage) is 100 uv to 100V in seven ranges. Null range switching is automatic with instrument input range so that meter resolution is a constant 1 ppm of input range.

Input resistance is infinite at null up to 11 VDC for true potentiometric measurements, eliminating source loading error. Off-null loading is virtually eliminated also, due to the high input resistance of the null detector (either 10 or 1 megohms, depending on null range). Typical input impedance for off-null conditions is thousands of megohms per volt of input. A high ratio of null detector input resistance to Kelvin-Varley divider output resistance is mandatory for good off-null meter accuracy. For Model 883AB this ratio is greater than 50 to 1 (1 megohm to 20 K ohms) in the worst case. Above 11 VDC, input resistance is an excellent 10 megohms.

Guard circuits are used where necessary in Model 883AB. Leakage between high side of input and ground or low signal input is typically in the order of several hundred thousand megohms.

For AC measurements, the instruments utilize a low-noise AC to DC converter with a mid-band loop gain of 66 db, providing a useful frequency range from 20 Hz. to 100 kHz and maintaining excellent accuracy to 1 mv.

Engineering design of the 883AB included thorough shock, vibration, humidity, and temperature testing to assure years of hard use under severe environmental conditions. Clean front panel layout with large, in-line numerals and automatic decimal switching simplify operation. Straightforward internal layout shows consideration for calibration and maintenance functions. All electrical components are flow-soldered on rugged glass-epoxy boards.

Other desirable features of Model 883AB include: rapid determination of input to ±3% of full scale in conventional voltmeter mode; virtual immunity to damage by accidental overload; recorder/output provision.

The instruments are equipped with resilient feet and tilt-up bale for bench use. Metal handles are available for either half-rack or side-by-side rack mounting.

883AB

AS A DIFFERENTIAL VOLTMETER

DC ACCURACY: ±(0.005% of input +0.0002% of range + 5 uv) from 0 to ±1100 VDC at 23° C ±1° C (nominal calibration temperature), less than 70% relative humidity.

±(0.01% of input + 5 uv) from 0 to ±1100 VDC within 13° C to 35° C (55° F to 95° F) temperature range, less than 80% relative humidity. Derate accuracy outside this temperature range at 0.0007%/° C to extremes of 0° C and 50° C (32° F and 122° F).

NOTE: Thorough error analysis studies into total instrument stability taking into account the documented stabilities of individual components and utilizing probability and statistical methods, indicate that typical instrument stability (defined as a specification met by 80% to 90% of all instruments) is 44 ppm (0.0044%) peak-to-peak per year. An instrument so categorized need be calibrated only once per year to meet all specifications. Additional stability data upon request.

AC ACCURACY (13° C to 35° C):
- 20 Hz to 5 kHz ±(0.1% of input + 25 uv) from 0.001 to 1100V
- 5 kHz to 10 kHz ±(0.15% of input + 25 uv) from 0.001 to 1100V
- 10 kHz to 20 kHz ±0.3% of input from 0.1 to 1100V
- 20 kHz to 100 kHz ±1% of input from 0.1 to 110V
- 10 Hz to 20 Hz ±(0.3% of input +100 uv) from 0.001 to 1100V
- 5 Hz to 10 Hz ±(1% of input +250 uv) from 0.001 to 1100V

NOTE: Derate accuracy outside the above temperature range at ±0.005%/° C below 10 kHz, or ±0.009%/° C above 10 kHz, to extremes of 0° C and 50° C.

VOLTAGE RANGES: 1, 10, 100, 1000V AC and DC, with 10% overranging capability on each range.

NULL RANGES: 100 uv through 100V AC and DC, in seven ranges.

DC INPUT RESISTANCE: Infinite at null from 0 to 11 VDC; 10 megohms above 11 VDC.

AC INPUT IMPEDANCE: 1 megohm, 40 uuf.

METER RESOLUTION: 1 uv maximum.

VOLTAGE DIAL RESOLUTION: 1 uv maximum.

AS A CONVENTIONAL VOLTMETER

DC ACCURACY: ±3% of range.

AC ACCURACY: ±3% of range within frequency and voltage ranges listed under "AC accuracy as a differential voltmeter."

RANGE: Voltage Range	DC Input Resistance	AC Input Impedance
1000-0-1000	10 Meg	1 Meg, 40 uuf
100-0-100	"	"
10-0-10	"	"
1-0-1	"	"
*0.1-0-0.1	"	"
*0.01-0-0.01	"	"
*0.001-0-0.001	1 Meg	"
*0.0001-0-0.0001	"	"

NOTE: 10% overvoltage capability on each range. *These ranges obtained by using null ranges with all five voltage readout dials set to zero.

GENERAL

ELECTRICAL DESIGN: Completely solid-state.

INPUT RESISTANCE OF NULL DETECTOR: 10 megohms for two highest null ranges, all input ranges; 1 megohm for two lowest null ranges, all input ranges.

REFERENCE ELEMENT: Temperature-compensated zener diodes.

REGULATION OF REFERENCE SUPPLY: 0.0005% for a 10% line voltage change.

STABILITY OF REFERENCE SUPPLY: 0.0005% peak-to-peak per hour. 0.0025% peak-to-peak per year.

ACCURACY OF OFF-NULL DEFLECTION: ±5% of null range (±3% with voltage dials at zero).

KELVIN-VARLEY ACCURACY: ±0.002% of setting from 1/11 of full scale to full scale. Ratio stability of decade resistors, 10 ppm/year.

RECORDER OUTPUT: Adjustable from 0 to ±20 mv minimum for full scale right and left deflections.

POLARITY: Front panel switch selects +DC, -DC, and AC.

WARMUP TIME: DC-15 seconds; AC-1 minute.

COMMON MODE REJECTION: 130 db at DC; 85 db at 60 Hz; 70 db at 400 Hz. NOTE: Battery operation of Model 883AB provides complete isolation from power system ground, for elimination of error due to ground loops.

OPERATING TEMPERATURE RANGE: 0° C to 50° C (See Accuracy).

STORAGE TEMPERATURE RANGE: 40° C to +60°C (-40° F to +140° F).

SHOCK: Meets requirements of MIL-T-945A and MIL-S-901B.

VIBRATION: Meets requirements of MIL-T-945A.

INPUT POWER: Rechargeable battery or 115/230 VAC ±10%, 50 - 440 Hz, approximately 4 watts during line operation or approximately 6 watts during recharge (minimum 30 hours operation on full charge).

MOUNTING: Resilient feet provided for bench and portable use. For side-by-side EIA Rack Mounting of two units, add Adapter Kit 881A-103 (includes handle-brackets and key plate). For EIA Rack Mounting of a single unit, add Adapter Kit 881A-102 (includes brackets with handles).

SIZE: 7" high x 8-1/2" wide x 14-3/4" deep. (19" wide in rack configurations) (17.8 x 21.5 x 37.4 cm)

WEIGHT: Approximately 14 lbs. (6.35 kg)

PRICE: Model 883AB - $1495.00
Rack Adapter Kit 881A-103 - $15.00
Rack Adapter Kit 881A-102 - $25.00

FLUKE

SOLID-STATE DC DIFFERENTIAL VOLTMETER

FEATURES

- Absolute accuracy ±0.0025% of Input
- All Solid State
- 100 uv Full Scale Null Sensitivity
- Rechargeable Battery Power (Model 885AB)
- 0 to 1100 VDC
- Resolution 0.1 ppm of range
- Grounded recorder output

Fluke Model 885AB DC Differential Voltmeter achieves an absolute accuracy of ±25 parts per million of input +1 ppm of range +5 uv from 0 to 1100 VDC. Model 885AB operates from either line or battery power. Batteries are compact, rechargeable nickel-cadmium units which operate the voltmeter more than 24 hours on full charge. In addition to true portability, battery power offers complete line isolation for elimination of ground loop errors.

Temperature coefficient and stability parameters of the zener reference and precision wirewound resistors are commensurate with the extreme accuracy of the 885AB. Temperature coefficient of zener reference is better than 1 ppm/° C; stability of reference supply is within 15 ppm peak-to-peak per sixty days of operation. Reference voltage is applied across a Kelvin-Varley voltage divider with four decades of Fluke-manufactured precision wirewound resistors plus high-resolution interpolating vernier for six-digit readout. Critical resistors of the divider are temperature coefficient grouped to better than 0.5 ppm/°C. Ratio stability of the Kelvin-Varley resistor decades is within 5 ppm/year.

From 0 to 11 VDC (zener voltage), the 885AB directly compares the voltmeter input voltage to the Kelvin-Varley divider output voltage by means of the high input impedance null detector. Thus, the instrument operates potentiometrically, with infinite input resistance at null (zero meter deflection), thereby eliminating source loading error. Because of the high input resistance of the null detector, off-null input resistance is extremely high also, typically in the order of thousands of megohms per volt of input. Above 11 VDC, input resistance is an excellent 10 megohms.

Off-null accuracy of the 885AB is preserved by the high ratio of null detector input resistance to Kelvin-Varley divider output resistance. This ratio is always better than 50 to 1 (1 megohm minimum to 20 K ohms maximum).

The null detector is a DC amplifier with extreme sensitivity and stability obtained through the use of a unique high-gain, photo-chopper-stabilized solid-state circuit. Transformer coupling in the null detector provides complete isolation for the recorder output feature. Low side of the 0 to 0.5V full scale recorder output is common to the chassis, assuring operation of the 885AB with virtually all recorders, regardless of input isolation characteristics. The instrument may also be used conveniently as an isolation amplifier.

Full scale null deflection (difference between unknown input voltage and Kelvin-Varley output voltage) is 100 uv to 100V in seven ranges. Null range switching is automatic with instrument input range switching so that maximum meter resolution is a constant 0.1 ppm of range above 1 VDC.

The instrument may be operated as a conventional voltmeter to rapidly determine the input to ±3% of range. Operator features include large, in-line readout, virtual immunity to damage by accidental overload, and automatic decimal switching with range. All electrical components are flow-soldered on glass-epoxy printed circuit boards.

Model 885AB is equipped with resilient feet and tilt-up bail for bench use. Metal handles are available for either single or side-by-side rack mounting.

885AB SPECIFICATIONS

AS A DIFFERENTIAL VOLTMETER

ABSOLUTE ACCURACY: ±(0.0025% of input + 0.0001% of range + 5 uv) from 0 to 1100 VDC at 23° C ±1° C (nominal calibration temperature), less than 70% relative humidity, 30 day calibration cycle.

±(0.005% of input + 5 uv) from 0 to 1100 VDC within 16° C to 32° C (60° F to 90° F) temperature range, less than 70% relative humidity.

INPUT RANGES: 1, 10, 100, 1000 VDC with 10% overranging capability.

NULL RANGES:

Input Range	Null Ranges
1 V	0.0001, 0.001, 0.01, 0.1 V
10 V	0.0001, 0.001, 0.01, 0.1, 1 V
100 V	0.001, 0.01, 0.1, 1, 10 V
1000 V	0.01, 0.1, 1, 10, 100 V

INPUT RESISTANCE: Infinite at null up to 11 VDC; 10 megohms above 11 VDC.

METER RESOLUTION: 1 uv maximum. (0.1 ppm of range above 1 VDC, 1 ppm of range below 1 VDC).

VOLTAGE DIAL RESOLUTION: 1 uv maximum. (1 ppm of range).

AS A CONVENTIONAL VOLTMETER

ACCURACY: 3% of range.

RANGES:

Voltage Range	Input Resistance
1000-0-1000	10 Meg
100-0-100	"
10-0-10	"
1-0-1	"
*0. 01-0-0.01	"
*0.001-0-0.001	1 Meg
*0.0001-0-0.0001	"

NOTE: 10% overranging capability. *These ranges obtained using null ranges with all readout dials at zero.

GENERAL

ELECTRICAL DESIGN: Completely solid-state.

INPUT RESISTANCE OF NULL DETECTOR: 10 megohms on the three least sensitive null ranges, all input ranges; 1 megohm on the two most sensitive null ranges, all input ranges.

REFERENCE ELEMENT: Temperature-compensated zener diodes (temperature coefficient less than 1 ppm/° C).

REGULATION OF REFERENCE SUPPLY: 0.0002% for a 10% line voltage change.

STABILITY OF REFERENCE SUPPLY:

0.0005% peak-to-peak per hour
0.001% peak-to-peak per day
0.0015% peak-to-peak per sixty days

ACCURACY OF OFF-NULL DEFLECTION: ±5% of null range (±3% of null range with voltage dials set to zero).

KELVIN-VARLEY DIVIDER ACCURACY: ±0.0012% of setting from 1/10 full scale to full scale. ±0.00012% terminal linearity below 1/10 full scale.

RECORDER/ISOLATION AMPLIFIER OUTPUT: Adjustable from 0 to 0.5V minimum for end-scale meter deflection, source resistance 5K to 8K, linearity better than ±0.5% of end-scale. Gain as an isolation amplifier is (0.5V/null-range sensitivity).

POLARITY: Reversible via front panel switch.

WARMUP TIME: 3 minutes.

DC COMMON MODE REJECTION: 140 db or 0.1 uv/volt of common mode voltage.

AC COMMON MODE REJECTION:

140 db at 50, 60 and 120 Hz
120 db at 400 Hz

OPERATING TEMPERATURE RANGE: Within accuracy specifications from 16° C to 32° C (60° F to 90° F), derated at 0.00035%/°C outside these limits to 0° C and 50° C (32° F and 122° F).

STORAGE TEMPERATURE RANGE:

- 40° C to 60° C (- 40° F to 140° F)

SHOCK: Meets requirements of MIL-T-945A and MIL-S-901B.

VIBRATION: Meets requirements of MIL-T-945A.

HUMIDITY: Within specifications up to 70% relative humidity.

INPUT POWER: Rechargeable battery or 115/230 VAC ±10, 50-440 Hz, approximately 2 watts during line operation or approximately 7 watts during recharge (minimum 24 hours operation on full charge).

MOUNTING: Resilient feet provided for bench and portable use. For side-by-side EIA Rack Mounting of two units, add Adapter Kit 881A-103 (includes handle-brackets and key plate). For EIA Rack Mounting of a single unit, add Adapter Kit 881A-102 (includes brackets with handles).

SIZE: 7" high x 8-1/2" wide x 14-3/4" deep. (19" wide in rack configuration). (17.8 x 21.6 x 37.4 cm).

WEIGHT: Approximately 15 lbs. (6.80 kg)

PRICE: Model 885AB - $1295.00
Rack Adapter Kit 881A-103 - $15.00
Rack Adapter Kit 881A-102 - $25.00

887AB

FLUKE

SOLID STATE AC/DC DIFFERENTIAL VOLTMETER

Features

- DC Accuracy ± 0.0025%
- AC Accurarcy ± 0.05%
- All - Solid - State
- 100 uv Full Scale Null Sensitivity
- Rechargeable Battery Power
- 0 - 1100 VAC and Dc
- Large, In - Line Readout

DESCRIPTION

The most accurate Fluke all-solid-state AC/DC Differential Voltmeter is offered with the " combination " line- or battery-powered Model 887AB. Batteries in the Model 887AB are compact, rechargeable, nickel cadmium units which operate the voltmeter for more than 30 hours after recharge. Battery power makes the instrument truly portable as well as offering complete isolation from the power line, eliminating error from measurements where ground loops contribute to inaccuracy.

DC accuracy of the 887AB is an extreme ±(25 ppm of input + 1 ppm of range + 5 uv) from 0 to 1100 VDC, complemented by AC accuracy of ±(0.05% of input + 0.0025% of range) from 0.001 to 500 VAC. Basic frequency range is 20 Hz to 5 KHz, with reduced accuracy to 5 Hz and 100 KHz.

Internal reference voltage of the Model 887AB is derived from temperature-compensated zener diodes, developing more than 11 volts. Each zener is Fluke-processed for determination and historical documentation of temperature coefficient and stability parameters. Overall temperature coefficient of the reference is less than 1 ppm/°C, with stability better than 13 ppm peak-to-peak per sixty days.

The zener voltage is applied across a Kelvin-Varley type voltage divider with four decades of Fluke-manufactured precision wirewound resistors plus high-resolution interpolating vernier for six-digit readout. Critical resistors in in the divider are temperature coefficient matched to within 0.5 ppm/°C. Ratio stability of these resistors is better than 5 ppm peak-to-peak per year.

From 0 to 11 VDC (zener voltage), the 887AB directly compares the voltmeter input voltage to the Kelvin-Varley divider output voltage by means of the high input impedance null detector. Thus, the instrument operates potentiometrically, with infinite input resistance at null (zero meter deflection), thereby eliminating source loading error. Because of the high input resistance of the null detector, off-null input resistance is extremely high also, typically in the order of thousands of megohms per volt of input. Above 11 VDC, input resistance is an excellent 10 megohms.

Off-null accuracy of the 887AB is preserved by the high ratio of null detector input resistance to Kelvin-Varley divider output resistance. This ratio is always better than 50 to 1 (1 megohm minimum to 20 K ohms maximum).

The null detector is an extremely sensitive, chopper-stabilized, solid-state DC amplifier. Output of the amplifier drives the rugged taut-band-suspension panel meter and recorder output feature. Wide environmental capabilities of the voltmeter attest to the critical leakage parameters met by this null detector.

Full scale null deflection (difference between unknown input voltage and Kelvin-Varley output voltage) is 100 uv to 100V in seven ranges. Null range switching is automatic with instrument input range switching so that maximum meter resolution is a constant 1 ppm of input range.

For AC measurements, the Model 887AB utilizes a low-noise AC to DC converter with a mid-band loop gain of 66 db, providing a useful frequency range from 5 Hz to 100 KHz and maintaining excellent accuracy to 1 mv. Above 1% of range, converter noise is always less than ±5 ppm of range. Environmental and long-term stabilities of the solid state converter are among outstanding design parameters.

The 887AB may be operated as a conventional voltmeter to rapidly determine the input to ±3% of range. Operator features include large, in-line readout, virtual immunity to damage by accidental overload, and automatic decimal switching with range. All electrical components are flow-soldered on glass-epoxy printed circuit boards.

The instruments are equipped with resilient feet and tilt-up bails for bench use. Metal handles are available for either single or side-by-side rack mounting.

SPECIFICATIONS

AS A DIFFERENTIAL VOLTMETER

DC ACCURACY: ±(0.0025% of input + 0.0001% of range + 5 uv) from 0 to ±1100 VDC at 23°C ±1°C (nominal calibration temperature), less than 70% relative humidity.

±(0.005% of input + 5 uv) from 0 to ±1100 VDC within 16°C to 32°C (60°F to 90°F) temperature range, less than 70% relative humidity. Derate accuracy outside this temperature range at 0.00035%/°C to extremes of 0°C and 50°C (32°F and 122°F).

NOTE: Thorough error analysis studies into total instrument stability taking into account the documented stabilities of individual components and utilizing probability and statistical methods, indicate that typical instrument stability (defined as a specification met by 80% to 90% of all instruments) is 20 ppm (0.002%) peak-to-peak per year. An instrument so categorized need be calibrated only once per year to meet all specifications. Additional stability data upon request.

AC ACCURACY:

At 23°C ±1°C (nominal calibration temperature), relative humidity less than 70%;

30 Hz to 5 KHz ±(0.05% of input + 0.0025% of range from 0.001 to 500 VAC ±0.1% of input from 500 to 1100 VAC

5 KHz to 10 KHz ±(0.07% of input + 0.005% of range) from 0.001 to 500 VAC ±0.1% of input from 500 to 1100 VAC

10 KHz to 20 KHz ±(0.15% of input + 0.01% of range) from 0.001 to 1100 VAC

Over the temperature range 13°C to 35°C (55°F to 95°F), relative humidity less than 70%;

20 Hz to 5 KHz ±(0.1% of input + 25 uv) from 0.001 to 1100 VAC.

5 KHz to 10 KHz ±(0.15% of input + 25 uv) from 0.001 to 1100 VAC.
10 KHz to 20 KHz ±0.3% of input from 0.1 to 1100 VAC
20 KHz to 50 KHz ±0.5% of input from 0.1 to 110 VAC
50 KHz to 100 KHz ±1% of input from 0.1 to 110 VAC
10 Hz to 20 Hz ±(0.3% of input +100 uv) from 0.001 to 1100 VAC.
5 Hz to 10 Hz ±(1% of input +250 uv) from 0.001 to 1100 VAC.

Outside the 13°C to 35°C temperature range, the above specifications may be derated at 0.003%/°C (below 5 KHz) or 0.005%/°C (above 5 KHz) to the extremes of 0°C and 50°C (32°F and 122°F).

VOLTAGE RANGES: 1, 10, 100, 1000 VAC and ±DC, with 10% over-ranging capability on each range.

NULL RANGES: 100 uv through 100V end scale AC and DC, in seven ranges.

DC INPUT RESISTANCE: Infinite at null from 0 to ±11 VDC; 10 megohms above ±11 VDC.

AC INPUT IMPEDANCE: 1 megohm, 40 pf.

METER RESOLUTION: 1 ppm of range (1 uv maximum).

VOLTAGE DIAL RESOLUTION: 1 ppm of range (1 uv maximum).

AS A CONVENTIONAL VOLTMETER

DC ACCURACY: ±3% of range.

AC ACCURACY: ±3% of range within frequency and voltage ranges listed under "AC accuracy as a differential voltmeter."

887AB SPECIFICATIONS

RANGE:

Voltage Range	DC Input Resistance	AC Input Impedance
1000-0-1000	10 Meg	1 Meg, 40 pf
100-0-100	"	"
10-0-10	"	"
1-0-1	"	"
*0.1-0-0.1	"	"
*0.01-0-0.01	"	"
*0.001-0-0.001	1 Meg	"
*0.0001-0-0.0001	"	"

NOTE: 10% overvoltage capability on each range. *These ranges obtained by using null ranges with all voltage read-out dials set to zero.

GENERAL

ELECTRICAL DESIGN: Completely solid-state.

INPUT RESISTANCE OF NULL DETECTOR: 10 megohms for two least sensitive null ranges, all input ranges; 1 meg-ohm for two most sensitive null ranges, all input ranges.

REFERENCE ELEMENT: Temperature-compensated zener diode, temperature coefficient less than 1 ppm/°C over operating temperature range.

REGULATION OF REFERENCE SUPPLY: 0.0002% for a 10% line voltage change.

STABILITY OF REFERENCE SUPPLY:
- 0.0005% peak-to-peak per hour
- 0.0007% peak-to-peak per day
- 0.0013% peak-to-peak per sixty days

STABILITY OF INSTRUMENT:
- 0.0025% peak-to-peak per sixty days

ACCURACY OF OFF-NULL DEFLECTION: ±5% of null range (±3% with voltage dials at zero).

KELVIN-VARLEY DIVIDER ACCURACY: ±0.0012% of setting from 1/10 of full scale to full scale. ±0.00012% of terminal linearity below 1/10 full scale.

RECORDER OUTPUT: Adjustable from 0 to ±20 mv minimum for full scale right and left deflections.

POLARITY: Front panel switch selects +DC, -DC, and AC.

WARMUP TIME: 3 minutes.

COMMON MODE REJECTION: 130 db at DC; 85 db at 60 Hz; 70 db at 400 Hz. NOTE: Battery operation provides complete isolation from power system ground, for elimination of error due to ground loops.

OPERATING TEMPERATURE RANGE: 0°C to 50°C (see Accuracy).

STORAGE TEMPERATURE RANGE: -40°C to +60°C (-40°F to +140°F).

SHOCK: Meets requirements of MIL-T-945A and MIL-S-901B.

VIBRATION: Meets requirements of MIL-T-945A.

INPUT POWER: Rechargeable battery or 115/230 VAC ±10%, 50 - 440Hz, approximately 4 watts during line operation or approximately 6 watts during recharge (minimum 30 hours operation on full charge).

MOUNTING: Resilient feet provided for bench and portable use. For side-by-side EIA Rack Mounting of two units, add Adapter Kit 881A-103 (includes handle-brackets and key plate). For EIA Rack Mounting of a single unit, add Adapter Kit 881A-102 (includes brackets with handles).

SIZE: 7" high X 8-1/2" wide X 14-3/4" deep. (19" wide in rack configurations). (17.7 x 21.5 x 37.4 cm)

WEIGHT: Approximately 14 lbs. (5.89 kg)

PRICE: Model 887AB - $1695.00
Rack Adapter Kit 881A-103 - $15.00
Rack Adapter Kit 881A-102 - $25.00

FLUKE

SOLID STATE DC DIFFERENTIAL VOLTMETER

FEATURES

- Infinite Input Resistance from 0 to ±1100 VDC
- Absolute Accuracy ±0.01% of Input
- All-Solid-State
- Battery and Grounded Recorder Options
- 1 mv Full Scale Null Sensitivity
- Resolution 1 ppm of Range
- Continuous Dial Rotation

All solid-state Model 891A is a versatile new DC differential voltmeter which combines the advantages of a precision high-voltage reference with those of battery-powered operation. Loading of the circuit under test is prevented over the entire range of 0 to ±1100 VDC by infinite input resistance at null, the benefit of a newly developed 1100 VDC reference supply. Battery operation assuring portability and complete isolation from the power line, is made possible by the use of an efficient dc-to-dc converter to boost battery voltage to an accurately established 1100 volts. The 1100v reference supply is regulated by comparing a sample of its potential to that of aged and matched zener diodes with a high-gain, extremely stable DC amplifier.

The reference voltage is applied across a Kelvin-Varley voltage divider with three decades of Fluke manufactured precision wirewound resistors plus a high resolution interpolating vernier for five-digit readout. Input resistance of the Kelvin-Varley divider is 1.1 megohm resulting in extremely low maximum power dissipation of 1.1 watts at 1100 volts, a factor critical to battery operation.

From 0 to ±1100 VDC, the 891A directly compares the voltmeter input voltage to the Kelvin-Varley divider output voltage by means of a high input impedance null detector. Thus, the instrument operates potentiometrically over its entire range, with infinite input resistance at null (zero meter deflection), thereby eliminating source loading error. Because of the very high input resistance of the null detector, off-null input resistance is extremely high also.

End scale null deflection (difference between unknown input voltage and Kelvin-Varley output voltage) is 1 millivolt to 100 volts in six ranges. Null range switching is automatic with instrument input range so that maximum meter resloution is a constant 1 ppm of range above 1 VDC.

The null detector is a DC amplifier with high sensitivity and stability obtained through the use of a FET-chopper-stabilized circuit. Input resistance of the null detector is 100 megohms for the 100v through 0.1v null ranges, and 10 megohms on the 0.01 and 0.001v null ranges.

The optional rechargeable battery power pack which may be included initially or added easily at a later date assures complete isolation from the line as well as maximum portability. The instrument may be operated directly from the line, from the line during battery charging, or for at least 8 hours on a full charge. Power consumption is a modest 4 watts for operation and a total of only 8 watts while the batteries are charging.

The recorder output module like the battery pack is optional and may be included initially or added at a later date. The output terminals are completely isolated from the internal circuitry and the low terminal is grounded. This enables the instrument to drive any recorder regardless of input isolation characteristics. The recorder output is adjustable from 0 to ±0.2v for full scale meter deflection.

The instrument may be operated as a conventional voltmeter to rapidly determine the input to ±3% of range. In this mode, input resistance is an excellent 100 megohms. Operator features include large, in-line readout with 360° rotation of voltage dials, virtual immunity to damage by accidental overload, and automatic decimal switching with range.

SPECIFICATIONS

AS A DIFFERENTIAL VOLTMETER

ABSOLUTE ACCURACY: ±(0.01% of input +0.001% of range + 10 uv) from 0 to ±1100 VDC at 23°C ±2°C (nominal calibration temperature), up to 80% relative humidity. ±(0.02% of input + 0.001% of range + 10 uv) from 0 to ±1100 VDC, from 10°C to 40°C up to 70% relative humidity.

INPUT RANGES: 1, 10, 100, 1000 VDC with 10% overranging capability.

NULL RANGES:

INPUT RANGE	NULL RANGES
1v	0.001, 0.01, 0.1v
10v	0.001, 0.01, 0.1, 1v
100v	0.01, 0.1, 1, 10v
1000v	0.1, 1, 10, 100v

INPUT RESISTANCE: Infinite at null from 0 to 1100 VDC.

METER RESOLUTION: 10 uv maximum (1 ppm of range above 1v, 10 ppm of 1v range).

VOLTAGE DIAL RESOLUTION: 10 uv maximum (10 ppm of range).

AS A CONVENTIONAL VOLTMETER

ACCURACY: ±3% of range.

RANGES AND INPUT RESISTANCE:

1000-0-1000	100 Megohm input resistance
100-0-100	100 Megohm input resistance
10-0-10	100 Megohm input resistance
1-0-1	100 Megohm input resistance
*0.1-0-0.1	100 Megohm input resistance
*0.01-0-0.01	10 Megohm input resistance
*0.001-0-0.001	10 Megohm input resistance

NOTE: 10% over-ranging capability. *These ranges obtained using null ranges with all readout dials at zero.

GENERAL

ELECTRICAL DESIGN: Completely solid-state.

INPUT RESISTANCE OF NULL DETECTOR: 100 megohm on all ranges except 10 megohms on 0.01 and 0.001v ranges.

REFERENCE ELEMENT: Temperature compensated zener diodes.

REGULATION OF REFERENCE SUPPLY: 0.0005% for a 10% line voltage change.

INSTRUMENT STABILITY (peak-to-peak):

10 ppm per hour
20 ppm per day
40 ppm per month
90 ppm per year

KELVIN-VARLEY DIVIDER ACCURACY: ±0.005% of dial setting above 1/10 of full scale.

RECORDER OUTPUT: Available as option -02, adjustable from 0 to ±0.2v for end scale null deflection. Low side grounded. Loading does not affect null deflection accuracy.

POLARITY: Reversible via front panel switch.

WARMUP TIME: Less than 1 minute.

DC COMMON MODE REJECTION: 120 db (1 uv/volt of common mode voltage).

AC COMMON MODE REJECTION: Up to 100v peak-to-peak 50-500 Hz produces no measureable instrument error.

OPERATING TEMPERATURE RANGE: 0°C to 50°C (derated outside the limits of 10°C and 40°C at 15 ppm/°C).

STORAGE TEMPERATURE RANGE:
891A (line power only)
−40°C to 70°C (−40°F to 158°F).
891A (line and rechargeable batteries)
−40°C to 60°C (−40°F to 140°F).

HUMIDITY:
Up to 80% RH below 25°C
Up to 70% RH above 25°C

SHOCK: Meets requirements of MIL-T-945A and MIL-S-901B.

VIBRATION: Meets requirements of MIL-T-945A

INPUT POWER: Model 891A, 115/230 VAC ±10%, 50 - 500 Hz, approximately 4 watts; with -01 option, operates from rechargeable batteries or 115/230 VAC ±10%, 50 - 500 Hz, approximately 8 watts during recharge while operating on line (16 hours to recharge, 8 hours minimum operation on full charge).

NOTE: Switch incorporated for changing from 115 VAC to 230 VAC operation.

SIZE:
891A - 8½" wide x 7" high x 12¼" deep.

WEIGHT: **(Approximate)**
891A - 12 lbs.
Battery Power Option - 2 lbs.
Recorder Output Option - 0.3 lbs.

MOUNTING:
891A - Carrying handle detents into custom-designed feet for use as a tilt-up bail. Optional brackets MEE-7008 used for 19" EIA rack mounting.

PRICE:
891A - $895.00
891A Rack Mounting Brackets MEE-7008 - $30.00

OPTIONS:
Battery Power (-01) - $100.00
Recorder Output (-02) - $50.00

All prices f.o.b. factory, Mountlake Terrace, Washington

SOLID-STATE AC/DC DIFFERENTIAL VOLTMETER

FEATURES:

- Infinite Input Resistance from 0 to ±1100 VDC
- DC Accuracy ±0.01% of Input
- AC Accuracy ±0.05% of Input
- All-Solid-State
- Battery and Grounded Recorder Options
- Resolution 1 ppm of Range
- Continuous Dial Rotation

All-solid-state Models 893A and 893AR are versatile new AC/DC differential voltmeters which combine the advantages of a precision high-voltage reference with those of battery-powered operation. Loading of the circuit under test is prevented over the entire range of 0 to ±1100 VDC by infinite input resistance at null, the benefit of a newly developed 1100 VDC reference supply. Battery operation assuring portability and complete isolation from the power line, is made possible by the use of an efficient dc-to-dc converter to boost battery voltage to an accurately established 1100 volts. The 1100v reference supply is regulated by comparing a sample of its potential to that of aged and matched zener diodes with a high-gain, extremely stable DC amplifier.

The reference voltage is applied across a Kelvin-Varley voltage divider with three decades of Fluke-manufactured precision wirewound resistors plus a high resolution interpolating vernier for five-digit readout. Input resistance of the Kelvin-Varley divider is 1.1 megohm resulting in extremely low maximum power dissipation of 1.1 watts at 1100 volts, a factor critical to battery operation.

From 0 to ±1100 VDC, the 893A directly compares the voltmeter input voltage to the Kelvin-Varley divider output voltage by means of a high input impedance null detector. Thus, the instrument operates potentiometrically over its entire range, with infinite input resistance at null (zero meter deflection), thereby eliminating source loading error. Because of the very high input resistance of the null detector, off-null input resistance is extremely high also.

End scale null deflection (difference between unknown input voltage and Kelvin-Varley output voltage) is 1 millivolt to 100 volts in six ranges. Null range switching is automatic with instrument input range so that maximum meter resolution is a constant 1 ppm of range above 1 VDC.

The null detector is a DC amplifier with high sensitivity and stability obtained through the use of a FET-chopper-stabilized circuit. Input resistance of the null detector is 100 megohms for the 100v through 0.1v null ranges, and 10 megohms on the 0.01 and 0.001v null ranges.

For AC measurements, Models 893A and 893AR utilize a low-noise AC to DC converter providing a useful frequency range from 5 Hz to 100 kHz and maintaining excellent accuracy to 1 mv. Above 1% of range, converter noise is always less than ±5 ppm of range. Environmental and long-term stabilities of the solid-state converter are among outstanding design parameters.

The recorder output module and the rechargeable battery pack are optional and may be included initially or added at a later date. The recorder output terminals are completely isolated from the internal circuitry and the low terminal is grounded. This enables the instrument to drive any recorder regardless of input isolation characteristics.

The instrument may be operated as a conventional voltmeter to rapidly determine the input to ±3% of range. In this mode, input resistance is an excellent 100 megohms. Operator features include large, in-line readout with 360° rotation of voltage dials, virtual immunity to damage by accidental overload, and automatic decimal switching with range.

893A
893AR
SPECIFICATIONS

AS A DIFFERENTIAL VOLTMETER

DC ACCURACY: ±(0.01% of input + 0.001% of range +10 uv) from 0 to ±1100 VDC at 23°C ±2°C, up to 80% RH. ±(0.02% of input + 0.001% of range + 10 uv) from 0 to ±1100 VDC, from 10°C to 40°C up to 70% RH.

AC ACCURACY (% of input):
At 23°C ±2°C, less than 70% RH.
50 Hz to 10 kHz; 0.001 to 500 VAC; ±0.05% of input +25 uv)
500 to 1100 VAC; ±0.1% of input
Over range of 10°C to 40°C, less than 70% RH.
5 Hz to 10 Hz; 0.001 to 1100 VAC; ±(1% of input + 250 uv)
10 Hz to 20 Hz; 0.001 to 1100 VAC; ±(0.5 % of input + 100 uv)
20 Hz to 50 Hz; 0.001 to 1100 VAC; ±(0.15% of input + 25 uv)
50 Hz to 20 kHz; 0.001 to 110 VAC; ±(0.1 % of input + 25 uv)
110 to 1100 VAC; ± 0.15% of input
20 kHz to 50 kHz; 0.001 to 110 VAC; ±(0.15% of input +25 uv)
50 kHz to 100 kHz; 0.001 to 110 VAC; ± 0.5 % of input

INPUT RANGES: 1, 10, 100, 1000 VAC and ±DC, each with 10% overranging capability.

NULL RANGES:

Input Range	Null Ranges
1v	0.001, 0.01, 0.1v
10v	0.001, 0.01, 0.1, 1v
100v	0.01, 0.1, 1, 10v
1000v	0.1, 1, 10, 100v

DC INPUT RESISTANCE: Infinite at null from 0 to 1100 VDC.

AC INPUT IMPEDANCE: 1 megohm, 20 pf.

METER RESOLUTION: 10 uv maximum (1 ppm of range above 1v, 10 ppm of 1v range).

VOLTAGE DIAL RESOLUTION: 10 uv maximum (10 ppm of range).

AS A CONVENTIONAL VOLTMETER

DC ACCURACY: ±3% of range.

AC ACCURACY: ±3% of range within frequency and voltage ranges listed under "AC accuracy as a differential voltmeter".

RANGE AND INPUT RESISTANCE:

RANGE	DC INPUT RESISTANCE	AC INPUT IMP.	
1000-0-1000	100 M	1 M	20 pf
100-0-100	100 M	1 M	20 pf
10-0-10	100 M	1 M	20 pf
1-0-1	100 M	1 M	20 pf
*0.1-0-0.1	100 M	1 M	20 pf
*0.01-0-0.01	10 M	1 M	20 pf
*0.001-0-0.001	10 M	1 M	20 pf

NOTE: 10% over-ranging capability. *These ranges obtained using null ranges with all readout dials at zero.

GENERAL

ELECTRICAL DESIGN: Completely solid-state.

INPUT RESISTANCE OF NULL DETECTOR: 100 megohms on all ranges except 10 megohms on 0.01 and 0.001v ranges.

REFERENCE ELEMENT: Temperature compensated zener diodes.

REGULATION OF REFERENCE SUPPLY: 0.0005% for a 10% line voltage change.

REFERENCE STABILITY (peak-to-peak):

10 ppm per hour	40 ppm per month
20 ppm per day	90 ppm per year

KELVIN-VARLEY DIVIDER ACCURACY: ±0.005% of dial setting above 1/10 of full scale.

RECORDER OUTPUT: Available as option -02, adjustable from 0 to ±0.2v for end scale null deflection. Low side grounded. Loading does not affect null deflection accuracy.

POLARITY: Reversible via front panel switch.

WARMUP TIME: Less than 1 minute.

DC COMMON MODE REJECTION: 120 db (1 uv/volt of common mode voltage)

AC COMMON MODE REJECTION: Up to 100v peak-to-peak 50 - 500 Hz produces no measurable instrument error.

OPERATING TEMPERATURE RANGE: Within DC accuracy specifications from 10°C to 40°C; Derate DC accuracy outside these limits to 0°C and 50°C at 15 ppm/°C.
Within AC accuracy specifications from 10°C to 40°C, derate at 40 ppm/°C outside those limits to 0°C and 50°C.

STORAGE TEMPERATURE RANGE:
893A (line power only)
−40°C to +70°C
893A (line and rechargeable batteries)
−40°C to +60°C

HUMIDITY: Up to 80% RH below 25°C
Up to 70% RH above 25°C

SHOCK AND VIBRATION: Meets MIL-T-945A.

INPUT POWER: Model 893A and 893AR, 115/230 VAC ±10%, 50 - 500 Hz, approximately 4 watts; with -01 option, operates from rechargeable batteries or 115/230 VAC ±10%, 50 - 500 Hz, approximately 8 watts during recharge while operating on line (16 hours to recharge, 8 hours minimum operation on full charge).
NOTE: Switch incorporated for changing from 115 VAC to 230 VAC operation.

SIZE:
893A - 8½" wide x 7" high x 10¼" deep. (21.5 x 17.7 x 26.0 cm)
893AR - 17" wide x 3½" high x 12¼" deep. (43.1 x 88 x 31.3 CM) (19" wide after installation of mounting brackets)

WEIGHT: (approximate)
893A or 893AR - 12 lbs. (5.44 kg)
Battery Power Option - 2 lbs.
Recorder Output Option - 0.3 lbs.

MOUNTING:
893A Carrying handle detents into custom designed feet for use as a tilt-up bail. Optional brackets MEE-7008 used for 19" EIA rack mounting.
893AR Self-supporting on custom-designed feet and included tilt bail. Rack mountable with optional brackets MEE-7001 or optional 18" chassis slides MEE-8078.

PRICE:
893A - $1,195.00 893AR - $1,195.00

OPTIONS:
Battery Power (-01) - $100.00 (available for 893A only)
Recorder Output (-02) - $50.00

ACCESSORIES:
893AR Rack Mounting Brackets MEE-7001 - $15.00
893A Rack Mounting Brackets MEE-7008 - $30.00
893AR 18" Chassis slides MEE-8078 - $50.00

All Prices f.o.b. factory, Mountlake Terrace, Washington.

895A

SOLID STATE DIFFERENTIAL VOLTMETER

FEATURES

- Infinite input resistance at null, from 0 to ±1100 VDC
- Absolute accuracy ±0.0025% of Input
- All Solid State
- Incorporates Ratiometer Capability
- 100 uv Full Scale Null Sensitivity
- 0 to 1100 VDC
- Resolution 0.1 ppm of range
- Grounded recorder output

All-solid-state Model 895A DC Differential Voltmeter achieves an absolute accuracy of ±(25 parts per million of input +1 ppm of range +5 uv) from 0 to ±1100 VDC. Over the entire range from 0 to ±1100 VDC, the 895A offers infinite input resistance at null, made possible through the incorporation of a unique Fluke solid-state, photo-chopper-stabilized 1100 VDC reference supply. This supply is calibrated against a zener EMF with state-of-the-art stability and temperature coefficient parameters. Due to the excellent stability of the zener supply, the overall stability of the 1100 VDC reference is better than 5 ppm peak-to-peak per hour, and 8 ppm peak-to-peak per day.

The reference voltage is applied across a Kelvin-Varley voltage divider with four decades of Fluke-manufactured precision wirewound resistors plus high-resolution interpolating vernier for six-digit readout. Critical resistors of the divider are temperature coefficient grouped to better than 0.5 ppm/°C. Ratio stability of the Kelvin-Varley resistor decades is within 5 ppm/year.

From 0 to ±1100 VDC, the 895A directly compares the voltmeter input voltage to the Kelvin-Varley divider output voltage by means of a high input impedance null detector. Thus, the instrument operates potentiometrically over its entire range, with infinite input resistance at null (zero meter deflection), thereby eliminating source loading error. Because of the very high input resistance of the null detector, off-null input resistance is extremely high also, typically in the order of thousands of megohms per volt of input.

End scale null deflection (difference between unknown input voltage and Kelvin-Varley output voltage) is 100 uv to 100V in seven ranges. Null range switching is automatic with instrument input range switching so that maximum meter resolution is a constant 0.1 ppm of range above 1 VDC.

The null detector is a DC amplifier with extreme sensitivity and stability obtained through the use of a unique high-gain, photo-chopper-stabilized solid-state circuit. Input resistance of the null detector is an extreme 100 megohms on all ranges down to 0.1V; 10 megohms on the 0.01V range; and 1 megohm on the 0.001 and 0.0001V ranges. Transformer coupling in the null detector provides complete isolation for the recorder output feature. Low side of the 0 to 0.5V full scale recorder output is common to the chassis, assuring operation of the 895A with virtually all recorders, regardless of input isolation characteristics. Such excellent isolation provides another application for the 895A; general purpose isolation amplifier with a gain of 0.5V/null-range sensitivity setting.

The 895A is also designed for those applications where it is desired to obtain an extremely accurate ratio of one voltage to another. By placing the front panel polarity switch in the "RATIO" position, the Kelvin-Varley divider is connected across rear panel posts for connection to an external reference up to 1000 VDC. At null, then, the voltage dial reading indicates the ratio of front panel input to rear reference input.

The instrument may be operated as a conventional voltmeter to rapidly determine the input to ±3% of range. In this mode, input resistance is an excellent 100 megohms. Operator features include large, in-line readout, virtual immunity to damage by accidental overload, and automatic decimal switching with range. All electrical components are flow-soldered on glass-epoxy printed circuit boards for ruggedness and reliability.

Model 895A is equipped with resilient feet and tilt-up bail for bench use. Metal handles are available for either single or side-by-side rack mounting.

895A SPECIFICATIONS

AS A DIFFERENTIAL VOLTMETER

ABSOLUTE ACCURACY: ±(0.0025% of input +0.0001% of range + 5 uv) from 0 to ±1100 VDC at 23° C ±1° C (nominal calibration temperature), less than 70% relative humidity.

±(0.005% of input + 5 uv) from 0 to ±1100 VDC, within the temperature range of 16° C to 32° C (60° F to 90° F), less than 70% relative humidity. Derate accuracy outside this temperature range at 0.00035%/° C to extremes of 0° C and 50° C.

NOTE: Thorough error analysis studies into total instrument stability taking into account the documented stabilities of individual components and utilizing probability and statistical methods, indicate that typical instrument stability (defined as a specification met by 80% to 90% of all instruments) is 20 ppm (0.002%) peak-to-peak per year. An instrument so categorized need be calibrated only once per year to meet all specifications. Additional stability data upon request.

INPUT RANGES: 1, 10, 100, 1000 VDC with 10% over-ranging capability.

NULL RANGES:

Input Range	Null Ranges
1 V	0.1, 0.01, 0.001, 0.0001 V
10 V	1, 0.1, 0.01, 0.001, 0.0001 V
100 V	10, 1, 0.1, 0.01, 0.001 V
1000 V	100, 10, 1, 0.1, 0.01 V

INPUT RESISTANCE: Infinite at null from 0 to ±1100 VDC.

METER RESOLUTION: 1 uv maximum (0.1 ppm of range above 1 VDC, 1 ppm of range below 1 VDC).

VOLTAGE DIAL RESOLUTION: 1 uv maximum (1 ppm of range).

AS A CONVENTIONAL VOLTMETER

ACCURACY: ±3% of range

RANGES AND INPUT RESISTANCE:

1000-0-1000	100 Megohm input resistance
100-0-100	100 Megohm input resistance
10-0-10	100 Megohm input resistance
1-0-1	100 Megohm input resistance
*0.1-0-0.1	100 Megohm input resistance
*0.01-0-0.01	10 Megohm input resistance
*0.001-0-0.001	1 Megohm input resistance
*0.0001-0-0.0001	1 Megohm input resistance

NOTE: 10% overranging capability. *These ranges obtained using null ranges with all readout dials at zero.

AS A RATIOMETER

CIRCUIT: "RATIO" position of polarity switch places Kelvin-Varley divider across rear panel binding posts for connection to external reference input voltage. Null detector remains between front panel input and Kelvin-Varley variable tap. At null, voltage dial (Kelvin-Varley) setting indicates decimal ratio of front panel input voltage to rear reference input voltage.

RATIO: Zero to unity (six-digit readout).

REFERENCE INPUT VOLTAGE: 0 to ±1000 VDC with no power derating over entire range.

RATIO ACCURACY:
±0.0012% of setting at 0.1 ratio and above
±0.00012% of terminal linearity below 0.1 ratio

TEMPERATURE COEFFICIENT OF RATIO:
0.0001% of setting/° C above 0.1 ratio
0.00001% of terminal linearity/° C below 0.1 ratio

GENERAL

INPUT RESISTANCE OF NULL DETECTOR:
100 megohms on 100, 10, 1, and 0.1V null ranges
10 megohms on 0.01V null range
1 megohm on 0.001 and 0.0001V null ranges

REGULATION OF REFERENCE SUPPLY: 0.0002% for a 10% line voltage change.

STABILITY OF REFERENCE SUPPLY:
0.0005% peak-to-peak per hour
0.0008% peak-to-peak per day
0.0013% peak-to-peak per sixty days

STABILITY OF METER ZERO (includes noise): ±2 uv for a 10% line voltage change on most sensitive (0.0001V) null range.

KELVIN-VARLEY DIVIDER ACCURACY: ±0.0012% of setting from 1/10 full scale to full scale. ±0.00012% terminal linearity below 1/10 full scale.

REFERENCE ELEMENT: Temperature compensated Zener diodes.

WARM-UP TIME: 30 minutes.

RECORDER/ISOLATION AMPLIFIER OUTPUT: Adjustable from 0 to 0.5V minimum for end-scale meter deflection, source resistance 5K to 8K, linearity better than ±0.5% of end-scale. Gain as an isolation amplifier is (0.5V/null-range sensitivity).

POLARITY: Front panel switch selects +DC, -DC, and Ratio.

DC COMMON MODE REJECTION: 140 db or 0.1 uv/volt of common mode voltage.

AC COMMON MODE REJECTION: 140 db at 50, 60, and 120 Hz; 120 db at 400 Hz and 1000 Hz.

OPERATING TEMPERATURE RANGE: 0° C to 50° C (32° F to 122° F). See Accuracy.

HUMIDITY: Within specifications up to 70% relative humidity.

STORAGE TEMPERATURE RANGE: -40° C to +70° C (-40° F to 158° F).

SHOCK: Meets requirements of MIL-T-945A and MIL-S-901B.

VIBRATION: Meets requirements of MIL-T-945A.

INPUT POWER: 115/230 VAC ±10%, 50 to 1000 Hz, 15 watts, 20 VA.

MOUNTING: Resilient feet provided for bench and portable use. For side-by-side EIA Rack Mounting of two units, add Adapter Kit 881A-103 (includes handle-brackets and key plate). For EIA Rack Mounting of a single unit, add Adapter Kit 881A-102 (includes brackets with handles).

SIZE: 7" high x 8-1/2" wide x 14-3/4" deep. (19" wide in rack configurations) (17.7 x 21.5 x 37.4 cm)

WEIGHT: 16 pounds. (7.25 kg)

PRICE: $1395.00
Rack Adapter Kit 881A-103 - $15.00
Rack Adapter Kit 881A-102 - $25.00

931B

TRUE RMS DIFFERENTIAL VOLTMETER

FEATURES:

- *TRUE RMS RESPONSE*
- *ALL SOLID STATE*
- *±0.05% ACCURACY*
- *RECORDER OUTPUT*
- *2 Hz – 2 MHz BANDWIDTH*

APPLICATIONS:

- *VIBRATION, ACOUSTIC AND SEISMIC SCIENCES*
- *NOISE MEASUREMENTS*
- *POWER SUPPLY RIPPLE MEASUREMENTS*
- *SECONDARY AC MEASUREMENT STANDARD*

The all solid-state Model 931B is designed for state of the art rapid measurements of AC waveforms regardless of their shape. Accuracies to ±0.05% of reading are obtained in a simple to operate portable instrument with a five digit readout and automatic indicating decimal point.

The 931B employs the principle of the differential thermocouple transfer standard to obtain its high degree of accuracy, incorporating unique Fluke solid-state circuitry to accomplish the thermal transfer virtually instantaneously and automatically as the voltage readout dials are adjusted to their proper setting.

As with all Fluke differential voltmeters, the 931B incorporates a "TVM" or conventional direct-reading mode for rapid indication of the RMS value of input. Frequency response in TVM mode is 2 Hz to 2 MHz. Response in the null or differential mode is 2 Hz to 1 MHz.

Available options for the Model 931B are listed below.

Basic 931B - BNC input, line powered.
Option -01 - BNC input, line or rechargeable battery powered.

Rechargeable battery configurations incorporate Nickel-Cadmium batteries for up to 22 hours of continuous operation between recharging.

The operational advantages of the 931B have been enhanced by the addition of a NULL DAMPING selector switch. This offers the operator the choice of normal differential mode operation over the frequency range of 10 Hz to 1 MHz, or operation down to 2 Hz. Operation of the 931B at frequencies over 20 Hz while in the 2 Hz mode is not recommended due to the slow response of the meter circuit.

Accuracy of measurement for each mode is graphically shown in Figure 1.

The 931B series will withstand up to 1500V peak or 1000V RMS on any range under any combination of control settings with no damage. No reset is necessary, and the instrument will function normally after removal of overload.

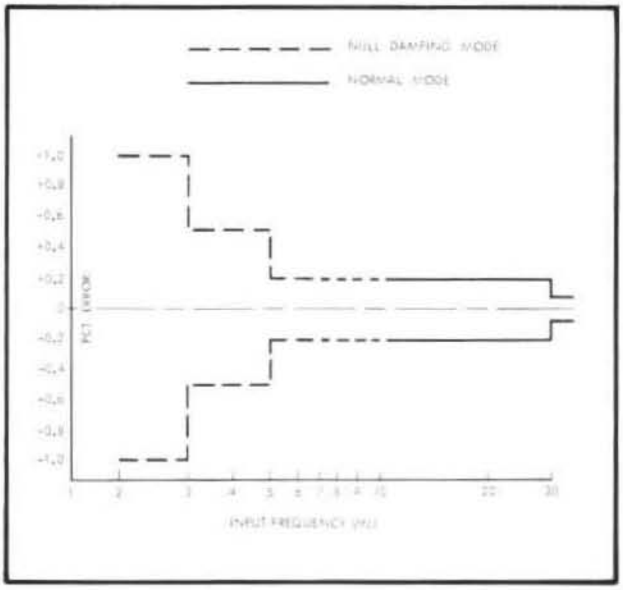


Figure 1

True RMS response is guaranteed through the use of thermocouples, which by definition produce an output due to the heating effect of an applied current. The 931B series finds many applications in AC measurements where distortion is greater than the allowable measurement error, where measurements involve waveforms over which there is no control of harmonic content, and where non-sinusoidal waveforms are to be measured. A DC output, proportional to meter deflection and accurate to within ±1% of end scale, is available for recording purposes or as an RMS to DC converter.

The 931B series is packaged in a lightweight, compact configuration, the same as used for Fluke solid-state differential voltmeters. Resilient feet and tilt-up bail are standard equipment for bench use. Kits are available for side-by-side or single unit mounting in a standard EIA rack.

AS A DIFFERENTIAL VOLTMETER

INPUT VOLTAGE RANGE . . . . 0.01 to 1100V RMS in five ranges of 0.1 1, 10, 100 and 1000V RMS, each with 10% overranging.

INPUT FREQUENCY RANGE

Null Damping Mode	2 Hz to 10 Hz
Normal Mode	10 Hz to 1 MHz

NULL RANGES (end scale percentage deviations from voltage dial setting)

10%-0- 10%	(0.2% per scale division)
3%-0- 3%	(0.1% per scale division)
1%-0- 1%	(0.02% per scale division)
0.3%-0-0.3%	(0.01% per scale division)
0.1%-0-0.1%	(0.002% per scale division)

ACCURACY (at 23°C ±1°C)

2 Hz - 10 Hz Mode	
2 Hz to 3 Hz	±1.0% of input, 0.01V to 1100V RMS
3 Hz to 5 Hz	±0.5% of input, 0.01V to 1100V RMS
5 Hz to 10 Hz	±0.2% of input, 0.01V to 1100V RMS
10 Hz - 1 MHz Mode	
10 Hz to 30 Hz	±0.2% of input, 0.01V to 1100V RMS
30 Hz to 50 kHz (MID-BAND)	±(0.05% of input +0.005% of range), 0.01V to 500V RMS
30 Hz to 50 kHz	±0.1% of input, 500V to 1100V RMS
20 kHz to 50 kHz	±0.15% of input, 500V to 1100V RMS
50 kHz to 100 kHz	±0.2% of input, 0.01V to 1100V RMS
100 kHz to 200 kHz	±0.5% of input, 0.01V to 1100V RMS*
200 kHz to 500 kHz	±1.0% of input, 0.01V to 1100V RMS*
500 kHz to 1 MHz	±3.0% of input, 0.01V to 1100V RMS

*input voltage x frequency product should not exceed 1 x 10^8 volt-hertz.

CREST FACTOR . . . . 10 or 1500V peak.

TEMPERATURE COEFFICIENT OF ACCURACY (0°C to 50°C)

2 Hz to 3 Hz	±0.1%/°C
3 Hz to 5 Hz	±0.05%/°C
5 Hz to 30 Hz	±0.025%/°C
30 Hz to 30 kHz	±0.0025%/°C
30 kHz to 50 kHz	±0.004%/°C
50 kHz to 200 kHz	±0.01%/°C
200 kHz to 1 MHz	±0.03%/°C

AS A DIRECT (TVM) VOLTMETER

INPUT VOLTAGE RANGE . . . . 0.003V to 1100V RMS in eleven end scale ranges of 0.01 to 1000V in 1, 3 sequence, each with 10% overranging.

INPUT FREQUENCY RANGE . . . . 2 Hz to 2MHz.

ACCURACY (0°C to 50°C)

10 Hz to 500 kHz	±3% of end scale
2 Hz to 2 MHz	±8% of end scale

CREST FACTOR . . . . 10 at end scale increasing proportionately to 30 at 1/3 scale or 1500V peak.

931B SPECIFICATIONS

GENERAL

INPUT	BNC connector mounted on front panel.
INPUT IMPEDANCE	1 Megohm shunted by less than 8 pf at front panel BNC connector.
SHORT TERM STABILITY	Better than 0.005% per hour and 0.02% per day without adjustment of front panel "CAL" control.
LONG TERM STABILITY	Better than 0.01% for 30 days and 0.02% for 90 days, reset to zero during periodic calibration.

NOTE: The stability figures are included in the accuracy specifications for the instrument.

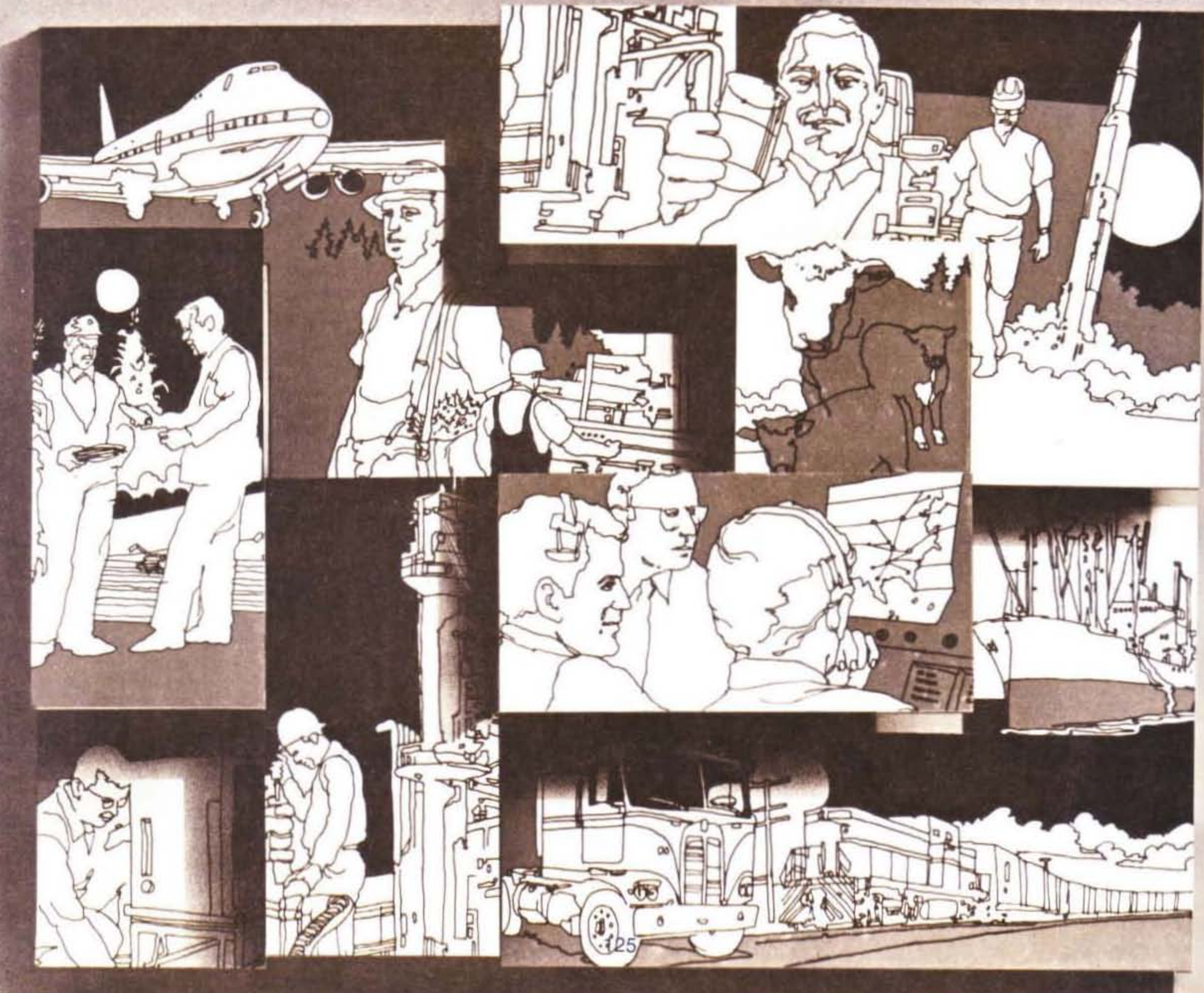
OVERLOAD PROTECTION	Transistor driver and relay protect instrument from damage by overloads up to 1500V peak or 1000V RMS on any range and automatically reset upon removal of overload.
LINE REGULATION	Better than 0.0005% for a 10% line voltage change from nominal.
DC RECORDER OUTPUT	Linear, proportional to meter deflection. Either 1 VDC at end scale (1K output resistance), or adjustable from 0 to 1 VDC at end scale. Accuracy of output (0°C to 50°C): 10 Hz to 500 kHz - ±1% of end scale 2 Hz to 2 MHz - ±5% of end scale
ENVIRONMENT:	
OPERATING TEMPERATURE RANGE	0°C to 50°C
STORAGE TEMPERATURE RANGE:	
Models 931B	–40°C to +70°C
Models 931B-01	–40°C to +60°C
SHOCK AND VIBRATION	Meets the hammer-blow shock and all variable and fixed frequency vibration requirements of MIL-T-945A.
INPUT POWER:	
Models 931B and 931B-01	115/230 VAC 50-440 Hz, 3 watts. 22 hours minimum operation from internal rechargeable Nickle-Cadmium batteries and input power of 24 watts required for recharging while operating Model 931B-01.
MOUNTING	Resilient feet provided for bench and portable use. For side-by-side EIA Rack Mounting of two units, add Adapter kit 881A-103 (includes handle-brackets and key plate.) For EIA Rack Mounting of a single unit, add Adapter Kit 881A-102 (includes brackets with handles).
SIZE	7" high x 8½" wide x 11¾" deep. (19" wide in rack configurations). (17.8 x 21.6 x 29.9 cm)
WEIGHT:	
Models 931B	11½ pounds. (5.21 kg)
Models 931B-01	15 pounds.

PRICES:

Model 931B	$1195.00	Rack adapter kit 881A-102	$25.00
Model 931B-01	$1295.00	Rack adapter kit 881A-103	15.00

section 5

calibrators



Fluke calibrators answer the need for wide range calibration applications. Outputs are dialed up using decade switches and the accuracy and stability of these instruments are able to satisfy the most critical requirements for a precision calibration or voltage reference source.

Fluke ac and dc voltage and current calibrators combine ruggedness and reliability with extreme accuracy and stability. The results are standards lab instruments that are at home in the calibration lab or on the production line.

DC Calibration

DC Calibrators employ either especially processed and selected Zener diodes housed in temperature-controlled ovens to produce an exceptionally stable reference or ultra-stable solid state reference amplifiers to achieve the highest possible degree of accuracy. Reference amplifiers are practically immune to temperature changes and are now the preferred reference for state-of-the-art calibrators. All dc calibrators employ overvoltage and overcurrent protection to ensure against damage to equipment in the event of component failure or operator error. All solid state circuitry is conservatively designed to run cool without needing cooling fans. Instruments are suited to either bench top or rack mount operation using the optional rack mount hardware.

AC Calibration

AC calibration is achieved using **Fluke's** new 5200A/5205A precision Calibration System. This state-of-the-art system delivers frequencies from 10 Hz to 1.2 MHz at outputs up to 1200V. Ease of operation, low distortion, and high reliability make this equipment ideal for production ac calibration on the assembly line or as a working standard in the calibrations laboratory.

AC/DC Calibration

Fluke offers the convenience of ac/dc voltage, current and resistance calibration in one instrument in the Model 760A Meter Calibrator. This popular instrument finds a wide range of applications in the calibration lab or on the production line. For on-site calibrations, **Fluke's** new Model 515A Portable Calibrator offers precision ac voltage, dc voltage and resistance standards in a unit weighing only 13 pounds. Basic accuracy for the 515A is specified for a full year over a wide temperature range to assure the utmost in versatility and reliability.

Consult the following selection guide to find the **Fluke** calibrator meeting your general requirements. Then, look at the detail specifications in the following pages to locate the instrument meeting your exact requirements.

CALIBRATOR SELECTION GUIDE

Model	332B	332D	3330B	335A	335D	341A	343A	382A	515A	5200A	760A
Function	dc volts	dc volts	dc volts dc current	dc volts[1]	dc volts[1]	dc volts	dc volts	dc volts dc current	ac/dc volts ohms	ac volts	ac/dc volts current, ohms
Basic accuracy	0.002%	0.001%	0.003% voltage 0.006% current	0.002%	0.001%	0.005%	0.002%	0.01%	0.003% dc volts 0.04% @10V ac 0.015% 1KΩ to 1MΩ	0.02% 30 Hz to 20 kHz[2]	0.05% dc volts 0.2% ac volts 0.1% dc current 0.25% ac current 0.1% ohms
Range	0 to 1100V	0 to 1100V	0 to 1100V 0 to 100 mA	0 to 1100V	0 to 1100V	0 to 1100V	0 to 1100V	0 to 50V 0 to 2A	to 100V dc 1V, 10V, 100V ac to 10 MΩ	0 to 100V[6]	1mV - 1000V 1μA-10A 1Ω-10MΩ
Max. output current	50mA	50mA	100mA	50mA	50mA	25mA	25mA	2A	to 10mA dc and ac volts	50 mA	10A
Regulation Line-load	0.0002%	0.0002%	5 ppm of output (volts) 5 ppm of range (current)	0.0002%	0.0002%	0.0005%	0.0005%	0.0005%	(at 100V dc) ±5 ppm-load <10 ppm-line	0.001% line 0.005% load (10Hz-20kHz)	0.05% line
Stability	0.001%/mo	5ppm/mo	15ppm/mo (voltage) 30ppm/mo (current)	0.001%/mo	5ppm/mo	0.003%/mo	0.0015%/mo	0.005%/mo	Within performance specs for 12 months	0.005%/24 hours (amplitude) 0.05%/24 hours (frequency)	Within performance specs for 12 months
Ripple & Noise	20-40μV	20-40μV	60-200μV 20nA-1μA	20-40μV	20-40μV	<100μV	<50μV	0.002% of range	<0.01% RMS at 100V dc	Note 4	0.5% dc[5]

[1]includes 0.002% differential voltmeter and high ε null detector in same unit
[2]reduced accuracy at higher frequencies
[3]reduced regulation above 20 kHz
[4]total harmonic distortion & noise: 0.04% 10 Hz-100 kHz, 0.3% 100 kHz-500kHz, 1% 500 kHz-1 MHz
[5]distortion 0.5% and noise 0.1% ac
[6]operation to 1200V using companion model 5205A power amplifier

FLUKE

VOLTAGE CALIBRATOR

FEATURES

- 0.002% Calibration Accuracy
- Entirely Solid State (No Cooling Fans)
- Overcurrent and Overvoltage Protection
- 0.1 ppm Resolution
- 7 inch Panel Height
- Remote Sensing
- All Circuitry Shielded and Guarded

Model 332B is an extremely stable voltage standard, which will deliver any desired output voltage up to 1111 volts with an accuracy of 0.002%. The instrument is designed to satisfy the most critical requirements for a precision calibrator or voltage reference source. The outstanding regulation and environmental specifications and the overvoltage and overcurrent protection features indicate that the instrument is well suited for day to day use on the production line as well as in controlled laboratory environment.

Output voltage is set by seven in-line decade switches to provide 0.1 part per million resolution in each voltage range. Three voltage ranges provide full scale outputs of 0-11, 0-111, or 0-1111 volts. Output current for any range is rated at 0 to 50 milliamperes.

Overcurrent and overvoltage limits are provided to afford protection in the event of component failure or operator error. The current limit may be set to operate at any level from 1.0 ma to 60 ma by means of a continuously adjustable front panel control. When limiting begins, a panel light illuminates. When the overload is removed, the supply returns to normal operation. Continuous limiting will not harm the supply. The overvoltage trip may be set to operate at any point from 10% to 110% of each voltage range by a continuously variable front panel control. In the event the set point is exceeded, the calibrator is immediately returned to standby mode and the output is disconnected from the load. Normal operation may be restored by returning the power switch to STANDBY and then to OPERATE.

All circuitry in the 332B is completely solid state. The heating effects of vacuum tube filaments is thus eliminated. In order to further reduce heat dissipation in the instrument, incoming power is preregulated to deliver only the required output power. As a result, there is very little temperature rise at any operating level and no fans or other extraneous cooling methods are required. Adverse effects of heat on components is eliminated and reliability and stability are significantly improved.

The main regulating loop, which controls the output voltage, consists of a chopper stabilized amplifier having more than 180 db of gain at DC. Output voltage is controlled by a sample string consisting of Fluke-manufactured precision wire wound resistors that are carefully selected and matched for resistance ratio and very low temperature coefficient. The voltage reference element is a specially processed and selected zener diode with extensive test history of stable operation. The diode is housed in a proportionally controlled zener oven along with the associated constant current source to provide an exceptionally stable reference. STANDBY position of the power switch supplies power to the zener oven and all control circuitry.

Mechanical construction utilizes plug-in, glass-epoxy printed circuit boards flow-soldered by a unique Fluke process. For rack mounting, the 332B requires only 7 inches of rack space and side panels are tapped for mounting standard chassis slides. Resilient rubber feet are also provided for bench top use.

332B SPECIFICATIONS

OUTPUT VOLTAGE: 0 to 1111.1110 VDC.

VOLTAGE RANGES: 10, 100, and 1000V ranges with outputs as follows:

0 to 11.111110 (1 uv steps)
0 to 111.11110 (10 uv steps)
0 to 1111.1110 (100 uv steps)

RESOLUTION: 0.1 ppm of range (1 uv maximum).

ACCURACY OF OUTPUT: (For 90 Days)

10V range - ±(0.002% of setting + 10 uv)
100V range - ±(0.002% of setting + 0.00002% of range)
1000V range - ±(0.002% of setting + 0.00002% of range)

NOTE: The above accuracies are absolute, relative to NBS standards, and include effects of stability, line regulation, load regulation, and calibration uncertainties under standard reference conditions of 23°C ±1°C and up to 70% relative humidity.

TEMPERATURE COEFFICIENT OF OUTPUT: Less than (0.0002% of setting + 1 uv) per °C from 0°C to +50°C.

STABILITY OF OUTPUT: (At standard reference conditions described under ACCURACY OF OUTPUT).

10V range
±(0.001% of setting + 10 uv) per month
±(0.002% of setting + 20 uv) per year

100V and 1000V ranges
±(0.001% of setting + 20 uv) per month
±(0.002% of setting + 40 uv) per year

OUTPUT CURRENT: 0 to 50 milliamperes at any output voltage.

OVERCURRENT PROTECTION: Automatically limits output current at any preset level between 1 ma and 60 ma via continuously variable front panel control. Panel lamp illuminates during limiting. Normal operation restored upon removal of overload.

OVERVOLTAGE PROTECTION: Automatically disables output voltage if level exceeds setting of front panel control. Continuously variable from 10% to 110% of each range. Manual reset.

DESIGN: All solid-state throughout (no vacuum tubes).

RIPPLE AND NOISE :

10V range - less than 20 uv RMS
100V range - less than 30 uv RMS
1000V range - less than 40 uv RMS

OUTPUT RESISTANCE: Less than 0.0005 ohms or ($0.0001E_O$) ohms (whichever is greater) at DC.

SETTLING TIME: Typically, within 10 ppm of final output, less than 20 seconds after a range change.

LINE REGULATION: 0.0002% of setting or 10 uv for a 10% line voltage change from nominal.

LOAD REGULATION: 0.0002% of setting or 10 uv for full load change.

COMMON MODE REJECTION: Better than 140 db from DC to 400 Hz, up to 700V RMS or 1000 VDC. (Output voltage changes less than 10^{-7} of the applied common mode voltage.)

ISOLATION: Either output terminal may be floated up to 1000 VDC from chassis ground.

TERMINAL CONFIGURATION:

Voltage output	2 terminals
Remote sense	2 terminals
Guard	1 terminal
Chassis	1 terminal

REMOTE SENSE: Separate terminals are provided for sensing the output voltage directly at the load, reducing errors due to voltage drop in connecting wires between the instrument and load.

METER (switch selectable): 0 - 1200 VDC
0 - 60 ma

OPERATING TEMPERATURE RANGE: 0°C to 50°C (see ACCURACY OF OUTPUT and TEMPERATURE COEFFICIENT OF OUTPUT).

STORAGE TEMPERATURE RANGE: -40°C to +65°C.

RELATIVE HUMIDITY: 0 to 70%.

SHOCK: Meets all test requirements of MIL-T-945A, rigidly mounted or rack-mounted with slides.

VIBRATION: Meets all test requirements of Mil-T-945A, rigidly mounted or rack-mounted with slides.

ALTITUDE: 10,000 ft. operating; 50,000 ft. non-operating.

FUNGUS NUTRIENTS: None.

MERCURIC COMPONENTS: None.

FUSES: One power line fuse, one high voltage fuse.

INPUT POWER: 115/230 VAC ±10%, 50 - 60 Hz, single phase. Approximately 130 VA fully loaded.

SIZE: 7" high x 19" wide x 18" behind panel.
(17.8 x 48.2 x 45.7cm)
WEIGHT: 60 lbs. (27.21 kg)

MOUNTING: Standard EIA relay rack (tapped for attachment of slides); resilient feet provided for bench use.

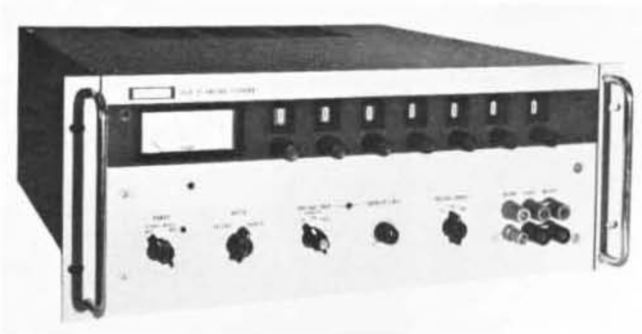
PRICE: $2595.00.

All prices are f.o.b. factory, Mountlake Terrace, Washington.

332D

FLUKE

DC VOLTAGE STANDARD



FEATURES

- **0.001% Accuracy**
- **Entirely Solid State (No Cooling Fans)**
- **Overcurrent and Overvoltage Protection**
- **0.1 ppm Resolution**
- **7 inch Panel Height**
- **Remote Sensing**
- **All Circuitry Shielded and Guarded**

Model 332D is an extremely stable voltage standard, which will deliver any desired output voltage up to 1111 volts with an accuracy of 0.001%. The instrument is designed to satisfy the most critical requirements for a precision calibrator or voltage reference source. The outstanding regulation and environmental specifications and the overvoltage and overcurrent protection features indicate that the instrument is well suited for day to day use in a controlled laboratory environment.

Calibration of each instrument is referenced to zero error as defined by the primary standards of the John Fluke Mfg. Co., and these standards are certified by the company as being directly traceable to national standards maintained by NBS. Through historical data and techniques used by the company, it can be shown that the initial calibration of each full range setting of the instrument differs from the theoretical absolute value by no more than the following:

LEVEL	UNCERTAINTY
Up to 10 VDC	3 ppm
10 VDC to 100 VDC	4 ppm
100 VDC to 1000 VDC	7 ppm

Further, linearity within a range is calibrated using a Fluke Model 720A constant-current (Kelvin-Varley) divider which is self-calibrating using the ratio (relative) technique. Maximum error contributed during linearity calibration should not exceed 1.5 ppm.

If it is desired that the unit be referenced to local standards, each full range setting should be calibrated to such standards. The statement of accuracy then becomes, in fact, a statement of the stability of the instrument.

Output voltage is set by seven in-line decade switches to provide 0.1 part per million resolution in each voltage range. Three voltage ranges provide full scale outputs of 0-11, 0-111, or 0-1111 volts. Output current for any range is rated at 0 to 50 milliamperes.

Overcurrent and overvoltage limits are provided to afford protection in the event of component failure or operator error. The current limit may be set to operate at any level from 1.0 ma to 60 ma by means of a continuously adjustable front panel control. When limiting begins, a panel light illuminates. When the overload is removed, the supply returns to normal operation. Continuous limiting will not harm the supply. The overvoltage trip may be set to operate at any point from 10% to 110% of each voltage range by a continuously variable front panel control. In the event the set point is exceeded, the calibrator is immediately returned to standby mode and the output is disconnected from the load. Normal operation may be restored by returning the power switch to STANDBY and then to OPERATE.

All circuitry in the 332D is completely solid state. The heating effects of vacuum tube filaments is thus eliminated. In order to further reduce heat dissipation in the instrument, incoming power is preregulated to deliver only the required output power. As a result, there is very little temperature rise at any operating level and no fans or other extraneous cooling methods are required. Adverse effects of heat on components is eliminated and reliability and stability are significantly improved.

Mechanical construction utilizes plug-in, glass-epoxy printed circuit boards flow-soldered by a unique Fluke process. For rack mounting, the 332D requires only 7 inches of rack space and side panels are tapped for mounting standard chassis slides. Resilient rubber feet are also provided for bench top use.

332D SPECIFICATIONS

OUTPUT VOLTAGE: 0 to 1111.1110 VDC.

OUTPUT CURRENT: 0 to 50 milliamperes at any output voltage.

VOLTAGE RANGES: 10, 100, and 1000V ranges with outputs as follows:

0 to 11.111110 (1 uv steps)
0 to 111.11110 (10 uv steps)
0 to 1111.1110 (100 uv steps)

RESOLUTION: 0.1 ppm of range (1 uv maximum).

ACCURACY OF OUTPUT: (For 60 Days)

10V range - ±(0.001% of setting + 10 uV)
100V range - ±(0.001% of setting + 0.00002% of range)
1000V range - ±(0.0015% of setting + 0.00002% of range)

NOTE: The above accuracies are absolute, relative to NBS standards, and include effects of stability, line regulation, load regulation, and calibration uncertainties under standard reference conditions of 23°C ±1°C and up to 70% relative humidity.

STABILITY OF OUTPUT: (At standard reference conditions described under ACCURACY OF OUTPUT).

10V Range
±(5 ppm of setting + 7 uV) per month
100V and 1000V Range
±(5 ppm of setting + 30 uV) per month

OVERCURRENT PROTECTION: Automatically limits output current at any preset level between 1 ma and 60 ma via continuously variable front panel control. Panel lamp illuminates during limiting. Normal operation restored upon removal of overload.

OVERVOLTAGE PROTECTION: Automatically disables output voltage if level exceeds setting of front panel control. Continuously variable from 10% to 110% of each range. Manual reset.

DESIGN: All solid-state throughout (no vacuum tubes).

RIPPLE AND NOISE:

10V range - less than 20 uv RMS
100V range - less than 30 uv RMS
1000V range - less than 40 uv RMS

OUTPUT RESISTANCE: Less than 0.0005 ohms or ($0.0001E_0$) ohms (whichever is greater) at DC.

SETTLING TIME: Typically, within 10 ppm of final output, less than 20 seconds after a range change.

LINE REGULATION: 0.0002% of setting or 10 uv for a 10% line voltage change from nominal.

LOAD REGULATION: 0.0002% of setting or 10 uv for a full load change.

COMMON MODE REJECTION: Better than 140 db from DC to 400 Hz, up to 700V RMS or 1000 VDC. (Output voltage changes less than 10^{-7} of the applied common mode voltage.)

ISOLATION: Either output terminal may be floated up to 1000 VDC from chassis ground.

TERMINAL CONFIGURATION:

Voltage output	-	2 terminals
Remote sense	-	2 terminals
Guard	-	1 terminal
Chassis	-	1 terminal

REMOTE SENSE: Separate terminals are provided for sensing the output voltage directly at the load, reducing errors due to voltage drop in connecting wires between the instrument and load.

METER (switch selectable): 0 - 1200 VDC
0 - 60 ma

OPERATING TEMPERATURE RANGE: 0°C to 50°C (see ACCURACY OF OUTPUT and TEMPERATURE COEFFICIENT OF OUTPUT).

STORAGE TEMPERATURE RANGE: –40°C to +65°C.

RELATIVE HUMIDITY: 0 to 70%.

SHOCK: Meets all test requirements of MIL-T-945A, rigidly mounted or rack-mounted with slides.

VIBRATION: Meets all test requirements of MIL-T-945A, rigidly mounted or rack-mounted with slides.

ALTITUDE: 10,000 ft. operating; 50,000 ft. non-operating.

FUSES: One power line fuse, one high voltage fuse.

INPUT POWER: 115/230 VAC ±10%, 50 - 60 Hz, single phase. Approximately 130 VA fully loaded.

SIZE: 7" high x 19" wide x 18" behind panel.
(17.8 x 48.2 x 45.7cm)
WEIGHT: 60 lbs. (27.21 kg)

MOUNTING: Standard EIA relay rack (tapped for attachment of slides); resilient feet provided for bench use.

PRICE: $2995.00

All prices are f.o.b. factory, Mountlake Terrace, Washington.

FLUKE

Programmable Calibrator 3330B

FEATURES:

- Calibrated voltage to 1100V
- Calibrated current to 110 ma
- Four terminal output - floating and guarded
- Voltage/current limit and crowbar protection
- DTL—TTL logic compatable program inputs

PROGRAMMABLE FOR:

- Mode - Current or voltage
- Range - 1000V or 100 ma in three ranges
- Level - 0 to 110% of range, seven decades
- Voltage/current limit - 10% steps within range
- Polarity
- Crowbar
- Standby - operate

OUTPUT ACCURACY:

- .003% voltage mode
- .006% current mode
- (See Specifications)

The Model 3330B now offers the newest parameter required for calibration systems - - - programmability. The unit may be programmed for analog DC outputs within .003% of command from 0 to ±1111 VDC in three ranges. In addition to analog voltage outputs, the 3330B is a programmable DC current calibrator accurate to ±.006% of programmed value.

One input line programs from voltage to current mode. Output in current mode is 0 to 111 ma in three ranges using the same control lines as in voltage mode. Compliance voltages up to 1000 VDC are available on the 1 and 10 ma ranges, and 500 VDC on the 100 ma range.

For protection and system versalitity, the 3330B offers independent control of current and voltage limits in both modes of operation, plus a single-line control crowbar for safe switching of loads. While operating in the voltage mode, the unit can be programmed to limit current for protection against catastrophic load failure such as might be encountered in repetitious testing of components. In the current mode, the voltage trip point can be programmed to trip the output to zero if a faulty program or equipment failure causes the voltage to exceed the command value. When ever current through the load is being limited, or when the output trip has functioned, a contact closure flags the control system as an alarm. Continuous operation is resumed after removal of overload. After voltage trip-out, the instrument is restored to normal operation by programming to operate from standby.

All program input lines to the unit are applied to semiconductors, not relay coils that require driving currents. Thus, interface with DTL and TTL solid-state logic is possible. Logic 1 (0 ±.5 VDC or contact closure) on any input line requires no current from the source; a small amount (2.5 ma) of current sinking is the only requirement.

The 3330B utilizes a new reference amplifier for best possible control of the output versus time and temperature. Reference stability is checked for long periods of time, and TC is carefully documented. Reference voltage will typically remain within 10 ppm peak-to-peak over several months duration. Because the reference is not ovened, warmup is extremely fast.

The error amplifier of the 3330B includes a solid-state low-noise FET chopper, eliminating replacement of mechanical devices due to wear. All precision resistors are manufactured by Fluke for best possible accuracy, stability, and temperature coefficient of resistance. TC of critical resistors is held to better than 1 ppm/°C.

Full control of the instrument is possible from the front panel, as well as by programming lines. Remote programming can be overridden at the front panel if desired.

The Model 3330B is housed in the latest Fluke custom-designed package, requiring only 7 inches of rack space.

Specifications

CONSTANT VOLTAGE MODE

ANALOG OUTPUTS:

10V range - 0 to 11.111110V (1 uv steps)
100V range - 0 to 111.11110V (10 uv steps)
1000V range - 0 to 1111.1110V (100 uv steps)

ACCURACY OF OUTPUT (% of Programmed Level):

10V range - ±0.003% or ±30 uv
100V range - ±0.003% or ±300 uv
1000V range - ±0.003% or ±3 mv

NOTE: Above accuracies apply for 90 days at standard reference conditions of 23°C ± 1°C (nominal calibration temperature, constant line voltage, up to 70% relative humidity, and constant external load.) With uninterrupted operation for more than one hour at loads greater than 25 mA, the specified accuracy is ±0.005% over an operating temperature range of 23°C ±5°C.

OUTPUT CURRENT:

10V and 100V ranges - 0 to 100 milliamperes at any programmed level.

1000V range - 0 to 50 milliamperes at any programmed level.

TEMPERATURE COEFFICIENT OF OUTPUT: Less than 4 ppm of output or .4 ppm of range/°C.

STABILITY OF OUTPUT (ppm of programmed level):

10V range	- 5 ppm or 10 uv/day
	15 ppm or 30 uv/month
100V range	- 5 ppm or 100 uv/day
	15 ppm or 300 uv/month
1000V range	- 5 ppm or 1 mv/day
	15 ppm or 3 mv/month

NOTE: Stabilities apply at standard conditions described under accuracy of output.

RIPPLE AND NOISE:

	Up to 50 ma Load	Up to 100 ma Load
10V range	60 uv rms	100 uv rms
100V range	70 uv	100 uv
1000V range	100 uv	200 uv

LINE/LOAD REGULATION: 5 ppm of programmed level or 2 ppm of range for combined 10% line voltage and full load changes.

CONSTANT CURRENT MODE

ANALOG OUTPUTS:

1 ma range - 0 to 1.1111110 ma (0.1 na steps)
10 ma range - 0 to 11.111110 ma (1 na step)
100 ma range - 0 to 111.11110 ma (10 na steps)

ACCURACY OF OUTPUT:

±0.006% of programmed level, or 0.0006% of current range.

NOTE: Accuracy applies for 90 days at standard reference conditions described under constant voltage mode.

TEMPERATURE COEFFICIENT OF OUTPUT: Less than 6 ppm of programmed level or .4 ppm of range/°C.

STABILITY OF OUTPUT:

10 ppm of programmed level or 1 ppm of range/day.
30 ppm of programmed level or 6 ppm of range/mo.

NOTE: Stabilities apply at standard conditions described under constant voltage mode.

COMPLIANCE VOLTAGE:

1 ma and 10 ma ranges - up to 1000V
100 ma range - up to 500V
(See voltage limit)

RIPPLE AND NOISE: For negative ground or floating operations:

I Range	Ripple
1 ma	20 na
10 ma	100 na
100 ma	1 ua

CROWBAR: Output terminals may be shorted through 5 ohms to limit compliance voltage while changing loads. Operated remotely through single line (see input/output table), or locally by switch.

LOAD REGULATION:

1 ma range - 2 ppm of range per 100V compliance
10 ma range - 5 ppm of range
100 ma range - 5 ppm of range

GENERAL SPECIFICATIONS

CURRENT LIMIT (voltage or current operation):

Remote mode - programmable in 10% steps from 1% to 110% limit range (see input/output table).

Local mode - Continuously adjustable from 1 ma to 110 ma.

NOTE: Limit indication by contact closure (see input/output table), and front panel lamp.

VOLTAGE TRIP (voltage or current operation):

Remote mode - Programmable in 10% steps from 1% to 110% limit range (see input/output table).

Local mode - Continuously adjustable from 1% to 110% of range.

NOTE: Output goes to zero and unit returns to standby if trip point is exceeded. Trip indication by contact closure (see input/output table), and front panel lamp.

ISOLATION:

Programming lines are isolated from output.
Output is isolated and guarded from chassis.
Potential between programming lines and either side of output should not exceed 1150V.

METER: For local operation, switch selectable to indicate 0 to 1100 VDC or 0 to 110 ma.

PROGRAM INPUTS/OUTPUTS: See table for line functions. All inputs/outputs through 50-pin rear connector. Mating connector supplied.

OUTPUT CONNECTIONS: Separate output and sense terminals provided for four-terminal connection to load. All front panel output, guard, and chassis connections are duplicated on rear terminal strip.

SENSE LINE CURRENT:
0 to 1.1 mA at 10% overrange on any range.

OPERATION: Local via front panel controls or remote via program input, selectable at front panel.

RESPONSE TIME (Time from application of program until output settles within specifications):

1, 10, 100 ma ranges - 500 milliseconds typical-dependent on load resistance.
10V range - 60 milliseconds
100V range - 300 milliseconds
1000V range - 3 seconds

TEMPERATURE: 0°C to +50°C operating.
−40°C to +65°C non-operating

RELATIVE HUMIDITY: 0 to 70%.

SHOCK: 15g, 11 millisecond half-sine wave (MIL-T-21200)

VIBRATION: 10 Hz - 55 Hz, 3g maximum (MIL-T-21200)

ALTITUDE: To 50,000 feet non-operating
To 10,000 feet operating

INPUT POWER: 115/230 VAC ± 10% 48-62 Hz single phase, approximately 130 VA fully loaded.

SIZE: 7" high x 17" wide x 18" deep.

WEIGHT: 58 lbs.

MOUNTING:

Bench: Self-supported on included custom-designed feet.

Rack: Accepts optional brackets MEE-7003 for 19" rack mounting and optional 18" chassis slides MEE-8078 (24" slides also available).

PRICES:

3330B - $3595.00
MEE-7003 rack mounting brackets - $25.00
MEE-8078 chassis slides - $50.00

All prices f.o.b. factory, Mountlake Terrace, Washington.

3330B PROGRAMMING INPUT/OUTPUT TABLE

INPUTS	LINES	CODING
		Logic "0" = +2.4 to +20V or open circuit Logic "1" = 0 to +0.5V or closed circuit
STANDBY/OPERATE	1	STANDBY = "0" OPERATE = "1"
MODE	1	VOLTAGE = "0" CURRENT = "1"
RANGE	2	CODE
10V or 1 MA		"00" (Code "11" not allowed)
100V or 10 MA		"01"
1000V or 100 MA		"10"
OUTPUT LEVEL (7 decades)	28	DECADE CODING DIGIT 8421 DIGIT 8421 DIGIT 8421 0 = 0000 4 = 0100 8 = 1000 1 = 0001 5 = 0101 9 = 1001 2 = 0010 6 = 0110 10 = 1010 3 = 0011 7 = 0111
CURRENT LIMIT		
LOCAL/REMOTE	1	LOCAL = "0" REMOTE = "1"
REMOTE LIMIT LEVEL	4	CODING MA 8421 MA 8421 MA 8421 1 = 0000 40 = 0100 80 = 1000 10 = 0001 50 = 0101 90 = 1001 20 = 0010 60 = 0110 100 = 1010 30 = 0011 70 = 0111 110 = 1011
VOLTAGE TRIP		
RANGE	2	CODE
10V		"00"
100V		"01"
1000V		"10"
VOLTAGE TRIP LEVEL (1.0% to 110% of selected range)	4	CODING RGE.% 8421 RGE.% 8421 REG.% 8421 1.0% = 0000 40% = 0100 80% = 1000 10% = 0001 50% = 0101 90% = 1001 20% = 0010 60% = 0110 100% = 1010 30% = 0011 70% = 0111 110% = 1011
POLARITY	1	(+) = "0" (–) = "1"
CROWBAR	1	OFF = "0" ON = "1"
OPERATE FLAG OUTPUT	1	CONTACTS CLOSED IN OPERATE MODE CONTACTS OPEN IN STANDBY MODE
CURRENT LIMIT FLAG OUTPUT	1	CONTACTS CLOSED IN NORMAL OPERATION
VOLTAGE TRIP FLAG OUTPUT	1	CONTACTS CLOSED IN VOLTAGE TRIP MODE

FLUKE

DC VOLTAGE STANDARD DIFFERENTIAL VOLTMETER NULL DETECTOR

AS A CALIBRATOR
±0.002% Absolute Accuracy
0 to 1111.1110 VDC Output Range
0 to 50 ma Output Current
Overcurrent and Overvoltage Protection
Remote Sensing

AS A DIFFERENTIAL VOLTMETER
±0.002% Absolute Accuracy
Infinite Input Resistance from 0 to 1111.1110 VDC

AS AN ALL-AROUND SYSTEMS INSTRUMENT
Null Detector and Voltage Standard may be used Individually and Simultaneously
All Circuitry Shielded and Guarded
Entirely Solid State (No Cooling Fan)
7-inch Panel Height

Model 335A is a versatile new instrument combining the functions of a precision voltage standard with those of a differential voltmeter and a high-impedance null detector. It will furnish any desired output voltage or measure any input voltage up to 1111 VDC with absolute accuracy of ±0.002%. In differential voltmeter mode, the infinite input resistance of true potentiometric measurement is obtained by adjusting the output of the calibrator to equal the unknown voltage as indicated by zero deflection of the null detector. As with all Fluke solid-state differential voltmeters, the null detector may be used as a direct-reading device in TVM (transistor voltmeter) mode to provide an instant indication of voltage to within ±3%. The null detector may also be used separately from the calibrator function when required by various instrumentation arrangements. As with other differential voltmeters, accuracy is determined in large part by the accuracy and stability of the voltage source. The calibrator function of the Model 335A is an extremely stable and accurate voltage source designed to satisfy the most critical system requirements. The outstanding regulation and environmental specifications, and the overvoltage and overcurrent protection features indicate that the instrument is well suited for day-to-day use on the production line as well as in controlled environments.

Output voltage is set by seven in-line decade switches to provide 0.1 part per million resolution in each voltage range. Three voltage ranges provide full scale outputs of 0-11, 0-111, or 0-1111 volts. Output current for any range is rated at 0 to 50 milliamperes.

Overcurrent and overvoltage circuits afford protection in the event of component failure or operator error. The current limit may be set to operate at any level from 1 ma to 60 ma by a front panel control. When limiting begins, a panel light illuminates. Normal operation is resumed when the overload is removed. Continuous limiting will not harm the instrument. The overvoltage trip may be set to operate at any point from 1 to 1200 volts by a front panel control. If the set point is exceeded, the instrument is immediately returned to standby mode and the load is disconnected. Normal operation may be restored by turning the power switch to STANDBY and then to OPERATE. The overvoltage trip operates independently of the output range switch, for maximum protection of the load.

Complete solid-state circuitry in the 335A results in maximum reliability and minimum heat dissipation. Preregulation limits the incoming power to that required by the output load. The greatly reduced temperature rise eliminates both any need for a cooling fan and the adverse effect of heat on components thereby significantly improving stability and reliability.

The main regulating loop uses a chopper stabilized amplifier having more than 180 db of gain at DC to sense changes in the output voltage. The reference for regulation is established by a zener diode and a precision decade rheostat in the sample string which consists of Fluke-manufactured precision wirewound resistors carefully selected and matched for resistance ratio and very low temperature coefficient. (The front panel voltage controls adjust the output voltage by adjusting the resistance of the sample string.) The zener diode which has an extensive test history of stable operation, is housed in a propertionally controlled oven along with an associated constant current source to provide an exceptionally stable reference. STANDBY position of the power switch supplies power to the zener oven and all control circuitry.

The null detector is a chopper stabilized amplifier with large amounts of negative feedback to raise the input impedance and provide a stable and accurate gain characteristic. The overall sensitivity is adjusted by varying both the input divider and the feedback. The recorder output is adjustable from 0 to 1 volt for full scale meter deflection and may be grounded or floated to 100 VDC above ground.

Errors caused by associated elements of the instrumentation setup can be minimized by proper use of the remote sensing and guard terminals. In calibrator mode, remote sensing greatly reduces the effect of lead resistance and assures delivery of full voltage to the load. Ground currents circulating through the load and the voltage standard are prevented by proper connection of the guard.

Mechanical construction utilizes plug-in, glass-epoxy printed circuit boards flow-soldered by an unique Fluke process. For rack mounting, the 335A requires only 7 inches of rack space and side panels are tapped for mounting standard chassis slides. Resilient feet are also provided for bench top use.

335A SPECIFICATIONS

AS A VOLTAGE STANDARD

OUTPUT VOLTAGE: 0 to 1111.1110 VDC.

OUTPUT CURRENT: 0 to 50 milliamperes.

VOLTAGE RANGES: 10, 100, and 1000V with outputs as follows:
0 to 11.111110 (1 uv steps)
0 to 111.111110 (10 uv steps)
0 to 1111.1110 (100 uv steps)

RESOLUTION: 0.1 ppm of range (1 uv maximum).

ACCURACY OF OUTPUT: (For 90 Days)
10V range - ±(0.002% of setting + 10 uv)
100V range - ±(0.002% of setting +0.00002% of range)
1000V range - ±(0.002% of setting +0.00002% of range)

NOTE: The above accuracies are absolute, relative to NBS standards, and include effects of stability, line regulation, load regulation, and calibration uncertainties under standard reference conditions of 23°C ±1°C and up to 70% relative humidity.

TEMPERATURE COEFFICIENT OF OUTPUT: Less than ±(0.0002% of setting + 1 uv)/°C from 0°C to +50°C.

STABILITY OF OUTPUT: (At standard reference conditions described under ACCURACY OF OUTPUT).

10V range
±(0.001% of setting + 10 uv) per month
±(0.002% of setting + 20 uv) per year

100V and 1000V ranges
±(0.001% of setting + 20 uv) per month
±(0.002% of setting + 40 uv) per year

OVERCURRENT PROTECTION: Automatic current limiting continuously adjustable from 1 to 60 ma with front panel control and indicator. Normal operation restored upon removal of overload.

OVERVOLTAGE PROTECTION: Automatically disconnects load if output voltage exceeds 1 to 1200V setting of front panel controls. Manual reset.

RIPPLE AND NOISE:
10V range - less than 20 uv RMS.
100V range - less than 30 uv RMS.
1000 range - less than 40 uv RMS.

SETTLING TIME: Typically, within 10 ppm of final output, less than 20 seconds after a range change.

OUTPUT RESISTANCE:
Less than 0.0005 ohms or $(0.0001E_0)$ ohms at DC.

REGULATION: 0.0002% of setting or 10 uv for either a 10% line voltage change or a full load change.

COMMON MODE REJECTION: Better than 125 db from DC to 400 Hz, up to 700V RMS or 1000 VDC.

ISOLATION: Either output terminal may be floated up to 1000 VDC from chassis ground.

REMOTE SENSING: Separate terminals are provided to sense the output voltage directly at the load, reducing errors caused by voltage drop in connecting wires between the output and the load.

AS A DIFFERENTIAL VOLTMETER

ABSOLUTE ACCURACY:
TEMP. COEF. OF ACCURACY:
INPUT RANGES:
STABILITY:
} Same as output characteristics under Voltage Standard

NULL SENSITIVITIES: 1000V to 10 uv (full scale) in 9 decade ranges. Any null sensitivity may be used on any voltage range.

INPUT RESISTANCE:
Infinite at null from 0 to 1111.1110 VDC.

METER AND DIAL RESOLUTION: 0.1 ppm of range.

AS A CONVENTIONAL VOLTMETER

ACCURACY: ±3% of range.

RANGES:

Voltage Range	Input Resistance
1000-0-1000	100 Megohms
100-0-100	100 Megohms
10-0-10	100 Megohms
1-0-1	100 Megohms
0.1-0-0.1	10 Megohms
0.01-0-0.01	10 Megohms
0.001-0-0.001	1 Megohm
0.0001-0-0.0001	1 Megohm
0.00001-0-0.00001	1 Megohm

GENERAL

DESIGN: Solid-state throughout (no tubes).

STABILITY OF METER ZERO:
On most sensitive range (10 uv full scale):
0.5 uv peak-to-peak noise.
0.5 uv peak-to-peak stability for 10% line voltage variation.

RECORDER/ISOLATION AMPLIFIER OUTPUT: Adjustable from 0 to over 1.0V for end-scale meter deflection; source resistance 5 to 8 kilohms; linearity better than ±0.5% of end-scale. Gain as an isolation amplifier is 1.0V/null range sensitivity. Recorder output may be grounded or floating up to 100 VDC.

TEMPERATURE: 0°C to +50°C, operating; -40°C to +65°C, non-operating.

HUMIDITY: 0 to 70% relative humidity.

SHOCK AND VIBRATION: Meets all requirements of MIL-T-945A, rigidly mounted or rack-mounted with slides.

ALTITUDE: 10,000 ft. operating; 50,000 ft. non-operating.

FUNGUS NUTRIENTS; MERCURIC COMPONENTS: None

FUSES: One power-line fuse; one high-voltage fuse.

INPUT POWER: 115/230 VAC ±10%, 50-60 Hz, single phase, approximately 130 VA fully loaded.

MOUNTING: Standard EIA relay rack (tapped for attachment of slides); resilient feet for bench use.

SIZE: 7" high by 19" wide by 18" behind panel.
(17.8 × 48.2 × 45.7 cm)

WEIGHT: approximately 50 lbs. (22.67 kg)

PRICE:
$2,895.00 f.o.b. factory, Mountlake Terrace, Wash.

DC VOLTAGE STANDARD DIFFERENTIAL VOLTMETER NULL DETECTOR

FLUKE®

FEATURES:

AS A DC VOLTAGE STANDARD
±0.001% Accuracy
0 to 1111.1110 VDC Output Range
0 to 50 ma Output Current
Overcurrent and Overvoltage Protection
Remote Sensing

AS A DIFFERENTIAL VOLTMETER
±0.001% Accuracy
Infinite Input Resistance from 0 to 1111.1110 VDC

AS AN ALL-AROUND SYSTEMS INSTRUMENT
Null Detector and Voltage Standard may be used Individually and Simultaneously.
All Circuitry Shielded and Guarded.
Entirely Solid State (No Cooling Fan).
7-Inch Panel Height

Model 335D is a versatile new instrument combining the functions of a precision voltage standard with those of a differential voltmeter and a high-impedance null detector. It will furnish any desired output voltage or measure any input voltage up to 1111 VDC with an accuracy of ±0.001%. In the differential voltmeter mode, the infinite input resistance of true potentiometric measurement is obtained by adjusting the output of the calibrator to equal the unknown voltage as indicated by zero deflection of the null detector. As with all Fluke solid-state differential voltmeters, the null detector may be used as a direct-reading device in TVM (transistor voltmeter) mode to provide an instant indication of voltage to within ±3%. The null detector may also be used separately from the calibrator function when required by various instrumentation arrangements. As with other differential voltmeters, accuracy is determined in large part by the accuracy and stability of the voltage source. The calibrator function of the Model 335D is an extremely stable and accurate voltage source designed to satisfy the most critical system requirements. The outstanding regulation and environment specifications, and the overvoltage and overcurrent protection features indicate that the instrument is well suited for day-to-day use in controlled environments.

Calibration of each instrument is referenced to zero error as defined by the primary standard of the John Fluke Mfg. Co., Inc. and these standards are certified by the company as being directly traceable to national standards maintained by NBS. Through historical data and techniques used by the company, it can be shown that the initial calibration of each full range setting of the instrument differs from the theoretical absolute value by no more than the following:

LEVEL	UNCERTAINTY
Up to 10 VDC	3 ppm
10 VDC to 100 VDC	4 ppm
100 VDC to 1000 VDC	7 ppm

Further, linearity within a range is calibrated using a Fluke Model 720A constant-current (Kelvin-Varley) divider which is self-calibrating using the ratio (relative) technique. Maximum error contributed during linearity calibration should not exceed 1.5 ppm.

If it is desired that the unit be referenced to local standards, each full range setting should be calibrated to such standards. The statement of accuracy then becomes, in fact, a statement of the stability of the instrument.

Output voltage is set by seven in-line decade switches to provide 0.1 part per million resolution in each voltage range. Three voltage ranges provide full scale outputs of 0-11, 0-111, or 0-1111 volts. Output current for any range is rated at 0 to 50 milliamperes.

Overcurrent and overvoltage circuits afford protection in the event of component failure or operator error. The current limit may be set to operate at any level from 1 ma to 60 ma by a front panel control. When limiting begins, a panel light illuminates. Normal operation is resumed when the overload is removed. Continuous limiting will not harm the instrument. The overvoltage trip may be set to operate at any point from 1 to 1200 volts by a front panel control. If the set point is exceeded, the instrument is immediately returned to standby mode and the load is disconnected. Normal operation may be restored by turning the power switch to STANDBY and then to OPERATE. The overvoltage trip operates independently of the output range switch, for maximum protection of the load.

Complete solid-state circuitry in the 335D results in maximum reliability and minimum heat dissipation. Pre-regulation limits the incoming power to that required by the output load. The greatly reduced temperature rise eliminates both any need for a cooling fan and the adverse effect of heat on components thereby significantly improving stability and reliability.

The null detector is a chopper stabilized amplifier with large amounts of negative feedback to raise the input impedance and provide a stable and accurate gain characteristic. The overall sensitivity is adjusted by varying both the input divider and the feedback. A recorder output is adjustable from 0 to 1 volt for full scale meter deflection and may be grounded or floated to 100 VDC above ground.

Mechanical construction utilizes plug-in, glass-epoxy printed circuit boards flow-soldered by an unique Fluke process. For rack mounting, the 335D requires only 7 inches of rack space and side panels are tapped for mounting standard chassis slides. Resilient feet are also provided for bench top use.

335D SPECIFICATIONS

AS A VOLTAGE STANDARD

OUTPUT VOLTAGE: 0 to 1111.1110 VDC.

OUTPUT CURRENT: 0 to 50 milliamperes.

VOLTAGE RANGES: 10, 100, and 1000V with outputs as follows:

0 to 11.111110 (1 uv steps)
0 to 111.11110 (10 uv steps)
0 to 1111.1110 (100 uv steps)

RESOLUTION: 0.1 ppm of range (1 uv maximum).

ACCURACY OF OUTPUT: (For 60 Days)

10V range - ±(0.001% of setting + 10 uV)
100V range - ±(0.001% of setting + 0.00002% of range)
1000V range - ±(0.0015% of setting + 0.00002% of range)

NOTE: The above accuracies are absolute, relative to NBS standards, and include effects of stability, line regulation, load regulation, and calibration uncertainties under standard reference conditions of 23°C ±1°C and up to 70% relative humidity.

TEMPERATURE COEFFICIENT OF OUTPUT: Less than ±(0.0002% of setting + 1 uv)/°C from 0°C to +50°C.

STABILITY OF OUTPUT: (At standard reference conditions described under ACCURACY OF OUTPUT).

10V Range
±(5 ppm of setting + 7 uV) per month

100V and 1000V Range
±(5 ppm of setting + 30 uV) per month)

OVERCURRENT PROTECTION: Automatic current limiting continuously adjustable from 1 to 60 ma with front panel control and indicator. Normal operation restored upon removal of overload.

OVERVOLTAGE PROTECTION: Automatically disconnects load if output voltage exceeds 1 to 1200V setting of front panel controls. Manual reset.

RIPPLE AND NOISE :
10V range - less than 20 uv RMS
100V range - less than 30 uv RMS
1000V range - less than 40 uv RMS

SETTLING TIME: Typically, within 10 ppm of final output, less than 20 seconds after a range change.

OUTPUT RESISTANCE:
Less than 0.0005 ohms or $(0.0001E_O)$ ohms at DC.

REGULATION: 0.0002% of setting or 10 uv for either a 10% line voltage change or a full load change.

COMMON MODE REJECTION: Better than 125 db from DC to 400 Hz, up to 700V RMS or 1000 VDC.

ISOLATION: Either output terminal may be floated up to 1000 VDC from chassis ground.

REMOTE SENSING: Separate terminals are provided to sense the output voltage directly at the load, reducing errors caused by voltage drop in connecting wires between the output and the load.

AS A DIFFERENTIAL VOLTMETER

ABSOLUTE ACCURACY:
TEMP. COEF. OF ACCURACY:
INPUT RANGES:
STABILITY:
} Same as output characteristics under Voltage Standard

NULL SENSITIVITIES: 1000V to 10 uv (full scale) in 9 decade ranges. Any null sensitivity may be used on any voltage range.

INPUT RESISTANCE:
Infinite at null from 0 to 1111.1110 VDC.

METER AND DIAL RESOLUTION: 0.1 ppm of range.

AS A CONVENTIONAL VOLTMETER

ACCURACY: ±3% of range.

RANGES:	Voltage Range	Input Resistance
	1000-0-1000	100 Megohms
	100-0-100	100 Megohms
	10-0-10	100 Megohms
	1-0-1	100 Megohms
	0.1-0-0.1	10 Megohms
	0.01-0-0.01	10 Megohms
	0.001-0-0.001	1 Megohm
	0.0001-0-0.0001	1 Megohm
	0.00001-0-0.00001	1 Megohm

GENERAL

DESIGN: Solid-state throughout (no tubes).

STABILITY OF METER ZERO:

On most sensitive range (10 uv full scale):
0.5 uv peak-to-peak noise.
0.5 uv peak-to-peak stability for 10% line voltage variation.

RECORDER/ISOLATION AMPLIFIER OUTPUT: Adjustable from 0 to over 1.0V for end-scale meter deflection; source resistance 5 to 8 kilohms; linearity better than ±0.5% of end-scale. Gain as an isolation amplifier is 1.0V/null range sensitivity. Recorder output may be grounded or floating up to 100 VDC.

TEMPERATURE: 0°C to +50°C, operating; -40°C to 65°C, non-operating.

HUMIDITY: 0 to 70% relative humidity.

SHOCK AND VIBRATION: Meets all requirements of MIL-T-945A, rigidly mounted or rack-mounted with slides.

ALTITUDE: 10,000 ft. operating; 50,000 ft. non-operating.

FUSES: One power-line fuse; one high-voltage fuse.

INPUT POWER: 115/230 VAC ±10%, 50-60 Hz, single phase approximately 130 VA fully loaded.

MOUNTING: Standard EIA relay rack (tapped for attachment of slides); resilient feet for bench use.

SIZE: 7" high by 19" wide by 18" behind panel.
(17.8 x 48.2 x 45.7cm)

WEIGHT: Approximately 50 lbs.(22.67kg)

PRICE: $3695.00 f.o.b. factory, Mountlake Terrace, Washington.

341A

FLUKE

DVM CALIBRATOR

FEATURES

- 0 TO 1100 VOLTS IN 3 RANGES
- ±0.005% ACCURACY
- COMPLETELY SOLID-STATE
- FOUR TERMINAL FLOATING OUTPUT
- 1 PPM RESOLUTION
- 3½ INCHES HIGH
- ADJUSTABLE CURRENT LIMIT WITH INDICATOR

The Fluke Model 341A is an outstanding new addition to the Fluke line of ultra-precise and stable DC calibrators. The instrument covers 0 to 1100 VDC in three ranges of 10, 100, and 1000 volts, each with 10% overranging. Calibration accuracy is an absolute ±0.005% of setting from 0.6 volts to 1100 volts, without consideration of range percentage factors or fixed error floors. (See graph below.) Below 0.6 volts, accuracy is constant at ±0.0003% of range.

MODEL 341A ACCURACY OVER THREE RANGES

The primary instrument reference is a reference amplifier with precisely known characteristics. This device is a zener diode with active circuitry added to provide a voltage reference with very low temperature coefficient over a 50°C temperature span. The reference amplifier is the principal contributor to the outstanding stability characteristics of the 341A. Output voltage stability is well within 7 ppm per hour and 20 ppm per month. Typical six month stability is 40 ppm.

Stability of the reference amplifier is complemented by the unique FET-chopper stabilized error amplifier. This amplifier is a very high-gain circuit, carefully designed to prevent noise and rattle on the output. Combined rattle and noise are specified at 100 microvolts RMS on all ranges and settings. Peak-to-peak ripple and noise are typically less than 200 mircrvolts. Short term rattle and random excursions are held to less than 1 ppm.

A separate negative voltage limiter feedback circuit operates around the error amplifier at all times. This maintains the amplifier in a linear operating region, regardless of transients such as large changes in output setting, down ranging, or switching to the standby mode. Thus recovery time and settling time are very fast and always optimum.

Another circuit loop functions to limit output current at any front-panel set value from 1 to 30 milliamperes. The loop is closed at all times to monitor against any load change including a short-circuited output, and to maintain the error amplifier in a linear state. A continuous short will return quickly upon removal of overload.

For positive protection of the main series regulator transistors, a simple fail-safe electronic crowbar circuit clamps the voltage across the regulators to a safe level.

The Model 341A is housed in the unique and attractive Fluke rack-width package, only 3-½" high.

OUTPUT VOLTAGE: 0 to 1111.10 VDC.

OUTPUT CURRENT: 0 to 25 milliamperes at any setting.

VOLTAGE RANGES: 10, 100, and 1000 VDC with outputs as follows:
0 to 11.11110 (10 uv steps)
0 to 111.1110 (100 uv steps)
0 to 1111.110 (1 mv steps)

RESOLUTION: 1 ppm of range (10 uv maximum).

ACCURACY OF OUTPUT (for 30 day period):
10V range ±0.005% of setting
or ±0.0003% of range
100V range - ±0.005% of setting
or ±0.0002% of range
1000V range - ±0.005% of setting
or ±0.0002% of range

NOTE: Above accuracies apply after warm-up at standard reference conditions of 23°C ±1°C (nominal calibration temperature), constant line voltage, up to 70% relative humidity, and constant external load. The accuracy over a 6 month period and 23 ±5°C temperature range is ±0.007% of setting or ±0.0003% of range.

TEMPERATURE COEFFICIENT OF OUTPUT: Less than (5 ppm of setting + 0.1 ppm of range + 2 uv) per °C from + 15°C to + 35°C. Less than (8 ppm of setting + 0.1 ppm of range + 2 uv) per °C from 0°C to + 50°C.

STABILITY OF OUTPUT: (At standard reference conditions described under ACCURACY OF OUTPUT):

10V range (whichever is greater)
±0.0005% of setting or 5 uv per hour
±0.002% of setting or 15 uv per month
±0.004% of setting or 30 uv per 6 months

100V range (whichever is greater)
±0.0005% of setting or 10 uv per hour
±0.002% of setting or 25 uv per month
±0.004% of setting or 50 uv per 6 months

1000V range (whichever is greater)
±0.0005% of setting or 20 uv per hour
±0.002% of setting or 50 uv per month
±0.004% of setting or 100 uv per 6 months

OVERCURRENT PROTECTION: Automatically limits output current at any preset level between 1 ma and 30 ma via continuously variable front panel control.

DESIGN: Solid-state throughout (no vacuum tubes).

RIPPLE AND NOISE (all frequencies): Less than 100 uv RMS.

SETTLING TIME: Within 50 ppm of final output in 5 seconds.

LINE REGULATION: 0.0005% of setting plus 25 uv for a 10% line voltage change from nominal.

LOAD REGULATION: 0.0005% of setting plus 25 uv for a full load change.

ISOLATION: Output may be floated up to 500 VDC from chassis.

METER: Switch selectable to full range voltage or full range current.

REMOTE SENSE: Separate terminals are provided for sensing the output voltage directly at the load eliminating errors due to voltage drop in leads between instrument and load.

WARM-UP TIME: Within 50 ppm of final output at turn-on. Within 15 ppm of final output in 30 minutes.

TEMPERATURE RANGE:
0°C to +50° C operating
-40°C to +65°C non-operating

RELATIVE HUMIDITY: 0 to 70%

SHOCK: 15g, 11 millisecond half sine wave (MIL-T-21200).

VIBRATION: 10 Hz - 55 Hz, 4.5g maximum (MIL-T-21200).

ALTITUDE: (MIL-T-21200):
Up to 10,000 ft. operating (3.048 km)
Up to 50,000 ft. non-operating (15.24 km)

INPUT POWER: 115/230 VAC ±10%, 50-440 Hz, single phase. Approximately 60 VA fully loaded.

SIZE: 3-½" high x 17" wide x 18" deep.
(88.9 mm x 431.8 mm x 457.2 mm)

WEIGHT: 23 lbs. (10.43 Kg)

MOUNTING:

Bench: Self-supported on included custom-designed feet.

Rack: Accepts optional brackets MEE-7001 for 19" EIA rack mounting and optional 18" chassis slided MEE-8078 (24" slides also available).

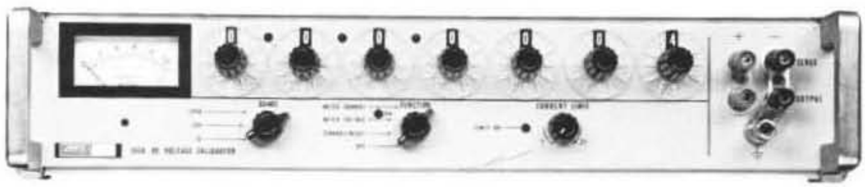
PRICES: 341A - $1,295.00
MEE-7001 rack mounting brackets - $15.00
MEE-8078 chassis slides - $50.00

All prices f. o. b. factory Mountlake Terrace, Washington

343A

FLUKE

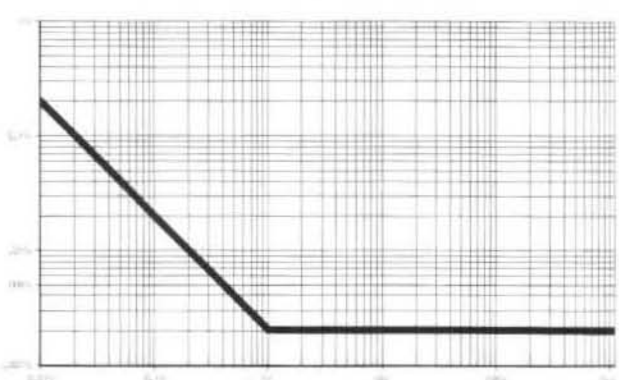
DVM CALIBRATOR



FEATURES

- Absolute accuracy 0.002% of setting
- Current limit and crowbar protection
- 3-1/2" panel
- Extremely fast response
- 0.1 ppm resolution (seven digits)
- Four terminal floating output

The Fluke 343A seven-dial DC Calibrator provides parameters of stability, accuracy, temperature coefficient and response required by a broad range of laboratory and production applications. With an absolute accuracy of 20 parts per million, it is natural to use the 343A to calibrate a wide variety of digital and differential voltmeters. (See graph below.) Stability of the output is considerably better than 5 ppm per hour and 15 ppm per month. Stability for six months is typically within 25 ppm of setting. Stability of output versus both time and temperature rests primarily with the reference amplifier; a zener-transistor combination with a recorded history of extremely stable output EMF.



MODEL 343A ACCURACY OVER THREE RANGES

Noise on the output (including ripple) is specified at 50 uv RMS. Low noise is an inherent characteristic of the high-gain DC error amplifier of the 343A, a FET-chopper-stabilized circuit. Chopper frequency is high for fast amplifier response, and the specific frequency of operation eliminates beats with line frequencies or harmonics thereof. Quick amplifier response and operation of the amplifier in an optimum linear state at all times provides an output well within 15 ppm five seconds after any range or setting change, or switching on from the standby mode. Overshoot is negligible under the same conditions.

Fluke wirewound bobbin-type resistors are used in all circuit applications where accuracy, stability, and temperature coefficients are critical. Temperature coefficients are matched so closely that the 343A is within 3 ppm/°C over a 20°C span (+15°C to +35°C).

Cleanliness of the DC output is evident in the combined ripple and noise specification of 50 uv RMS. Short term jitter and other random excursions are almost nonexistent (less than 1 ppm).

A simple amplifier/comparator circuit is utilized to establish a convenient variable current limiter. Any maximum current output from 1 to 30 milliamperes may be set via a front panel control. In addition to providing for current protection of the load, a fail-safe crowbar protects the series pass elements from damage should the total voltage across the elements exceed a safe level.

All seven decade switches of the 343A are gold-plated units designed for continuous use as would be encountered in a production line calibrator, with heavy-duty switch parts mounted on the best available insulating material. Parallel contacts are used for uniform contact resistance over hundreds of thousands of operations.

Environmental considerations are an inherent part of the 343A design. Temperature, altitude, humidity, shock and vibration parameters are well known, documented and conservatively rated. The instrument will perform well in severe field use, and in virtually any unconditioned temperature/humidity environment.

The 343A is housed in an attractive 3-1/2 inch package with custom frame components and vinyl-clad aluminum covers. Simple brackets (optional) allow installation in a 19 inch relay rack.

OUTPUT VOLTAGE: 0 to 1111.1110

OUTPUT CURRENT: 0 to 25 milliamperes at any setting.

VOLTAGE RANGES: 10, 100, and 1000 VDC with outputs as follows:

0 to 11.111110 (1 uv steps)
0 to 111.11110 (10 uv steps)
0 to 1111.1110 (100 uv steps)

RESOLUTION: 0.1 ppm of range (1 uv maximum).

ACCURACY OF OUTPUT (whichever is greater):

10V range - ±0.002% of setting or ±0.0002% of range
100V range - ±0.002% of setting or ±0.0001% of range
1000V range - ±0.002% of setting or ±0.0001% of range

NOTE: Above accuracies apply after warm-up at standard reference conditions of 23° C ±1° C (nominal calibration temperature), constant line voltage, up to 70% relative humidity, and constant external load.

TEMPERATURE COEFFICIENT OF OUTPUT: Less than (3 ppm of setting +0.1 ppm of range +2 uv) per °C from +15° C to +35° C. Less than (5 ppm of setting +0.1 ppm of range +2 uv) per °C from 0° C to +50° C.

STABILITY OF OUTPUT: (At standard reference conditions described under ACCURACY OF OUTPUT):

10V range (whichever is greater)
±0.0005% of setting or 5 uv per hour
±0.0015% of setting or 15 uv per month

100V range (whichever is greater)
±0.0005% of setting or 10 uv per hour
±0.0015% of setting or 25 uv per month

1000V range (whichever is greater)
±0.0005% of setting or 20 uv per hour
±0.0015% of setting or 50 uv per month

OVERCURRENT PROTECTION: Automatically limits output current at any present level between 1 ma and 30 ma via continuously variable front panel control. Panel lamp illuminates during limiting.

DESIGN: Solid-state throughout (no vacuum tubes).

RIPPLE AND NOISE: Less than 50 uv RMS (50/60 Hz line).

SETTLING TIME: Within 15 ppm of final output in 5 seconds.

LINE REGULATION: 0.0005% of setting plus 25 uv for a 10% line voltage change from nominal.

LOAD REGULATION: 0.0005% of setting plus 25 uv for a full load change.

ISOLATION: Output may be floated up to 500 VDC from chassis.

METER: Switch selectable to full range voltage or full range current.

REMOTE SENSE: Separate terminals are provided for sensing the output voltage directly at the load, eliminating errors due to voltage drop in leads between instrument and load.

TERMINALS: One pair sense, one pair output, plus chassis post (duplicated on rear terminal strip).

WARM-UP TIME: Within 25 ppm of final output at turn-on. Within 5 ppm of final output in 30 minutes.

TEMPERATURE RANGE:

0° C to +50° C operating
-40° C to +65° C non-operating

RELATIVE HUMIDITY: 0 to 70%

SHOCK: 15g, 11 millisecond half-sine wave (MIL-T-21200).

ALTITUDE (MIL-T-21200):

Up to 10,000 ft. operating (3.048 Km)
Up to 50,000 ft. non-operating (15.24 Km)

INPUT POWER: 115/230 VAC ±10%, 50-440 Hz, single phase. Approximately 60 VA fully loaded.

SIZE: 3-1/2" high x 17" wide x 18" deep. (88.9 mm x 431.8 mm x 457.2 mm)

WEIGHT: 23 lbs. (10.43 Kg)

MOUNTING:

Bench: Self-supported on included custom-designed feet.
Rack: Accepts optional brackets MEE-7001 for 19" EIA rack mounting and optional 18" chassis slides MEE-8078 (24" slides also available).

PRICES: 343A - $1795.00
MEE-7001 rack mounting brackets - $15.00
MEE-8078 chassis slides - $50.00

VOLTAGE/CURRENT CALIBRATOR

FEATURES

- All Solid State
- 0 to 50 VDC, ±0.01%
- ±0.02% Current Calibration, 0 to 2 amps
- 5 ppm Regulation
- Continuously Variable Current/Voltage Limiting
- Six Dial Resolution

APPLICATIONS

- Voltmeter Calibration
- Ammeter Calibration
- Current Shunt Calibration
- Current and Voltage Standard, Precision Thermal Transfer AC Measurements
- Instrumentation System Calibration
- Gyro Torquer
- Solenoid Excitation
- Resistor Calibration

DESCRIPTION

The all-solid-state Fluke Model 382A is a combination ±0.01% voltage calibrator and ±0.02% current calibrator. In the constant voltage mode, two ranges are available: 0 to 5 volts and 0 to 50 volts. A unique current-limiting circuit limits the output to any preset value from 2 ma to 2 amps in three ranges.

In the constant current mode, four ranges are available: 0 to 5 ma, 0 to 50 ma, 0 to 500 ma, and 0 to 2 amps. A voltage-limiting circuit limits the output to any preset value from 5 to 55 volts in one continuously variable range. For additional load protection the 382A is designed so that voltage and current limiting may operate simultaneously. When either voltage or current limiting begins, a front panel lamp illuminates. The calibrator is not harmed by a continuous short-circuit, and normal operation is restored upon removal of overload.

Output voltage or current is controlled via six in-line front panel decade switches, or remotely by an external, programmed resistance attached to the rear terminal board. Terminals are provided both front and rear for sensing the output voltage directly at the load when IR drop in load leads could create error.

Stability of the 382A is excellent. Voltage stability is 20 ppm, 25 ppm, and 50 ppm per hour, day, and month respectively. Basic current stability is 25 ppm per hour and 50 ppm per month.

The front panel mounts a single meter which may be switched to monitor either voltage or current output.

Regulation circuitry consists of two separate feedback loops. The main loop, which controls the output voltage and current, contains a chopper-stabilized amplifier having more than 160 db of gain at DC, and Fluke-manufactured sampling string resistors which are precisely matched for both resistance accuracy and temperature coefficient. The second feedback loop senses the voltage drop across the series regulating transistor, and controls a pre-regulator accordingly to maintain low power dissipation in the series element. The necessity for forced air cooling is thereby eliminated.

The voltage reference element is a specially processed and selected zener diode with a test history of stable operation. Current for the reference element is supplied by a constant current regulated source. The reference zener diode, along with the current regulating components, are enclosed in a temperature-controlled oven to further stabilize the output.

Mechanical construction utilizes plug-in printed circuit boards for ease of calibration and maintenance. All heat-producing elements are isolated from control circuitry to ensure stable operation even at high ambient temperatures.

For rack mounting, Model 382A requires 5-1/4 inches of rack space, and has side panels tapped for standard chassis slides. Resilient rubber feet are also provided for bench use.

CONSTANT VOLTAGE MODE

OUTPUT VOLTAGE: 0 to 50 VDC; 0 to 5 VDC.

OUTPUT CURRENT: 0 to 2 amperes.

CALIBRATION ACCURACY: ±0.01% of setting or 100 uv (whichever is greater).

LINE REGULATION: 0.0005% or 50 uv (whichever is greater) for a 10% line change from nominal.

LOAD REGULATION: 0.0005% or 50 uv (whichever is greater) for a 2 ampere load change.

STABILITY:
±0.002% or 100 uv (whichever is greater) per hour.
±0.0025% or 100 uv (whichever is greater) per day.
±0.005% or 100 uv (whichever is greater) per month.

RIPPLE: Less than 50 uv RMS.

RESOLUTION: 100 uv (50V range); 10 uv (5V range).

OUTPUT POLARITY: Either terminal may be grounded or both may be left floating up to 500V above ground.

REMOTE SENSING: Output voltage may be sensed directly at load via front panel binding posts or rear terminal strip.

REMOTE PROGRAMMING: Via external rheostat connected to rear terminal strip (1000 ohms per volt on 50 V range; 10,000 ohms per volt on 5V range).

OUTPUT IMPEDANCE: Less than 0.0005 ohm from DC to 100 cps; less than 0.005 ohm to 1 KC; less than 0.5 ohm to 100 KC.

CURRENT LIMITING: Continuously variable from 2 ma to 2 amps in three full scale ranges of 20 ma, 200 ma, and 2 amps.

GENERAL

CONNECTORS: Front panel insulated binding posts for positive and negative output, positive and negative sense, and chassis ground. Rear terminal strip has same connections plus remote programming and reference monitoring terminals.

METER: One meter to monitor either output voltage or current.

TEMPERATURE RANGES: 0°C to 55°C operating; -40°C to 60°C storage.

CONSTANT CURRENT MODE

OUTPUT CURRENT: 0 to 5 milliamperes
0 to 50 milliamperes
0 to 500 milliamperes
0 to 2 amperes

OUTPUT VOLTAGE: 0 to 50 VDC minimum.

CALIBRATION ACCURACY: ±0.02% of setting or ±0.002% of range (whichever is greater).

LINE REGULATION: 0.0005% of range for a 10% line change from nominal.

LOAD REGULATION: 0.001% of range for a 50V load change.

STABILITY: 5 ma and 50 ma ranges - ±0.0025% of setting or ±0.0005% of range (whichever is greater) per hour; ±0.005% of setting or ±0.001% of range (whichever is greater) per month.

500 ma and 2 amp ranges - ±0.0025% of setting or ±0.0005% of range (whichever is greater) per hour after 2 minutes at constant current output; ±0.005% of setting or ±0.001% of range (whichever is greater) per month after 2 minutes at constant current output.

RIPPLE: Less than 0.002% of range RMS.

RESOLUTION: 0.01 ua on 5 ma range
0.1 ua on 50 ma range
1 ua on 500 ma range
10 ua on 2 amp range

OUTPUT POLARITY: Negative terminal may be grounded, or both positive and negative terminals may be left floating up to 500V above ground. Positive terminal must be isolated from chassis ground by load.

REMOTE PROGRAMMING: Via external rheostat connected to rear terminal strip (10,000 ohms per ma for 5 ma range; 1000 ohms per ma for 50 ma range; 100 ohms per ma for 500 ma range; 10 ohms per ma for 2 amp range).

VOLTAGE LIMITING: Continuously variable from 5 to 55 VDC in one range.

INPUT POWER: 115/230 VAC ±10%, 50 to 60 cps, approximately 300 VA fully loaded.

SIZE: 5-1/4" high x 19" wide x 18" behind panel. (13.3 x 48.2 x 45.7 cm)

MOUNTING: Standard relay rack; side panels tapped for standard chassis slides; rubber feet for bench use.

WEIGHT: Approximately 50 pounds. (22.67 kg)

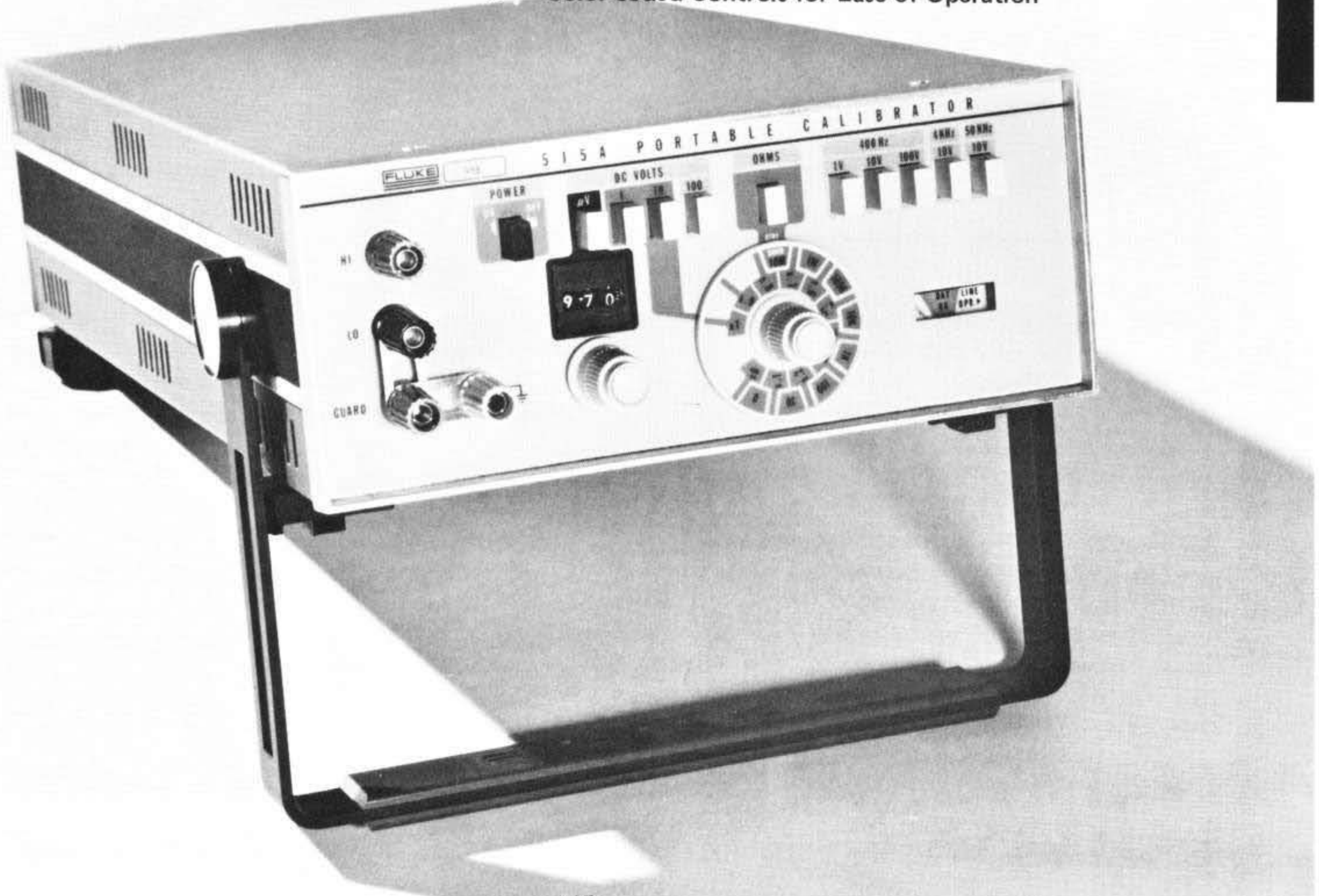
PRICE: $ 1795.00 f.o.b. factory, Mountlake Terrace, Washington.

FLUKE®

Portable Calibrator **515A**

FEATURES

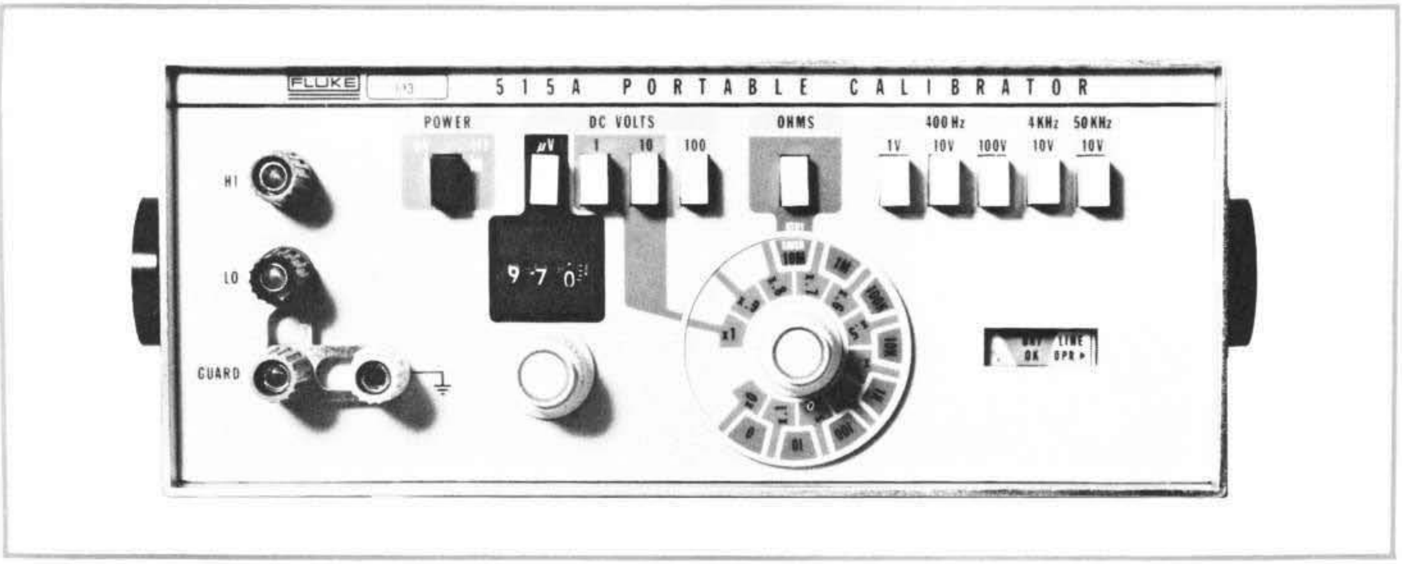
- AC Volts, DC Volts and Ohms
- 0.003% DC Accuracy
- One Set of Output Terminals for All Functions
- Built-in Rechargeable Battery Pack for On-Site Calibration
- Small, Lightweight
- Color-coded Controls for Ease of Operation



The Model 515A Portable Calibrator is a precision voltage and resistance calibration source for on-site calibration of measuring instruments. The Model 515A provides dc voltage, ac voltage and resistance standards in a unit only 3½ inches high by 8½ inches wide by 16 inches deep. The instrument weighs just 13 pounds including the rechargeable battery back which eliminates warmup delays after transit and allows eight hours operation free of line power for true portability. The 515A basic calibration accuracy is specified over a temperature range of 18°C to 28°C for a one year period thus making it easy to use in production test and calibration lab environments without complex correction terms. The long calibration cycle also makes the 515A economical to own by minimizing maintenance overhead costs.

The 515A can be used effectively to test a wide range of characteristics in measuring instruments. Here are a few of the many applications.

General	DC Volts	AC Volts	Resistance
Zero Offset	Input Offset Current	Frequency Response	Linearity
Zero Stability	A/D Linearity	Converter Linearity	Residual Resistance
Autoranging	Absolute Accuracy	Residual Noise	Absolute Accuracy
Overranging		Absolute Accuracy	



MODEL 515A FRONT PANEL LAYOUT

All 515A outputs are made available at a single set of output terminals. Generally, connections to the test instrument may be made once for a complete series of tests. In addition to the HI and LO outputs, terminals are available to allow guarding and shielding of test leads in critical test situations.

Functional controls are conveniently organized and color coded for clarity. The POWER pushbutton applies power to the operating circuitry of the 515A. If the unit is connected to the ac line, the internal battery is placed on charge; otherwise, the 515A automatically operates from the battery and its state of charge is indicated on the meter to the right of the panel. Dual purpose feet on the rear of the unit provide a convenient storage location for the line cord.

DC VOLTS ranges include "µV" with a digital readout and vernier control to provide 0 through 999 µV with 0.2 µV resolution. The "1" and "10" volt ranges, operating in conjunction with the multiplier dial, provide 10 voltage steps plus "0" in each range. The "100" volt range offers a single precise value of dc voltage.

The OHMS pushbutton and the associated positions on the multiplier dial make fixed decade resistance values from 10 MΩ down to 10Ω available with a "0" position provided for residual resistance tests without disturbing test lead connections.

AC voltage tests may be made at three frequencies. At 400 Hz, the unit offers 1V, 10V, and 100V rms sine wave while 10V rms is available at 4 kHz and 50 kHz.

All output function pushbuttons are interlocked for safety.

Specifications

DC Voltage

Range:

μV:	0 to 999 μV continuous (0.2 μV resolution)
1V:	0.0 to 1.0V in 0.1V steps
10V:	0 to 10V in 1V steps
100V:	100V cardinal point

Accuracy: (@23°C ±5°C for 1 year; 30 minute warmup)

μV Range:	±2 μV
1V, 10V and 100V ranges:	±(0.003% of setting or 30 μV, whichever is greater)

Ripple:

μV Range:	< 10 μV rms
1V, 10V and 100V Ranges:	< 0.01% of range rms

Load Regulation:	**Load R**	**Output Change (% of setting)**
μV, 1V, and 10V Ranges:	> $10^8\,\Omega$	– 0.0%
	10 MΩ	– 0.003%
	1 MΩ	– 0.03%
100V Range:	±5 ppm (no load to full load)	

Output Current: Function of source resistance, except 100V range which is limited at approximately 0.5 mA. No damage to instrument with short circuit on output.

Source Resistance:	
μV, 1V, 10V Ranges:	300 ohms
100V Range:	< 1 ohm (up to 0.5 mA load)

Line Regulation: (±10% line voltage change)

μV Range:	< 1 μV
1V, 10V Ranges:	< 1 ppm of range
100V Range:	< 10 ppm of range

Temperature Coefficient (0°C to 18°C, 28°C to 50°C)

μV Range:	±0.1 μV/°C
1V, 10V Ranges:	±5 ppm/° C
100V Range:	±8 ppm/° C

AC VOLTAGE

Voltage Range: 1V, 10V, 100V cardinal points

Output Frequencies:

10V	400 Hz, 4 kHz, 50 kHz
1V, 100V	400 Hz

Accuracy: (@23°C ±5°C for 1 year; 30 minute warmup)

Voltage:	
1V:	±0.05%
10V:	±0.04% – 400 Hz and 4 kHz ±0.1% – 50 kHz
100V:	±0.06%
Frequency:	±1% except @ 50 kHz; ±5%

Total Harmonic Distortion and Noise:

400 Hz and 4 kHz:	< 0.03%
50 kHz:	< 0.05%

Load Regulation:

10V outputs (0 to 10 mA)	±0.004% except @ 50 kHz; ±0.008%
1V output (< 1Ω Source Z)	–0.005% (20 kΩ); –0.01% (10 kΩ)
100V output (< 30Ω Source Z)	–0.006% (500 kΩ); –0.015% (200 kΩ)

Output Current : (For load regulation as stated above)

1V,10V output	0 to 10 mA rms
100V output	0 to 0.5 mA rms

NOTE: Current limiting protects the 515A output from damage due to short circuit on output.

Line Regulation (±10% line voltage change)

All Voltages at all frequencies:	<±10 ppm

Temperature Coefficient: (0°C to 18°C, 28°C to 50°C)

All Voltages at all frequencies:	<±25 ppm/°C

RESISTANCE

Range: 10Ω through 10 MΩ in decade steps + zero setting.

Accuracy: (@23°C ±5°C for 1 year; referred to "0" ohms position)

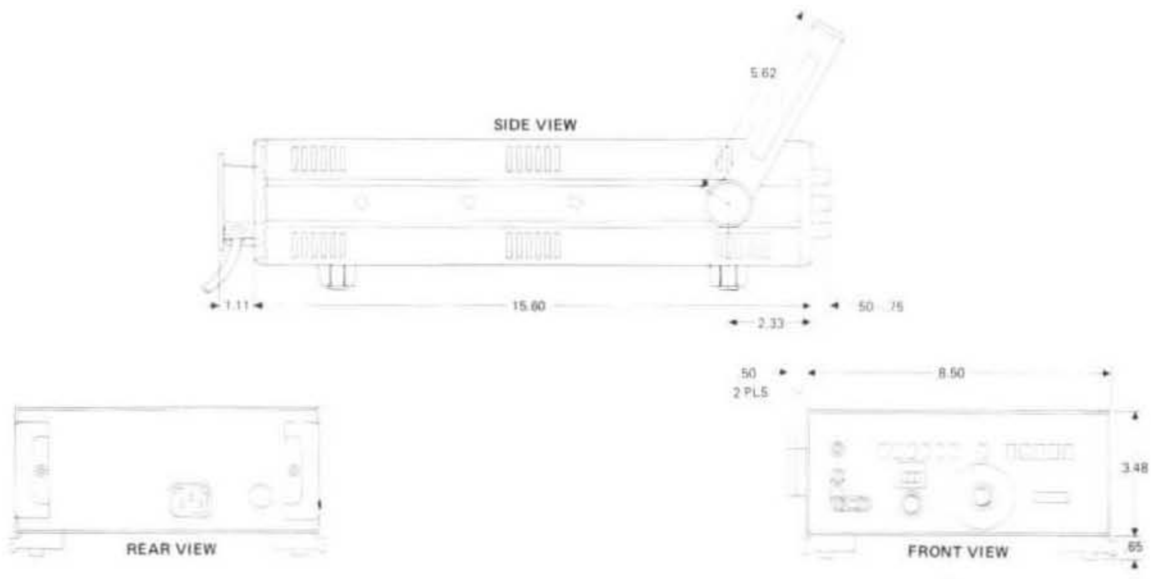
0Ω:	Residual Resistance; <0.15Ω
10Ω– 100Ω:	±0.06%
1 kΩ – 1 MΩ:	±0.015%
10 MΩ:	±0.075%

515A Specifications Continued

Power Rating:	0.2 Watt or 100V (DC or RMS), whichever is less
Temperature Coefficient:	(0°C to 18°C, 28°C to 50°C) referred to residual resistance
0Ω:	< +0.4%/°C
10Ω – 100 Ω:	< ±10 ppm
1 kΩ – 1 MΩ:	< ±5 ppm
10 MΩ:	< ± 10 ppm
Relative Humidity:	< 70%, 0°C to 45°C
Input Power:	100/115/200/230V ac, ±10%, < 10 Watts, 50 – 440 Hz, single phase or internal batteries. Eight hours operation from batteries when fully charged. Charging is automatic during line operation. Front panel meter indicates condition of charge and battery/line operation.

GENERAL

Size:	3½" H x 8½" W x 16" D
Weight:	13 lbs.
Operating Temperature:	0°C to 50°C
Storage Temperature:	–40°C to +50°C; to +60°C with batteries removed.
Output Connectors:	4 binding posts for HI, LO, GUARD and CHASSIS
Shock:	20g., 11 msec half-sine wave.
Vibration:	4.5g, 10 Hz to 55 Hz
Altitude:	0 to 10,000 feet operating 50,000 feet non-operating



Price:

515A (Including batteries and charging circuit). $1995

Accessories:

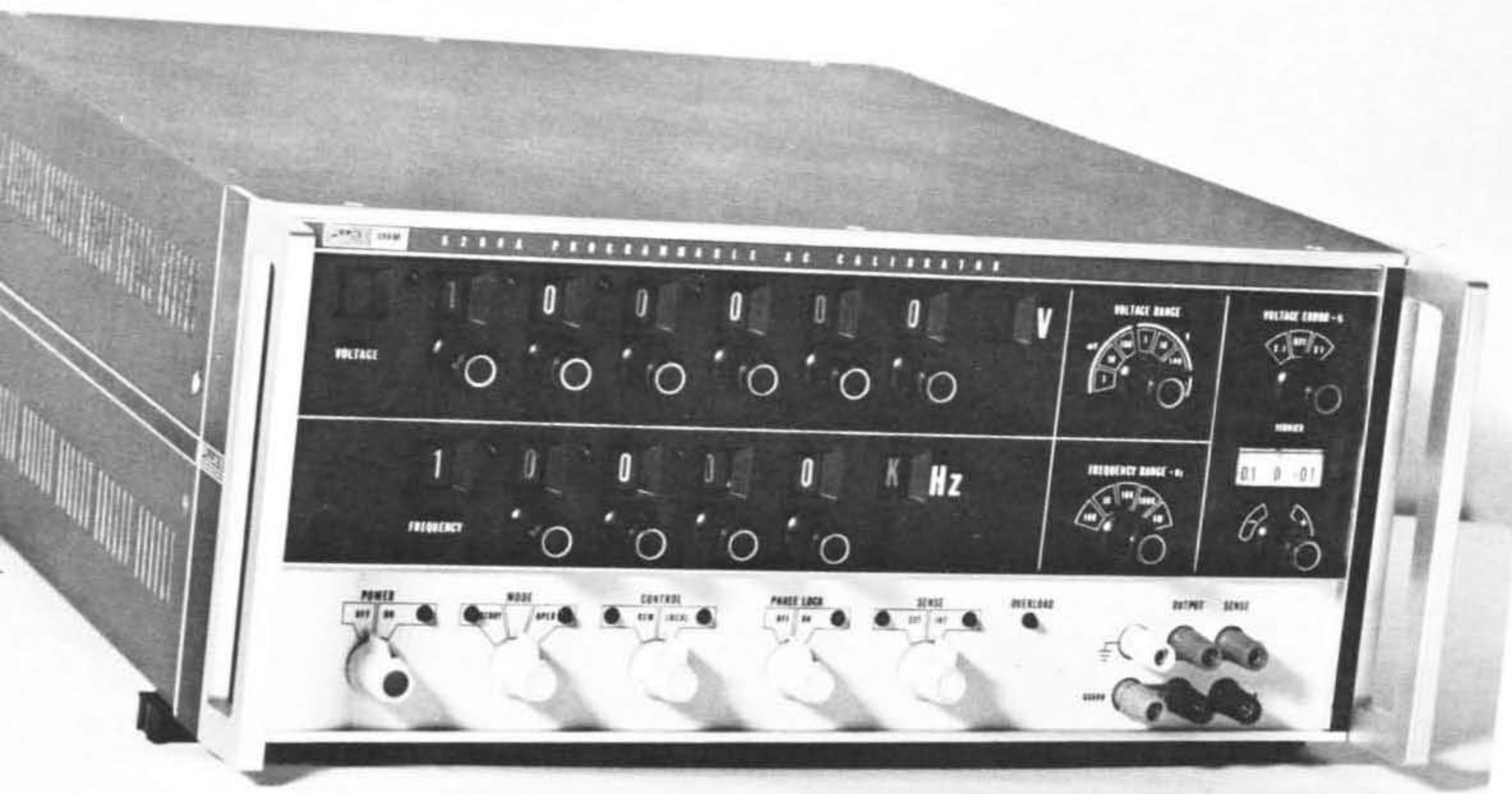
M00-200-618	Side-By-Side Rack Mount	30
M00-200-619	Offset Rack Mount	35
M00-200-620	Panel Mounting Frame	25
M03-203-700	Front Panel Cover	10

FLUKE®

Precision AC Calibrator 5200A

FEATURES:

- Up to 1.2 MHz Operation
- Field Installable RCU Option
- Fast Response Time
- Phase Lock Input
- Quadrature Output
- Fully Guarded
- Field Replaceable Circuit Boards



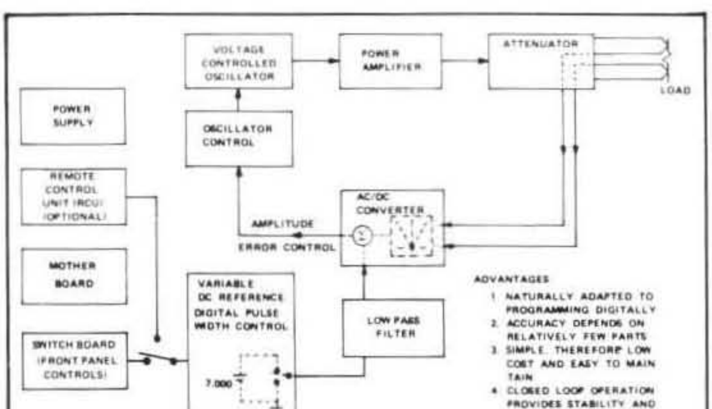
The Fluke 5200A AC Calibrator brings to manufacturing and laboratory environments greater precision over wider operating frequencies than conventional AC calibrators. The operational frequency range is 10 Hz to 1.2 MHz with accurate AC voltages in ranges of 100μV rms to 120V rms at currents up to 50 milliamperes.

A very fast wide band AC to DC converter, an extremely stable voltage controlled oscillator, together with an easily programmed DC digital pulse width reference are the heart of the 5200A calibrator. High switch reliability is obtained through 5 volt logic level switching of the DC digital pulse width reference. This technique further allows the 5200A to be easily adaptable for remote programming.

Advanced design engineering by Fluke has conquered the inherent instability problems of voltage controlled oscillators and thereby does away with the need for complex relay programmed attenuators and ratio transformers. The ½ second response time of the AC to DC converter eliminates the usual long AC calibrator settling times.

Accurate output amplitude selection is made in six decade ranges of 1 mV to 100 V. (A seventh range of 1,000 V is provided for use with a companion Fluke Precision Power Amplifier Model 5205A.) Six digit resolution within the selected voltage range provides 1nV through 100μV steps.

The extreme midband absolute accuracy of ±0.02% of output, ±0.002% of range, together with a total harmonic distortion of less than 0.04% up to 100 kHz enables the 5200A to achieve unmatched performance capabilities.



FLUKE 5200A BLOCK DIAGRAM

For production and voltmeter calibration applications traditionally requiring time consuming error calculations the 5200A provides a vernier scale that reads percent of error directly. Measurement is provided in two ranges, ±3% or ±0.3%. Error measurements can be resolved to ±0.01% on the 3% range or ±0.001% on the 0.3% range.

All solid state engineering has made the 5200A a more durable piece of precision equipment than vacuum tube ac calibrators. For shock and vibration requirements the 5200A is designed to meet or exceed Military Standard MIL-T-21200.

To insure a minimum of down time and servicing costs, the 5200A has been engineered with interchangeable circuit boards that are field replaceable. Long term reliability has been built into the 5200A by keeping the total parts count low. In addition, absolute accuracy relative to NBS Standards for 90 days within operating temperatures of 23 ± 5°C gives the 5200A a longer calibration cycle.

The Fluke 5200A is a fully guarded AC Calibrator which allows for floating operation and eliminates the system ground loop problems of non-guarded calibrators.

The oscillator of the 5200A may be phase locked to an external source to effectively produce synchronous signals of precision amplitude and stability. This feature provides expanded capabilities to slave a current source for wattmeter calibration or synchronous operation to line or system frequencies. A rear input jack is provided for the external signal and a front panel On-Off switch enables the phase lock function.

A quadrature output which is 90° out of phase with the fundamental is provided on the rear panel. Quadrature signal amplitude is proportional to the dialed output settings of the fundamental, up to 10 V rms maximum for a full scale setting on any range. This extra capability lends itself well for servo amplifier testing and synchronous detection.

Extremely fast response time, 0.5 seconds from 100 Hz to 1.2 MHz, avoids the unnecessary delays of conventional AC calibrators. Recovery from short circuits and overload conditions are within these specified settling times.

The output of the 5200A is protected by current limiting. When the overload is removed, the output will recover automatically to the preset level. Thus an operator need never worry about damaging the calibrator or meter under test. Transistion from the voltage mode to the current limit mode is typically 2 microseconds.

The Model 5200A provides High, Low, High Sense, Low Sense, Guard and Ground terminals on both the front and rear panels. An auxiliary output jack is provided on the rear panel for monitoring frequency with an external counter. Output amplitude is 3 V rms, short circuit protected.

One of the most unique and valuable features of the Fluke 5200A calibrator remote control option is its programmability. A field installable isolated RCU provides for the remote programming of frequency ranges, amplitude ranges, frequencies, amplitudes and all control functions except for Error Measurement. This programming may be made in serial or parallel depending on the system environment. All programming levels are compatible with TTL logic and contact closure.

Standard Levels:

Logic "1" = 0 to .4V dc

Logic "0" = +2.8 to +5.0V dc

For inverted logic levels, order Option –03 with Option 01.

Additional computer interface information is available. Request Application Bulletin #14.

For systems requiring greater voltage and current capabilities the 5200A is compatible with the Fluke 5205A Precision Power Amplifier. The 5205A extends the 120V rms at 50 mA current level limits of the 5200A to 1200V rms at 200 mA rms up to 120 kHz. When used together the 5200A and 5205A instrument pair may be controlled manually or remotely as a single instrument.

A separate data sheet is available for more detailed information on the 5205A Precision Power Amplifier, capabilities, specifications and system applications.

Specifications / Amplitude

VOLTAGE RANGES

1 mV, 10 mV, 100 mV, 1V, 10V, 100V
(1000V with 5205A Power Amp)

Overrange

20% on all ranges (120V maximum)

Range Limits

10% to 120% (100μV and above)

Resolution

0.0001% of Range (1nV on 1 mV range)

RESPONSE TIME

For any programmed amplitude, the output voltage and frequency will settle to within 0.01% of change as follows:

10 Hz - 100 Hz	4 Seconds Max.
100 Hz - 1 MHz	0.5 Seconds

The output will recover from short circuits and overload conditions within the specified settling time.

AMPLITUDE ERROR MEASUREMENT

0 to ± 0.3% with 0.001% resolution

0 to ± 3% with 0.01% resolution

An "OFF" error switch position is provided to easily lock out the error measurement function which is automatically disabled in program mode.

ACCURACY

(For 90 days, 23 ±5°C, after 1 hour warmup.)

1, 10, 100 Volt Ranges	(X% of setting +Y% of range)
10 Hz to 30 Hz	(0.1 +0.005)
30 Hz to 20 kHz	(0.02 +0.002)
20 kHz to 100 kHz	(0.05 +0.005)
100 kHz to 1 MHz	(0.33 +0.03)

1, 10, 100mV Ranges	(X% of setting + YuV)
10 Hz to 30 Hz	(0.1 +10)
30 Hz to 20 kHz	(0.02 +10)
20 kHz to 100 kHz	(0.05 +20)
100 kHz to 1 MHz	(0.33 +30)

SHORT TERM AMPLITUDE STABILITY

1 mV to 100V Ranges:

The change in rms value will be less than (0.0007% of setting + 0.0003% of range) pk-pk for the 1kHz thru 1MHz ranges and 0.004% pk-pk of range for the 100 Hz range over a 10 minute interval.

LONG TERM AMPLITUDE STABILITY

(At Constant Line, Load and Temperature)

±0.005% of setting for 24 hours

±0.01% of setting for 6 months

AMPLITUDE TEMPERATURE COEFFICEINT

(0° to 18°C and 28°C to 50°C)

±(0.025 x accuracy) per °C

MAXIMUM OUTPUT CURRENT

50 mA rms from 10% to 120% of range

NOTE: Min. Load impedance for specified accuracy:

1, 10, 100 mV Ranges . . . 3KΩ

1V Range . . . . 50Ω above 100 kHz

CURRENT LIMIT

The output is protected against overloads and short circuits by a current limiter.* Upon removal of the overload, the output will recover automatically.

**NOTE: See Maximum Inductive Load Current*

MAXIMUM OUTPUT VOLTAGE

120V rms. Maximum volt-hertz product is 1.0×10^7 (See Figure 1).

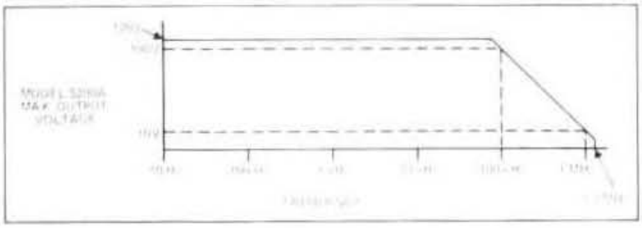


Figure 1. MAXIMUM OUTPUT AND FREQUENCY CHART.

TOTAL HARMONIC DISTORTION AND NOISE

(Bandwidth 10 Hz to 10 MHz)

10 Hz to 100 kHz . . . (0.04% of setting +10 uV rms) *

100 kHz to 500 kHz . . . . (0.3% of setting + 30uV rms)

500 kHz to 1MHz . . . . (1.0% of setting + 30uV rms)

*For output currents exceeding 15 mA:

20 kHz to 100 kHz

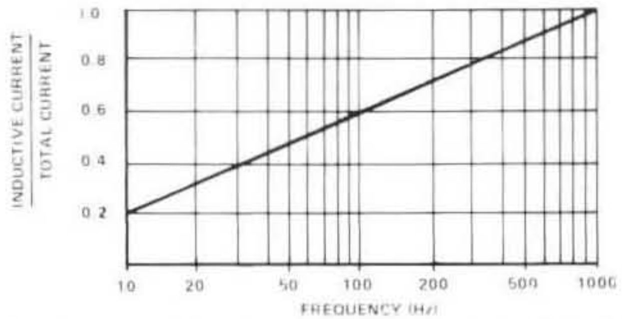
$$\left[0.04 + \left(\frac{0.3}{V}\right)\left(\frac{F}{100}\right)\left(\frac{I}{50}\right)^2\right]\%$$

V = volts, F = kHz, I = mA

MAXIMUM CAPACITIVE LOAD

1000 pf

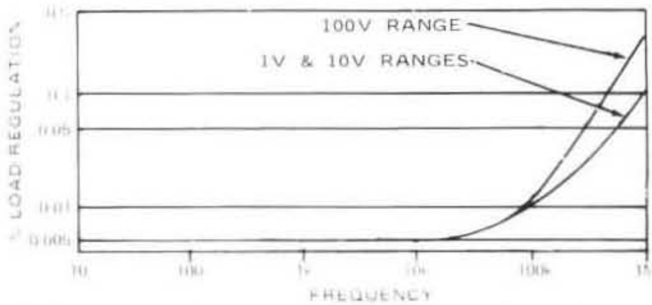
MAXIMUM INDUCTIVE LOAD CURRENT



The above graph does not restrict the use of Precision Inductive Dividers which have a maximum voltage limit of 0.35 times Frequency or higher.

LOAD REGULATION

% of Range (No load to full load)



NOTE: Output impedance on the 1 mV to 100 mV ranges is less than 1 ohm in series with 1μHenry.

LINE REGULATION

±0.001% of setting for a 10% change in line voltage.

Specifications / Frequency

FREQUENCY RANGES

100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz

Overrange

20% on all ranges (1.2 MHz maximum)

Range Limits

10% to 120% (10 Hz and above)

Resolution

0.01% of Range (.01 Hz on 100 Hz Range)

QUADRATURE OUTPUT (Minimum Load Z = 3kΩ)

Amplitude

10V rms ±5% when full scale output is selected for any of the normal output signal. Quadrature amplitude is proportional to the dialed output voltage. (BNC connector on rear panel)

Phase

$90° \pm (1° + 0.03°$ per kHz), 40 Hz to 1.2 MHz

$90° \pm 3°$, 10 Hz to 40 Hz

ACCURACY

(For 90 days, 23 ±5°C, after 1 hour warmup.)

	(X% of setting + Y% of range)
100 Hz to 100 kHz Ranges	(1.0 +0.1)
1 MHz Range	(3.0 +0.3)

FREQUENCY STABILITY

±0.05% for 24 hours

±0.1% for 6 months

FREQUENCY TEMPERATURE COEFFICIENT (0° to 18°C and 28°C to 50°C)

±0.025% of setting per °C

EXTERNAL FREQUENCY PHASE LOCK INPUT

The oscillator of the 5200A has the capability of being phased locked to an external signal. Phase lock accuracy is $\pm(1° + 0.05°$ per kHz) over a ±1% band around the center frequency. (BNC connector on rear panel)

COUNTER OUTPUT

Auxiliary frequency counter output (BNC Connector) on rear panel; 3V pulse, short circuit protected.

EXTERNAL SENSE

A two position switch is provided to control Internal or External Sensing on the 1V, 10V, and 100V ranges.

OUTPUT TERMINALS

High, Low, High Sense, Low Sense, Guard, and Ground terminals on front and rear panels. Front panel terminals are 5-way binding post. Rear panel terminals are via P.C. Board edge card connector with mating connector supplied (P/N 337675).

LOCAL/REMOTE OPERATION

Two position switch, interlocked with the optional remote programming function. In the LOCAL mode, all control is implemented from the front panel switches. In REMOTE, control is obtained via the programming lines through a rear panel connector. When the REMOTE function is called on the programming line, the Local/Remote switch on the front panel will be locked in the REMOTE condition, disabling the error measurement control and all other front panel controls except the POWER ON-OFF. When the LOCAL function is called on the programming line, the front panel Local/Remote switch may be operated in either the LOCAL or REMOTE condition at the operator's discretion.

SAFETY FEATURES

When the ac power is turned on, the instrument is automatically set to the Standby condition. When in Remote Sense and the sense leads are accidentally disconnected, the output voltage will not exceed 0.7 Volts above the programmed setting on the 1 Volt thru 100 volt ranges. The 1 millivolt thru 100 millivolt ranges are not affected.

CALIBRATION REQUIREMENTS

The 5200A is calibrated at the factory by instrumentation traceable to the National Bureau of Standards. Periodic calibration of the 1V, 10V, and 100V ranges may be accomplished through the use of a thermal transfer standard and a precision dc source, such as the Fluke Models 540B and 332D. The accuracy on the 1 mV, 10 mV, and 100 mV ranges depend on precision inductive dividers which are tested at the factory with special verification equipment, and do not require periodic adjustment. All other adjustments can be made with general purpose laboratory equipment.

Input Power

100, 115, 200, 230V ac ± 10%, switch selectable, 50 to 60 Hz (50 Hz to 400 Hz Option available), 100 Watts.

Dimensions

7" (177 mm) x 17" (431 mm) x 20.25" (514 mm)

Weight

45 pounds (10, 4 kg)

ENVIRONMENTAL

Cooling

Forced air cooled. Air intake through re-useable filter on rear panel. Air exit along both sides of 5200A.

Temperature

0°C to 50°C operating, −40°C to +75°C storage

Relative Humidity

0 to 80 percent (0°C to +40°C)
0 to 70 percent (+40°C to +50°C)

Shock

20 g. 11 millisecond half-sine wave

Vibration

4.5g., 10 Hz to 55 Hz

Altitude

0 to 10,000 feet operating
50,000 feet non-operating

5200A Isolated Remote Programming

OPTION −01

All functions of the 5200A AC Calibrator are remotely programmable except for the Power On-Off switch and the Error Measurement Control. While operating in a remote configuration, the 5200A remains totally isolated. Isolation is typically 10^9 ohms in parallel with 30 pf between logic common and analog output. This optional capability of the 5200A can be added in the field at any time and does not require the unit to be sent to the factory for modification.

The −01 Option of the 5200A permits the remote selection of all functions, frequencies and amplitudes by means of an external programming device, usually part of an automated system. The −01 Option is for use with systems employing negative-true logic. Systems operating with positive-true logic use the −03 Option in addition to the −01 Option.

The remote programming option consists of a Remote Control Unit (plug-in printed circuit board assembly), an 86 pin card-edge connector (P/N 337840), a prewired address matrix card (P/N 350074) and a blank Address Matrix card (P/N 350058). The RCU contains all the control logic and mounts in an assigned position within the 5200A. The card edge connector can be jumpered to meet various system requirements before being installed to connect the remote programming source to the 5200A. The matrix address card is also jumpered in accordance with system requirements and is installed on the RCU printed circuit board assembly.

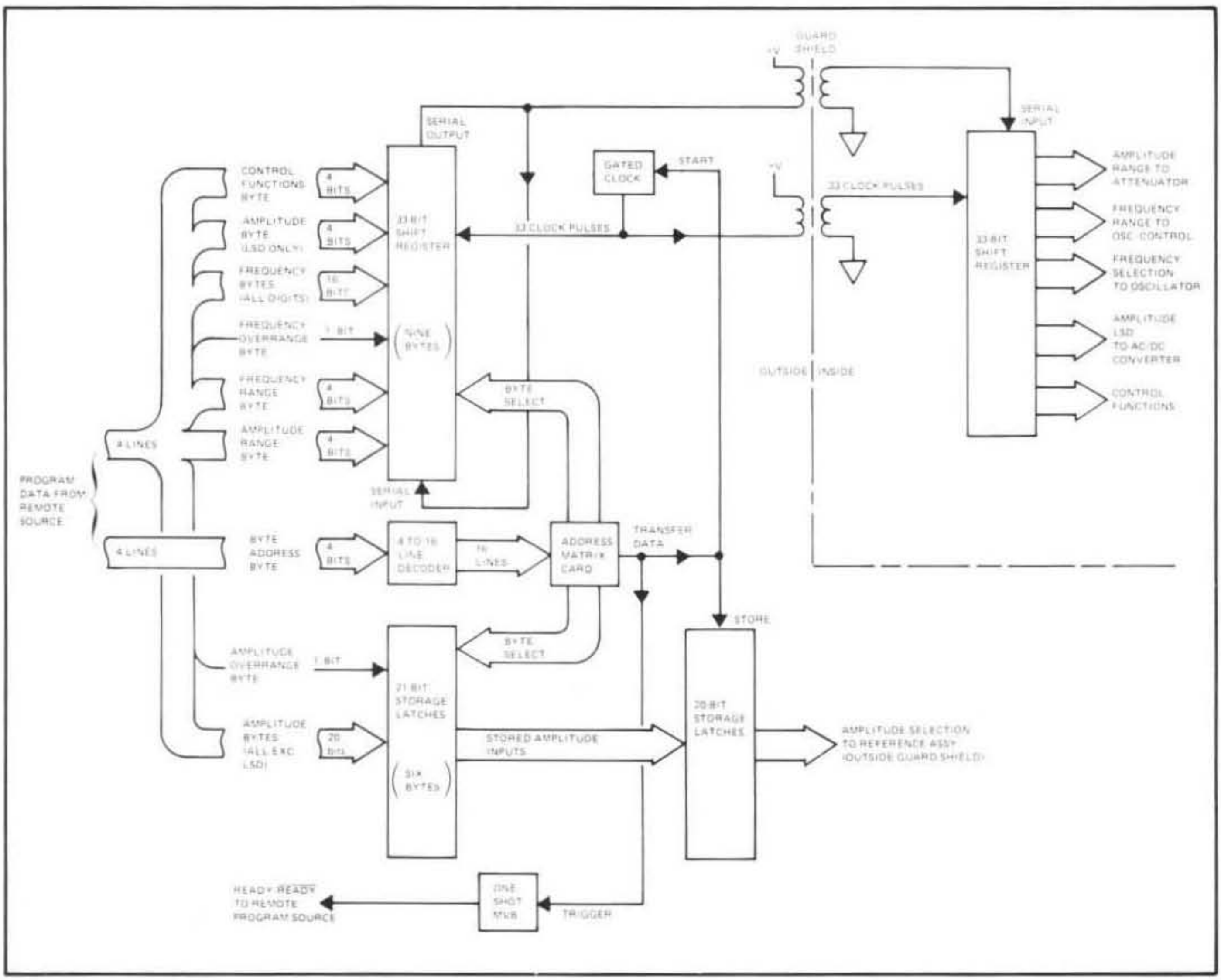
Once installed in the 5200A, the RCU requires no operator attention. The function of the RCU is to receive and store operational commands and parameters from some remote programming source, and when necessary, pass them through the guard shield to control the output frequency, output amplitude and operating mode of the calibrator. The RCU can receive remote control information in parallel or serial (by byte) form depending upon the system requirements.

When serial programming is employed program data generated by the program source in the form of a 54-bit program word is fed over a common set of four data lines to the register, one byte at a time. Each portion of the input register is addressable and as a byte of data is placed on the data lines, the designated portion of the input register is addressed and then strobed. In this manner, the remote programming source can fill the RCU Input register byte by byte. When the input register is loaded a data transfer command is addressed and the 5200A reacts to the program data.

In parallel programming form since each data bit has an assigned unique line, there is no need for multiple connections on the card edge connector, as in the case of serial programming.

The blank Address Matrix card (supplied) permits the assignment of byte numbers of the different input register elements as required for various system configurations. Regardless of how the Address Matrix card is jumpered the 54-bit program word must be placed in the assigned positions of the input register.

For additional information on remote programming the 5200A AC calibrator in serial or parallel formats or interfacing, request Application Bulletin #14 or contact the John Fluke Mfg. Co., Sales Product Specialist Department.



REMOTE CONTROL UNIT, SERIAL OPERATION

5200A GROUP PARALLEL PROGRAMMING FORMAT

DATA DESCRIPTION	NUMBER OF BITS
No Data, Group Address reserved for Master Strobe Command	
Voltage Range	3
Voltage Amplitude Overrange Bit	1
Voltage Amplitude, Most Significant Decade	4
Voltage Amplitude, Second Decade	4
Voltage Amplitude, Third Decade	4
Voltage Amplitude, Fourth Decade	4
Voltage Amplitude, Fifth Decade	4
Voltage Amplitude, Sixth Decade	4
Frequency Range	3
Frequency Overrange Bit	1
Frequency, Most Significant Decade	4
Frequency, Second Decade	4
Frequency, Third Decade	4
Frequency, Fourth Decade	4
Remote Sense, Local/Remote, Phase Lock, Standby/Operate	4
TOTAL COMMAND BITS	52

5200A GROUP SERIAL FORMAT

4 BITS Data and 4 BITS Address

5200A CONTROL BITS		5200A RESPONSE BITS	
Group Address	4	Standby Status Flag	1
Address Strobe	1	5200A Current Limit Flag	1
Parallel Load Strobe	1	Ready/Not Ready Flag	1
		Remote Status Flag	1

REMOTE CONTROL UNIT OPTION CARD-EDGE CONNECTOR PIN ASSIGNMENTS

PIN NO.	FUNCTION
1	LSB (1) of amplitude least significant digit
3	3SB (2)
5	2SB (4)
7	MSB (8)
9	LSB (1) fifth
11	3SB (2)
13	2SB (4)
15	MSB (8)
17	LSB (1) fourth
19	3SB (2)
21	2SB (4)
23	MSB (8)
25	LSB (1) third
27	3SB (2)
29	2SB (4)
31	MSB (8)
33	LSB (1) second
35	3SB (2)
37	2SB (4)
39	MSB (8)
41	LSB (1) most
43	3SB (2)
45	2SB (4)
47	MSB (8)
49	Amplitude overrange bit — provides 1.199999 on any range
51	not used

CARD-EDGE CONNECTOR PIN ASSIGNMENTS (con't)

PIN NO.	FUNCTION
53	frequency overrange bit — provides 1.1999 on any range
55	MSB (8) of frequency most significant digit
57	2SB (4)
59	3SB (2)
61	LSB (1)
63	MSB (8) second
65	2SB (4) of frequency second significant digit
67	3SB (2)
69	LSB (1)
71	MSB (8) of frequency third significant digit
73	2SB (4)
75	3SB (2)
77	LSB (1)
79	MSB (8) least
81	2SB (4)
83	3SB (2)
85	LSB (1)
2	not used
4	
6	
8	
10	
12	remote control flag — logic 1 indicates remote mode available
14	ready/$\overline{\text{ready}}$ flag — logic 1 indicates 5200A not yet settled
16	+5V common
18	overload flag — logic 1 indicates the 5200A (or 5205A) output is overloaded
20	5205A operate flag — logic 1 indicates operate mode (0 = standby)
22	5200A operate flag — logic 1 indicates operate mode (0 = standby)
24	+5V dc
26	not used
28	
30	
32	
34	MSB (8) of group address — permits serial entry of remote control data
36	2SB (4)
38	3SB (2)
40	LSB (1)
42	Address strobe — enters data group selected by group address
44	Parallel address — causes parallel entry of remote control data
46	not used
48	
50	
52	
54	MSB (4) of amplitude range — refer to Table 6-1
56	2SB (2)
58	LSB (1)
60	LSB (1) frequency — refer to Table 6-2
62	2SB (2)
64	MSB (4)
66	not used
68	
70	
72	
74	
76	
78	
80	remote sense command — logic 1 = 5200A in external sense, 0 = internal sense
82	remote control command — logic 1 = 5200A in remote control, 0 = local
84	phase lock command — logic 1 = 5200A in phase lock mode
86	operate command — logic 1 = 5200A operate mode, logic 0 = standby
NOTE	MSB = Most significant bit LSB = Least significant bit

PRICE

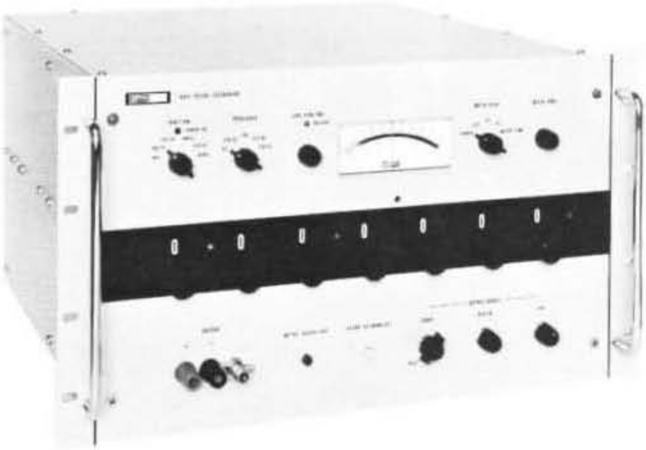
Model 5200A AC Calibrator	$4195
Option –01, Remote Control Logic . . . . (supplied with mating connector, standard address matrix card and blank address matrix card)	995
Option –02, 50 Hz to 400 Hz Input Power . .	500
Option –03, Logic Level Inversion . . . . . (requires Option –01)	$50

ACCESSORIES

M07-205-600 Rack Mounting Bracket	$25
M00-280-610 Chasis Slides for 24" Cabinets . .	50
5200A - 7015K Extender Board	25

760A

METER CALIBRATOR



FEATURES

Calibrates DC, AC, Volts, Amps, Ohms
Displays Percent-Error Directly
Simple, Rapid Operation
Calibrates digital and long scale multimeters.
Calibrates Panel Meters, Relays, Many Other Components
Full Set of Environmental Specifications
Within Specifications for One Year Minimum
Excellent Amplitude Stability

ACCURACY (% of setting)@ STD. REF. CONDITIONS	
DC Volts (1 mv - 1000v)	±(0.05% + 25 microvolts)*
DC Current (1 ua - 10A)	±(0.1% + 0.01 microampere)
AC Volts (1 mv - 1000V)	±(0.2% + 25 microvolts)*
AC Current (1ua - 10A)	±(0.25% + 0.025 microampere)
Ohms (1 ohm - 10 Meg)	±(0.1% ± 0.5 ohm)
* except ±0.33% at 1, 3, and 10 millivolts STD. REF. CONDITIONS: 20 - 30°C, less than 50% R.H.	

The classic meter calibrator has been obsoleted by the new Fluke Model 760A. This all-solid-state instrument eliminates cumbersome, time-consuming techniques by offering direct percent-error readout, a single range for each function (AC, DC, volts, amps, ohms) compact size, a minimum of controls and indicators, and a full complement of interlocks and safety features. Old-style calibrators were usually nothing more than hand-marked long-scale meters across an appropriate power source. The instrument undergoing calibration was also placed across the power source, and the two meter readings were compared. Error was computed, usually with the assistance of a correction table to gain adequate accuracy. Contrastingly, the 760A operates by adjusting the output for a cardinal point on the meter under test, then reading error directly on ±10%, ±3%, or ±1% (equal 10 db step) ranges. Accuracy figures for the 760A are percent of setting so that they apply over the entire voltage or current range, not just at several discrete full-range points.

With a 1000 volt capability (up to 20 ma), 10 ampere capability (to more than 1V compliance), and a 10 megohm rheostat in 1 ohm steps, the 760A can easily calibrate high-impedance VTVMs, medium-impedance VOMs, plus low-impedance electrodynamometer and iron-vane meters.

One of the most important parameters of the Model 760A is the unusually long re-calibration interval. The unit is guaranteed to remain within specifications for one year minimum. In addition the instrument is assigned a full set of environmental specifications which include simulated shipboard shock and vibration.

Many meter calibrators use the power line as an AC source, together with the usual distortion that can completely invalidate an AC calibration. Model 760A includes a stable, low-distortion (typically less than 0.1% third harmonic) oscillator that is selectable for either 60 Hz or 400 Hz. Four-hundred hertz is in the mid-band of virtually all AC voltmeters and also matches the power frequency of aircraft-missile systems and ancillary equipment. Sixty hertz is useful for calibrating instruments that respond to power-line frequency only, or are otherwise severely limited in response.

For safety the 760A is interlocked so that the output is zero when changing to a different function or frequency. In addition a red warning lamp indicates when a 100V potential is exceeded at the output posts.

As with other Fluke instruments, flow-soldered glass-epoxy boards are used to the maximum extent, and all critical accuracy- and stability-determining components are of Fluke manufacture or special processing.

760A SPECIFICATIONS

CALIBRATOR FOR DC VOLTMETERS

RANGE: 0.001V to 1000V.

ACCURACY: ±(0.1% of setting +25 uv) from 0.001V to 1000V except 0.33% at 1 mv, 3 mv, 10 mv.*

RESOLUTION: 100 uv.

CURRENT CAPABILITY: 0 to 20 ma except 0.5 ohm minimum load resistance. Currents to 800 ma at certain settings. Details upon request.

RIPPLE AND NOISE (RMS): Less than 0.5% of output or 150 uv.

CALIBRATOR FOR DC AMMETERS

RANGE: 1 ua to 10A.

ACCURACY: ±(0.25% of setting +0.025 ua).*

RESOLUTION: 1 ua.

VOLTAGE CAPABILITY: 0 to 1V minimum (5V open circuit).

RIPPLE AND NOISE (RMS): Less than 0.5% of output or 0.05 ua.

CALIBRATOR FOR AC VOLTMETERS

RANGE: 0.001V to 1000V.

FREQUENCY: 60 Hz and 400 Hz.

ACCURACY: ±(0.25% of setting +25 uv) from 0.001V to 1000V except 0.33% at 1 mv, 3 mv, 10 mv.*

RESOLUTION: 100 uv.

CURRENT CAPABILITY: 0 to 20 ma except 0.5 ohm minimum load resistance. Currents to 900 ma at certain settings. Details upon request.

HARMONIC DISTORTION: Less than 0.5% of output.

NOISE: Less than 0.1% of output or 30 uv.

CALIBRATOR FOR AC AMMETERS

RANGE: 1 ua to 10A.

FREQUENCY: 60 Hz and 400 Hz.

ACCURACY: ±(0.25% of setting +0.025 ua).

RESOLUTION: 1 ua.

VOLTAGE CAPABILITY: 0 to 1V minimum (5V open circuit).

HARMONIC DISTORTION: Less than 0.5% of output.

NOISE: Less than 0.1% of output or 0.02 ua.

CALIBRATOR FOR OHMMETERS

RANGE: 0 to 10 megohms.

ACCURACY: ±(0.1% of setting +0.5 ohm).

RESOLUTION: 1 ohm.

POWER DISSIPATION: Up to 0.25 watt and 35°C.

GENERAL

ERROR INDICATION (% of setting):

10-0-10	(0.2%/scale division)
3-0-3	(0.1%/scale division)
1-0-1	(0.02%/scale division)

SEARCH INDICATION: 0 to 100% of setting (accuracy ±3% of end-scale).

OUTPUT CONTROLS: Coarse switch, medium and fine verniers (resolution better than 0.02% of setting).

OUTPUT TERMINALS: Multipurpose binding posts on 3/4 inch centers for (+), (-), and chassis.

AC FREQUENCY ACCURACY: ±1% for 400 Hz; phase-locked to power line for 50 Hz and 60 Hz (remains locked for ±1% frequency variations, manually adjustable to cover 48 to 52 and 55 to 65 Hz).

REFERENCE: Aged, temperature-compensated zener diode.

CALIBRATION STABILITY: Within performance specifications for 12 months with no internal adjustments. Improved specifications require more frequent calibration intervals.

SAFETY FEATURES: Front panel lamp indicates when output voltage is greater than 100V. Output terminals are de-energized and indicator lamp is lighted if unit is overloaded or if COARSE output control is not at minimum when FUNCTION or FREQUENCY setting is changed. Setting COARSE output control to minimum (RESET) restores operation.

TEMPERATURE:
- Operating, 0°C to +50°C. Improved specifications apply from 20°C to 30°C.
- Non-operating, -62°C to +75°C.

HUMIDITY: Up to 85% and 35°C. Improved specifications apply up to 50% RH.

SHOCK: Meets MIL-T-945A and MIL-S-901C (grade B).

VIBRATION: Meets MIL-STD-167.

LINE REGULATION: 0.05% of setting for a 10% line change from nominal; less than 0.1% of setting for a 1% line frequency change at 60 Hz.

INPUT POWER: 115/230 VAC ±10%, single-phase, 50 Hz ±2 Hz and 60 Hz ±5 Hz, approximately 200 watts full load, 40 watts no load.

MOUNTING: Standard EIA rack mounting with chassis slides (not supplied) or bench mounted on nylon feet.

SIZE: 19" wide by 10-1/2" high by 18 inches deep behind panel.

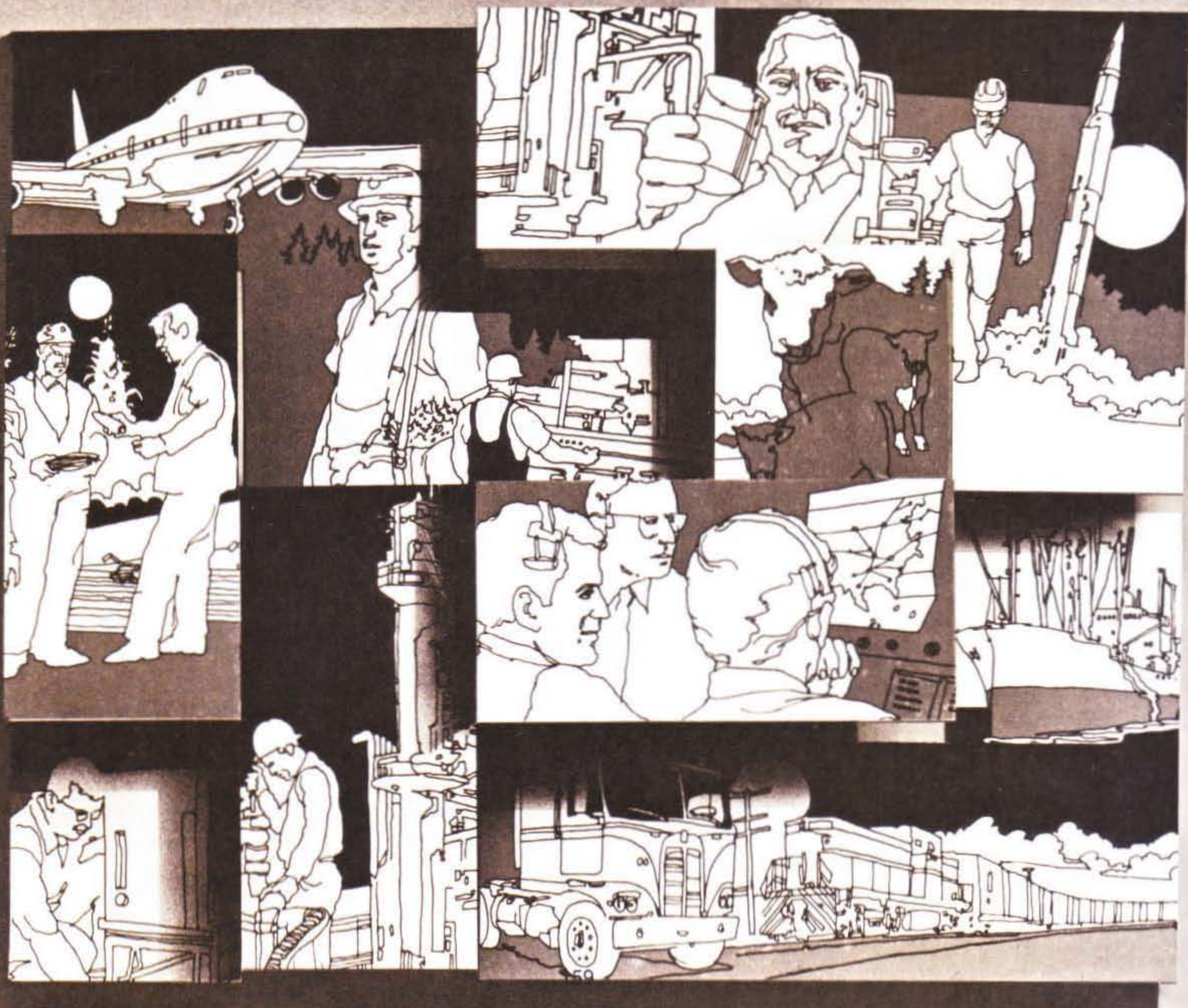
WEIGHT: Approximately 77 pounds.

PRICE: $2,995.00 f. o. b. factory, Mountlake Terrace, Washington

* These accuracies apply over environmental extremes. See table on reverse side for improved specifications over normal environmental ranges.

section 6

ac and dc standards



Philosophy of DC Systems

DC standards laboratories depend primarily on two basic standards, the standard resistor and the standard cell. These two standards require reference to the fundamental units of voltage and resistance as maintained by National or International Standards Laboratories. If this is done at regular intervals traceability has been achieved, which means that the fundamental unit has been transported to the user's facility. When the fundamental unit is available in the standards lab, it must then be multiplied by means of voltage and resistance ratio measurements. It is important that traceability be achieved for ali levels with sufficient accuracy; in other words, the error contribution of multiplying should be kept as low as possible.

Voltage ratios are usually obtained by a resistive divider. Resistive divider ratios may be established to a high accuracy without knowing the ohmic value of the resistors. It is not necessary to have traceability of ratio measurements to any national standardization laboratory because ratios are dimensionless quantities. What has to be done is to compare one fraction of the voltage in a divider to another one and to determine the difference; this can be performed without absolute resistance standards.

DC System Requirements

Following are some essential requirements for a DC voltage measuring and generating calibration system:

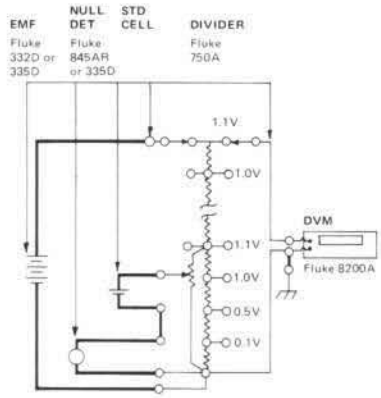
A resistive ratio device and a means to establish a ratio resolution and accuracy of at least 0.1 ppm.

A voltage ratio device with its output directly traceable to the legal unit of E.M.F.

There are a number of ways to make up a DC calibration system using ratio devices. Equipment choice must be made on the basis of cost versus performance, existing instruments and system accuracy requirements. Because differential and digital voltmeters with accuracies of 50 and 25 ppm are commonly used in production and quality control areas, the calibration system must have an accuracy of at least $\pm$ 10 ppm with respect to the unit of E.M.F. as maintained at the user's facility. Figure 1 shows a complete system designed to calibrate digital voltmeters.

The Model 332B Voltage Calibrator was chosen as the voltage source because of its extremely good stability (10 ppm/month), low noise and ripple (less than 40 μv at max. output), and high resolution (0.1 ppm). In fact, the Model 332B is a calibrator which will deliver any desired voltage up to 1111 volts with an accuracy of 20 ppm/6 months. The 845AR is a high sensitivity null detector with a 1 microvolt full scale range, an overload capability of 1100 volts on any range with a typical recovery time of 4 seconds and a ten megohms input impedance. Couples with this are the features of leakage resistance of 10^{12} ohms, capability for being floated to 1100 volts above ground and use as an isolation amplifier.

Fig. 1 DVM Calibration System



Other applications of this system include use as a

Power Supply Calibrator: accuracy 5-7 ppm (accuracy of standard cell not included)

Differential Voltmeter: accuracy 5-8 ppm (100 volts and below)

Ratio Calibrators: absolute linearity: 0.1 ppm of input

Power Standard cell

DC Transfer Standards

In most standards laboratories, a bank or several banks of saturated standard cells provide traceability to the standard volt. The **Fluke** Model 731B DC Transfer Standard was designed to give the calibration facility and standards lab a working standard for production testing. Standard cells are extremely sensitive, especially to shock, vibration and temperature change. The Model 731B can be hand-carried and subjected to severe environmental conditions and still provide transfer accuracies to a few ppm traceable to the delicate saturated cells.

AC Standards

Thermal transfer instruments may be used to accurately measure an unknown ac voltage or current by determining the difference between it and a preset accurately measured dc equivalent. **Fluke's** Model 540B Thermal Transfer Standard provides this capability when used with a set of A40 Current Shunts or A55 Voltage Thermal Converters. Thermal transfers for voltage measurement may be conducted at frequencies from 5 Hz to 50 MHz and for current measurement from 5 Hz to 100 KHz.

Fluke's AC Reference Standard, the Model 510A, is a precision fixed frequency ac voltage source suited to calibration or test applications. Outputs of 10V rms and 10 mA rms at frequencies from 50 Hz to 100 kHz are available.

540B CURRENT TRANSFER ACCESSORIES

Models A40

Model C41

Model A40A

Part No. 212852 & Part No. 212860

Models A40 and A40A Current Shunts are designed to convert the Model 540B Thermal Transfer Standard to an RMS current measuring device over a 2.5 milliampere to 20 ampere range, with a frequency response from 5 Hz to 100 kHz. The A40 shunts covering the range of 10 milliamperes to 5 amperes plug into panel connectors on the 540B, and electrically shunt the heater of the thermal converter. The A40A shunts (10 amperes and 20 amperes) are connected to the panel connectors of the 540B by a special cable.

Thus, the nominal heater current rating of 5 ma is maintained at the nominal shunt rating. In the same manner as the 540B voltage ranges, each shunt is useful from ½ to 1 times its nominal rating. With no shunt in place, the 5 ma heater rating of the 540B thermal converter allows current transfers from 2.5 ma to 5 ma.

Internal construction of the shunts includes straight-wire, bifilar-wound ribbon, and folded-ribbon resistive elements, depending on shunt size. The resistive elements are in good thermal contact with the shunt case, which in the larger shunts is an efficient finned-aluminum extrusion.

All AC/DC differences expressed in the specifications are deviations from theoretical standards maintained by the National Bureau of Standards, and may be obtained without the use of calibration curves or correction tables.

SPECIFICATIONS

SHUNTS

CURRENT RATINGS: 10, 20, 30, 50, 100, 200, 300, and 500 milliamperes; 1, 2, 3, 5, 10 and 20 amperes. NOTE: Each shunt may be used from ½ to 1 times nominal rating.

OVERALL CURRENT RANGE: 2.5 milliamperes to 20 amperes. (5 ma nominal rating of 540B thermal converter heater allows current transfers from 2.5 ma to 5 ma without shunts.)

ACCURACY: (% of input):

SHUNT	FREQUENCY	AC/DC DIFFERENCE
10 ma - 5A	5Hz - 20 kHz	±0.02%
	20 kHz - 50 kHz	±0.03%
	50 kHz - 100 kHz	±0.05%
10A - 20A	5 Hz - 20 kHz	±0.03%
	20 kHz - 50 kHz	±0.05%

CALIBRATION: Each shunt when used in conjunction with a 540B is within the above deviations from zero error as defined by reference standards maintained by the John Fluke Standards Laboratory and periodically calibrated by the National Bureau of Standards. These ac/dc difference figures do not include the National Bureau of Standards random and systematic error uncertainties. John Fluke or NBS test reports to the nearest 0.01% are available at extra cost. Fluke test fee schedule is available upon request.

PRICE:

A40 Shunts	
10, 20, 30 ma	$100.00 each
50, 100, 200, 300, 500 ma	$100.00 each
1, 2, 3, 5 amps	$100.00 each
A40A Shunts	
10, 20 amps	$100.00 each

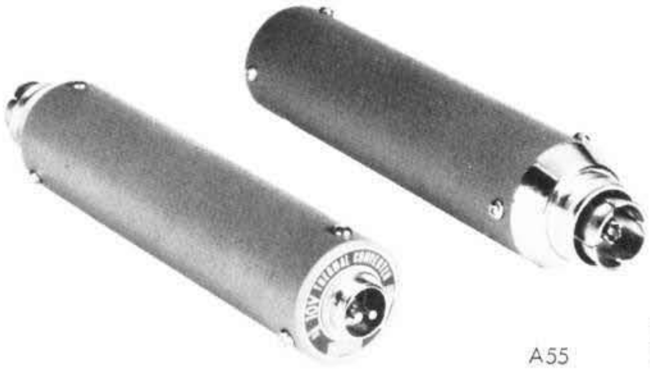
CASE

Model C41 case (illustrated) manufactured of ABS plastic with polyurethane foam cushion is available for transporting and storing a complete set of A40 and A40A shunts. Price $75.00.

CABLES

Part No. 212860 (24 in. long). One required to connect A40A (10 and 20 amp) shunt to front panel connector. Price $20.00 RF input cable to A40A shunt, Part No. 212852 $15.00.

THERMAL CONVERTERS



A55

C55 CASE

FEATURES

Frequency Range 5 Hz - 50 MHz

Excellent Thermal Characteristics

Rugged Construction

Compact Design

APPLICATIONS

Laboratory standard

Laboratory calibration of AC voltage sources and precise measurement of unknown AC voltages

Production line testing and calibration of AC voltmeters, voltage sources and AC/DC transfer standards

Model A55 Thermal Converters make possible extremely accurate thermal-transfer AC measurements from subaudio frequencies to the VHF region. The design of the A55 series is comparable to that of standards maintained by the National Bureau of Standards.

A specially constructed thermocouple, selected for frequency characteristics and low DC reversal error, is the thermally responsive element of the A55 series. AC and DC input voltage are applied directly across the thermocouple heater on the 0.5 volt model. For higher voltages, low temperature coefficient metal-film resistors provide the proper division ratio.

The thermocouple, range resistors, and compensation components are compactly mounted on a printed circuit board, with good thermal isolation and mechanical rigidity.

A55 converters can be used with the Model 540B Thermal Transfer Standard. The 540B contains an internal transfer circuit, high-resolution electronic galvanometer, reference supply, and search circuit; by itself it may be used over a frequency range from 5 Hz to 1 MHz. By connecting the A55 converter output to the jack provided, the internal transfer circuit of the 540B is bypassed so that only the null detector and reference supply are used.

Each A55 has a useful range from 1/2 to 1 times the rating of the converter, with the specified AC/DC difference applicable over this range.

To store the A55 converters and accessories, a Model C55 container with a molded polyurethane foam cushion insert is available. The C55 is designed to accommodate a complete set of nine converters and accessories.

A55 SPECIFICATIONS

RANGE: 0.5, 1, 2, 3, 5, 10, 20, 30, and 50 volts. (NOTE: Each converter may be used from 1/2 to 1 times voltage rating).

ACCURACY OF CALIBRATION AND CERTIFICATION (% OF INPUT):

1 MHz - ±0.05%
10 MHz - ±0.10%
20 MHz - ±0.15%
30 MHz - ±0.20%
50 MHz - ±0.50%

Each converter is furnished (at no charge) with a John Fluke production test record listing the AC/DC difference characteristic at the above frequencies to the nearest ±0.01%, except at 50 MHz for the 20, 30, and 50 volt converters. The AC/DC difference is established by comparison to John Fluke standards that are periodically intercompared to the standards of NBS.

Typical AC/DC differences are less than ±0.01% below 1 MHz, ±0.01% at 1 MHz, ±0.02% at 20 MHz, ±0.1% at 30 MHz, and ±0.3% at 50 MHz. (All calibration is referenced to center of 874-TL coaxial tee attached to converter input connector.)

John Fluke test reports to the nearest ±0.01% at varying frequencies and voltages are available at extra cost. A test fee schedule will be immediately forwarded upon request. For NBS test reports, price/delivery and other information should be requested directly from NBS.

INPUT IMPEDANCE: Approximately 200 ohms/volt.

OUTPUT VOLTAGE: 7 millivolts nominal at rated input.

OUTPUT RESISTANCE: 8 ohms nominal.

REVERSAL ERROR: Less than 0.025%.

INPUT CONNECTOR: GR type 874-L.

OUTPUT CONNECTOR: Amphenol 80-PC2M 2-pin, microphone type.

SIZE AND WEIGHT:

Converter	Diameter	Length	Weight
0.5V	1-3/8"	3-5/16"	10 oz.
1V, 2V	1-3/8"	5-3/16"	13 oz.
3V, 5V	1-3/8"	6-1/2"	15 oz.
10V, 20V			
30V, 50V	1-3/8"	7-1/16"	1 lb.

PRICE: 0.5V - $195.00 ea.
1V, 2V, 3V, or 5V - $195.00 ea.
10V, 20V, 30V, or 50V - $195.00 ea.

Model C55 storage case $75.00 All prices f.o.b. factory, Mountlake Terrace, Washington

OPTIONAL ACCESSORY KIT:
Model A55-110 Accessory Kit is recommended for use with Model A55 Thermal Converters in virtually any calibration or measurement setup. The kit includes:

1) Coaxial Tee for A55 Input (GR Type 874-TL).
2) Three Coaxial Adapters for A55 Input (GR Type 874 to UHF, BNC, and Type N jacks).
3) Interconnecting coaxial cable, AC source to coaxial tee.

KIT PRICE: $75.00

510A

AC REFERENCE STANDARD

Features

- OUTPUT VOLTAGE: 10 volts RMS
- ACCURACY: ±0.01% for 30 days
  ±0.02% for 90 days
- OUTPUT CURRENT:
  10 mA RMS, Short Circuit Protected
- FIXED FREQUENCY OUTPUT:
  50 Hz to 100 kHz
- TOTAL HARMONIC DISTORTION:
  Less than 0.005% to 50 kHz
- SHORT TERM STABILITY:
  20 ppm pk-pk
- DC CALIBRATION
- BATTERY OPERATION

DESCRIPTION

The Fluke 510A is a precision ac voltage source which can be used as a calibration standard or as a fixed frequency source for test applications. In the calibration laboratory, the 510A provides an accurate reference for calibrating both True rms and Average reading ac voltmeters. On the production line, the 510A can be used to rapidly verify ac test instrumentation or to generate a precise ac stimulus for circuit testing.

The output of the 510A is both fixed frequency and fixed amplitude. The frequency may be varied ±1% of center frequency by a front panel screwdriver adjustment. Frequency resolution is ±0.05 per cent. No external adjustments are provided for amplitude control. Variable amplitude levels may be obtained by using ratio transformers or other voltage divider techniques.

The outstanding accuracy and stability of the 510A is achieved by comparing the peak amplitude of each cycle of the ac signal to a dc reference amplifier with precisely known characteristics. AC amplitude errors are fed back as correction signals to the oscillator amplifier circuits to maintain constant amplitude. Calibration of the 510A Reference Standard is accomplished by calibrating the dc reference amplifier and internal resistor divider networks; a procedure easily implemented with standard laboratory instruments.

Total harmonic distortion is less than 50 ppm up to 50kHz, and 150 ppm at 100 kHz, thus assuring a pure output sine wave that can be used to calibrate average, peak, or true rms reading ac to dc converters.

An optional rechargeable battery pack provides up to 16 hours of operation without ac line power. A front panel meter provides a continuous display of battery condition. Whenever the 510A is being operated from an ac line, the battery is maintained at the appropriate charge level and will continue to operate the Reference Standard should ac power failure occur.

The 510A is fully protected from overloads and short circuits. When the load current exceeds the 10 ma output capability, the UNCAL lamp on the front panel illuminates.

Up to four 510A Reference Standards may be bolted together for mounting in a standard EIA 19 inch rack assembly. Output terminals are provided on both the front and rear panels so that the units may be easily connected in either bench or system configurations.

SPECIFICATIONS

OUTPUT VOLTAGE . . . . 10V rms

OUTPUT CURRENT . . . . 10 mA rms, short circuit protected

SINGLE FIXED FREQUENCY OUTPUT . . . . Any single fixed frequency from 50 Hz to 100 kHz. Standard frequencies are: 50; 60; 400; 1,000; 2,400; 5,000; 19,200 and 100,000 Hertz.

AMPLITUDE ACCURACY USING AC CALIBRATION	24 Hours	30 Days	90 Days
50 Hz – 20 kHz	±0.01%	±0.015%	±0.02%
20 kHz – 50 kHz	±0.015%	±0.025%	±0.035%
50 kHz – 100 kHz	±0.04%	±0.05%	±0.06%

Above accuracy applies after 10 minutes warmup, operating temperature of 23 ±2°C, and includes worst case deviations of the output caused by line, load, stability, and noise conditions. Assumes calibration against an AC-DC transfer standard with an AC-DC difference of 50 ppm from 50 Hz to 50 kHz and 300 ppm from 50 kHz to 100 kHz.

SPECIFICATIONS

AMPLITUDE ACCURACY USING DC CALIBRATION	Using a DC reference accurate to ±15 ppm and standard laboratory equipment, the 510A may be calibrated to achieve the following accuracies at standard operating temperatures of 23 ±2°C, and worst case deviations caused by line, load, stability and noise conditions.		
	30 Days		90 Days
50 Hz – 5 kHz	±0.01%		±0.02%
5 kHz – 10 kHz	±0.02%		±0.03%
10 kHz – 30 kHz	±0.05%		±0.07%
30 kHz – 100 kHz	±0.15%		±0.17%
AMPLITUDE STABILITY	24 Hours	30 Days	90 Days
50 Hz – 20 kHz	±0.002%	±0.005%	±0.01%
20 kHz – 100 kHz	±0.004%	±0.01%	±0.02%

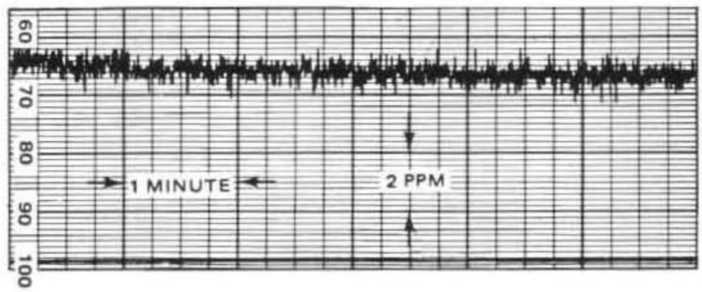


Figure 1-1. TYPICAL SHORT TERM STABILITY

AMPLITUDE NOISE: Amplitude deviation due to noise is less than 20 ppm peak-to-peak through a 1 Hz bandwidth over a 1 minute interval.

AMPLITUDE TEMPERATURE COEFFICIENT	15° – 50°C	0° – 15°C
50 Hz – 5 kHz	5 ppm/°C	12 ppm/°C
5 kHz – 10 kHz	7 ppm/°C	15 ppm/°C
10 kHz – 30 kHz	10 ppm/°C	17 ppm/°C
30 kHz – 100 kHz	15 ppm/°C	22 ppm/°C

TOTAL HARMONIC DISTORTION: (See total harmonic distortion chart in Figure 1-2.)

CENTER FREQUENCY ACCURACY: ±0.1%

FREQUENCY RESOLUTION: ±0.05% using front panel vernier

FREQUENCY VERNIER: Screwdriver adjustment, ±1% of center frequency

FREQUENCY STABILITY: 500 ppm per month

FREQUENCY TEMPERATURE COEFFICIENT: Less than 150 ppm/°C

COMMON MODE REJECTION: Greater than 100 db for common mode signals from 1 Hz to 500 Hz, 10V peak-to-peak maximum.

Common Mode Rejection is defined as the affect on the rms or average value of the 10V rms output due to a common mode signal between the low terminal and chassis. This rejection is:

Greater than 70 db for common mode signals from 500 Hz to 1 MHz, 3V peak-to-peak maximum.

Maximum allowable dc potential between output low and chassis ground is 100 volts.

LOAD REGULATION: (See load regulation chart in Figure 1-3.)

SPECIFICATIONS

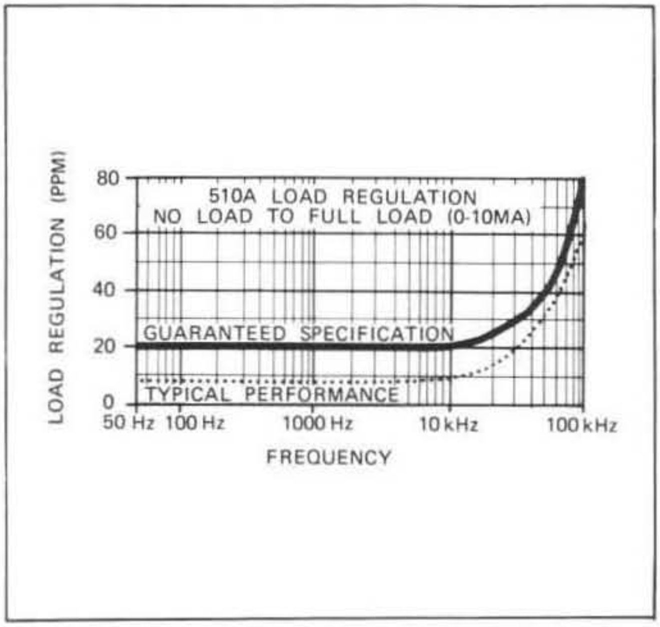


Figure 1-2. TOTAL HARMONIC DISTORTION

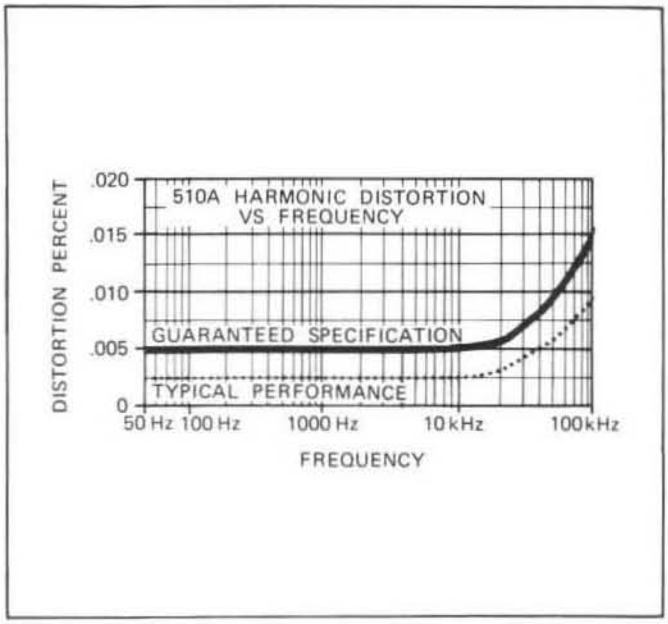
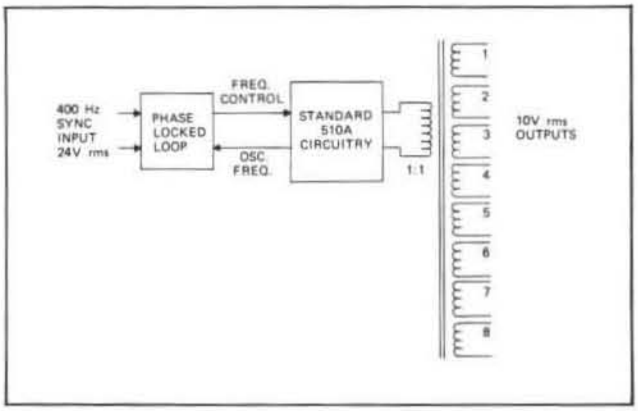


Figure 1-3. LOAD REGULATION

LINE REGULATION	< 10 ppm, ±10% line change
OUTPUT CONNECTIONS	High, Low and Chassis binding posts on front and rear panels.
UNCALIBRATED INDICATION	Front panel display labeled "UNCAL" indicates when load exceeds 10 mA.
ENVIRONMENTAL	
Operating Temperature Range	0°C to 50°C
Storage Temperature	–40°C to +75°C; –40°C to +60°C with batteries
Humidity Range	Up to 80% relative humidity, 0°C to 35°C Up to 70% relative humidity, 35°C to 50°C
Shock	20g, 11 millisec half-sine wave
Vibration	4.5g, 10 Hz – 55 Hz
Altitude	0 to 10,000 feet – Operating 50,000 feet – Non-Operating
INPUT POWER . . . . 115/230V ac ±10%, 50 – 500 Hz, Single Phase	An optional rechargeable battery pack will power the AC Reference Standard for 16 hours. The battery pack is field installable.
SIZE	3–1/2" high x 4–1/4" wide x 12" deep (8.8 x 10.7 x 30.4 CM) (2.26 kg)
MOUNTING	Up to four 510A's can be mounted side by side and installed in a standard 19" EIA rack with optional accessory ears.

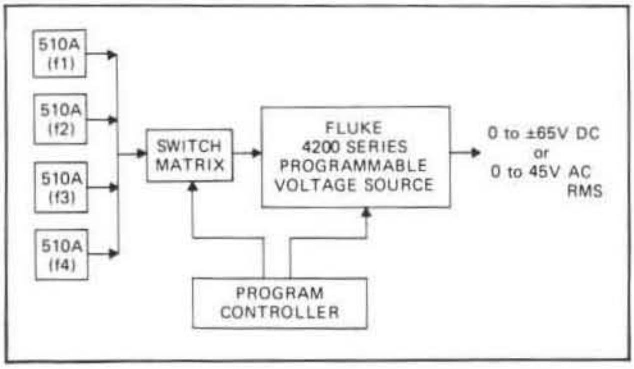
APPLICATIONS



PHASE LOCKED AC REFERENCE STANDARD

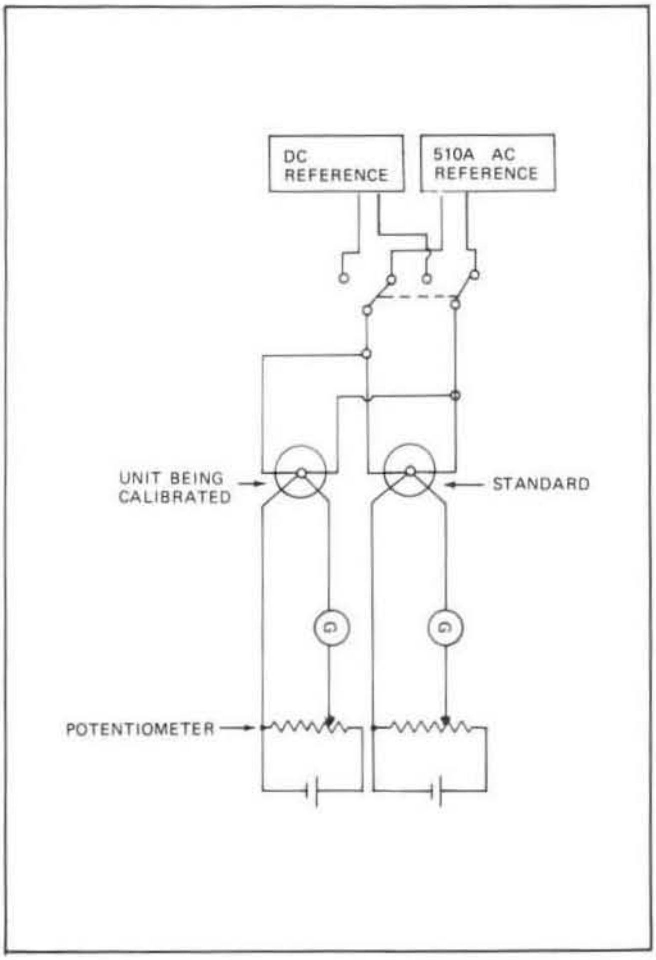
For accurate frequency synchronization and multiple outputs, a standard 510A can be modified to phase lock to an external signal source. The block diagram above shows the Model 510A/AA, designed to synchronize with an external 400 Hz signal and provide eight transformer coupled outputs. Programmable phase reversal at each of the eight outputs is also provided. Typical specifications for the 510A/AA are as follows:

Frequency:	400 Hz ±5% (other frequencies can be specified)
Output Voltage:	10V rms (eight outputs, transformer coupled)
Output Accuracy:	±0.1%
Output Phase Relationship:	0° ±1° or 180° ±1° (programmable)
Total Harmonic Distortion:	0.2%
Phase Lock Capture Range:	±5% about center frequency
Sync Input Voltage: Voltage:	24V rms



PRECISION AC SOURCE FOR AUTOMATIC TEST SYSTEMS

The Model 510A may be used as a reference standard for self calibration and verification of the ac measuring components within an automatic test system. When used as an external reference for any of the Fluke 4200 Series programmable voltage sources, precise ac voltages from 0 to 45 volts rms and current levels up to 0.7 amps rms can be supplied to the unit under test. Overall system accuracies of ±0.02% can be achieved for frequencies up to 5 kHz. Send for the 4200 Series data sheets or contact your Fluke representative for further information.



THERMAL CONVERTER CALIBRATION

The excellent short term stability of the Model 510A allows easy comparison and calibration of ac/dc thermal converters without the need of complex bridge comparators. With the 510A and a stable dc source, the above schematic approach may be used to achieve high sensitivity at the galvanometer for fast and accurate thermal converter calibration.

ORDERING INFORMATION: The 510A can provide only one fixed frequency. Eight standard frequencies are identified by option numbers −02 through −09. Any other single frequency can be provided on special order for an additional charge of $50. The 510A with the rechargeable battery pack is identified as 510A-01. When ordering battery pack separately for field installation, suffix the −01 with a "K," e.g. 510A-01K.

To order a standard frequency with no battery pack, specify the model and option, e.g. "510A-04, 400 Hz AC Reference Standard." To order a standard frequency with the battery pack option, drop the leading zero on the frequency option number and suffix the second number to the −01, e.g. "510A-014" identifies a 400 Hz frequency model with rechargeable battery pack. A special frequency should be identified with specific nomenclature, e.g. "Model 510A (or 510A-01 if a battery is required) with a special frequency of 24.8 kHz."

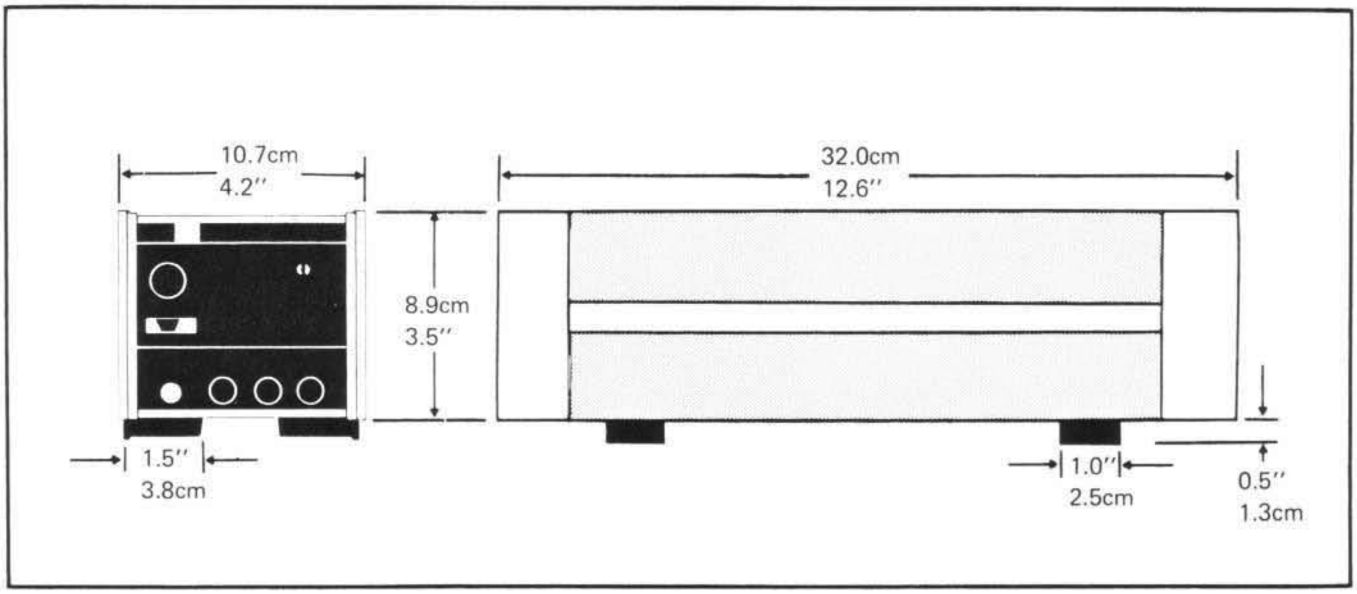
PRICE:

510A	AC Reference Standard	$565.00
510A−01	AC Reference Standard with Rechargeable Battery Pack . .	$680.00
Option −01K	Field Installable Battery Pack Kit	$ 100.00

One of the following standard frequency options are provided at no charge. Special frequencies may be ordered for an additional charge of $ 50.00.

Option −02	50 Hz	Option −06	2,400 Hz
Option −03	60 Hz	Option −07	5,000 Hz
Option −04	400 Hz	Option −08	19,200 Hz
Option −05	1,000 Hz	Option −09	100,000 Hz

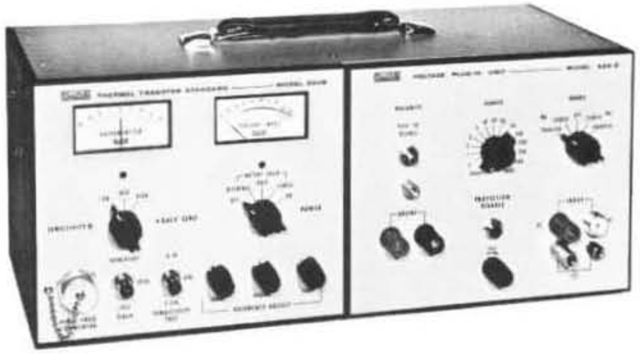
Rack Mounting Accessory Kit for one 510A; M03-201-601 . . . . $ 40.00
Rack Mounting Accessory Kit for two 510A's; M03-201-603 . . . . $ 40.00
Rack Mounting Accessory Kit for three 510A's; M03-206-604 . . . . $ 40.00
Rack Mounting Accessory Kit for four 510A's; M03-205-605 . . . . $ 40.00



OUTLINE DRAWING

540B

TRANSFER STANDARD



FEATURES

0.01% AC/DC transfer Accuracy

Thermocouple Overvoltage Protection

Frequency Range 5 cps - 1 MC

All solid-state including Fluke Galvanometer

Less than 0.01% DC Reversal

Single configuration for rack or bench mounting

Polarity Reversal Switch

Protection Disable Switch

APPLICATIONS

Laboratory Standard

Laboratory calibration and measurement of AC voltage and current sources

Field, portable and production line AC calibration and measurement

Fluke Model 540B is a thermal transfer type instrument for precise measurement and calibration of AC voltage and current, incorporating design features for rapid, simple operation and positive protection from severe overloads. Voltage capability of Model 540B is 0.25V to 1000V RMS AC in 14 ranges, with a frequency range from 5 cps to 1 MC. Basic AC to DC transfer accuracy is ±0.01% without the use of calibration curves or correction tables.

The thermally responsive element of Model 540B is a specially constructed vacuum thermocouple, which is protected from overvoltage burnout by a unique solid-state trigger-relay circuit. Up to 1500V DC or RMS AC may be applied on any range without damage to the thermocouple or other components. On the 0.5V range, this represents an overload of 3000 times range. The pushbutton protection disable switch may be used to bypass the overvoltage protection circuit to ascertain that the effects of diode aging are not causing any consequential error.

Each input range of the 540B may be used to measure voltages from 1/2 to 1 times the range setting. Maximum galvanometer resolution varies between 0.0012% of input per scale division at 1 times range to 0.006% of input per scale division at 1/2 of range setting. Galvanometer used is the rugged all-solid-state Fluke Model 841B. Three galvanometer sensitivity ranges are provided. A momentary-contact, center-off toggle switch is also provided to display galvanometer deflection for both 0.1% and 0.01% of input voltage, at any setting of the galvanometer sensitivity switch.

Model 540B includes a solid-state search circuit with meter, for visual indication at all times of percent of rated range voltage. The search meter indicates when the overload circuit has operated, by deflecting up scale into a red "overload" area. After an overload condition, the instrument is returned to normal operation simply by setting the "mode" switch to the off position.

The basis of transfer comparison in the Model 540B is always 1 to 1; that is, AC and DC voltages are always placed across the same portion of transfer circuit. Thus, accuracy is independent of range division ratios.

DC reversal of the thermocouple is less than 0.01% of input voltage. For convenience, a "push-to-reverse" switch reverses polarity of DC input.

For precision AC current calibration and measurement, Fluke offers a series of Model A40 current shunts which plug in to front panel terminals of the 540B. Current range is 2.5 milliamperes to 20 amperes with 14 shunts.

Model 540B is equipped with a high frequency thermal converter input jack so that the galvanometer and Lindeck reference supply may be used with Fluke Model A55 Thermal Converters. Nine A55 converters cover a range from 0.25V to 50V, with a frequency response to 50 MC.

The 540B is equipped with resilient feet for bench mounting and portable use. Panel extensions with handles are available for rack mounting the instrument. Kit part number is 540B-103.

VOLTAGE RANGES: 0.5, 1, 2, 3, 5, 10, 20, 30, 50, 100, 200, 300, 500, and 1000V, with each range useful from 1/2 to 1 times rating.

ACCURACY:

Range	Frequency	AC/DC Difference
All except 1000V	5 cps - 50 KC	±0.01%
1000V	5 cps - 20 KC	±0.02%
1000V	20 KC - 50 KC	±0.04%
0.5 thru 50V	50 KC - 100 KC	±0.05%
20 thru 50V	100 KC - 500 KC	±0.10%
0.5 thru 10V	100 KC - 1MC	±0.1%
100 thru 500V	50 KC - 100 KC	±0.20%

CALIBRATION: Each range is adjusted to be within the above deviations from zero error as defined by reference standards maintained by the John Fluke Standards Laboratory and periodically calibrated by the National Bureau of Standards. These ac/dc difference figures do not include the National Bureau of Standards random and systematic error uncertainties. John Fluke or NBS test reports to the nearest 0.01% are available at extra cost. Fluke test fee schedule is available upon request.

SEARCH CIRCUIT: Solid-state circuit provides visual indication of input voltage as a percentage of range selected.

INPUT IMPEDANCE: 180 ohms/volt of input.

POLARITY: Reversible via front panel pushbutton switch.

GALVANOMETER: Fluke Model 841B solid-state electronic type.

GALVANOMETER RESOLUTION:
0.0012% of input/scale division at rated input.
0.006% of input/scale division at 1/2 rated input.

THERMOCOUPLE REVERSAL ERROR: Less than 0.01% of input at 100% of rated current or voltage. Less than 0.03% at 50% of rated current or voltage.

OVERLOAD PROTECTION: Up to 1500V DC or RMS AC may be applied to the instrument on any range without damage to any component.

ELECTRICAL DESIGN: All solid-state.

POWER: Self contained rechargeable nickel-cadmium cells for complete isolation from power system. 200 hours of operation on full charge; 16 hours charging time; 115/230 vac ±10%, 50 to 440 Hz, approximately 7 watts.

HIGH FREQUENCY THERMAL CONVERTERS: Nine John Fluke Model A55 High Frequency Thermal Converters are available for use with the Model 540B, extending the frequency response to 50 MC. One is provided for each voltage range of the 540B from 0.5 volts to 50 volts, and may be used from 1/2 to 1 times the rated voltage. Technical data for the A55 series will be furnished upon request.

CURRENT SHUNTS: Fourteen Fluke Model A40 Current Shunts are available for use with Model 540B, for current transfer measurements over a 2.5 ma to 20 amp range, frequency range 5 cps to 100 KC, with a basic transfer accuracy of ±0.03%. Technical data upon request.

SIZE: 7" high x 17" wide x 7-3/4" deep. (19" wide with 540B-103 rack mounting kit installed.)

PRICE: Model 540B (with rechargeable battery pack installed and including power cord) $1195.00

Model 540B-110 Rechargeable Battery Pack (for retrofitting earlier units) $150.00.

540B-103 Rack Mounting Kit, $15.00.

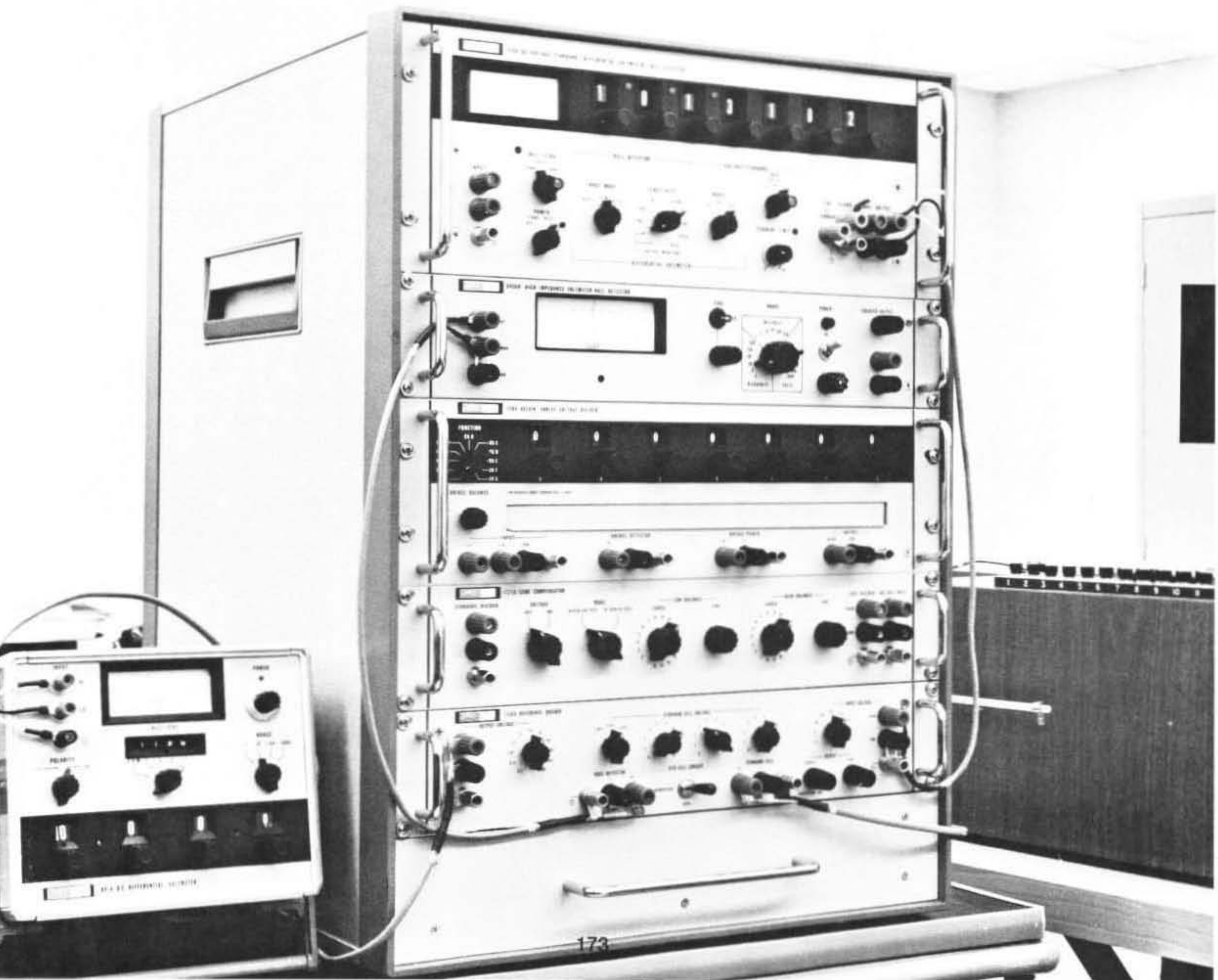
All prices f.o.b. factory, Mountlake Terrace, Wash.

Calibration Systems 7105A

(DC VOLTAGE & RATIO CALIBRATION SYSTEMS)

FEATURES:

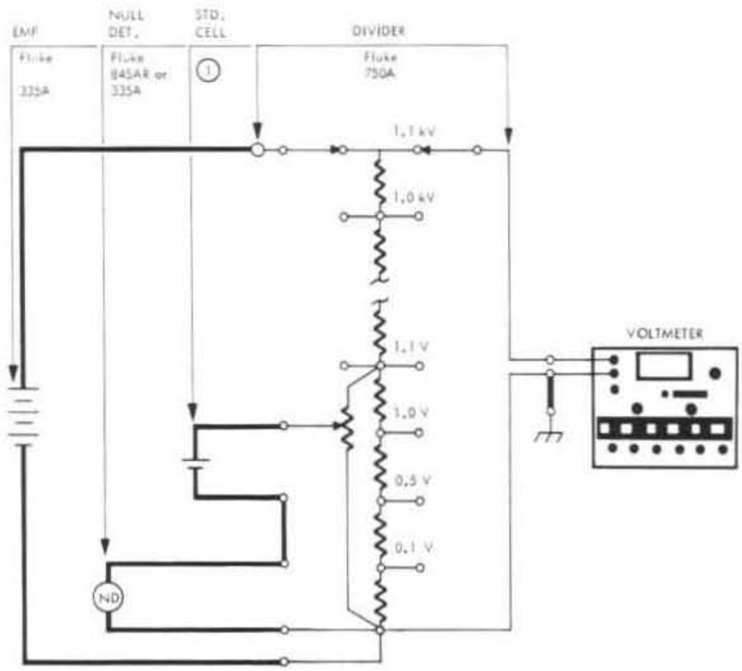
- 5 PPM Accuracy
- Traceable to NBS
- 0.1 PPM Resolution and Ratio Accuracy
- Self-Calibrating
- All System Instruments are Fluke Solid State
- Functional Enclosure for Self-Contained Operation



APPLICATION	7105A *	
Voltmeter Calibrator Power Supply Calibrator	5 ppm up to 100 v, 8 ppm up to 1.1 kv	
Differential Voltmeter	5 ppm to 100 v 20 ppm to 1.1 kv	
Ratio Calibrator	0.1 ppm of input	
Self–Calibrating System	yes	
Null Detector	19 Ranges, 1 uv to 1 kv in 1, 3, sequence (using 845 AR)	9 Ranges, 10 uv to 1 kv in 1, 10, sequence (using 335A)

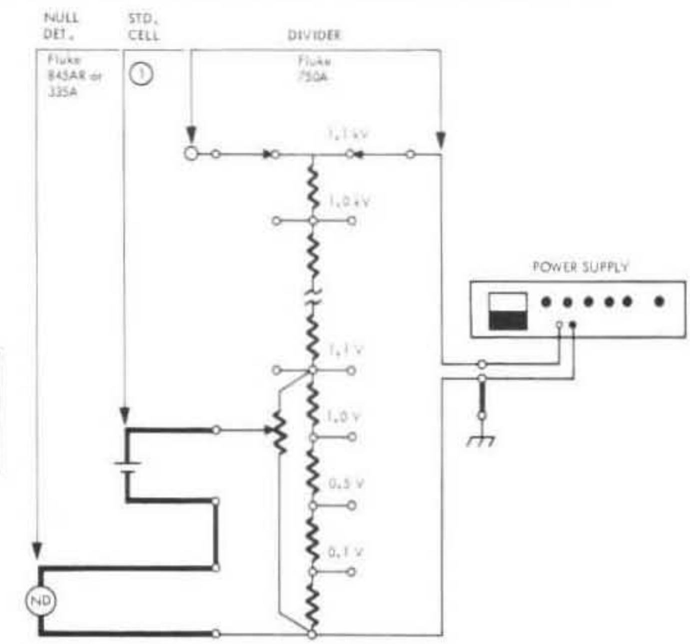
*Standard Cell not supplied

VOLTMETER CALIBRATOR



7105A	
RANGE	ACCURACY ② ④
1.1 kv	8 ppm
1.0 kv	8 ppm
500 v	6 ppm
100 v	5 ppm
50 v	5 ppm
10 v	5 ppm
1.1 v	5 ppm
1.0 v	5 ppm ③
0.5 v	6 ppm ③
0.1 v	8 ppm ③

POWER SUPPLY CALIBRATOR



7105A	
RANGE	ACCURACY ② ④
1.1 kv	7 ppm
1.0 kv	7 ppm
500 v	5 ppm
100 v	4 ppm
50 v	4 ppm
10 v	4 ppm
5 v	4 ppm
1.1 v	4 ppm

NOTES

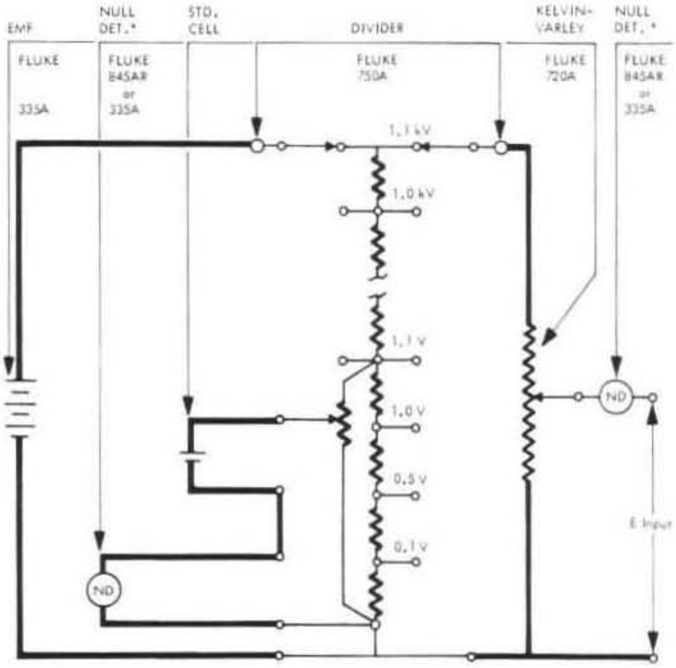
① Standard Cell not supplied.

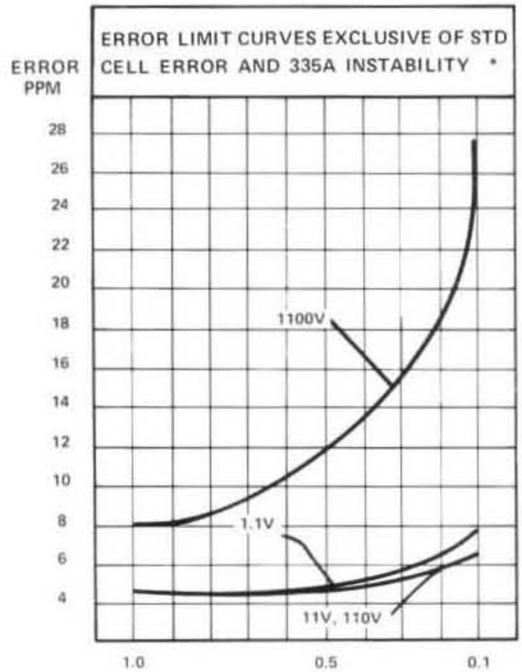
② Self-Calibration capability of system allows user to obtain stated accuracy at any time.

③ Plus loading error.

④ Standard Cell uncertainty not included.

DIFFERENTIAL VOLTMETER



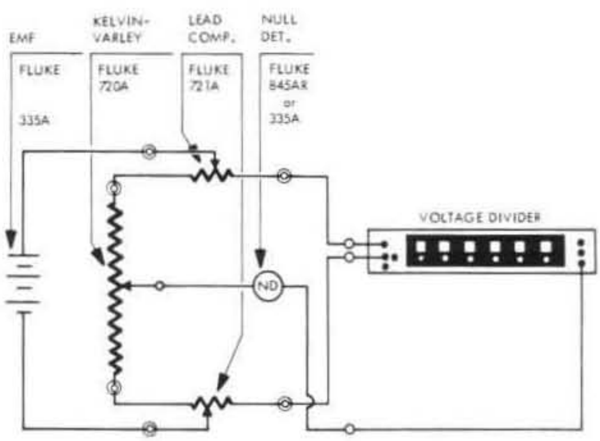


"S" SETTING OF 720A

*System 7105A has two Null Detectors to continuously monitor the 335A's EMF while measuring E input.

NOTE: The 335A may be used as a differential voltmeter, with accuracy of ±(20 ppm + 10 uv) on the 10 volt range, ±(20 ppm + 20 uv) on the 100 volt range, and ±(20 ppm + 40 uv) on the 1000 volt range.

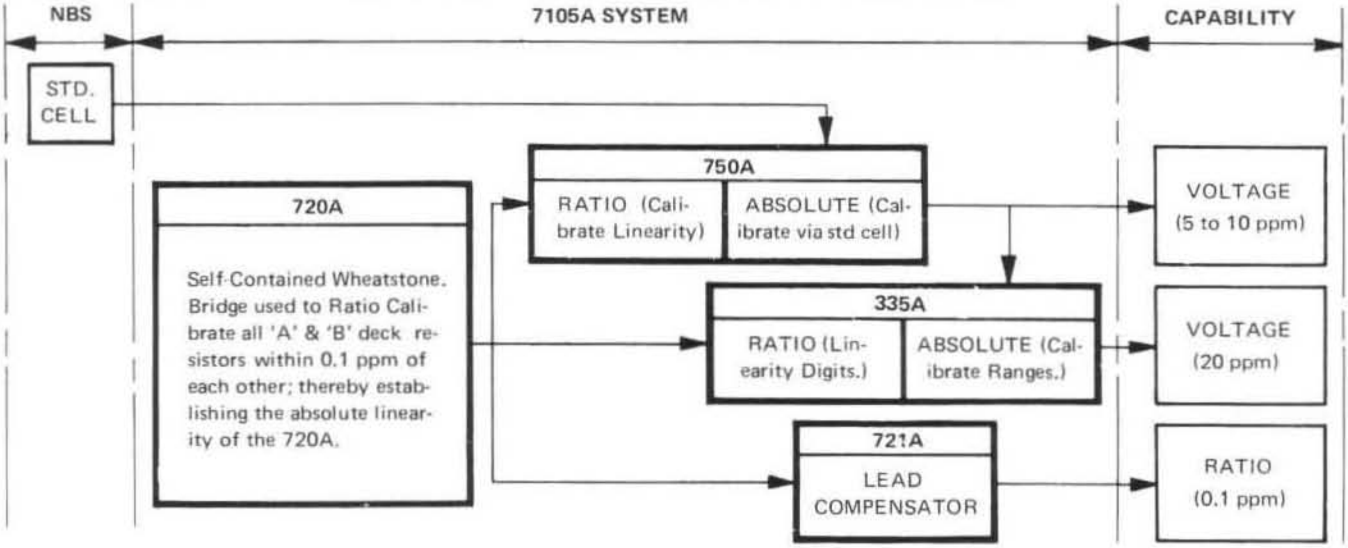
RATIO CALIBRATOR



SPECIFICATIONS: (720A S = 1.1 to 0.1)	
ABSOLUTE LINEARITY	0.1 ppm of input
RESOLUTION	0.1 ppm of input
INPUT TAPS	1.1 & 1.0
MAXIMUM INPUT VOLTS	1.1 kv & 1.0 kv
INPUT RESISTANCE	110 k & 100 k
POWER COEFFICIENT	0.2 ppm of input/watt
TEMP COEFFICIENT**	0.1 ppm of input/^{o}C
STABILITY**	1 ppm/year
MAXIMUM RATIO BETWEEN 720A AND TEST DIVIDER RESISTANCE USING 721A IS 4000: 1	

** Self-Calibration of 720A removes linearity deviations caused by time or temperature.

TRACEABILITY VIA SELF-CALIBRATION FEATURE



NULL DETECTOR

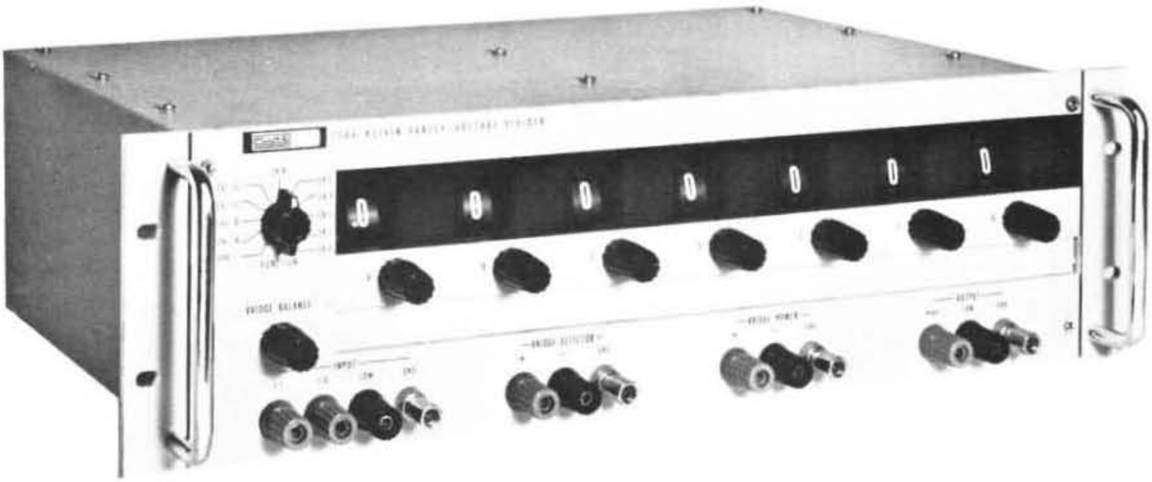
	7105A with 845AR and 335A NULL DETECTOR	
RANGES	(19) 1 uv to 1 kv in 1, 3 sequence	(9) 10 uv to 1 kv in 1, 10 sequence
RESOLUTION	0.2 uv maximum	0.5 uv maximum
INPUT RESISTANCE	10 megs up to 100 mv 100 megs up to 1 kv	1 meg up to 1 mv 10 megs up to 100 mv 100 megs up to 1 kv
ISOLATION	10^{12} ohms (input can be floated 1100 v)	
RECORDER	Isolated recorder output	

DESCRIPTION AND PRICE

	7105A
VOLTAGE SOURCE	335A
NULL DETECTOR	845AR & 335A
VOLTAGE DIVIDER	750A
KELVIN-VARLEY	720A
LEAD COMPENSATOR	721A
CABINET	Controlled heat-rise cabinet with lead storage drawer
ACCESSORIES	Test leads supplied
POWER	115/230 VAC ±10%, 50-440 Hz
ENVIRONMENT	23°C ±10°C, up to 70% RH
DIMENSIONS	29" High x 20" Wide x 23" Deep
WEIGHT (Approximate)	130 lbs
PRICE	7105A - \$7355 7105A–502 - \$575
NOTE: Standard Cell not supplied	

See appropriate FLUKE TECHNICAL DATA FILE for further information regarding Fluke instruments used in system.

KELVIN-VARLEY VOLTAGE DIVIDER



FEATURES

- ±0.1 ppm ABSOLUTE LINEARITY
- 0.1 ppm RESOLUTION
- SELF-CALIBRATION
- 1100-VOLT INPUT RATING
- 11-WATT INPUT POWER RATING

APPLICATIONS

Calibration of Ratio Devices, Bridge Elements, Voltage Dividers, and Precision Potentiometers.

SYSTEMS APPLICATIONS

Measurement of Absolute Voltage, Current, and Resistance.
Measurement of Relative Voltage, Current, and Resistance.
Standardization of Laboratory Instruments.

Model 720A is a primary ratio standard which meets the most exacting requirements of the standards laboratory. Absolute linearity of 0.1 ppm, temperature coefficient of linearity of 0.1 ppm/° C, and self-calibration make the 720A the most accurate instrument available for the comparison of primary and secondary voltage and resistance standards. The linearity has a small power derating coefficient of 0.2 ppm per watt which is achieved by matching the resistors' temperature coefficients close to zero. This permits operation at up to 1100 volts and 11 watts.

The remarkable convenience of direct ratio reading without reference to correction charts is the result of the unique self-calibration ability of the Model 720A which not only enables this instrument to achieve superior linearity but also permits it to be used over a wider temperature range without degradation of performance. For example, if the divider is removed from controlled environment at 25° C to a location at an ambient temperature of 35° C, it will perform to specifications without correction charts after completion of the self-calibration procedure, which requires about 20 minutes. An additional benefit is compensation for any linearity drift in the first two decades.

The self-calibration procedure consists of equalizing the resistance steps of each of the first two decades by adjusting variable resistors accessible from the front panel. A Wheatstone bridge and the necessary switching are incorporated in the Model 720A so that the only external test units required are a stable source of 10 volts and 20 volts DC and a sensitive null detector capable of resolving 0.5 microvolt such as the Fluke Model 845A. The procedure may easily be adapted to use batteries as the voltage source if a suitable DC power supply is not available.

The design and construction of the Model 720A are such that state-of-the-art linearity and stability are maintained without self-calibration. Fluke precision wirewound resistors used throughout the instrument are manufactured for high stability and low temperature coefficient. Each step of the first decade actually consists of four resistors carefully selected and matched for resistance value and near zero temperature coefficient by an exclusive Fluke process. In addition, the resistors making up each succeeding decade are selected and matched to produce a completely matched divider.

The great care taken in the construction and matching of resistive elements results in the excellent linearity specifications of the Model 720A shown graphically in Figures 1 through 4. Absolute linearity is ±0.1 ppm of input at dial settings above 0.1 as shown in Figure 1. The temperature coefficient of linearity shown in Figure 2 is ±0.1 ppm of input/° C for dial settings above 0.1. Figure 3 shows the power coefficient of linearity which is ±0.2 ppm of input/watt at dial settings above 0.1. Stability of absolute linearity for a period of one year following self-calibration is 0±1 ppm/year at dial settings above 0.1 as shown in Figure 4. All of these specifications improve at dial settings below 0.1 according to formulas given in Figures 1 through 4.

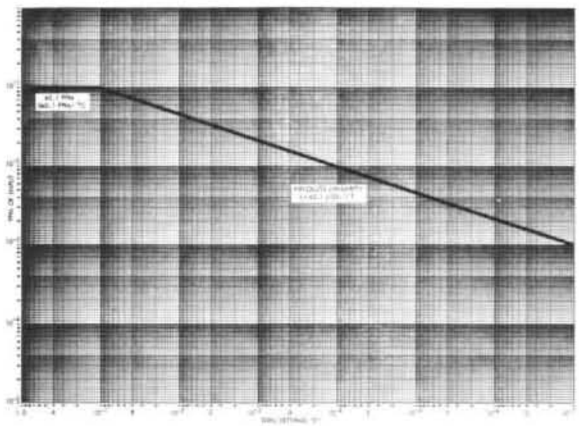


Figure 1. Absolute Linearity

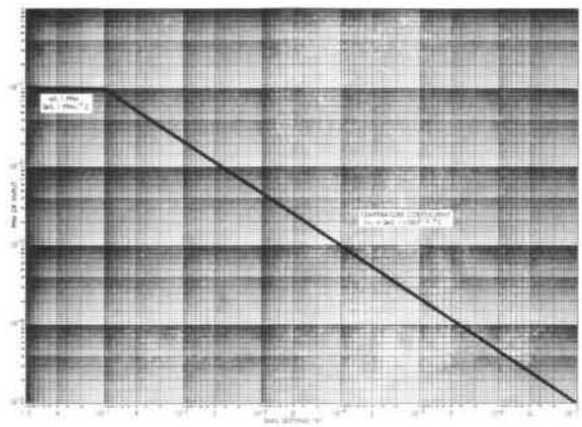


Figure 2. Temperature Coefficient

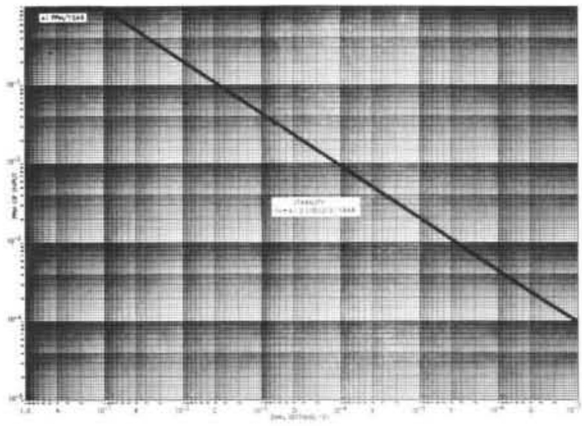


Figure 3. Stability

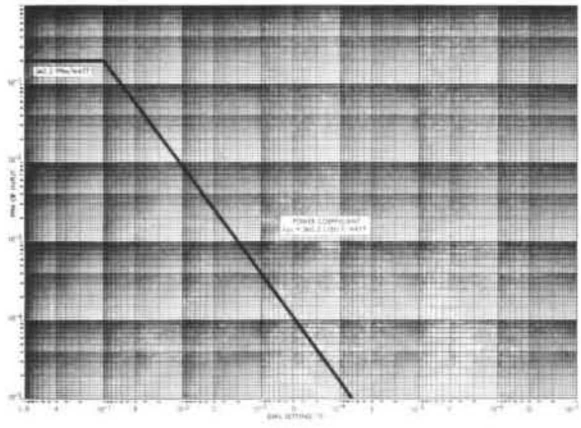


Figure 4. Power Coefficient

720A SPECIFICATIONS

RATIO RANGE: 0 to 1.0 (1.0 input tap) and 0 to 1.1 (1.1 input tap).

RESOLUTION: 0.1 ppm of input with 7 decades.

ABSOLUTE LINEARITY (at calibration temperature and without the use of a correction chart):*
±0.1 ppm of input at dial settings of 1.1 to 0.1.
±0.1 $(10S)^{1/3}$ of input at dial settings (S) of 0.1 to 0.

ABSOLUTE LINEARITY STABILITY (without self-calibration): ±1.0 ppm of input/year at dial settings of 1.1 to 0.1.
±1.0 $(10S)^{2/3}$ ppm of input/year at dial settings (S) of 0.1 to 0.
NOTE: The self-calibration procedure may be used at any time to reset absolute linearity to ±0.1 ppm of input.

TEMPERATURE COEFFICIENT OF LINEARITY: ±0.1 ppm of input/°C maximum at dial settings of 1.1 to 0.1.

SHORT-TERM LINEARITY STABILITY: Under typical conditions in a standards laboratory environment (temperature maintained within ±1°C) and with an applied voltage of up to 100 volts, stability of linearity is 0.1 ppm/30 days.

POWER COEFFICIENT OF LINEARITY: ±0.2 ppm of input/watt maximum at dial settings of 1.1 to 0.1.
±0.2 $(10S)^2$ ppm of input/watt maximum at dial settings (S) of 0.1 to 0.

MAXIMUM END ERRORS:
Zero error, at output low: 0.004 ppm of input.
Zero error, at input low: 0.05 ppm of input.
Full-scale error: 0.05 ppm of input.

THERMAL VOLTAGES: ±0.5 uv maximum.

MAXIMUM INPUT POWER:
10 watts on 1.0 input terminal.
11 watts on 1.1 input terminal.

MAXIMUM INPUT VOLTAGE:
1000 volts on 1.0 input terminal.
1100 volts on 1.1 input terminal.

BREAKDOWN VOLTAGE:
2000 volts to case at 10,000 feet.
2500 volts to case at sea level.

INPUT RESISTANCE: 100 kilohms ±0.005% at 1.0 input terminal at 25°C.
110 kilohms ±0.005% at 1.1 input terminal at 25°C.

TEMPERATURE COEFFICIENT OF INPUT RESISTANCE: ±1 ppm/°C maximum.

MAXIMUM OUTPUT RESISTANCE: 66 kilohms.

OPERATING TEMPERATURE RANGE: 0°C to 50°C (32°F to 122°F).
NOTE: When the Model 720A is used at temperatures below 15°C (59°F) or above 35°C (95°F), the range of the calibration adjustments may be exceeded and linearity must be derated 0.1 ppm/°C from the calibration temperature.

OPERATING HUMIDITY RANGE: Up to 70% relative humidity at 35°C (95°F) (no derating).
Up to 80% relative humidity at 35°C (95°F).
(0.1 ppm of input linearity derating) between 70% and 80% relative humidity.

STORAGE TEMPERATURE RANGE: -34°C to 70°C (-29°F to 158°F).

SHOCK: Meets requirements of MIL-T-945A and MIL-S-901B, rigidly mounted or rack mounted with slides.

VIBRATION: Meets requirements of MIL-T-945A, rigidly mounted or rack mounted with slides.

SIZE: 5-1/4" rack mounted. (14.0 x 48.2 x 33.0 cm)

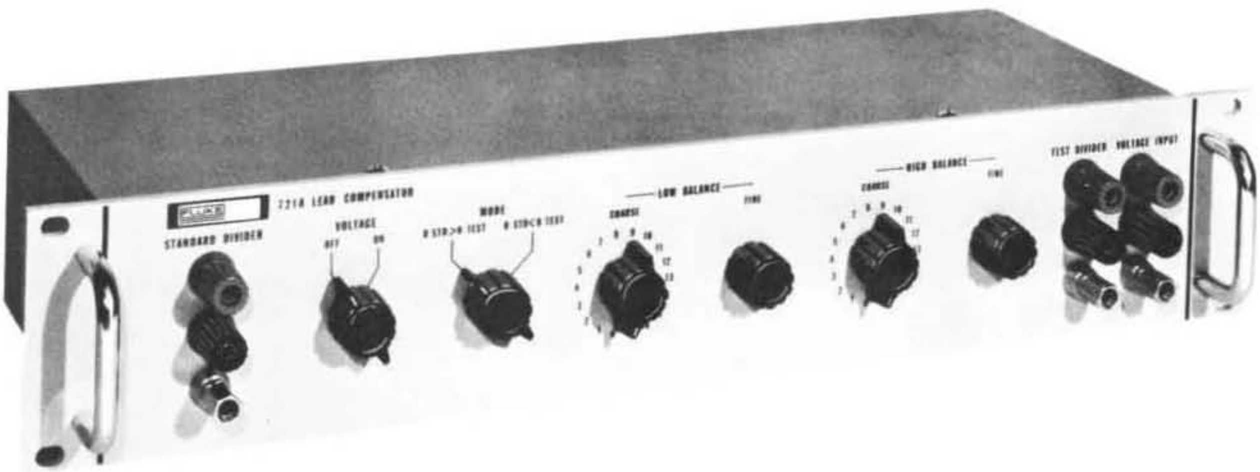
WEIGHT: 18 pounds. (8.16 kg)

PRICE: $1695.00
All prices f.o.b. factory, Mountlake Terrace, Wash.

* Absolute linearity is defined as the linearity between maximum and minimum output voltages.

FLUKE

LEAD COMPENSATOR



FEATURES

- 4000:1 Maximum Resistance Ratio
- Mode Switch Interchanges Divider Leads
- Voltage Switch Removes Power

The Model 721A Lead Compensator equalizes the voltage drop across two resistive dividers connected in parallel for calibration. Because there is almost always a difference between two dividers at their zero and full scale voltages, calculations must be made for each calibration point unless the effects of contact and lead resistance are eliminated from the measurement by compensation. Figure 1 is a diagram of a typical calibration set up. For accurate comparison, the proportion of total resistance between points A and B through the standard divider to the total resistance between points A and B through the unknown divider must be exactly the same as the proportion of standard divider resistance to unknown divider resistance. If this proportion is not maintained the comparison will be nonlinear.

The Model 721A is easy to use. First, the dividers and power supply are connected through the Model 721A as shown in Figure 1. Then, the dividers are dialed to zero and the null detector is connected between divider outputs and the low balance controls are adjusted to produce a null. Then, the dividers are dialed to full scale and the high balance controls are adjusted to produce a null. Finally, the dials are returned to zero and the low balance is rechecked. The dividers are now ready for comparison of absolute linearity; the lead resistance, contact resistance, and end resistance have been compensated.

Features which make the Model 721A exceptionally easy to use are: its design for divider ratios of up to 4000:1 which eliminates the need for external parallel resistors at high ratios, the mode switch which interchanges the divider terminals permitting the higher resistance divider to be connected to either set of terminals, and the voltage switch which removes the input voltage and grounds the wipers of the fine adjust potentiometers to permit balancing out thermal voltages in the measuring circuit.

SPECIFICATIONS

RESOLUTION OF RESISTANCE COMPENSATION: 0.1 milliohms.

MAXIMUM RATIO BETWEEN DIVIDER RESISTANCE: 4000:1.

MAXIMUM ALLOWABLE LEAD RESISTANCE: 150 milliohms.

MAXIMUM DIVIDER VOLTAGE: 1500 VDC.

FINE CONTROL: 10-turn 150 milliohm slide wire.

COARSE CONTROL: 18-position switch.

MODE SWITCH: Reverses divider terminals so that dividers may be connected without regard to which has the higher resistance.

BINDING POSTS: Gold plated copper.

OPERATING TEMPERATURE RANGE: 0° C to +50° C.

STORAGE TEMPERATURE RANGE: -40° C to +70° C.

RELATIVE HUMIDITY: 0 to 80%.

VIBRATION: Meets requirements of MIL-T-945A, rigidly mounted or rack-mounted with slides.

SHOCK: Meets requirements of MIL-T-945A, rigidly mounted or rack-mounted with slides.

ALTITUDE: 10,000 feet operating; 50,000 feet non-operating.

FUNGUS NUTRIENTS: None.

MERCURIC COMPONENTS: None.

VOLTAGE SWITCH: Removes input voltage and ground wipers of fine adjust potentiometers to allow null detector adjustment for balancing out thermal voltages in measuring circuit.

SIZE: 3-1/2" high x 19" wide x 6" deep.
(8.9 x 48.2 x 15.2 kg)
WEIGHT: 6 pounds (2.72 kg)

PRICE: $335.00, f.o.b. factory, Mountlake Terrace, Washington.

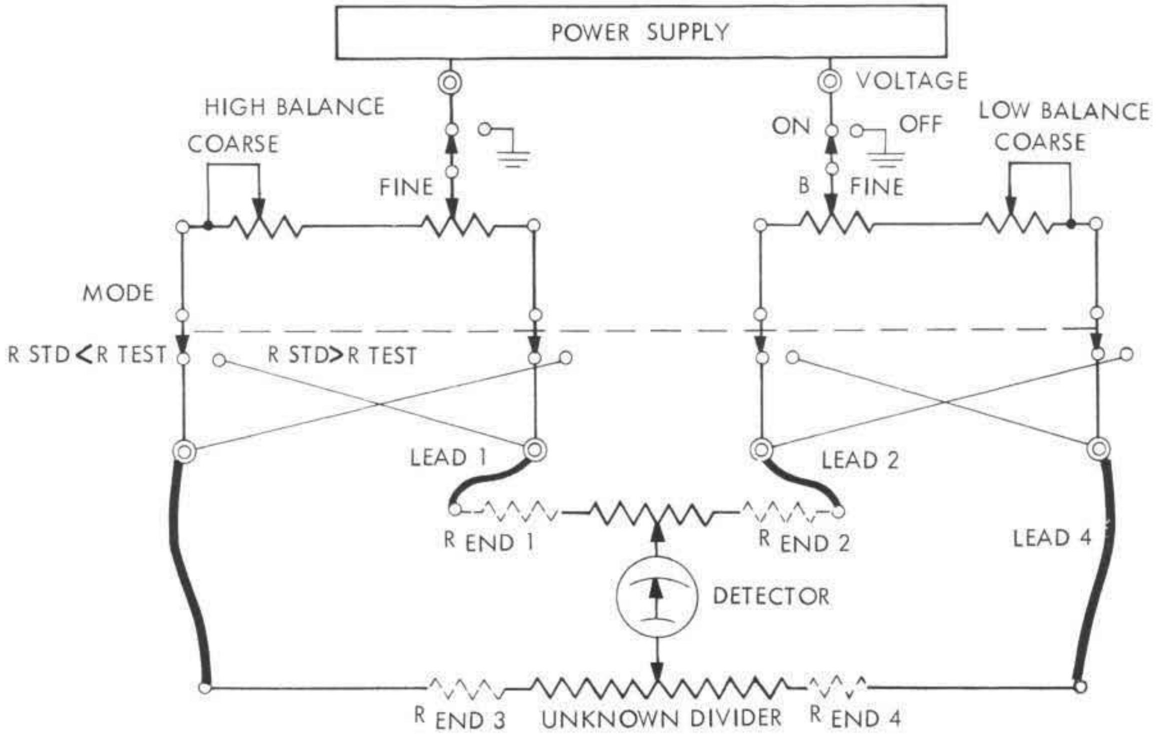


FIGURE 1. DIVIDER CALIBRATION SET-UP USING FLUKE MODEL 721A LEAD COMPENSATOR

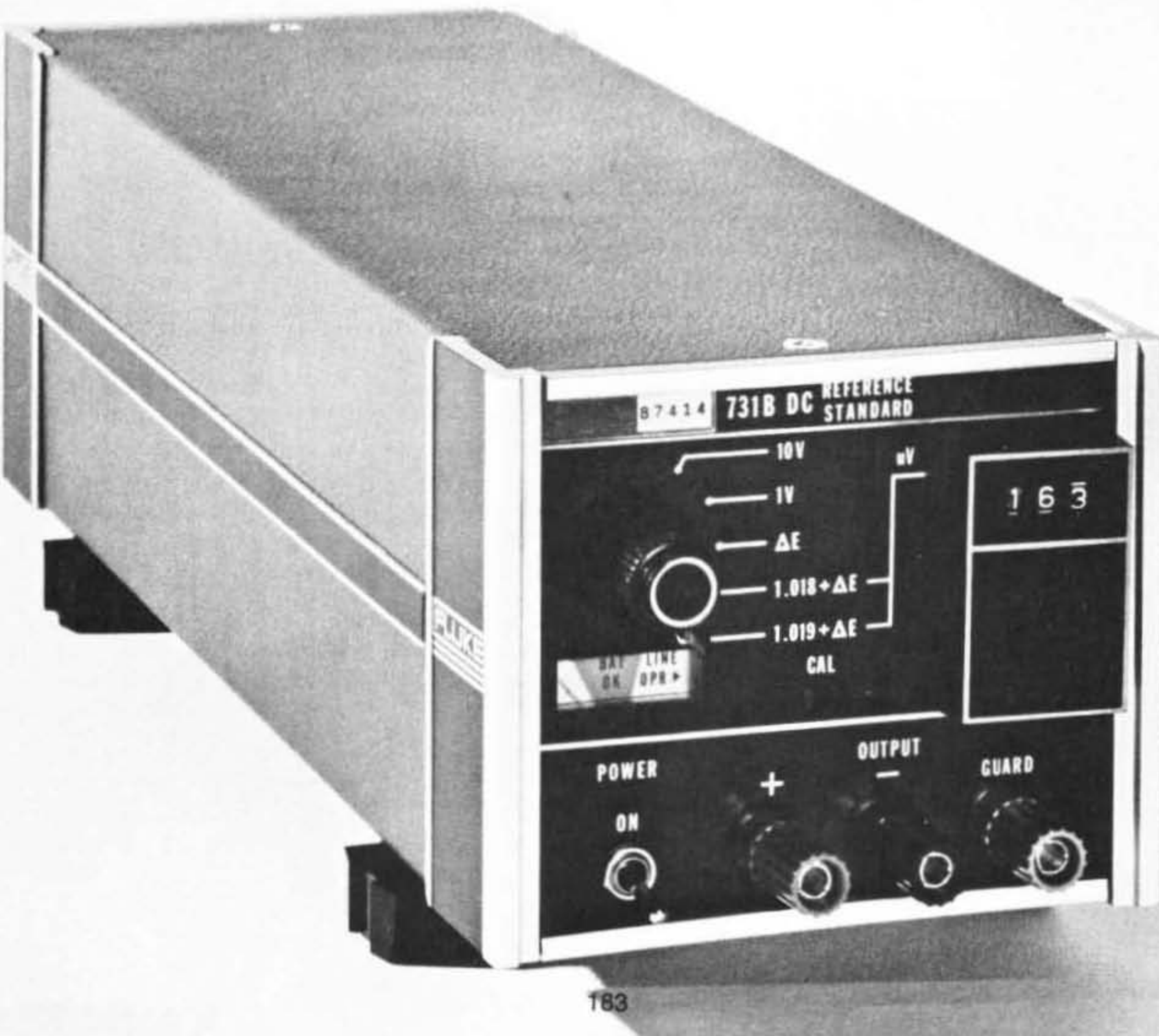
DC Reference Standard 731B

APPLICATIONS

- Standard Cell Substitution.
- Test Amplifier Gain and Stability
- Verify Calibration
- Long Term Stability Tests

FEATURES

- 2 PPM Transfer Accuracy
- 30 PPM Absolute Accuracy for 1 year
- Wide Temperature Operating Range
- Short Circuit Proof
- Line and Battery Operation



The Fluke Model 731B DC Reference Standard is a solid state versatile instrument providing standard cell accuracy, but utilizes the excellent performance capabilities of the latest solid state technology. The instrument furnishes a variety of precision voltages with switched output ranges including 1.0; 1.018 + ΔE; 1.019 + ΔE; 10.0; and ΔE volts. Delta E (ΔE) provides a variable output of 0 through 999 μV which is either added to the voltage of a standard cell transfer or may be used directly as a low level source stable dc voltage.

With its unexcelled stability, the DC Reference Standard provides absolute accuracy on any output of 30 ppm per year. Incorporating Fluke design experience with ref-amps and stable resistors, the Model 731B may be used as a portable standard cell or dc voltage reference standard in unusually demanding physical environmental conditions for applications which require state-of-the-art accuracy and stability.

The DC Reference Standard is operated from the line or internal rechargeable batteries which are included in the standard unit. Rack mounting in standard 19" EIA racks of 1, 2, 3, or 4 units side-by-side is available.

SPECIFICATIONS

Output Voltage:

Ranges
- 10.0
- 1.0
- 1.018+ ΔE
- 1.019+ ΔE
- ΔE (+0 to 999 μV with 1 μV resolution)

Output Accuracy: Absolute accuracy at 23°C ±1°C after 30 minute warm-up

Range	Period 30 days	90 days	1 Year
10V	±10 PPM	±15 PPM	±30 PPM
1V	±10 PPM	±15 PPM	±30 PPM
1.018+ΔE	±10 PPM	±15 PPM	±30 PPM
1.019+ΔE	±10 PPM	±15 PPM	±30 PPM
ΔE			± 2 uV

Transfer Accuracy:

	4 hr
Between standard cells on 1.018V + ΔE or 1.019V + ΔE ranges:	2 ppm
Between standard cell and 1V output:	3 ppm
Between 10V output and standard cell or 1V output:	5 ppm

Temperature Coefficient:

Less than 1 PPM/C°, 10°C to 45°C
Less than 2 PPM/C°, 0°C to 10°C and 45°C to 55°C

Output Current:

10 Volt Range:

The 10 volt range is used in applications where some degree of loading is placed on the Reference Transfer Standard such as a Kelvin Varley Divider or other resistance networks.

Loading Effect on the 10V Range:

Load R.	Output Change (PPM)
100 MΩ	0
10 MΩ	0.005 ≈ 0
1 MΩ	.05
0.1 MΩ	.5
10 KΩ	5

1V, 1.018V, 1.019V Ranges:

The Reference Transfer Standard is designed to perform as a standard cell and therefore is intended to operate into a high impedance on the 1V, 1.018V and 1.019V ranges drawing minute currents. This impedance is usually infinity as in potentiometric circuits, or , in other applications should be at least 100 Megohms to prevent source loading.

Source Resistance:

10V Range: <0.07Ω
1V, 1.018V, 1.019V, ΔE Ranges: <1 kΩ

Output Protection:

The output may be shorted indefinitely without damage to instrument.

Line Regulation:

Less than 1 PPM for ±10% line variation.

Ripple & Noise:

Less than 1 PPM P-P dc to 1 Hz
Less than 20 μV RMS 1 Hz to 1 MHz
Except <70 μV RMS @ 10V output

Common Mode Rejection:

120 db at DC
100 db at 60 Hz
85 db at 400 Hz

Isolation:

Output may be floated up to 500 VDC between chassis ground and guard.

Calibration Adjustment:

Separate internal adjustments for the 5 output voltages. Front panel adjustment common to all voltages including the 10.000V output. Basic reference adjustments accessible from the front panel.

Temperature/Humidity:

+0°C to +55°C operating.
−40°C to +60°C non-operating.
Up to 70% RH for temperatures ≤35°C

Shock & Vibration:

Meets requirements of MIL-T-21200L

Terminals:

Three five-way binding posts for positive, negative and guard. All terminals are solid copper with gold flash.

Battery Operation:

Rechargeable nickel-cadmium batteries provide at least 30 hours of continuous operation.

Input Power:

115V or 230V ±10 VAC, 50 to 400 Hz single phase or internal battery operation.
6 watts maximum, 120 Ma maximum

Size:

3½" high x 4¼" wide x 12" deep. (8.8 x 10.7 x 30.4 cm)

Weight:

5 lbs. (2.26 kg)

Prices: Model 731B $495.00

Rack Mounting Kits:	No. of 731B's mtd.	Kit No.	Price
	one (single)	M03-201-601	$ 40.00
	two(side-by-side)	M03-201-603	$ 40.00
	three (side-by-side)	M03-206-604	$ 40.00
	four(side-by-side)	M03-205-605	$ 40.00

750A

FLUKE

REFERENCE DIVIDER

FEATURES

- ACCURACY ±0.001% OF OUTPUT
- SWITCHED INPUTS AND OUTPUTS
- OVERVOLTAGE PROTECTION TO 2 KV
- 3-1/2 INCH RACK HEIGHT
- STANDARD CELL REFERENCE OUTPUT
- CALIBRATION ADJUSTMENTS PROVIDED

Model 750A is an extremely accurate and stable reference voltage divider for calibration of precision DC voltmeters, volt boxes, DC calibrators, etc. The instrument is a 10 ppm (0.001%) divider with switched input taps ranging from 1100 volts to 1.1 volts and switched output taps ranging from 1100 volts to 0.1 volt. In addition, the unit has a separate output which covers the range of 1.017000 volts to 1.019999 volts in microvolt steps, so that the divider may be standardized directly to any known standard cell EMF.

The instrument incorporates a solid-state overvoltage protection circuit which prevents damage when voltages up to 2 KV are applied on any range. All precision resistors of the 750A are bobbin-type units of unique Fluke design and manufacture. Temperature coefficients of these resistors are controlled in the divider string to better than 1ppm/°C. Nominal divider current is 1 milliampere, and power dissipation per resistor is held to a low value.

Usability of the Model 750A is enhanced by the switching of input and output taps. Switching not only makes operation easier and faster but also eliminates the change in resistance when a lead is moved from one binding post to another as well as the potential hazard of moving the lead.

Although the 750A has excellent laboratory standard specifications, portable and field use applications are made possible through excellent electrical and mechanical design, including establishment of severe environmental parameters.

750A

SPECIFICATIONS

INPUT VOLTAGES (SWITCHED): 1.1, 5, 10, 50, 100, 500, 1000, 1100 VDC.

OUTPUT VOLTAGES (SWITCHED): 0.1, 0.5, 1, 1.1, 5, 10, 50, 100, 500, 1000, 1100 VDC.

STANDARDIZING OUTPUT: 1.017000 to 1.019999 VDC in 1 uv steps.

DIVISION RATIO ACCURACY AND STABILITY (Referenced to Standard Cell Tap): ±(0.001% of output +0.5 uv) for 1 year.

CALIBRATION: All ranges above 1.1 V are adjustable ±10 ppm.

CALIBRATION RESOLUTION: 0.2 ppm.

DIVIDER CURRENT: 1 ma nominal

INPUT CURRENT ADJUST: Coarse and fine front-panel rheostats provide an input voltage adjustment span of 10 mv with better than 1 uv resolution.

OVERVOLTAGE PROTECTION: Up to 2 KV may be applied on any range without damage.

OPERATING TEMPERATURE RANGE: 15° C to 35° C.

TEMPERATURE COEFFICIENT OF OUTPUT: ±1 ppm/° C over operating range.

INITIAL CALIBRATION TEMPERATURE: 23° C ±1° C.

STORAGE TEMPERATURE RANGE: -30° C to +70° C.

HUMIDITY: 0 to 70%

SHOCK: Meets 20g, 11 millisecond tests of MIL-E-4970A.

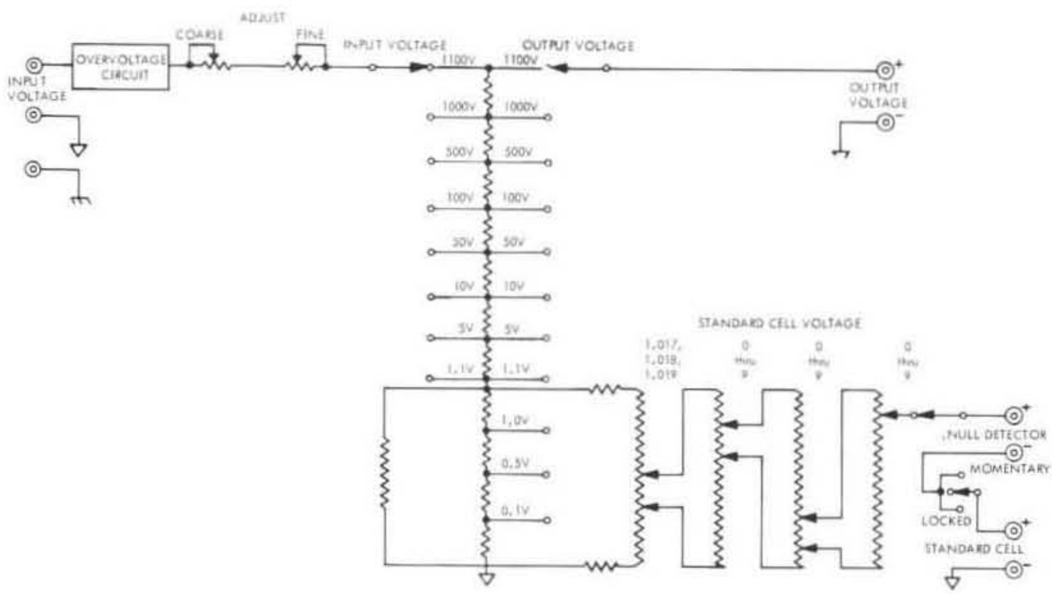
VIBRATION: Meets 10 cps - 55 cps tests of MIL-T-945A.

POWER: Two 6.75 V mercury batteries power overvoltage protection circuit. Recommended replacement interval is 1 year.

SIZE: 3-1/2" high x 19" wide x 13" behind panel. (8.8 x 48.2 x 33.0 cm)

WEIGHT: 16 pounds (7.25 kg)

PRICE: $1295.00 All prices are f.o.b. factory, Mountlake Terrace, Washington.



SIMPLIFIED SCHEMATIC DIAGRAM - MODEL 750A

845AB
845AR

HIGH IMPEDANCE VOLTMETER/NULL DETECTOR

845AB

845AR

FEATURES

- 100 M and 10 M Input Resistance
- 1 uv - 1000V End Scale Ranges
- Input Isolation 10^{12} Ohms
- Grounded Recorder Output
- Rechargeable Battery Operation (Model 845AB)

APPLICATIONS

- Standardization of Voltage Dividers
- Intercomparison of Standard Cells
- Ratio Measurements
- Voltage Measurements With A DC Calibrator
- General Purpose Transistorized Voltmeter
- Isolation Amplifier

Joining the line of Fluke all-solid-state null detectors are the Models 845AB and 845AR, designed for extremely high input impedance, sensitivity, and isolation. Model 845AB operates either from the line or from built-in rechargeable batteries; Model 845AR is a line-powered rack-mounting version, with 3-1/2 inch panel height. Both offer resistance of 10 megohms on ranges of 1 microvolt to 100 millivolts end-scale, and 100 megohms on ranges of 300 millivolts to 1000 volts end-scale. Source loading through leakage is virtually eliminated by input isolation of 10^{12} ohms regardless of power line, chassis ground, or guard connections.

Nineteen end-scale ranges from 1 microvolt to 1000 VDC with excellent accuracy make the instrument useful as a general purpose transistorized voltmeter. Recorder output provides ±1 VDC for end-scale deflection with ±0.5% linearity and does not affect input isolation. This enables use of the unit as a DC isolation amplifier with voltage gain up to 120 db depending on range switch setting. Rechargeable battery-powered Model 845AB may be completely isolated from the power line.

The 845 series are capable of being floated up to 1100 VDC from ground at either input terminal when used in a bridge circuit to compare voltage divider ratios. The unit will withstand overloads up to 1100 VDC on any range with a typical recovery time of 4 seconds.

Input voltages are applied through an input divider and filter circuit to a photo-chopper-stabilized amplifier. The input filter minimizes effects of source noise and provides a response time better than null detectors with input resistance an order of magnitude lower. The synchronously rectified output of the chopper-amplifier is further amplified in a direct-coupled amplifier before being applied to the meter and recorder output terminals. All circuitry is guarded including the power supply and recorder output which operate through guarded transformers of unique Fluke design and manufacture.

A 4-1/2 inch meter is incorporated in the 845 series for ease of readout. Meter is a taut-band type, eliminating stickiness inherent in jeweled movements. All controls and terminals including recorder output and recorder output gain control are located on the front panel.

The instrument is ruggedly constructed for shock and vibration resistance, with electrical components mounted on glass epoxy printed circuit boards. Development of the 845 series included thorough environmental testing, evaluation, and establishment of excellent specifications. The Model 845AB is 7 inches high, and half-rack width for side-by-side mounting with optional brackets. Model 845AR is designed for full-width mounting in a standard EIA 19-inch rack, with a compact 3-1/2 inch panel height.

RANGE: 1 uv through 1000 VDC end scale in nineteen ranges, using X1 and X3 progression.

INPUT RESISTANCE: 100 megohms on 300 mv range and above; 10 megohms on 100 mv range and below.

ACCURACY: Model 845AB
±(2% end scale +0.1 uv)
Model 845AR
±(3% end scale +0.1 uv)

MAXIMUM METER NOISE (Input Shorted):

Range	Noise (peak-peak)
1 uv	0.20 uv
3 uv	0.25 uv
10 uv - 1000V	0.30 uv

METER RESPONSE TIME: (to 90% of reading)

Range	Time
1 uv	5 sec.
3 uv	3 sec.
10 uv - 1000V	1-1/2 sec.

INPUT ISOLATION: Better than 10^{12} ohms at less than 50% relative humidity and 25° C regardless of line, chassis or recorder grounding. Better than 10^{10} ohms up to 80% relative humidity and 35° C. With driven guard, isolation improves by at least one order of magnitude up to 10^{13} ohms. Either input terminal can be floated 1100V off chassis ground.

DC COMMON MODE REJECTION: Better than 160 db, input short-circuited, 80% relative humidity; better than 140 db, open-circuited, 50% relative humidity; better than 120 db, open-circuited, 80% relative humidity.

AC COMMON MODE REJECTION: (below 100 kHz) 100 volts RMS or 120 db greater than end scale, whichever is less, will affect reading less than 2% of end scale. (Input open-circuited).

AC NORMAL MODE REJECTION: (60 Hz and above) Ac voltages 60 db above end scale will affect reading less than 2% of end scale. Maximum voltage not to exceed 750V RMS.

RECORDER OUTPUT: 0-1 volt, one side at chassis ground; linear to 0.5% of end scale. Source Impedance 5K to 7.5K. Response time is approximately half that of the meter; therefore, noise may exceed meter noise by 6 db.

OPERATING TEMPERATURE RANGE: Within all specifications from 15° C to 35° C. Within all specifications from 0° C to 50° C except for the following:

Maximum Noise - derate by a factor of 2

Meter Response Time (1 uv and 3 uv ranges) - derate by a factor of 2 below 15° C

Input Isolation - 10^9 ohms at 50° C and 80% relative humidity

DC Common Mode Rejection - derate by 20 db above 35° C

STORAGE TEMPERATURE RANGE: Model 845AR, -40° C to +70° C; Model 845AB, -40° C to +60° C.

STABILITY OF ZERO: Better than 0.15 uv/hr.; better than 0.3 uv/day.

TEMPERATURE COEFFICIENT OF ZERO: Less than 0.1 uv/° C from 15° C to 35° C. Less than 0.2 uv/° C from 0° C to 50° C.

ZERO CONTROL RANGE: ±5 uv minimum.

RELATIVE HUMIDITY: 0 to 80%.

SHOCK: Meets 400 lb. hammer blow tests of MIL-T-945A and MIL-S-901B.

VIBRATION: Meets 10 Hz - 55 Hz tests of MIL-T-945A.

OVERLOAD CAPABILITY: Up to 1100 VDC may be applied on any range. Typical recovery time is 4 seconds.

INPUT POWER: Model 845AR - 115/230 VAC ±10%, 50 - 440 Hz, approximately 3 watts. Model 845AB - rechargeable battery or 115/230 VAC ±10%, 50 - 440 Hz, approximately 6 watts during recharge (40 hours operation on full charge, batteries trickle-charged while instrument operates from power line).

MOUNTING (Model 845AB): Resilient feet provided for bench and portable use. For side-by-side EIA Rack Mounting of two units, add Adapter Kit 881A-103 (includes handle-brackets and key plate). For EIA Rack Mounting of a single unit, add Adapter Kit 881A-102 (includes brackets with handles).

MOUNTING (Model 845AR): Standard EIA relay rack. Resilient feet provided for bench use.

SIZE: Model 845AB - 7" high x 8-1/2" wide x 8" deep (19" wide in rack configurations). Model 845AR - 3-1/2" high x 19" wide x 8-1/4" behind panel.

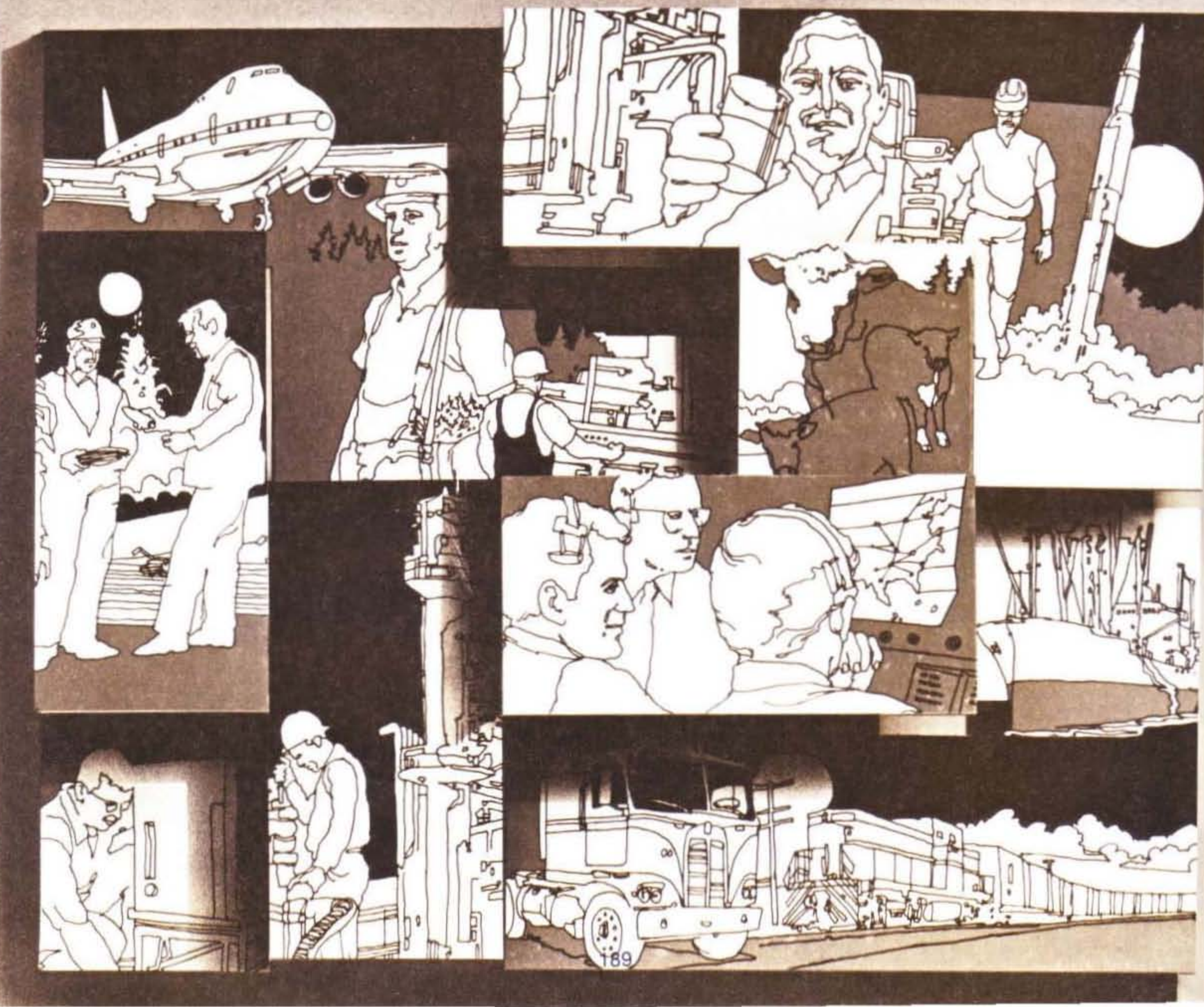
WEIGHT: Model 845AB - 10-1/4 lbs.
Model 845AR - 9 lbs.

PRICE: Model 845AB - $560.00
Model 845AR - $560.00
Rack Adapter Kit 881A-103 - $15.00
Rack Adapter Kit 881A-102 - $25.00
Low Thermal Cables A-71 - $24.00

All prices are f.o.b. factory, Mountlake Terrace, Washington

section 7

power supplies



The John Fluke Mfg. Co. Inc. produces the highest quality power supplies and Power DAC's (high power digital-to-analog converters) in the industry.

Fluke high voltage power supplies have become the standard of the industry where quality and reliability are essential. They provide excellent performance through sound electrical and mechanical design. Power supplies from 0-10,000 volts are available with current capabilities from 0-50 mA. All instruments incorporate over-current protection circuits with front panel reset.

Fluke Power DAC's provide both DC and AC stimulus for automatic test systems with unbeatable accuracy, stability, and reliability.

Complete specifications for all **Fluke** power supplies are included in this section. A brief synopsis of these instruments is given below:

HIGH VOLTAGE POWER SUPPLIES

		408B	410B	412B	415B
Output voltage		0-6000V	0-10,000V	0-2100V	0-3100V
Current		0-20mA	0-10mA	0-30mA	0-30mA
Regulation line		0.001%	0.001%	0.001%	0.0005%
	load	0.001%	0.001%	0.001%	0.0005%
Stability	hour	±0.005%	±0.005%	±0.005%	±0.002%
	day	±0.020%	±0.020%	±0.020%	±0.010%
Maximum ripple RMS		<1mV	<1mV	<500μV	<100μV
Resolution		5mV	5mV	5mV	5mV
Calibration		±0.25%	±0.25%	±0.25%	±0.25%

POWER DAC'S

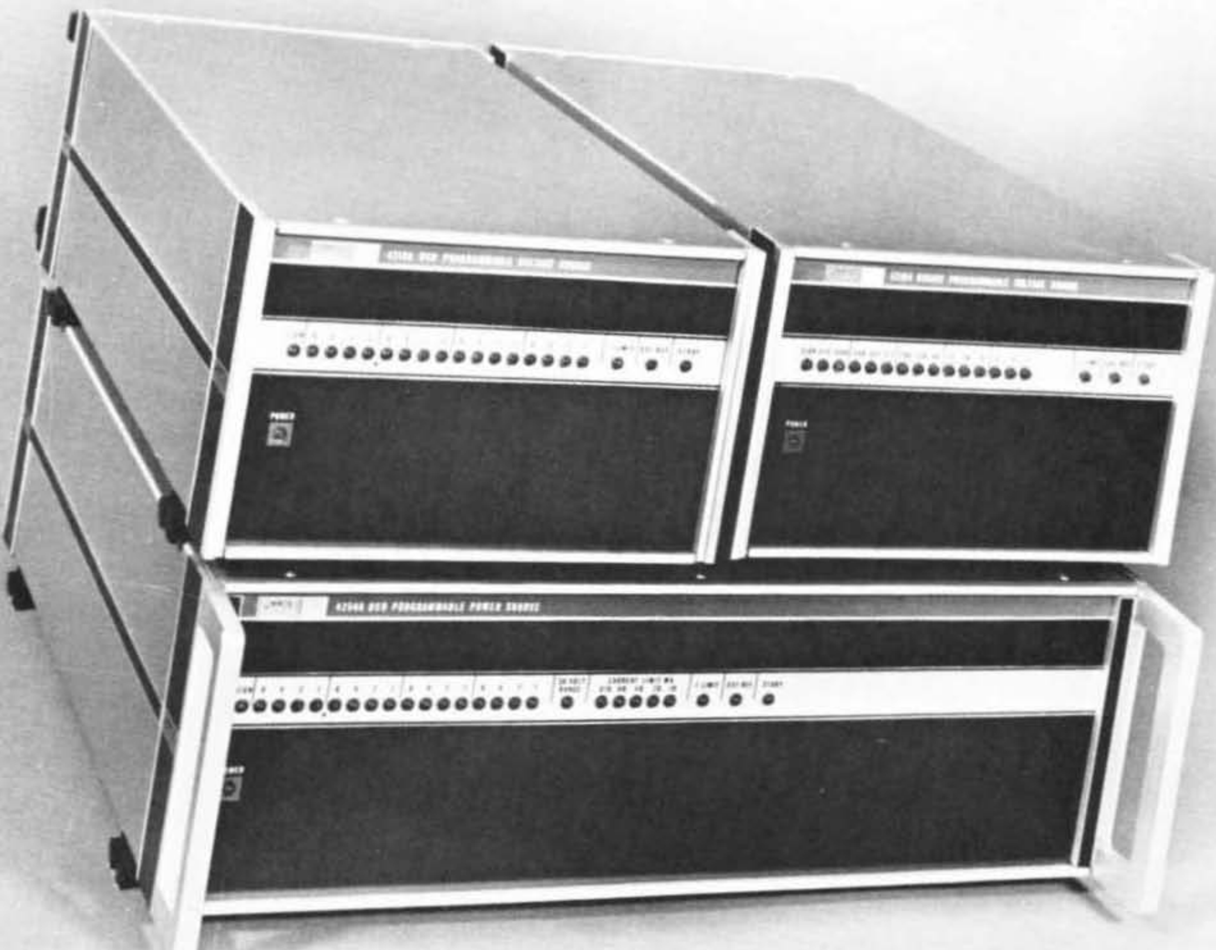
	4210A	4216A	4250A	4265A	4270A	4275A
Prog. Coding	BCD	Binary	BCD	Binary	BCD	Binary
Output Volts	±10V	±16V	±65V	±65V	±100V	±110V
Resolution	1mV*	1mV	1mV*	1mV	1mV*	0.5mV
Output Current	100mA	100mA	1 A	1 A	0.5A	0.5A
Ripple & Noise RMS	300μV	300μV	1 mV	1 mV	1.2 mV	1.2 mV
Settling Time	30μs	30μs	100μs	100μs	110μs	110μs
Prog. Noise	50mV pk	50mV pk	100mV pk	100mV pk	100mV pk	100mV pk

*100μV resolution available as a standard option.

Programmable Power-DACS
4200 Series

FEATURES:

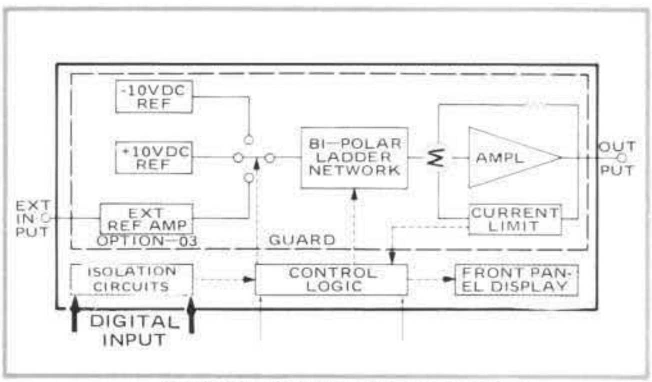
- BCD or Binary 2's Complement Coding
- Isolated Digital Control of AC and DC External Sources
- Up to 65 Volts at 1 amp or 110 Volts at ½ amp
- Front Panel Program Display
- Fully Guarded
- Multiple-Unit Addressing
- 100uV Resolution Capability
- 30 to 110uV Response Time



WHAT IS A POWER DAC?

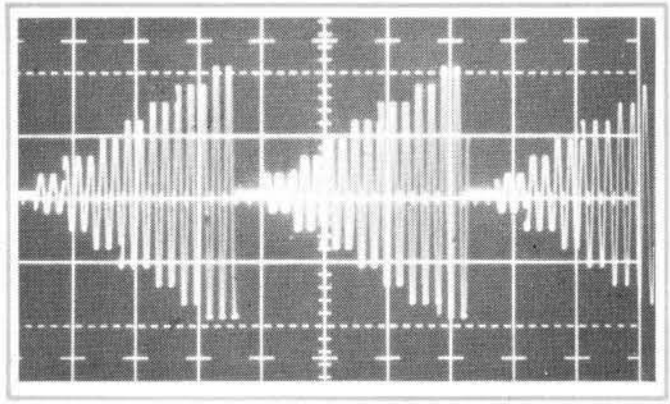
The Fluke 4200 Series of programmable power sources, appropriately called POWER-DAC's, are unique within the power source industry. Since they were designed specifically for automatic test systems, they incorporate many features that are not available in typical "programmable" power supplies. Speed, accuracy, low programming noise, true current limiting, isolated control logic, ac or dc external reference capability and appropriate digital control and response signals assure optimum performance for a broad range of applications. Protection is built in to allow the POWER-DAC's to be operated in series or parallel, just like batteries. Current sink capability coupled with the programmable current limit feature, allow them to be used as dynamic loads. The POWER-DAC's will operate with up to 1000 volts between chassis ground and guard (normally connected to the output low terminal) allowing them to be used as a programmable vernier for high voltage power supplies.

Six models of POWER-DAC's are offered: Models 4210A, 4250A and 4270A are programmable with BCD coding. Models 4216A, 4265A and 4275A are programmable in straight binary, two's compliment coding for negative values. Models 4210A and 4216A offer 16 volt, 100 mA capability. The 4250A and 4265A provide up to 65 volts at 1 amp. Models 4270A and 4275A provide 110 volts at 0.5 amps.



POWER-DAC BLOCK DIAGRAM

All POWER-DACs are bi-polar, which yields no offset or polarity preference. As a result, the power sources may be used to control the amplitude of either DC or AC signals. An External Reference feature (Option –03) provides an amplifier whose output may be switched in place of the precision internal DC reference. An external signal level between 0 and ±14.5 volts DC or peak AC may be connected to the input of the external reference amplifier. The external signal can then be programmed through the power source in precise increments. Frequencies from DC to 30 kHz may be used as the external reference for the 4250A, 4265A, 4270A, and 4275A. The 4210A and 4216A will amplify frequencies from DC to 100 kHz. One control bit is provided for selecting either the internal or external reference on program command.



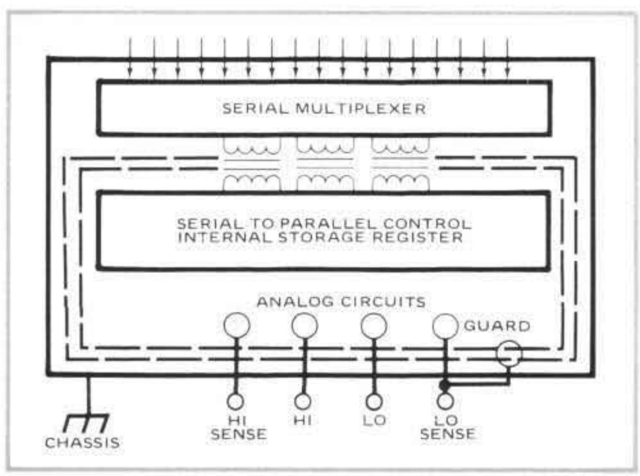
DIGITAL CONTROL OF A 30 kHz EXTERNAL SOURCE

A front panel display of the digital program command is presented on light emitting diodes. The display indicates the contents of the internal memory register and is an effective tool for program checkout.

The unique current limit capability of the POWER-DAC allows several units to be operated in parallel or series. No special hardware/software provisions or protection features have to be employed. Program commands to several sources do not have to occur in any particular time sequence, thus allowing the units to be operated independently, in series or in parallel, at the discretion of the system programmer.

The program settling time required to achieve 0.01% accuracy of the programmed increment varies from 30 μsec to 110 μsec depending on model. This settling time includes polarity change, range change and selecting either the internal or external reference if required.

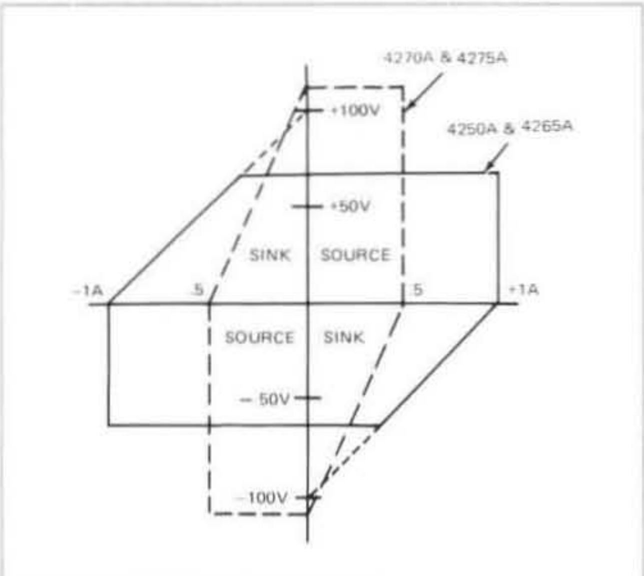
Eliminating the control system's digital noise from the analog output is achieved by using isolated control logic. The command data is transferred across an analog guard to an internal storage register before the ditital-to-analog conversion is started. Using this technique, 1 MHz digital ground noise is attenuated 1000: 1 and 10 MHz noise is attenuated 100: 1 at the analog output.



ISOLATED CONTROL LOGIC BLOCK DIAGRAM

Models 4250A, 4265A, 4270A and 4275A offer an optional (–06) programmable current limit control feature for applications involving current sensitive devices. One of two current ranges, 100 mA and 1 amp, may be programmed on Models 4250A and 4265A. The current limit level within the 100 mA range can be programmed in 10 mA increments; the 1 amp current range can be programmed in 100 mA increments. The 4270A and 4275A current limit ranges are half of the 4250A and 4265A levels; that is, 50 mA and 500 mA full scale.

The programmable current limit range is called by one control line. The percent of range is controlled by 4-Bits BCD (8421). If a current limit condition occurs, an I-LIMIT signal is generated to allow the control system to detect the abnormal status. When the overload is removed, the supply will automatically recover to the pre-programmed state. Without the current limit option, the 4250A and 4265A are limited at ±1.2 amps and the 4270A and 4275A at ±0.6 amps. The programmable current limit option is not available for the 4210A or 4216A; therefore both are limited at ±100 mA. All models feature an I-LIMIT flag.



CURRENT SOURCE AND SINK CAPABILITY

Models 4250A and 4265A provide up to 1 amp output current at 65 volts. In addition each will sink current in accordance with the above diagram. Sink current decreases linearly from 1 amp at 0 volts to .3 amp at 65 volts. Models 4270A and 4275A are shown to provide up to +110 volts at .5 amp and their associated sinking capability also decreases linearly from .5 amp at 0 volts to 0 amps at 110 volts as shown above. To calculate the amount of current a POWER-DAC is capable of sinking at a given voltage level, use the following equations:

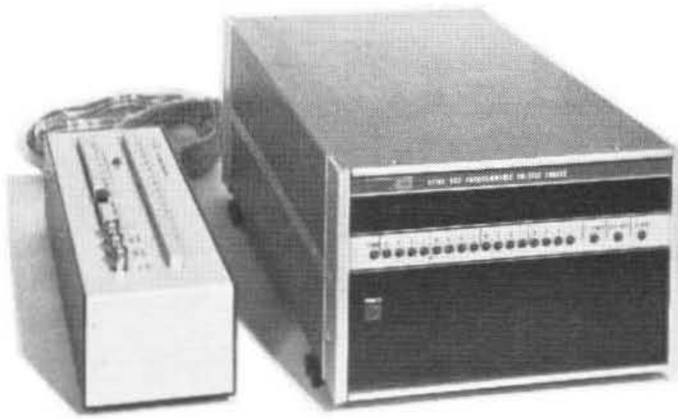
4250A/65A	$I_s = 1000 - 10\,E_o$ (MA)
4270A/75A	$I_s = 500 - 4.5\,E_o$ (MA)

If additional voltage resolution is desired, a 5th decade is offered for BCD models only (Option –07). When ordered with the 4210A, 100 μV increments may be programmed to the full scale value of ±9.9999 volts. NOTE: The 5th BCD decade is available in BCD models 4250A and 4270A; however, it cannot be installed simultaneously with the Programmable Current Limit Option (–06). The 5th BCD decade is not displayed on the front panel of the 4210A but is displayed on the 4250A and 4270A.

The modular construction of the POWER-DAC facilitates modification for special versions. Inverted programming logic, programmable dividers for the analog output, or special programming requirements can easily be added to standard units. The entire output voltage range can be shifted as well, i.e., the relative bit weight can be changed. Models equipped with programmable current limit (–06) may be provided with an additional set of terminals for monitoring output current.

A4200 MANUAL CONTROL UNIT

For bench operation, calibration or troubleshooting, a Manual Control Unit (A4200) is available as an accessory. The A4200 allows the operator to manually select each control line as well as monitor the strobe pulse and READY/NOT READY flags developed in the POWER-DAC. In general, the A4200 is used in the MANUAL Mode.



However, to view such characteristics as programming noise or settling time, rise time, etc., an AUTO Mode is provided which engages an internal 10 kHz clock in the A4200. By calling all bits within any 8421 decade, the POWER-DAC will develope a staircase function on the analog output which may be examined on a scope.

PROGRAMMABLE DC OR AC AMPLIFIER OPERATION

One of the most important features of the 4200 Series POWER-DAC's is the ability to amplify or attenuate, by digital control, both AC and DC signals generated by external sources. Most applications for this feature are derived from two basic requirements;

1. The need to provide programmable gain or attenuation to unknown time varying signals.

2. The need to provide a variable output signal from a known fixed amplitude source.

This capability is offered by the External Reference Amplifier, (Option −03). *It provides appropriate buffering for* the external DC or AC voltage source which may then be switched in as the reference for the precision ladder network in place of the internal DC standard. One programming bit selects the internal or external reference. The polarity of the output from the POWER-DAC will be the same as the external reference polarity, regardless of the state of the sign bit.

To appreciate the utility of the external reference feature, the following examples are given for the two basic applications noted above:

Problem 1

In a hybrid digital/analog flight control simulator, a 0 to 3V rms, 400 Hz error signal must be amplified by factors of 2.5, 5.0 and 7.5 during the simulation exercise. A maximum output current of 300 mA is required to drive a magnetic display. Which 4200 Series POWER-DAC is appropriate and what program codes are required for each gain setting, assuming straight binary coding is used?

Solution:

Either the Model 4265A or 4275A could be used to provide the necessary gain and current output. Assume the 4275A is chosen because of the higher programming resolution offered.

Refer to the External Reference Specifications, page 4. For the maximum value of the external source, calculate the resolution. ($2\ E_{xr} \times 10^{-4}$ for the high range)

$$3\text{V rms} \times 2 \times 10^{-4} = .6\text{ mV rms}$$

Multiply the maximum value of E_{xr} by the desired gain and divide by the resolution to get the program code.

Gain of 2.5: $\dfrac{3\text{V rms} \times 2.5}{6 \times 10^{-4}\text{V rms}} = 12{,}500_{10} = 030324_8$

Gain of 5.0: $\dfrac{3\text{V rms} \times 5}{6 \times 10^{-4}\text{V rms}} = 25{,}000_{10} = 060650_8$

Gain of 7.5: $\dfrac{3\text{V rms} \times 7.5}{6 \times 10^{-4}\text{V rms}} = 37{,}500_{10} = 111174_8$

Problem 2

In an automatic test system, a .01 Hz to 30 kHz Function Generator has a fixed output amplitude of 5V rms. A 250 mV rms signal is required for the unit under test. BCD coding is used in the automatic test system. Which POWER-DAC is appropriate and what BCD code is used to program the desired output.

Solution:

Assuming 70 mA rms is sufficient current to drive the load, the 4210A is the appropriate POWER-DAC.

Refer to the External Reference Specifications, page 4. Calculate the resolution obtained with the 5V rms external reference: ($E_{xr} \times 10^{-4}$)

$5 \times 10^{-4} = .5$ mV rms

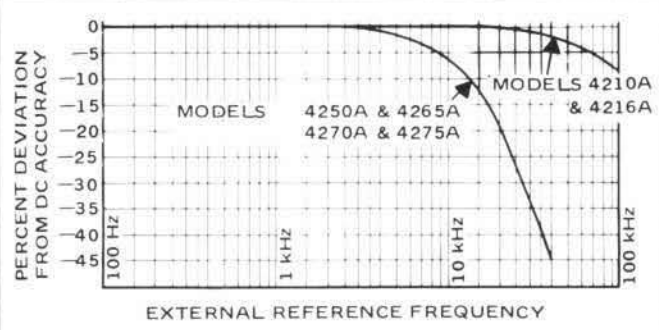
To get the program code divide the desired output by the *resolution:*

$$\frac{250 \times 10^{-3}\text{ Volts}}{5 \times 10^{-4}\text{ Volts}} = 500$$

The 4-digit BCD program code would be 0500.

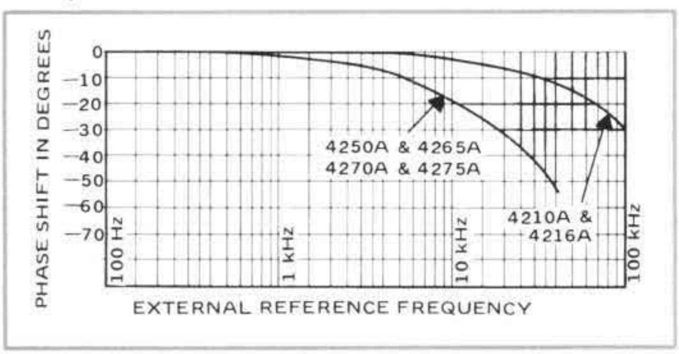
Accuracy Vs. Frequency

An external signal source, at an amplitude of 10V RMS, was used as the external reference. Typical output accuracy versus frequency is shown for full scale programmed output.



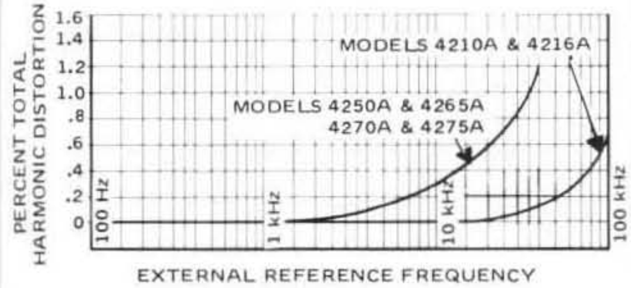
Phase Shift Vs. Frequency

Phase shift between the external source and the output of the POWER-DAC is dependent on frequency. Typical phase shift for each model is shown for a full scale programmed output level.



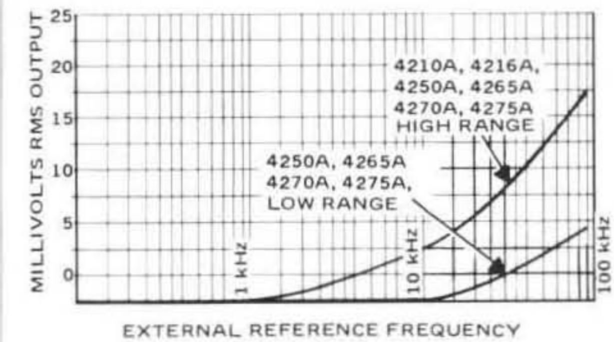
Total Harmonic Distortion Vs. Frequency

Total harmonic distortion caused by the POWER-DACs is shown over a frequency range of 100 Hz to 100 k Hz



AC External Reference Feedthrough

When all magnitude bits are programmed to zero, feedthrough of the external reference signal to the output will occur due to stray coupling. The amount of feedthrough will depend upon the amplitude and frequency of the external reference. This curve illustrates typical feedthrough with 10V RMS external reference over a frequency range of 100 Hz to 100 kHz.



EXTERNAL REFERENCE SPECIFICATIONS

	BCD CODED MODELS			BINARY CODED MODELS		
	4210A	4250A	4270A	4216A	4265A	4275A
INPUT VOLTAGE RANGE	0 to ±14.5V DC or Peak AC			0 to 14.5V DC or Peak AC		
FREQUENCY RANGE (DC to the −3db point)	100 kHz	30 kHz	30 kHz	100 kHz	30 kHz	30 kHz
INPUT IMPEDANCE	100K Ω in parallel with 70 pf			100K Ω in parallel with 70 pf		
PEAK OUTPUT VOLTAGE						
Low Range	±17V	±17V	±17V	±17V	±17V	±46V
High Range		±66V	±110V		±66V	±110V
OUTPUT CURRENT						
DC Peak	100 mA	1 Amp	0.5 Amps	100 mA	1 Amp	0.5 Amps
AC RMS	70 mA	0.7 Amp	0.35 Amps	70 mA	0.7 Amp	0.35 Amps
GAIN $\frac{E_{omax}}{E_{xr}}$						
Low Range	X1.0	X1.0	X1.0	X1.638	X1.638	X3.277
High Range		X10.0	X10.0		X6.553	X13.107
RESOLUTION						
Low Range	$E_{xr} \times 10^{-4}$	$E_{xr} \times 10^{-4}$	$E_{xr} \times 10^{-4}$	$E_{xr} \times 10^{-4}$	$E_{xr} \times 10^{-4}$	$.5E_{xr} \times 10^{-4}$
High Range		$E_{xr} \times 10^{-3}$	$E_{xr} \times 10^{-3}$		$4E_{xr} \times 10^{-4}$	$2E_{xr} \times 10^{-4}$

PROGRAMMING THE POWER DAC.

All POWER-DACs have TTL/DTL compatible logic interfaces. Models are available in either straight binary or 8421 BCD coding and provide fully isolated logic including internal memory. Standard BCD models have 4 decades which are in turn binary by decade. In addition, a 5th decade is available (Option –07) for additional resolution with the BCD models. All BCD models are programmed by sign and magnitude; straight binary models are coded in 2's complement for negative voltages.

Complete system communication features are included with all POWER-DACs. A "data strobe" line is provided to allow the control system to tell the power source when a valid command is present. The instruments will respond to the system with a "NOT READY" signal during the programming interval to indicate a "busy" condition. After the programming interval, the "NOT READY" flag will change state to indicate a "READY" condition.

A Standby/Operate control line is provided to allow a single control bit to reduce the output to less than 1% of the pre-programmed level without disturbing the stored command word. Upon switching the control line from the "Standby" to the "Operate" level, the output will revert to the preprogrammed level.

Programmable Current Limit, Option –06, offers two current limit ranges. Each range is programmable in 10% steps from 10% to 110% range. When a current limit condition occurs, a status line "I-LIMIT", from the instrument changes logic state to alert the system.

CONTROL FEATURES

All program control and response lines are accessible on the rear panel through an Amphenol Blue Ribbon 57-30500 connector (Mating connector–supplied).

Logic Levels:

All 4200's are delivered with standard logic levels of:
Logic "1" = 0 to +.4V dc or contact closure. 1.6 mA per bit maximum sinking current.
Logic "0" = +2.0 to +5V dc. Jumpers are provided on the isolated control logic card so that the logic levels may be easily inverted at the customer's facility; i.e.,
Logic "1" = +2.0 to +5V dc
Logic "0" = 0 to +.4V dc or contact closure.

Sign:

Connector Pin 35: Logic "1" = Negative output voltage.

Magnitude:

4210A, 4250A, 4270A, 4-Bit Binary-Coded-Decimal (BCD) digits labeled ABCD. Digit values greater than 9 (i.e. 10 thru 15, which violate the definition of BCD coding) will be accepted and converted to an equivalent analog value. A 5th BCD decade (Option –07) may be added to increase resolution on all BCD POWER-DACs. The –07 Option; however, is not compatible with the Programmable Current Limit Option (–06) in the 4250A and 4270A.

4216A, 4265A, 14-binary bits plus sign bit. Two's complement binary coding for negative values is used.

4275A, 16-binary bits plus sign bit. (Otherwise it's the same as 4265A above).

Range:

Connector Pin 29: Logic "1" = High Voltage Range
Logic "0" = Low Voltage Range

Current Limit:

Connector Pin	Function	Logic "1"	Logic "0"
42	Range	High Range	Low Range
43	Magnitude	80% of Range	0% of Range
44	Magnitude	40% of Range	0% of Range
45	Magnitude	20% of Range	0% of Range
46	Magnitude	10% of Range	0% of Range

NOTE

Programming pins 43, 44, 45 and 46 to logic "0" will limit current at a minimum value of 10% of range. Programming above 110% of range will not increase limiting above 110%.

Data Strobe:

Connector pin 33. The Isolated Control Logic requires a strobe pulse to start the digital-to-analog conversion process after a valid command is present. Minimum pulse width is 500 nanoseconds. A negative slope (+5V to 0V transition) is required.

External Reference:

Connector Pin 36: Logic "0" = Internal DC Reference
Logic "1" = External Reference

Standby:

Connector Pin 34: Logic "0" = Operate Mode
Logic "1" = Standby; Output is at 0 ±100 mV

RESPONSE SIGNALS

Current Limit Flag:

Connector Pin 49: Logic "1" represents a limit condition when either sourcing or sinking current.

Ready/Not Ready Flag:

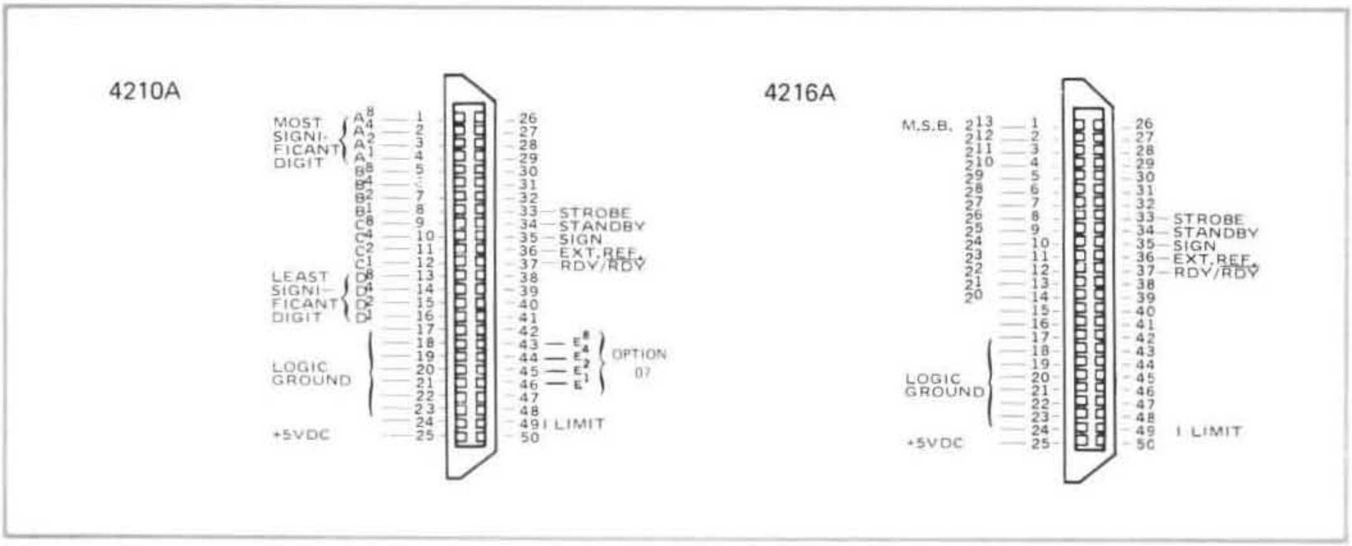
Connector Pin 37: Logic "0" = "Ready" condition. The output is within 0.01% of the programmed increment.
Logic "1" = "Not Ready" condition. The power source is in the process of settling to the programmed value.

POWER CONNECTIONS: +5 VDC

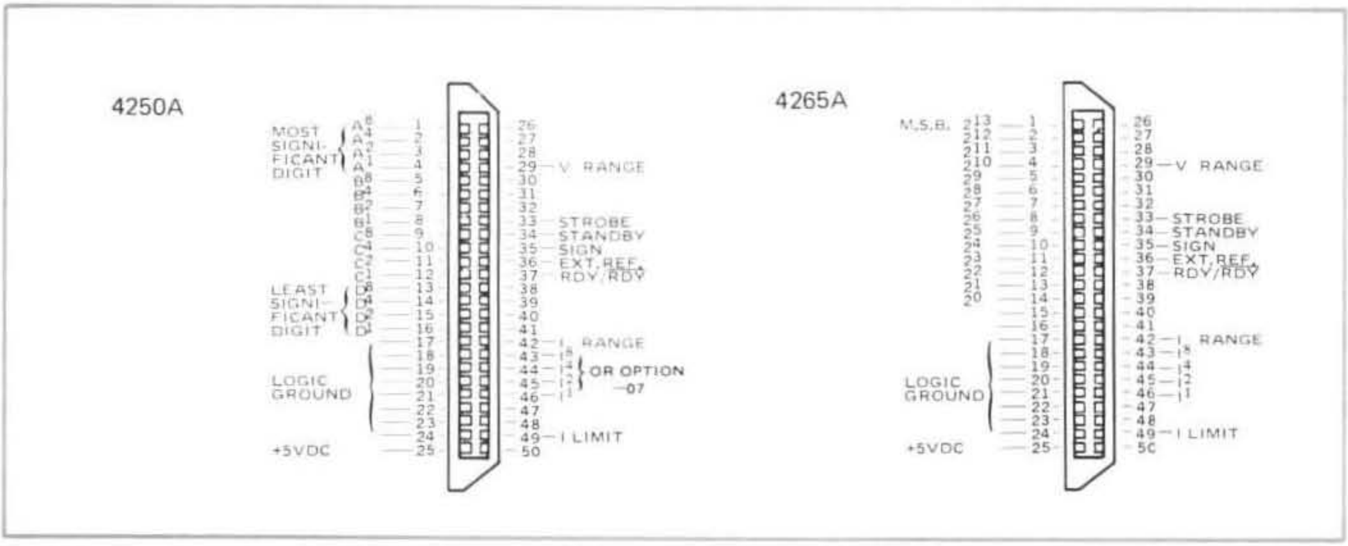
Connector Pin 25: An internal, isolated power supply furnishes +5 VDC up to 125 mA for use by the external system interface logic.

Logic Ground:

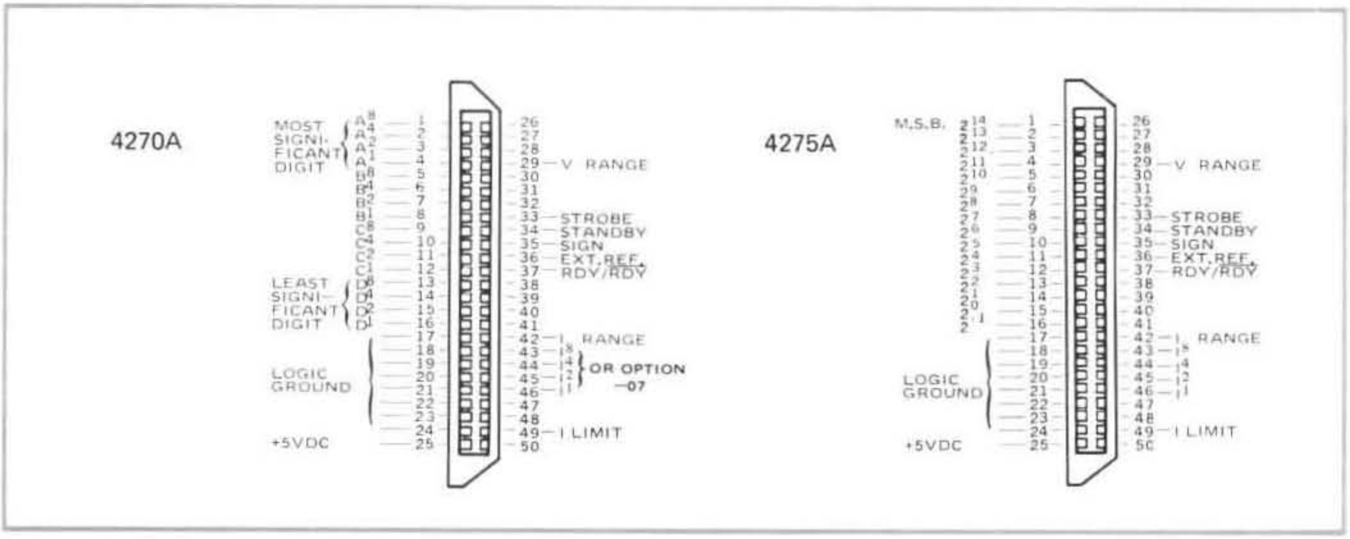
Connector Pins 17 thru 24: It is recommended that a large ground strap be used between the interface logic and the power source to reduce the digital programming noise on the system ground.



PROGRAMMING CONNECTOR WIRING DIAGRAM



PROGRAMMING CONNECTOR WIRING DIAGRAM



PROGRAMMING CONNECTOR WIRING DIAGRAM

MODEL	OUTPUT VOLTAGE	CODE	OUTPUT CUR-RENT	RESOLUTION	ACCURACY (1) 15-35°C 90 DAY	SETTLING (4) TIME	STABILITY 24 HR.
4210A	0 to ±9.999V (4) BCD Digits and Sign.	BCD	100 mA	1 mV (100 μV Optional)	±(0.01% of output +100 μV)	18 μsec to .1% of programmed increment 30 μsec to .01% of programmed increment	±(10 ppm of output +20 μV)
4250A	0 to ±9.999V 0 to ±65V (4) BCD Digits and Sign.	BCD	1 Amp	1 mV (100 μV Optional) on 16V range 10 mV (1 mV Optional) on 65V range	Lo Range ±(0.01% of output +100 μV) High Range ±(0.01% of output +700 μV)	70 μsec to .1% of programmed increment 100 μsec to .01% of programmed increment	Lo Range ±(10 ppm of output +40 μV) High Range ±(10 ppm of output +280 μV)
4270A	0 to ±9.999V 0 to ±99.99V (4) BCD Digits and Sign.	BCD	.5 Amp	1 mV (100 μV Optional) on 10V range 10 mV (1 mV Optional) on 110V range	Lo Range ±(0.01% of output +100 μV) High Range ±(0.01% of output +700 μV)	80 μsec to .1% of programmed increment 110 μsec to .01% of programmed increment	Lo Range ±(10 ppm of output +40 μV) High Range ±(10 ppm of output +280 μV)
4216A	0 to ±16.383V 14 Bits and Sign.	BINARY	100 mA	1 mV	±(0.01% of output +100 μV)	18 μsec to .1% of programmed increment 30 μsec to .01% of programmed increment	±(10 ppm of output +20 μV)
4265A	0 to ±16.383V 0 to ±65.532V 14 Bits and Sign.	BINARY	1 Amp	1 mV on 16V range 4 mV on 65V range	Lo Range ±(0.01% of output +100 μV) High Range ±(0.01% of output +300 μV)	70 μsec to .1% of programmed increment 100 μsec to .01% of programmed increment	Lo Range ±(10 ppm of output +40 μV) High Range ±(10 ppm of output +120 μV)
4275A	0 to ±32.7675V 0 to ±110V 16 Bits and Sign.	BINARY	.5 Amp	.5 mV on 32V range 2 mV on 110V range	Lo Range ±(0.01% of output +160 μV) High Range ±(0.01% of output +530 μV)	85 μsec to .1% of programmed increment 110 μsec to .01% of programmed increment	Lo Range ±(10 ppm of output +60 μV) High Range ±(10 ppm of output +120 μV)

(1) One year accuracy is only twice the 90 day specification, i.e., the one year accuracy spec. for the 4210A is ±(0.02% of output +200 μV).

(2) 90 day stability is three times the specified 24 hour stability. One year stability is six times the 24 hour specification.

STABILITY (2) 90 DAY (3)	RIPPLE AND NOISE (6)	PROGRAM-ING NOISE (7)	TEMPERATURE COEFFICIENT <15°C, >35°C	OUTPUT RESISTANCE	REGULATION LINE & LOAD (5)	SHORT CIRCUIT PROTECTION	INPUT AND POWER	BASE PRICE
±(30 ppm of output +60 μV)	300 μV rms 2mV p-p	50 mV PK	±(10 ppm +15 μV)/°C	100 μ Ω	0.001%	Current Limit @ 100 mA	115/230 VAC ±10% 48-62 Hz 15 Watts	$1445
Lo Range ±(30 ppm of output +70 μV) High Range ±(30 ppm of output +490 μV)	Lo Range 500 μV rms 7mV p-p High Range 1 mV rms 7mV p-p	Lo Range 50 mV PK High Range 100 mV PK	Lo Range ±(10 ppm +5 μV)/°C High Range ±(10 ppm +35 μV)/°C	20 μ Ω	0.001%	Programmable Current Limit in 10% Steps to 100 mA and 1 Amp. (Option –06)	115/230 VAC ±10% 48-62 Hz 100 Watts	$1795
Lo Range ±(30 ppm of output +70 μV) High Range ±(30 ppm of output +490 μV)	Lo Range 500μV rms 7mV p-p High Range 1.2mV rms 7mV p-p	Lo Range 50 mV PK High Range 100 mV PK	Lo Range ±(10 ppm +5 μV)/°C High Range ±(10 ppm +35 μV)/°C	40 μ Ω	0.001%	Lo Range 500 μV rms High Range 1.2 mV rms to 10 MHz	115/230 VAC ±10% 48-62 Hz 200 Watts	$1895
±(30 ppm of output +60 μV)	300 μV rms 2mV p-p	50 mV PK	±(10 ppm + 15 μV)/°C	100 μ Ω	0.001%	Current Limit @ 100 mA	115V/230 VAC ±10% 48-62 Hz 15 Watts	$1445
Lo Range ±(30 ppm of output +70 μV) High Range ±(30 ppm of output +210 μV)	Lo Range 500 μV rms 7mV p-p High Range 1 mV rms 7mVp-p	Lo Range 50 mV PK High Range 100 mV PK	Lo Range ±(10 ppm +5 μV)/°C High Range ±(10 ppm +15 μV)/°C	20 μ Ω	0.001%	Programmable Current Limit in 10% Steps to 100 mA and 1 Amp. (Option –06)	115/230 VAC ±10% 48-62 Hz 100 Watts	$1795
Lo Range ±(30 ppm of output +105 μV) High Range ±(30 ppm of output +370 μV)	Lo Range 500 μV rms 7mV p-p High Range 1.2 mV rms 7mV p-p	Lo Range 50 mV PK High Range 100 mV PK	Lo Range ±(10 ppm +5 μV)/°C High Range ±(10 ppm +15 μV)/°C	40 μ Ω	0.001%	Programmable Current Limit in 10% Steps to 50 mA and .5 Amp. (Option –06)	115/230 VAC ±10% 48-62 Hz 200 Watts	$1895

(3) At Constant Line, Load and Temperature.

(4) Not affected by range change.

(5) No Load to Full Load, ± 10% Line Change.

(6) 10 Hz to 10 MHz bandwidth.

(7) 200 mV PK with Range change.

SYSTEM INTERFACE CONSIDERATIONS

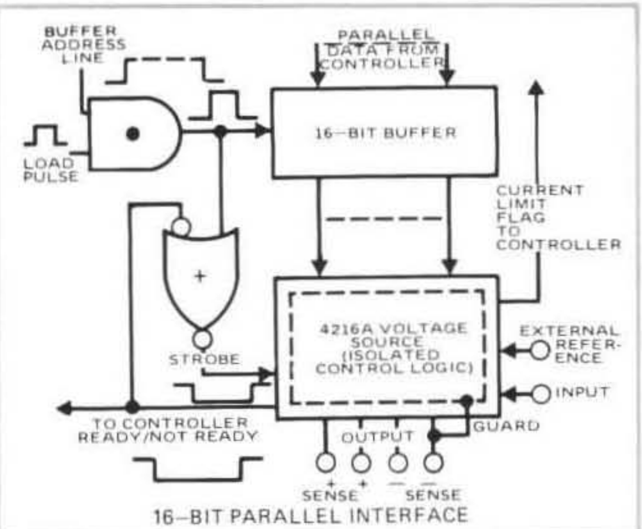


Figure 1. All 16-bits of the command word are transferred to the buffer from the controller in parallel. If the command lines can be held valid for 2.4 microseconds or longer, register storage is not required. The negative leading slope of the Data Strobe initiates the transfer of the command data across the guard into an internal memory register of the 4216A. If the command data cannot be held constant for a minimum of 2.4 microseconds, the buffer must contain a storage register. The Ready/Not Ready signal for the 4216A is logically "OR'd" with the load pulse to inhibit further program changes during the settling time interval. Both the Ready/Not Ready and Current Limit Flags can be sent to the controller as abnormal status indicators.

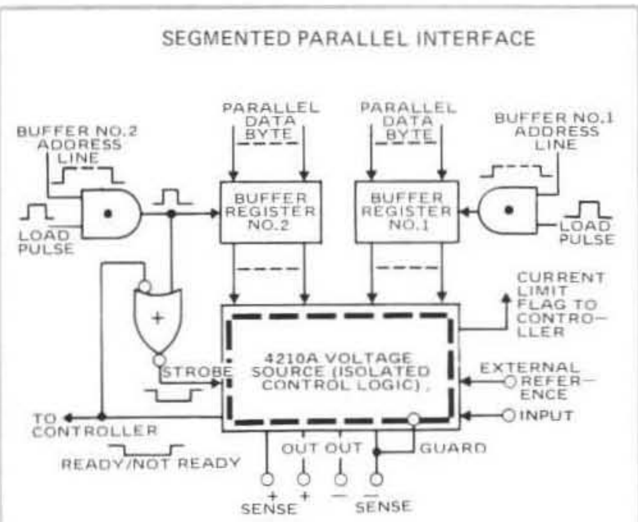


Figure 2. When more than one controller word is required to complete the command for the 4250A, the command command may be stored as word segments in buffer registers. As shown, Buffer #1 is loaded, but no Data Strobe is given to the 4250A. Upon loading Buffer #2, the Load Pulse is used as the Data Strobe for initiating transfer of the data in both buffers to the internal memory of the 4250A. The word size of the buffers and their functional bit assignments can be configured to fit the needs of the controller's software format.

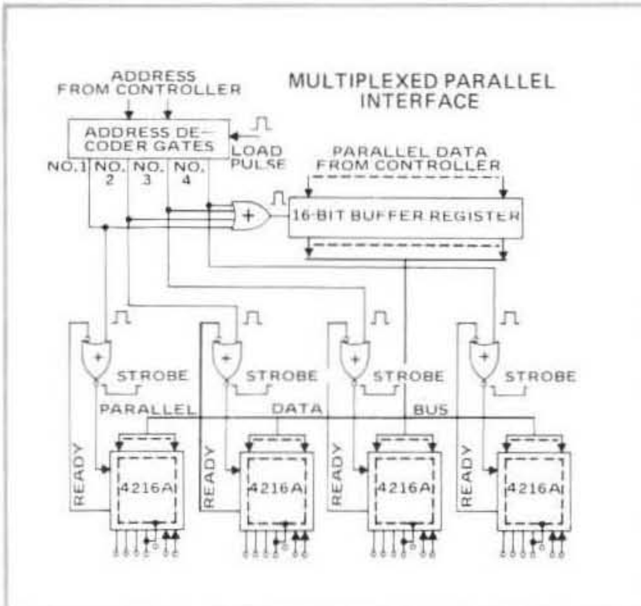


Figure 3. Several voltage sources may be multiplexed from one system interface register as shown in the above diagram. An instrument address, in conjunction with the buffer load pulse strobes the contents of the buffer register into the appropriate 4216A memory. If the parallel data from the controller can be held valid for a minimum of 2.4 microseconds, then there is no need for the storage register in the buffer; the command data could be captured in the internal memory of the Isolated Control Logic of the 4216A. Ready/Not Ready and Current Limit Flags can be used by the controller as required.

POWER-DACs have been interfaced with most major computers used in the scientific or electronic community. In many cases, the software driver package, as well as the actual hardware, is available. The following manufacturers and models are meant to be representative, but by no means inclusive, of the computers easily interfaced with the POWER-DAC.

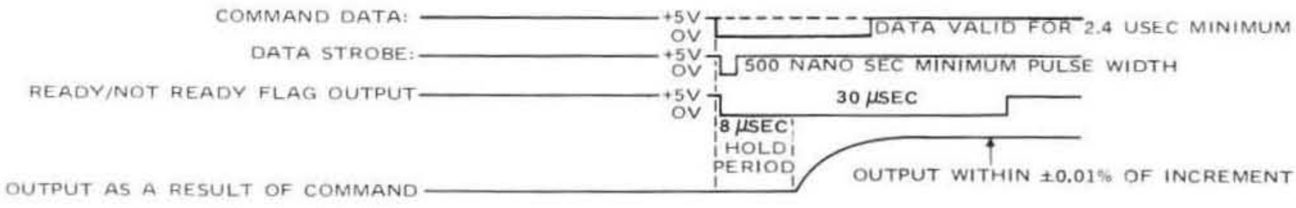
DEC	PDP8, PDP11, PDP12
Data General	Nova Series
H.P.	2114, 2115, 2116, 2100
Phillips	800 Series
Varian	520, 620 Series
Computer Automation	
General Automation	
Systems Engineering Labs	
IBM	1130
Lockheed	MAC-16
Honeywell	H-316

Please contact the factory for additional assistance regarding interfacing to any of the above computers or your specific computer.

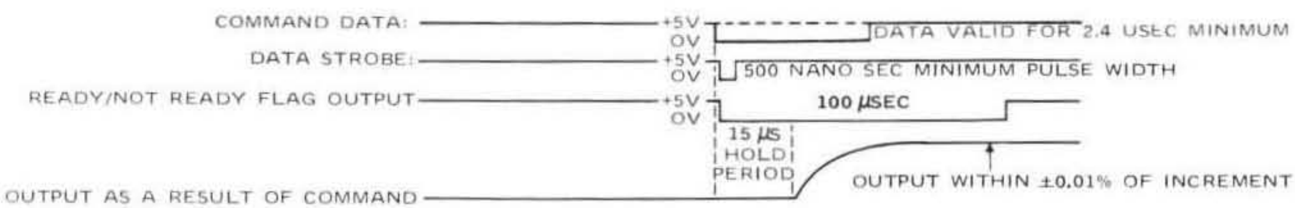
CONTROL SIGNAL TIMING

Isolated Control Logic (Standard on all 4200's)

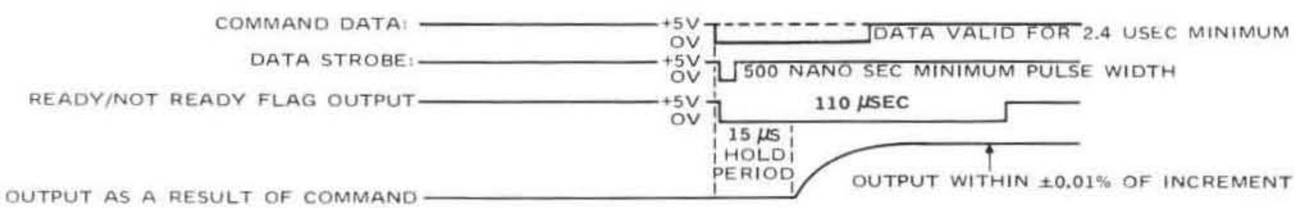
When using isolated control logic, it is necessary that all program control lines be at their final logic state (settled) either prior to or simultaneously with the negative slope, +5V to 0V transition, of the Data Strobe. The program control lines must be held in a valid state for a minimum of 2.4 micro-seconds while the data is transferred across the guard into the internal memory register. The pulse width of the Data Strobe should be 500 nanoseconds minimum. The following diagram indicates the time relationship of the programming signals and a typical analog output change.



TIMING FOR MODELS 4210A & 4216A



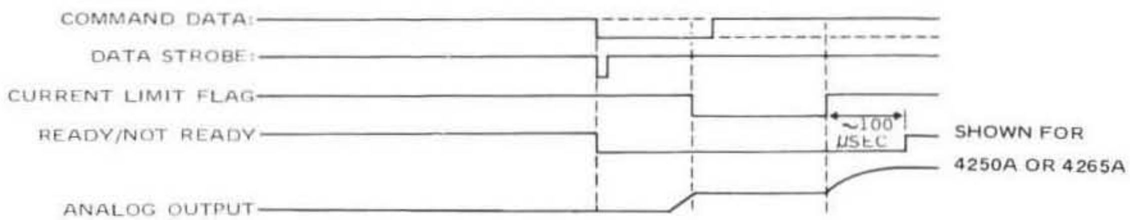
TIMING FOR MODELS 4250A & 4265A



TIMING FOR MODELS 4270A & 4275A

Current Limit Operation

A discrete Current Limit Flag on pin 49 switches from +5 Volts to 0 Volts whenever the load current exceeds the programmed limit or a current sink overload condition occurs. Coincident with the Current Limit Flag, the Ready/Not Ready Flag will indicate a Not Ready condition. Normally, the current limit condition will occur during the programming interval when the "Not Ready" condition already exists. In this instance, the "Not Ready" state will remain valid until approximately 100 microseconds after the overload is removed. The "Lag" of the current limit flag from actual time of overload is typically 20 μsec. The following diagram illustrates this timing relationship.



APPLICATIONS

The following examples are only a few of the diverse applications of the 4200 Series POWER-DACs. For your special application, contact the factory or your nearest Fluke Representative.

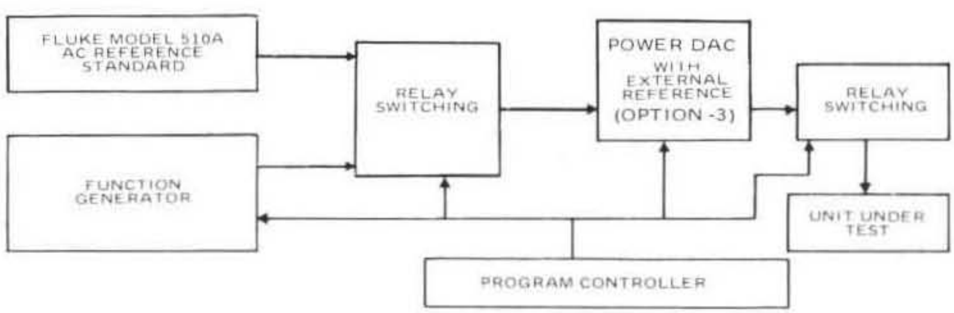
Automatic Testing

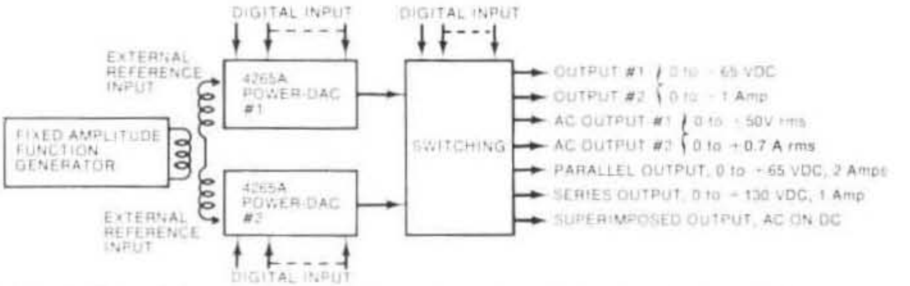
The POWER-DACs provide outstanding versatility in automatic test system applications. The diagram below depicts the 4200 POWER-DACs being used to furnish either precision DC or AC voltages to the unit under test. When using the Fluke Model 510A AC Reference Standard as an external reference, AC stimulus values between 0 and 70V RMS can be applied depending on Model with an overall accuracy of ±0.03%, between DC and 1 kHz. Frequencies to 30 kHz can be provided at reduced accuracies. Precise amplitude control of a Function Generator (for frequencies up to 30 kHz) can also be provided. For avionics testing, the Model 510A can be phase locked to a 400 cycle power source, thus allowing accurate, in-phase stimulus to the unit under test.

Parallel or series operation-just like batteries

Two or more POWER-DACs may be connected in series to obtain higher output voltages. Using the Model 510A, AC Reference Standard as an external source for one of the supplies, very accurate AC sine waves can be superimposed on plus or minus DC levels. Also, the 4200 power sources can act as precision programmable verniers when placed in series with high voltage power supplies. The guard terminal may be floated up to 1000 volts above chassis ground.

With the 4200 Series POWER-DAC, you can double, or even triple your current or voltage capability by a simple parallel or series connection with external relays. No special hardware or software protection features are required. With several POWER-DACs in your system you have both single unit control and unlimited power configuration at the discretion of the programmer.





The 4200 Series POWER-DACs provide a wide range of automatic test system capability. With the equipment shown above, note the different types of output obtainable.

Program Drivers For Other Power Supplies

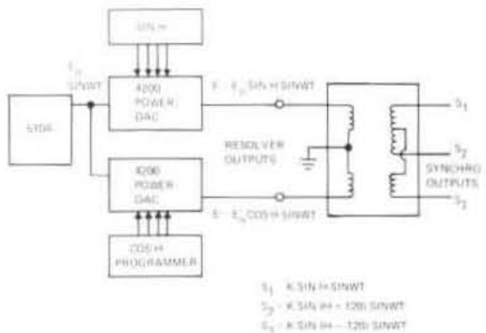
POWER-DACs are being used as programmers for high voltage power supplies. The remarkable stability and accuracy of Fluke POWER-DACs makes them the logical choice for programming voltage controlled power supplies such as Sorensen Model DCR 6000 .25 (6000V at .25 amps). With a 1.5 mV/V ratio or programmed input to output, the 1 mV resolution of the POWER-DAC allows typical repeatability of 0.25% worst case and often an order of magnitude better. Such a system is assembled using a PDP-8.

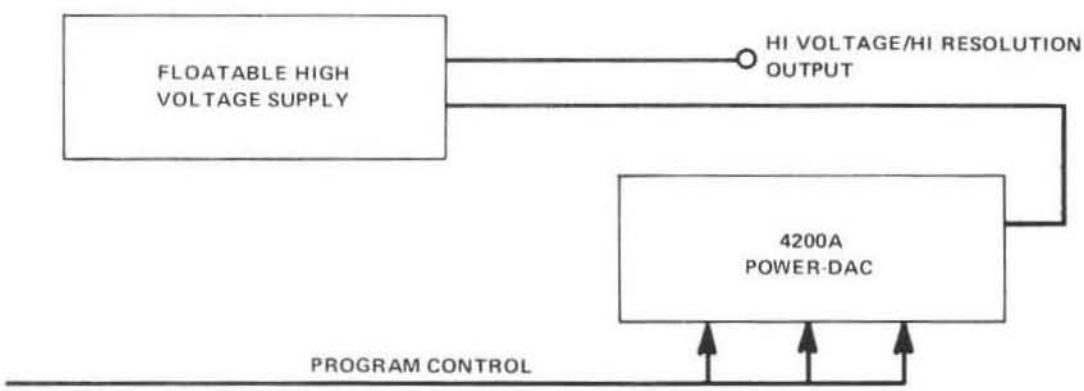
Fast High Voltage Vernier

The POWER-DACs can give additional resolution and very fast response when placed in series with any Floatable Hi Voltage Power Supply. Such an arrangement allows 1 mV resolution for any high voltage.

Synchro/Resolver Stimulus

POWER-DACs can be used as stimuli for Synchro or Resolver Simulators. By programming "A" POWER-DAC to Cos Θ and programming "B" POWER-DAC to Sin Θ and using the External Reference (–03 Option in both POWER-DACs, Resolver Outputs are immediately derived. These may be transformed through a Scott – Tee Transformer to give Synchro Outputs. A Fluke 510A provides the External AC Reference at the selected frequency.





ENVIRONMENTAL SPECIFICATIONS

Operating Temperature:	0°C to +50°C
Storage Temperature:	−40°C to 75°C
Relative Humidity:	0 to 80%
Shock:	20G, 11 millisecond half-sine wave
Vibration:	4.5G, 10 Hz to 55 Hz
Altitude:	10,000 feet operating, 50,000 feet non-operating

OPTION DESCRIPTION

External Reference, Option −03

The external reference option allows the POWER DAC's to be used as programmable attenuators or amplifiers for a broad range of dc or ac signals. Refer to page 4 for complete specifications and description of this option.

Programmable Current Limit, Option −06

Programmable current limit is available for models 4250A, 4265A, 4270A and 4275A. Two current limit ranges are provided, and each range is programmable in 10% steps up to 110% of range. Accuracy of the current limit function is ±(4% of the programmed value + 4 mA). Without the programmable current limit option, each model will limit the maximum output current to approximately 120% of the rated output.

Additional Programming Resolution, Option −07

Five BCD digits of resolution may be obtained for models 4210A, 4250A and 4270A using Option −07. This yields 100 microvolt resolution on the 4210A and on the low range of the 4250A and 4270A. One millivolt resolution is obtained on the high range of the 4250A and 4270A.

Accuracy, and all other specifications remain the same as for the standard models with 4 digit programming resolution.

Programmable current limit, Option −06, cannot be obtained with Option −07.

ISOLATED MULTI-STROBE LOGIC, OPTION -09

Isolated Multi-Strobe logic is available for all 4200 series Power DAC's. It provides exactly the same function as the standard control logic described earlier in this brochure, plus it will allow programming directly from any 16 bit or 18 bit BCD program source (e.g. 16 bit mini computer). This is accomplished by splitting the 24 possible programming bits into a data word of 16 bits (Magnitude), an 8 bit control work [Polarity, Voltage Range, External Reference Current Limit Range, and Current Limit Magnitude (4 bits)] and providing individual strobe lines for each word. By use of circuit board jumpers the data word may be increased to 18 bits (Magnitude, Polarity, Voltage Range) and a 6 bit control word [External Reference, Current Limit Range and Current Limit Magnitude (4 bits)]. For the Binary Coded Power DAC's, a similar arrangement also allows a 16/8 or 18/6 dual word plus the 2's complement coding feature.

The 09 Option has circuit board jumpers to allow conversion between negative and positive true logic, asynchronous or synchronous standby/operate control, and single or dual strobe mode.

The 09 Option has multiple addressing capabilities for up to 8 power DAC's equipped with 09 Options. The 09 Option has a 56 pin edge card connector in addition to the standard Amphenol Blue Ribbon 50 pin program input connector for making easy connections to 7 successive power DAC's. Mating connector kit for the 56 pin edge card connector is Fluke P/N 382903 (Not supplied). 3 foot, 6 foot and 12 foot chaining cables are also available as Fluke part numbers 310946, 341206, and 341198 respectively. The program source must drive one TTL load per power DAC used. For multiple addressing applications, the 09 Option also has common bussed, status pollable indication of current limit and power failure conditions.

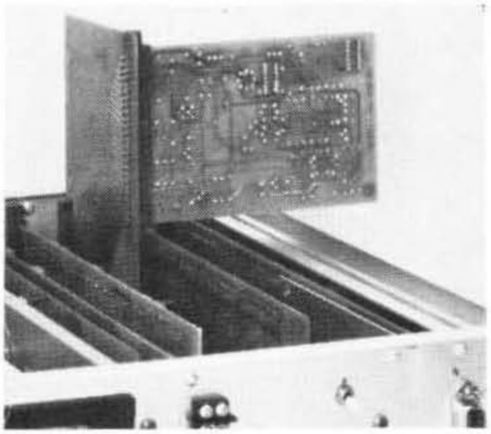
For further detailed programming information for the 09 Option, contact the Factory (Product Specialist Group).

ACCESSORY DESCRIPTION

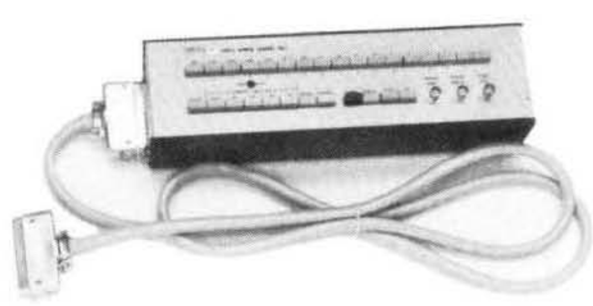
Service and Calibration

For manual checkout, calibration and control, an auxiliary Manual Control Unit, (A4200) is available which will allow the operator to test the POWER-DACs in a dynamic programming mode as well as a static mode. Each of the control bits may be manually programmed through switches. In addition, an internal 10 kHz clock and a 4-bit binary counter are provided to exercise the voltage sources in a dynamic switching mode. BNC connectors are provided on the Manual Control Unit so that the Data Strobe and the Ready/Not Ready signals can be observed on an oscilloscope as well as allowing an external pulse generator to drive the counter-programmer. A five foot cable is included with the Manual Control Unit.

In addition, an Extender Card (Fluke P/N 292623) and an Extender Cable (Fluke P/N 337584) are provided to allow complete access to the plug-in PCBs for servicing.



EXTENDER CARD INSTALLATION



MANUAL CONTROL UNIT

PRICE:	
Model 4210A or 4216A	$1445
Opt. 4200A–03 External Reference	200
Opt. 4210A–07 100μV Resolution (4210A only)	300
Opt. 4210A–09 Multi-Strobe Logic	125
Opt. 4216A–09 Multi-Strobe Logic	125

PRICE:	
Model 4250A or 4265A	$1795
Opt. 4200A–03 External Reference	200
Opt. 4250A–06 Programmable Current Limit	200
Opt. 4250A–07 100μV Resolution (4250A only) (not available with –06)	300
Opt. 4250A–09 Multi-Strobe Logic	125
Opt. 4265A–09 Multi-Strobe Logic	125

PRICE:	
Model 4270A or 4275A	$1895
Opt. 4200A–03 External Reference	200
Opt. 4270A–06 Programmable Current Limit	200
Opt. 4270A–07 100μV Resolution (4270A only) (not available with –06)	300
Opt. 4270A–09 Multi-Strobe Logic	125
Opt. 4275A–09 Multi-Strobe Logic	125

NOTE: The mating connector for the programming input lines, Amphenol Blue Ribbon Type 57-30500 is included with each POWER-DAC (Fluke P/N 266056).

NOTE: Options 03 and 06 are field installable (takes only a screw driver) at the same price listed above by adding a "K" after the option number, example 4200A–03K. Option 09 is also field installable but at a price of $425. Option 07 is not available as a field installable Kit.

ACCESSORIES	
M05-203-601 Half-rack Mounting Bracket for a single 4210A or 4216A	$ 25
M05-200-603 Dual Half-rack Brackets for side-by-side mounting of two 4210A's or 4216A's	15
M05-203-602 Single Half-rack Center Mount for a single 4210A or 4216A	25
M05-205-600 Rack Mounting Bracket for a 4250A, 4265A, 4270A, 4275A	15
M00-260-610 Chassis Slides for 18" Cabinets	50
M00-280-610 Chassis Slides for 24" Cabinets	50
Service and Calibration Kit Accessories:	
Model A4200 Manual Control Unit	250
PCB Extender Board P/N 292623	25
PCB Extender Cable P/N 337584	25

ORDERING INFORMATION

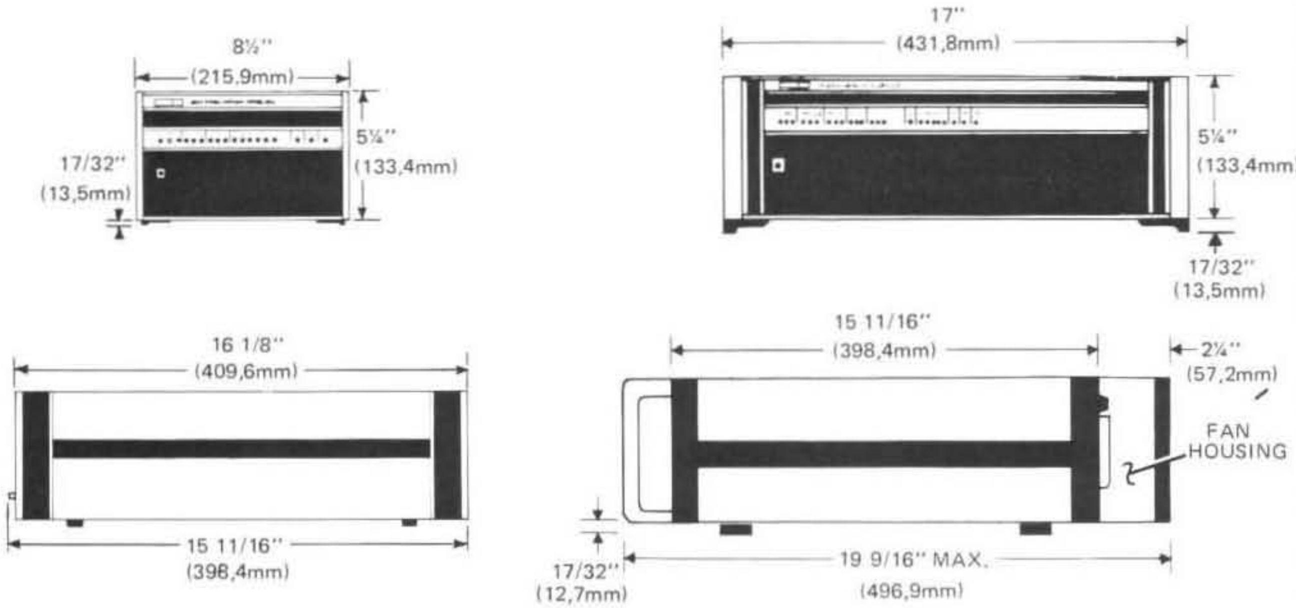
All 4200 Series POWER-DAC's come equipped with isolated control logic and front panel display of the digital command word. (For special applications requiring direct coupled control logic, e.g., for manual operation, it may be obtained on a special basis. Contact the factory for a special quotation).

Options are ordered as separate line items. Note that Option –03, External Reference, has a part number "4200A–03" which is used for all model numbers. The current limit Option –06 for the 4265A is specified as "Option 4250A–06." Similarly, Option –06 for the 4275A is specified as "4270A–06."

Example Order Format:

A 4275A with External Reference and Programmable Current Limit would be ordered as follows:

Model 4275A	$1895
Option 4200A–03, External Reference	200
Option 4270A–06, Current Limit	200



4210A & 4216A
WEIGHT: 12 POUNDS
(5,5Kg)

4250A, 4265A, 4270A and 4275A
WEIGHT: 35 POUNDS
(15,9Kg)

408B

FLUKE

POWER SUPPLY

FEATURES

0 - 6000 Volts	0.001% Regulation
0 - 20 ma	5 mv Resolution
Adjustable Overcurrent Trip	All-silicon-transistor Amplifiers

Fluke Model 408B is an extremely well regulated, low noise instrument designed to meet the most exacting high voltage DC power supply requirements. The design utilizes a high-gain, all-silicon-transistor amplifier coupled with a single 4-65 series pass tube to provide exceptionally low ripple and high stability. Conservative design and high reliability components ensure stable, maintenance-free service for extended periods of time.

The high voltage source is developed by a voltage doubler utilizing a tapped-primary transformer, high-voltage silicon-rectifier stacks and oilfilled filter capacitors. Output of this DC source is regulated by the type 4-65 series pass tube. The pass tube is controlled by a solid-state feedback amplifier with greater than 130 db of DC gain resulting in excellent regulation and ripple performance. The switched decade voltage divider which controls output voltage consists of stable, low-temperature-coefficient wirewound resistors manufactured and processed by Fluke. The output of the supply is available at front and rear panels through MS3102A-18-16S connectors. Output polarity may be selected by means of the front panel switch to provide either positive- or negative-grounded operation. A zero-center panel meter monitors output voltage.

The 408B is protected against overcurrent conditions by a current-trip circuit factory set at 25 ma load current. The current-trip level may be internally adjusted to latch off the supply between 5 and 25 ma.

Design development included thorough testing under adverse conditions of temperature, humidity, altitude, shock and vibration to ensure reliable operation under severe environmental conditions. Package design has provided for a sturdy mechanical structure utilizing flow-soldered, glass-epoxy printed circuit boards for component mounting. Interlocks interrupt the high-voltage excitation when top or bottom covers are removed. Side panels are tapped to provide for mounting with standard chassis slides or other rack mounting arrangements. Resilient rubber feet are also provided for bench top use.

408B SPECIFICATIONS

OUTPUT VOLTAGE: 0 to ±6000 VDC.

OUTPUT CURRENT: 0. to 20 milliamperes.

OUTPUT POLARITY: + or - grounded via front panel switch.

LINE REGULATION: 0.001% or 2 mv (whichever is greater) for 10% line change from nominal.

LOAD REGULATION: 0.001% or 5 mv (whichever is greater) for full load change.

STABILITY: ±0.005% per hour; ±0.02% per day after warmup.

RESOLUTION: 5 millivolts.

RIPPLE: Less than 1 mv RMS; less than 5 mv peak-to-peak.

VOLTAGE CALIBRATION:

0 to 5000V in 5 steps of 1000V
0 to 900V in 9 steps of 100V
0 to 90V in 9 steps of 10V
0 to 9V in 9 steps of 1V
0 to 1.2V vernier

CALIBRATION ACCURACY: ±0.25% or 250 mv (whichever is greater) with vernier at zero.

RESETABILITY: ±0.05% or 50 mv (whichever is greater).

RECOVERY TIME: Within 50 microseconds.

WARMUP TIME: 30 minutes.

OVERCURRENT TRIP: Set to latch off at 25 ma load current. Internally adjustable from 5 to 25 ma.

METER: 6000-0-6000 VDC (±3%).

OUTPUT CONNECTORS: MS3102A-18-16S front and rear (one mating connector supplied).

HUMIDITY: 0 to 80%.

OPERATING TEMPERATURE RANGE: 0°C to 50°C.

STORAGE TEMPERATURE RANGE: -20°C to +70°C.

ALTITUDE, OPERATING: 0 to 10,000 ft.

ALTITUDE, NON-OPERATING: 0 to 50,000 ft.

VIBRATION: Meets MIL-T-945A.

SHOCK: Meets MIL-E-4970A (20 g's, 11 milliseconds in three principal axis).

TEMPERATURE COEFFICIENT OF OUTPUT: Less than 20 ppm per °C from +10°C to +40°C.

INPUT POWER: 115/230 VAC ±10%, 50 - 60 cps, approximately 300 VA at full output. Operation at 400 cps available upon request.

SIZE: 19" wide x 8-3/4" high x 15" behind panel (rack mount with resilient feet for bench use).

WEIGHT: Approximately 59 pounds.

PRICE: $895.00 all prices are f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

410B

FLUKE

POWER SUPPLY

FEATURES

0 - 10,000 Volts	0.001% Regulation
0 - 10 ma	5 mv Resolution
Adjustable Overcurrent Trip	All-silicon-transistor Amplifiers

Fluke Model 410B is an extremely well regulated, low noise instrument designed to meet the most exacting high voltage DC power supply requirements. The design utilizes a high-gain, all-silicon-transistor amplifier coupled with a single 4-65 series pass tube to provide exceptionally low ripple and high stability. Conservative design and high reliability components ensure stable, maintenance-free service for extended periods of time.

The high voltage source is developed by a voltage doubler utilizing a tapped-primary transformer, high-voltage silicon-rectifier stacks and oilfilled filter capacitors. Output of this DC source is regulated by the type 4-65 series pass tube. The pass tube is controlled by a solid-state feedback amplifier with greater than 130 db of DC gain resulting in 0.001% regulation and less than 1 mv RMS ripple. The switched decade voltage divider which controls output voltage consists of stable, low-temperature-coefficient wirewound resistors manufactured and processed by Fluke. The output of the supply is available at front and rear panels through MS3102A-18-16S connectors. Output polarity may be selected by means of the front panel switch to provide either positive- or negative-grounded operation. A zero-center panel meter monitors output voltage.

The 410B is protected against overcurrent conditions by a current-trip circuit factory set at 12 ma load current. The current-trip level may be internally adjusted to latch off the supply between 5 and 15 ma.

Design development included thorough testing under adverse conditions of temperature, humidity, altitude, shock and vibration to ensure reliable operation under severe environmental conditions. Package design has provided for a sturdy mechanical structure utilizing flow-soldered, glass-epoxy printed circuit boards for component mounting. Interlocks interrupt the high voltage excitation when top or bottom covers are removed. Side panels are tapped to provide for mounting with standard chassis slides or other rack mounting arrangements. Resilient rubber feet are also provided for bench top use.

SPECIFICATIONS

OUTPUT VOLTAGE: 0 to ±10,000 VDC.

OUTPUT CURRENT: 0 to 10 milliamperes.

OUTPUT POLARITY: + or - grounded via front panel switch.

LINE REGULATION: 0.001% or 2 mv (whichever is greater) for 10% line change from nominal.

LOAD REGULATION: 0.001% or 5 mv (whichever is greater) for full load change.

STABILITY: ±0.005% per hour; ±0.02% per day after warmup.

RESOLUTION: 5 millivolts.

RIPPLE: Less than 1 mv RMS; less than 5 mv peak-to-peak.

VOLTAGE CALIBRATION:
0 to 9000V in 9 steps of 1000V
0 to 900V in 9 steps of 100V
0 to 90V in 9 steps of 10V
0 to 9V in 9 steps of 1V
0 to 1.2V vernier

CALIBRATION ACCURACY: ±0.25% or 250 mv (whichever is greater) with vernier at zero.

RESETABILITY: ±0.05% or 50 mv (whichever is greater).

RECOVERY TIME: Within 50 microseconds.

WARMUP TIME: 30 minutes.

OVERCURRENT TRIP: Set to latch off at 12 ma load current. Internally adjustable from 5 to 15 ma.

METER: 10,000-0-10,000 VDC (±3%).

OUTPUT CONNECTORS: MS3102A-18-16S front and rear (one mating connector supplied).

HUMIDITY: 0 to 80%.

OPERATING TEMPERATURE RANGE: 0°C to 50°C.

STORAGE TEMPERATURE RANGE: -20°C to +70°C.

ALTITUDE, OPERATING: 0 to 10,000 ft.

ALTITUDE, NON-OPERATING: 0 to 50,000 ft.

VIBRATION: Meets MIL-T-945A.

SHOCK: Meets MIL-E-4970A (20 g's, 11 milliseconds in three principal axis).

TEMPERATURE COEFFICIENT OF OUTPUT: Less than 20 ppm per °C from +10°C to +40°C.

INPUT POWER: 115/230 VAC ±10%, 50 - 60 cps, approximately 300 VA at full output. Operation at 400 cps available upon request.

SIZE: 19" wide x 8-3/4" high x 15" behind panel (rack mount with resilient feet for bench use). (48.2 x 22.2 x 38.1 cm)
WEIGHT: Approximately 59 pounds. (26.76 kg)

PRICE: $995.00, all prices are f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

FLUKE

POWER SUPPLY

Model 412B combines the high reliability of silicon transistor amplifiers with the high voltage capability of series pass tubes to provide a conservatively rated 0 to 2100 volt, 30 ma power supply. Careful attention to mechanical layout combined with the high gain feedback amplifier results in extremely low ripple and excellent regulation characteristics. Conservative design and high reliability components ensure stable, maintenance-free service for extended periods of time.

The high voltage supply is developed by a voltage doubler circuit using a switched secondary high voltage transformer, high voltage silicon rectifier stacks and oil-filled filter capacitors. Output of this supply is regulated by parallel type 8068 series pass tubes. The tubes are in turn controlled by a solid-state feedback amplifier with greater than 130 db of DC gain. The variable voltage divider sampling string, which is switched to change output voltage, consists of stable, low temperature coefficient, wirewound resistors manufactured by Fluke. Output of the supply is available at both the front panel and rear panel through UG 931/U connectors. Output polarity is controlled by a front panel switch to provide either positive or negative grounded operation. A zero center panel meter monitors output voltage.

FEATURES

- 0-2100 VDC
- 0-30 ma
- Overcurrent Protection
- 1 mv Peak-to-peak Ripple
- 0.001% Regulation
- 5 mv Resolution
- 3-1/2" Panel Height
- All-Silicon Transistor Amplifiers

The 412B is protected against overcurrent conditions by a circuit which opens the input to the high voltage rectifier in the event that output current exceeds 32 milliamps. This circuit may be internally adjusted to trip at other current levels as required.

The instrument has been thoroughly tested under extreme conditions of temperature, humidity, altitude, shock and vibration to ensure reliable operation under severe environmental conditions. Package design has provided a sturdy mechanical structure. Side panels are tapped to provide for mounting with a standard chassis slide or other rack mounting arrangements. Resilient rubber feet are also provided for bench top use.

412B SPECIFICATIONS

OUTPUT VOLTAGE: 0 to ±2100 VDC.

OUTPUT CURRENT: 0 to 30 milliamperes.

OUTPUT POLARITY: + or - grounded via front panel switch.

LINE REGULATION: 0.001% or 2 mv (whichever is greater) for 10% line change from nominal.

LOAD REGULATION: 0.001% or 5 mv (whichever is greater) for full load change.

STABILITY: ±0.005% per hour; ±0.02% per day after warmup.

RESOLUTION: 5 millivolts.

RIPPLE: Less than 500 uv RMS; less than 1 mv peak-to-peak.

VOLTAGE CALIBRATION:
- 0 to 1500V in 3 steps of 500V
- 0 to 500V in 5 steps of 100V
- 0 to 90V in 9 steps of 10V
- 0 to 9V in 9 steps of 1V
- 0 to 1.2V vernier

CALIBRATION ACCURACY: ±0.25% or 100 mv (whichever is greater) with vernier at zero.

RESETABILITY: ±0.05% or 50 mv (whichever is greater).

RECOVERY TIME: Within 50 microseconds.

WARMUP TIME: 30 minutes to meet specifications.

OVERCURRENT PROTECTION: Set to latch off at 32 ma load current.

METER: 2100-0-2100 VDC (±3%).

OUTPUT CONNECTORS: UG931/U front and rear (one mating connector supplied).

HUMIDITY: 0 to 80%.

OPERATING TEMPERATURE RANGE: 0°C to 50°C.

STORAGE TEMPERATURE RANGE: -20°C to +70°C.

ALTITUDE, OPERATING: 0 to 10,000 ft.

ALTITUDE, NON-OPERATING: 0 to 50,000 ft.

VIBRATION: Meets MIL-T-945A.

SHOCK: Meets MIL-E-4970A (20 g's, 11 milliseconds in three principal axis).

TEMPERATURE COEFFICIENT OF OUTPUT: Less than 20 ppm per °C from +10°C to +40°C.

INPUT POWER: 115/230 VAC ±10%, 50 - 60 cps, approximately 300 VA at full output. Operation at 400 cps available upon request.

SIZE: 19" wide x 3-1/2" high x 15" behind panel (rack mount with resilient feet for bench use). (48.2 x 8.9 x 38.1 cm)
WEIGHT: Approximately 28 pounds. (12.70 kg)

PRICE: $495.00, all prices are f.o.b. factory, Mountlake Terrace, Washington.

415B

POWER SUPPLY

FEATURES

- 0-3100 VDC
- 0-30 ma
- Overcurrent Protection
- 1 mv Peak-to-peak Ripple
- 0.0005% Regulation
- 5 mv Resolution
- 3-1/2" Panel Height
- All-Silicon Transistor Amplifiers
- 100 uv RMS Ripple

Model 415B combines the high reliability of silicon transistor amplifiers with the high voltage capability of series pass tubes to provide a conservatively rated 0 to 3100 volt, 30 ma power supply. Careful attention to mechanical layout combined with the high gain feedback amplifier results in extremely low ripple and excellent regulation characteristics. Conservative design and high reliability components ensure stable, maintenance-free service for extended periods of time.

The high voltage supply is developed by a voltage doubler circuit using a switched secondary high voltage transformer, high voltage silicon rectifier stacks and oil-filled filter capacitors. Output of this supply is regulated by parallel type 8068 series pass tubes. The tubes are in turn controlled by a solid-state feedback amplifier with greater than 130 db of DC gain. The variable voltage divider sampling string, which is switched to change output voltage, consists of stable, low temperature coefficient, wirewound resistors manufactured by Fluke. Output of the supply is available at both the front panel and rear panel through UG 931/U connectors. Output polarity is controlled by a front panel switch to provide either positive or negative grounded operation. A zero center panel meter monitors output voltage.

The 415B is protected against overcurrent conditions by a circuit which opens the input to the high voltage rectifier in the event that output current exceeds 32 milliamps. This circuit may be internally adjusted to trip at other current levels as required.

The instrument has been thoroughly tested under extreme conditions of temperature, humidity, altitude, shock and vibration to ensure reliable operation under severe environmental conditions. Package design has provided a sturdy mechanical structure. Side panels are tapped to provide for mounting with a standard chassis slide or other rack mounting arrangements. Resilient rubber feet are also provided for bench top use.

OUTPUT VOLTAGE: 0 to ±3100 VDC.

OUTPUT CURRENT: 0 to 30 milliamperes.

OUTPUT POLARITY: + or - grounded via front panel switch.

LINE REGULATION: 0.0005% or 2 mv (whichever is greater) for 10% line change from nominal.

LOAD REGULATION: 0.0005% or 5 mv (whichever is greater) for full load change.

STABILITY: ±0.002% per hour; ±0.01% per day after warmup (constant line, load, and temperature).

RESOLUTION: 5 millivolts.

RIPPLE: Less than 100 uv RMS; less than 1 mv peak-to-peak.

VOLTAGE CALIBRATION:
- 0 to 2500V in 5 steps of 500V
- 0 to 500V in 5 steps of 100V
- 0 to 90V in 9 steps of 10V
- 0 to 9V in 9 steps of 1V
- 0 to 1.2V vernier

CALIBRATION ACCURACY: ±0.25% or 100 mv (whichever is greater) with vernier at zero.

RESETABILITY: ±0.05% or 50 mv (whichever is greater).

RECOVERY TIME: Within 50 microseconds.

WARMUP TIME: 60 minutes to meet specifications.

OVERCURRENT PROTECTION: Set to latch off at 32 ma load current.

METER: 3100-0-3100 VDC (±3%).

OUTPUT CONNECTORS: UG931/U front and rear (one mating connector supplied).

HUMIDITY: 0 to 80%.

OPERATING TEMPERATURE RANGE: 0°C to 50°C.

STORAGE TEMPERATURE RANGE: -20°C to +70°C.

ALTITUDE, OPERATING: 0 to 10,000 feet.

ALTITUDE, NON-OPERATING: 0 to 50,000 feet.

VIBRATION: Meets MIL-T-945A.

SHOCK: Meets MIL-E-4970A (20 g's, 11 milliseconds in three principal axes).

TEMPERATURE COEFFICIENT OF OUTPUT: Less than 20 ppm per °C from +10°C to +40°C.

INPUT POWER: 115/230 VAC ±10%, 50 - 60 cps, approximately 300 VA at full output. Operation at 400 cps available upon request.

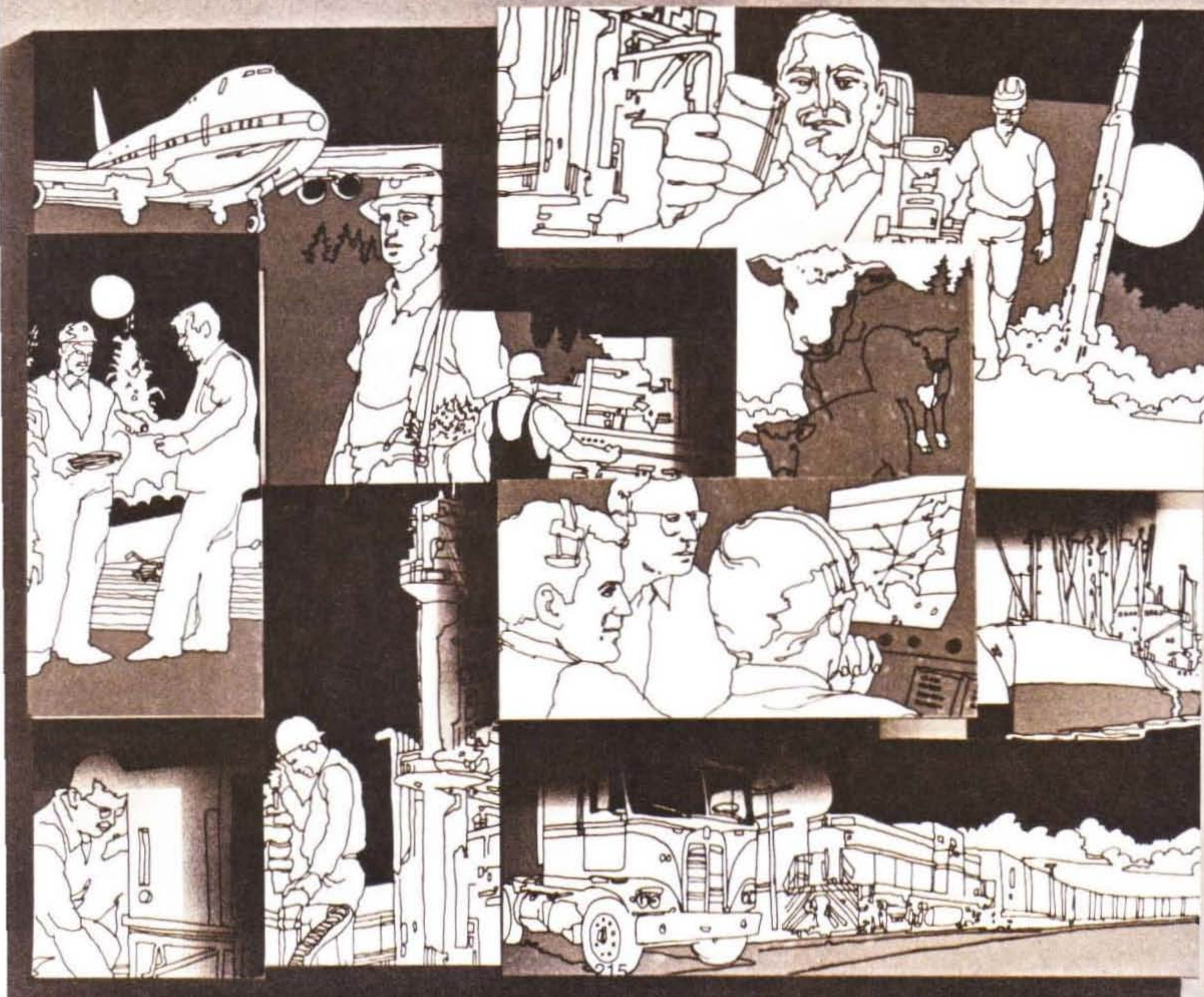
SIZE: 19" wide x 3-1/2" high x 15" behind panel (rack mount with resilient feet for bench use).
(13.3 x 43.1 x 45.7 cm)

WEIGHT: Approximately 30 pounds. (27.21 kg)

PRICE: $595.00 f.o.b. factory, Mountlake Terrace, Washington.

section 8

frequency synthesizers time and frequency standards



A coherent frequency synthesizer is a device that produces an output frequency which is related to an input reference by the ratio of two integers. A typical synthesizer will produce any selected frequency within its specified range in increments of 1 Hz or smaller. The frequency selection may be accomplished with front panel control switches having in-line readout or by remote logic drive. The reference frequency from which the output is derived is provided from an external standard, typically a high quality crystal oscillator, or may be optionally included within the synthesizer.

Measure of Performance

The real quality of a frequency synthesizer is measured by the spectral purity of its output. Spectral purity is a gross term used to describe contaminants, including noise and discrete spurious signals, in the output of the synthesizer.

Three specifications describe the spectral purity of **Fluke** synthesizers. These are signal to noise ratio in a 30 kHz bandwidth, phase noise spectral density measured in a 1 Hz bandwidth at certain offsets from the carrier and spurious output levels.

Features

The **Fluke** Model 645A is a synthesizer of the "direct" type. The output of a direct synthesizer is obtained by performing a series of arithmetic operations on the reference frequency. The primary advantage of a direct synthesizer is its capability of micro-second switching speeds. The Model 645A has this advantage, but maintains state-of-the-art spectral performance.

With the introduction of the 6160B, **Fluke** has also satisfied the requirement for a lower cost synthesizer offering premium performance. The 6160B is of the "indirect" type employing a VCO that is phase locked to the reference frequency. While not as fast as the 645A, the 6160B offers very good noise performance, attractive cost performance, and switching speed that is fast for its type and adequate for most applications.

COMPARISON OF PERFORMANCE FEATURES

FEATURE	MODEL 645A	MODEL 6160A
Frequency: Range Increments	 dc - 50 MHz 0.01 Hz	 1 MHz - 160 MHz 1 Hz
Spurious:	−100dB	−83dB to −100dB
Signal-to-Phase Noise Ratio*	78dB	74dB**
Switching Time	20μs	0.8 ms
Levelling	± 0.25dB	± 1dB
Output Level	1 V rms into 50Ω	1 V rms into 50Ω

*Residual, measured in a 30 kHz band excluding a 1 Hz band centered on the carrier.
**Specification improves for dialed frequencies below 80 MHz.

Applications

Synthesizers find application whenever an agile, highly accurate, high performance frequency source is required. They are particularly important when the source must be remotely programmed or when more than one source must be related to one common frequency reference. These very requirements generally exist in the form of local oscillators and exciters for modern communications systems, such as satellite up and down links and spectrum surveillance receivers. These systems always require good phase noise performance and a minimum of spurious outputs; and a further need for frequency agility or coherence makes the use of frequency synthesizers mandatory.

The **Fluke** Models 645A and 6160B are ideally suited for these applications. Because of their highly flexible modular construction, the units can be customized for almost any application, with changes in frequency range, resolution, control features, and many others possible.

Among the many other applications for **Fluke** Frequency Synthesizers are testing of crystals, automatic testing of filters and networks, laboratory signal generator replacement and nuclear magnetic resonance (NMR) studies.

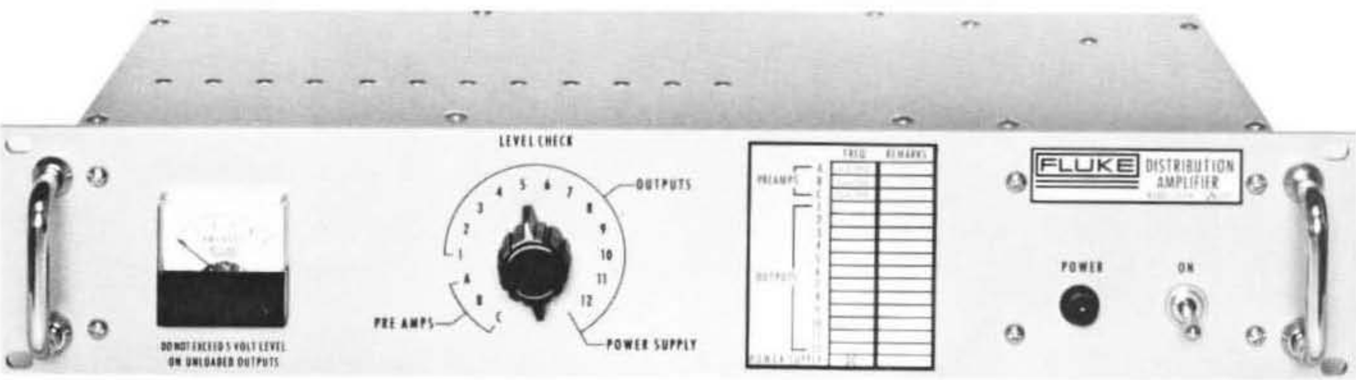
Time and Frequency Standards and Accessories

The **John Fluke Mfg. Co., Inc.** also provides instruments for maintaining frequency and time standards and distributing standard frequencies from the standards laboratory.

The Model 207-5 VLF Receiver/Comparator is used to receive frequency references from such universally accepted standards as those maintained by the National Bureau of Standards and the U.S. Naval Observatory, as well as those maintained in England and France. The unit compares the in-house frequency standard to the received reference and presents a record of relative time difference between the two for long term maintenance of the local standard.

The Model 203A Distribution Amplifier completes the standardization process by providing the means to distribute the standard frequencies throughout a laboratory or manufacturing complex. Each 203A provides twelve output channels that can be chosen to operate at any one of three commonly used reference frequencies. Also, more than one unit may be cascaded for further distribution at remote locations.

DISTRIBUTION AMPLIFIER



- 3 STANDARD FREQUENCY INPUTS
- ALL SOLID STATE - MODULARIZED CONSTRUCTION
- 12 OUTPUT CHANNELS
- RELIABILITY AND VERSATILITY AT LOW COST
- CHANGE CHANNEL FREQUENCIES WITH NO CHANGE IN WIRING

The Model 203A Distribution Amplifier provides an economical method of distributing precision frequencies to many remote locations. The amplifier will accept input frequencies of 100 kHz, 1 MHz and 5 MHz and the 12 output amplifiers will provide output frequencies at any of the three input frequencies in any combination desired.

A floating input permits cascading of distribution amplifiers to construct a network of any complexity. As an example, a single Model 203A in the central standards laboratory could feed a number of different laboratories. An additional amplifier at each laboratory could be used to distribute the standard frequency to benches for operation of counters, frequency synthesizers, and communications equipment.

Signal input and output BNC type connectors are located on the rear panel of the unit and all are labeled.

When used with a precision oscillator and a Fluke VLF Receiver it is possible to operate all frequency-dependent test equipment in a laboratory to an accuracy of a few parts in 10^{11}, and short-term stabilities of a few parts in 10^{11}. This is an improvement of several orders of magnitude over present techniques which depend on the stability of time base oscillators in each individual piece of equipment between calibrations.

SPECIFICATIONS

Change of frequency for a given channel is easily accomplished by inserting the module of appropriate frequency into that channel. Each module is clearly labeled. Preamplifiers and Power Supply are also on separate modules.

INPUT FREQUENCIES: Each of the 3 input channels will accept 5 MHz, 1 MHz, and/or 100 kHz depending on the preamplifier installed.

INPUT LEVEL: 0.5 to 5.0 volts rms. Input level adjustment provided for each input on back panel.

INPUT IMPEDANCE: Nominally 50 ohms with any number of amplifier modules connected.

OUTPUT LEVEL: Each channel continuously adjustable for output range of 0.5 to 4.0 volts rms into 50 ohms. Level control for individual amplifiers is accessible through top cover.

STABILITY (SHORT TERM): Typically better than 1 x 10^{-11} Standard Deviation for a one-second averaging time at 1 MHz.

PHASE TEMPERATURE COEFFICIENT: Input to output phase temperature coefficient typically never exceeds $1^{o}/^{o}C$ for all 3 frequencies.

BANDWIDTH: Less than 3% of input frequency for 3 db down and 15% for 30 db down.

HARMONICS: 60 db below signal level.

SPURIOUS: 80 db below signal level.

ISOLATION: With all inputs energized, the signal level at any output connector is changed less than 3% when any other output is short circuited.

METERING: Front panel meter and switch provides indication of preamplifier and output signal levels.

TEMPERATURE: Operating: $0^{o}C$ to $50^{o}C$
Non-operating: $-40^{o}C$ to $+75^{o}C$

HUMIDITY: 0 to 85% relative humidity.

SIZE: Front panel 3½" X 19", 9" behind front panel.

WEIGHT: 13 pounds.

POWER REQUIREMENTS: 115/230 volts, ±10%, 50-400 Hz, approximately 35 watts.

A separate connector on the rear panel provides for input of standby DC at any voltage from 22 to 30 VDC. Internal circuitry detects loss of primary power and automatically cuts over to the external standby DC power.

ORDERING INFORMATION

Model 203A Distribution Amplifier with a standard configuration of 4 output channels at each of the 3 input frequencies – $1495.00

NOTE: The base unit is designed to accept 3 preamplifiers (1 at each of the 3 input frequencies) each of which is capable of driving up to 12 amplifiers.

Model 203A Distribution Amplifier with a nonstandard configuration consisting of any combination of output channels (including deletions) - - - $1520.00 base price less $25.00 for each preamplifier deleted or $32.50 for each amplifier deleted.

All prices FOB factory.

VLF Receiver/Comparator 207–5

FEATURES:

- Electronic Servo
- Completely Solid State Design
- Extensive Use of High Reliability Integrated Circuits
- 80 dB Dynamic Range with No AGC or Operator Control
- Dual Conversion
- Offset Intermediate Frequencies
- 10 Nanovolt Sensitivity
- –50 dB Signal/Noise Tracking
- 8.0 To 31.9 kHz and 60.0 kHz Coverage
- Designed for Operator Ease

Model 207-5 VLF Receiver/Comparator is an all electronic phase tracking receiver designed to provide state-of-the-art calibration of local frequency standards and facilities for VLF propagation measurements. Frequency coverage is from 8.0 to 31.9 kHz in steps of 100 Hz with an additional channel at 60.0 kHz. The superior design features of the Model 207-5 set this instrument apart from all others. Such advanced features as symmetrical clipping of RF and IF to provide more than 80 dB of dynamic range with no operator control while eliminating the need for impulse noise blanking, dual conversion with offset IF's, extensive use of high reliability integrated circuits, and "tell-tale" front panel indicator lights are unique to the Model 207-5.

The Model 207-5 has been designed with particular attention to ease of operation. Frequency selection is by means of rotary switches with large in-line indicators.

Front panel lights provide immediate indication of normal operation of the receiver. Controls are logically grouped and clearly marked. A front panel meter permits the operator to monitor important circuit functions, and when necessary, to make all needed internal adjustments without other test equipment.

The Model 207-5, provides, in a single chassis, a frequency standard, the means to compare it to standard VLF transmissions, and in turn to compare other frequency standards to the internal corrected standard.

The 1 MHz quartz crystal oscillator, with stability of 2 parts in 10^9 per day mounts in the instrument chassis and operates from the regulated supply.

The oscillator is ruggedly constructed and offers moderately high stabilities which are sufficient for the calibration of laboratory instruments such as frequency counters. The crystal is housed in a proportionally controlled oven, and, as in the case of the VLF receiver itself, the electronic circuitry is all solid-state.

The comparison input allows the operator to compare a second frequency standard with the local standard. The comparison is made with an absolute minimum of operator adjustment. To make such a measurement, the signal to be compared is introduced at a convenient BNC connector located on the front panel of the instrument. This signal automatically disables the RF section of the receiver and indicates this mode of operation by the presence of the "No Signal" light. The relative phase comparison between the working standard and house standard is read directly from the strip-chart recorder in the same manner as when the house standard is compared to a received VLF signal.

Removal of the input signal returns the receiver to normal operation. The digital accumulator and relative-time chart readout will resume the previous comparison between the house standard and VLF signal without loss of phase information so long as they have not changed relative phase by more than $\pm 180^\circ$ during the period of measurement.

Specifications

CALIBRATION ACCURACY ..... Short term and long term stability is better than ± 0.5 microsecond. Under normal laboratory conditions intrinsic calibration accuracy (relative to received VLF carrier) is better than $\pm 1 \times 10^{-11}$ on a 24-hour basis.

FREQUENCY COVERAGE ..... 8.0 to 31.9 kHz in steps of 100 Hz, plus channel at 60.0 kHz.

RECEIVER SENSITIVITY ..... 10 nanovolt signal at 50 ohm antenna input terminal enables phase tracking. Tracking is maintained at an input signal-to-noise ratio of -50 dB (Gaussian noise measured in a 10 kHz bandwidth). Sensitivity stated is that of receiver exclusive of antenna.

SELECTIVITY .... 60 dB bandwidth approximately 200 Hz.

IF and IMAGE REJECTION ...... The straight-through IF and primary image rejection is at least 60 dB

DYNAMIC RANGE .... Symmetrical clipping in RF and IF stages assures reliable phase-locked servo operation over an 80 dB range of carrier level without the use of AGC. Less than ± 0.25 microsecond phase shift will be experienced for a 40 dB change in signal level. The total signal level operating range is in excess of 140 dB, including 60 dB front panel attenuator.

RF FILTER CAPABILITY .... A front panel five-position switch permits selection of either a broadband filter or narrow band filters. Broadband filter position will normally be used for all channel tracking capability; optional plug-in narrowband filters provide additional frequency selectivity. Filters may be ordered for any frequency within range of the receiver.

BANDWIDTH

a. RF bandwidth (narrowband filters) nominal 1.5% of center frequency.

b. IF bandwidth - nominal 50 Hz.

c. Servo bandwidth (equivalent noise bandwidth) equal to selected tracking rate times received frequency. Thus servo bandwidth when receiving 16 kHz is from 0.00048 Hz to 0.016 Hz depending on tracking rate.

AUTOMATIC SERVO DISABLE CIRCUIT . . . . An electronic switch is provided to disable the phase servo whenever the VLF carrier drops below a minimum level; a front panel warning lamp lights at the same time. Tracking resumes automatically when carrier returns.

STANDARD FREQUENCY INPUT . . . . 100 kHz, 1 MHz or any integral multiple of 100 kHz between these two frequencies.

INTERNAL STANDARD

Output Frequency . 1 MHz

Output Level. . . . . 1 volt into 50 ohms

Stability . . . . 24 hours (at shipment) $\pm 5 \times 10^{-9}$
24 hours (after 1 mo.) $\pm 2 \times 10^{-9}$
1 second interval, $\pm 2 \times 10^{-10}$

Warmup Time . . . . Approximately 100 minutes to be within 1×10^{-7}

Adjustment Range . . . . By means of front-panel ten-turn potentiometer; approximately 4×10^{-10} per division with range of approximately 2×10^{-7}. Total mechanical adjustment approximately 6×10^{-7}

INPUT LEVEL . . . . . 0.2 to 5.0 volts rms into 1,000 ohms. Accepts sine wave, square wave or pulse input. Pulse amplitudes from 0.5 to 14.0 volts peak-to-peak.

DIGITAL ERROR ACCUMULATOR. . . A front panel digital counter is pulsed by the electronic phase servo and displays relative time difference between the local standard and VLF carrier. The counter accumulates up to 9999.9 microseconds. The counter dial may be manually set to zero or other desired initial reading independently of phase position of tracking servo.

FRONT PANEL RECORDER . . . . . . A built-in recorder on the front panel presents a time history of the accumulated phase difference between the local standard and the received VLF carrier. Recorder utilizes an inkless stylus and operates at one inch per hour. Full scale chart width may be 10 or 100 microseconds of relative phase, selectable with rear panel switch.

AUDIO OUTPUT. . . . A built-in speaker and volume control for aural monitoring of the received VLF station at the 1.1 kHz intermediate frequency is provided. Head phone jack is also provided to override speaker.

ADDITIONAL COMPARISON INPUT . . . .

Input Signal Frequency . . . . . . 1 MHz, 100 kHz or any integral multiple 100 kHz between these two frequencies.

Voltage . . . . 0.5 to 14.0 volts peak-to-peak, sine wave, square wave or pulse.

Impedance . . . . . . Greater than 1000 ohms

Connector . . . . . . Front panel BNC.

AUXILIARY OUTPUTS . . . . . . Following outputs are available on rear chassis BNC connectors:

a. Amplifier VLF station signal at 1.1 kHz intermediate frequency and phase coherent with RF carrier.

b. 100 kHz square wave phase corrected to received signal, level compatable with RTL.

c. 1 kHz square wave phase corrected to received signal, level compatable with RTL.

d. 100 Hz square wave phase corrected to received signal, level compatable with RTL.

e. Reference frequency offset +51.1 kHz from dialed frequency, level compatable with RTL.

Following outputs are available on rear chassis terminal block;

a. Relative time signal for external recorder; 0-1 Ma represents 0-10 or 100 microseconds depending on span selected by rear panel switch. Rear panel switch controls span of relative time recording.

b. Event marker in parallel with No Signal indicator light on front panel, 0 or +13 VDC.

c. Event marker in parallel with No Lock indicator light on front panel, 0 or +13 VDC.

d. Output of signal level phase detector in parallel with RF Signal indication on front panel meter, 20 dB range.

METER DISPLAY Front panel meter, in combination with Meter Function Switch, indicates:

a. Relative carrier level; 20 dB full scale plus indication of normal clipping operation of RF and IF stages.

b. Servo phase detector error voltage (zero-center)

c. Servo phase detector balance.

d. Signal phase detector balance.

e. Synthesizer alignment.

f. Level indication from internal power supply at plus and minus 13 VDC.

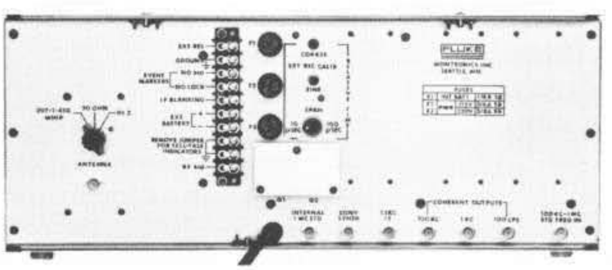
REAR PANEL CONTROLS:

a. Antenna selector switch; 3-position rotary switch selects input from Model 207-1-450 VLF Whip, other 50 ohm antenna, or High Impedance from long wire antenna.

b. Jumper on rear terminal block converts front panel indicator lights to "tell-tale" operation.

c. Coarse and fine adjustments of span for external recorder.

d Span selector switch for relative time recorder.



REAR PANEL VIEW

PHYSICAL SIZE AND CONSTRUCTION . . The receiver is designed for 19" relay-rack mounting, 7" high, 18" maximum depth behind panel. Net weight is approximately 35 lbs.

The instrument is of modular construction, using printed circuit boards and integrated circuit modules.

POWER REQUIREMENTS The receiver operates from 95-125 or 190-250 VAC, 60 Hz, or from a DC source of ±12 VDC standby batteries. External standby battery, when used, automatically assumes full operating load in the event of primary AC power failure. All receiver functions including servo tracking are sustained without interruption with the exception of the graphic recorder. For operation from 50 Hz power, order Model 207-5/AA.

ACCESSORIES

MODEL 207-1-450 VLF WHIP ANTENNA

A whip antenna specially designed for use with the Model 207-5. The base-mounted matching network is active, containing a field effect transistor and the required passive filter components, to achieve impedance matching from the antenna to a 50 ohm transmission line. Operating power for the field effect transistor is supplied through the center conductor of the coaxial cable from the receiver. One hundred feet of RG58/U cable is supplied with the antenna. Whip length is 102 inches.

CHASSIS SLIDES

Chassis is equipped with mounting hardware for Jonathan 110QD-18-A-2 chassis slides.

PLUG-IN-NARROW BAND RF FILTERS

Individual filters are available for each frequency within the operating range of the Model 207-5. Part No. is 207-422XXX where the center frequency is denoted by the last three figures.

PRICES:

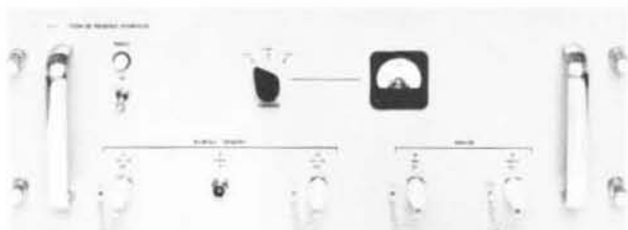
207-5 VLF	Receiver /Comparator . . . . 115 VAC, 60 Hz	$3995.00
207-5/AA VLF . .	Receiver/Comparator . . . . 230 VAC, 50 Hz	$3995.00
207-1-450	Antenna	$ 150.00

FLUKE SPECIAL PURPOSE SYNTHESIZERS

John Fluke frequency synthesizers are designed and constructed with highly flexible modularity. This provides the means by which the units can be individually tailored to particular systems applications, where required configurations differ from standard off-the-shelf products. The wide range of possible configurations are represented by the 6160A/A0, 6160A/DX, and 6160A/DY, shown below.

6160A/A0 was developed for use with a 50 times X-band multiplier. The unit is remotely programmed as if its output were at X-band.

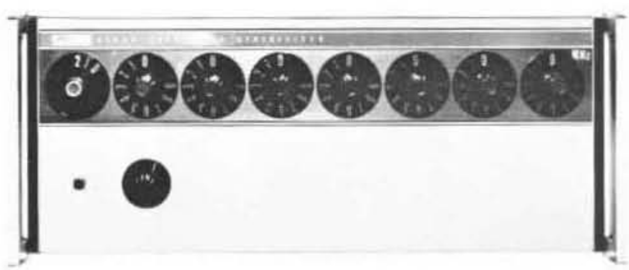
Frequency Range	130 - 160 MHz
Increments	20 Hz
Spurious	–70 dB
Internal Reference Stability	1 x 10^{-9}/24 hrs.
Programming	Remote BCD-TTL pos true



6160A/AO

6160A/DX was designed as a local oscillator for an HF receiver. A special AFC input has been supplied with this unit to provide the ability for the companion receiver to control the synthesizer frequency.

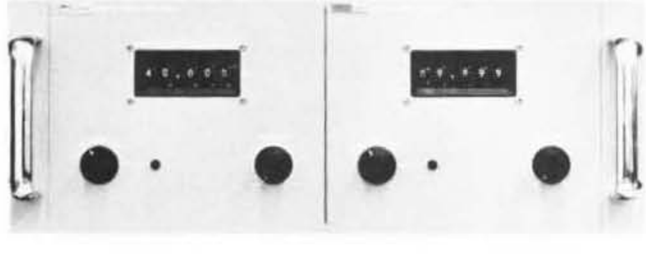
Frequency Range	4 - 30 MHz
Increments	1 Hz
Spurious	–80 dB
Internal Reference Stability	1 x 10^{-8}/24 hrs.
Programming	Front Panel Controls



6160A/DX

6160A/DY is another synthesizer designed to be a local oscillator for a satellite communications system. The main feature that distinguishes this unit from other Fluke synthesizers is its half-rack width, providing two agile frequency sources in the one rack increment.

Frequency Range	40 MHz - 160 MHz
Increments	1 kHz
Spurious	–55 dB
Frequency Reference	External 5 MHz
Programming	Front Panel Thumb Switches



6160A/DY

FLUKE®

Frequency Synthesizer 6160B

FEATURES:

- Output Frequency 1 MHz - 160 MHz, 1 Hz Steps
- Non-Harmonic Spurious −83 dB to −100 dB
- Signal-To-Phase Noise Ratio 74 dB (Typical)
- Switching Speed Less than 0.8 ms
- Modular Design Adaptable to Special Applications
- BCD Programming - TTL Positive True Logic
- Stability to 2 Parts in 10^9/24 Hrs.

DESCRIPTION

The 6160B frequency synthesizer uses the indirect method of frequency synthesis, employing phase-locked loops, digital dividers, and high Q VCO's. This method results in an attractive price/performance ratio with low discrete spurious and very low phase noise.

A unique feature of the 6160B is that the highest internally generated frequency is that of the output VCO, i.e., 80 to 160 MHz. This makes servicing easier, and eliminates UHF EMC problems.

A buffered 5 MHz output is available on the rear panel and may be utilized as a source for other applications. The 5 MHz input to the synthesizer is passed through a narrow band filter to eliminate noise and spurious signals offset by more than $\pm$200 Hz. The 6160B may be used on the bench or rack mounted,occupying only 7" of rack space. It operates from most primary voltages and frequencies, and in environments up to 50°C. Remote programming is DTL/TTL-BCD positive true logic or by contact closures. The internal standard with a 24 hour stability of $\pm$2 parts in 10^9 is available as an option, as is a lower cost TCXO having a stability of $\pm$5 parts in 10^6 per year.

The guaranteed non-harmonic spurious performance is plotted in Figure 1. Since the output VCO in the 6160B operates from 80 to 160 MHz, frequency division is employed for coverage of lower frequencies. This results in improved spurious specifications for frequencies lower than 80 MHz. Phase noise is similarly reduced for lower bands. Typical output phase noise spectrum of the Model 6160B is shown in Figure 2. This data represents the expected performance of a synthesizer measured in a 1 Hz bandwidth as a function of frequency offset either side of the signal. The curve is the residual phase noise from the 5 MHz input to the synthesizer output, measured at 160 MHz. Guaranteed performance points are also indicated.

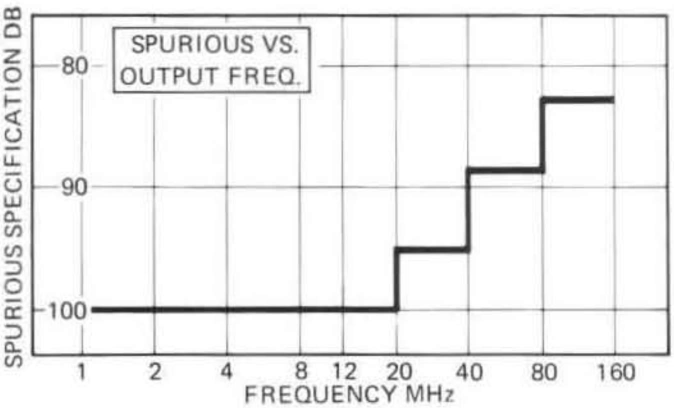


Fig. 1. NON-HARMONIC SPURIOUS PERFORMANCE

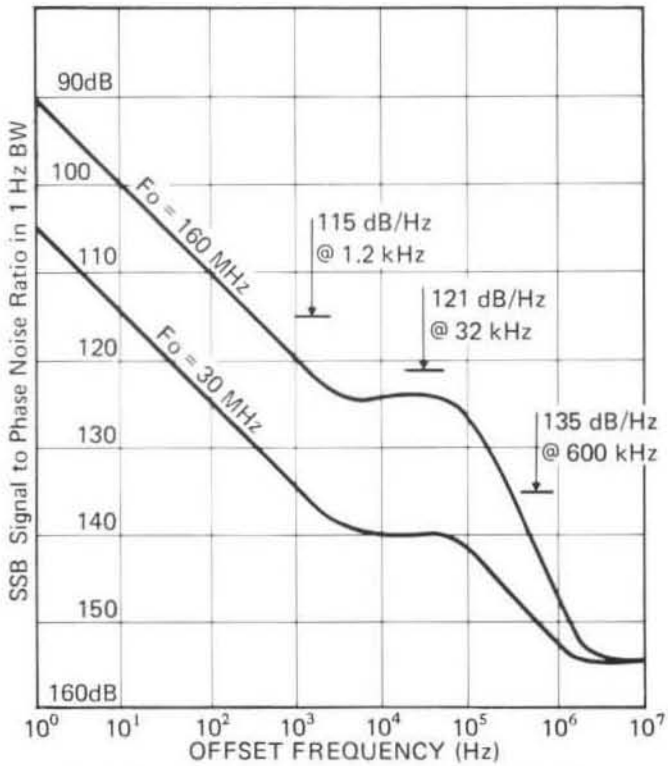


Fig. 2. NON-DISCRETE SPECTRAL PERFORMANCE

APPLICATIONS

SATELLITE COMMUNICATIONS

The new military and domestic communications satellites require large number of operating frequencies selectable on short notice. The low noise and spurious of the 6160B allows the output of this unit to be multiplied directly to microwave frequencies.

HF/VHF RECEIVERS

Fast switching speed and low spurious of the 6160B make this synthesizer an ideal choice for use in computer controlled or scanning surveillance receivers. Special versions of the 6160B can be tailored to the exact needs of a system while maintaining high performance characteristics.

AUTOMATED TEST SYSTEMS

BCD programmability, wide frequency range, electrically adjustable output level, and fast switching speed of the 6160B make this synthesizer an excellent selection for automatic test systems. Programming of frequency is by 34 parallel, TTL compatible lines. A remote flag and power flag are provided.

The 6160B is also useful in many other applications, including the following:

- Filter and Network Testing
- Crystal Testing
- Nuclear Magnetic Resonance Testing
- General Lab Use

Specifications

FREQUENCY

RANGES	1 MHz to 12 MHz	10 MHz to 160 MHz
INCREMENTS	0.1 Hz	1 Hz

SELECTION . . . . Front panel rotary switches, remote BCD-TTL or DTL positive true logic or contact closures. Logic "0" = 0 to +.9V dc. Logic "1" = +2 to +5V dc or open circuit.

SPURIOUS OUTPUTS

NON-HARMONIC . . . . Greater than 83 dB (to 100 dB) below fundamental. See chart on opposite page. *(Note: power line related spurious may exceed these specifications when unit is powered from 50 Hz, high line voltage source)*

HARMONICS . . . . Greater than 25 dB below fundamental. (Typically >30 dB)

SIGNAL TO NOISE RATIO (TYPICAL)

(Including the effects of the internal standard)

PHASE . . . . Greater than 62 dB

AMPLITUDE . . . . Greater than 94 dB

SYNTHESIZER RESIDUAL (TYPICAL) (Internal noise from 5 MHz input to synthesizer output)

PHASE . . . . Greater than 74 dB

AMPLITUDE . . . . Greater than 94 dB

Measured in a 30 kHz band excluding a 1 Hz band centered on the fundamental, for dialed frequencies from 80 MHz to 160 MHz. Improvement in signal to phase noise ratio is seen for lower frequencies.

PHASE NOISE SPECTRAL DENSITY

Guaranteed SSB S/N ratio at the synthesizer output measured in a 1 Hz bandwidth. Valid for dialed frequencies from 80 MHz to 160 MHz. Improvement for lower selected frequencies.

OFFSET FREQUENCY	GUARANTEED S/N
1.2 kHz	⟩ 115 dB
32 kHz	⟩ 121 dB
600 kHz	⟩ 135 dB

OUTPUT VOLTAGE

1 MHz - 160 MHz . . . . Adjustable from +3 dBm to +13 dBm into 50Ω (.3V to 1V rms) with front panel control or external dc voltage. Level maintained ±1 dB into 50Ω.

SWITCHING TIME . . . . Less than 800 μsec to be within 50 Hz of final frequency.

INTERNAL FREQUENCY STANDARD (Optional) . . . 5 MHz

OPTION	AGING RATE	TEMPERATURE STABILITY
–02	$\pm 2 \times 10^{-9}$/Day	1×10^{-8}, 0°C to 50°C
–05	$\pm 5 \times 10^{-6}$/Year	1×10^{-6}, 0°C to 40°C

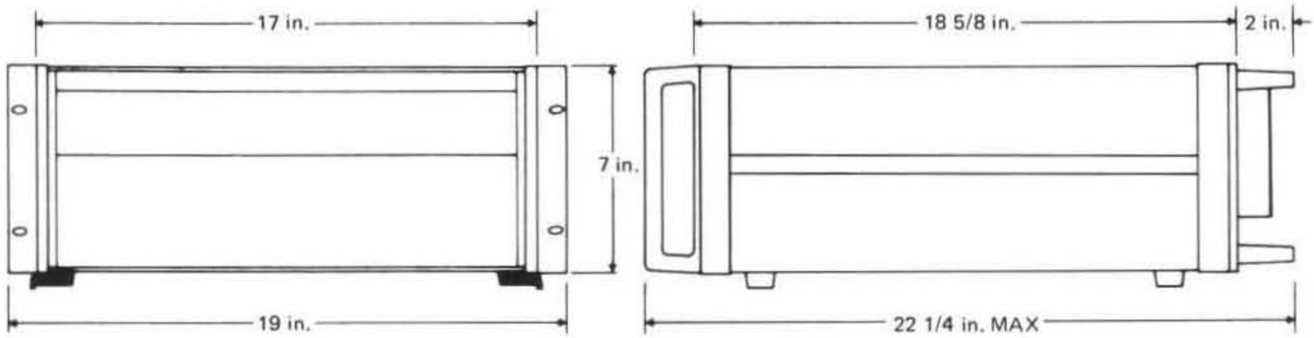
AUXILIARY OUTPUTS . . . . 5 MHz at nominally 1V rms into 50Ω.

AUXILIARY INPUTS:

Reference Frequency . . . . 5 MHz @ 0 dBm to +16 dBm into 50Ω

External Level Control . . . . 0.1 to 0.8 VDC nominal into >2 kΩ

Specifications



FRONT VIEW

SIDE VIEW

POWER REQUIREMENTS	115/230V rms ±10% selectable by rear panel switch, 50 – 440 Hz, 80 watts
DIMENSIONS, WEIGHT	Standard 19" (48.3 cm) relay rack width, 7" (17.8 cm) high, 20" (50.8 cm) behind front panel, 45 pounds (21 kg). Slides and rack mounting kit optional.
ENVIRONMENTAL	
OPERATING	0 to 50°C., 0 to 80% RH., 0 to 10,000 feet.
NON-OPERATING	–62°C to +70°C. 0 to 50,000 feet.

Model 6160B	$5495
Option –02 Frequency Std. 2 x 10^{-9}/24h . . .	550
Option –04 Rear panel RF output	N/C
Option –05 TCXO 5 X 10^{-6}/year	$250

ACCESSORIES:

M07-205-600 Rack Mounting Brackets for 6160B .	$25
M00-280-610 Chassis slides for 24" cabinets . . .	50

NOTE: The mating connector for the programming input lines (Amphenol 261-10022-2D1-50001) is included with 6160B.

The 6160B can be modified to suit special customer applications. Some examples of these modifications are special fixed frequency outputs, inverted or offset control logic, or tighter spurious specifications for a limited frequency range. Contact the factory for further information.

For Applications help, telephone (206) 774-2491.

FLUKE®

Frequency Synthesizer 645A

FEATURES:

- Output Frequency DC-50 MHz
- Non-Harmonic Spurious −100 dB
- Signal-to-Phase Noise Ratio 66 dB
- Guaranteed Spectral Performance
- Switching Speed 20 μSEC
- Search Oscillator and Internal Sweep
- Automatic Level Control (ALC)
- Modular Design
- BCD Programming Available

The Model 645A Frequency Synthesizer produces an output signal which is directly derived and coherent with a 5 MHz reference input through a process involving frequency multiplication, division and translation only. The output frequency covers the 0 to 50 MHz range in .01 Hz steps and the frequency may be either manually or electrically selected. A search oscillator allows interpolation between steps for continuous frequency variability of up to ±100 kHz symmetrically around the selected synthesized frequency.

During development of the 645A utmost attention was given to minimizing contaminants in the output. Discrete spurious signals were held to −100 db or less by choosing a prudent number scheme, careful packaging and filtering, and employing FET mixers in critical circuits. The noise content was minimized by employing low noise figure circuits, carefully distributing gain, maintaining high signal levels, and utilizing low synthesis multiplication factors along with low time delay processing.

For the most critical system applications it is sometimes possible to employ coherent noise cancellation techniques. The Model 645A has a fixed 10 MHz output which is highly coherent with the synthesizer output and useful in this situation.

The 645A may be used on the bench or rack mounted occupying only 8¾" of rack space. It operates from all domestic and foreign primary voltages and in environments up to 55°C.

Remote frequency selection is by decimal logic - ten lines per digit. If BCD programming is desired, an accessory Model A607 BCD to Decimal Converter is available. Also available as an option is a high stability reference oscillator.

APPLICATIONS

Synthesizers find applications whenever frequency stability and purity are needed, frequency and/or phase coherence is required, or when frequency agility is desired.

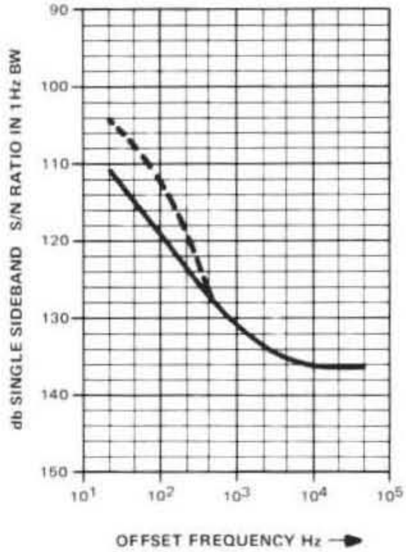
In communications systems, synthesizers are often used for transmitter exciters and receiver local oscillators. The low noise sidebands of the 645A results in a transmitter with low adjacent channel noise so that simultaneous reception is possible in close proximity. As a receiver local oscillator, the 645A allows greater than 100 db receiver dynamic range in IF bandwidths up to 3 kHz because of its low noise and spurious. Synthesizers also provide the ability to frequency-hop both the transmitter and receiver for secure communications. Users find that the symmetrical search is ideal for manually zeroing in on drifting transmitters.

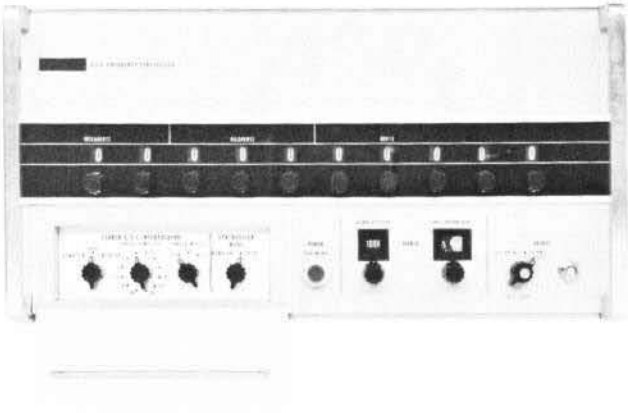
For high resolution doppler radar systems, high stability transmitters and receivers are required. The narrow linewidth and low sideband noise of the Model 645A, even when multiplied to microwave, make it ideal for doppler applications.

In automatic test consoles there is often a need for a fast, accurate and reliable programmable frequency source. Besides frequency programmability, either decimal or BCD, the level may be programmed and the search Oscillator may be remotely programmed, both in decade and frequency.

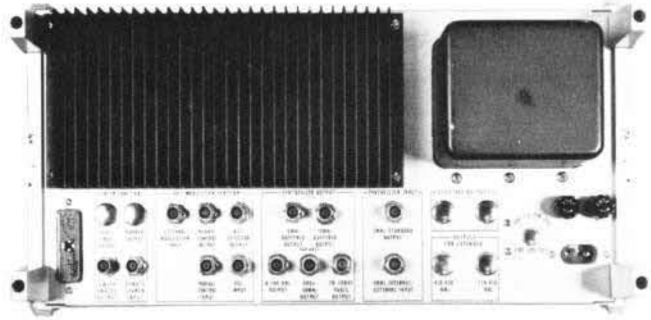
TYPICAL PHASE NOISE PERFORMANCE

The typical output phase noise spectrum of the Model 645A is shown here. This data represents the performance of a synthesizer measured in a 1 Hz bandwidth as a function of frequency offset either side of the signal. The dotted curve is measured phase noise at 49.9 MHz including the effects of the internal 5 MHz standard. The solid curve is the residual phase noise from the 5 MHz input to the synthesizer output, measured at 49.9 MHz.





Model 645A Front Panel view with less frequently used controls shown.



Model 645A Rear Panel view.

Specifications

FREQUENCY

Range . . . . DC to 50 MHz

Increments . . . . . .01 Hz

Selection . . . . . . Using front panel rotary switches or by remote contact closure.

SPURIOUS OUTPUTS

Non-Harmonic. . . Greater than 100 db below fundamental

Harmonics . . . . . Greater than 30 db below fundamental

SIGNAL TO NOISE RATIO

Including the effects of the internal standard (typical)

Phase . . . . Greater than 66 db

Amplitude . . . . Greater than 86 db

Synthesizer Residual (Internal noise from 5 MHz input to synthesizer output)

Phase . . . . Greater than 78 db

Amplitude . . . . Greater than 88 db

Measured in a 30 kHz band excluding a 1 Hz band centered on the fundamental. Valid for dialed frequencies from 1 MHz to 50 MHz.

RESIDUAL PHASE NOISE SPECTRAL DENSITY

. . . . . . SSB S/N ratio from 5 MHz input to synthesizer output measured in a 1 Hz bandwidth. Valid for dialed frequencies from 1 MHz to 50 MHz.

OFFSET FREQUENCY	MINIMUM S/N
20 Hz	104.6 db
200 Hz	116.6 db
5 kHz	129.9 db
50 kHz	132.0 db

OUTPUT VOLTAGE

50 Hz - 50 MHz . . Adjustable from 0.2 to 1.0 VRMS into 50Ω with Auto-Level-Control (ALC) by front panel control or external DC voltage. ALC control maintained from 20 kHz to 50 MHz at 1.0 VRMS ±0.25 db into 50Ω, 25°C ambient.

1.0 VRMS ±1 db into 50Ω. (ALC disabled). Spectral specifications are valid at 1.0 VRMS into 50Ω with or without ALC.

DC-100 kHz . . . . 100 mV RMS ±2 db into 50Ω.

Amplitude Modulation . . . . Both outputs capable of external modulation to 50% from DC to 10 kHz rate.

SWITCHING TIME. .

Less than 20 usec for output amplitude to be within ±1 db of final value and phase to be within ±0.1 radian at its new frequency (without ALC).

SEARCH OSCILLATOR . . . .

Continuous adjustment about selected synthesized signal with range of up to ±0.01 Hz to ±100 kHz selectable in decade steps by front panel or remote contact closure.

Local Search . . . Calibrated front panel control.

Remote Search . . Programmable by external resistance or voltage of −10V to +10 VDC.

Accuracy . . . . . . ±2% of range at 25°C; ±5% of range at 0 to 55°C.

Frequency Modulation . . . . May be modulated up to 1 kHz rate.

INTERNAL SWEEP GENERATOR . . . .

Internal triangular waveform with nominal half-periods of 10 ms to 50 sec in 1, 2, 5 sequences. Sweep width adjustable to nominally 100% 50% and 20% of decade selected. Waveform available on rear connector.

INTERNAL FREQUENCY STANDARD (Optional) . . . . 5 MHz.

Aging Rate . . . . . ±2 parts in 10^9 per 24 hours.

AUXILIARY OUTPUTS . . . . . . 5 MHz and 10 MHz at nominally 1 VRMS into 50Ω.

AUXILIARY INPUTS . . . . External 5 MHz frequency standard. 1 V rms, 50Ω
External ALC control voltage.

POWER REQUIREMENTS. . 100/115/200/230 VRMS ±10% selectable by rear panel switch, 50–400 Hz 125 Watts maximum.

DIMENSIONS, WEIGHT . . . . Standard 19" (48.3 cm) relay rack width, 8¾" (22.2 cm) high, 23-5/8" (60.0 cm) behind front panel, 90 pounds (41 Kg). Slides and rack mounting kit included.

ENVIRONMENTAL

Operating . . . . . 0 to 55°C.
0 to 85% RH.
0 to 10,000 feet.

Non-Operating . . −62°C to +75°C.

PRICES:

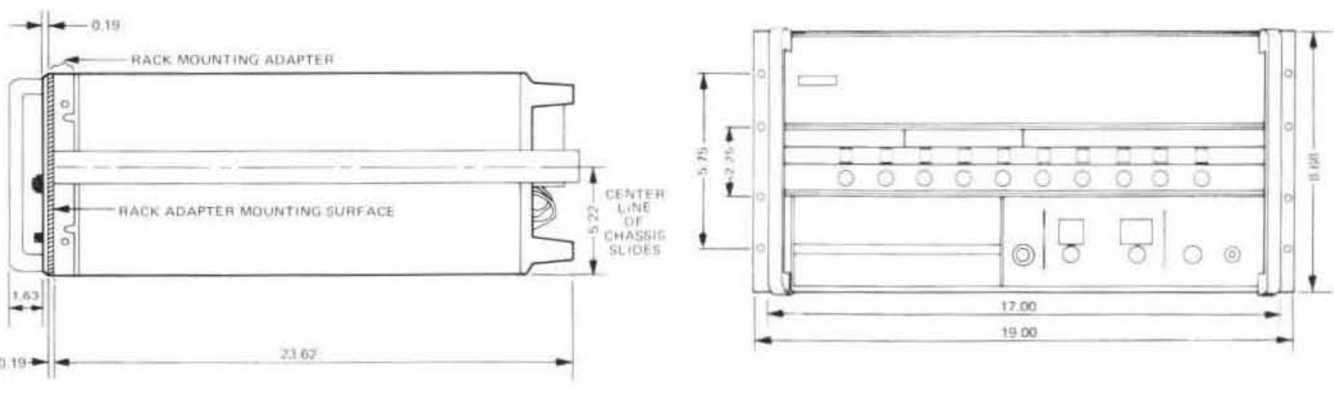
MODEL 645A-1568 . . . . $13,950.00
f.o.b. factory,
Mountlake Terrace,
Washington

OPTIONS AND ACCESSORIES:

−12 2 x 10^{-9} per day drift rate frequency standard . . . . $ 550.00

A607 BCD to decimal interface $1495.00
(External package, 3½" rack height)
(Compatable with DTL, TTL, positive true.)

OUTLINE DIMENSIONS (SHOWN WITH RACK INSTALLATION KIT ATTACHED)



Militarized Frequency Synthesizer 645M

FEATURES

- OUTPUT FREQUENCY DC-50 MHz
- NON-HARMONIC SPURIOUS – 100 DB
- SIGNAL-TO-PHASE NOISE RATIO 66 DB
- GUARANTEED SPECTRAL PERFORMANCE
- SWITCHING SPEED 20 USEC
- SEARCH OSCILLATOR AND INTERNAL SWEEP
- AUTOMATIC LEVEL CONTROL (ALC)
- MODULAR DESIGN
- BCD PROGRAMMING AVAILABLE
- MEETS THE ENVIRONMENTAL REQUIREMENTS OF MIL-E-16400F, AM 5, CLASS 4

645M Description

The 645M Frequency Synthesizer has the same specifications as the 645A, but is environmentally hardened to meet the requirements of MIL-E-16400F, Amendment 5, Class 4.

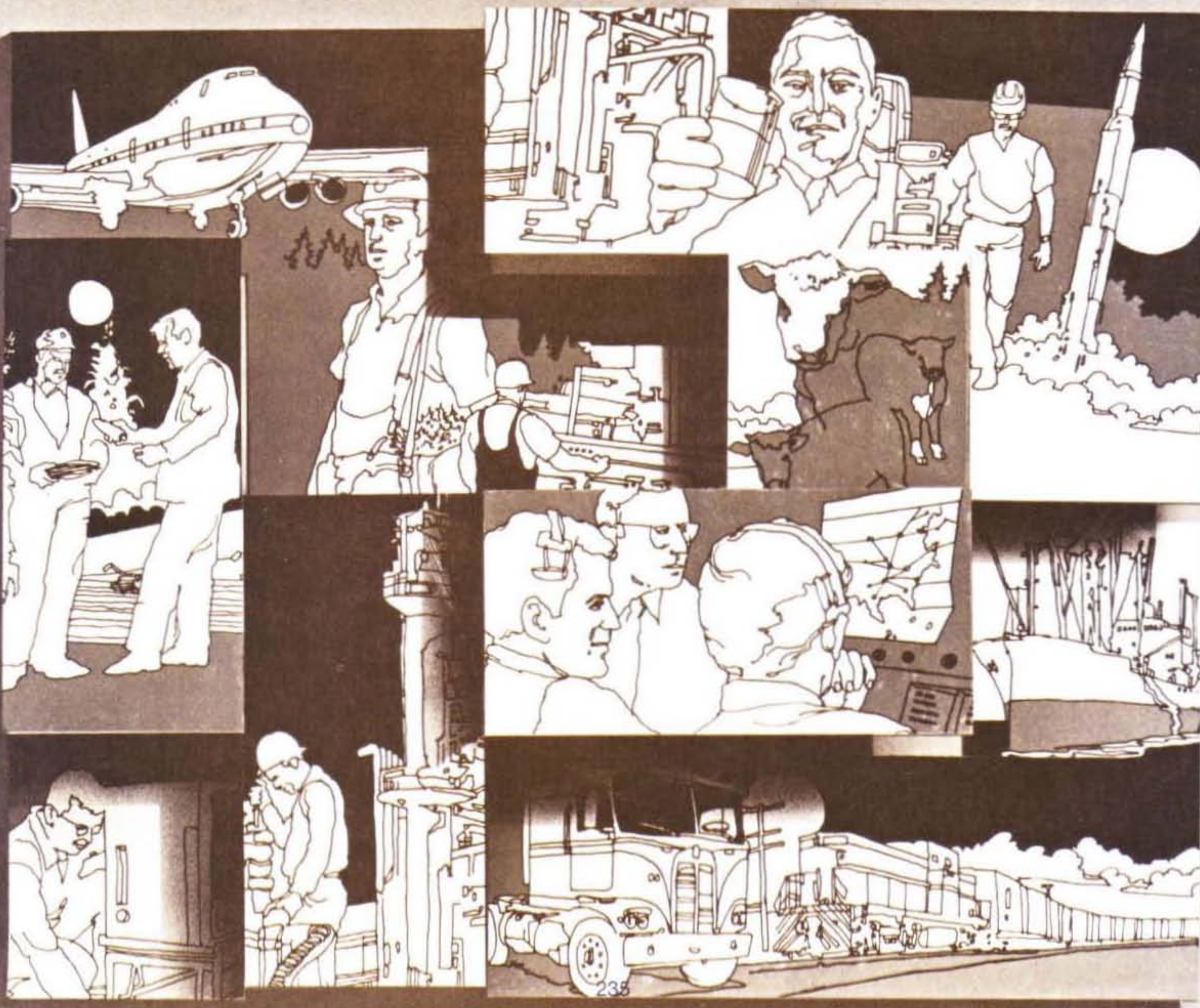
Specifications

POWER REQUIREMENTS	100/115/200/230 VRMS ± 10% selectable by internal jumpers, 50 - 400 Hz, 125 watts maximum.
DIMENSIONS, WEIGHT	Standard 19" (48.3 cm) relay rack width 10½" (26.7 cm) high, 23 5/8" (60.0 cm) behind front panel, 91 pounds (41.4 Kg). Slides and rack mounting kit included.
ENVIRONMENTAL CONDITIONS	
TEMPERATURE	Unit will perform in accordance with paragraph 3.8.1 of MIL-E-16400F, Amendment 5, Class 4. Temperature ranges are as follows:
OPERATING	0° to +50°C
NON-OPERATING	−62°C to +75°C
HUMIDITY	Operation, as described in paragraph 3.8.2 of MIL-E-16400F, Amendment 5, is possible at relative humidities ranging up to 95% for both continuous and intermittent periods, including conditions wherein condensation takes place in and on the equipment in the form of both water and frost.
ELECTROMAGNETIC INTERFERENCE	
EMISSION AND SUSCEPTIBILITY AND SELF COMPTAIBILITY	Unit will conform to MIL-STD-461-A Class 1D which is referenced by paragraph 3.9.4 of MIL-E-16400F Amendment 5.
SHOCK	Unit will conform to MIL-S-901C, Amendment 1, Grade A High Impact Shock Test which is referenced by paragraph 3.11.8.1 of MIL-E-16400F, Amendment 5. The instrument may momentarily experience signal interruption during - high impacts.
VIBRATION	Meets requirements of MIL-STD-167, Type 1 Environmental Vibration which is referenced by paragraph 3.11.8.2 of MIL-E-16400F, Amendment 5. During vibration, phase noise spectral characteristics are slightly degraded.

NOTES

section 9

automatic test equipment



The **Fluke** Terminal/10 Automatic Test System has been designed to permit you to select what you need either to fit into an existing system or to begin developing a new one at the lowest possible cost. In pursuing this concept to create a truly user-oriented system, the following features have been incorporated:

- An "off-the-shelf" or existing computer can be used. The computer selected is not dedicated for sole use with Terminal/10.
- Highly trained personnel to operate the system are not required.
- Initial investment need not be large. The system can be developed as requirements increase.
- BASIC/ATLAS languages are used.
- The non-dedicated computer concept provides multiple simultaneous time-share interactive terminals.

The **Fluke** Terminal/10 System can best be summarized in one word – FLEXIBILITY. Fluke Applications Engineering assistance aids you in choosing the system configuration consistent with your present needs, allowing room for future expansion and avoiding the risk of obsolescence or inordinate extra cost.

The following pages describe two of the many possible configurations of Terminal/10. If your needs are High Accuracy Component Test/Analysis, Analog PCB Testing, Analog Module Testing or precision Data Acquisition, Terminal/10 can provide the solution.

Fluke invites you to discuss your Automatic Test Requirements with us to configure a system that will efficiently and economically serve your needs.

CONTENTS

FLUKE AUTOMATED CALIBRATION SYSTEMS
7505B METER CALIBRATION
7510A OSCILLOSCOPE CALIBRATION
TECHNICAL DATA

INTRODUCTION

For twenty-five years, Fluke has represented excellence in precision electronic instrumentation. During these twenty-five years, calibration requirements have become more demanding in terms of accuracy and precision. The calibration laboratory today has to deal with these increases in the quality of measurements, as well as a phenomenal increase in the number of measurements. These problems, coupled with a shortage of skilled manpower and budget restrictions, have created a genuine challenge for calibration laboratory managers.

Fluke TERMINAL/10 Automated Calibration Systems have been developed to meet this challenge.

This brochure discusses the application of automation to the calibration laboratory and describes in detail the TERMINAL/10 Automatic Calibration Systems.

SOLVING THE CALIBRATION PROBLEM

Calibration laboratory workload profiles, documentation requirements, and even calibration procedures vary widely among laboratories. Contributing factors include the nature of the parent industry, the company management philosophy, and the customer. Companies providing equipment for the consumer market typically have calibration philosophies quite different from those providing equipment to the military.

Individual calibration laboratories need to select calibration systems and procedures which are consistent with their peculiar needs. This selection may naturally include or exclude the use of automatic calibration systems. If automated systems are selected, they must be tailored to the primary requirements of the laboratory, and must be flexible to adapt to the changing needs. Among the selection criteria should be:

Performance Test versus Adjustment

Large laboratories faced with an abundance of a particular type of instrument (an oscilloscope for example) may elect to separate the performance test and adjustment parts of the calibration process. This effectively means the individual performing the test is not the one accomplishing calibration adjustments. Many laboratories supporting NASA agencies find that this mode of operation satisfies their unique calibration requirements. An automatic calibration system fits nicely into this environment.

Large versus Small Workload

Smaller laboratories often use one individual to perform both performance test and adjustments. These laboratories usually have many one-of-a-kind instruments and may have a heavy concentration of workload in selected categories. Here low-cost, time-shared TERMINAL/10 calibration stations may be used both for test and adjustment procedures. Adjustment messages provided by the computer are many times more effective than a manual process, in that set-up time and review of the test procedure are drastically reduced.

Documentation Requirements

Most laboratories have libraries of calibration procedures and maintain files of historical calibration data. The amount of data accumulated and the media in which it is stored can be strongly influenced by military specifications (MIL–C–45662A/B and MIL-Q-9858). In many cases, instrument calibration procedures for automated systems can be generated directly from the existing manual procedures. The computer programs can be written to be self-documenting, and can provide for storage of test data in accordance with the governing specifications.

Recall Systems

Instrument inventory control systems may be as simple as a manually-accessed card file or as sophisticated as a large computer program utilizing massive memory. In the larger laboratories the recall system is often combined with property management systems, calibration information systems, and management reports to provide a wide variety of data, from equipment location to an individual employee's productivity.

Fluke TERMINAL/10 systems utilize a distributed-system architecture which allows ready interface to existing data processing facilities. This interface may be through the use of compatible media such as magnetic tape or can be accomplished via an industry standard asynchronous cable-connected interface. For inventories up to twenty thousand instruments, the TERMINAL/10 computer can be configured to perform the entire recall task.

Satellite Operations

Many organizations utilize satellite calibration laboratories to reduce turn-around-time and the high cost of transporting test equipment. Equipping the satellites with automated calibration stations, further decreases turn-around-time and overall labor costs.

FLUKE'S ARCHITECTURE FITS THE NEED

The versatile architecture of TERMINAL/10 provides a straightforward and economical method for automating calibration processes. Multiple TERMINAL/10 work stations allow separation of work within the laboratory in the normal manner. A typical installation incorporates both a 7505B Meter Calibration Station and a 7510A Oscilloscope Calibration Station operating simultaneously from a single computer.

Each Calibration station operates as a peripheral to the computer, thereby allowing the user to add stations as required without being forced to invest in a new computer for each station. What's more, a separate terminal such as a Teletype can be used for program development concurrent with the operation of calibration stations. There is no need to stop testing while developing or editing programs.

TERMINAL/10 is totally modular in nature and is not a "universal test set". Each station makes available a specific range of stimulus, measurement and switching capability, optimized to meet the test requirements and achieve the goals as defined by the application.

Figure 1 illustrates a typical TERMINAL/10 installation.

To enhance the efficiency and speed of TERMINAL/10 in the calibration environment, Fluke has developed a highly efficient software operating system. This system partitions the computer high speed memory between stations and supervises transfers of programs and data between the peripheral disc memory and the high speed core memory. Each station operates from programs residing in the high speed memory.

All transfers of commands and data between the computer and a calibration station are handled on an "interrupt" basis. The interrupt routine, which provides the time-sharing feature, requires only 300 microseconds to service each work station. Transfers from the disc take place when additional programs or program segments are required. Proprietary techniques have been developed by Fluke which minimize the time used in disc transfers.

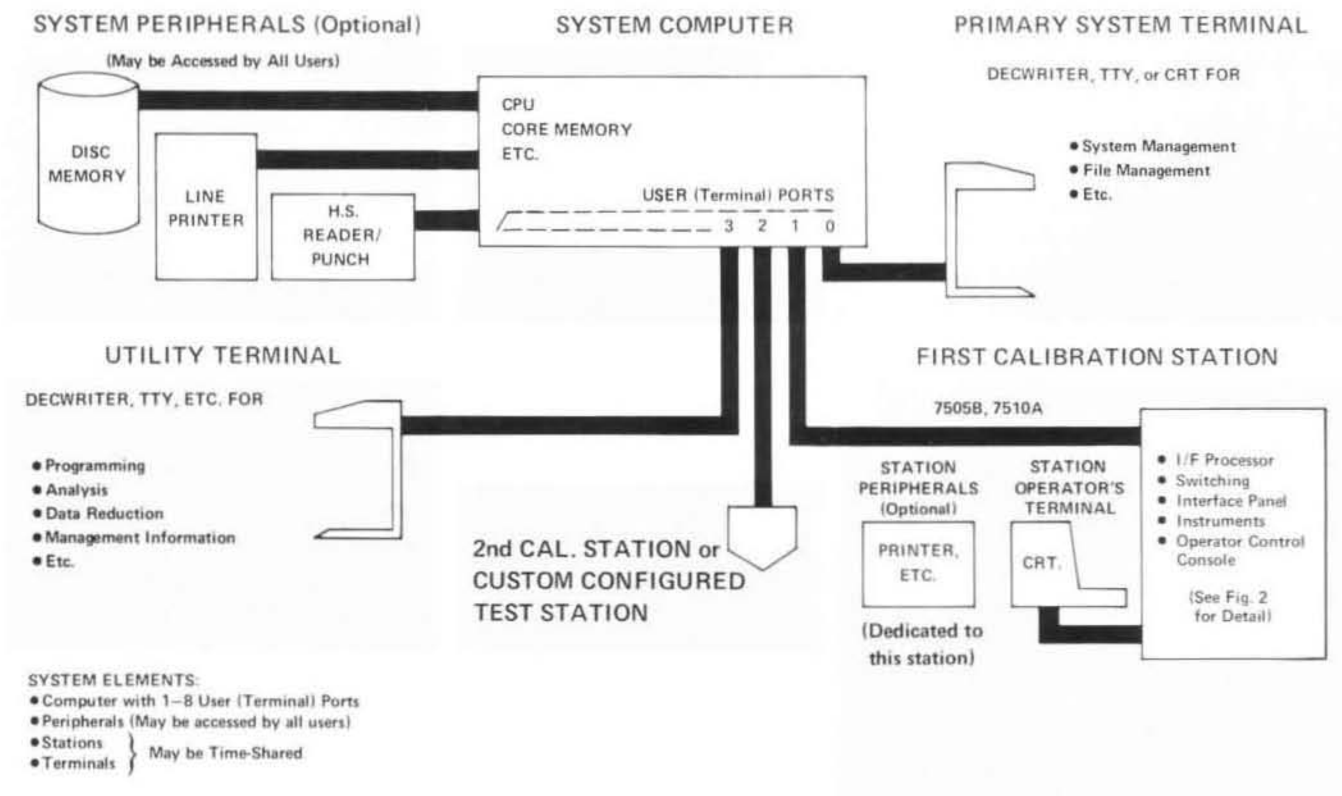


Figure 1. TERMINAL/10 Calibration System

Figure 2 illustrates the hardware organization of a typical calibration station. Each instrument in the station is interfaced to the computer through the Fluke 1100A Interface Processor. The 1100A, with up to fifteen instrument interface cards, translates commands received from the computer into specific instrument actions. Interconnection of stimulus and measurement instruments, as well as the Test Instrument (TI), is provided by the Fluke 1200B switching subsystem.

The 1100A is usually connected to the computer via a serial control interface which communicates with the computer using bit-serial/character-serial ASCII (American Standard Code for Information Interchange). The data rate is 4800 baud. For those system applications where higher speeds are required, a parallel control interface may be utilized. It provides communication between the computer and the 1100A at speeds over ten times faster than that of the serial control interface.

Each of the calibration stations described has the following assets:

- A single-port, standard interface with the system computer.
- A CRT terminal which allows the operator to efficiently communicate with the computer.
- An auxiliary five-key keyboard which simplifies operator responses during an instrument calibration.
- A single Test Instrument interface panel with programmable switching to select input/output signals, and with indicator lights to complement displayed messages in directing the operator to the proper connectors for each test
- Programmable stimulus and measurement instrumentation.

Software has been developed by Fluke to coordinate the operation of station hardware in performing tests according to industry accepted methods.

Test instrument oriented procedure tables are processed by this software to perform calibrations and generate variables data.

Programs are also available to generate and edit procedure tables and to produce test reports from calibration variables data.

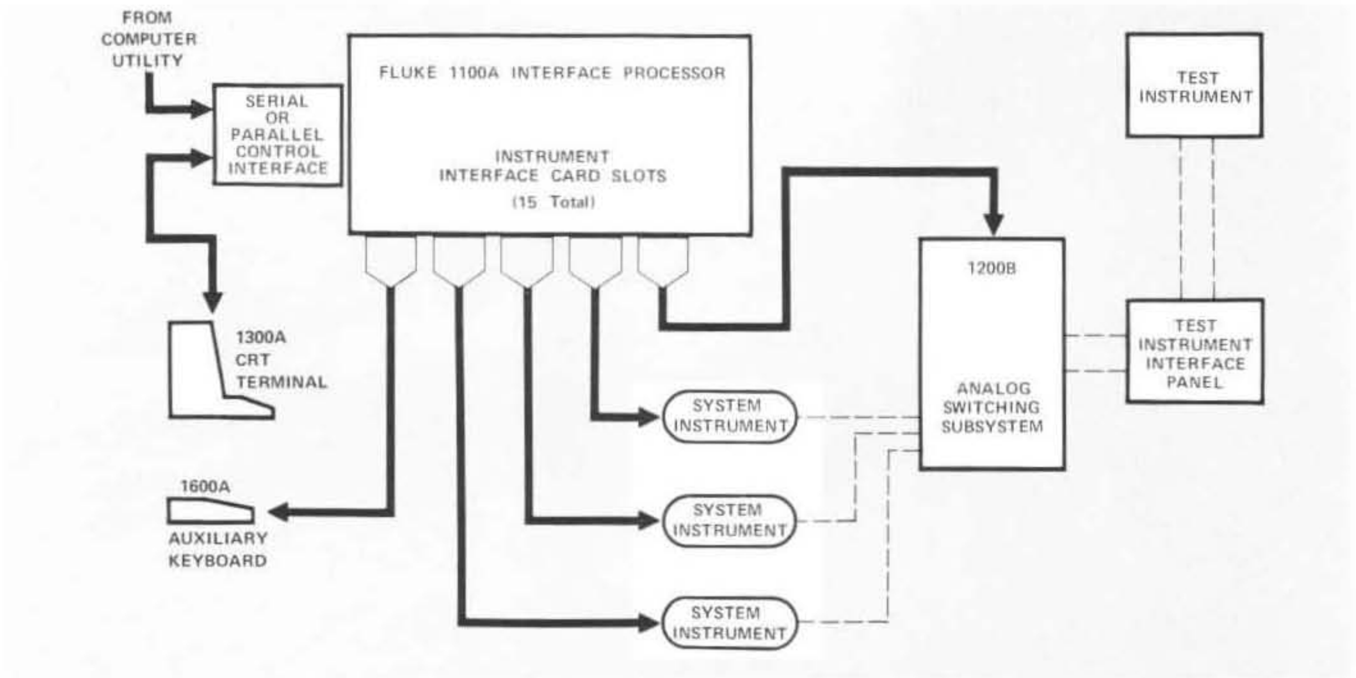


Figure 2. Calibration Station Block Diagram

7505B METER CALIBRATION STATION - SPECIFICATIONS

This station provides stimulus and measurement capability for calibration of VOM's, VTVM's, DMM's, Precision DVM's, instrumentation amplifiers, dc sources, dc calibrators and passive devices such as voltage dividers.

DC measuring instruments may be tested for linearity, accuracy, and stability from 0 to ±1100V, or 0 to ±110 mA, using a programmable dc voltage/current calibrator. Excellent performance to the microvolt level is possible using a built-in divider which also doubles as an accurate resistance standard for testing over the 1Ω to 10 MΩ range.

A programmable precision DVM aids in load regulation, ripple, and accuracy tests of power supply or amplifier outputs.

Optionally available are:

- A programmable ac calibrator to provide 100 uV to 1100V rms, mid-band, with a frequency range from 10 Hz to 1.2 MHz.
- AC and dc current source and measurement capability to 10A.
- Waveform stimulus (sine, square, triangle).
- Frequency, Period and Time Interval measurement.
- Line regulation testing using a programmable line voltage source.
- Accuracy enhancement - allowing 10 ppm dc voltage generation and measurement.

Figure 3 shows a typical Meter Calibration Station Installation.

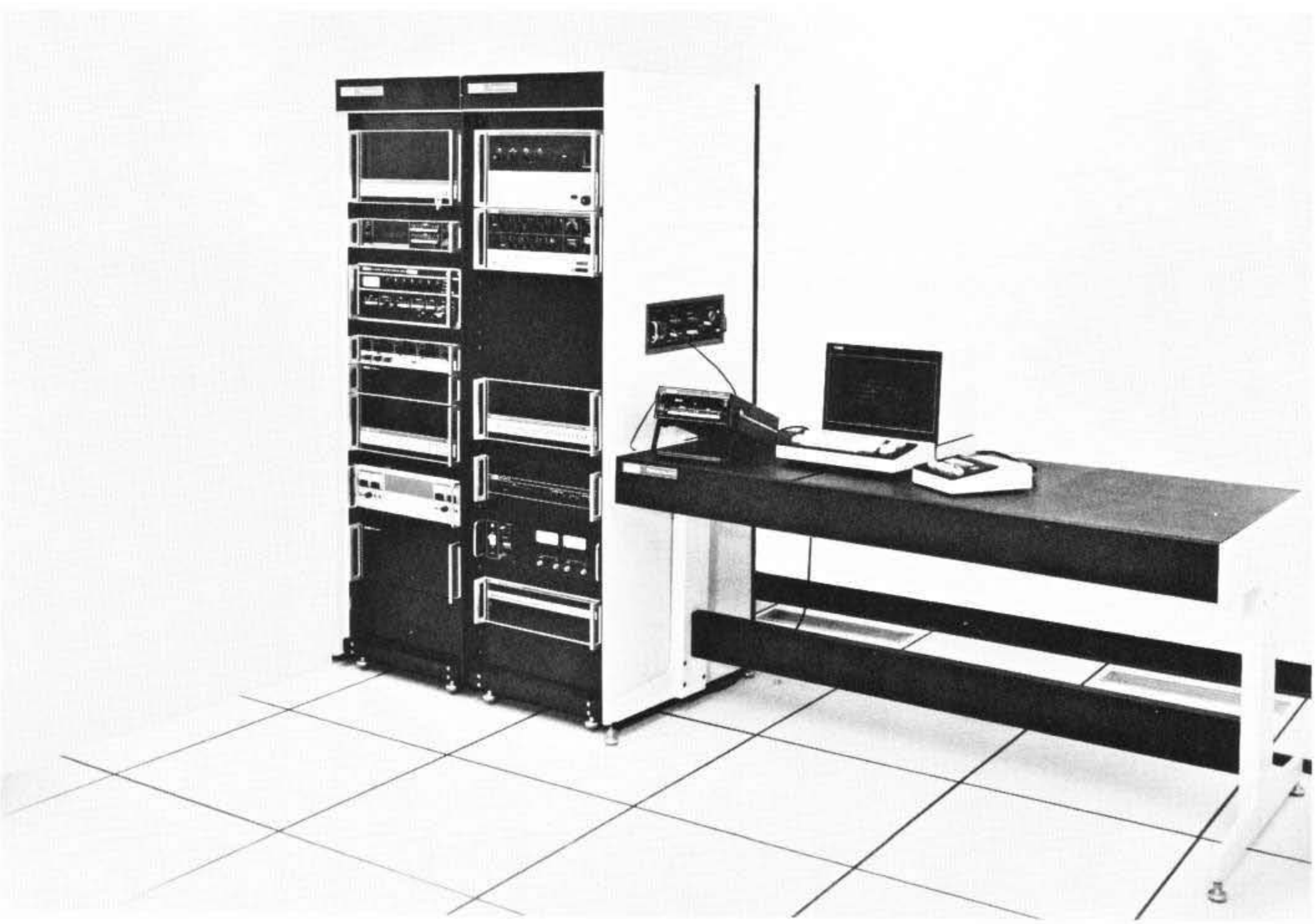


Figure 3. 7505B Meter Calibration Station

7505B METER CALIBRATION STATION SPECIFICATION SUMMARY (All specifications apply at the Terminals of the Test Instrument Interface Panels at 23°C ±1°C with a RH between 30% – 50%)

STIMULUS

DC VOLTAGE/CURRENT

Voltage Range:	1uV to 1100V, ±0.005% ±0.001% Enhanced
Current Range:	100 pA to 110 mA, ±0.006%
*Extended Current Ranges:	1A, ±0.1%; 10A, ±0.2%

RESISTANCE/RATIO STANDARD

Resistance Range:	1Ω to 10MΩ, ±0.005% at Cardinal points
Ratio Ranges:	1:1 to 10:1

*AC VOLTAGE

Voltage Range:	100 uV to 1200V, ±0.02% midband
Frequency Range:	10 Hz to 1.2 MHz

*AC CURRENT

Current Range:	1 uA to 100 mA, ±0.2% to 10A, ±0.4%
Frequency Range:	50 Hz to 1 kHz

*AC WAVEFORM

Waveforms:	Sine, Square, Triangle
Voltage Range:	0.1 to 10V P-P
Frequency Range:	0.001 Hz to 1 MHz

*AC LINE VOLTAGE

Voltage Range:	96V to 144V
Current Range:	0 to 20A
Frequency:	Same as line (50 Hz-60 Hz)

*DC CALIBRATION REFERENCE STANDARD

Voltages (four each):	1V and 10V, 3 ppm transfer accuracy; 10 ppm monthly stability

MEASUREMENT

DC VOLTAGE/CURRENT

Voltage Range:	10uV to 1100V, ±0.004% ±0.001% Enhanced
Current Range:	1uA to 110 mA, ±0.01%
*Extended Current Range:	to 1A, ±0.1% to 10A, ±0.2%

AC VOLTAGE

Voltage Range:	1mV to 1100V, ±0.05% midband
Frequency Range:	10 Hz to 100 kHz

AC CURRENT

Current Range:	1uA to 110 mA, ±0.2%
*Extended Current Range:	to 10A, ±0.3%
Frequency Range:	10 Hz to 1 kHz

RESISTANCE

Resistance Range: (4 Terminal)	100uΩ to 12MΩ ±0.01% midband

DC:DC VOLTAGE RATIO

Ratio Range:	10^{-7} : 1 to 100:1, ±0.001%

AC:AC VOLTAGE RATIO

Ratio Ranges:	
1V Ref	10^{-3}:1 to 1000:1, ±0.05%
10V Ref	10^{-4}:1 to 100:1, ±0.05%
100V Ref	10^{-5}:1 to 10:1, ±0.05%

*FREQUENCY, PERIOD, TIME INTERVAL

Frequency Range:	0 - 50 MHz
Period/Time Interval Range:	0.1 us to 10^8s

** Optional*

NOTES:

1. *Specification extremes do not necessarily apply simultaneously.*
2. *In order to provide concise specifications, range and accuracy floor specifications have been omitted. Detailed specifications are available on request.*

7505B BASIC STATION EQUIPMENT

1100A	Interface Processor (with 1100A-7016 bit serial controller)
1200B	Switch Matrix
1300B	CRT Terminal
1600A	Auxiliary Keyboard
1740A	Resistance/Ratio Standard
8400A	Digital Multimeter (measures resistance and AC/DC voltage or current)
3330B/AH	DC Voltage/Current Stimuli
1400A	Equipment Mounting Rack (with Power Distribution Panel)
7505B	Test Instrument Interface

7505B STATION OPTIONS

7505B-7001	AC Voltage Stimulus
7505B-7002/7003	AC/DC Extended Current Stimulus
7505B-7004	Waveform Stimulus
7505B-7005	Frequency, Period, Time Interval Measurement
7505B-7006	AC Line Voltage Stimulus
7505B-7007	Calibration Reference Standard
7505B-7008	Work Station Table
7505B-7010	63 inch Work Station Rack
7505B-7011	DC:DC and AC:AC Voltage Ratio Measurement
7505B-7012	Replaces 1100A-7016 with 1100A-7026 parallel controller.
7505B-7020	Applications Software Package

7510A OSCILLOSCOPE CALIBRATION STATION DESCRIPTION

This station is optimized for the calibration of oscilloscopes, plug-ins, and provides the capability for calibrating related test instruments such as electronic counters.

The 7510A incorporates a fully programmable digital multimeter and switching for ac/dc voltage measurements such as Test Instrument power supply voltage. The station can accommodate up to nine simultaneous connections to the TI which can be accessed randomly. Additional internal connections are available for monitoring signal levels.

A programmable synthesized signal source covers the frequency range from 0.1 Hz to 160 MHz. Its sine wave output from 1 kHz to 160 MHz is available for triggering and frequency response testing.

The frequency range may be optionally extended to 1.4 GHz via the signal generator option.

Input normalization and time domain response tests are performed using a square wave output from 0.1 Hz to 1 MHz. A pulse output is also available over the same range for sweep tests.

A programmable power source provides a DC or 500 Hz squarewave output from 10 μV to 100V for gain tests.

Figure 4 shows a typical installation of a 7510A Oscilloscope Calibration Station.

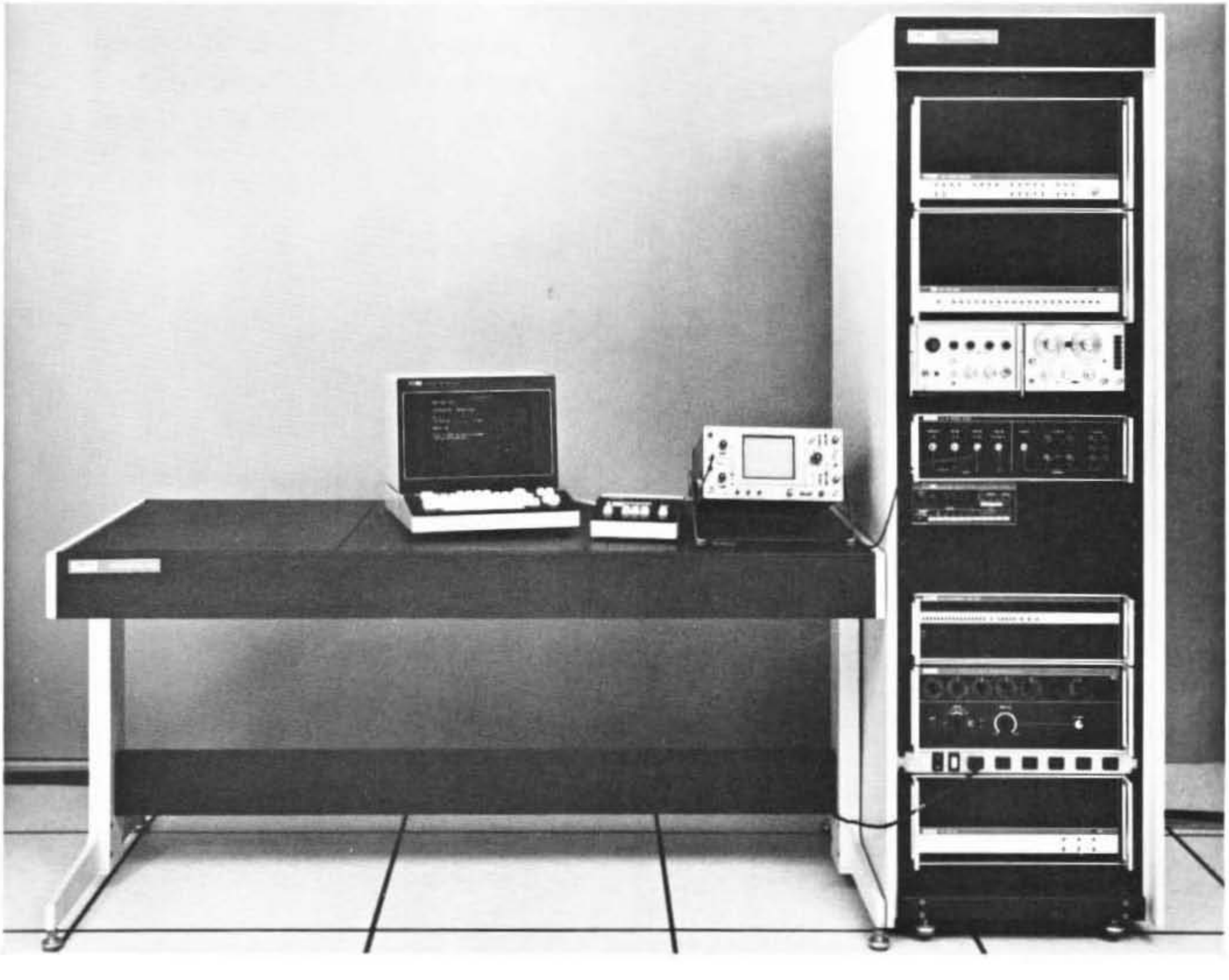


Figure 4. 7510A Oscilloscope Test Station

7510A OSCILLOSCOPE STATION SPECIFICATION SUMMARY (All specifications apply at the Terminals of the Test Instrument Interface Panels at 23°C ±1°C with a RH of 30% – 50%)

STIMULUS

FREQUENCY RESPONSE CALIBRATION SOURCE
(Sine Wave - Synthesized)

Frequency Range:	1 kHz to 160 MHz
Voltage Range:	2V p-p maximum into 50 ohms. Output can be programmed over a continuous 10 dB range and with programmable fixed attenuations of 3, 10, 20, and 30 dB over a total range of 73 dB.
Flatness:	±0.5 dB

SIGNAL GENERATOR OPTION

*Frequency Range:	1 MHz to 1400 MHz
*Amplitude:	–80 dBm to +10 dBm, may be set over any 20 dB range under program control.

LOW FREQUENCY TIME CALIBRATION SOURCE
(Time Marks - Synthesized)

Time Range:	1 us to 20s per period
Voltage Range:	> 2V p-p, into 50 ohms. Fixed attenuations of 3, 10, 20, and 30 dB in any combination may be programmed into the output.
Duty Cycle:	5%
Time Accuracy:	±0.001%

INPUT NORMALIZATION CALIBRATION SOURCE
(Square Wave - Synthesized)

Frequency Range:	.05 Hz to 1 MHz
Voltage Range:	> 2V p-p, into 50 ohms. Fixed attenuations of 3, 10, 20, and 30 dB in any combination may be programmed into the output.
Rise Time:	Less than 12 ns
Distortion:	Aberrations less than 2%
*Voltage Range:	Greater than 100V p-p, with no load (not synthesized)
*Rise Time:	Less than 1 ns at 0.5V p-p, into 50 ohms

AMPLITUDE CALIBRATION SOURCE

Voltage Range:	±1 mV to ±100V full scale in six ranges.
Resolution:	±0.01% of full scale
Output Impedance:	50 ohms, ±1%
Waveform:	Both dc and square wave outputs available. A single program command will provide the 500 Hz square wave.

MEASUREMENT

DC Volts:	
Voltage Range:	10uV to ±1200V, ±0.02%
Resistance:	10MΩ to 16MΩ, ±0.02%
AC Volts:	
Voltage Range:	1 mV to 1100V, 0.1% midband
Frequency Range:	30 Hz - 100 kHz

** Optional*

NOTES:

1. *Specification extremes do not necessarily apply simultaneously.*
2. *In order to provide concise specifications, range and accuracy floor specifications have been omitted. Detailed specifications are available on request.*

7510A BASIC STATION EQUIPMENT

1100A Interface Processor (with 1100A-7016 bit serial controller)
1200B Switch Matrix
1300B CRT Display and Keyboard
1600A Auxiliary Keyboard
6160A Frequency Synthesizer
A697 Synthesizer Extender
4270A/A4299 Power DAC
8200A Digital Voltmeter
1400A Rack and Power Distribution
7510A Test Instrument Interface
General Radio 1592A
Programmable Line Voltage Stimulus

7510A STATION OPTIONS

7510A-7001 1400 MHz Signal Source

7510A-7002 High Amplitude/Fast Rise Square wave source

7510A-7003 Replace 1100A-7016 with 1100A-7026 parallel controller

7510A-7020 Applications Software Package

SOFTWARE

The software available with a TERMINAL/10 calibration system is extensive, covering operation, maintenance, and support on both the system and calibration station levels.

Operating software, TEST/10 BASIC-DOS, includes an Interpreter for programs written in the TEST/10 BASIC language, a Time Sharing Executive to allow several test stations to use the system computer and peripherals, and Peripheral Handlers to structure files and manage the use of disc memories, paper tape reader/punches, line printers, and other peripheral devices.

Applications Support Software (in the form of procedure table generators, verifiers, and editors) assists the test engineer in quickly translating his calibration procedures to a form which can be used by the system. The resulting procedure tables reflect the characteristics of the TI, and changes to the tables are not required when hardware is added to the system or calibration methods are changed.

Procedure Table Processors are application programs which contain station control capability, and define the calibration method. These are unique to each class of instrument families such as voltmeters or oscilloscopes. A table processor conducts an instrument calibration in accordance with parameters contained in a specific procedure table. These processors are available in a ready to-run form requiring only the generation of procedure tables as described above to make the system operational.

Maintenance Software includes station self-test programs to exercise instruments and switching to detect actual or potential trouble spots. Also included are diagnostic programs necessary to maintain the computer and system peripherals.

Self Calibration programs are available to calibrate specific test station functions and provide correction data to be stored and used for "accuracy enhancement" during later station use. These calibrations are referenced to the Test Instrument interface panel and include corrections for errors contributed by station switching and wiring.

Additional support software is available to reduce and analyze test data resulting from execution of applications and maintenance programs. A general test report formatting program may be easily modified to meet individual lab requirements.

Figure 5 illustrates the organization of the software elements.

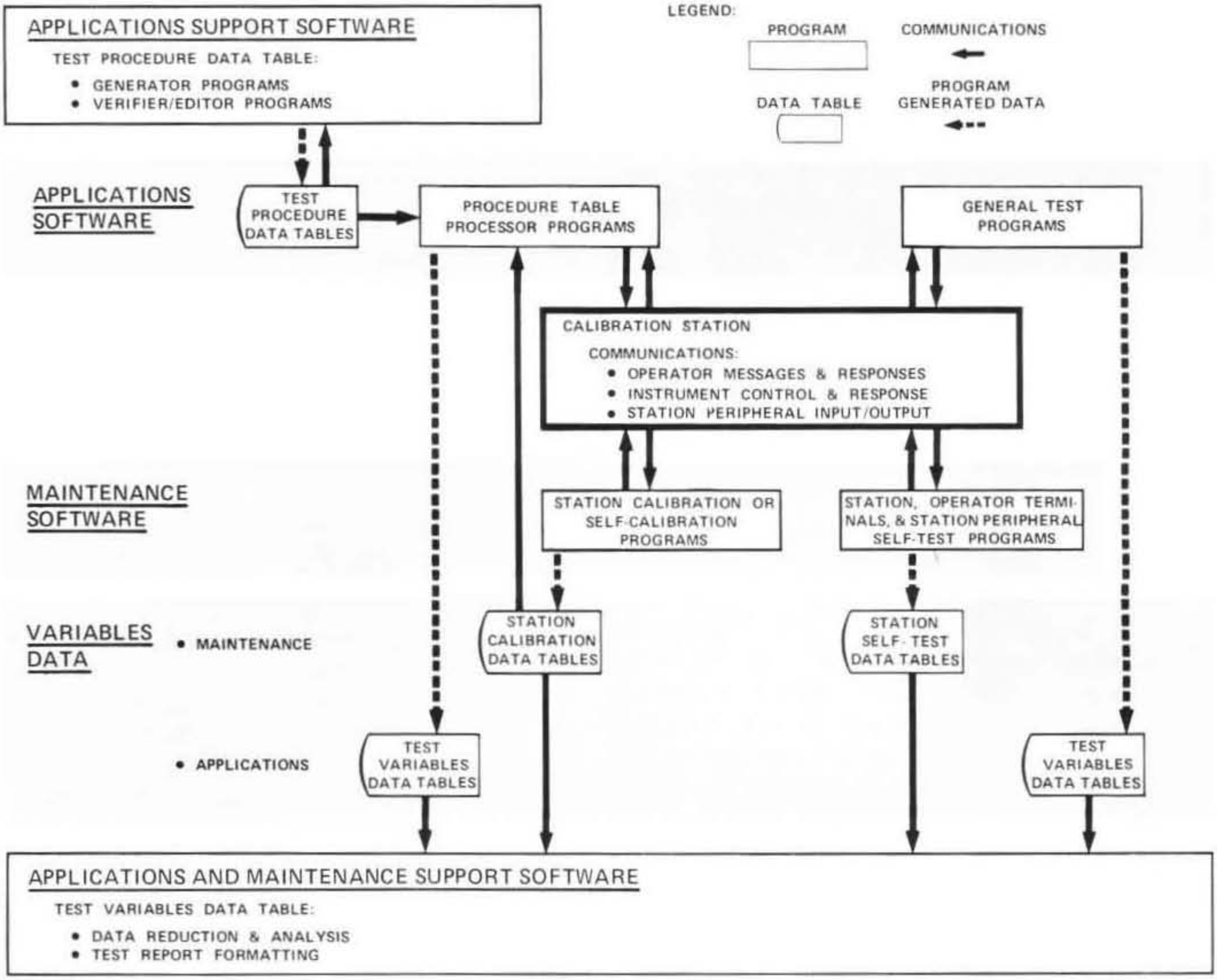


Figure 5. Calibration Station Software

COMPUTER CONFIGURATION

1105A Computer System Features

- Powerful CPU architecture with eight general registers, vectored multilevel priority interrupts, automatic stack handling and twelve basic addressing modes.
- Memory with 16 bit basic word size, providing 8 bit byte addressing, expandability to 28k words (optionally expandable to 128k words) and high speed direct memory access.
- Rotating magnetic disc memory with removable cartridge capacity of 1.2 million words, expandable to 9.7 million words of on-line program and data storage.
- A full complement of central computer peripherals available off the shelf, including line printers, IBM-compatible magnetic tape transports, high speed paper tape input/output, and a dual cassette magnetic tape transport.
- Complete hardware interface capability to time-share a minimum of four TERMINAL/10 calibration stations, program development terminals or clerical operations terminals in any combination.

The minimum configuration includes a PDP11 computer, 16k words of core memory, a 30 cps teleprinter, a disc memory subsystem with one transport (1.2 million words), a dual cassette tape transport or high-speed paper-tape reader and punch interfaced system enclosure and wiring, and diagnostic and maintenance documentation.

This basic 1105A configuration will support two concurrently running applications (e.g. one 7505B and one 7510A). Each additional application can be accommodated by an additional 4k words of memory. Additional disc memory is needed only when extremely varied test instrument inventories must be provided for, or when the 1105A computer system will be called upon to provide instrument recall or other clerical tasks.

Efficient hard copy communication to calibration laboratory management from the 1105A is provided by optional line printer-generated reports. Low operating cost interface to larger computer installations is available through optional IBM-compatible seven or nine-track magnetic tape transports.

Figure 6 is a picture of a typical installation of both calibration stations with the computer utility.

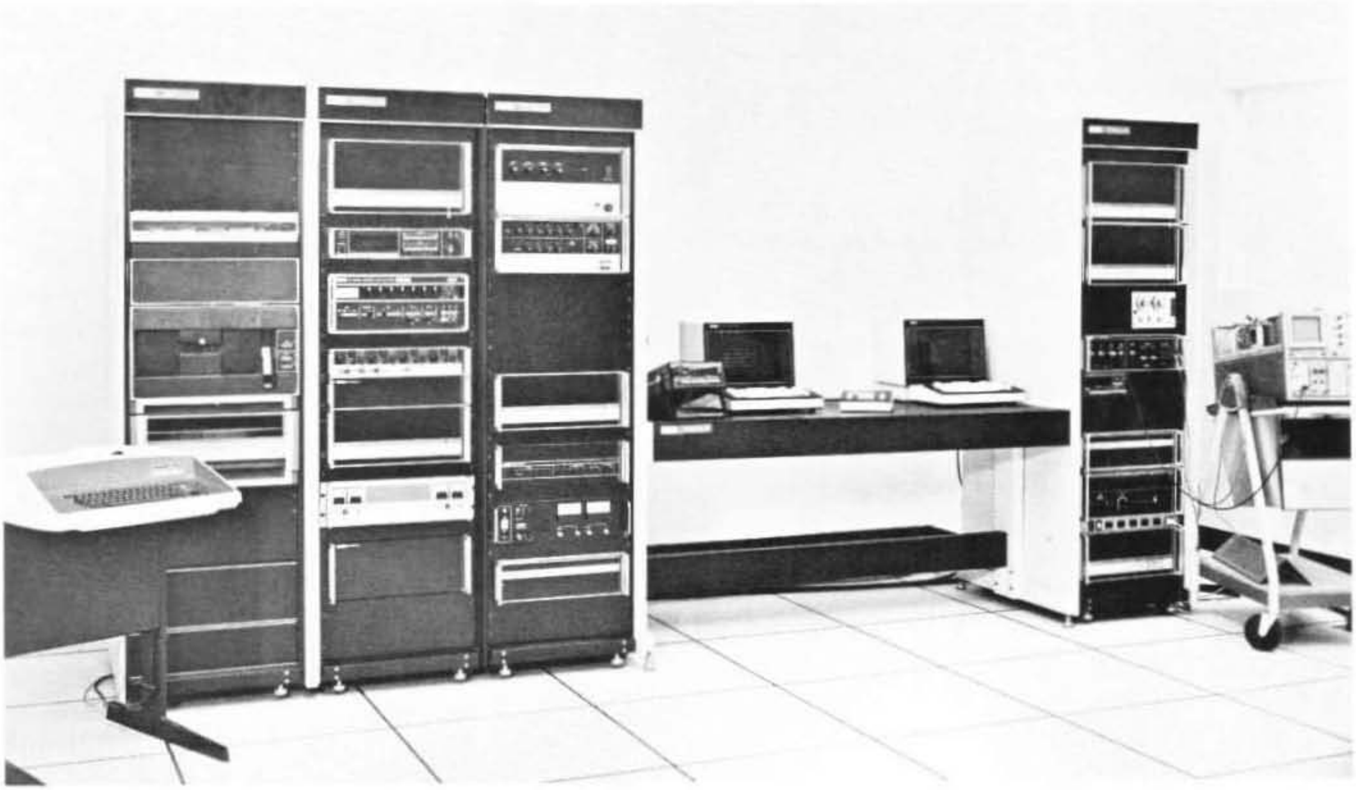


Figure 6. 7505B Meter and 7510A Scope Calibration System With 1105A Computer Utility.

1105A EQUIPMENT COMPLEMENT

PDP11 Computer Including:

- 16k words of core memory
- 1.2M word disc
- 30 cps teleprinter
- Mag tape cassette or high-speed paper-tape reader and punch
- EIA Serial Station I/F
- Maintenance and diagnostic software

Options to 1105A:

1105A-01	Add'l 8k words core memory
1105A-03	Dual DEC tape
1105A-04	60 line, 132 column, 64 character line printer
1105A-1601	Fluke TEST/10 BASIC Disc Operating System Software

SYSTEM SUPPORT

Fluke provides comprehensive system support before and after installation.

An installation bulletin is prepared and sent to the customer in advance of system delivery to provide early visibility of the installation requirements. This bulletin covers physical configuration, clearances, operating environments, and power requirements of the particular system configuration.

The TERMINAL/10 system acceptance is a two part procedure. Prior to system shipment, the customer is requested to perform a pre-acceptance test on the system at the factory. The system is then shipped via padded air-ride van and a final acceptance test is performed at the customer site following installation.

Comprehensive self-test software and hardware is provided with every system to insure complete checks on each instrument and element of the system.

Training

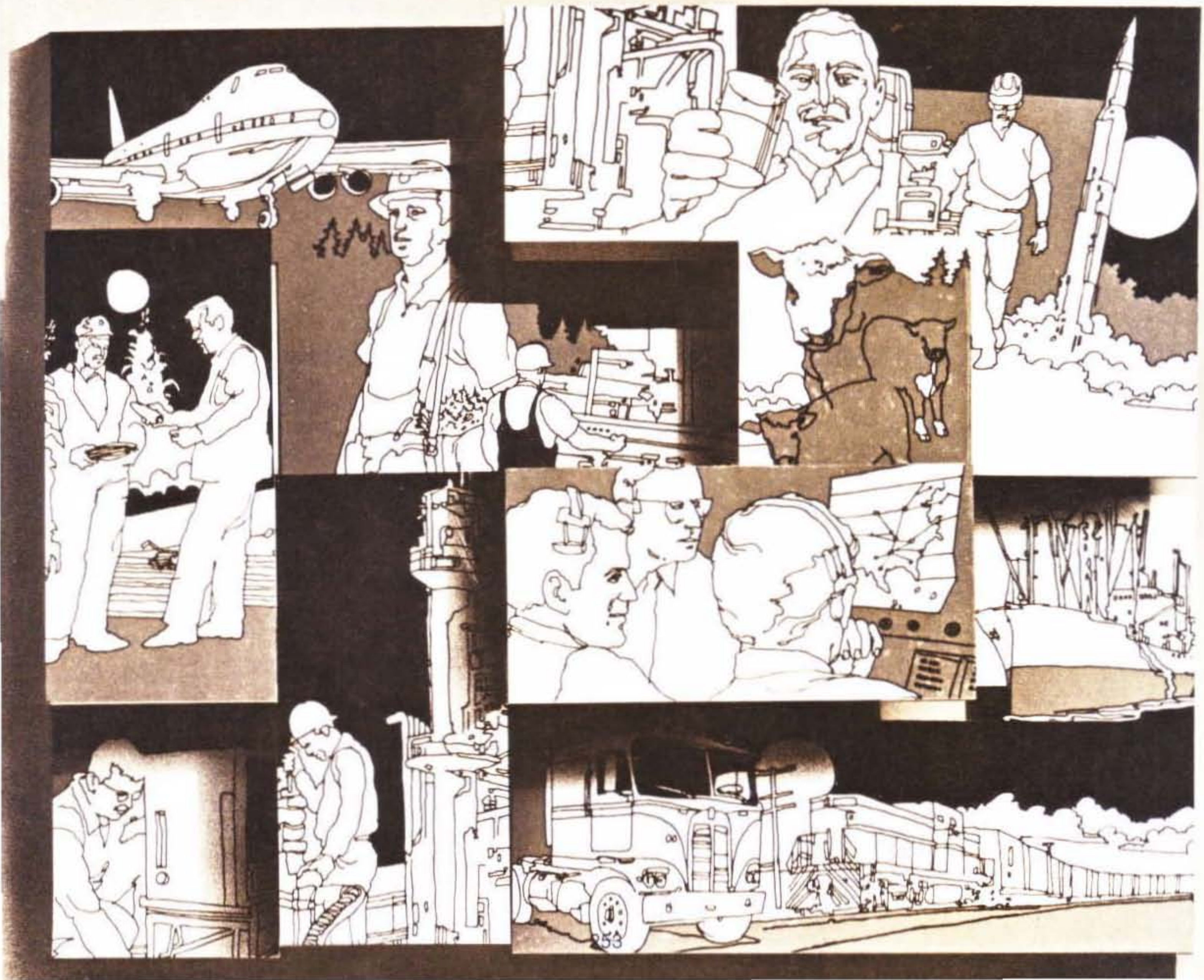
TERMINAL/10 includes a comprehensive 5-day training course at the Fluke plant near Seattle. The course includes design philosophy, programming, operator training and maintenance. Typical class size is five. Continuing support is always available from your Fluke field or factory ATE specialists. An additional three days of training at the customer's facility is provided during installation.

Warranty

The Fluke TERMINAL/10 system carries a full ninety day on-site warranty commencing the day acceptance tests have been completed. Follow-on service is available through monthly service contracts for on-site repair and preventative maintenance on all portions of the system. In addition, all standard Fluke instruments in the system carry a full one-year warranty, as detailed on their respective data sheets.

section 10

logic test equipment



Fluke's Trendar subsidiary has established a top reputation for supplying the most cost effective and high performance logic testing equipment available today. By mid-1973, over 2,000,000 logic boards had been diagnosed on the Trendar 2000 and 1000 logic testers. Customers state that they have never achieved a higher test validity and confidence level in their logic nodule performance. Costs are lower and start-up is faster than with any competitive alternatives.

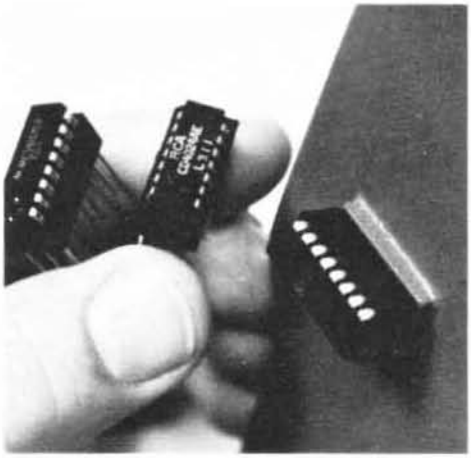
The **Fluke** Trendar products are practical. Thousands of Trendar 200 Testclips are used by production and service technicians world wide to speed up logic board diagnosis. The Testclip provides three products in one, a logic probe, a logic states clip and an IC tester which detects faulty performance of IC's in-circuit. One large computer company studied the troubleshooting speed of their best technicians and found that the Testclip doubled their performance.

Ask your **Fluke** Representative for the latest technical data and demonstrations of these superior logic testing products.

TRENDAR 200 TESTCLIP™

Pocket size
IC tester
finds PCB
logic faults
fast

Features



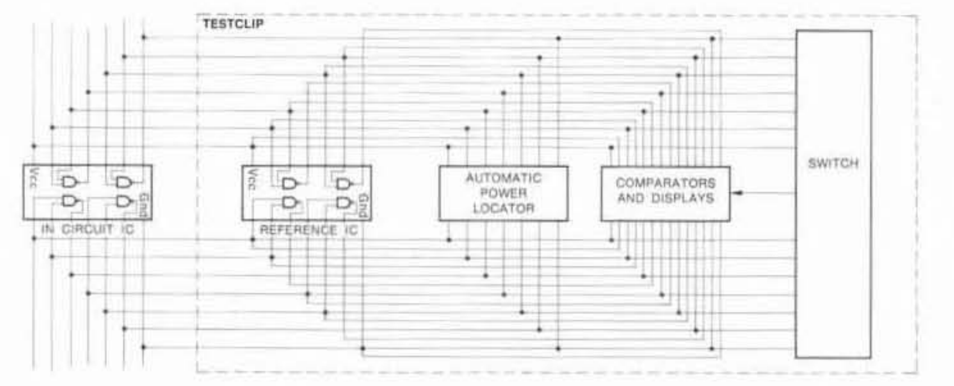
The TRENDAR 200 IC TESTCLIP is a *complete* pocket-size test set offering performance and capability unavailable until now.

Equally useful in production testing, service diagnosis, and research/development, it functionally tests digital IC's while they are operating in-circuit. Real-time behavior of IC's is compared to that of a reference IC plugged into the TESTCLIP. Board imperfections, solder defects, and faulty IC's are easily located.

TESTCLIP replaces the three commonly-used logic-checking devices: logic probe, logic states display clip, and hand-held IC comparator. With it, a universal fault-locating procedure called FAULTRACK® can easily find functional faults on any IC logic board. The total investment, including reference IC's, is *half* that of other logic checking devices — and TESTCLIP provides superior test validity.

- Automatically tests digital IC's in-circuit at megahertz rates
- Automatically locates IC faults *and* board faults
- Displays power status, logic states, toggling, and failures *by pin number*
- Handles logic levels from 4.5V to 10V automatically without adjustment
- Versions available for DTL, TTL, HTL, and CMOS logic
- Waveform and timing integrity ensured by intimate contact of reference and test IC's
- Minimized circuit load — high-Z and low-C inputs ensure against upset circuit behavior
- Programmed with low-cost IC sockets — no soldering
- Operates anywhere; portable case carries 36 reference IC's

How the TESTCLIP tests

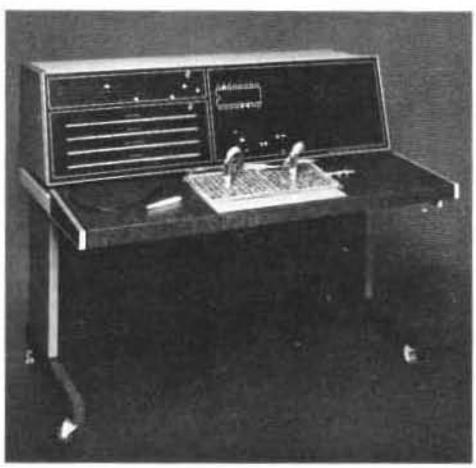


Testing circuit boards is a quick, easy procedure with the TRENDAR 200 TESTCLIP. A known-good IC of the type to be tested is inserted into a conventional socket which plugs into the TESTCLIP. The TESTCLIP is then snapped onto the IC to be tested. The input pins are effectively paralleled. The reference IC sees the same input signals toggling on the board as the IC being tested sees. Outputs are continuously compared. An indicator at the appropriate pin number displays any failure to compare.

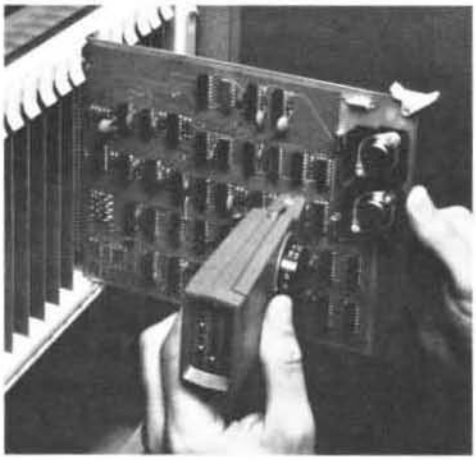
The diagram shows the TESTCLIP paralleling the input signals from the test IC to the reference IC via minimum capacitance connections. The auto-power locator sniffs out V_{CC} and ground, automatically powering the internal circuitry. High-Z comparators continuously check outputs and display any failures. Stuck-pin or toggling behavior is checked by dialing the pin number, and observing the Logic Monitor indicator. Static states, high-speed toggling, and single transitions are displayed. An extender probe enables the operator to observe the toggling behavior of adjacent IC's.

A TRENDAR-developed procedure called FAULTRACK enables the operator to isolate faults easily on any actively operating logic board. TRENDAR Bulletin 122 discusses FAULTRACK in detail.

The board may be activated by operating it on an extender from its own unit, or on any logic tester such as the TRENDAR 1000 or TRENDAR 2000. See Bulletins 110B and 120 for details.

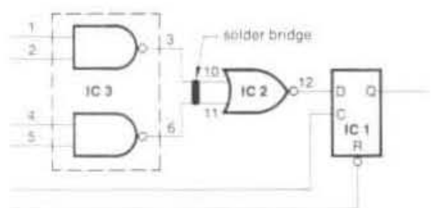


Tests IC's and Boards

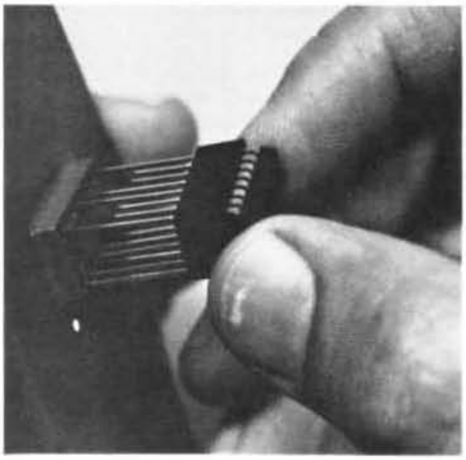


A defective IC will not toggle nor follow its truth table if there is a physical fault — solder bridge, broken trace, etc. — on the board. The fault will appear as a stuck-logic-state IC input or a functional IC output failure. This is illustrated by the adjacent diagram, where the operator is working from right to left. IC 1 and IC 2 are toggling and do not show failures. Moving the TESTCLIP onto IC 3, *output* node failures will be displayed for pins three and six because of the NOR gate solder bridge shown. Absence of stuck pins is indicated by the Logic Monitor display of toggling at pins three and six. The solder bridge will be revealed by physical examination or a resistance check. Removing this bridge and rechecking will show that IC 3 now functions properly.

Having identified the defective nodes, the TRENDAR 200 TESTCLIP proves itself as a tester and verifier of the *IC and the board* — a particularly useful feature in production testing, field maintenance, and R&D investigations.



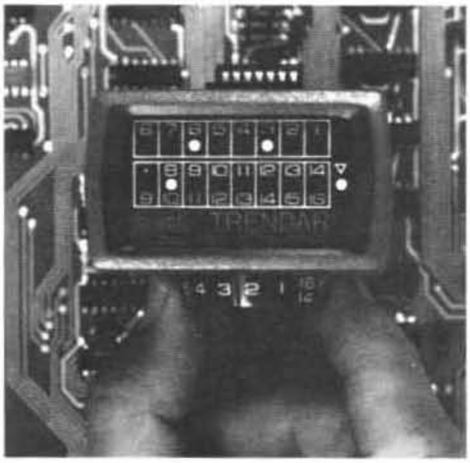
Programming



To test an IC, the TESTCLIP need only distinguish between inputs and outputs. The reference IC is inserted into a "programmed" standard 16-pin socket which has replaceable pins. The output pin positions are replaced with short pins supplied with the sockets, dedicating the socket to a specific IC type. Circuit board IC inputs connected to long socket pins carry these signals to both comparator inputs, thus preventing failure indication. The short socket pins enable the comparators to check output correspondence between the reference and in-circuit IC's.

Each socket can be reused thousands of times. The reference IC is tested every time an in-circuit IC is tested; if it should ever fail, it can easily be replaced by plugging a new IC into the same socket.

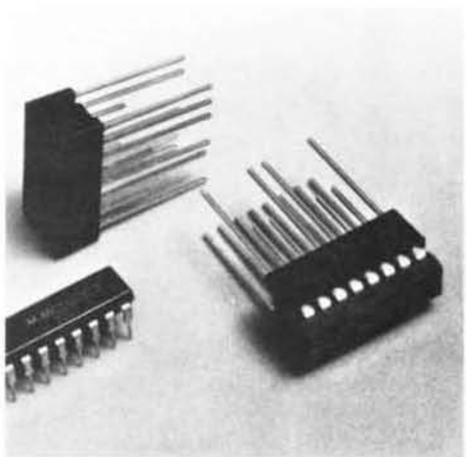
Display



Three kinds of data are displayed by the TESTCLIP. With the reference removed, slow logic states behavior of up to sixteen pins can be seen simultaneously. The Logic Monitor "probe" indicates power and displays narrow pulses and fast toggling. When the reference IC is plugged in, the displays indicate node failures.

Carrying Case

The tough compact case holds the TESTCLIP and up to 36 reference IC's in sockets, and a matching accessory case carries up to 63 more. These two small cases enable a technician to test and verify any of the standard IC's in his company's products, even at remote sites.



Specifications

	Supply Voltage	Current Required: @ 5V	10V	15V
200-01	4.5 to 10V	60ma	200ma	•
200-02	4.5 to 5.5V	60ma	•	•
200-03	10 to 15V	•	60ma	100ma

Auxiliary Power Supply (Optional): Nominal 10VDC @ 60ma. Plugs into 200-03, when insufficient power is available from board under test.

Maximum Input Voltage: Equal to Supply Voltage

Signal Input Impedance: 50K ohms paralleled by input load of reference IC

Test Rate: Continuous (except during reset)

Reset Rate: Approx. 10 per second, 2 μsec reset duration

Failure Display: Sixteen indicators display ON for failure, OFF for no failure at output of tested IC.

Failure Blanking:

200-01	Nominal 400 nsec @ 5V.
200-02	Nominal 100 nsec @ 5V.
200-03	Nominal 200 nsec @ 10V.

Faults of shorter duration are ignored.

IC Pin Capacity: Handles 8, 14, and 16-pin dual in-line packages. Flatpacks require special probing adapters.

Logic Monitor: Single indicator displays ON for logic one, OFF for logic zero at IC pin selected by sixteen position rotary switch.

Logic Probe: 12" lead, allows probing of nearby circuit nodes.

Logic Monitor Display: Minimum detectable pulse width (nominal)

	@ 5V	@ 10V
200-01	100 nsec	75 nsec
200-02	100 nsec	•
200-03	•	100 nsec

Maximum pulse repetition rate 1 MHz for 200-01, 5 MHz for -02 & -03 (indicated by flashing at approximately 5 per second)

Single pulse indication, single flash approximately 100 msec long

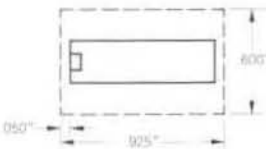
Reference IC Receptacle: Accepts industry standard 16-pin IC socket with 0.025" square posts, 0.635" posts used for IC inputs, 0.320" posts used for IC outputs

Size: 2³⁄₁₆" x 1⁵⁄₁₆" x 6⅛" (5.6cm x 3.3cm x 15.5cm)

Weight: 6 oz. (170 gm)

Carrying Case: 10" x 7½" x 3⅛" (25.4cm x 19cm x 7.9cm)

Clearance required around IC to be tested:



Other TRENDAR Products

The TRENDAR 200 IC TESTCLIP™ is one of a full series of products offered by TRENDAR for testing and trouble-shooting digital PC assemblies. Other products currently available include:

The TRENDAR 2000 General Purpose Test Station, which provides automatic testing and rapid fault isolation of both simple and complex digital PC assemblies. Extensive excitation capabilities, simple programming, high test rate (up to 4,000,000 tests per pin per second), and a broad range of troubleshooting tools have proven its superiority in dozens of production test applications throughout the world.

The TRENDAR 1000 LOGICTESTER™, a low-cost, portable digital PC board tester for field-service and low-volume production test applications. Its 128 digital signal sources make it fully program-compatible with the TRENDAR 2000.

More Data

Bulletin 122, FAULTRACK, comments in depth on the use of the TRENDAR 200 IC TESTCLIP as a logic card tester.

Bulletin 131, "Questions and Answers on the TRENDAR 200 IC TESTCLIP" provides answers to the most commonly asked questions about the features and use of the TESTCLIP. Request them from TRENDAR or your representative.

Warranty:

Fluke TRENDAR warrants this instrument to be free from defects in materials or workmanship for a period of one year.

Ordering Information

TRENDAR 200 IC TESTCLIP (Specify -01 General Purpose, -01 High Speed TTL, or -03 CMOS/HTL) complete with ten 16-pin sockets, 40 programming pins, 16-pin Extender Cable, Probe Extension and Manual, in carrying case.	$395

Accessories

TC1 Reference IC Sockets for TESTCLIP, 63 each (with 250 programming pins), in carrying case.	50
TC2 Reference IC Sockets for TESTCLIP, 25 each (with 100 programming pins), to fill carrying case.	20
TC3 Replacement 14-pin IC Clips (2 ea.)	30
TC4 Replacement 16-pin IC Clips (2 ea.)	30
TC5 Replacement Probe Extension.	10
TC6 14-pin Extender Cable (14-pin IC's only).	20
TC7 16-pin Extender Cable (14 & 16-pin IC's).	20
TC8 Auxiliary Power Supply for use with TRENDAR 200-03 when insufficient power is available from board under test.	20

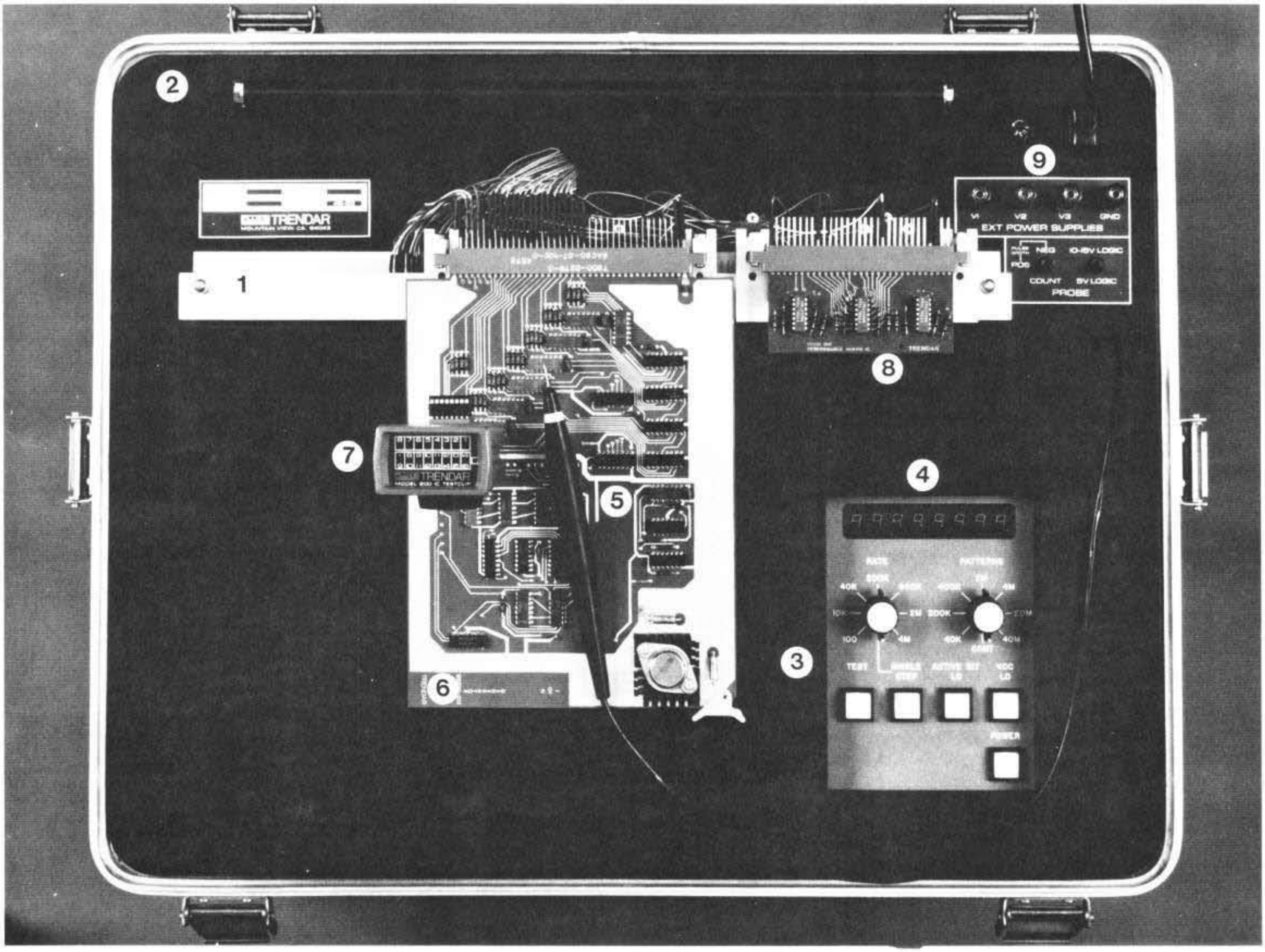
Services

SC1 Out-of-Warranty Repair Service, flat rate for incidental faults including parts, repair, retest, handling, and return shipment.	65

FLUKE

TRENDAR 1000 LOGICTESTER™

Digital logic testing for factory and field



- One pass go/no go test — using unique Output Count Integrator
- High-speed — up to 4,000,000 patterns/second
- High productivity *and* highest confidence level
- 129 signal sources
- FAULTRACK® isolates faults rapidly
- Rugged portable case for field use
- Handles boards with hundreds of pins
- Programs prepared quickly
- Low real cost
- Fully compatible with TRENDAR 2000 test station

1. **Interconnect block.** Plugs into LOGICTESTER to interface circuit board. Wired jumpers produce specific programs.
2. **Ejection bar.** Disengages interconnect block after use.
3. **Control panel.** Contains settings for rate and number of tests, power, marginal V_{CC}, test initiation, pulse polarity and single step operation.
4. **Counter display.** Indicates node toggling sums and pulse widths.
5. **Logic probe.** Shows instantaneous logic states and toggling activity, provides high-impedance input to transition and interval counters.
6. **Unit under test.** Printed circuit board inserted for digital logic testing.
7. **TESTCLIP™ in-circuit IC tester.** New pocket-size TRENDAR digital logic test instrument checks board integrity *and* individual IC's.
8. **Performance board.** Provides logic level interfaces, custom control signals, and passive loads.
9. **External power connections.** Terminals for supply voltages.

What the TRENDAR 1000 LOGICTESTER does:

- It exercises circuit boards to determine which are good and which are defective *— with a very high level of confidence.*
- It rapidly locates faults in defective boards

This portable LOGICTESTER provides the same *thorough* testing as the TRENDAR 2000 Test Station, which has established new levels of throughput in production board testing. By thorough, we mean test rates up to 4,000,000 patterns per second and sequences longer than 40,000,000 — a combination which guarantees that all active nodes will be exercised by a vast array of test sequences. Faults are identified and located rapidly with a combination of diagnostic tools and a universal procedure which unerringly finds defects in boards *and* components.

Fully compatible with the larger TRENDAR 2000 Test Station, the TRENDAR 1000 LOGICTESTER has been developed for lower-volume applications in field service and production testing. Mounted in a tough, waterproof fiberglas case, it can be safely shipped by air and hauled around the field with confidence. A complete test station, it contains all 128 of TRENDAR's unique pattern generators plus a programmable generator. Test boards are interfaced through a simple, rugged aluminum channel interconnect fixture.

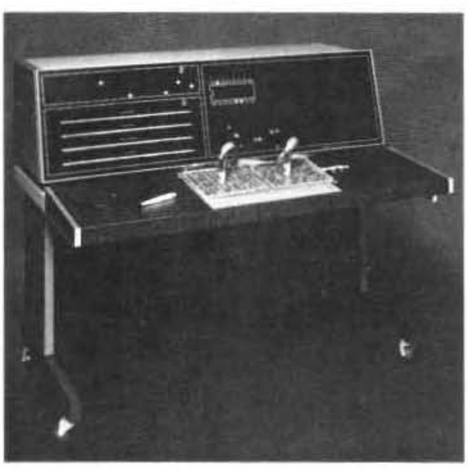
The productivity of the TRENDAR 1000 is unequalled for the modest investment: Its troubleshooting capability outstrips computer testers costing up to ten times as much. Field service centers can economically test and repair circuit boards locally. Troubleshooting time is slashed, and boards that would otherwise be lost can be saved.

Build-up of costly board inventory is prevented, and board losses from obsolete inventory are reduced.

Test programs developed by the factory can be implemented in the field in minutes — or programming can be done on-site. Handling engineering changes and/or board versions is a simple matter.

The TRENDAR 1000 LOGICTESTER is equally well-suited to production testing requirements. Total investment in one LOGICTESTER *including dozens of programs* is under $8,000 — with the same high test validity as the high-volume TRENDAR 2000 Test Station. The LOGICTESTER will pay for itself at a production rate of 25 to 50 boards per month.

One TRENDAR 2000 Test Station supported by a number of compatible TRENDAR 1000 LOGICTESTERS for fault isolation can produce the highest board production rate per dollar. We'll show you how.



FAULTRACK

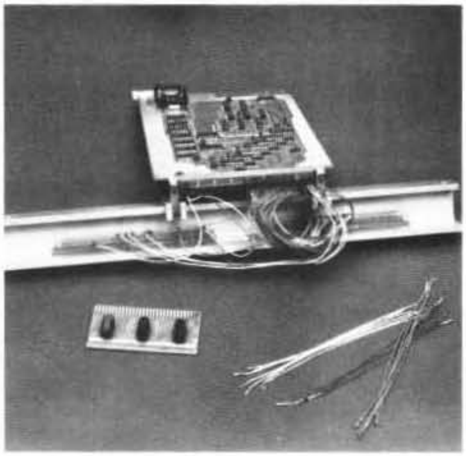
FAULTRACK is a technique of rapid troubleshooting made practical by TRENDAR's logic testing products. Faults leave a "track" of responses which do not correspond to those of a previously-measured good board.

With the TRENDAR 1000 LOGICTESTER, FAULTRACK offers two troubleshooting methods. First is the node toggling sum (transition count) method of determining normal behavior: node counts are compared to correct values established by measuring a known-good board. Go/no-go testing of outputs is achieved by checking node counts with the TRENDAR 1000 logic probe and built-in counter. Incorrect counts are back-tracked into the circuit until the IC inputs compare but outputs do not; the defective node is thus identified. Where feedback loop faults or lack of initialization prevent identification of the defective node, the second method is used: TESTCLIP.

The TRENDAR 200 IC TESTCLIP is supplied with the LOGICTESTER. It can be used to test all IC's on the board. It isolates a defect in a closed signal loop — which is not practical otherwise. Stuck-pin faults can be back-tracked to their cause. The TESTCLIP will catch and display node failures caused by board defects or IC (pin) faults. It is ideal for rapidly diagnosing field failures, most of which are IC-related.

A large percentage of boards can be completely and validly checked with the TESTCLIP alone. Operators quickly master the use of these companion FAULTRACK methods.

Programming



A board is "programmed" by selecting the appropriate excitation signals from the array of 128 TRENDAR signal sources and assigning them to circuit inputs. Pattern generator signal sources are selected for duty cycles, frequencies, and phase relationships which will produce appropriate activity in the circuit.

The suitability of a program can be verified by checking node activity. After ensuring that all nodes are active, deliberate insertion of faults at any or all internal active pins will cause non-comparative counts at board outputs.

No software, programming matrix, or other complications are required because the TRENDAR test fixture *itself* is the "program." These rugged, precision channel-aluminum fixtures are low in cost and fully reusable. They are tailored to a specific board type by simply mounting the board's mating connector and connecting jumpers from the selected pattern generators. If any control signal exclusions are required or if level shifting is needed, an appropriate accessory IC performance board is mounted on the interconnect fixture. Passive component loads can also be mounted. Programming details are described in TRENDAR Bulletin 124.

Brief Specifications

Signal Sources: 128 standard 5V compatible signal generators plus one programmable generator

Pattern Rate: Eight selectable rates from single step to 4 MHz

Number of Patterns: Seven selectable up to 40 million plus continuous

Test Modes: Single Step and Auto-Test

Probe: Shows '0' and '1' logic states and flashes for toggling. Logic level selection for 5V and 10V logic

Counter: Eight digit display shows transition totals or pulse width

Output Count Integrator: Accepts up to 60 outputs from Unit Under Test and generates a single integrated signal which may be counted for a one pass go/no-go test. Intermediate test points allow back-tracking to the failed output(s).

Pulse Width: Selectable positive or negative pulse intervals from 1 μsec to 100 sec

Module Power Supply: 5V with adjustable current limit to 6A. Marginal V_{CC} to -10%. Inputs for three additional supplies.

Power Requirements: 115 or 230 V AC $\pm 10\%$, (48-62 Hz, 150 Watts) maximum

Size: Height x Width x Depth, 11⁷⁄₁₆" x 24" x 18⅞" (29 cm x 61 cm x 48 cm)

Weight: 75 lb. (34 Kg)

Operating Environment: 32°F to 122°F (0°C to 50°C), 0 to 95%, Relative Humidity non-condensing

Warranty:

This product is warranted against defective materials and workmanship for one year.

More Data

Bulletin 123, TRENDAR 1000 LOGICTESTER Technical Description, provides technical details and specifications.

Bulletin 112, Questions and Answers on the TRENDAR 1000 LOGICTESTER, provides answers and discussion of the most frequently asked questions about the TRENDAR 1000.

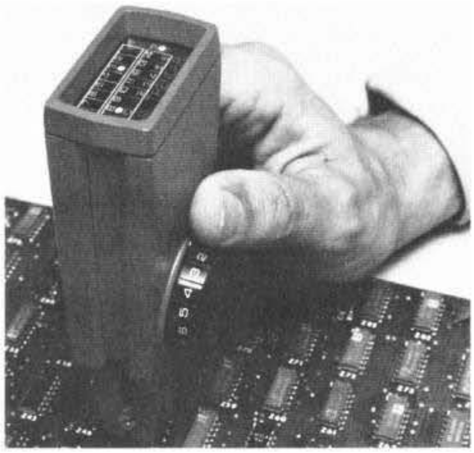
Bulletin 122, FAULTRACK, describes the universal fault isolation techniques in detail.

Bulletin 124, Test Preparation on the TRENDAR 1000 LOGICTESTER, is a brief course on the TRENDAR programming techniques, complete with circuit examples.

Bulletin 130, TRENDAR 200 LOGIC TESTCLIP, describes this hand-held in-circuit IC Tester.

Bulletin 110B, TRENDAR 2000 General Purpose Test Station, describes this full scale production test station.

Other TRENDAR Products



The TRENDAR 200 IC TESTCLIP™ combines the power of a logic probe, a logic states display clip and an IC comparator in one compact instrument. It functionally tests digital IC's while they are operating in-circuit. Its ability to spot both board faults and IC defects makes it ideal for production test, field service, and the engineering lab.

The TRENDAR 2000 General Purpose Test Station provides automatic testing and rapid fault isolation of digital PC assemblies. Extensive excitation capabilities, simple programming, high test rate and a broad range of troubleshooting tools have proven its superiority in dozens of production test applications throughout the world. The TRENDAR 1000 LOGICTESTER uses the identical pattern generators and test rates. Thus, it is fully program compatible, not only for field service but also as a fault-finding station supporting the TRENDAR 2000 in the factory.

Ordering Information

TRENDAR 1000 LOGICTESTER complete with Output Count Integrator, TRENDAR 200 IC TESTCLIP, integral carrying case, and 1 Operation & Maintenance Manual.	$5,975

Options

01	230VAC, 50-60 Hz	N/C

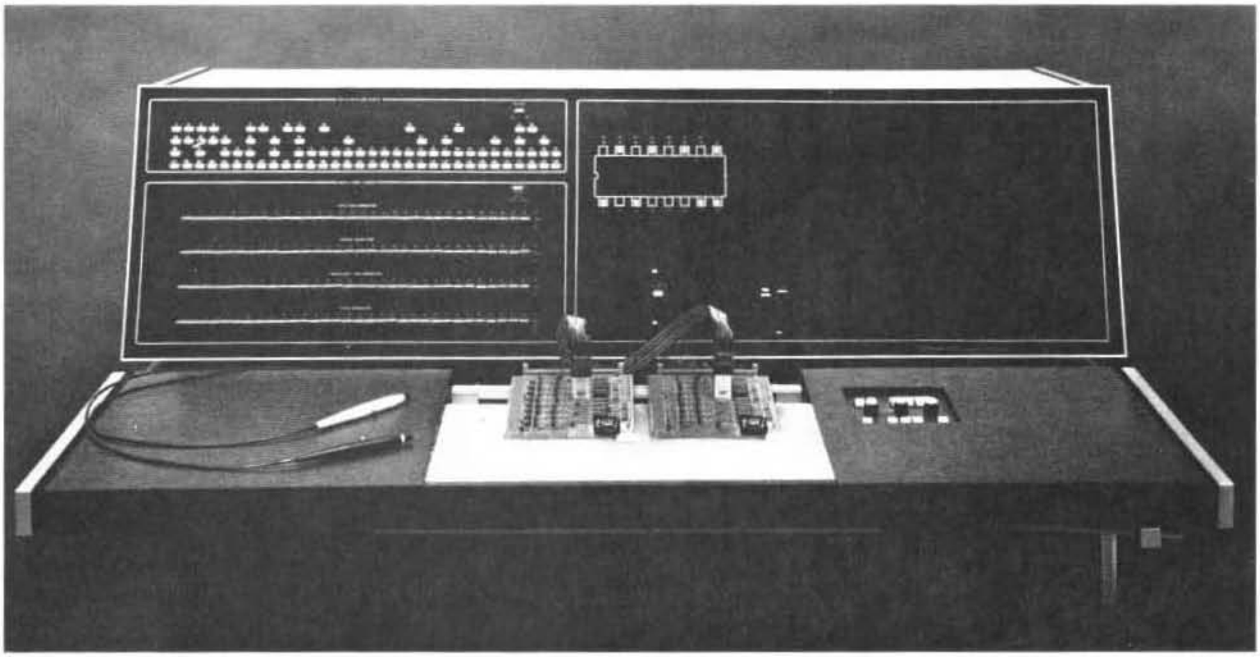
Accessories

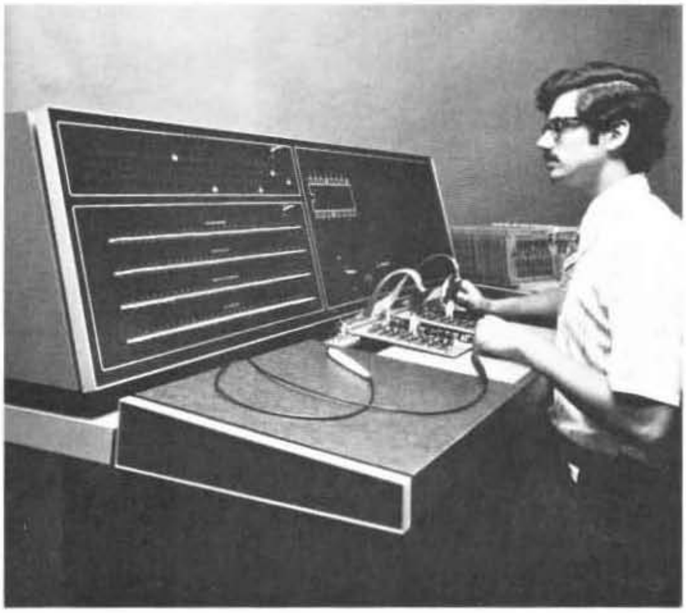
L1	Self Test Module.	245
L2	Interconnect Block, for interfacing to tester including 4 pivoting connector mounting arms and mating connector for Output Count Integrator. Allows probing underside of operating board.	1 to 9: 45 10 & up: 40
L3	Connector Mounting Arms (pair), for performance boards and boards with two edge connectors.	10
L5/A	Wire Kit, standard. Contains pre-crimped programming wires of various lengths, configurations and colors. Sufficient for 10 typical boards.	190
L5/B	Wire Kit, 1000 each, 12" 4 colors, terminals one end, stripped and tinned other end.	250
L5/C	Wire Kit, 1000 each, 12" 4 colors, terminals both ends.	250
L5/D	Wire Kit, 1000 each, 7" 4 colors, terminals both ends.	250
L6	Terminals, 600 each, loose, Berg Mini-PV, for hand crimping use Berg HT-95 crimp tool, available from Berg Electronics, Inc., New Cumberland, PA 17070.	60
L7/U	Performance Card, Universal (Kit of 10 suitable for mounting IC's or miscellaneous components).	100
L9	Output Count Integrator, spare (one included with TRENDAR 1000).	250
L10	Spares Kit, Minimum (Miscellaneous components).	45
L11	Spares Kit, Complete Assembly Level (including 9 complete PC boards plus miscellaneous components).	1,850
TC1	Reference IC Sockets for TESTCLIP, 63 each (with 250 programming pins), in carrying case.	50
TC2	Reference IC Sockets for TESTCLIP, 25 each (with 100 programming pins) to fill carrying case.	20
TC3	Replacement 14-pin IC Clips (2 each) for TESTCLIP.	30
TC4	Replacement 16-pin IC Clips (2 each) for TESTCLIP.	30
TC5	Replacement Probe Extension.	10
TC6	14-pin Extender Cable for TESTCLIP (14-pin IC's only).	20
TC7	16-pin Extender Cable for TESTCLIP (14 & 16-pin IC's).	20
LS1	Two days training in operation, programming and troubleshooting for one to three personnel at TRENDAR factory. (Note: The self-training material provided will be sufficient for most users. Factory training is available for those desiring individualized instruction).	200 per day

FLUKE

TRENDAR 2000

DIGITAL LOGIC TEST STATION





- A truly new circuit module test technique
- Obsoletes dedicated circuit board test stations
- Isolates circuit board faults to exact causes
- Exercises all combinations of internal circuit states
- Performs time-compressed simulation of in-service operation
- Eliminates expensive test procedures
- Eliminates programming cost and delay
- Simple operation – fits present personnel and methods

Benefits

Ultimately, your choice of tester is determined by the benefits you expect. TRENDAR users throughout the world report:

1. Highest confidence in the tested board

Boards that are tested and passed by the TRENDAR 2000 work in the end product. The fact that there is a significant final reject rate of boards passed by other testers is not usually discussed. The higher confidence level in TRENDAR-tested boards results from two factors. First, the test station applies millions of test combinations and sequences at the highest test pattern rates. Second, the powerful FAULTRACK® tools will trap intermittent or marginal faults that may not repeat for millions of test steps.

2. Higher productivity

High speed testing and fault isolation produce a three to ten times increase in boards produced per man hour.

3. Fault finding superiority

The superiority of comparative testing for fault isolation speed is uncontested. Even software systems are beginning to utilize "known-good boards" to store truth tables. TRENDAR treats the known-good board as a read-only memory of indefinite length. It always has the proper response stored. To this we add eight diagnostic tools which trap multiple and loop faults that defy software diagnostics. The universal FAULTRACK procedure can be learned in one sitting.

4. The fastest startup

The TRENDAR 2000 is typically testing the week it is delivered. Two days of training in operation and programming suffice.

5. Compatible field service unit

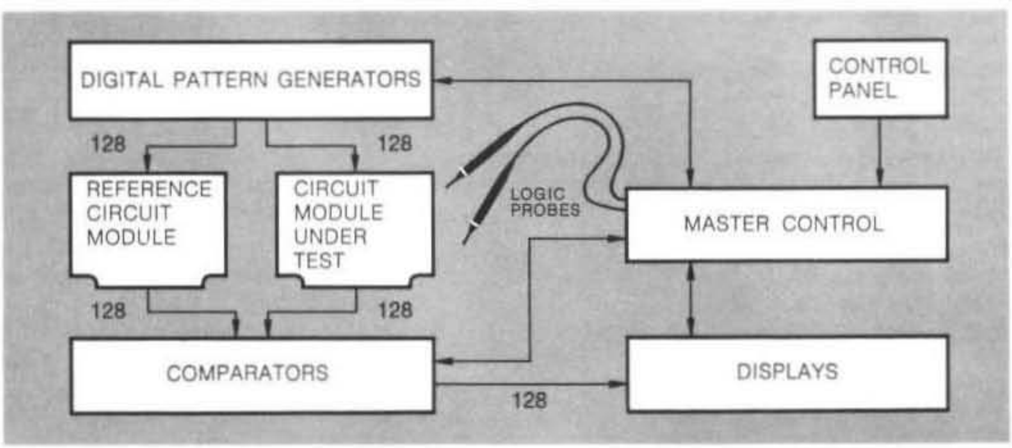
TRENDAR users gain the benefits of the low-cost program-compatible TRENDAR 1000 LOGICTESTER™ for field service use. And the TRENDAR 200 IC TESTCLIP™ can be used with both, yielding unmatched fault detecting capability in factory and field.

6. Lowest annual cost

Adding all the direct and indirect costs together, nothing matches TRENDAR's low effective cost. Request TRENDAR's economic analysis kit and check your own situation. A table of industry standard data accompanies it, making the analysis very straightforward.

TRENDAR users are enthusiastic about their results. We'll happily supply their names. Check for yourself.

How it Tests

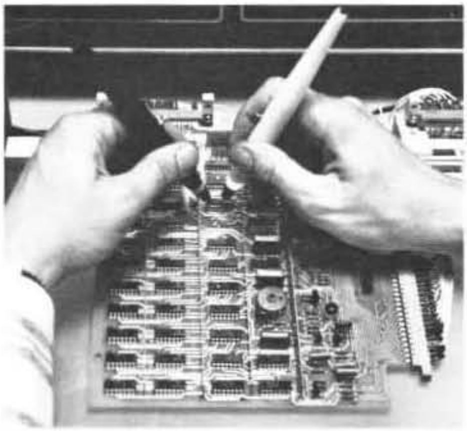


The TRENDAR 2000 General Purpose Test Station assesses the performance of a circuit module by comparing it to a known reference. Four uniquely combined digital pattern generators provide inputs which are routed to corresponding pins on the reference module and the module under test. The output behavior of the modules is measured by digital comparators. Any logic function abnormality is detected and displayed as a failure. Testing will pause or continue, depending on when the fault isolation will be done.

Testing is carried out automatically under various applied voltage (V_{cc}) levels, at the selected clock rates and number of tests.

Easy-to-understand displays continuously indicate test status, test pattern count or frequency, and fault conditions. The tracking probe displays circuit states for direct tracking of defects.

Fault Isolation



Costs of isolating faults and repairing circuit modules are rising with increased board complexity and component density.

Most faults stem from solder bridges, non-plated through holes, defective components, flaws in soldering and improper assembly. Multiple faults occur frequently.

All such faults can be directly measured and pinpointed with the TRENDAR 2000. Other testers are limited to truth-table comparisons: inferential non-direct diagnostics. Software approaches assume IC's are bad, not always the case. Multiple fault diagnostics are not practical. Difficult sleuthing by skilled technicians result.

With TRENDAR's FAULTRACK,© a universal trouble-shooting method, any technician quickly learns to backtrack misbehaving signal tracks to the source defect. The TRENDAR 2000 automatically tells him which pins to follow. Using non-corresponding signals as a guide, the signal path is tracked back to a point where logic behavior corresponds. The fault lies at this stage and can be quickly identified as a mechanical, component, or assembly defect.

Multiple faults are pinpointed as readily as single faults. Loop faults, which defy software systems, are readily detected with the TRENDAR 200 IC TESTCLIP.

Preparing to Test

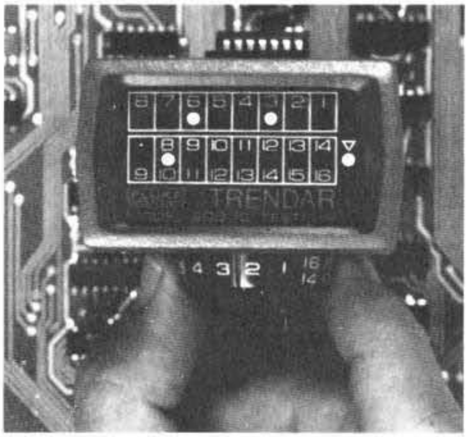
Preparing a circuit module test with the TRENDAR 2000 is a simple task. It typically requires one to four hours, in contrast to the days or even weeks of programming required for some test methods.

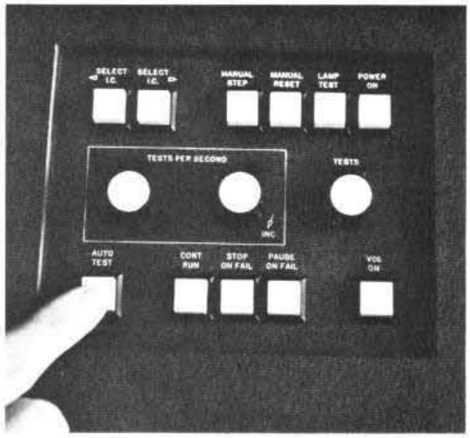
An engineer or technician examines the circuit logic schematic and decides which digital pattern generators will properly exercise the module inputs. Functions such as reset, power, and ground are selected. Corresponding outputs from the two modules are routed to one of the 128 output comparators for failure display. The engineer then marks his decisions on a wire list.

All communication of test signals, controls, and module outputs is made through this interconnect block. Each type of circuit module is interfaced with a similar block wired and dedicated for it. The interconnect block mounts card connectors and the 640-pin connector, which mates with the main connector in the test station.

Then an assembler wires the interconnect block, following the interconnect block schematic or a wiring list. The wiring can be checked out by interchanging the circuit modules in operation. TRENDAR 2000 test procedures are reduced to test clock rate, number of tests, and test station operating mode.

Ultra-Thorough Testing





The TRENDAR 2000 applies an entirely new level of thoroughness: basic testing plus circuit exercising to a degree that ensures ultimate reliability. Millions of tests are performed in a fraction of a second.

Both reference and test modules operate simultaneously under a unique sequence of test patterns. All possible internal combinations and sequences will be exercised for combinatorial and sequential logic. Up to 10 million test cycles are repeated three times with normal and marginal voltages.

Speed-dependent circuits are fully tested at rated clock frequency — the clock rate is simply set or varied by the operator, according to your requirements.

One button starts fully automatic testing. Four digital pattern generators are provided:

1 of N Generator produces a random pulse at one of 32 outputs in each clock period.

*TRENDAR Sequence Generator** produces a unique pattern simulating any digital code of up to 32 parallel bits and/or serial sequences up to 2^{33} bits long.

Pseudo-Gray Code Generator produces up to 32 random outputs—only one bit changing at a time.

Clock-Generator produces 24 Gray Code outputs and 8 Eight Phase outputs for use as clocks or for square-wave sources of known frequencies.

*Patent applied for

Brief Specifications

Inputs: 128 standard 5V compatible signal generators

Outputs: 128 standard 5V comparators

Test Speed: Adjustable 1 Hz to 4 MHz

Number of Tests: Selectable up to 30,000,000 per pin

Trouble-shooting Aids: Dual logic probes, dual IC test clips, and TRENDAR 200 IC TESTCLIP

Module Power Supplies: 5V, with adjustable HI, NORMAL, LOW settings, adjustable current limit

Power Requirements: 115 VAC, 60 Hz, (230 VAC, 50 Hz) 800 watts

Size: Height x Width x Depth 46" x 60" x 39.5", 117 cm x 153 cm x 100 cm

Weight: 460 lb. (209 kg)

Accessories Furnished: Wired self-test interconnect block

For more information: request bulletins 110, 111, 112, 122, 160.

Ordering Information

TRENDAR 2000 Digital Logic Test Station, Including Self-Test Block, 2 days training (order S1 or S2 from below) and 2 Operation & Maintenance Manuals. Includes Buffered IC Clips (formerly Option 02) and TRENDAR 200 IC TESTCLIP.	$25,000

Options (Ordered with Test Station)

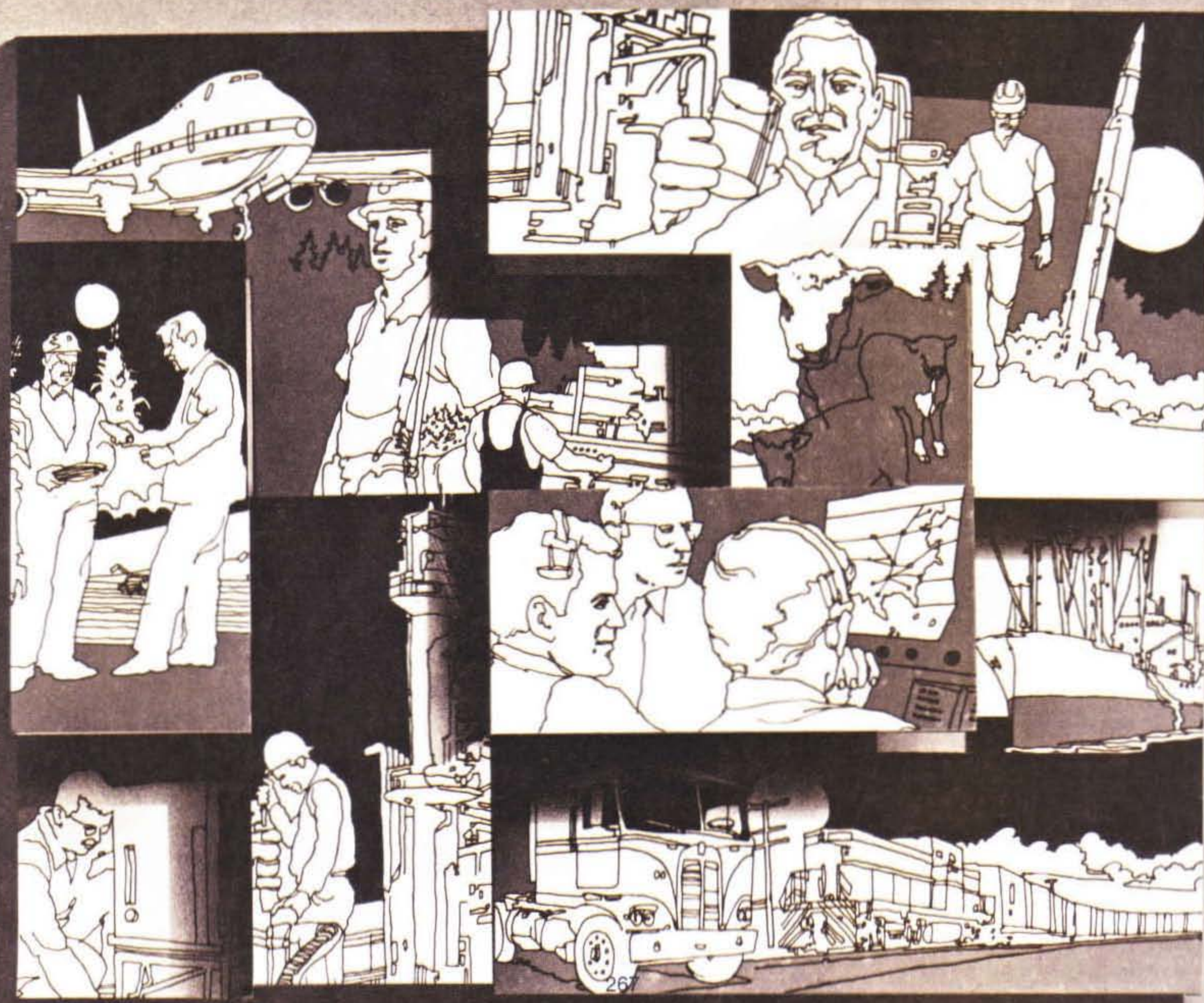
01 Programmable Code Generator.	1,600
03 230V/115V/50-60 Hz	450

Accessories (Allow 30 days for shipment on Accessory orders)

A1 Interconnect Block, one required per circuit module or module family; includes 4 connector arms.	1 to 9: 85 10 to 49: 75 50 & up: 70
A2/A Wiring Kit, various length single, double and triple jumpers, suitable for wiring approximately 10 interconnect blocks, 1300 jumpers.	395
A2/B Wiring Kit, 1000 - 12" single jumpers crimped with Berg Mini PV terminals on one end, stripped and tinned on other.	250
A2/C Wiring Kit, 1000 - 12" single jumpers with PV terminals on both ends.	250
A2/D Wiring Kit, 1000 - 7" single jumpers with PV terminals on both ends.	250
A5/U Performance Card, Universal (Kit of 10 suitable for mounting IC's or miscellaneous components).	100
A6-14 Buffered IC Clips for 14-pin DIP's only (pair).	180
A6-16 Buffered IC Clips for 14 and 16-pin DIP's (pair).	180
A6-16E Buffered IC Clips (pair) for monitoring 16 pins of 24, 28 and 40-pin DIP's (0.600" wide).	240
A7 Connector Mounting Arms for interconnect blocks, for mounting boards with 2 or more edge connectors on one side (pair).	10
A8 Terminal Kit (600 Berg Mini-PV terminals for hand crimping) requires Crimp Tool, Berg HT-95, available from Berg Electronics, New Cumberland, PA 17070.	60
A10 Spares Kit, Minimum (Miscellaneous component parts).	185
A11 Spares Kit, Normal (Including 5 complete PC Boards plus miscellaneous components).	950
A12 Spares Kit, Complete Assembly Level, (Including 12 complete PC boards, plus miscellaneous components).	3,500
A13 Additional Operation & Maintenance Manuals.	15
TC1 Reference IC Sockets for TESTCLIP, 63 each (with 250 programming pins) in carrying case.	50
TC2 Reference IC Sockets for TESTCLIP, 25 each (with 100 programming pins) to fill carrying case.	20
TC3 Replacement 14-pin IC Clips (2 each) for TESTCLIP.	30
TC4 Replacement 16-pin IC Clips (2 each) for TESTCLIP.	30
TC5 Replacement Probe Extension for TESTCLIP.	10
TC6 14-pin Extender Cable for TESTCLIP (14-pin IC's only).	20
TC7 16-pin Extender Cable for TESTCLIP (14 & 16-pin IC's).	20

section II

accessories



accessories

The following list identifies part numbers and prices for rack mount hardware and other accessory items which are associated with a particular instrument model. Additional information appears on the individual data pages for corresponding instrument model.

	Rack Adapter(s)		Chassis Slides		Miscellaneous	
Model	P/N - Description	Price	P/N - Description	Price	P/N - Description	Price
A40					C41 Case 212860 Shunt Cable	75.00 20.00
A40A					212852 RF Input Cable	15.00
A55					C55 Case A55 - 110 Coaxial Connector Set	75.00 75.00
A90	MEE-7006 Single Ctr. MEE-7013 Single Offset MEE-7014 Dual	40.00 40.00 25.00			MEE-4008 Dust Cover	10.00
1000	See data pages for Model 1000					
1900A	See data pages for Model 1900A					
1941A	MOO-200-616	50.00			2010A-7009 Interface Cable	75.00
1950A	MOO-200-615	50.00				
1952A	MOO-200-614	50.00				
1980A					A53 Antenna	18.00
200	See data pages for Model 200					
2000	See data pages for Model 2000					
2010A					MO7-203-546 Dust Cover	15.00
203A			A60-01	50.00		
207-5			A60-01	50.00		
2100A	MOO-200-618 Dual MOO-200-619 Offset MOO-200-620 Panel Frame	30.00 35.00 25.00			C82 Carrying Case MO3-203-700 Front Panel Cover	100.00 10.00
2150A	MOO-200-618 Dual MOO-200-619 Offset MOO-200-620 Panel Frame	30.00 35.00 25.00				
332B			A60-01	50.00		
332D			A60-01	50.00		
3330B	MEE-7003	25.00	MEE-8079 24" MEE-8078 18"	50.00 50.00		
335A			A60-01	50.00		
335D			A60-01	50.00		
341A	MEE-7001	15.00	MEE-8078 18" MEE-8079 24"	50.00 50.00		
343A	MEE-7001	15.00	MEE-8078 18" MEE-8079 24"	50.00 50.00		

	Rack Adapter(s)		Chassis Slides		Miscellaneous	
Model	P/N - Description	Price	P/N - Description	Price	P/N - Description	Price
382A			A60-01	50.00		
408B			A60-01	50.00		
410B			A60-01	50.00		
412B			A60-01	50.00		
415B			A60-01	50.00		
4210A	MO5-203-601 Single Offset MO5-200-603 Dual MO5-203-602 Single Center	25.00 15.00 25.00	MOO-280-610	50.00	292623 Extender PCB 337584 Extender PCB Cable	25.00 25.00
4216A	MO5-203-601 Single Offset MO5-200-603 Dual MO5-203-602 Single Center	25.00 15.00 25.00	MOO-280-610	50.00	292623 Extender PCB 337584 Extender PCB Cable	25.00 25.00
4250A	MO5-205-600	15.00	MOO-280-610	50.00	292623 Extender PCB 337584 Extender PCB Cable	25.00 25.00
4265A	MO5-205-600	15.00	MOO-280-610	50.00	292623 Extender PCB 337584 Extender PCB Cable	25.00 25.00
4270A	MO5-205-600	15.00	MOO-280-610	50.00	292623 Extender PCB 337584 Extender PCB Cable	25.00 25.00
4275A	MO5-205-600	15.00	MOO-280-610	50.00	292623 Extender PCB 337584 Extender PCB Cable	25.00 25.00
510A	MO3-201-601 Single MO3-202-603 Dual MO3-206-604 Triple MO3-205-605 Quad	40.00 40.00 40.00 40.00				
515A	MOO-200-618 Dual MOO-200-619 Offset	30.00 35.00			C82 Carrying Case MO3-203-700 Front Panel Cover	100.00 10.00
5200A	MO7-205-600	25.00	MOO-280-610 24"	50.00	5200A-7015K Extender Board	25.00
5205A	MO8-205-600	25.00	MOO-280-610 24"	50.00	340984 Triax Cable	1.80/ft.
540B	540B-103	15.00				
6160B	MO7-205-600	25.00	MOO-280-610 24"	50.00		
645A	MEE-7004	25.00				
720A			A60-01	50.00		
721A			A60-01	50.00		
731B	MO3-201-601 Single MO3-202-603 Dual MO3-206-604 Triple MO3-205-605 Quad	40.00 40.00 40.00 40.00				

	Rack Adapter(s)		Chassis Slides		Miscellaneous	
Model	P/N - Description	Price	P/N - Description	Price	P/N - Description	Price
8000A	MOO-200-612 Single Center MOO-200-611 Single Offset MOO-200-613 Dual	30.00 30.00 30.00			MOO-100-714 Dust Cover C-80 Case C-86 Case A80 Test Leads	8.00 15.00 15.00 5.00
8000A-05	MOO-200-612 Single MOO-200-611 Offset MOO-200-613 Dual	30.00 30.00 30.00			C-80 Case C-86 Case A80 Test Leads MOO-100-714 Dust Cover	15.00 15.00 5.00 8.00
8000A-06	MOO-200-612 Single MOO-200-611 Offset MOO-200-613 Dual	30.00 30.00 30.00			C-80 Case C-86 Case A80 Test Leads MOO-100-714 Dust Cover	15.00 15.00 5.00 8.00
8100B	MO3-200-607 Single MO3-200-606 Dual	40.00 25.00	MOO-260-610	50.00	MO3-203-700 Dust Cover C-82 Case	10.00 100.00
8110A	MEE-7006 Single Ctr. MEE-7013 Single Offset MEE-7014 Dual	40.00 40.00 25.00			MEE-4008 Dust Cover C-82 Case	10.00 100.00
8120A	MO3-200-607 Single MO3-200-606 Dual	40.00 25.00	MOO-260-610	50.00	MO3-203-700 Dust Cover C-82 Case	10.00 100.00
8200A	MO3-200-607 Single	40.00	MOO-260-610	50.00	8200A-4017 Extender Board MO3-203-700 Dust Cover C-82 Case	25.00 10.00 100.00
8300A	MEE-7001	15.00	MEE-8078 18" MEE-8079 24"	50.00 50.00	8300A-4013 Extender Boards 8300A-4015 Extender Boards	25.00 25.00
8350A	MO3-205-600 Single	15.00	MOO-280-610	50.00	A80 Test Leads	5.00
8375A	MO3-205-600 Single	15.00	MOO-280-610	50.00	8400A-7014 Extender PCB	25.00
8400A	MO3-205-600	15.00	MOO-260-610	50.00	8400A-7014 Extender PCB	25.00
845AB	881A-102 Single 881A-103 Dual	25.00 15.00			A71 Low Thermal Leads A80 Test Leads	24.00 5.00
853A	MEE-7010 Single	25.00			Test Leads Dust Cover	5.00 10.00
8600A	MOO-200-611 Offset MOO-200-612 Center MOO-200-613 Dual	30.00 30.00 30.00			C80 Vinyl Case C86 Poly. Case A80 Test Leads	15.00 15.00 5.00
8800A	MOO-200-625 Center	50.00			A80 Test Leads	5.00
883AB	881A-102 Single 881A-103 Dual	25.00 15.00				
885AB	881A-102 Single 881A-103 Dual	25.00 15.00				

	Rack Adapter(s)		Chassis Slides		Miscellaneous	
Model	P/N - Description	Price	P/N - Description	Price	P/N - Description	Price
887 AB	881A-102 Single 881A-103 Dual	25.00 15.00				
891A	MEE-7008 Single	30.00			MEE-4014 Dust Cover	10.00
893A	MEE-7008 Single	30.00			MEE-4014 Dust Cover	10.00
893AR	MEE-7001	15.00	MEE-8078 18" MEE-8079 24"	50.00 50.00		
895A	881A-102 Single 881A-103 Dual	25.00 15.00				
931B	881A-102 Single 881A-103 Dual	25.00 15.00				

NOTES

TO OUR CUSTOMERS –

It is our privilege to provide you with the new 1974-75 Fluke Test and Measurement Instruments catalog. We trust it will serve as a guide to help solve your instrumentation needs.

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