410B
DC Power Supply

Instruction Manual

P/N 294009
December 1965

FLUKE®

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90-days), or any product or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 1 year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC., SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify the JOHN FLUKE MFG. CO., INC., or nearest Service facility, giving full details of the difficulty, and include the model number, type number, and serial number. On receipt of this information, service data, or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way"* prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC, will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

Rev. 6/81

Change/Errata Information

Issue No: 4 6/79

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The instrument's pcb revision letter is equal to or higher than that which is indicated at the beginning of the change.

2. No revision letter is indicated at the beginning of the change/errata.

MANUAL

Title: MODEL 410B HIGH VOLTAGE DC POWER SUPPLY
Print Date: DECEMBER 1, 1965
Rev and Date: _____

C/E PAGE EFFECTIVITY

Page No.	Print Date
1	11/77
2	2/78
3	6/79

ERRATA #1

On page 2-2 paragraph 2-7e, change CAUTION note to read as follows:

CAUTION!

The sample string resistors in the 410B are subject to damage if the output voltage is reduced too rapidly. Pause approximately ½ second in each switch position when reducing the setting of the first decade switch (1000 volt increments). The second decade should be set to 300 or greater or the HIGH VOLTAGE switch set to STANDBY RESET before the first decade is set to 0 (zero).

CHANGE #1-3091

On page 5-10, remove Q204 from Ref Desig group Q203 and Q204 and add it to group Q205 and Q206 (use Code D). Change the tot qty of Q203 from 3 to 2. Change the tot qty of Q205 and Q206 from 2 to 3.

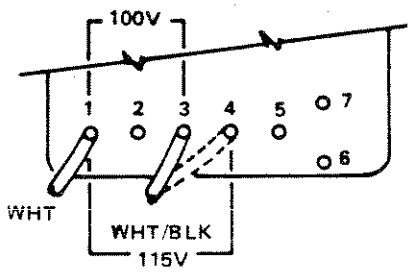
CHANGE #2-6647

On page 5-9 delete the entire C215 entry and add the following new entry:
C215; Cap, optional or factory selected.

CHANGE #3-6720

On page 1-1, delete information under "INPUT POWER" and add: 100/115/230V ac, 50 to 500 Hz, approximatly 300 VA at full output.

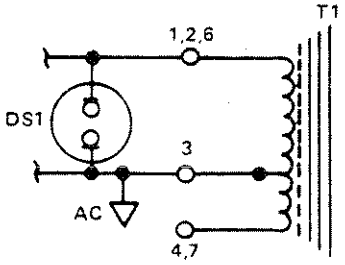
On page 2-1, delete information under paragraph 2-4 and add: Two power transformers (T1) are available for this instrument, 100/115V ac or115/230V ac. On the rear panel of each instrument a decal indicates the operating voltage of the transformer installed. This operating voltage can be changed by altering the wiring configuration of the transformer. To change the operating voltage of the 115/230V ac transformer, refer to the decal located on the power transformer. Refer to the drawing below for changing the operating voltage of the 100/115V ac transformer. To gain access to the power transformer, remove the instrument's top cover and the Delay PCB Assembly.



On page 5-3, add after T1 description: (115/230V). Add another listing for T1 as follows: T1; Transformer, Aux. (100/115V); Stock No. -5600-350918; Mfr. –89536; Mfr. Part No. -5600-350918; Tot. Qty. -1.

On the schematic diagram, add, as a separate note, the following primary configuration of T1 for the 100/115V ac power transformer.

Transformer connections shown are for 100V ac operation. For 115V ac operation, move the wire at terminal 3 to terminal 4 or 7.



CHANGE #4-7609

On page 5-10, change the stock no, mfr, mfr part no, and tot qty for transistors Q211 and Q212 from:
4805-203489, 07910, CDQ 10656, REF
to:
4819-168716, 07263, S19254, 2

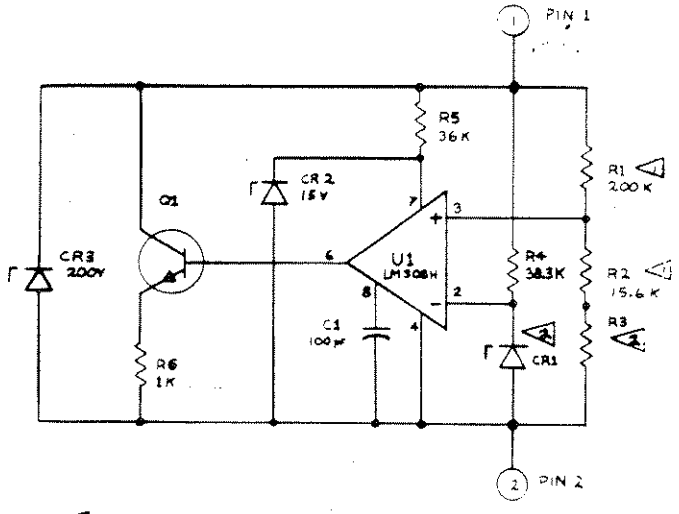
CHANGE #5-8438

On page 5-7, add the following new entry:
R155; Res, comp, 1.3k ± 5%, ½W; 4704-109157; 01121; EB1325; 1.

CHANGE #6–415–1030

On page 5-11, add the following replacement for voltage reference 83A1 (V201).
V201, 83A1 Substitute PCB, 451047, 89536, 451047.

On the schematic, remove and replace V201, R219 and R220 with the reference substitute shown below. Connect pin 1 to junction of R221 and base of Q206. Connect pin 2 to junction of DS203 and R141 (0V).

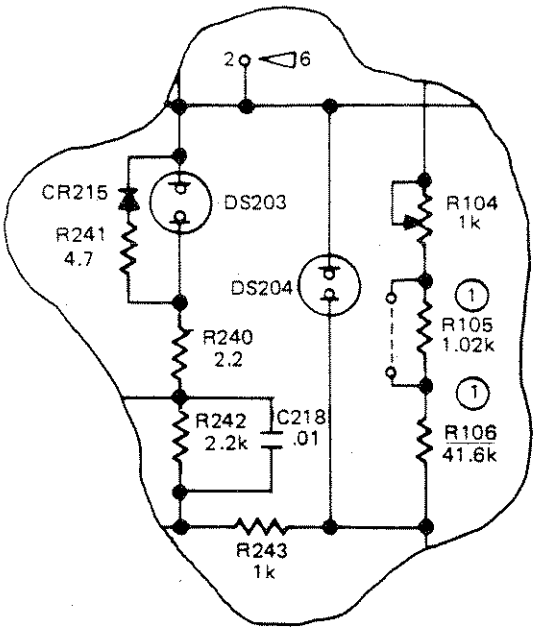


1 , 2 = Matched Components

CHANGE #7 – 11910

Rev. -G, Amplifier PCB Assembly

On the Functional Schematic (High Voltage Power Supply) make the following changes:



ADD: DS204

CHANGE #8 – 12060

Rev. -H, Amplifier PCB Assembly

On page 5-10, make the following changes:

FROM: Q211/Transistor, NPN, Si/4819-168716/07263/519254/Ref
TO: Q211/Transistor, NPN, Si/4805-203489/07910/CDQ10656/Ref

CHANGE #9 – 12329

Rev.-B, Front Panel Assembly (410B-406)

On page 5-6, make the following changes:

FROM: Handle, 6-7/16"/2404-101584/05704/805/2
TO: Handle/2404-494989/88245/1061-29/2

ERRATA #2

On page 1-1, under ELECTRICAL, add the following information:

Protection Class . . . . . #1 (Relates solely to insulation or grounding properties further defined in IEC 348.)

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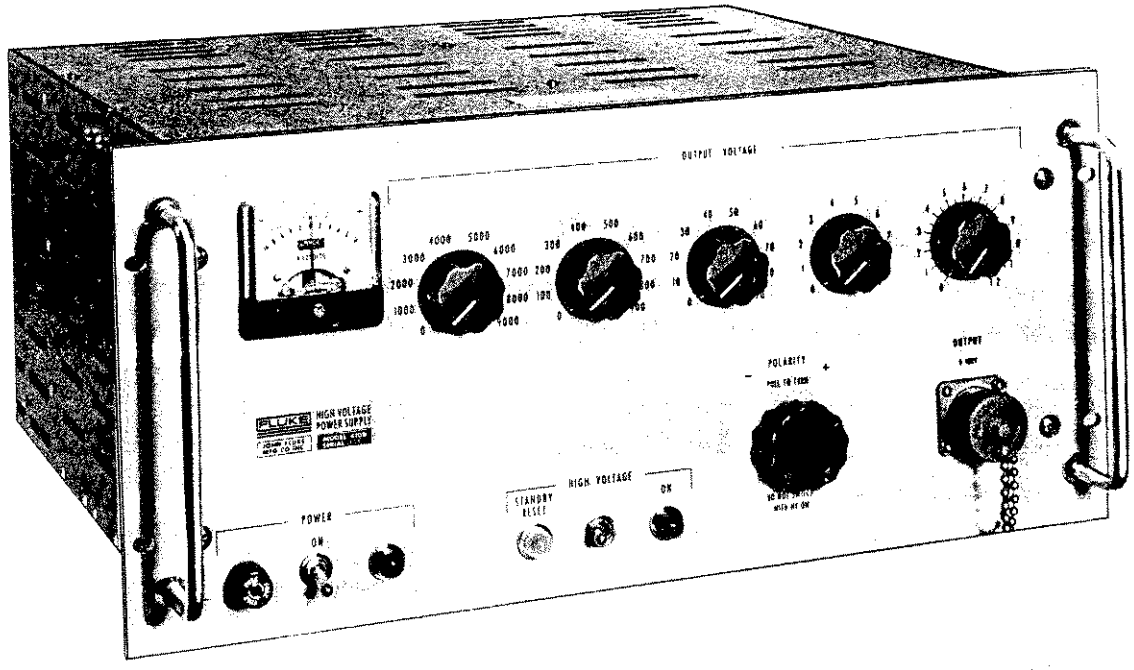
LIST OF ILLUSTRATIONS



MODEL 410B HIGH VOLTAGE DC POWER SUPPLY

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. GENERAL DESCRIPTION

1-3. The Fluke Model 410B High Voltage DC Power Supply is capable of providing an output of 0 to 10,000 vdc at 0 to 10 milliamperes. The output voltage is selected by four decade switches and a vernier potentiometer. The instrument may be operated with either positive or negative output terminal grounded, as selected by a front-panel switch. Overcurrent protection is provided to return the supply to standby operation in the event of excessive load current.

1-4. The Model 410B is a hybrid design utilizing silicon transistors for the amplifier circuitry and a vacuum tube for the necessary high voltage series passing element. A time-delay relay is incorporated in the input circuitry, which prolongs the life of the high voltage passing tube. The reference element is a highly stable temperature compensated gas tube.

1-5. The package design provides for adequate cooling at high ambient temperatures without the use of cooling fans. Rubber feet are provided for bench top operation to permit unrestricted air flow through the bottom cover air vents. The front panel is punched for mounting in a standard 19 inch rack. Side panels are tapped for Jonathan #130 quick disconnect chassis slides or other rack mounting supports.

1-6. RECEIVING INSPECTION

1-7. This instrument has been thoroughly checked and tested before being shipped from the factory. Immediately after receiving the instrument, carefully inspect for damage which may have occurred in transit. If any damage is noted, follow the instructions outlined on the warranty page in the back of this manual.

1-8. SPECIFICATIONS

1-9. ELECTRICAL

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).

INPUT POWER: 115/230 VAC ±10%, 50 - 60 Hz, approximately 300 VA at full output. Operation at 400 Hz available upon request.

1-10. MECHANICAL

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.

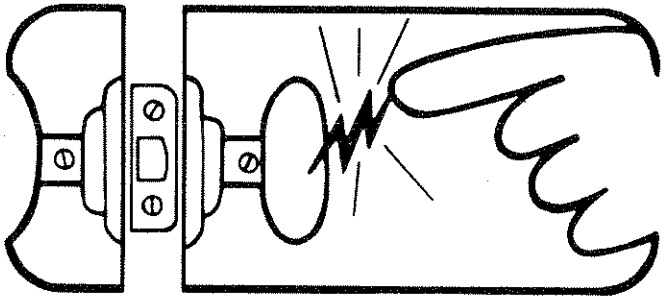
SIZE: 19" wide x 8-3/4" high x 15" behind panel (rack mount with resilient feet for bench use).

WEIGHT: Approximately 59 pounds.

static awareness

A Message From

John Fluke Mfg. Co., Inc.

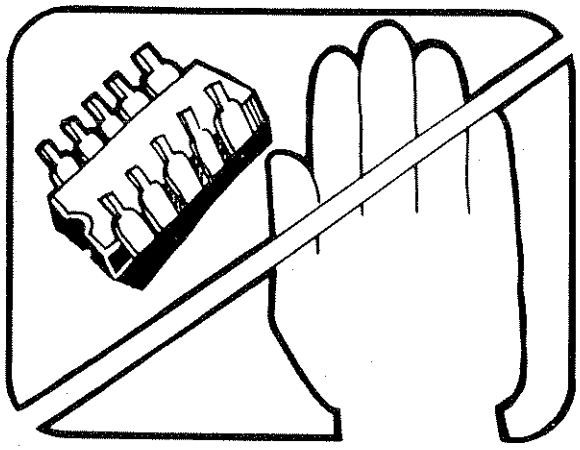


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

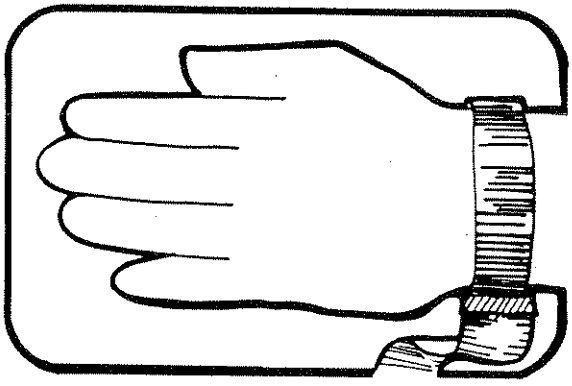
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗"

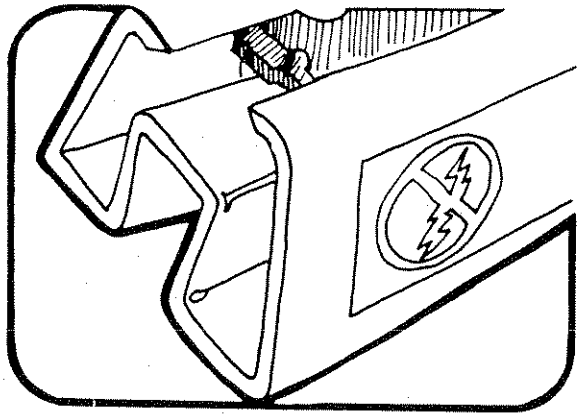
The following practices should be followed to minimize damage to S.S. devices.



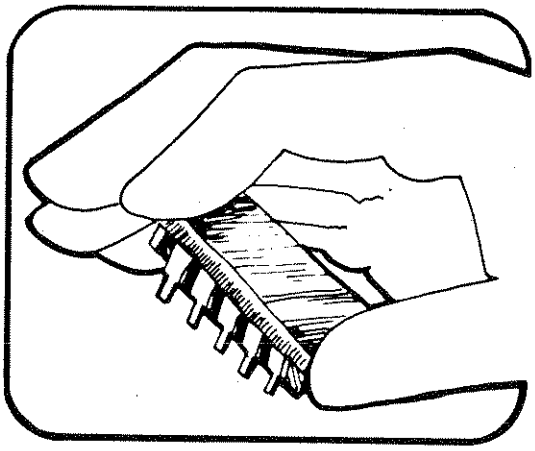
1. MINIMIZE HANDLING



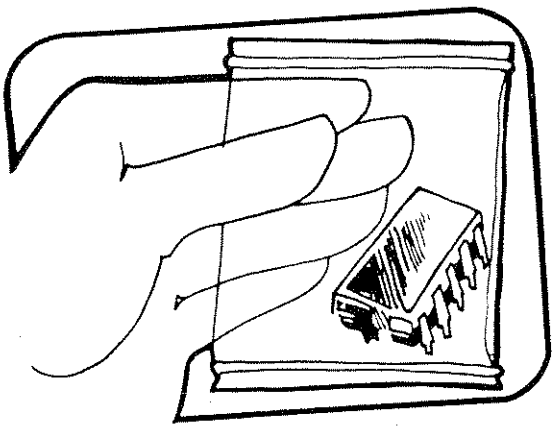
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



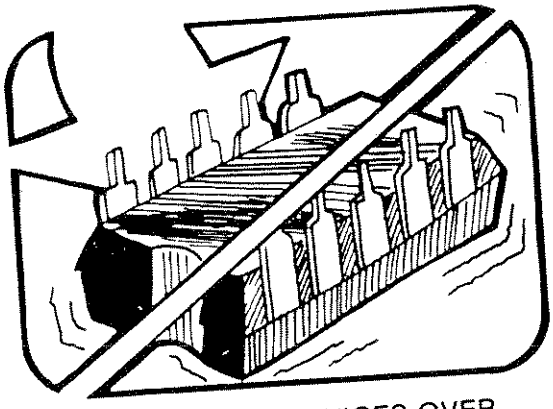
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



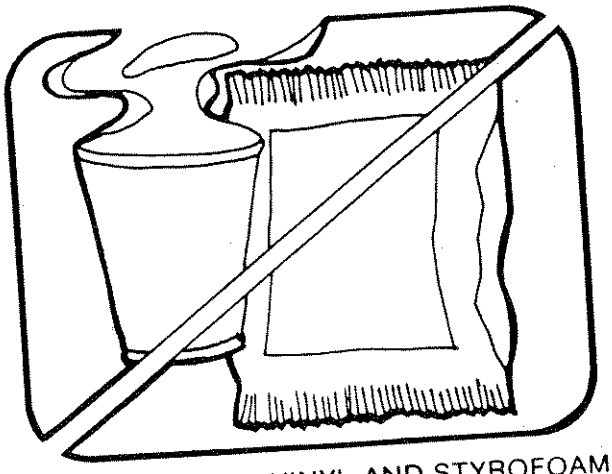
4. HANDLE S.S. DEVICES BY THE BODY



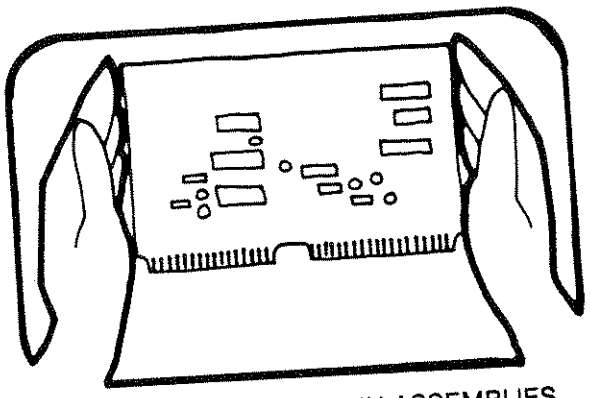
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT



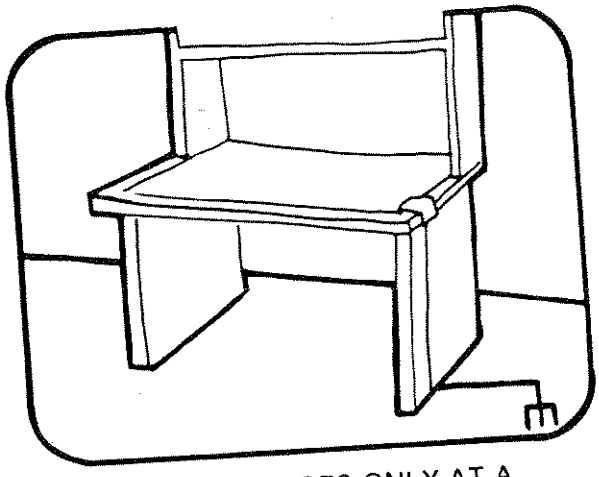
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS TO PROTECT INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION
10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.
11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

A complete line of static shielding bags and accessories is available from Fluke Parts Department, Telephone 800-526-4731 or write to:

JOHN FLUKE MFG. CO., INC.
PARTS DEPT. M/S 86
9028 EVERGREEN WAY
EVERETT, WA 98204

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SECTION II

OPERATING INSTRUCTIONS

2-1. FUNCTION OF EXTERNAL CONTROLS, TERMINALS, AND INDICATORS

2-2. The function of external controls, terminals, and indicators on the 410B is given in Figure 2-1.

2-3. INPUT POWER

2-4. Input power to the 410B is 115 vac or 230 vac (±10%), at a frequency of 50 to 60 Hz. Instruments are supplied for operation from 400 Hz when requested. The 410B is equipped with dual primary windings on transformer T1, which are usually connected in parallel for operation from 115 vac. When requested, instruments are wired with the primary windings connected in series for operation from 230 vac. If it becomes desirable to change from one operating voltage to the other, remove the top cover of the instrument, and change the jumper wires and the fuse as shown on the transformer decal.

CONTROL TERMINAL, OR INDICATOR	LOCATION	REFERENCE DESIGNATION	FUNCTION
POWER switch	Front panel	S1	Applies line power to the control circuit and to the auxiliary transformer.
POWER lamp	Front panel	DS1	Indicates the application of line power to the instrument circuitry.
Fuse	Front panel	F1	Protects the instrument against damage due to overload.
STANDBY-RESET lamp	Front panel	DS2	This lamp illuminates when the time delay cycle is completed when the HIGH VOLTAGE switch is set to STANDBY-RESET.
HIGH VOLTAGE switch	Front panel	S2	Energizes and de-energizes the primary of transformer T2.
HIGH VOLTAGE ON lamp	Front panel	DS3	This lamp illuminates when the HIGH VOLTAGE switch is set to ON (after the time-delay cycle is completed), indicating that the high voltage is available at the output connectors.
POLARITY switch	Front panel	S7	Used to select either a positive or negative output with respect to chassis ground. This switch must be pulled out to turn, which interrupts ac input power to the instrument.
OUTPUT VOLTAGE controls	Front panel	S3, S4, S5, S6, & R140	Switches S3, S4, S5, & S6 select the output voltage in steps of 1000V, 100V, 10V, and 1V, respectively. R140 provides a continuous output of 0 to 1.2 volts.
Voltmeter	Front panel	M1	Indicates the output voltage from -10.0 to +10.0 KV. Accuracy is approximately 3% of end scale.
OUTPUT connector	Front and back panels	J1 and J2	Provided for connecting the load circuit to the 410B.

Figure 2-1. FUNCTION OF EXTERNAL CONTROLS, TERMINALS, AND INDICATORS

2-5. INITIAL OPERATION

2-6. The following procedure is recommended when turning on the Model 410B for the first time after shipping or a long period of idleness. This procedure will minimize the possibility of accidental damage to the unit.

a. The 410B is shipped with the series passing tube removed from the socket and packed in a carton, which is fastened to the top cover. Install this tube in its socket and connect the plate wire to the plate cap before applying power to the instrument.
b. Connect the line plug to a 115 vac power source (or 230 vac if so wired).

WARNING

The round pin on the polarized three-prong plug connects the instrument case to power system ground. If a three-to-two pin adapter is used to connect to a two-contact outlet, connect the short lead on the adapter to a good ground.

Always cover the unused output connector with the cover provided to prevent accidental contact with the high voltage, and dirt accumulation on the connector.

c. Set the HIGH VOLTAGE switch to STANDBY-RESET.
d. Set the POWER switch to ON. The POWER lamp will illuminate. After approximately 30 seconds, the time-delay relay will close and the STANDBY-RESET lamp will illuminate.

CAUTION

The 410B is designed for convection cooling without the use of fans. For bench top operation, the rubber feet must be installed or other steps taken to ensure adequate spacing for unrestricted air flow through the vents in the bottom cover.

e. Set the second OUTPUT VOLTAGE dial to 500.
f. After the STANDBY-RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. Carefully observe if the HIGH VOLTAGE lamp illuminates and if the output voltage rises to within 3% of 500 volts as indicated by the panel meter.

CAUTION

If the output voltage exceeds approximately 500 volts, immediately set the HIGH VOLTAGE switch to STANDBY-RESET.

g. If the output voltage is 500 volts, the supply may be operated as in paragraph 2-7 or 2-8. If the output is not 500 volts, perform steps h. through j.
h. Set the HIGH VOLTAGE switch to STANDBY-RESET.
i. Locate and correct the source of trouble. Refer to Section IV.
j. Repeat the initial operating procedure.

2-7. GENERAL PURPOSE USE

a. Set the HIGH VOLTAGE switch to STANDBY-RESET.
b. Set the POWER switch to ON. The POWER lamp will illuminate. After approximately 30 seconds, the time-delay relay will close and the STANDBY-RESET lamp will illuminate.
c. Set the POLARITY switch to the desired polarity.
d. Connect the load to the power supply. Be sure the connection is firm.

WARNING

This instrument can produce lethal voltage. Always set the HIGH VOLTAGE switch to STANDBY-RESET and wait until the output decays to zero before connecting or disconnecting the load.

e. Set the OUTPUT VOLTAGE controls to the desired output. Check the external circuit for conflicts in grounding before applying power to the load.

CAUTION

The sampling string resistors in the 410B are subject to damage if the output voltage is reduced too rapidly. Pause approximately 1/2 second in each switch position when reducing the setting of the first decade switch (1000 volt increments).

f. After the STANDBY-RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. The STANDBY-RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate. The meter will indicate the approximate output voltage.

NOTE

If the overcurrent trip level has been reduced to less than 8 ma, it may be necessary to set the HIGH VOLTAGE switch to ON with a reduced output voltage to prevent actuating the overcurrent trip. In this case, step e., above, would follow step f. Figure 2-2 is a graph of the approximate maximum output voltage increment vs. the overcurrent trip setting. For example, if the overcurrent trip point has been reduced to 6 ma, the output voltage must be set to less than 3000 volts (approximately) to prevent actuating the overcurrent trip when the HIGH VOLTAGE switch is set to ON. Figure 2-2 is typical, and is intended to show only the general characteristic.

g. To remove the high voltage from the output connectors, set the HIGH VOLTAGE switch to STANDBY-RESET.

2-8. USE AS A CALIBRATOR

2-9. The 410B may be used for direct calibration of dc instruments to an accuracy of better than 0.25% or 250 millivolts at any voltage up to 10,000 volts. The

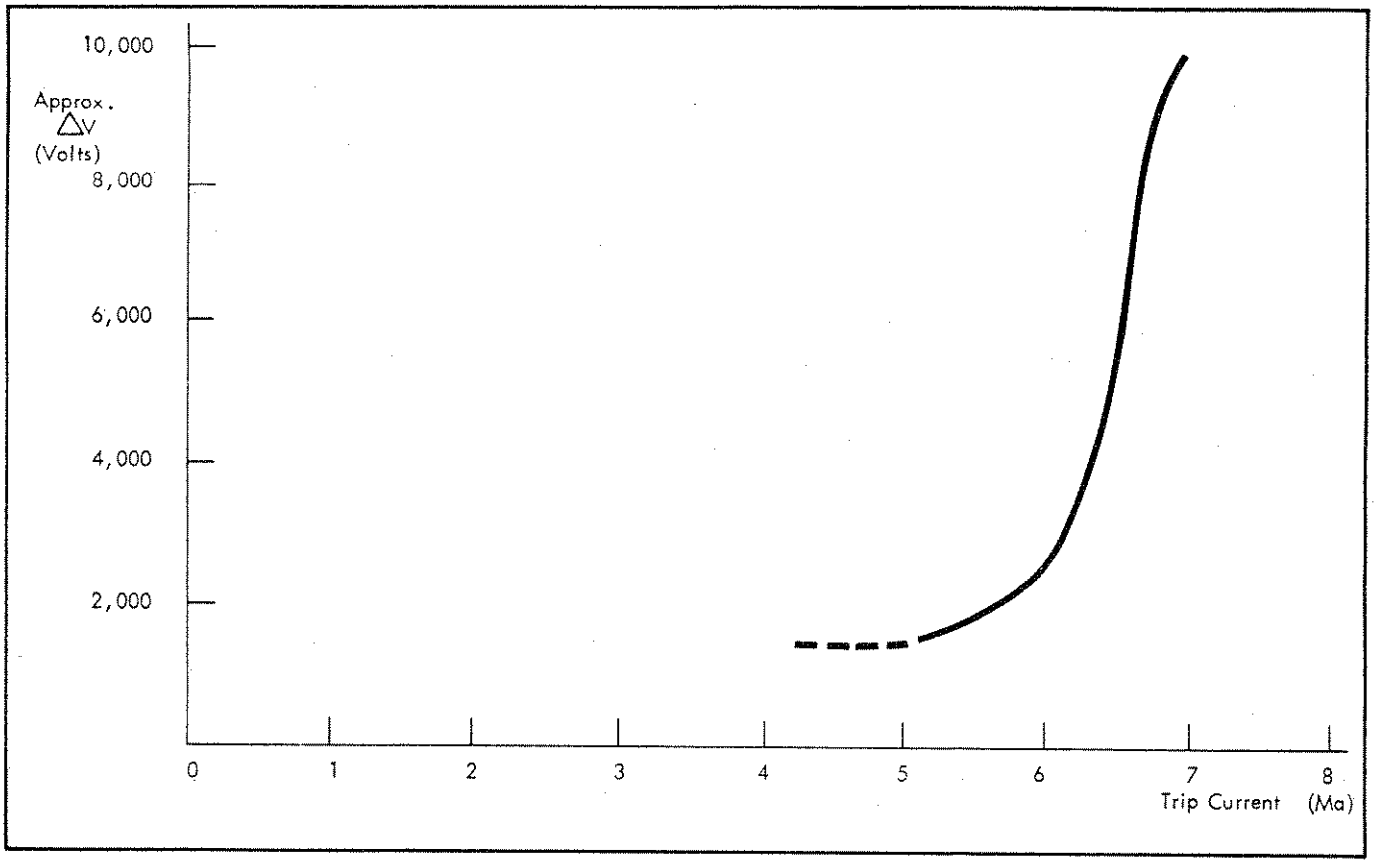


Figure 2-2. TYPICAL OUTPUT VOLTAGE INCREMENT VS. OVERCURRENT TRIP SETTING

four decade switches provide discrete steps with a resolution of one volt per step. The fifth dial provides a vernier with resolution of better than 5 millivolts for calibration between the cardinal points. When used with a Fluke differential voltmeter and voltage divider, the 410B is capable of calibrating dc instruments from 0 to 10,000 volts with an accuracy of 0.02% to 0.06%, depending upon the accuracy of the voltage divider and differential voltmeter used.

2-10. DIRECT CALIBRATION

a. Allow the power supply sufficient time to warm up to stable operating temperature, usually not less than one half hour. If possible, set the OUTPUT VOLTAGE dials for the maximum required output during warmup in order to stabilize the operating temperature of all of the sample-string resistors which will be used during calibration. When used in this manner the power supply will provide an output significantly better in stability and accuracy than is specified.

b. Set the POLARITY switch to the desired polarity.

c. Set the HIGH VOLTAGE switch to STANDBY-RESET.

d. Connect the instrument being calibrated to the OUTPUT connector.

e. Set the OUTPUT VOLTAGE dials to the initial calibration point.

f. Set the HIGH VOLTAGE switch to ON.

g. Successively set the OUTPUT VOLTAGE dials to the desired calibration points.

2-11. PRECISION CALIBRATION

a. Warm up supply as in paragraph 2-10a.

b. Set the POLARITY switch to the desired polarity.

c. Set the HIGH VOLTAGE switch to STANDBY-RESET.

d. Connect the instrument being calibrated to the OUTPUT connector. Also connect a voltage divider, such as a Fluke Model 80B-10 to the OUTPUT connector.

e. Connect a Fluke DC differential voltmeter to the output of the voltage divider. For calibration below 500 volts (1000 volts with the newer Fluke differential voltmeters) the voltage divider may be omitted.

f. Set the differential voltmeter to differentially measure the voltage at the desired calibration point. When the voltage divider is used, consider the division ratio when setting the dials of the voltmeter.

g. Set the HIGH VOLTAGE switch to ON.

h. Null the differential voltmeter by adjusting the power supply OUTPUT VOLTAGE dials. The accuracy of calibration is from 0.02% to 0.06%, depending on the accuracy of the differential voltmeter and voltage divider used.

i. Repeat steps f. and h. for as many calibration points as desired.

2-12. NOTES ON OPERATION

2-13. METER ACCURACY

2-14. The meter in the 410B has a basic accuracy of ±2%. Since multiplying and shunting resistors are used, the overall accuracy is approximately ±3% of end scale. However, the accuracy of the supply is ±0.25% of the output voltage. For example, if a voltage of 5000 volts is selected, the output voltage will be 5000 (±12.5) volts (±0.25% of 5000 = ±12.5). However, the panel meter may indicate 5000 (±300) volts (±3% of 10,000 = ±300) and still be within specified accuracy. Consequently, the front panel controls should be relied upon to indicate the magnitude of the output voltage.

2-15. OVERLOAD PROTECTION

2-16. The 410B is protected from damage due to overload by an overcurrent trip circuit. This circuit will return the supply to standby operation if the output current exceeds the pre-set level. This level is internally adjustable, and is usually set for 12 milliamperes, but may be adjusted to lower levels, down to approximately 5 milliamperes. If tripped, the supply may be returned to operation by setting the HIGH VOLTAGE switch to STANDBY-RESET, waiting 30 seconds for the time-delay relay to close, and then setting the HIGH VOLTAGE switch to ON.

2-17. POLARITY SWITCHING

2-18. The output polarity of the 410B may be changed by pulling out the POLARITY switch until it reaches the stop, rotating the switch to the desired polarity, and pushing the switch all the way back to the stop. An interlock (S9) actuated by the switch shaft disables the instrument when the switch is pulled out. In order to return the supply to operation, the HIGH VOLTAGE switch must be set to STANDBY-RESET. After 30 seconds, when the STANDBY-RESET lamp illuminates, set the HIGH VOLTAGE switch to ON.

2-19. COAXIAL CABLE ASSEMBLY

2-20. Coaxial cables used to connect the instrument to a load are not provided by John Fluke Mfg. Co., Inc. Procurement of cables and the assembly of mating cable connectors must be carefully undertaken to insure safety of personnel.

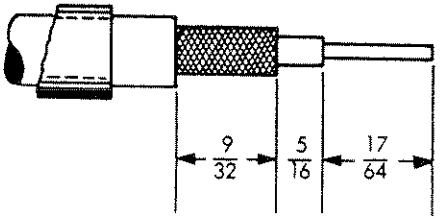
WARNING!

Extreme care should be exercised when utilizing high voltage conductors and connectors. Improper assembly of cable connectors or careless use of high voltage equipment may expose personnel to voltage of lethal magnitude.

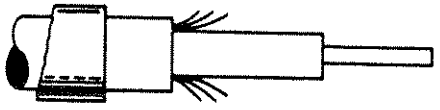
2-21. General instructions are provided herein for the assembly of two types of cable connectors issued as an accessory item with John Fluke instruments. Additional information on the assembly of these connectors, or on other types of connectors considered for use with the instrument, may be obtained from the cable or connector vending agency.

2-22. DAGE TYPE 486-1 CONNECTOR ASSEMBLY

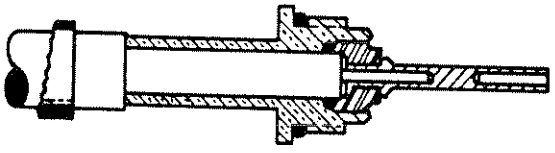
a. Cut cable off square on end. Slide outer sleeve over cable and slide back out of way. Trim cable to dim. shown being careful not to nick center conductor or braid. Tin dip center conductor. Remove all excess solder.



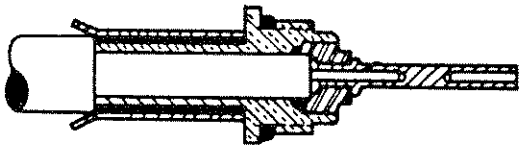
b. Rotate dielectric to slightly flare braid.



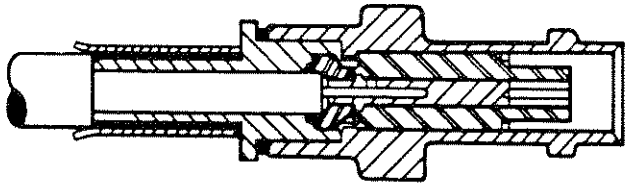
c. Push cable into nut sub-assembly until the center conductor is visible thru hole in contact. Soft solder center conductor thru hole in contact. Remove excess solder. Fold braid down over back end tube of nut. Trim excess braid if necessary.



d. Slide outer sleeves over braid until it is flush against back of nut. Crimp as close to nut as possible using proper crimping tool.

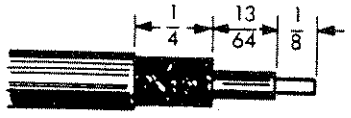


e. Insert finished cable assy. into body either jack or plug and tighten by rotating body. Do not rotate nut sub-assembly.

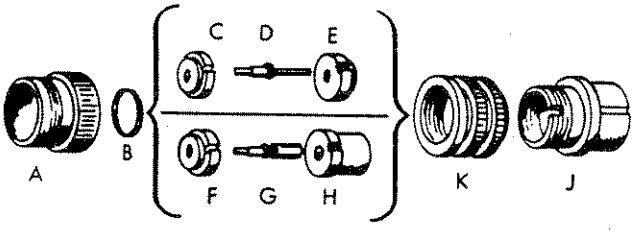


2-23. AMPHENOL MS 3106A CONNECTOR ASSEMBLY

a. Strip cable jacket, braid, and dielectric to dimensions shown. All cuts are to be sharp and square. Do not nick braid, dielectric, and center conductor. Tinning of center conductor is not necessary if contact is to be crimped. For solder method, tin center conductor avoiding excessive heat.



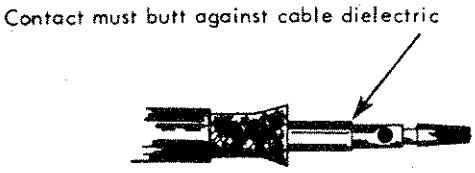
b. Disassemble connector by removing the back shell and retainer ring.



WITH PIN INSERT (Male)		WITH SOCKET INSERT (Female)	
A	Back Shell	A	Back Shell
B	Retainer Ring	B	Retainer Ring
C	Pin Rear Insert	F	Socket Rear Insert
D	Pin Contact	G	Socket Contact
E	Pin Front Insert	H	Socket Front Insert
J	Front Shell	J	Front Shell
K	Coupling Ring	K	Coupling Ring

c. Insert cable thru clamp MS 3057A and rear components of connector. Place the cable center conductor into the socket contact.

d. Soft solder contact to cable center conductor. Do not get any solder on outside surfaces of contact. Avoid excessive heat to prevent swelling or dielectric.



e. Provide a connection from the cable shield to the securing bolt of the cable clamp. The connecting copper wire should be approximately 5 inches long and size 14 or larger in diameter. A terminal lug should be used to connect the wire to the clamp. The wire should be carefully soldered to the shield, taking care not to damage the insulation of the cable. Loose ends of the shield should be clipped off to prevent shorting the center conductor or contact to the shield.

f. Assemble the cable connector by placing the contact into the socket front insert, then coupling the back shell to the front shell in the reverse of the disassembly procedure.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. This section of the manual describes the operation of the Model 410B. Reference is made to the functional schematic following Section V. This schematic is intended to aid in understanding the theory of operation, and in troubleshooting. A block diagram of the 410B is given in Figure 3-1. Operation of the 410B is discussed in the following paragraphs.

3-3. OVERALL OPERATION

3-4. The output voltage is controlled by the series passing tube V202, which is controlled by the feedback amplifier consisting of Q208 through Q214. Transistors Q213 and Q214 are connected as a differential amplifier, in which the output is proportional to the difference between the two inputs. The input of Q214 is connected to the summation point, which is the junction of the reference resistor R106, and the voltage control resistors R107 through R140. The feedback amplifier controls the output voltage so that the summation point is essentially at the same potential as the positive output bus. Any voltage difference between these two points is amplified by the differential amplifier, and further amplified by Q212 through Q208, and applied to the grid of the series passing tube V202. The passing tube then increases or decreases its conductance until the voltage at the summation point is equal to the voltage of the positive bus. Tube V201 is a highly stable voltage reference which maintains a constant voltage of approximately 83 volts. Since the summation point is always held near zero volts, a constant current of 2 milliamperes flows through reference resistors R104 through R106, and also through voltage control resistors R107 through R140. The output voltage is equal to the IR drop across the voltage control resistors, and may thus be precisely controlled by varying the resistance of the voltage control string.

3-5. CIRCUIT DESCRIPTIONS

3-6. CONTROL RELAYS

3-7. A full-wave rectifier is formed by CR301 through CR304, which furnishes dc voltage to the control relays K301 and K302. Approximately 30 seconds after power is applied to the instrument, time-delay relay K301

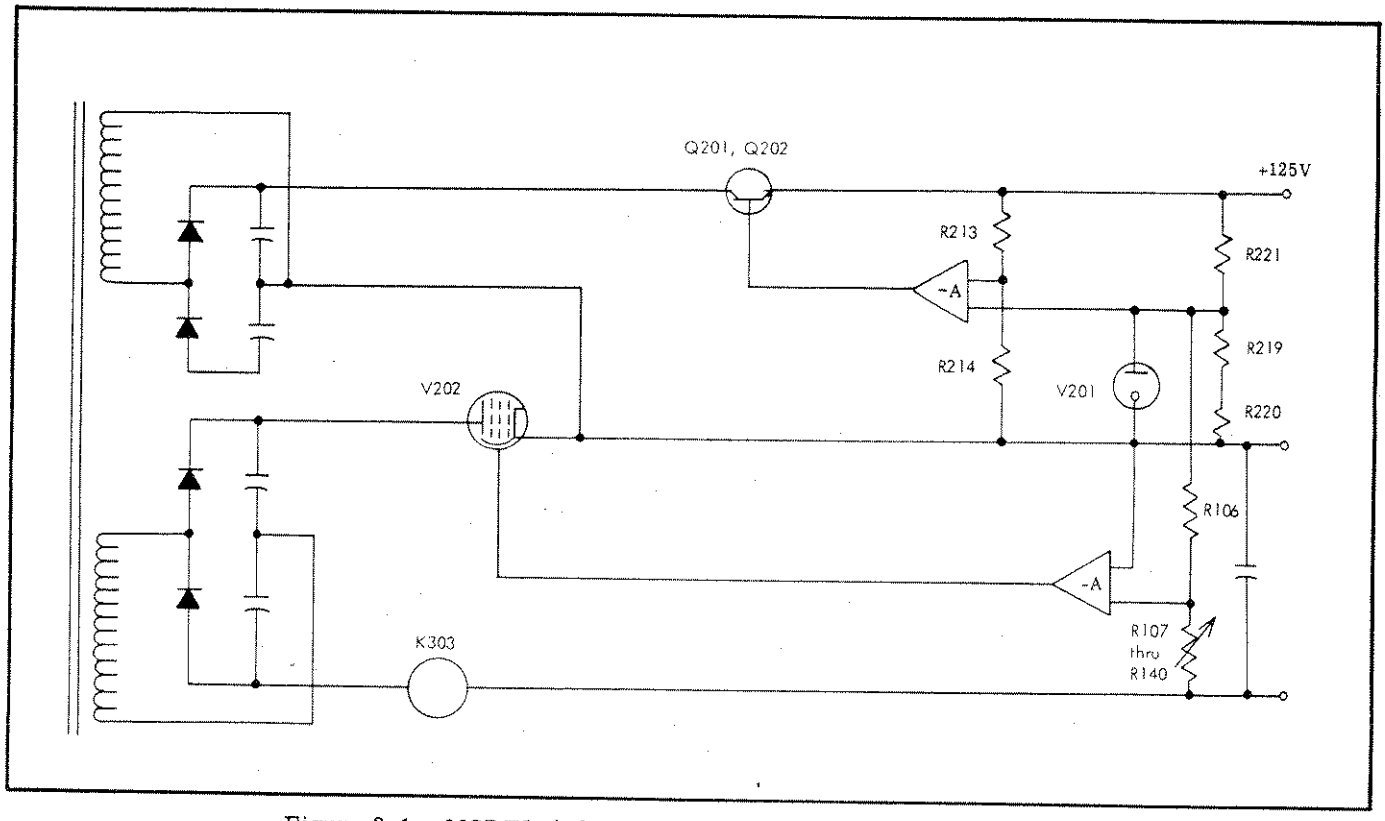


Figure 3-1. MODEL 410B DC POWER SUPPLY - BLOCK DIAGRAM

closes if S2 is set to the STANDBY-RESET position. This energizes K302, which opens K302A, removing K301 from the circuit, and closes K302B and K302C. When switch S2 is set to the HIGH VOLTAGE ON position after K302C is closed, the primary of transformer T2 is energized and transformer voltage is applied to CR401 and CR402.

3-8. OVERCURRENT PROTECTION

3-9. Relay K303 provides overcurrent protection. If the output current exceeds approximately 12 milliamperes, K303 is actuated, which closes K303A. This de-energizes K302, which closes K302A, and opens K302B and K302C, extinguishing the HIGH VOLTAGE ON lamp. The primary circuit of T2 is thus opened by K302C, and high voltage is removed from the output terminals. Before high voltage can be reapplied to the output terminals, switch S2 must be set to the STANDBY-RESET position. After the time-delay cycle is complete, voltage will be available at the output connector when the HIGH VOLTAGE switch, S2, is set to ON.

3-10. MAIN OUTPUT VOLTAGE

3-11. The main output voltage is developed by CR401, CR402, C3, C4, and R402 through R411. This is a full-wave, voltage-doubler circuit, which applies rectified, filtered, dc voltage to the plate of V202. The taps on the primary of T2 provide approximate control of the unregulated dc voltage, which minimizes power dissipation in V202 at low output voltage.

3-12. FEEDBACK AMPLIFIER

3-13. The feedback amplifier consists of essentially five stages composed of seven silicon transistors. Transistors Q213 and Q214 are connected as a differential amplifier. The output is taken from the collector load of Q214 and is applied to the common-emitter amplifier Q212. Output from the collector of Q212 is ac coupled back to the base of Q213 as negative feedback for loop stabilization. The output of Q212 is applied to the input of the compound-connected, emitter-follower pair of Q210 and Q211. This stage provides current gain and impedance matching between the high collector impedance of Q212 and the low emitter impedance of Q209. Transistors Q209 and Q208 are common base stages which provide the voltage gain and large voltage swing required by the grid of V202. C215 and R230 in the emitter of Q209 form a lead network for loop compensation.

3-14. AUXILIARY SUPPLIES

3-15. AC voltage for both the positive and negative auxiliary supplies is obtained from one transformer winding. One terminal of this winding is connected to the positive output of the 410B, which is the zero volt reference. The other terminal of the winding is connected to the junction of two half-wave rectifiers and filters. The positive auxiliary voltage is obtained from CR201, CR202, and C202. Auxiliary voltages of +95 volts, +20 volts, and +10 volts are obtained from CR205, CR206, and CR207, respectively, which are connected across the positive auxiliary voltage. The negative auxiliary voltage is obtained from CR203, CR204, and C203. An auxiliary voltage of -110 volts is obtained from CR208. This arrangement of the +95V, +20V, +10V, and -110V auxiliary supplies provides shunt regulation of these supplies.

3-16. REFERENCE VOLTAGE

3-17. Reference voltage for the instrument is obtained from V201, a gas-filled reference tube. Resistor R219 has a temperature coefficient of +0.45%/°C, which provides temperature compensation for V201. Transistors Q205 and Q206 are used as a differential amplifier. Transistor Q203 is operated as an emitter-follower voltage regulator, which provides 100 volts for the collector of Q205 and the emitter of Q204. The base of Q205 samples the output voltage of the +125 volt auxiliary supply, through the voltage divider R213 and R214. The output from Q206 represents the amplified difference between the reference voltage and the voltage at the base of Q205. Transistor Q204 provides further amplification of this voltage difference for application to series regulators Q202 and Q201. Neon lamps DS201 and DS202 are safety devices to prevent possible burn-out of Q201 and Q202 if the output of the instrument becomes short-circuited.

3-18. ACCURACY

3-19. The main sampling string resistors in the 410B are accurate to within ±0.1%. However, the accuracy of the 410B is specified as ±0.25%, because the calibration accuracy also depends upon the stability of the reference voltage. The voltage of reference tube V201 (83A1) changes slightly due to aging. The accuracy of the supply will remain within ±0.25% for at least 30 days. The calibration accuracy may be maintained at better than 0.25% if the instrument is recalibrated more often than the usual calibration period of 30 days.

3-20. All calibrated power supplies have an accuracy limit (floor) as the output voltage approaches zero. This floor is caused by zero shift in the error amplifier, contact resistance in the sampling string circuit, and the accuracy of the sampling string resistors used for the least significant digits. The accuracy floor may be reduced by using more expensive components and additional circuitry. However, this results in greater initial cost and longer calibration time. Thus, very low accuracy floors are usually found only in precision calibrators. The 410B has an accuracy of ±0.25% or 250 millivolts, whichever is greater, when the first four voltage controls are used. Thus, the ±0.25% accuracy applies from 10,000 volts to 100 volts.

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

4-2. Maintenance of the Model 410B DC Power Supply should consist primarily of occasional cleaning, tube replacement, and calibration. Preventive maintenance is discussed in paragraph 4-3. A discussion of trouble-shooting and a troubleshooting chart are presented in paragraph 4-6. Calibration procedures and the equipment necessary are presented in paragraph 4-14.

WARNING

Caution should be exercised when servicing this power supply. The metal shell of some of the electrolytic capacitors may be as much as 10, 100 volts above chassis ground. Capacitors C5 and C219 are high-quality, oil-filled units capable of retaining a charge for several days. Before servicing or removing tubes, all capacitors and plate caps should be shorted to the chassis. It is recommended that the shorting wire remain connected to C5 and C219 during servicing to prevent build-up of capacitor voltage due to dielectric absorption.

4-3. PREVENTIVE MAINTENANCE

4-4. Periodic cleaning of the Model 410B is desirable because of the high voltage present. Any contamination, particularly on the high voltage capacitors, may cause corona discharge, which will appear as noise in the output voltage. Components may be cleaned with Freon, or with a lint-free rag saturated with denatured alcohol. Ceramic switches may be cleaned with denatured alcohol or tetrachloroethane. After cleaning, the ceramic surface should be coated with a 10% solution of Dow Corning silicon fluid (200 viscosity grade). Denatured alcohol or tetrachloroethane may be used as a thinner for the silicon fluid.

4-5. Printed circuit boards in the 410B are coated with a polyurethane compound to prevent moisture absorbtion. If components are replaced, it will be necessary to recoat the circuit board in the immediate area of the part replaced. Aerosol containers of Epocast, available from Furane Plastics, Inc., Los Angeles, California, provide a convenient way of recoating the circuit board area. The recoated circuit board does not require baking.

4-6. TROUBLESHOOTING

4-7. It is recommended that all checks be made with the POLARITY switch turned to negative output polarity, and when possible, the output voltage set to 500 volts. Most voltages are referred to the positive bus, and when the output polarity is negative, the positive bus is connected to the earth grounded chassis. This affords some protection to the person performing the tests.

4-8. The power supply should be allowed to warm-up before the following accuracy checks. Usually, one-half hour of operation is adequate. Figure 4-1 is a list of various failures and probable causes. Reference to Figure 4-1 will occasionally indicate the cause of a failure. Components may be located by referring to Section V. A list of equipment required is given in Figure 4-2.

4-9. AUXILIARY VOLTAGES

a. Connect the 881A common lead to the 410B chassis ground (shell of the OUTPUT connector).
b. Set the POLARITY switch to negative.
c. Set the POWER switch to ON.
d. Set the OUTPUT VOLTAGE controls to zero.
e. Set the HIGH VOLTAGE switch to ON.
f. Connect the 881A positive lead to the junction of CR206 and CR207.
g. The 881A should indicate +10 (±1) vdc.
h. Connect the 881A positive lead to the junction of CR205 and CR206.
i. The 881A should indicate +20 (±2) vdc.
j. Connect the 881A positive lead to the junction of CR205 and R203.
k. The 881A should indicate +95 (±9.5) vdc.
l. Connect the 881A positive lead to the junction of CR208 and R205.
m. The 881A should indicate -110 (±11) vdc.
n. Connect the 881A positive lead to the positive end of C211. Also connect the 910A RMS Voltmeter across the same points as the 881A.
o. The 881A should indicate 125 (±2.25) vdc. The 910A should indicate less than 0.005 volts rms ripple.

4-10. LINE REGULATION AND RIPPLE

a. Connect the variable transformer between the 410B and the line. Set the transformer to 115 volts output.

WARNING

A good power line ground must be provided when the variable transformer is used.

b. Connect the 910A and the 881A across the OUTPUT connector. Also connect the oscilloscope across the OUTPUT connector.
c. Set the POWER switch to ON.
d. Set the HIGH VOLTAGE switch to ON.
e. Set the OUTPUT VOLTAGE controls to 500 volts, and record the voltage indicated by the 881A.
f. Increase the variable transformer output to 127 vac,

SYMPTOM	PROBABLE CAUSE	REMEDY
No output	Blown fuse	Check fuse F1, and replace if necessary.
	Open heater of V202	Determine if tube will warm-up; if not replace.
	Open R104; Shorted C219	Check and replace if necessary.
Constant percentage error in output voltage	Out of calibration	Recalibrate per paragraph 4-14.
	Defective R106	Check and replace if necessary.
Percentage error over part of range or Output erratic over part of range	Defective wirewound resistor in the sampling string. (R107 thru R140)	Set the output voltage to a maximum and decrease one switch position at a time until the error disappears. The defective resistor will be found at the last switch position in which the error was noted.
Output erratic over entire range	Defective V202	Test and replace if necessary.
	Defective output voltage switch, or dirty switch printed circuit board.	Replace switch, clean printed circuit board.
	Defective R104 or R106	Check and replace if necessary.
Output rises to over 10KV and follows line voltage variations	Defective V202, or Q208 thru Q214	Test and replace if necessary.
	Open sampling resistor or switch	Test R107 thru R140, and S3 thru S6, and replace if necessary.
Poor load regulation	Defective Q208 thru Q214	Check and replace if necessary.
Output voltage suddenly rises above preset value	Internal arcing in V202	Check and replace if necessary.
Noise in output	Dirty high-voltage switches, capacitors, or printed circuit boards.	Clean per paragraph 4-4.
Excessive drift	Defective V201, Q213, or Q214	Check by replacement.
Excessive ripple	Excessive ripple in +125V auxiliary supply	If auxiliary supply ripple exceeds approximately 5 mv, replace defective component.
	Defective C219, C5, Q213, or Q214	Check and replace if necessary.
Loss of control	Open R243	Check and replace if necessary.

Figure 4-1. TROUBLESHOOTING

EQUIPMENT	SPECIFICATIONS REQUIRED
Variable transformer	3 ampere capacity, 100 volts to 130 volts output.
RMS Voltmeter, Fluke Model 910A, or equivalent	RMS measurement of non-sinusoidal waves.
DC Differential Voltmeter, Fluke Model 881A, or equivalent	Voltmeter/Voltage Divider must be capable of measuring 0 to 10,000 vdc with a minimum accuracy of 0.05% + 50 microvolts. Voltmeter must have a 1 millivolt null detector for use with the 80E.
Voltage Divider, Fluke Model 80E-10, or equivalent	
Oscilloscope, Tektronix Model 541, with Type L plug-in unit, or equivalent	Minimum sensitivity of 5 mv/cm. 10 MHz bandwidth.
Blocking capacitor	0.05 microfarads, 10,000 vdc rating.
Load resistors	50K ±5%, 5W 1K ±5%, 2W
Insulated screwdriver	Must have sold insulated shaft capable of withstanding 10,000 vdc.

Figure 4-2. EQUIPMENT REQUIRED FOR TROUBLESHOOTING AND CALIBRATION

while observing the 910A. Ripple indicated by the 910A and by the oscilloscope should be less than 1 millivolt rms, and 5 millivolts peak-to-peak, respectively. The voltage change indicated by the 881A should be less than 5 millivolts.

g. Decrease the transformer output from 115 vac to 103 vac, while observing the 910A. Ripple indicated by the 910A and by the oscilloscope should be less than 1 millivolt rms and 5 millivolts peak-to-peak, respectively. The voltage change indicated by the 881A should be less than 5 millivolts from step e.

h. If desired, repeat steps e. through g. with the POLARITY switch in the opposite polarity.

i. Set the variable transformer to 115 vac output, and set the HIGH VOLTAGE switch to STANDBY-RESET.

j. Disconnect the 881A and the 910A.

k. Connect the 80E-10 Voltage Divider to the output of the 410B, and connect the 881A to the output of the voltage divider.

l. Connect the 10KV blocking capacitor in series with the 910A input, and connect the series combination across the 410B OUTPUT connector.

m. Set the HIGH VOLTAGE switch to ON.

n. Set the OUTPUT VOLTAGE controls to 10,000 volts, and record the voltage measured by the voltmeter/voltage divider combination.

o. Increase the variable transformer output to 127 vac, while observing the 910A. Ripple indicated by the 910A and by the oscilloscope should not exceed 1 millivolt rms and 5 millivolts peak-to-peak, respectively. The voltmeter/voltage divider should indicate less than 0.100 volts change in the 410B output voltage from the value measured in step n.

p. Decrease the transformer output from 115 vac to 103 vac, while observing the 910A. Ripple indicated by the 910A and by the oscilloscope should not exceed 1 millivolt rms and 5 millivolts peak-to-peak, respectively. The voltmeter/voltage divider should indicate less than 0.100 volts change in the 410B output voltage from the value measured in step n.

q. If desired, repeat steps n. through p. with the POLARITY switch in the opposite polarity.

4-11. LOAD REGULATION

a. Connect the variable transformer between the 410B and the line. Set the transformer to 103 vac output.

b. Connect the 881A across the OUTPUT connector.

c. Set the POWER switch to ON.

d. Set the HIGH VOLTAGE switch to ON.

e. Set the OUTPUT VOLTAGE controls to 500 volts.

f. Record the voltage indicated by the 881A.

g. Carefully connect the 50K load resistor across the OUTPUT connector. The load current should be 0.010 ampere.

h. The 881A should indicate less than 0.005 volts change from the voltage measured in step f.

4-12. STABILITY

a. Connect the 80E-10 to the output of the 410B, and connect the 881A to the output of the voltage divider.

b. Set the POWER switch to ON.

c. Set the HIGH VOLTAGE switch to ON.

d. Set the OUTPUT VOLTAGE controls to 10,000 volts.

e. After a minimum operating time of 30 minutes, record the voltage indicated by the voltmeter/voltage divider.

f. After an additional 60 minutes of operation, the voltage change indicated by the voltmeter/voltage divider should be less than 0.5 volt (0.0005 volt indicated by the 10V tap).

4-13. OUTPUT AT ZERO VOLTS

a. Connect the voltmeter to the OUTPUT connector.
b. Set the POWER switch to ON.
c. Set the OUTPUT VOLTAGE controls to zero.
d. Set the HIGH VOLTAGE switch to ON.
e. The 881A should indicate less than 0.030 volts in both output polarities. If not, exchange Q213 and/or Q214 with another transistor of the same type used elsewhere in the instrument, so that the beta of the two transistors is more nearly equal.

4-14. CALIBRATION

4-15. The Model 410B may be calibrated as often as necessary. However, it is recommended that the reference voltage be checked every 30 days, and the overcurrent limit be checked every six months. As reference tube V201 (83A1) ages, the reference voltage changes slightly. It has been found that some reference tubes are more stable than others. However, most reference tubes will change by less than 0.1% for every 100 hours of operation after the first hundred hours. If the output voltage is recorded before the reference current is adjusted, a more realistic calibration period can be determined. The equipment required for calibration is given in Figure 4-2.

4-16. REFERENCE CURRENT ADJUSTMENT

a. Connect the 80E-10 Voltage Divider to the output of the 410B, and connect the voltmeter to the output of the voltage divider.
b. Set the OUTPUT VOLTAGE controls to 9,900 volts, using only the first two dials.
c. Set the POLARITY switch to negative.
d. Set the POWER switch to ON.
e. Set the HIGH VOLTAGE switch to ON.
f. Set the differential voltmeter to differentially measure 9,900 volts, considering the voltage divider ratio. For example, using the 80E-10 Voltage Divider, set the differential voltmeter to measure 9.9 volts.

WARNING

Use an insulated screwdriver to adjust R104. The case of this resistor is 85 volts above chassis ground for negative output polarity, and may be as much as 10,085 volts above ground for positive output polarity.

g. After a minimum operating time of 30 minutes, adjust R104 for a null on the differential voltmeter. Within 24 volts of 9,900 volts is sufficient (24 millivolts with the 80E-10). This control may be adjusted through the access hole on the right side panel near the front.

4-17. OVERCURRENT TRIP ADJUSTMENT

a. Connect a 1K ±5%, 2W resistor to the OUTPUT connector.
b. Set the OUTPUT VOLTAGE controls to zero.
c. Set the POLARITY switch to negative.
d. Set the POWER switch to ON.
e. Set the HIGH VOLTAGE switch to ON.
f. Set the 410B for maximum current trip by turning R151 completely clockwise. This control may be adjusted through the access hole on the left side of the instrument.
g. Set the OUTPUT VOLTAGE controls to that output voltage which will deliver 12 milliamperes to the load resistor. For example, 12 volts will deliver approximately 12 milliamperes to a 1K resistor.

NOTE

If it is desired to set the overcurrent trip to some value other than 12 milliamperes, then the output voltage in step g. should be chosen to provide the desired trip current.

h. Slowly turn R151 counter-clockwise until the overcurrent trip removes power from the high voltage transformer.

4-18. METER CALIBRATION

4-19. The panel meter is adjusted at the factory, and will not usually require attention. If adjustment is necessary, proceed as follows:

a. Set the POWER switch to ON.
b. Set the HIGH VOLTAGE switch to ON.
c. Set the OUTPUT VOLTAGE controls to 10,000 volts.
d. Adjust R150 so that meter deflection corresponds to 10KV. This resistor may be adjusted through the access hole on the bottom of the instrument.

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains information necessary to describe all normally replaceable parts. Separate assembly lists are used to describe the parts on the final assembly and various assemblies and subassemblies. Each list has a corresponding illustration on which the parts for that list are identified. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke stock number.

5-3. Each list provides the following information on each part:

a. The REFERENCE DESIGNATION column indicates the reference designation used on the schematic diagram.

b. The DESCRIPTION column describes the part in words, along with any applicable values, tolerances, etc. Indentation is used to show assembly, subassembly, and parts relationship. See abbreviations and symbols on next page.

c. Entries in the FLUKE STOCK NUMBER column indicate the number by which Fluke stocks the part. This number should be used when ordering parts from the Fluke factory or your Fluke representative.

d. Entries in the MFR. column indicate a typical manufacture of the part by the manufacturer's code number. Appendix A lists the manufacturers and their code numbers.

e. Entries in the MFR. PART NO. column are part numbers assigned by the manufacturer indicated in the Mfg. column.

f. The number in the TOTAL QTY column indicates the total quantity of the part used in the instrument. "REF" indicates that the total quantity of the part has been previously given. The total quantity of each part is listed the first time the part appears. All other listings of the same part refer back to the reference designation of the first appearance of the part for the total quantity.

g. The number in the REC. QTY. column indicates the recommended spares quantity necessary to support approximately one to five instruments for a period of two years. The basis used to select the recommended spares quantity is that a small group of parts will be required to correct a majority of the problems that occur. Since there is a chance that any part may fail, a stock of at least one of every part used in addition to the recommended parts will be needed for complete maintenance during one year of isolated service.

h. The USE CODE column identifies certain parts which have been added, deleted, or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section. These changes are normally made when improved components become available or when the latest circuit improvements are developed by our engineering department. The serial number listed indicates the instruments in which that particular part was used. The symbol "~" is used to indicate an approximate serial number. If a different part should be used for replacement, it is listed by Fluke stock number in the description column.

5-4. HOW TO OBTAIN PARTS

5-5. Standard components have been used whenever possible. Thus, most parts can be obtained locally. However, parts may be ordered directly from the manufacturer using the manufacturer's part number or from Fluke using the Fluke stock number. In addition, the most commonly replaced parts that can not be obtained locally may be obtained from your Fluke representative. If a part you have ordered has been replaced by a new or improved part, Fluke will normally send you this part along with an explanation.

5-6. When ordering parts from Fluke always include:

a. Reference designation, description, and Fluke stock number.

b. Instrument model and serial number.

c. Most structural parts are not listed. In this case, give complete description, function, and location of part.

5-7. ABBREVIATIONS

ac	alternating current
Al	aluminum
assy	assembly
cap	capacitor
car flm	carbon film
cer	ceramic
comp	composition
conn	connector
cps	cycles per second
db	decibel
dc	direct current
dpdt	double pole double throw
dpst	double pole single throw
elect	electrolytic
fxd	fixed
Ge	germanium
gmv	guaranteed minimum value
Hz	hertz (cycles per second)
K	kilohm
kc or Kc	kilocycle
kHz or KHz	kilohertz (kilocycles per/sec)
kv	kilovolt
kva	kilovolt-ampere
ma	milliampere
Mc or MC	megacycle
MHz	megahertz (megacycles per/sec)
meg or M	megohm
met flm	metal film
mfg	manufacturer
mv	millivolt
mw	milliwatt
na	nanoampere
pf	picofarad
piv	peak inverse voltage
plstc	plastic
pp	peak-to-peak
ppm	parts per million
rect	rectifier
res	resistor
rms	root-mean-square
sb	slow-blow
Si	silicon
S/N	serial number
sw	switch
spdt	single pole double throw
spst	single pole single throw
Ta	tantalum
tc	temperature coefficient
tstr	transistor
ua	microampere
uf	microfarad
uv	microvolt
va	volt ampere
vac	alternating current volts
var	variable
vdc	direct current volts
w	watt
wvdc	direct current working volts
ww	wirewound

5-8. PREFIX SYMBOLS

T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
K or k	kilo	10^{3}
h	hecto	10^{2}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
u	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	anto	10^{-18}

5-9. QUANTITY SYMBOLS

a or amp	ampere
f	farad
h	henry
hr	hour
Ω	ohm
sec	second
v or V	volt
w or W	watt

5-10. SPECIAL NOTES AND SYMBOLS

~ 000	Approximate serial number
Use 0000-000000	Part number indicated should be used if replacement is required.

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Final Assembly (see Figure 5-1)	410B	89536				
	Front Panel Assembly (see Figure 5-2)	3158-175729 (410B-406)	89536	3158-175729	1		
	Switch PCB Assembly (see Figure 5-3)	1702-175679 (410B-401)	89536	1702-175679	1		
	Amplifier PCB Assembly (see Figure 5-4)	1702-175687 (410B-402)	89536	1702-175687	1		
	Time Delay PCB Assembly (see Figure 5-5)	1702-175695 (410B-403)	89536	1702-175695	1		
	Rectifier PCB Assembly (see Figure 5-6)	1702-175703 (410B-404)	89536	1702-175703	1		
C1, C2	Cap, cer, 0.01 uf -20/+80%, 500V (not illustrated)	1501-105668	56289	29C9B5	2		
C3, C4	Cap, oil, .25/.25 uf ±20%, 7.5KV	1505-163766	99120	LK-75-504C	1		
C5	Cap, oil, 0.25 uf ±20%, 10KV	1505-163758	99120	LK-100-254N	1		
C219	Cap, oil, 0.05 uf ±10%, 10KV	1505-161158	01884	SMLE503-10M	1		
J2	Connector, H.V.	2104-100172	02660	MS3102A-18-16S -C	2		
K301	Relay, time delay 115V, 30 sec.	4502-105288	70563	115N030T	1	1	
P1	Line cord set, 3 wire	6005-102822	70903	PVC-PH-70	1		
R1	Res, comp, 470Ω ±10%, 1W	4704-109710	01121	GB4711	1		
S3A	Switch section, rot., 11 positions, 1 pole	5107-176149	71590	PS-284	1		
S3B	Switch rotor assembly	5108-175612	89536	5108-175612	1		
S7	Switch, rotary	5110-175711	89536	5110-175711	1		
S8, S9, S10	Switch, interlock (S9 and S10 not illustrated)	5104-115196	01963	E13-00A	3		
T1	Transformer, aux.	5600-176032	89536	5600-176032	1		
T2	Transformer, H.V.	5600-176024	89536	5600-176024	1		
V202	Electron tube, type 4-65A	5701-192351	89536	5701-192351	1	1	
	Meter cover	3155-169813	97945	1704-462-Y	1		
	Feet, rubber (not illustrated)	2819-103309	83478	9102-W	4		
	Knob assembly, pol. sw.	2405-175620	89536	2405-175620	1		
	Switch detent, 10 position, short	5108-155945	76854	239914-H	3		
	Switch detent, 10 position, long	5108-167833	76854	246305-H	1		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Mating connector, H. V.	2104-100156	02660	MS3106A-18-16P	1		
	Knob, 1-1/2"	2405-170035	89536	2405-170035	5		
	Cable clamp	2804-100149	02660	AN3057-10	1		
	Cap, H.V. connector	3155-172122	89536	3155-172122	2		

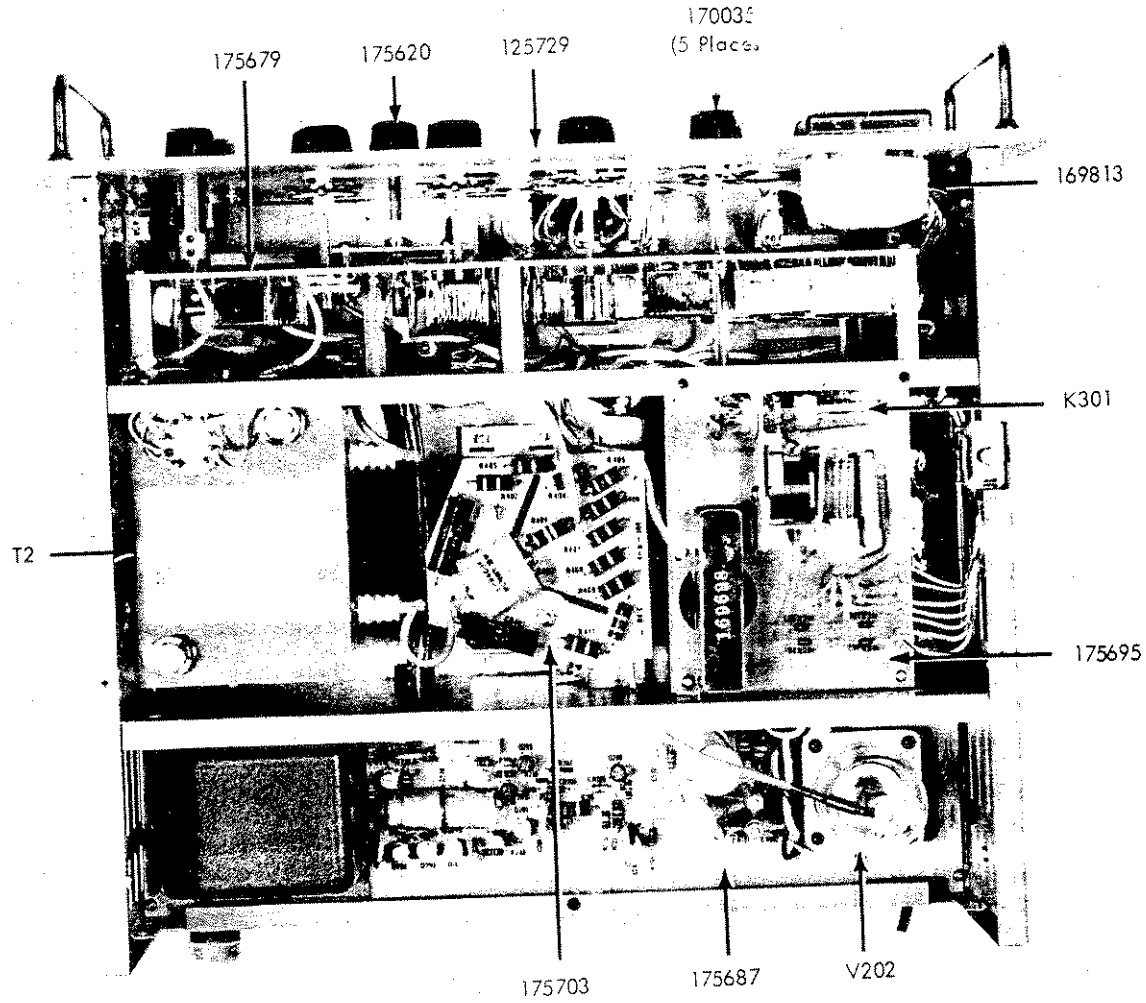


Figure 5-1. FINAL ASSEMBLY (Sheet 1 of 2)

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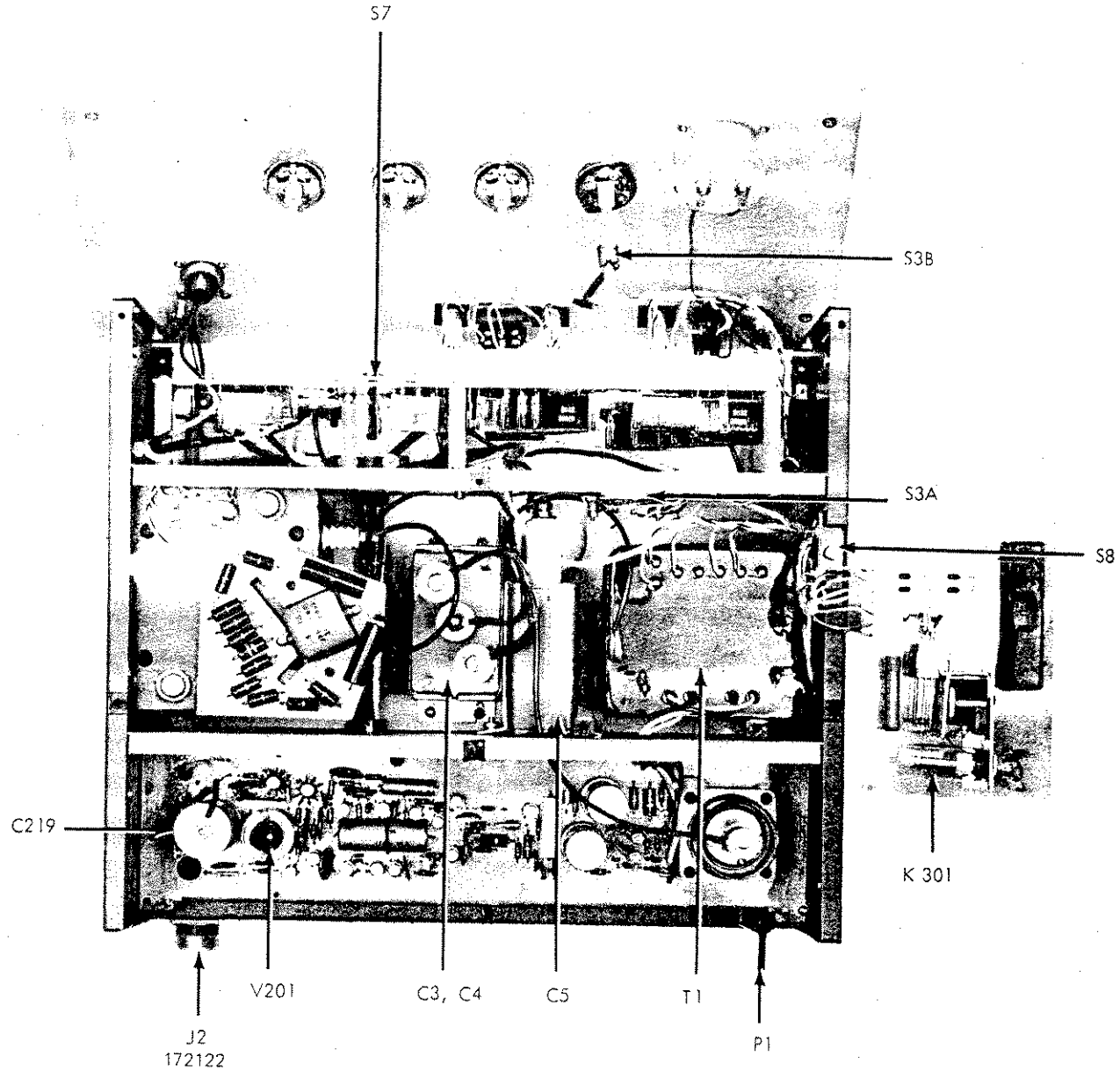

Figure 5-1. FINAL ASSEMBLY (Sheet 2 of 2)

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Front Panel Assembly	3158-175729 (410B-406)	89536	3158-175729	REF		
DS1	Lamp, red lens	3903-100206	91802	1040A1	2		
DS2	Lamp, white lens	3903-100214	91802	1040A4	1		
DS3	Lamp, red lens	3903-100206	91802	1040A1	REF		
F1	Fuse, 3A, sb (not illustrated)	5101-109280	03614	Type MDA	1	3	
J1	Connector, H. V.	2104-100172	02660	MS3102A-18-16S-C	REF		
M1	Meter, 50Ω, 500-0-500 ua ±2%	2901-166231	89536	2901-166231	1		
S1	Switch, toggle, DPST, 8A, 250V	5106-114835	04009	81024-GB	1		
S2	Switch, toggle, DPDT, 15A, 115V	5106-157883	73559	2GL50-63	1		
	Fuseholder	2102-100107	03614	HKP	1		
	Handle, 6-7/16"	2404-101584	05704	805	2		
	Cap, H.V. connector	3155-172122	89536	3155-172122	REF		

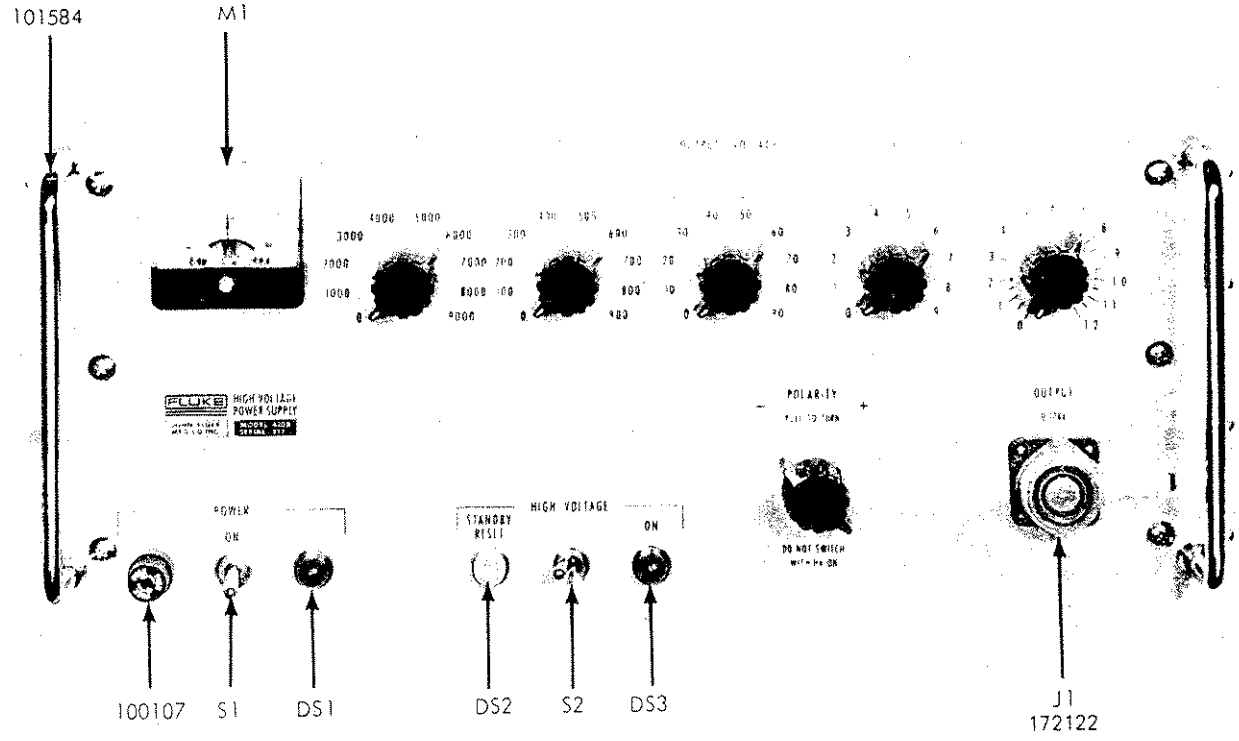

Figure 5-2. FRONT PANEL ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Switch PCB Assembly	1702-175679 (410B-401)	89536	1702-175679	REF		
C102	Cap, elect, 10 uf -10/+75%, 150V	1502-106351	56289	30D106G150DF4	1	1	
R104	Res, var, WW, 1K ±20%, 1-1/4W	4702-113266	71450	Type 110	1		
R105	Res, WW, 1.02K ±0.1%, 1/2W	4707-145128	89536	4707-145128	1		A
R106	Res, WW, 40K ±0.02%, 1/2W	4707-146530	89536	4707-146530	1	1	A
R106	Res, WW, 41.6K ±0.05%, 1 1/2W	4707-199778	89536	4707-199778	1	1	B
R107 thru R124	Res, WW, 250K ±0.05%, 2W	4707-156448	89536	4707-156448	18	2	
R125 thru R128	Res, WW, 100K ±0.1%, 1W	4707-142349	89536	4707-142349	4		
R129	Res, WW, 50K ±0.1%, 1W	4707-156455	89536	4707-156455	1		
R130 thru R133	Res, WW, 10K ±0.1%, 1W	4707-131664	89536	4707-131664	1		
R134	Res, WW, 5K ±0.1%, 1/2W	4707-149708	89536	4707-149708	1		
R135 thru R138	Res, met flm, 1K ±1%, 1/2W	4705-151324	75042	Type CEC-TO	6		
R139	Res, met flm, 499Ω ±1%, 1/2W	4705-151514	75042	Type CEC-TO	1		
R140	Res, var, WW, 600Ω ±10%, 2W	4702-155523	71450	Type 252	1		
R141	Res, comp, 4.7Ω ±5%, 1W	4704-109785	01121	GB47G5	3		
R142 thru R148	Res, met flm, 2.67M ±1%, 2W	4705-169391	14298	CM-2	7		
R149	Res, met flm, 309Ω ±1%, 1/2W	4705-172130	75042	Type CEC-TO	1		
R150, R151	Res, var, WW, 3K ±20%, 1-1/4W	4702-149781	71450	Type 110	2		
R152	Res, comp, 82Ω ±5%, 1/2W	4704-108746	01121	EB8205	1		
R153	Res, comp, 4.7Ω ±5%, 1W	4704-109785	01121	GB47G5	REF		
S4, S5, S6	Switch section, rot, 1 pole, 10 positions	5108-155978	76854	239956-FC	3		

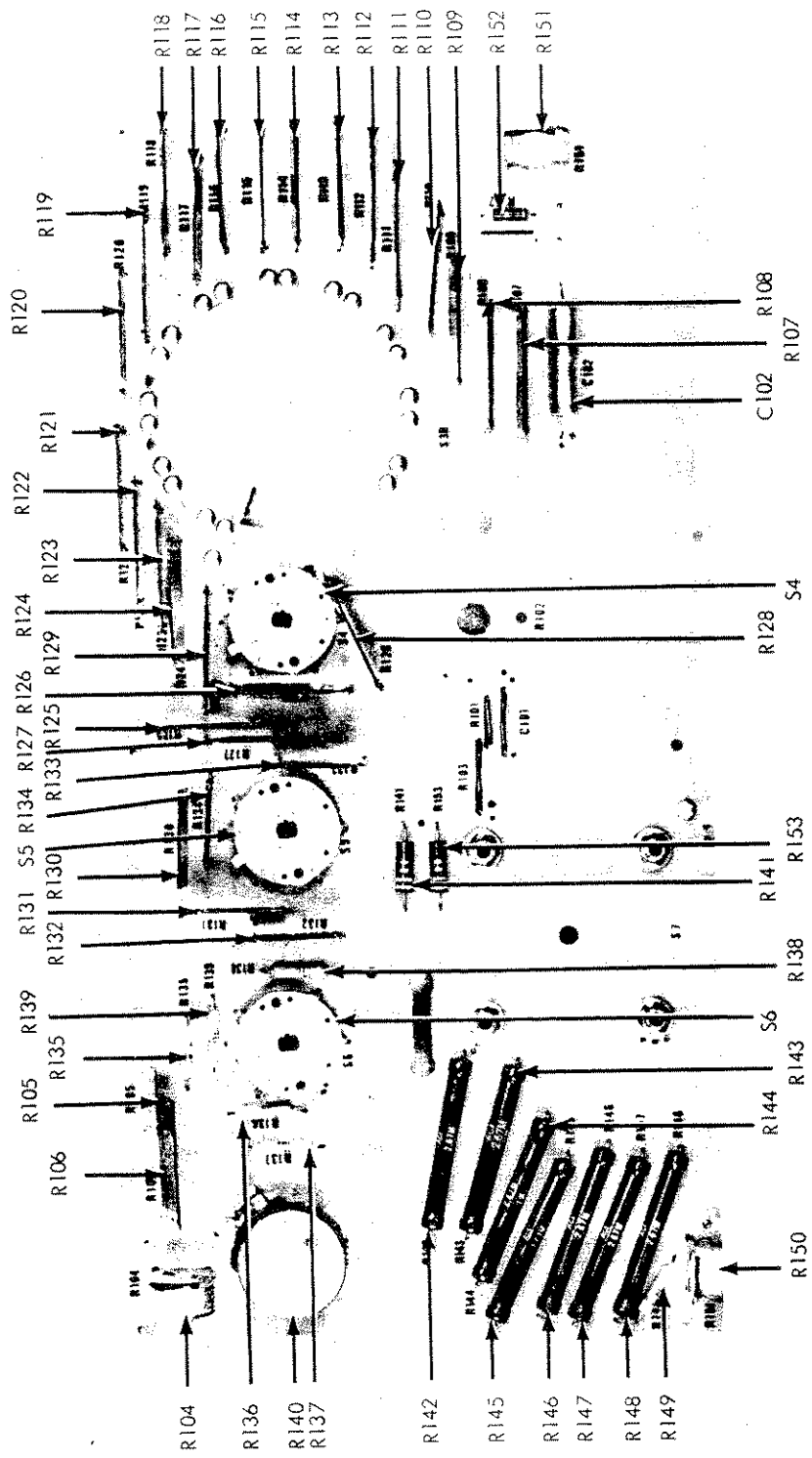

Figure 5-3. SWITCH CIRCUIT BOARD ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Amplifier PCB Assembly	1702-175687 (410B-402)	89536	1702-175687	REF		
C201	Cap, fxd, cer, 0.0033 uf ±20%, 1KV	1501-106674	56289	5GA-D33	1		
C202, C203	Cap, fxd, elec, 40 uf -10/+100%, 500V	1502-106765	56289	Type 66D	2	1	
C204	Cap, fxd, elec, 200 uf -10/+75%, 12V	1502-150284	56289	30D207G012DF4	1	1	
C205, C206	Cap, fxd, cer, 0.1 uf -20/+80%, 500V	1501-105684	56289	41C92	5		
C207	Cap, fxd, cer, 0.0047 uf ±10%, 500V	1501-106724	71590	CF-472	1		E
C207	Cap, fxd, cer, 0.005 uf ±20%, 1KV	1501-105650	56289	C023B102H502M	1		F
C208, C209	Cap, fxd, cer, 0.1 uf -20/+80%, 500V	1501-105684	56289	41C92	REF		
C210	Cap, fxd, cer, 0.05 uf -20/+80%, 500V	1501-105676	56289	33C58	1		
C211	Cap, fxd, elect, 40 uf -10/+75%, 250V	1502-161273	56289	34D406G250GL4	1	1	
C212	Cap, fxd, cer, 0.01 uf -20/+80%, 500V	1501-105668	56289	29C9B5	1		
C215	Cap, fxd, cer, 180 pf ±10%, 500V	1501-105890	71590	BB60181KS3N	1		
C216	Cap, fxd, cer, 0.0027 uf GMV, 500V	1501-106211	72982	ED-.0027	1		
C217	Cap, fxd, cer, 0.1 uf -20/+80%, 500V	1501-105684	56289	41C92	REF		
C218	Cap, fxd, cer, 0.01 uf GMV, 1.6KV	1501-106930	71590	DD16-103	1		
CR201 thru CR204	Diode, silicon, 600 PIV, 1A	4802-112383	05277	1N4822	10	2	
CR205	Diode, Si, zener, 75V , 0.005A	4803-168096	81483	1N3041A	1	1	
CR206, CR207	Diode, Si, zener, 10V, type 1N961A	4803-113324	07910	1N961A	2	1	
CR208	Diode, Si, zener, 110V , 0.005A	4803-168104	81483	1N3045A	1	1	
CR209	Diode, silicon, 600 PIV, 1A	4802-112383	05277	1N4822	REF		E
CR210, CR211	Diode, silicon, 100 PIV, 1A	4802-116111	05277	1N4822	4	1	
CR213, CR214	Diode, silicon, 100 PIV, 1A	4802-116111	05277	1N4822	REF		
CR215	Diode, Si, 200 PIV, 12A	4802-188854	04713	MR1112	1	1	
CR216, CR217	Diode, silicon, 600 PIV, 1A	4802-112383	05277	1N4822	REF		F
DS201 thru DS204	Lamp, neon, Type NE2E	3902-100347	71744	NE2E	4	2	
Q201, Q202	Transistor, NPN, Si, Type 2N3053	4805-150359	95303	2N3053	2	1	

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
Q203, Q204	Transistor, NPN, Si	4805-203489	07910	CDQ10656	3	2	
Q205, Q206	Transistor, NPN, Si	4805-203489	07910	CDQ10656	REF		C
Q205, Q206	Transistor, NPN, Si	4819-168716	07263	S19254	2		D
Q208, Q209, Q210	Transistor, PNP, Si	4805-190389	04713	SM4144	3	1	C
Q208, Q209, Q210	Transistor, PNP, Si	4805-159491	04713	SS7504	3		D
Q211, Q212	Transistor, NPN, Si	4805-203489	07910	CDQ10656	REF		
Q213, Q214	Transistor, NPN, Si	4805-203489	07910	CDQ10656	REF		C
Q213, Q214	Transistor, NPN, Si	4805-235812	89536	4805-235812	2		D
R201	Res, comp, 10Ω ±10%, 1/2W	4704-108092	01121	EB1001	1		
R202, R203	Res, WW, 30K ±5%, 10W	4706-155432	06136	10F-30000	2		
R204	Res, comp, 75Ω ±5%, 1/2W	4704-108753	01121	EB7505	1		
R205	Res, comp, 150K ±10%, 1W	4704-109801	01121	GB1541	1		
R206	Res, comp, 2.7K ±10%, 2W	4704-110148	01121	HB2721	1		C
R206	Res, comp, 2.2K ±10%, 2W	4704-109967	01121	HB2221	1		D
R207, R208	Res, comp, 6.2K ±5%, 1/2W	4704-108621	01121	EB6225	2		
R209	Res, met flm, 20K ±1%, 1/2W (not illustrated)	4705-162438	75042	Type CEC-TO	1		
R210	Res, met flm, 100K ±1%, 1/2W (not illustrated)	4705-151316	75042	Type CEC-TO	1		
R211	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	EB4731	2		
R212	Res, comp, 2.7K ±5%, 1/2W	4704-108837	01121	EB2721	1		
R213	Res, met flm, 40.2K ±1%, 1/2W (not illustrated)	4705-161059	75042	Type CEC-TO	1		
R214	Res, met flm, 80.6K ±1%, 1/2W	4705-150680	75042	Type CEC-TO	1		
R215	Res, comp, 180K ±10%, 1/2W	4704-108431	01121	EB1841	1		
R216	Res, comp, 82K ±10%, 1/2W	4704-108498	01121	EB8231	2		
R217	Res, comp, 39K ±10%, 1/2W (not illustrated)	4704-108555	01121	EB3931	1		
R218	Res, comp, 330Ω ±10%, 1/2W	4704-108589	01121	EB3311	1		
R219	Res, WW, 14K ±5%, +4500 PPM/°C	4707-172072	89536	4707-172072	1		A
R219	Factory selected part	1					B

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REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R220	Res, WW, 5K ±0.1%, 1/2W	4707-149708	89536	4707-149708	REF		A
R221 R221	Res, WW, 4K ±0.03%, 1/2W Factory selected part	4707-131672 1	89536	4707-131672	1	1	A B
R222	Res, comp, 10K ±10%, 1W	4704-109389	01121	GB1031	1		
R223, R224	Res, comp, 47Ω ±10%, 1/2W	4704-108688	01121	EB4701	2		
R226	Res, comp, 68K ±10%, 2W	4704-110114	01121	HB6831	1		
R227	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	1		
R228, R229	Res, comp, 82K ±10%, 1/2W	4704-108498	01121	EB8231	REF		
R230	Res, comp, 270Ω ±5%, 1/2W	4704-159616	01121	EB2715	1		
R231	Res, comp, 680Ω ±10%, 1/2W	4704-108712	01121	EB6811	1		
R232	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	EB4731	REF		
R233	Res, comp, 4.7K ±10%, 1/2W	4704-108381	01121	EB4721	2		
R234	Res, comp, 100K ±10%, 1/2W	4704-108126	01121	EB1041	1		
R235	Res, comp, 4.7K ±10%, 1/2W	4704-108381	01121	EB4721	REF		
R236	Res, met flm, 1K ±1%, 1/2W	4705-151324	75042	Type CEC-TO	REF		
R237, R238	Res, comp, 270K ±10%, 1/2W	4704-108258	01121	EB2741	2		
R239	Res, comp, 1.2M ±10%, 1/2W	4704-108407	01121	EB1251	1		
R240	Res, comp, 2.7Ω ±10%, 1W (not illustrated)	4704-109850	01121	GB27G1	1		
R241	Res, comp, 4.7Ω ±5%, 1W	4704-109785	01121	EB47G5	REF		
R242	Res, comp, 2.2K ±10%, 1/2W	4704-108605	01121	EB2221	1		
R243	Res, met flm, 1K ±1%, 1/2W (not illustrated)	4705-151324	75042	Type CEC-TO	1		
V201 V201	Electron Tube, volt. ref, Type 83A1 Factory selected	5701-170076 1	89536	5701-170076	1	1	A B

1 R221, R219, and V201 constitute a factory selected and matched set. For replacement, order part number 239707.

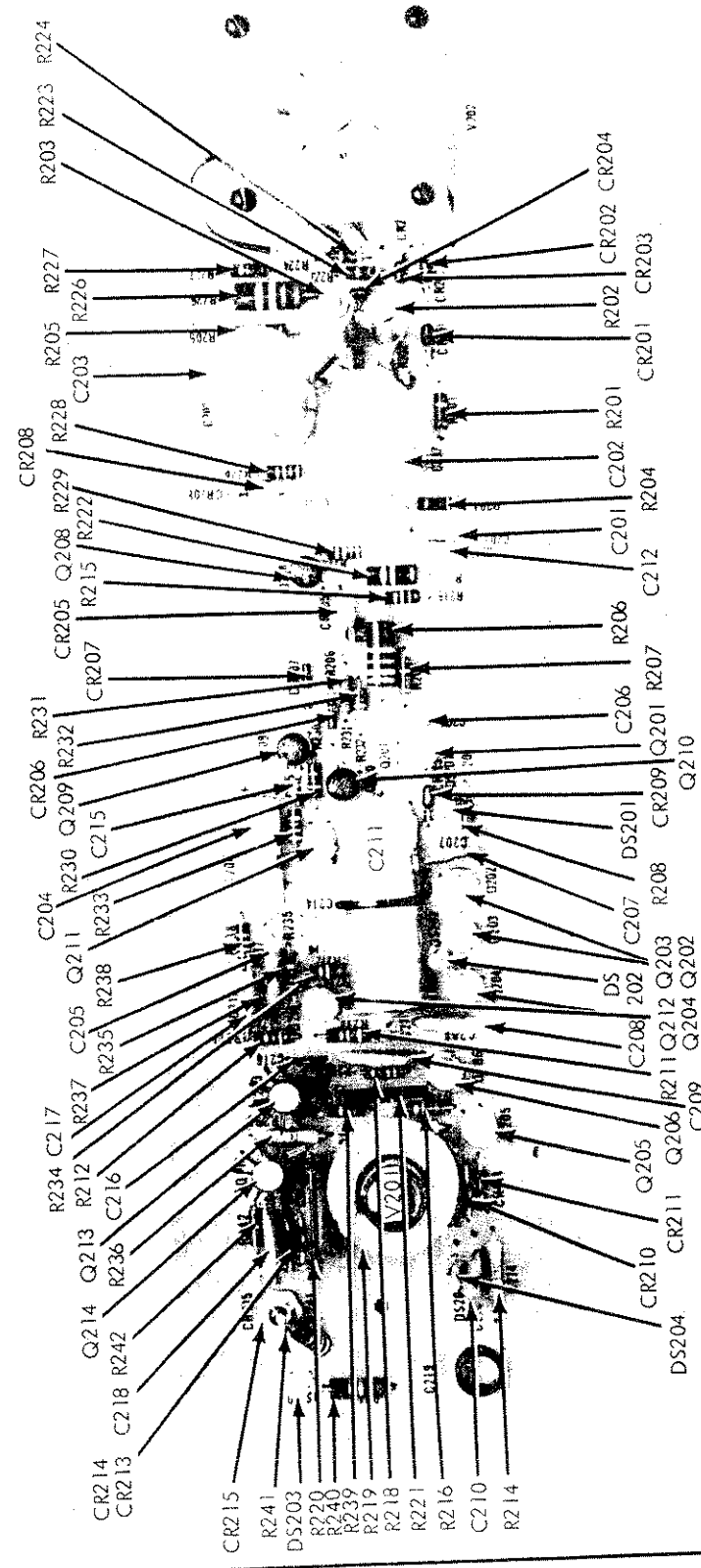

Figure 5-4. AMPLIFIER CIRCUIT BOARD ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Time Delay PCB Assembly	1702-175695 (410B-403)	89536	1702-175695	REF		
CR301 thru CR304	Diode, silicon, 600 PIV, 1A	4802-112383	05277	IN4822	REF		
K302	Relay, armature, DPDT, 230 VAC, 5A	4504-148940	73949	A410-060713-00	1		
K303	Reed switch	4501-169698	89536	4501-169698	1		
R301	Res, WW, 1K ±5%, 10W	4706-157933	06136	10F-1000	1		

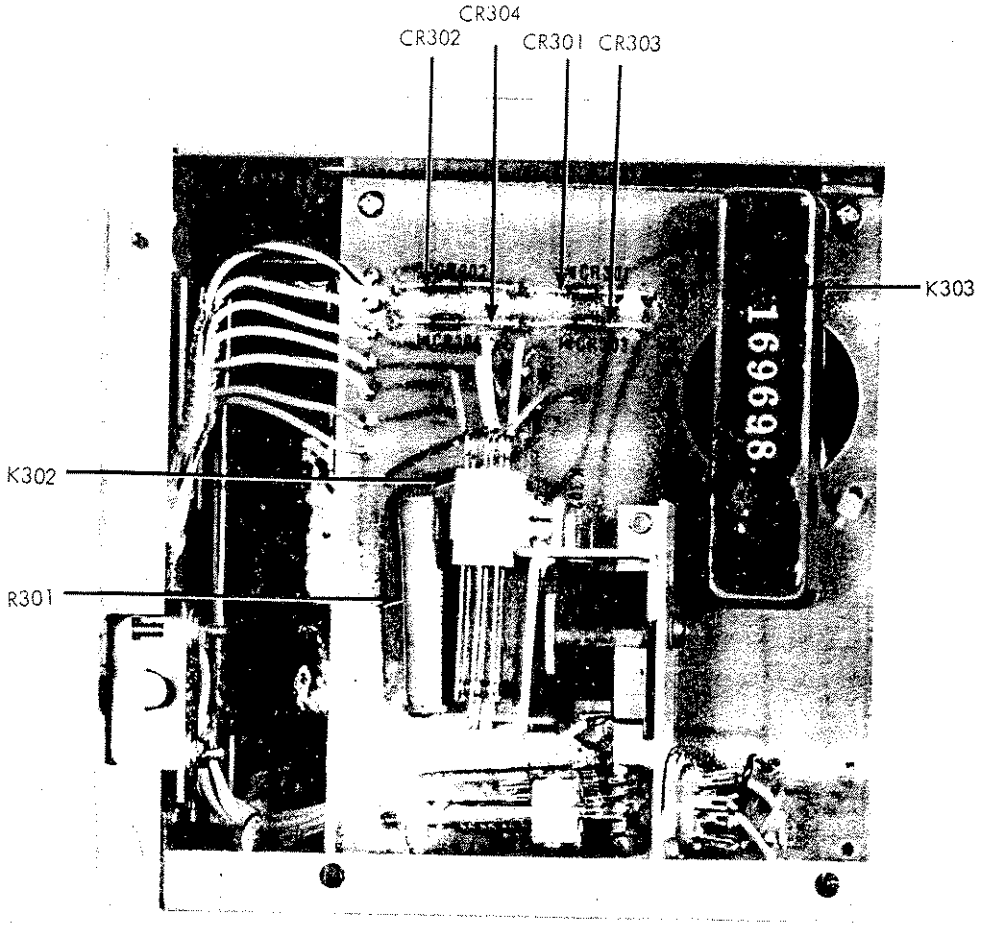

Figure 5-5. TIME DELAY CIRCUIT BOARD ASSEMBLY

5-11. USE CODE EFFECTIVITY

The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as necessary on forthcoming instruments.

USE CODE	EFFECTIVITY
No Code	Model 410B serial number 123 and on.
A	Model 410B serial number 123 thru 812.
B	Model 410B serial number 813 and on.
C	Model 410B serial number 123 thru 1072.
D	Model 410B serial number 1073 and on.
E	Model 410B serial number 123 thru approximately 1331.
F	Model 410B serial number approximately 1332 and on.

Section 7
General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

List of Abbreviations and Symbols

A or amp	ampere
ac	alternating current
af	audio frequency
a/d	analog-to-digital
assy	assembly
AWG	american wire gauge
B	bel
bcd	binary coded decimal
°C	Celsius
cap	capacitor
ccw	counterclockwise
cer	ceramic
cermet	ceramic to metal(seal)
ckt	circuit
cm	centimeter
cmrr	common mode rejection ratio
comp	composition
cont	continue
crt	cathode-ray tube
cw	clockwise
d/a	digital-to-analog
dac	digital-to-analog converter
dB	decibel
dc	direct current
dmm	digital multimeter
dvm	digital voltmeter
elect	electrolytic
ext	external
F	farad
°F	Fahrenheit
FET	Field-effect transistor
ff	flip-flop
freq	frequency
FSN	federal stock number
g	gram
G	giga (10^9)
gd	guard
Ge	germanium
GHz	gigahertz
gmv	guaranteed minimum value
gnd	ground
H	henry
hd	heavy duty
hf	high frequency
Hz	hertz
IC	integrated circuit
if	intermediate frequency
in	inch(es)
intl	internal
I/O	input/output
k	kilo (10^3)
kHz	kilohertz
kΩ	kilohm(s)
kV	kilovolt(s)
lf	low frequency
LED	light-emitting diode
LSB	least significant bit
LSD	least significant digit
M	mega (10^6)
m	milli (10^{-3})
mA	milliampere(s)
max	maximum
mf	metal film
MHz	megahertz
min	minimum
mm	millimeter
ms	millisecond
MSB	most significant bit
MSD	most significant digit
MTBF	mean time between failures
MTTR	mean time to repair
mV	millivolt(s)
mv	multivibrator
MΩ	megohm(s)
n	nano (10^{-9})
na	not applicable
NC	normally closed
(-) or neg	negative
NO	normally open
ns	nanosecond
opnl ampl	operational amplifier
p	pico (10^{-12})
para	paragraph
pcb	printed circuit board
pF	picofarad
pn	part number
(+) or pos	positive
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
PROM	programmable read-only memory
psi	pound-force per square inch
RAM	random-access memory
rf	radio frequency
rms	root mean square
ROM	read-only memory
s or sec	second (time)
scope	oscilloscope
SH	shield
Si	silicon
serno	serial number
sr	shift register
Ta	tantalum
tb	terminal board
tc	temperature coefficient or temperature compensating
tcxo	temperature compensated crystal oscillator
tp	test point
u or μ	micro (10^{-6})
uhf	ultra high frequency
us or μs	microsecond(s) (10^{-6})
uut	unit under test
V	volt
v	voltage
var	variable
vco	voltage controlled oscillator
vhf	very high frequency
vlf	very low frequency
W	watt(s)
ww	wire wound
xfmr	transformer
xstr	transistor
xtal	crystal
xtlo	crystal oscillator
Ω	ohm(s)
μ	micro (10^{-6})

Federal Supply Codes for Manufacturers

D9816
Westermann Wilhelm Augusta-Anlage
Mannheim-Nackarau Germany

00199
Marcon Electronics Corp
Kearny, New Jersey

00213
Nytronics Comp. Group Inc.
Darrlingon, South Carolina

00327
Welwyn International Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors Inc.
Passaic, New Jersey

00779
AMP, Inc.
Harrisburg, Pennsylvania

01121
Allen Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronics & Defense Sector
Lawndale, California

01295
Texas Instruments Inc.
Semiconductor Group
Dallas,Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics/Shallcross Inc.
Electro Components Div.
Manchester, New Hampshire

01884
Sprague Electric Co.
(Now 56289)

01961
Varian Associates Inc.
Pulse Engineering Div.
Convoy, Connecticut

02111
Spectrol Electronics Corp.
City of Industry, California

02114
Amperex Electronic Corp.
Ferrox Cube Div.
Saugerties, New York

02131
General Instrument Corp.Government
Systems Div.
Westwood, Massachusetts

02395
Sonar Radio Corp.
Hollywood, Florida

02533
Leigh Instruments Ltd.
Frequency Control Div.
Don Mills, Ontario, Canada

02606
Fenwal Labs
Division of Travenal Labs
Morton Grove, Illinois

0266
Bunker Ramo-Eltra Corp.
Amphenol NA Div.
Broadview, Illinois

02735
RCA-Solid State Div.
Somerville, New Jersey

02799
Arco Electronics Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products& Batteries
Auburn, New York

03797
Genisco Technology Corp.
Eltronics Div.
Rancho Dominquez, Calif.

03877
Gilbert Engineering Co.Inc
Incon Sub of Transitron
Electronic Corp.
Glendale, Arizona

03888
KDI Electronics Inc.
Pyrofilm Div.
Whippany, New Jersey

03911
Clairex Corp.
Clairex Electronics Div.
Mount Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Cooper Industries, Inc.
Arrow Hart Div.
Hartford, Connecticut

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Midland-Ross Corp.
Midtex Div.
N. Mankato, Minnesota

04222
AVX Corp.
AVX Ceramics Div.
Myrtle Beach, S. Carolina

04423
Telonic Berkley Inc.
Laguna Beach, California

04713
Motorola Inc.
Semiconductor Group
Phoenix, Arizona

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Corcom Inc.
Libertyville, Illinois

05276
ITT Pomona
Electronics Div.
Pomona, California

05277
Westinghouse Elec. Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05397
Union Carbide Corp.
Materials Systems Div.
Cleveland. Ohio

05571
Sprague Electric Co.
(Now 56289)

05574
Viking Connectors Inc
Sub of Criton Corp.
Chatsworth, Calif.

05820
EG & G Wakefield Engineering
Wakefield, Massachusetts

05972
Loctite Corp.
Newington, Connecticut

06001
General Electric Co.
Electric Capacitor Product Section
Columbia, S. Carolina

06141
Fairchild Weston Systems Inc.
Data Systems Div.
Sarasota, Florida

06192
La Deau Mfg. Co.
Glendale, California

06229
Electrovert Inc.
Elmsford, New York

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol NA Div.
SAMS Operation
Chatsworth, California

06555
Beede Electrical Instrument
Penacook, New Hampshire

06665
Precision Monolithics
Sub of Bourns Inc.
Santa Clara, California

06666
General Devices Co. Inc.
Indianapolis, Indiana

06739
Electron Corp.
Littleton, Colorado

06743
Gould Inc.
Foil Div.
Eastlake, Ohio

06751
Components Inc.
Semcor Div.
Phoenix, Arizona

06776
Robinson Nugent Inc.
New Albany, Indiana

06915
Richco Plastic Co.
Chicago, Illinois

06961
Vernitron Corp.
Piezo Electric Div.
Bedford, Ohio

06980
Varian Associates Inc.
Eimac Div.
San Carlos, California

07047
Ross Milton Co., The
Southampton, Penna.

07138
Westinghouse Electric Corp.
Industrial & Government
Tube Div.
Horseheads, New York

07233
Benchmark Technology Inc.
City of Industry, Calif.

07239
Biddle Instruments
Blue Bell, Penna.

07256
Silicon Transistor Corp.
Sub of BBF Inc.
Chelmsford, Massachusetts

07261
Avnet Corp.
Culver City, California

07263
Fairchild Camera & Instrument
Semiconductor Div.
Mountain View, California

07344
Bircher Co. Inc., The
Rochester, New York

Federal Supply Codes for Manufacturers (cont)

07557
Campion Co. Inc.
Philadelphia, Penna.

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07716
TRW Inc. (Can use 11502)
IRC Fixed Resistors/
Burlington
Burlington, Iowa

07792
Lenna Engineering Corp.
Northampton, Massachusetts

07810
Bock Corp.
Madison, Wisconsin

07933
Raytheon Co.
Semiconductor Div.
Mountain View, Calif.

08235
Industro Transistor Corp.
Long Island City, New York

08261
Spectra-Strip
An Eltra Co.
Garden Grove, Calif.

08530
Reliance Mica Corp.
Brooklyn, New York

08718
ITT Cannon Electric
Phoenix Div.
Phoenix, Arizona

08806
General Electric Co.
Minature Lamp Products
Cleveland, Ohio

08863
Nylomatic
Fallsington, Penna.

08988
Skottie Electronics Inc.
Archbald, Pennsylvania

09021
Airco Inc.
Airco Electronics
Bradford, Penna.

09023
Cornell-Dublier Electronics
Fuquay-Varina, N. Carolina

09214
General Electric Co.
Semiconductor Products Dept.
Auburn, New York

09353
C and K Components Inc.
Newton, Massachusetts

09423
Scientific Components Inc.
Santa Barbara, California

09579
CTS of Canada, Ltd
Streetsville, Ontario

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, South Dakota

09975
Burroughs Corp.
Electronics Components
Detroit, Michigan

10059
Barker Engineering Corp.
Kenilworth, New Jersey

10389
Illinois Tool Works Inc.
Licon Div.
Chicago, Illinois

10582
CTS of Asheville
Skyland, N. Carolina

11236
CTS Corp.
Berne Div.
Berne, Indiana

11237
CTS Corp of California
Paso Robles Div.
Paso Robles, California

11295
ECM Motor Co.
Schaumburg, Illinois

11358
Columbia Broadcasting System
CBS Electronic Div.
Newburyport, Massachusetts

11403
Vacuum Can Co.Best Coffee Maker Div.
Chicago, Illinois

11502
TRW Inc.
TRW Resistive Products Div.
Boone, North Carolina

11503
Keystone Columbia Inc.
Freemont, Indiana

11532
Teledyne Relays Teledyne
Industries Inc.
Hawthorne, California

11711
General Instrument Corp.
Rectifier Div.
Hicksville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Naperville, Illinois

12040
National Semiconductor Corp.
Danbury, Connecticut

12060
Diodes Inc.
Northridge, California

12136
PHC Industries Inc.
Formerly Philadelphia Handle Co.
Camden, New Jersey

12300
AMF Canada Ltd.
Potter-Brumfield
Guelph, Ontario, Canada

12323
Practical Automation Inc.
Shelton, Connecticut

12327
Freeway Corp.
Cleveland, Ohio

12443
Budd Co.,The
Plastics Products Div.
Phoenixville, Pennsylvania

12581
Hitachi Metals International Ltd.
Hitachi Magna-Lock Div.
Big Rapids, Missouri

12615
US Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co. Inc.
Dover, New Hampshire

12749
James Electronic Inc.
Chicago, Illinois

12856
MicroMetals Inc.
Anaheim, California

12881
Metex Corp.
Edison, New Jersey

12895
Cleveland Electric Motor Co.
Cleveland, Ohio

12954
Microsemi Corp.
Components Group
Scottsdale, Arizona

12969
Unitrode Corp.
Lexington, Massachusetts

13050
Potter Co.
Wesson, Mississippi

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Bunker-Ramo Corp.
Amphenol Cadre Div.
Los Gatos, California

13606
Sprague Electric Co.
(Use 56289)

13689
SPS Technologies Inc.
Hatfield, Pennsylvania

13919
Burr-Brown Research Corp.
Tucson, Arizona

14099
Semtech Corp.
Newbury Park, California

14140
McGray-Edison Co.
Commercial Development Div.
Manchester, New Hampshire

14193
Cal-R-Inc.
Santa Monica, California

14298
American Components Inc.
an Insilco Co. RPC Div.
Conshohocken, Pennsylvania

14298
ACIC Inc.
Sub of Insilco Corp.
Research Triangle Park, NC

14329
Wells Electronics Inc.
South Bend, Indiana

14482
Watkins-Johnson Co.
Palo Alto, California

14552
Microsemi Corp.
Santa Ana, California

14655
Cornell-Dublier Electronics
Div. of Federal Pacific
Electric Co. Govt Cont Dept.
Newark, New Jersey

14704
Crydom Controls
(Division of Int Rectifier)
El Segundo, California

14752
Electro Cube Inc.
San Gabriel, California

14936
General Instrument Corp.
Discrete Semi Conductor Div.
Hicksville, New York

14949
Trompeter Electronics
Chatsworth, California

15412
Amtron
Midlothian, Illinois

15542
Scientific Components Corp.
Mini-Circuits Laboratory Div.
Brooklyn, New York

15636
Elec-Trol Inc.
Saugus, California

15782
Bausch & Lomb Inc.
Graphics & Control Div.
Austin, Texas

15801
Fenwal Eletronics Inc.
Div. of Kidde Inc.
Framingham, Massachusetts

15818
Teledyne Inc. Co.
Teledyne Semiconductor Div.
Mountain View, California

15849
Useco Inc.
(Now 88245)

15898
International Business
Machines Corp.
Essex Junction, Vermont

16245
Conap Inc.
Olean, New York

16258
Space-Lok Inc.
Burbank, California

16352
Codi Corp.
Linden, New Jersey

16469
MCL Inc.
LaGrange, Illinois

16473
Cambridge Scientific Industries
Div. of Chemed Corp.
Cambridge, Maryland

16733
Cablewave Systems Inc.
North Haven, Connecticut

16742
Paramount Plastics
Fabricators Inc.
Downey, California

16758
General Motors Corp.
Delco Electronics Div.
Kokomo, Indiana

17069
Circuit Structures Lab
Burbank, California

17117
Electronic Molding Corp.
Woonsocket, Rhode Island

17338
High Pressure Eng. Co. Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors Inc.
Asbury Park, New Jersey

17745
Angstrohm Precision, Inc.
Hagerstown, Maryland

17856
Siliconix Inc.
Santa Clara, California

18178
E G & Gvactee Inc.
St. Louis, Missouri

18324
Signetics Corp.
Sacramento, California

18520
Sharp Electronics Corp.
Paramus, New Jersey

18542
Wabash Inc.
Wabash Relay & Electronics Div.
Wabash, Indiana

18565
Chomerics Inc.
Woburn, Massachusetts

18612
Vishay Intertechnology Inc.
Vishay Resistor Products Group
Malvern, Pennsylvania

18632
Norton-Chemplast
Santa Monica, California

18677
Scanbe Mfg. Co.
Div. of Zero Corp.
El Monte, California

18736
Voltronics Corp.
East Hanover, New Jersey

18927
GTE Products Corp.
Precision Material Products
Business Parts Div.
Titusville, Pennsylvania

19315
Bendix Corp., The
Navigation & Control Group
Terboro, New Jersey

19451
Perine Machinery & Supply Co.,
Kent, Washington

19613
Minnesota Mining & Mfg. Co.
Textool Products Dept.
Electronic Product Div.
Irving, Texas

19647
Caddock Electronics Inc.
Riverside, California

19701
Mepco/Centralab Inc.
A N. American Philips Co.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

20891
Cosar Corp.
Dallas, Texas

21317
Electronics Applications Co.
El Monte, California

21604
Buckeye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Semiconductor Group
Rivera Beach, Florida

22526
DuPont, EI DeNemours & Co. Inc.
DuPont Connector Systems
Advanced Products Div.
New Cumberland, Pennsylvania

22767
ITT Semiconductors
Palo Alto, California

22784
Palmer Inc.
Cleveland, Ohio

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Applied Sciences Inc.
Rockville, Maryland

23880
Stanford Applied Engineering
Santa Clara, California

23936
William J. Purdy Co.
Pamotor Div.
Burlingame, California

24347
Penn Engineering Co.
S. El Monte, California

24355
Analog Devices Inc.
Norwood, Massachusetts

24444
General Semiconductor
Industries, Inc.
Tempe, Arizona

24655
Genrad Inc.
Concord, Massachusetts

24759Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

24796
AMF Inc.
Potter & Brumfield Div.
San Juan Capistrano, Calif.

24931
Specialty Connector Co.
Greenwood, Indiana

25088
Siemen Corp.
Isilen, New Jersey

25099
Cascade Gasket
Kent, Washington

25403
Amperex Electronic Corp.
Semiconductor & Micro-Circuit Div.
Slatersville, Rhode Island

25706
Daburn Electronic & Cable Corp.
Norwood, New Jersey

26629
Frequency Sources Inc.
Sources Div.
Chelmsford, Massachusetts

26806
American Zettler Inc.
Irvine, California

27014
National Semiconductor Corp.
Santa Clara, California

27167
Corning Glass Works Corning
Electronics
Wilmington, North Carolina

27264
Molex Inc.
Lisle, Illinois

27440
Industrial Screw Products
Los Angeles, California

Federal Supply Codes for Manufacturers (cont)

27745
Associated Spring Barnes Group Inc.
Syracuse, New York

27956
Relcom (Now 14482)

28198
Positronic Industries
Springfield, Missouri

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
3M Center
Saint Paul, Minnesota

28425
Serv-O-Link
Euless, Texas

28478
Deltrol Corporation
Deltrol Controls Div.
Milwaukee, Wisconsin

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, California

28484
Emerson Electric Co.
Gearmaster Div.
McHenry, Illinois

28520
Heyco Molded Products
Kenilworth, New Jersey

29083
Monsanto Co.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

29907
Omega Engineering Inc.
Stamford, Connnecticut

30035
Jolo Industries Inc.
Garden Grove, California

30146
Symbex Corp.
Painesville, Ohio

30148
AB Enterprise Inc.
Ahoskie, North Carolina

30161
Aavid Engineering Inc.
Laconia, New Hampshire

30315
Itron Corp.
San Diego, California

30323
Illinois Tool Works Inc.
Chicago, Illinois

30800
General Instrument Corp.
Capacitor Div.
Hicksville, New York

31019
Solid State Scientific Inc.
Willow Grove, Pennsylvania

31091
Alpha Industries Inc.
Microelectronics Div.
Hatfield, Pennsylvania

31323
Metro Supply Company
Sacramento, California

31448
Army Safeguard Logistics Command
Huntsville, Alabama

31746
Cannon Electric
Woodbury, Tennessee

31827
Budwig
Ramona, California

31918
ITT-Schadow
Eden Prairie, Minnesota

32293
Intersil
Cupertino, California

32539
Mura Corp.
Westbury, Long Island, N.Y.

32559
Bivar
Santa Ana, California

32767
Griffith Plastics Corp.
Burlingame, California

32879
Advanced Mechanical Components
Northridge, California

32897
Murata Erie North America Inc.
Carlisle Operations
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Div.
Riverside, California

33096
Colorado Crystal Corp.
Loveland, Colorado

33173
General Electric Co.
Owensboro, Kentucky

33246
Epoxy Technology Inc.
Billerica, Massachusetts

33297
NEC Electronics USA Inc.
Electronic Arrays Inc. Div.
Mountain View, California

33919
Nortek Inc.
Cranston, Rhode Island

34333
Silicon General Inc.
Garden Grove, California

34225
Advanced Micro Devices
Sunnyvale, California

34359
Minnesota Mining & Mfg. Co.
Commercial Office Supply Div.
Saint Paul, Minnesota

34371
Harris Corp.
Harris Semiconductor
Products Group
Melbourne, Florida

34649
Intel Corp.
Santa Clara, California

34802
Electromotive Inc.
Kenilworth, New Jersey

34848
Hartwell Special Products
Placentia, California

35009
Renfrew Electric Co. Ltd.
IRC Div.
Toronto, Ontario, Canada

36665
Mitel Corp.
Kanata, Ontario, Canada

37942
Mallory Capacitor Corp.
Sub of Emhart Industries
Indianapolis, Indiana

39003
Maxim Industries
Middleboro, Massachusetts

40402
Roderstein Electronics Inc.
Statesville, North Carolina

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.(Now 53342)

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Executive Offices
Lexington, Massachusetts

50088
Thomson Components-Mostek Corp.
Carrollton, Texas

50120
Eagle-Picher Industries Inc.
Electronics Div.
Colorado Springs, Colorado

50157
Midwest Components Inc.
Muskegon, Mississippi

50541
Hypertronics Corp.
Hudson, Massachusetts

50579
Litronix Inc.
Cupertino, California

51167
Aries Electronics Inc.
Frenchtown, New Jersey

51372
Verbatim Corp.
Sunnyvale, California

51406
Murata Erie, No. America Inc.
(Also see 72982)
Marietta, Georgia

51499
Amtron Corp.
Boston, Massachusetts

51605
CODI Semiconductor Inc.
Kenilworth, New Jersey

51642
Centre Engineering Inc.
State College, Pennsylvania

51791
Statek Corp.
Orange, California

51984
NEC America Inc.
Falls Church, Virginia

52063
Exar Integrated Systems
Sunnyvale, California

52072
Circuit Assembly Corp.
Irvine, California

52152
Minnesota Mining & Mfg.
Saint Paul, Minnesota

52333
API Electronics
Haugpauge,Long Island,New York

Federal Supply Codes for Manufacturers (cont)

52361
Communication Systems
Piscataway, New Jersey

52525
Space-Lok Inc.
Lerco Div.
Burbank, California

52531
Hitachi Magnetics
Edmore, Missouri

52745
Timco
Los Angeles, California

52763
Stettner-Electronics Inc.
Chattanooga, Tennessee

52769
Sprague-Goodman Electronics Inc.
Garden City Park, New York

52771
Moniterm Corp.
Amatrom Div.
Santa Clara, California

52840
Western Digital Corp.
Costa Mesa, California

53021
Sangamo Weston Inc.
(See 06141)

53217
Technical Wire Products Inc.
Santa Barbara, California

53342
Opt Industries Inc.
Phillipsburg, New Jersey

53944
Glow-Lite
Pauls Valley, Oklahoma

54294
Shallcross Inc.
Smithfield, North Carolina

54453
Sullins Electronic Corp.
San Marcos, California

54473
Matsushita Electric Corp.
(Panasonic)
Secaucus, New Jersey

54583
TDK
Garden City, New York

54869
Piher International Corp.
Arlington Heights, Illinois

54937
DeYoung Mfg.
Bellevue, Washington

54590
RCA Corp.
Electronic Components Div.
Cherry Hill, New Jersey

55026
American Gage & Machine Co.
Simpson Electric Co. Div.
Elgin, Illinois

55112
Plessey Capacitors Inc.
(Now 60935)

55261
LSI Computer Systems Inc.
Melville, New York

55285
Bercquist Co.
Minneapolis, Minnesota

55576
Synertek
Santa Clara, California

55680
Michicon/America/Corp.
Schaumburg, Illinois

56282
Utek Systems Inc.
Olathe, Kansas

56289
Sprague Electric Co.
North Adams, Massachusetts

56365
Square D Co.
Corporate Offices
Palatine, Illinois

56375
DAL Industries Inc.
Wescorp Div.
Mountain View, California

56481
Shugart Associates
Sub of Xerox Corp.
Sunnyvale, California

56708
Zilog Inc.
Campbell, California

56856
Vamistor Corp. of Tennessee
Sevierville, Tennessee

56880
Magnetics Inc.
Baltimore, Maryland

57026
Endicott Coil Co. Inc.
Binghamton, New York

57053
Gates Energy Products
Denver, Ohio

58014
Hitachi Magnalock Corp.
(Now 12581)

58104
Simco
Atlanta, Georgia

58474
Superior Electric Co.
Bristol, Connecticut

59124
KOA-Speer Electronics Inc.
Bradford, Pennsylvania

59640
Supertex Inc.
Sunnyvale, California

59660
Tusonix Inc.
Tucson, Arizona

59730
Thomas and Betts Corp.
Iowa City, Iowa

59831
Semtronics Corp.
Watchung, New Jersey

60395
Xicor Inc.
Milpitas, California

60399
Torin Engineered Blowers
Div. of Clevepak Corp.
Torrington, Connecticut

60705
Cera-Mite Corp.
(formerly Sprague)
Grafton, Wisconsin

60935
Westlake Capacitor Inc.
Tantalum Div.
Greencastle, Indiana

61804
M/A Com Inc.
Burlington, Massachusetts

61857
SAN-O Industrial Corp.
Bohemia, Long Island, NY

61935
Schurter Inc.
Petaluma, California

62351
Apple Rubber
Lancaster, New York

62793
Lear Siegler Inc.
Energy Products Div.
Santa Ana, California

63743
Ward Leonard Electric Co.Inc.
Mount Vernon, New York

64154
Lamb Industries
Portland, Oregon

64155
Linear Technology
Milpitas, California

64834
West M G Co.
San Francisco, Calif.

65092
Sangamo Weston Inc.
Weston Instruments Div.
Newark, New Jersey

65940
Rohm Corp & Whatney
Irvine, California

65964
Evox Inc.
Bannockburn, Illinois

66150
Entron Inc.
Winslow Teltronics Div.
Glendale, New York

66608
Bering Industries
Fremont, California

70290
Almetal Universal Joint Co.
Cleveland, Ohio

70485
Atlantic India Rubber Works Inc.
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Bimbach Co. Inc.
Farmingdale, New York

71034
Bliley Electric Co.
Erie, Pennsylvania

71183
Westinghouse Electric Corp.
Bryant Div.
Bridgeport, Connecticut

71400
Bussman Manufacturing
Div. McGraw-Edison Co.
St. Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Div. of ITT
Fountain Valley, California

71482
General Instrument Corp.
Clare Div.
Chicago, Illinois

Federal Supply Codes for Manufacturers (cont)

71590
Mepco/Centralab
A North American Philips Co.
Fort Dodge, Iowa

71707
Coto Corp.
Providence, Rhode Island

71744
General Instrument Corp.
Lamp Div/Worldwide
Chicago, Illinois

71785
TRW Inc.
Cinch Connector Div.
Elk Grove Village, Illinois

71984
Dow Corning Corp.
Midland, Michigan

72005
AMAX Specialty Metals Corp.
Newark, New Jersey

72136
Electro Motive Mfg. Corp.
Florence, South Carolina

72228
AMCA International Corp.
Continental Screw Div.
New Bedford, Massachusetts

72259
Nytronics Inc.
New York, New York

72619
Amperex Electronic Corp.
Dialight Div.
Brooklyn, New York

72653
G C Electronics Co.
Div. of Hydrometals Inc.
Rockford, Illinois

72794
Dzus Fastner Co. Inc.
West Islip, New York

72928
Gulton Industries Inc.
Gudeman Div.
Chicago, Illinois

72982
Murata Erie N. America Inc.
Erie, Pennsylvania

73138
Beckman Industrial corp.
Helipot Div.
Fullerton, California

73168
Fenwal Inc.
Ashland, Massachusetts

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrance, California

73445
Amperex Electronic Corp.
Hicksville, New York

73559
Carlingswitch Inc.
Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cold Spring, Kentucky

73893
Microdot
Mt. Clemens, Mississippi

73899
JFD Electronic Components
Div. of Murata Erie
Oceanside, New York

73905
FL Industries Inc.
San Jose, California

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quam Nichols Co.
Chicago, Illinois

74217
Radio Switch Co.
Marlboro, New Jersey

74306
Piezo Crystal Co.
Div. of PPA Industries Inc.
Carlisle, Pennsylvania

74542
Hoyt Elect.Instr. Works Inc.
Penacook, New Hampshire

74840
Illinois Capacitor Inc.
Lincolnwood, Illinois

74970
Johnson EF Co.
Waseca, Minnesota

75042
TRW Inc.
IRC Fixed Resistors
Philadelphia, Pennsylvania

75297
Litton Systems
Kester Solder Div.
Chicago, Illinois

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
(Now 83330)
Mount Vernon, New York

75915
Tracor Littlefuse
Des Plaines, Illinois

76854
Oak Switch Systems Inc.
Crystal Lake, Illinois

77122
TRW Assemblies & Fasteners Group
Fastener Div.
Moutainside, New Jersey

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77542
Ray-O-Vac Corp
Madison, Wisconsin

77638
General Instrument Corp.
Rectifier Div.
Brooklyn, New York

77900
Shakeproof Lock Washer Co.
(Now 78189)

77969
Rubbercraft Corp. of CA Ltd.
Torrance, California

78189
Illinois Tool Works Inc.
Shakeproof Div.
Elgin, Illinois

78277
Sigma Instruments Inc.
South Braintree, Mass.

78290
Struthers Dunn Inc.
Pitman, New Jersey

78553
Eaton Corp.
Engineered Fastener Div.
Cleveland, Ohio

78592
Stoeger Industries
South Hackensack, New Jersey

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Co.
Goshen, Indiana

79727
C - W Industries
Southampton, Pennsylvania

79963
Zierick Mfg. Corp.
Mount Kisco, New York

80009
Tektronix
Beaverton, Oregon

80031
Mepco/Electra Inc.
Morristown, New Jersey

80032
Ford Aerospace & Communications Corp.
Western Development
Laboratories Div.
Palo Alto, California

80145
LFE Corp.
Process Control Div.
Clinton, Ohio

80183
Sprague Products
(Now 56289)

80294
Bourns Instruments Inc.
Riverside, California

80583
Hammerlund Mfg. Co. Inc.
Paramus, New Jersey

80640
Computer Products Inc.
Stevens-Arnold Div.
South Boston, Mass.

81073
Grayhill Inc.
La Grange, Illinois

81312
Litton Systems Inc.
Winchester Electronics Div.
Watertown, Connecticut

81439
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Electronics Inc.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82227
Airpax Corp.
Cheshire Div.
Cheshire, Connecticut

82240
Simmons Fastner Corp.
Albany, New York

Federal Supply Codes for Manufacturers (cont)

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Sub of Raytheon Co.
Chicago, Illinois

82415
Airpax Corp
Frederick Div.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Custom Div.
Woodstock, New York

82879
ITT
Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83014
Hartwell Corp.
Placentia, California

83055
Signalite Fuse Co.
(Now 71744)

83058
TRW Assemblies & Fasteners Group
Fasteners Div.
Cambridge, Massachusetts

83259
Parker-Hannifin Corp.
O-Seal Div.
Culver City, California

83298
Bendix Corp.
Electric & Fluid Power Div.
Eatonville, New Jersey

83315
Hubbell Corp.
Mundelein, Illinois

83330
Kulka Smith Inc.
A North American Philips Co.
Manasquan, New Jersey

83478
Rubbercraft Corp. of America
West Haven, Connecticut

83553
Associated Spring Barnes Group
Gardena, California

83740
Union Carbide Corp.
Battery Products Div.
Danbury, Connecticut

84171
Arco Electronics
Commack, New York

84411
American Shizuki
TRW Capacitors Div.
Ogallala, Nebraska

84613
FIC Corp.
Rockville, Maryland

84682
Essex Group Inc.
Peabody, Massachusetts

85367
Bearing Distributing Co.
San Fransisco, California

85372
Bearing Sales Co.
Los Angeles, California

85480
W. H. Brady Co.
Industrial Product
Milwaukee, Wisconsin

85932
Electro Film Inc.
Valencia, California

86577
Precision Metal Products Co.
Peabody, Massachusetts

86684
Radio Corp. of America
(Now 54590)

86928
Seastrom Mfg. Co. Inc.
Glendale, California

87034
Illuminated Products Inc.
(Now 76854)

88219
GNB Inc.
Industrial Battery Div.
Langhorne, Pennsylvania

88245
Winchester Electronics
Litton Systems-Useco Div.
Van Nuys, California

88486
Triangle PWC Inc.
Jewitt City, Connecticut

88690
Essex Group Inc.
Wire Assembly Div.
Dearborn, Michigan

89020
Amerace Corp.
Buchanan Crimptool Products Div.
Union, New Jersey

89265
Potter-Brumfield
(See 77342)

89536
John Fluke Mfg. Co., Inc.
Everett, Washington

89597
Fredericks Co.
Huntingdon Valley, Penna.

89709
Bunker Ramo-Eltra Corp.
Amphenol Div.
Broadview, Illinois

89730
General Electric
Lamp Div.
Newark, New Jersey

90201
Mallory Capacitor Co.
Sub of Emhart Industries Inc.
Indianapolis, Indiana

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Duracell Inc.
Technical Sales & Marketing
Bethel, Connecticut

91094
Essex Group Inc.
Suflex/IWP Div.
Newmarket, New Hampshire

91247
Illinois Transformer Co.
Chicago, Illinois

91293
Johanson Mfg. Co.
Boonton, New Jersey

91462
Alpha Industries Inc.
Logansport, Indiana

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91507
Froeliger Machine Tool Co.
Stockton, California

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
A Gulf Western Mfg. Co.
Connector Div.
Huntingdon, Pennsylvania

91737
ITT Cannon/Gremar
(Now 08718)

91802
Industrial Devices Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co. Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co.
Woonsocket, Rhode Island

91984
Maida Development Co.
Hampton, Virginia

91985
Norwalk Valve Co.
S. Norwalk, Connecticut

92914
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94144
Raytheon Co.
Microwave & Power Tube Div.
Quincy, Massachusetts

94222
Southco Inc.
Concordville, Pennsylvania

94988
Wagner Electric Corp.
Sub of Mcgraw-Edison Co.
Whippany, New Jersey

95146
Alco Electronic Products Inc.
Switch Div.
North Andover, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

Federal Supply Codes for Manufacturers (cont)

95573
Campion Laboratories Inc.
Detroit, Michigan

95712
Bendix Corp.
Electrical Comp. Div.
Franklin, Indiana

95987
Weckesser Co. Inc.
(Now 85480)

96733
SFE Technologies
San Fernando, California

96853
Gulton Industries Inc.
Measurement & Controls Div.
Manchester, New Hampshire

96881
Thomson Industries Inc.
Port Washington, New York

97525
EECO Inc.
Santa Ana, California

97540
Whitehall Electronics Corp.
Master Mobile Mounts Div.
Fort Meyers, Florida

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Pennwalt Corp.
SS White Industrial Products
Piscataway, New Jersey

97966
CBS
Electronic Div.
Danvers, Massachusetts

98094
Machlett Laboratories Inc.
Santa Barbara, California

98159
Rubber-Teck Inc.
Gardena, California

98278
Malco A Microdot Co.
South Pasadena, California

98291
Sealectro Corp.
BICC Electronics
Trumbill, Connecticut

98372
Royal Industries Inc.(Now 62793)

98388
Lear Siegler Inc.
Accurate Products Div.
San Deigo, California

99120
Plastic Capacitors Inc.
Chicago, Illinois

99217
Bell Industries Inc.
Elect. Distributor Div.
Sunnyvale, California

99378
ATLEE of Delaware Inc.
N. Andover, Massachusetts

99392
Mepco/Electra Inc.
Roxboro Div.
Roxboro, North Carolina

99515
Electron Products Inc.
Div. of American Capacitors
Duarte, California

99779
Bunker Ramo- Eltra Corp.
Barnes Div.
Lansdown, Pennsylvania

99800
American Precision Industries
Delevan Div.
East Aurora, New York

99942
Mepco/Centralab
A North American Philips Co.
Milwaukee, Wisconsin

TRANSFORMER CONNECTIONS SHOWN ARE FOR 115VAC OPERATION. FOR 230 VAC OPERATION REMOVE CONNECTIONS FROM 4,7 TO T1 AND 2,6 TO T1 CONNECT 2,6 TO 3

CHANGES

(1) FOR S/N 813 AND ON
R105 REPLACED WITH BUSS WIRE
R106 CHANGED FROM 40K TO 41.6K
R220 DELETED
R218, R223 & V201 ARE A MATCHED SET

(2) FOR S/N 1073 AND ON
R206 CHANGED FROM 2.7K TO 2.2K

(3) FOR S/N APPROXIMATELY 1332 AND ON
C207 CHANGED FROM 0.0047uf TO 0.005uf
CR209 DELETED
CR216 & CR217 ADDED

NOTES

1. ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE NOTED.
2. ALL RESISTORS WITH SAME NUMBER ARE CONNECTED
3. ▲ INDICATES FACTORY MATCHED OR SELECTED COMPONENT

1 C215 (180PF) IS OPTIONAL (OR FACTORY SELECTED) C215 TO BE REMOVED IN FINAL TEST WHEN NECESSARY TO REDUCE OUTPUT NOISE LEVEL. (S/N APPROX. 53400 AND ON)

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(205) 837-0581

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Suite B
Tempe, AZ 85282
(602) 438-8314

Tucson
(602) 790-9881

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16969 Von Karman
Suite 100
Irvine, CA 92714
(714) 863-9031

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John Fluke Mfg. Co., Inc.
2020 N. Lincoln Street
Burbank, CA 91504
(213) 849-7181

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(408) 727-0513

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(619) 292-7656

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14180 East Evans Ave.
Aurora, CO 80014
(303) 695-1000

CT, Hartford
John Fluke Mfg. Co., Inc.
Glen Locken East
41-C New London Turnpike
Glastonbury, CT 06033
(203) 659-3541

DC, Washington
(301) 770-1570

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(813) 799-0087

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Orlando, FL 32803
(305) 896-4881

Tampa
(813) 251-9211

GA, Atlanta
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2700 Delk Rd., Suite 150
Marietta, GA 30067
(404) 953-4747

IL, Chicago
John Fluke Mfg. Co., Inc.
1150 West Euclid Ave.
Palatine, IL 60067
(312) 705-0500

IN, Indianapolis
John Fluke Mfg. Co., Inc.
8777 Purdue Rd.
Suite 101
Indianapolis, IN 46268
(317) 875-7870

LA, Baton Rouge
(504) 924-1203

New Orleans
(504) 455-0814

MA, Boston
John Fluke Mfg. Co., Inc.
Middlesex Tech Center
900 Middlesex Turnpike
Building 8
Billerica, MA 01821
(617) 663-2400

MD, Baltimore
(301) 792-7060

Rockville
John Fluke Mfg. Co., Inc.
5640 Fishers Lane
Rockville, MD 20852
(301) 770-1570

MI, Detroit
John Fluke Mfg. Co., Inc.
33031 Schoolcraft
Livonia, MI 48150
(313) 522-9140

MN, Bloomington
John Fluke Mfg. Co., Inc.
1801 E. 79th St., Suite 9
Bloomington, MN 55420
(612) 854-5526

MO, St. Louis
John Fluke Mfg. Co., Inc.
11756 Borman Drive
Suite 160
St. Louis, MO 63146
(314) 993-3805

NC, Greensboro
John Fluke Mfg. Co., Inc.
1310 Beaman Place
Greensboro, NC 27408
(919) 273-1918

NJ, Paramus
John Fluke Mfg. Co., Inc.
P.O. Box 930
Paramus, NJ 07653-0930
West 75 Century Road
Paramus, NJ 07652
(201) 262-9550

NM, Albuquerque
(505) 881-3550

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John Fluke Mfg. Co., Inc.
4515 Culver Road
Rochester, NY 14622
(716) 323-1400

OH, Cleveland
John Fluke Mfg. Co., Inc.
7830 Freeway Circle
Middleburg Heights, OH 44130
(216) 234-4540

Dayton
John Fluke Mfg. Co., Inc.
5450 Far Hills Avenue
Suite 111
Kettering, OH 45429
(513) 436-2224

OK, Northeast
(918) 749-0190

OR, Portland
(503) 227-2042

PA, Philadelphia
John Fluke Mfg. Co., Inc.
200 Lindenwood Drive
Malvern, PA 19355
(215) 647-9550

Pittsburgh
(412) 261-5171

TX, Austin
(512) 459-3344

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John Fluke Mfg. Co., Inc.
1801 Royal Lane
Suite 307
Dallas, TX 75229
(214) 869-0311

El Paso
(915) 533-3508

Houston
(713) 240-5995

San Antonio
John Fluke Mfg. Co., Inc
10417 Gulfdale
San Antonio, TX 78216
(512) 340-0498

UT, Salt Lake City
(801) 268-9331

WA, Seattle
John Fluke Mfg. Co., Inc.
5020 148th Ave. N.E.
Suite #110
Redmond, WA 98052
(206) 881-6966

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Navy	(714) 863-9031, CA (301) 770-1570, MD
USAF	(513) 436-2224, OH (512) 340-2621, TX
Security	(301) 770-1570, MD

Service Center Areas

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FL, Orlando (305) 896-4881
IL, Chicago (312) 705-0500
MD, Rockville (301) 770-1576
NJ, Paramus (201) 262-9550
TX, Dallas (214) 869-2848
WA, Everett (206) 356-5560

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Litho in U.S.A. 11/87

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Fluke Asia Ltd
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200 Connaught Road
Central, Hong Kong
Tel: 852 5 482116
TLX: (780) 87058 FLUKE
FAX: (852) 5-479863

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Tel: 61-2-736-2888
TLX: (790) 25887 A/B: ELSCOAA 25887
FAX: 61-2-733663

Elmeasco Instruments Pty. Ltd.
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12 Maroondah Highway
Ringwood, Victoria 3134
Australia
Tel: 61-3-879-2322
TLX: (790) 30418 A/B: ELTENTAA 30418
FAX: (61) (3) 879-4310

Elmeasco Instruments Pty. Ltd.
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Salisbury, Queensland 4107
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TLX: (790) 44062 A/B: ELMQLDAA44062

Elmeasco Instruments Pty. Ltd.
P.O. Box 154
Prospect, South Australia 5082
Tel: 61-8-344-9000 TLX: (790) A/B 87519

Elmeasco Instruments Pty. Ltd.
P.O. Box 413
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46-48 Kings Park Road
West Perth, Western Australia 6005
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Tel: 61-9-481-1500
TLX: (790) 94765 A/B: ASECSAA 94765
FAX: (61) (9) 322-2075

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Gerate GmbH & Co.
Vertrieb KG
Obachgasse 28
1220 Vienna, Austria
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TLX: (847) 134759
FAX: 43-222-25-72-75

Bahrain ●
Basma W.L.L.
P.O. Box 5701
Manama, Bahrain
Tel: 973-251364; TLX: (955) 9003
FAX: (965) 245218

Bangladesh ●
Motherland Corporation
24 Hatkhola Road, Tikatuli
Dacca-3, Bangladesh
Tel: 257249
TLX: (950) 642022 PCO BJ
Cable: "MOTHERLAND" DACCA

Belgium ■
N.V. Philips
Industrial & Electro-Acoustic Systems
5600 MD Eindhoven
The Netherlands
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Tlx: 35000 phtc nl
Fax: 040-785651

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Coasin Bolivia S.R.L.
Casilla 7295
La Paz, Bolivia
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TLX: (336) 3233 COALAP BV
Cable: COALAP

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ATP Cia. Tek Eletronica Ltda.
Al. Amazonas 422,
Alphaville, 06400, Barueri
Sao Paulo, Brazil
Tel: 55-11-421-5477,
TLX: (391) 1171413 HITK BR

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No. 8 Blk D
Sufri Shophouse Complex
Mile 1 Jalan Tutong
Bandar Seri Begawan
Negara Brunei Darussalam
Tel: 673-2-23109 or 23557
TLX: (799) BU 2265 RANKOC

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TLX: (514) 685-0039

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Fax: (613) 723-9458

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Intronica Chile, Ltda.
Casilla 16228 (Mail)
Santiago 9, Chile
Tel: 56-2-2321886
TLX: (332) 346351 INTRON CK

China, Peoples Republic of ●
Fluke International Corporation
P.O. Box 9085
Beijing
People's Republic of China
Tel: 86-01-65-7281
TLX: (716) 222237 FBSC CN

Instrimpex - Fluke Service Center
57, Xisi Dong Da Jie
Xicheng-qu
Beijing
Peoples Republic of China
Tel: 86-01-65-7281

Colombia ●
Sistemas E Instrumentacion, Ltda.
Carrera 13, No. 37-43, Of. 401
Ap. Aereo 29583
Bogota DE, Colombia
Tel: 57-232-4532
TLX: (396) 45787 COASN CO

Cyprus ■
Chris Radiovision, Ltd.
P.O. Box 1989
Nicosia, Cyprus
Tel: 357-21-66121; TLX: (826) 2395

Cyprus, Northern ■
Ucok Buroteknik
2C & 2D Muftu Ziyai Street
Lefkosa, Northern Cyprus
Mersin 10, Turkey
Tel: 90-741-357-20-71777
TLX: (821) 57267

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TLX: (851) 928855 AMTEST G
Fax: 44-9328-61919

Denmark ■
Tage Olsen A/S
Ballerup Byvej 222
2750 Ballerup
Denmark
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TLX: (855) 35293 TOAS DK

Eastern European Countries ■
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P.O. Box 1107
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Proteco Coasin Cia., Ltda.
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TLX: (393) 22085 ESIND

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Electronic Engineering Liaison Office
P.O. Box 2891 Horreya
11361 Heliopolis, Cairo
Egypt
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Tlx: 35000 phtc nl
Fax: 040-785651

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Awa New Zealand Limited
37 Freeston Road
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