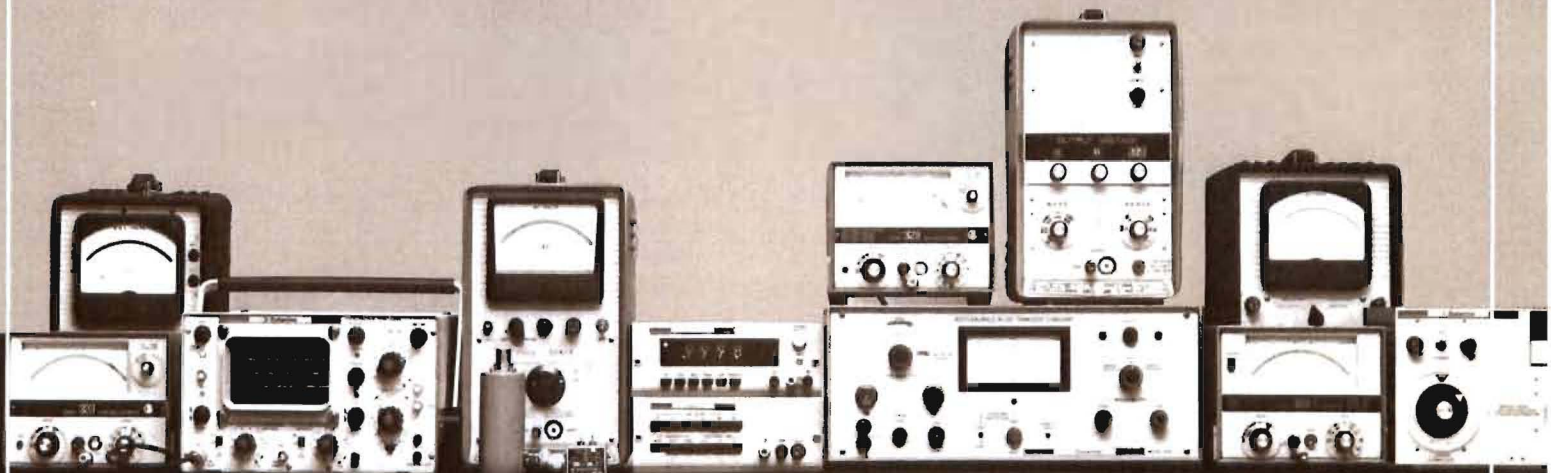


Ballantine Electronic Instruments 1972

CONDENSED CATALOG 142



BALLANTINE LABORATORIES, INC.

FOUR DECADES OF INNOVATION IN ELECTRONIC INSTRUMENTATION

The Name Ballantine

... has been associated with the most advanced thinking in electronic instrumentation for forty years. That has never been more true than it is today, as modern Ballantine designs reach into the most advanced technologies, providing new metrological and analytical capabilities with greater convenience and certainty. The record of consistent achievement set down here speaks for itself.

Ballantine *Four Decades of Innovation in Electronic Instrumentation*

1932 Stuart Ballantine develops the first practical vacuum-tube voltmeter, for use in audio-frequency research on microphones.

1935 Stuart Ballantine applies for patents on the first logarithmic-scale VTVM, based on his earlier invention of the variable- μ vacuum tube.

1938 Ballantine introduces the first commercial logarithmic voltage-scale VTVM — the classic Model 300. Over 30,000 of these instruments had been sold when the design was finally discontinued, in 1966! Serial number 4 of the Model 300 is on permanent display at the Smithsonian Institution, in Washington, D.C.

1942 Ballantine produces the first commercial VTVM to provide sub-millivolt sensitivity over the audio-frequency and low radio-frequency bands.

1943 Ballantine introduces the first commercial instrument capable of reading peak and peak-to-peak voltages in the 0.01Hz–20Hz infrasonic region.

1948 Ballantine introduces the first logarithmic-scale RF/HF VTVM — submillivolt sensitivity and high accuracy up to 5MHz.

1953 Ballantine develops the first commercial direct-reading True-RMS VTVM, combining the sensitivity and the automatic-current-limiting characteristics of the electronic amplifier with the RMS accuracy of the vacuum thermocouple.

1957 Ballantine produces the first AC instruments with selectable response — peak/peak-to-peak/average/RMS.

1960 Ballantine introduces the first commercial instrumentation for measuring true-RMS values of broadband noise, pulses, and other harmonic-rich waveforms.

1962 Ballantine produces the first commercial Attenuator-Thermoelement (A-T) Voltmeter. (Selby-Behrent NBS type), thereby extending accurate AC measurement and calibration to 1000MHz.

1963 Ballantine produces the first commercial UHF Micro-potentiometer (Selby NBS type) thereby extending the accurate calibration of signal generators, AC Voltmeters, and oscilloscopes up to 900MHz.

1965 Ballantine develops the first commercial AC/DC voltage calibrators with error-computing capabilities, for rapid instrument calibration.

1968 Ballantine introduces the first automatically-balanced AC/DC transfer standard — primary-standard AC measurements with the direct-reading convenience of general-purpose laboratory equipment.

1969 Ballantine introduces the first commercial broadband direct-reading digital AC instrumentation.

1970 Ballantine introduces the first commercial broadband digital AC instruments with 1 microvolt resolution and four-digit accuracies.

1971 Ballantine introduces the first completely self-protected auto-balance AC/DC transfer standard, NBS traceable to ± 50 PPM (the present limit of the state of the art).

The Ballantine Product Line

... is today the broadest and most diversified in the company's long history. As this summary indicates, the main emphasis of Ballantine Laboratories' design and production continues to be directed toward more and more sophisticated AC and Waveform measurement. A fair balance has been maintained between frequency-domain and time-domain instrumentation.

Ballantine's leadership in these fields is perhaps best reflected by the fact that seven of the instruments listed here are true "state-of-the-art" designs, and five of them are unique in their respective classes.

Many of the designs described in this catalog are new — introduced within the past 12 months. Others are third- and fourth-generation refinements of well-established instruments. In 1972, at least four more Ballantine instruments, now in the final stages of development and field evaluation, will be introduced. Watch for them — they are sure to expand your measurement capabilities.

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Note: All specifications and prices subject to change without notice.
All prices are domestic U.S. prices, f.o.b. Boonton, New Jersey.

Series 3500

Computer-Compatible Precision AC/DC Modular Digital Instrumentation

This modular, computer-programmable measurement system attains *the highest accuracy and the greatest sensitivity, over the broadest bandwidth* of any digital AC measurement system available — by an order of magnitude in most respects! The Model 3600 Digital-Readout/DC-DVM module is designed to be combined with the Model 3571A True-Average AC Converter module to provide a complete direct-reading AC/DC voltage measurement system of unusually high resolution, accuracy, and convenience.

All ranges of this system are remotely programmable, and BCD outputs are standard. This high-performance equipment is the logical first choice for programmable and computer-compatible automated AC measurement systems requiring the highest accuracy and dependability. Its moderate price also recommends it for use in manual laboratory and production-test applications.

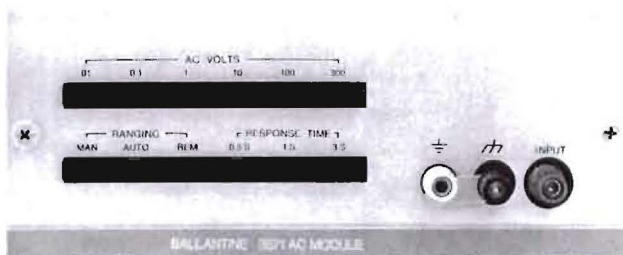
The Model 3571A True-Average Converter module has a bandwidth of 30Hz to 10MHz -- a significant contribution to the state of the art in digital broadband-average systems.

Its sensitivity is 10mV full scale, which provides 1 microvolt resolution. Its mid-range accuracy is $\pm 0.2\%$ rdg $\pm 0.01\%$ f.s. over 50Hz to 100kHz, higher than any other average-responding device in this class.

The Model 3600 Digital Display/DC-DVM module is more than a compatible digital voltmeter for displaying the DC output of the AC converters. It presents a complete data and control interface

to any remote digital programming/computing device. Without the converter, it provides four ranges of precise, stable, digital DC voltage measurement, with $4\frac{1}{2}$ -digit resolution (± 19999 full-range). Its most sensitive range is 1.9999 Volts, which provides 100 μ V resolution. Internal self-calibration, against a 100 PPM standard, is an available option. Excellent CMRR and NMRR ensure freedom from errors due to ground loops, noise, etc.





Model 3571A
Broadband, True Average AC Converter



Model 3600
DC Digital Voltmeter & AC Display

	Model 3571A	Model 3600														
Ranges	10mV, 100mV, 1V, 10V, 100V, 300V	1V, 10V, 100V, 100V														
Overrange	10% on all ranges	100% (50% on 1000V range)														
Resolution	$\pm 0.01\%$ of range, 1 μV on 10mV range (with Model 3600)	100 μV														
Digits	—	Four plus 1														
Bandwidth	30Hz to 10MHz	—														
Accuracy	<table border="0"> <thead> <tr> <th>Frequency</th> <th>Accuracy</th> </tr> </thead> <tbody> <tr> <td>30Hz–50Hz</td> <td>$\pm(0.5\% \text{ rdg} + 0.1\% \text{ f.s.})$</td> </tr> <tr> <td>50Hz–100kHz</td> <td>$\pm(0.2\% \text{ rdg} + 0.01\% \text{ f.s.})^*$</td> </tr> <tr> <td>100kHz–1MHz</td> <td>$\pm(0.5\% \text{ rdg} + 0.1\% \text{ f.s.})$</td> </tr> <tr> <td>1MHz–3MHz</td> <td>$\pm(1\% \text{ rdg} + 0.1\% \text{ f.s.})$</td> </tr> <tr> <td>3MHz–5MHz</td> <td>$\pm(2\% \text{ rdg} + 0.1\% \text{ f.s.})$</td> </tr> <tr> <td>3MHz–10MHz</td> <td>$\pm(3\% \text{ rdg} + 0.1\% \text{ f.s.})$</td> </tr> </tbody> </table> <p>10mV, 100mV, 1V, 10V 3MHz–10MHz $\pm(5\% \text{ rdg} + 0.1\% \text{ f.s.})$ 100V, 300V Overall accuracy, 30Hz to 10MHz typically within 1% rdg + 0.1% f.s. * Typically within $\pm 0.1\%$ rdg.</p>	Frequency	Accuracy	30Hz–50Hz	$\pm(0.5\% \text{ rdg} + 0.1\% \text{ f.s.})$	50Hz–100kHz	$\pm(0.2\% \text{ rdg} + 0.01\% \text{ f.s.})^*$	100kHz–1MHz	$\pm(0.5\% \text{ rdg} + 0.1\% \text{ f.s.})$	1MHz–3MHz	$\pm(1\% \text{ rdg} + 0.1\% \text{ f.s.})$	3MHz–5MHz	$\pm(2\% \text{ rdg} + 0.1\% \text{ f.s.})$	3MHz–10MHz	$\pm(3\% \text{ rdg} + 0.1\% \text{ f.s.})$	$\pm(0.01\% \text{ rdg} + 0.01 \text{ f.s.} + 1 \text{ digit})$
Frequency	Accuracy															
30Hz–50Hz	$\pm(0.5\% \text{ rdg} + 0.1\% \text{ f.s.})$															
50Hz–100kHz	$\pm(0.2\% \text{ rdg} + 0.01\% \text{ f.s.})^*$															
100kHz–1MHz	$\pm(0.5\% \text{ rdg} + 0.1\% \text{ f.s.})$															
1MHz–3MHz	$\pm(1\% \text{ rdg} + 0.1\% \text{ f.s.})$															
3MHz–5MHz	$\pm(2\% \text{ rdg} + 0.1\% \text{ f.s.})$															
3MHz–10MHz	$\pm(3\% \text{ rdg} + 0.1\% \text{ f.s.})$															
Temperature Coefficient	$\pm(0.006\% \text{ rdg} + 0.002\% \text{ of range})/^{\circ}\text{C}$ midband	—														
Crest Factor	Approximately 2:1 full scale. Approximately 20:1 downscale.	—														
Polarity	—	Automatic														
CMRR	—	$> 100 \text{ dB}$, DC–60Hz, 1 K Ω unbalanced														
NMRR	—	$> 60 \text{ dB}$ at 60 Hz														
Input Imped.	2 Megohms shunted by 25 pF	10 megohms, all ranges														
Stability	Specified accuracy, at least 3 months	—														
Response Time	0.5, 1, or 3 sec. front-panel selected, to within 0.2% of full scale specified accuracy.	—														
Reading Speed	—	200 msec (50 or 33 msec available on request)														
DC output	$\pm 1.0\text{V}$ for 100% f.s. input, 10 kilohm source impedance, accuracy as above.	—														
Power	Supplied by either Model 3600 DVM or Model 3579 Power Module.	Self-powered. Requires 115/230 Volts $\pm 10\%$, 50–400Hz														
Warm up	30 minutes to full specifications.															
Environment	Operating: Temperature: -4°C to $+40^{\circ}\text{C}$ Rel. Humidity: 0 to 90% (75% for 3600) Altitude: 0 to 10,000 ft. above sea level	Non-operating: -55°C to $+60^{\circ}\text{C}$ 0 to 90% (75% for 3600) 0 to 40,000 ft. above sea level														
BCD Output	BCD outputs of AC measurement are available at the rear panel of the 3600. They are 1-2-4-8 positive, DTL & TTL compatible.															
Dimensions	3 1/2" high x 8 1/2" wide x 12" deep (9 cm x 22 cm x 31 cm).															
Weight	6 pounds (2.8 Kilograms)	7 1/2 pounds (3.5 Kilograms)														
Options	Manual or programmable ranging. Time constants actuated by contact closures.	1. Remote programming of range and internal calibration. 2. BCD output, 1-2-4-8 positive. 3. Modular Interface capability. 4. Internal Calibration— Zener reference.														

PRICES: Model 3571A \$800; Model 3600 \$645; Model 3579 \$245.

Wideband True RMS Voltmeters Series 323



- Meaningful RMS Measurements — Including Harmonics and High Crest Factors.
- True Portability — Line/Recharge-Battery Operation.
- Highest Readability — Logarithmic Voltage Scales for Consistently High Resolution; Linear dB Scales.
- Greatest Versatility — 10Hz to 20MHz; 100 μ V Sensitivity; 1% Basic Accuracy.
- High Reliability — no vulnerable thermocouples; 500V overload protection, all ranges.

Series 323 True-RMS Wideband analog AC voltmeters are the *most sophisticated, most accurate, widest bandwidth* instruments of their kind. They feature the world-famous Ballantine logarithmic voltage scale (linear dB scale) providing constant reading accuracy, end to end, and they employ the most advanced broadband, high-crest-factor, true-RMS measurement circuit ever provided in this class of instrumentation. (This circuit actually *measures* the RMS value, and is not to be confused with “RMS calibrated,” average-responding devices.)

The all-solid-state Series 323 Voltmeter/Amplifiers have a bandwidth of 2Hz to 20MHz (usable to beyond 50MHz at reduced accuracy) — widest bandwidth in the field. The accuracy from 50Hz to 2MHz is $\pm 1\%$ f.s. or $\pm 2\%$ rdg, with gradually broadened tolerances above and below that band. Its high sensitivity and logarithmic scale permits readings as low as 100 μ V to *full accuracy!* The wide bandwidth and high crest-factor ratio ensures valid RMS readings even

MODELS	323 & 323-01	323-06 & 323-07	323L Series
Voltage Range	300 μ V to 300V, 12 ranges.	100 μ V to 330V, 12 ranges plus “METER +10dB” mode	300 μ V to 300V.
Decibel Range	-70dB to +50dB, referred to 1V.	-78dBm to +52dBm, 0dBm = 1mW, 600 Ω	-70dB to +50dB 0dBm: 1mW/600 Ω (Models 323L-06/07)
Frequency Range	10Hz to 20MHz ($-3dB$, <math><4Hz</math> and $>50MHz$)		2Hz to 20MHz
Accuracy	50Hz-2MHz: $\pm 1\%$ f.s. or $\pm 2\%$ rdg, whichever is better, increasing to $\pm 5\%$ at ends of range ($\pm 10\%$ above 100V on upper ranges).		10Hz-2MHz: $\pm 1\%$ f.s. or $\pm 2\%$ rdg whichever is better, increasing to $\pm 3\%$ at 2Hz and 10MHz and $\pm 5\%$ at 20MHz.
Response	True RMS for wide range of waveforms.		
Input Imped.	2 megohms shunted by 15pF, (25pF, 1-30mV f.s. ranges).		
Crest Factor	5:1 at full scale, increasing to 15:1 at 1/3 full scale.		
Scales			
Logarithmic	1-3 and 3-10V	0.095-0.33 and 0.3-1.06V	1-3 and 3-10V
Decibels	0-10dB	-8.2 to +2.6dBm	0-10dB
CMRR	> 120dB, DC to 1KHz; > 80dB at 1MHz.		
Output	Rear BNC connector, -0.1V to 1.0V $\pm 1\%$ for each range simultaneously with meter reading, proportional to square of input voltage.		
Power Requirements	105-135/210-270, 50 to 420Hz, 6W. Optional internal rechargeable nickel-cadmium battery (in Models 323, 323-06, 323L, 323L-06 only).		
Dimensions	6.1" high x 7.8" wide x 10.2" deep. (15.5 cm x 19.6 cm x 25.9 cm.)		
Weight	9.5 pounds. (4.3 kg.) 14 pounds shipping weight. (6.3 kg.)		
Options	Series 600 Shunt resistors for current measurements, 10 μ A to 10A. Model 1301 80dB HV Probe for measurements to 10kV. Model 800 Rack Mounting Kit. Accommodates one or two Series 323 instruments in 19" rack (7" high). Model 618 Terminal Adapter, BNC female to single binding post.		

for noise waveforms, pulses, and other signals rich in harmonics.

Models 323, 323L, and 323-06 may be operated from line power or rechargeable battery; Models 323-01, 323L-01, and 323-07 from line only. Models 323-06/07 provide dBm scales, referenced to 1 milliwatt into 600 ohms as 0 dBm.

Optional accessories include the Model 1301 High-voltage, 80dB Attenuator Probe for measurement to 10,000 Volts (up to 1MHz); Series 600 plug-in Shunt

Resistor Assemblies for current measurement; and the Model 800 rack mounting kit for installing one (or two) 323 voltmeters in a 19" rack.

Other features include: rechargeable battery option; adjustable time constant; isolated signal ground; and positive overload protection. Series 323 Voltmeters are the *instruments of choice* for modern laboratory, production, and field measurements of true-RMS AC . . . acknowledged standards of the industry.

PRICES: Model 323 True RMS Voltmeter, battery or line. \$675; Model 323-01, same but line only. \$575; Model 323-06; same as 323, except 0dB=1mW/600 Ω \$695; Model 323-07; same as 323-06, but line only. \$595; Model 323L; same as 323, but 2Hz-20MHz bandwidth. \$705; Model 323L-01; same as 323L, but line only. \$605; Model 323L-06; same as 323L, except 0dB=1mW/600 Ω \$725; Model 323L-07; same as 323L-06, but line only. \$625.



Logarithmic AC Voltmeter/Amplifiers Series 303

- Highest Readability — Logarithmic Voltage Scales for Consistently High Resolution; Linear dB Scales.
- True Portability — Line/Rechargeable-Battery Operation.
- Greatest Versatility in Its Class — 2Hz-6MHz; 300 μ V to 10kV Ranges; 1% Basic Accuracy.

Series 303 instruments provide not only high-accuracy, broadband AC measurements (average-responding,

RMS-calibrated) but also function as precise-gain broadband AC amplifiers of excellent linearity and stability. Despite their moderate price, they provide performance that is unsurpassed in this class of analog AC instruments. The unique Ballantine logarithmic-voltage display (linear-dB scale) ensures uniform resolution and highest usable accuracy over the entire extent of every range.

The solid-state Model 303 has a range of 100 μ V to 350 Volts (to 1000 or 10,000 Volts with optional probes) over a frequency range from 2Hz to 6MHz and is usable with reduced accuracy to beyond 12MHz. All ranges are protected to 350 Volts. The midband accuracy is $\pm 1\%$ of reading from 30Hz to 1MHz, with broader tolerances above and below that band. The amplifier mode provides 40dB of gain, over 2Hz to 6MHz, with a linearity of better than ± 0.5 dB, up to 100mV output. Line or rechargeable-battery operation - Model 303 (Model 303-01, line only). Optional Model 600 shunt resistors for current-measurement (10 μ A to 10A). Half-rack packaging allows one or two 303 voltmeters to be mounted in a 19" rack with the Model 800 Rack Mounting Kit.

Thousands of Series 303 instruments are in service in leading electronics facilities all over the world . . . proof of their great value and versatility.

MODELS	303, 303-01, 303-09, without Probe	303-50 and 303-51 with Model 1303 20dB Probe			
Voltage Range	300 μ V–350V (12 ranges, 1mV FS to 350V)	3mV–1000V (11 ranges, 10mV FS to 1kV)			
Lowest indication in "Meter +10dB" Mode	100 μ V (10Hz–1MHz)	1mV (100 μ V without Probe) (10Hz–1MHz)			
Decibel Range	–78dBm to +52dBm; 0dBm = 1mW/600 Ω	–58dBm to +62dBm; 0dBm = 1mW/600 Ω			
Frequency Range	2Hz–6MHz 1Hz–10MHz (3dB bandwidth) Except 303-09 (see note 1)				
Accuracy (% of reading) (see note 2)	<table style="width: 100%; border: none;"> <tr> <td style="width: 33%;"></td> <td style="width: 33%; text-align: center;"> $\pm 1\%$, 30Hz – 1MHz $\pm 2\%$, 20Hz – 2MHz $\pm 3\%$, 10Hz – 3MHz $\pm 5\%$, 2Hz – 10Hz $\pm 5\%$, 3MHz– 6MHz $\pm 10\%$, 3MHz– 6MHz </td> <td style="width: 33%; text-align: center;"> With Probe to 350V 350–1000V </td> </tr> </table>			$\pm 1\%$, 30Hz – 1MHz $\pm 2\%$, 20Hz – 2MHz $\pm 3\%$, 10Hz – 3MHz $\pm 5\%$, 2Hz – 10Hz $\pm 5\%$, 3MHz– 6MHz $\pm 10\%$, 3MHz– 6MHz	With Probe to 350V 350–1000V
	$\pm 1\%$, 30Hz – 1MHz $\pm 2\%$, 20Hz – 2MHz $\pm 3\%$, 10Hz – 3MHz $\pm 5\%$, 2Hz – 10Hz $\pm 5\%$, 3MHz– 6MHz $\pm 10\%$, 3MHz– 6MHz	With Probe to 350V 350–1000V			
Response	Average, calibrated in RMS of a sine wave.				
Scales	Logarithmic voltage scales, 0.9 to 3.5 and 2.8 to 11. Linear decibel scale, –8.4 to +2.4dBm;				
Input Impedance	10 M Ω 15–25pF	10 M Ω 7.5pF (25pF without probe)			
Amplifier Mode	Gain 40dB ± 0.5 dB, 2Hz–6MHz. Full scale output 0.1V RMS. AC coupled. Source resistance 150 Ω . Input noise < 30 μ V. Model 303-09 has DC as well as AC output.				
Power Requirements	120/240V, 50–420Hz, 3W, or rechargeable nickel cadmium battery. (Models 303-01 and 303-51, line power supply only).				
Dimensions	6.1" high x 7.8" wide x 10.2" deep. (15.5 cm x 19.8 cm x 25.9 cm.)				
Weight	303 and 303-50: 8 lbs. (3.6 kg) net, 12 lbs. (5.4 kg) shipping. 303-01 and 303-51: 7 lbs. (3.2 kg) net, 11 lbs. (5.0 kg) shipping.				
Rack Mounting	Model 800 Rack Mounting Kit accommodates one or two Series 303 instruments in 19" x 7" Rack.				
Prices	303: \$395 303-01: 335	303-09: \$425 303-50: \$445 303-51: 385			

Note 1: Model 303-09 is an environmentalized, 4MHz version of 303-01, 100 μ V to 350 Volts (1mV FS to 350V FS).
Linear voltage scale.

Note 2: Accuracy in "Meter + 10dB" Mode is $\pm 1\%$ f.s. 100Hz–100kHz, $\pm 2\%$ f.s. 50Hz–200kHz, $\pm 3\%$ f.s. 20Hz–500kHz,
 $\pm 5\%$ f.s. 10Hz–1MHz.

PRICES: Model 303, \$395; Model 303-01, \$335.
Model 303-09, environmentalized, \$425; Model 303-50, \$445; Model 303-51, \$385.

Auto-Balance AC/DC Transfer Standard Model 1600A ATS



- Automatic Direct-Reading True-RMS measurements.
- Primary-Standard Accuracy and Stability; NBS-Referenced Calibration.
- Minimum Operator Manipulation — eliminates Error.
- Saves Time — eliminates multi-step procedures.
- Simplified Operation — no calibration adjustments.
- Manual Balancing Capability.

Model 1600A ATS is a unique Ballantine development. It provides all of the primary-standard accuracy and stability of the finest manual AC/DC transfer standards, including traceability to NBS ultimate references — yet does not require the laborious and error-provoking manual-balancing manipulations otherwise required for primary-level AC measurements.

In essence, the Model 1600A ATS automatically compares the heating effect of an internally servoed DC voltage with that of the AC input, and at balance, generates a DC voltage having the same heating value as the AC input, over broad ranges of frequency and crest factor. The DC may then be read on an external primary-standard potentiometer, or a DVM of appropriate accuracy and resolution. The realizable absolute accuracy of the 1600A ATS, with reference to the NBS AC/DC-difference standard, is better than ± 100 PPM, over a frequency range of 20Hz to 20kHz. At somewhat increased uncertainty, the bandwidth is 2Hz to 30MHz. The system is usable to beyond 100MHz.

The same thermoelement and coaxial attenuators are used for sensing both the applied AC and the internally de-

veloped DC balancing voltage. Both attenuators and thermoelement are housed in a Transfer Assembly (Model 11600A) that may be easily removed for use as a conventional AC/DC transfer standard or for shipment to the National Bureau of Standards, for calibration and certification.

This unique instrument makes possible, for the first time, automatic and direct-reading True-RMS AC measurements at the limit of the state of the art . . . without operator error, in seconds. Every standards laboratory and central calibration facility should investigate the advantages of this unique modern automated instrument.

Input Voltage Range(12 Ranges)	0.25—0.5/1/2/4/8/16/32/64/125/250/500/1000 volts.
Input Sensitivity	200 ohms/volt $\pm 5\%$ (0.25V—32V ranges) $\pm 2\%$ (32V—1000V ranges)
Frequency Range	DC and 5 Hz to 30 MHz, usable 2Hz to 100MHz.
Calibration Uncertainty: Manual mode, referenced to NBS certified standard	DC, 6 Hz to 20 Hz, $\pm 0.05\%$ DC, 20 Hz to 1 MHz, $\pm 0.01\%$ DC, 1 MHz to 10 MHz, $\pm 0.05\%$ DC, 10 MHz to 30 MHz, $\pm 0.2\%$ Special calibration to uncertainty of 0.005% available at additional cost.
Auto Transfer Mode	Manual-mode accuracy plus 0.005% of range.
Balance time (auto balance modes)	10 to 15 sec typical (depends on thermocouple time constant).
DC Output Voltage	Equal to True-RMS value of input voltage (0.25 to 1000 volts @ up to 2 mA).
DC Output Resistance	0.1 ohm to 10 volts, 1.0 ohm to 100 volts, 10 ohms to 1000 volts.
DC Output Stability	± 50 PPM Short term (1 to 3 sec @ constant ambient temp.)
DC output ripple & noise (rms)	90dB below full scale or 100 μ V, whichever is greater.
DC search meter accuracy	$\pm 5\%$ (0—1.6 scale with front panel multiplier indicator).
Null resolution; manual mode	0.005% minimum per minor scale division for 5 divisions either side of zero. Resolution decreases thereafter.
Overload protection	Peak-sensing circuit trips at approximately 125% of selected range for sinusoidal input signals. Protects each range to 1000% overload or 1500 volts, whichever is less.*
Crest factor	Greater than 10:1 with overload protection circuitry disabled 2:1 in normal mode.
Remote operation of AC—DC transfer	By external contact closure through rear connections.
Power requirements	115 or 230 VAC (switch selectable), 50 or 60 Hz, 0.45 amps @ 115 V.
Warmup time	Nominally 20 minutes.
Operating temperature	+10°C to +40°C.
Size	17" wide x 17" deep x 7" high (43.2cm x 13.2cm x 17.8cm)
Weight	40 lbs. (88 kg) net; 56 lbs. (123.2 kg) shipping.

*Overload protection circuit can be completely removed from measuring circuitry by means of PUSH TO DISABLE switch. This permits AC—DC transfer measurements in strict accordance with NBS practice

NOTES: Accuracies of the 1600A are referenced to the midpoint of a General Radio 874 "T" connector, and a Ballantine 11600A Transfer Assembly, certified by NBS to have an AC/DC difference uncertainty of less than $\pm 0.005\%$ to 20 kHz.

Correction data are available from Ballantine for the .25 to 8 volt ranges to provide accuracies within $\pm 1\%$ from 10 MHz to 30 MHz. This is an extra-cost option. Correspondence is invited on other correction data, on use beyond 30 MHz, and on remote programmability of attenuator.

NBS Test Reports can be obtained on the 11601A ATS Transfer Assembly with an uncertainty on AC—DC difference of less than $\pm 0.005\%$ up to 20 kHz.

PRICES: Model 1600A, \$3950; Model 11600A, \$2495; NBS Test Report on 11601A, \$250.

UHF Calibration Standards

Model 440 Micropotentiometers



The Model 440 Micropotentiometers are the only commercially available devices capable of developing accurately known NBS-traceable microvolt-level signals from DC to 900MHz. Based on the Selby National Bureau of Standards design, the Model 440 consists of a UHF thermocouple in series with a special thick-film radial resistor. When the combination is connected to an external signal source, the voltage drop across the resistor, which constitutes the low impedance output, can be held to a known value over the entire range of frequencies by monitoring the DC output of the thermocouple. Each thermocouple-resistor combination selected can be operated over an output voltage range of 4 to 1 within the overall limits of $17\mu\text{V}$ and 1.4V RMS. Ideal for calibration of AC voltmeters, oscilloscopes and signal generators. Calibration to 500MHz is included in the moderate price. A complete Micropotentiometer Kit, containing five resistors and three thermocouple housings, is available.

Model 390 A-T Voltmeter

The Model 390 A-T Voltmeter is also exclusively available from Ballantine Laboratories. It is a laboratory reference standard designed for calibration of AC voltmeters above 0.5 Volt, at frequencies from 1MHz to 1000MHz. The instrument consists of a stable, adjustable waveguide-below-cut-off attenuator

feeding a UHF thermocouple. Micro-meter setting for standard DC output is determined from NBS calibration at various frequencies and voltages. Calibration by NBS is required, but not included in the base price. Design is based on that of Myron C. Selby and L.F. Behrent of NBS.

These primary-standard devices belong in every calibration and standards

facility concerned with RF-UHF measurement. They are widely accepted as ultimate transfer standards, throughout the world.



Series 1394 Coaxial Thermal Converters

Using AC/DC transfer techniques, these wide-range RMS voltage standards provide voltage measurements accurate to $\pm 0.02\%$ as well as precise frequency influence tests. Based on design and development by F. L. Hermach of the National Bureau of Standards.

SPECIFICATIONS

Model	Nominal Voltage	Range
1394-0.5	0.5 volts	0.1 to 0.67 volts
1394-1	1.0 volts	0.2 to 1.35 volts
1394-2	2.0 volts	0.4 to 2.7 volts
1394-5	5.0 volts	1 to 6.7 volts
1394-10	10.0 volts	2 to 13.5 volts
1394-20	20.0 volts	4 to 27 volts
1394-50*	50.0 volts	10 to 67 volts
1394-100*	100.0 volts	20 to 135 volts

*Models 1394-50/100 calibrated to 30MHz, usable to 100MHz.

Uncertainty of AC/DC Transfer Difference— as referenced to NBS certified converter.

- DC, 20Hz–50kHz, $\pm 0.01\%$
- DC, 6Hz–10MHz, $\pm 0.05\%$
- DC, 10MHz–30MHz, $\pm 0.2\%$
- DC, 30MHz–60MHz, $\pm 0.5\%$
- DC, 60MHz–100MHz, $\pm 1.0\%$

Input Resistance: 200 ± 10 ohms/nom. volt.
Input Capacitance: 5pF nominal.

Series 1395A Thermal Converters.

Broadband primary-standard true-RMS-to-DC converters feature essentially constant input impedance and extremely high accuracy over wide frequency response. They provide fundamental, low-cost, NBS-traceable means for RMS calibration of AC and RF voltmeters, secondary-standard AC sources, signal generators, amplifiers, detectors etc.

SPECIFICATIONS

Calibration Accuracy (AC-DC difference):

Frequency Range	With Reference to Standard	Meas. Uncert.
20Hz–1MHz	Within $\pm 0.01\%$	$\pm 0.06\%$
5Hz–10MHz	Within $\pm 0.05\%$	$\pm 0.12\%$

Voltage Ranges:

Model 1395A-3: 3 Volts RMS max input.
Model 1395A-1: 1 Volt RMS max input.
Model 1395A-0.45: 0.45 Volt RMS max input.
Model 1395A-6: 6 Volts RMS max. input.

Input Impedance: $50\Omega \pm 0.15\Omega$, to 10MHz.
Output Impedance: Less than 10Ω .
Open Circuit Output Voltage (full-scale input): 7.0mV $\pm 12\%$.

Max AC/DC Reversal Error: 0.05%.
Dimensions: 1.5 in. Deep x 1.44 in. High x Long (exclusive of connectors)

Weight: 2.2 ounces.

Connectors: Male BNC, input; 2 turret lugs, output.

OPTIONS: NBS-traceable calibration report to 60MHz (Option-01); to 100MHz (Option-02). Include individual correction chart covering frequency range specified.

PRICES: Model 440 Micropotentiometer, includes one housing with thermocouple and resistor (less NBS calibration), \$295.

Each additional resistor: standard value, \$175; special value, \$195.

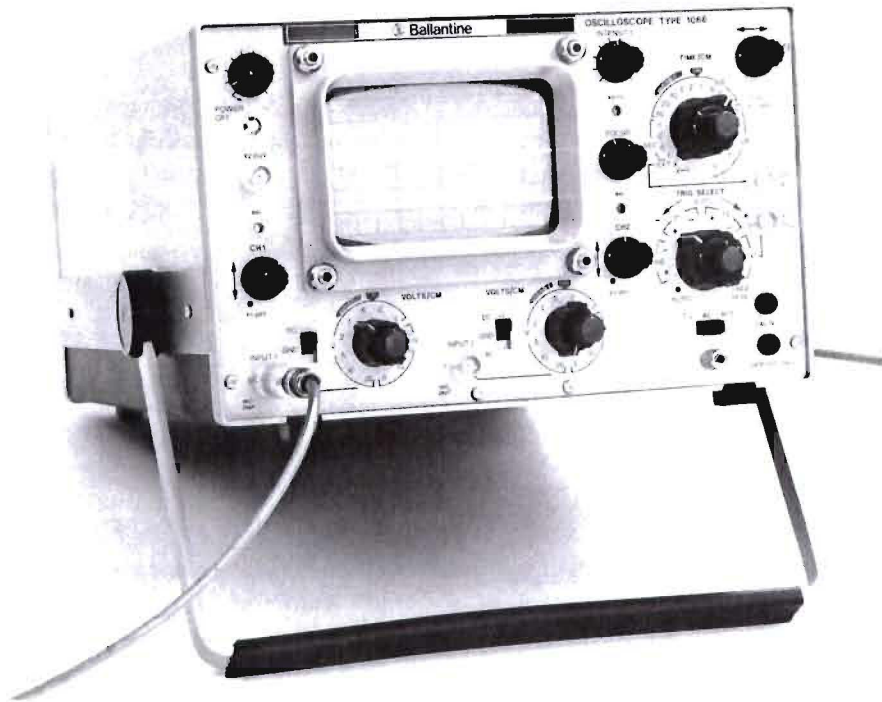
Model 440-01 Micropotentiometer Kit: 5 resistors, 3 thermocouple housings in mahogany case (less NBS calibration), \$1160.

Model 390 A-T Voltmeter, \$1995. Model 2390 Tee Adapter, \$200.

Series 1394 Coaxial Thermal Converters: 0.5 to 10V nominal voltage, \$165; 50 and 100V, \$195.

Series 1395A Thermal Converters: \$120, each (except 1395A-6, \$150).

Wideband Portable Dual-Channel Oscilloscope Model 1066A



- Easy to Use — Greatly Simplified Panel Layout.
- Maximum Convenience — Extremely Stable Trigger & Amplifier Circuits, Wide Range of Sensitivities, Fast Warmup.
- Lowest Cost in this Class of Instruments.
- Truly Portable — Small, Light, Rugged, Designed for Dependable Operation in Adverse Environments.

The Model 1066A dual-channel portable CRO has all the features normally found only in instruments costing twice as much. This solid-state professional oscilloscope incorporates a 4kV CRT supply for bright display on even the fastest sweeps — to 50 nanoseconds/cm, for precise fast-rise pulse work. It is designed around a premium cathode-ray tube of advanced design, providing exceptional linearity and resolution.

SPECIFICATIONS

CATHODE RAY TUBE

5-inch rectangular CRT. Illuminated graticule with 6 x 10cm display area. 4kV accelerating potential. P31 phosphor standard, P7 optional. Removable bezel permits attachment of oscilloscope cameras and viewing hoods as well as interchange of graticules.

VERTICAL DEFLECTION

Dual Channels (identical): Y1 and Y2.

Bandwidth (at 3dB down): DC to 15MHz; 5Hz to 5MHz in cascaded mode. 2Hz to 5MHz with AC coupling (less than 0.2Hz with attenuator probe).

Rise Time: 24nsec; 70nsec in cascade.

Deflection Factor: 5mV/cm to 20V/cm in 12 calibrated steps, 1-2-5 sequence. Extended to 1mV/cm in cascaded mode, and to <50V/cm with 2.5:1 vernier range.

Accuracy: within 3% (within 6% in cascade).

DC Drift: <2mm/hour after 30 min. warmup (constant line voltage and constant ambient temp. in 20°C to 30°C range). <1mm/minute within 1st hour after 30 min. warmup (constant ambient temp. and line voltage). <4mm/10°C drift with temperature.

Input RC: 1M Ω \pm 2%/28pF (AC/DC/Ground coupling).

Maximum Input: 400V (DC and AC peak).

Delay Line: Permits viewing leading edge of triggering waveform. PC type; introduces non-distorting, balanced signal delay of approx. 150nsec.

Display Modes:

Single Trace: Y1 or Y2.

Cascaded: Y2 and Y1.

Dual Trace: Chopped mode, selected automatically on 1msec/cm to 1 sec/cm time base ranges; 250kHz rate; Alternate mode from 0.5 msec/cm to 0.5 μ sec/cm. Z-axis blanking provided.

X-Y: via Y1 and Y2 identical channels.

External X: against Y1 or Y2, Y1 and Y2 dual trace, or cascaded Y2 and Y1.

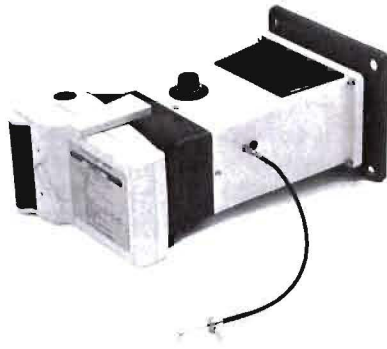
HORIZONTAL DEFLECTION

Time Base: 0.5 μ sec/cm to 1/sec/cm in 20 calibrated steps, 1-2-5 sequence. Accuracy, within 3% over center 8cm of CRT scale. 2.5:1 vernier extends range to 2.5sec/cm and 25 sec. full scale.

x10 Magnifier: Extends range to 50nsec/cm. Accuracy within 5% over center 8cm of CRT scale. Permits full screen 10cm display of any 1cm segment of normal time base. Expands normal time base around center (\pm 1.5cm) scale.

Other salient characteristics include: Protected-FET input circuitry for minimum drift, fast stabilization time, and low power consumption; single trace, dual trace, and X-Y display modes; built-in signal delay; DC to 15MHz bandwidth and $\pm 3\%$ accuracy; 5mV/cm sensitivity; amplifiers may be cascaded for 1mV/cm max. sensitivity (5Hz-5MHz); wide time-base ranges, from 1 second to 50ns/cm; internal calibrator; comprehensive trigger controls, including TV Sync.; will trigger positively on as little as 2mm peak-to-peak.

The Model 1066A is especially well suited to such demanding applications as: field maintenance of computers, peripherals, data terminals, and other digital equipment; communications-equipment maintenance, on modems, telemetry, and pulsed-carrier data links; maintenance of process servos, aircraft control and guidance devices, and



other A/D/A closed-loop systems; and field and studio maintenance of closed-circuit and broadcast TV equipment.

The Model 1066A may be ordered with a full range of accessories, including probes, viewing hoods, and compatible CRO cameras. Its compact design (only 7" x 11½" x 17"), its light weight (only 20 pounds), and its high-strength con-

struction recommend it for every field and bench application compatible with its high sensitivity and bandwidth.

Model 7000A Oscilloscope Camera

For all standard oscilloscopes with 6 x 10cm screens. (Other sizes optional.) Controls reduced to minimum. Prefocused, lens aperture preset. Polaroid Land Type 20C "Coaterless" ASA-3000 film provides prints in 30 seconds, requires no coating for permanence, at lowest cost for any quick-process 'scope camera. Hooded viewing port provides convenient viewing of CRT and graticule before exposure. High-quality Dallmeyer f 4.5, 2.4-inch lens. Object/image ratio is 1:0.65 (nominal). Three shutter speeds: 1/25 sec (fixed), time, and bulb. Adaptors are available for a wide range of oscilloscopes — or the Model 7000A camera may simply be hand-held in position during exposure.

External X Input: variable in 2 steps, 80msec/cm to 0.8V/cm (with x10 magnifier). Input RC, 100k Ω $\pm 10\%$ / <38pF. DC to 2MHz.

X-Y Operating Mode: via Y1 and Y2 channels. Deflection factor, 5mV/cm to 20V/cm, extended to 50V/cm with vernier. Accuracy, within 3%. Bandwidth (3dB down): DC to 1MHz (2Hz-1MHz, AC coupled). Phase shift <1°, DC-50kHz; <3°, DC-500kHz (5mV/cm deflection factor).

TRIGGER

Modes: Normal, free run, automatic (40Hz to 2MHz, useful to 20MHz). Bright baseline reference trace with no input (or <40Hz).

Coupling: AC, AC fast (low frequency reject), TV (optimizes frame-rate triggering of sweep).

Sources: Internal Y1 (\pm) and Y2 (\pm), External \pm , Line \pm .

Trigger Sensitivity (Manual):

AC Internal: 2mm p-p, 10Hz to 2MHz; 1cm at 2Hz and 20MHz.

AC External: 300mV p-p, 10Hz to 2MHz; 1.5V at 2Hz and 20MHz.

TV Internal: 1cm p-p video.

TV External: 1.5V p-p video.

ACF: same as AC coupled source above 50kHz.

Trigger Sensitivity (Automatic):

Internal: 2mm p-p, 40Hz to 2MHz.

External: 300mV p-p, 40Hz to 2MHz.

Trigger Level Control Range: Internal >6cm (± 3 cm), External >20V (± 10 V). Manual trigger level control deactivated when using automatic triggering.

External Trigger Input RC: 100k Ω $\pm 10\%$ / 15pF.

GENERAL

Amplitude Calibrator: square wave, line frequency, 1V p-p ampl. $\pm 2\%$. Rise time approx. 20 μ sec.

Channel Y2 Output: 25mV/cm of Y2 display (0.25V max). AC coupled, 5Hz to 5MHz.

Gate Output: Positive-going nominal 10V rectangular pulse with same duration as time base. Flat top and fast rise time for probe adjustment.

Ramp Output: Time base frequency ramp, positive-going nominal 8V p-p.

External Modulation: via rear-panel jack, AC coupled. Visible modulation at normal intensity with 2V p-p input. Blanking voltage, 60V p-p.

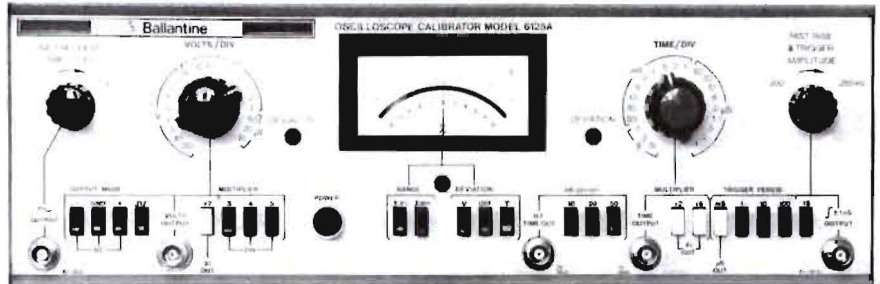
Power: 95-130V, 190-260V, 45 to 440Hz, approx. 28W (35VA).

Dimensions: Case—7"H x 11¼" W x 15½" D (17.8 x 28.5 x 39.4cm). Including knobs, feet, handles — 7.625" x 12.5" x 17.5" (19.6 x 31.8 x 43.7cm).

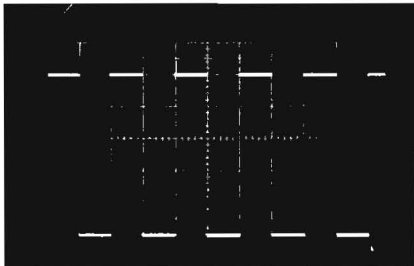
Weight: 19¼ lb. (9 kg); shipping, 30 lb. (13.5 kg).

PRICES: Model 1066A \$845; Model 7000A Oscilloscope Camera \$165.

Oscilloscope Calibrator Model 6125A



The Model 6125A provides in one compact, easy-to-use package, all facilities for the most accurate calibrations of oscilloscope parameters possible, outside of the standards laboratory. It comprises three precision instruments: a voltage calibrator; a sweep-time and delay-time calibrator; and a rise-time calibrator. Not to be confused with less accurate instruments of limited range, the Model 6125A approaches secondary-standard accuracy and stability in all calibrating-signal parameters . . . yet it costs less than the 3 individual instruments it replaces.

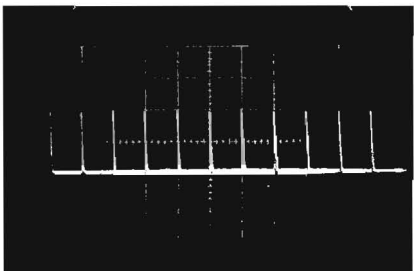


VOLTAGE CALIBRATOR

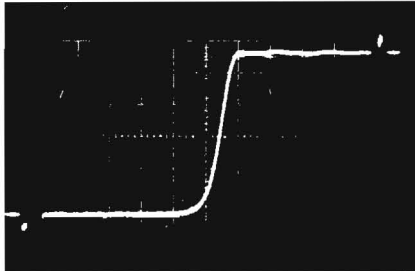
An accurate DC voltage, positive, negative, or zero, and a 1kHz positive-going square wave are provided for amplitude calibration. The main output voltage control switch is designed to correspond with that on most oscilloscopes. Pushbutton switching, plus a deviation meter, combine to allow the deviation meter to indicate percentage error directly. The 1kHz square wave is crystal controlled.

TIME CALIBRATOR

A high-stability quartz-crystal controlled time-mark generator provides time-



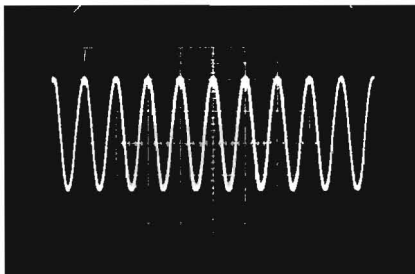
calibration pulses. The section is split into two ranges, each with its own output. The time per division switch corresponds to that on most oscilloscopes. Pushbutton switching, plus a deviation control, combine to allow the percentage error to be read directly from the deviation meter.



RISETIME CALIBRATOR

A 1Hz-1MHz square wave having faster than 1 nanosecond risetime is provided for risetime measurements. Both the risetime and the bandwidth of the amplifier can be checked, using this fast pulse. The time base of the oscilloscope is first calibrated with the Model 6125A and then the risetime of the calibration pulse is measured on the screen.

The ultra-high speed capabilities of the Model 6125A, permit precise calibration of realtime scopes with 100MHz bandwidths, and it is usable up to 500MHz bandwidth.



SYNCHRONIZATION TRIGGER CHECK

A 50/60Hz sinewave output of variable amplitude is available for the checking of trigger circuits at line frequency.

SPECIFICATIONS

VOLTAGE CALIBRATOR

Ranges: (a) Volts/division $10\mu\text{V}$ to 20V in 1, 2, 5 steps.

(b) Multiplier X 3, 4, 5, 6, 8, 10.

Output Modes: AC 1kHz positive going square wave (crystal controlled). DC Positive or Negative.

Zero.

Accuracy (with $1\text{M}\Omega$ load):

Less than $0.25\% \pm 5\mu\text{V}$ below 50mV .

Less than $0.25\% \pm 50\mu\text{V}$ at 50mV and above.

Ripple and hum: Less than $0.1\% + 2\mu\text{V}$ peak to peak.

Square wave risetime: less than $5\mu\text{sec}$.

Square wave overshoot: Less than 0.5%.

Regulation (for $1\text{M}\Omega$ load): Varies between 0 and 0.25% depending on setting.

Deviation ranges: $\pm 3\%$ and $\pm 10\%$. Analog meter with indicator light.

Deviation accuracy: $\pm 1\%$ FSD + 2.5% of reading.

Reference: High quality zener diode.

Temperature coefficients:

Reference $0.002\%/^{\circ}\text{C}$.

Output better than $0.01\%/^{\circ}\text{C}$.

Stability: 0.1% /year non-cumulative.

TIME CALIBRATOR

1. Time Output

Ranges (a) $100\text{nsec/division} - 0.5\text{sec/division}$ in 1, 2, 5 steps.

(b) Multiplier X 1, 2, 5, 10.

Amplitude: 1V p.p. into 50Ω .

Pulse Shape: Spike, width at base generally 20% of pulse interval.

Accuracy: Crystal locked 0.01%.

Deviation ranges: $\pm 3\%$ and $\pm 10\%$. Analog meter with indicator light.

Deviation Accuracy: 3% range, 0.1%; 10% range, 0.2%.

2. H.F. Output

Ranges: 10, 20, 50 nsec.

Amplitude: 1V p.p. into 50Ω .

Pulse shape: Sinewave.

Accuracy: Crystal locked 0.01%.

Deviation ranges: Not available.

RISETIME CALIBRATOR

Amplitude: Continuously variable square-wave between 200 and 250mV p.p. into 50Ω .

Risetime: 1 nanosecond positive going.

Period: 1 μsec to 1sec in decade steps.

Overshoot: less than 2%.

LINE FREQUENCY

SYNCHRONIZATION/TRIGGER CHECK

Amplitude: Continuously variable sine-wave 0-1V p.p. from $2\text{k}\Omega$ source.

Frequency: 50 or 60Hz as line.

Waveform: As line.

GENERAL

Power: 100/125V or 200/240V, 50/60Hz, 17 Watts.

Temperature range:

Operating $+10^{\circ}\text{C}$ to $+50^{\circ}\text{C}$.

Storage -10°C to $+70^{\circ}\text{C}$.

Dimensions: $16\frac{1}{2}''\text{W} \times 5\frac{1}{4}''\text{H} \times 11\frac{1}{2}''\text{D}$

($42\text{cm} \times 14\text{cm} \times 27\text{cm}$).

Weight: 15 pounds (7 kilograms).

PRICE: Model 6125A, \$1875.

Precision AC/DC High Voltage Calibrators Series 421



MODEL 421A

- Saves Time — speeds calibrations by simplifying procedures, eliminating intermediate self-checking, obviating result interpretation.
- Simplifies Operation and Training — eliminates error calculations, prevents reading or interpretation errors.
- Convenient — fast warmup, high long-term stability eliminates need for frequent verifications.

- Flexible — wide ranges, high resolution, low source impedance, both AC and DC.

Series 421 Precision Calibrators, despite their moderate prices, provide every facility for rapid, high-confidence calibration and standardization of a wide range of AC and DC instruments. Oscilloscopes, analog voltmeters, attenuators, DPM's, and DVM's can be checked over a wide range of voltage levels, on both AC and DC scales. The 421A provides 0 to ± 111.0 Volts DC, 0 to 111.0 Volts AC at 400Hz and 1kHz, and an additional range of 100 to 1000 Volts at 400Hz. Distortion on AC is less than 0.15%, and both RMS and peak-to-peak modes are provided. The Model 421B has an extended DC voltage range, to ± 300 V.

A unique development of Ballantine Laboratories, the Model 2421 Error Computing Accessory, provides quick, easy readings *directly in percent* of absolute error, tracking error, or tracking error in the presence of range error. Model 421B has the error-computing facility built in.

These calibrators are the first choice of cost-conscious laboratory, production, and quality-control supervisors throughout the industry.

SPECIFICATIONS — Series 421

Output Modes

AC: 400Hz or 1000Hz, RMS or Peak-to-Peak.
DC: Positive or Negative.

Voltage Ranges

AC: 1.11mV* to 111V*, 400Hz or 1000Hz 100 to 1110V, 400Hz only.
DC: 1.11mV* to ± 111 V* (421A); 1.11mV* to ± 300 V* (421B). * Full range.

Accuracy (Output EMF, full range)

AC/DC to 111V: $\pm 0.1\%$.
AC 100V to 1000V, 400Hz; $\pm 0.3\%$.
DC 100V to 300V: $\pm 0.15\%$ (421B).

Linearity of Controls

AC modes: $\pm 0.05\%$ of setting
DC modes: $\pm 0.1\%$ of setting (1/10 full to full range).

Source Resistance

AC (all models): $\pm 1000\Omega$ (1kV range) to $0.6\Omega \pm 30\%$ (1V) and $2.2\Omega \pm 10\%$ (1mV).
DC (421A): $1000\Omega \pm 5\%$ (100V range) to $10\Omega \pm 2\%$ (100mV) and $0.22\Omega \pm 20\%$ (1mV).
DC (421B): 2Ω max (1kV range) to $100\Omega \pm 2\%$ (1V) and $0.22\Omega \pm 20\%$ (1mV).

Stability: $\pm 0.01\%$ (1 hour), short time.

Calibration: Certificate supplied. Recommended calibration period: 1000 hours operation or 6 months.

Waveform: Distortion: 0.15% max. Frequency: $\pm 2\%$, nominal. Hum and noise: $\pm 0.05\%$ of full range max. Ripple (rms) on DC: 0.1% of full range $\pm 50\mu$ V.

Warm-up Time: To 0.05% of final value in 20 minutes.

Power Requirements: 120/240V, 50–420Hz, 40W.

Error Computer: Error range: $\pm 5.3\%$. Accuracy of setting $\pm 0.05\%$ ± 0.1 of setting.

NOTE: Error computer may be used externally with Model 421A or may be mounted in the same rack panel with it (421A-S3). It is built into Model 421B.

Dimensions

Model 421A, Portable: 13 $\frac{1}{2}$ "H x 7 $\frac{1}{2}$ "W x 10 $\frac{1}{2}$ "D. (34.3 cm x 19 cm x 26.7 cm).
Model 421A-S2/S3 Rack: 7" H x 19" W x 10" D. (17.8 cm x 48.25 cm x 26.7 cm).
Model 421B, Portable: 7" H x 13"W x 10"D. (17.8 cm x 33 cm x 26.7 cm).
Model 421B-S2, Rack: 7" H x 19" W x 10" D. (17.8 cm x 48.25 cm x 26.7 cm).

Weight

Model 421A, Portable: 19 lb. (8.6 kg); shipping — 25 lb. (11.3 kg).
Model 421A-S2, Rack: 20 lb. (9.1 kg); shipping — 26 lb. (11.8 kg).
Model 421A-S3, Rack: 21 lb. (9.6 kg); shipping — 27 lb. (12.3 kg).
Model 421B, Portable: 20 lb. (9.1 kg); shipping — 26 lb. (11.8 kg).
Model 421B-S2, Rack: 21 lb. (9.6 kg); shipping — 27 lb. (12.3 kg).

PRICES:

Model 421A, AC/DC HV Calibrator, \$795.
Model 421A-S2, rack mounted version, \$825.
Model 421A-S3, rack mounted with Error Computer, \$895. Model 421B, with built-in Error Computer, \$1295.
Model 2421 Error Computer, \$95. Optional Voltage Standard, Model 1350B, \$100.

Special-Purpose AC Voltmeter/Amplifiers

MODEL	310B	314A	320A	321A	340	300H
Voltage Range	100 μ V to 100V*		100 μ V to 330V [†]	100 μ V to 330V (RMS) [†] 300 μ V to 300V (Peak, Av)	300 μ V to 3V	30 μ V to 330V
Frequency Range	10Hz to 6MHz		5Hz to 4MHz (2Hz to 7MHz, 3dB bandwidth) (RMS) 10Hz to 1MHz (Average and Peak)		0.1 to 1000MHz (calibrated to 700MHz)	10Hz to 1MHz
Decibel Range	80dB to 140dB		80dB to 150dB referred to 1V			90 to 150, ref. to 1V
Accuracy	20Hz to 2MHz: $\pm 2\%$ 10Hz to 4MHz: $\pm 3\%$ 10Hz to 6MHz: $\pm 5\%$		Above 300 μ V: (RMS) 20Hz to 400kHz: $\pm 2\%$ rdg. 10Hz to 2MHz: $\pm 3\%$ rdg. \blacktriangle 5Hz to 4MHz: $\pm 4\%$ rdg. Below 300 μ V: (RMS) 20Hz to 400kHz: $\pm 3\%$ rdg. 10Hz to 2MHz: $\pm 4\%$ rdg. 5Hz to 4MHz: $\pm 10\%$ rdg.		0.1 to 100MHz: $\pm 4\%$ rdg. 100 to 700MHz: $\pm 10\%$ rdg.	Above 300 μ V: 10Hz to 700kHz: $\pm 2\%$ 700kHz to 1MHz: $\pm 3\%$ Below 300 μ V: 100Hz to 100kHz: $\pm 5\%$
Null Detector Mode	Sensitivity increases 10dB. Min. indicated voltage, 30 μ V		10 μ V, 100 μ V (Minimum observable voltage change is 2 μ V)		N.A.	Sensitivity 30 μ V
Response	Average, Calibrated in RMS of sinewave.		True RMS	True RMS, Average, Peak	True RMS	Average, Calibrated in RMS of sinewave.
Crest Factor	N.A.		15:1 down scale 5:1 full scale	15:1 downscale (RMS) [‡] 5:1 upscale (RMS)	Depends on range. Varies from 100:1 to 3:1 on most ranges.	N.A.
Scales	Logarithmic voltage, 0.9 to 11 Linear dB, 0 to 20. Mirror-backed.		Logarithmic voltage, 0.95 to 3.3, 3.0 to 10.6 Linear dB, 0 to 10.			Logarithmic voltage, 3 to 33 Linear dB, 10 to 10.
Input Impedance	2M Ω shunted by 15pF (25pF on 1mV and 10mV ranges)**		30mV to 330V: 10M Ω parallel with 11pF 300 μ V to 10mV: 10M Ω parallel with 27pF		30 μ V to 3V: > 1M Ω , 4pF 300 μ V to 30mV: 25k Ω , 4pF	2M Ω shunted by 15pF (25pF on most sensitive ranges)
Amplifier Characteristics	Max gain: 60dB Max output: 2V Freq. Response: 10Hz to 6MHz, ± 1 dB Equiv. Input Noise: Below 20 μ V, 60dB gain, input shorted, below 25 μ V, input open.	N.A.	Output: Rear binding posts, balanced or single ended Max gain: 90dB Max output: 50V into 20k Ω , 10V into 2k Ω Source Impedance: 350 Ω at 1kHz Freq. Response: 5Hz to 2MHz, 10.5dB; 4MHz, 1dB with 25pF max. capacitive loading.	N.A.	N.A.	Max gain: 40dB, ± 0.5 dB Max output: 0.3V Output imped: 3 ohms Min. load imped: 5k Ω and 50pF Freq. Response: 10Hz to 1MHz, ± 1 dB
Stability	Better than 1/5 stated accuracy for $\pm 10\%$ line change.		Better than 1/10 stated accuracy for $\pm 10\%$ line change. (Expected calibration stability, 5000 hours).		Better than 1/5 stated accuracy for $\pm 10\%$ line change.	$\pm 0.25\%$ for $\pm 10\%$ line change, 20Hz to 500kHz ($\pm 0.75\%$ at ends of range).
Warm up Time	Usable after 20 sec. Reading within 0.5% of final value in 10 minutes.		Usable after 20 sec. (RMS & Average), 5 min Peak. Within 0.3% of final value after 15 minutes.		Usable after 20 sec. Reading within 1% of final value after 15 min.	5 min.
Power Requirements	115/230V, 50 to 400Hz, 40 Watts		115/230V, 50 to 420Hz, 90 Watts		115/230V, 50-420Hz, 40W	115/230V, 50-420Hz, 35W
Dimensions	Portable 13" H x 7 1/2" W x 9 1/2" D (33cm x 29cm x 24cm) Rack 7" H x 19" W x 8 1/2" D (18cm x 48cm x 22cm)		15" H x 8 1/8" W x 11 1/2" D (38cm x 21cm x 30cm) 8 1/2" H x 19" W x 12 1/2" D (22cm x 48cm x 32cm)		13" H x 7 1/2" W x 9 1/2" D (33cm x 19cm x 24cm) 8 1/2" H x 19" W x 8 1/2" D (22cm x 48cm x 22cm)	11" H x 6" W x 7" D (28cm x 15cm x 18cm) 7" H x 19" W x 6 1/2" D (18cm x 48cm x 17cm)
Weight	Portable 14 lb. net (6.3 kg)		22 lb. net (10 kg)		16 lb. net (7 kg)	10 lb. net, 13 shipping (4.5 kg) (5.9 kg) 11 lb. net, 26 shipping (5 kg) (11.7 kg)
Additional Features	Optional Accessories: High Voltage Probe (1311) for 10kV RMS measurements. Shunt Resistors (Series 600), 0.1-1000 Ω , for current measurements, 0.1 μ A-10A.	Optional Accessories: dBm scale referenced to 1mW across 600 Ω . HV probe (1311) for 10kV RMS measurements, 20dB probe (5314) and adapter (6314). Shunt Resistors (Series 600), 0.1-1000 Ω , for current measurements, 0.1 μ A-10A.	Mean Square DC output: -1.0V (0.2V corresponds to full scale deflection). 1000 Ω source resistance. Optional Accessories: High Voltage probe (1311) for 10kV measurements. Shunt Resistors (Series 600) for current measurements 0.1 μ A-10A.	Mean Square DC output: 0.1 to 1.0V, for recorder. Optional Accessories: 40dB attenuators, 1340 and 6340 (HV), Adapter, 2340 (to N or BNC), Probe Tip, 4340, 50 Ω Tee Adapter, 5340.	Function Switch: SE NS x 10 position permits measurements down to 30 microvolts. Optional Accessories: Multiplier (1311) for 10kV measurements. Shunt Resistors (Series 600), for current measurements 0.1 μ A-10A.	

* Extensible to 1000V or 10 000V with optional probes. Sensitivity 30 μ V in Null Detector Mode.
† As Null Detector, 10 μ V-100 μ V.
‡ 2% rdg (Av), $\pm 3\%$ fs (Peak) Model 321A.

\blacktriangle 10Hz-1MHz: $\pm 5\%$ rdg (Av), $\pm 5\%$ fs (Peak) Model 321A.
§ For pulse and flat waveforms, 10:1 downscale. For Average response, 7:1 downscale, 4:1 upscale.
** Model 314A: Input impedance \approx 10M Ω shunted by 7.5pF with Model 15314 probe.

Accessories

Note: Special accessories for particular instruments are listed on the appropriate pages. Listed below are accessories usable with a number of different instruments, as well as special accessories for the Ballantine instruments listed on this and the following pages.

Shunt Resistors, Series 600, for current measurements up to 10 amperes (lower limit varies with voltmeter used — as low as 1 μ A with Models 310B, 314A, and 320A). Six models from 0.01 to 1000 ohms.

PRICES:

Portable	Rack-Mounting
310B ACVM \$450.	310B-S2 \$475.
314A ACVM 495.	314A-S2 525.
320A True-RMS VM 625.	320A-S2 650.
321A True-RMS VM 695.	321A-S2 725.
340 Millivoltmeter 695.	340-S2 725.
300H ACVM 295.	300H-S2 325.

Rack Mounting Kit, Model 800, for mounting one or two half-rack instruments such as the 303 and 323 Series.

Probes. Capacitive 80dB attenuator probes for measurements to 10kV. Model 1301, with plug for 3/4" spaced binding posts. Model 1311, with connector for UHF female.

For Model 314A AC Voltmeter: Model 5314 20dB probe; Model 6314 Adapter (to N/BNC male).

For Model 317 AC Voltmeter: Model 2317A Cathode Follower Probe for measurements up to 350mV; Model 3317 30dB Attenuator for use with 2317A for measurements from 300mV to 350V.

Series 600 Shunt Resistors: 0.01 Ω , \$65; 0.1 Ω , \$50; 1 to 1000 Ω , \$30 each.

Model 800 Rack-Mounting Kit, \$50.

Probes: Model 1301, \$90. Model 1311, \$85. Model 5314, \$85.

Model 2317A, \$100. P/N 8300, \$100; P/N 8301/02/03, \$25/\$7/\$3. Model 3345, \$85.

Attenuators: Model 3317, \$50. Model 1340, \$65. Model 6340, \$50.

Adapters: Model 6314, \$25. Model 4340, \$10. Model 5340, \$65. Model 1345, \$65.

For Model 340 True-RMS Voltmeter: 40dB Attenuators: Models 1340 and 6340 (HV). Model 4340 Probe Tip Adapter; Model 5340 Tee Adapter.

For Model 345 DC/AC Volt/Ohmmeter: Set of Probes with cable assemblies: P/N8300, AC; P/N8301, DC; P/N8302/ohms; P/N8303, common. Model 1345 Tee Adapter, 50 Ω line. Model 3345 HV Probe, to 10kV DC.

Cables, Tee and Terminal Adapters. Ballantine provides, at modest prices, every kind of adapter and cable accessory required by standard laboratory and production test procedures. Consult factory or local field representative.

Ballantine Instrumentation Classics

It has proved next to impossible to discontinue a Ballantine instrument. Indeed, the very first Ballantine commercial-production design, the Model 300, was finally removed from active production in 1966 (28 years after its introduction!), and requests for it continue to arrive regularly. For the convenience of engineers who have standardized on these "classics" of the measurement art, intermittent small-scale production is maintained on the models listed below . . . all of which have been superseded by more modern, more capable, and generally lower priced, designs. Please inquire before ordering.

SPECIFICATIONS

Model 300E Voltmeter/Amplifier, for systems use. 30Hz to 200kHz. 300 μ V to 300V. Linear dB: -10 to +10. Mechanically programmable. Half-rack.

Model 300G Voltmeter/Amplifier. 10Hz to 250kHz. 1mV to 1000V. High accuracy: 1% rdg, 20Hz to 20kHz.

Model 302C Battery operated Voltmeter. 2Hz to 150kHz. 100 μ V to 1kV. Linear dB: 0 to 20.

Model 305A Peak/Peak-to-Peak Voltmeter/Amplifier. 5Hz to 500kHz (harmonics up to 2MHz). 1mV to 1kV. Linear dB: 0 to 10.

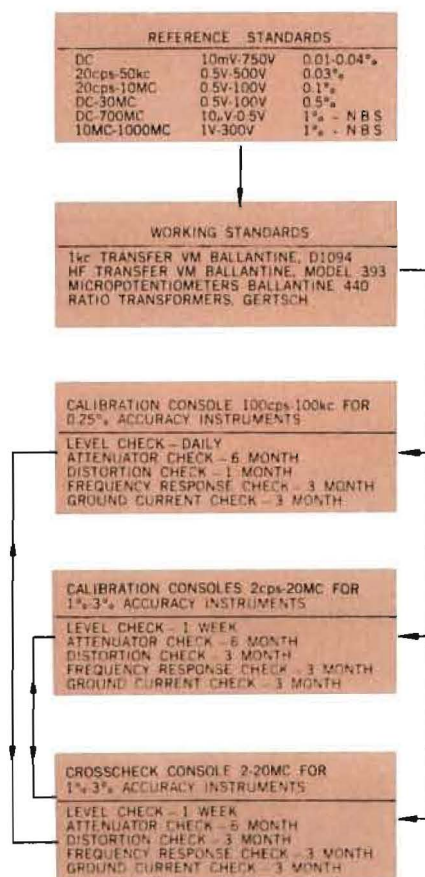
Model 316 Peak-to-Peak Infrasonic Voltmeter. 0.01Hz to 30kHz. 20mV to 200V. Linear dB: 0 to 20.

Model 317 Wideband Voltmeter. 10Hz to 11MHz (30MHz as null detector). 300 μ V to 350V (up to 10kV with optional probe).

Model 345 High Accuracy AC/DC VOM. 20Hz to 1GHz. DC range: 0 to 1100V (10kV with optional multiplier). AC range: 0-350V. Ohms: 0-500M Ω . Logarithmic scales; auxiliary scale for low level measurements. Accuracies (in % rdg): 1% DC, 2% AC, 3% Ohms.

Ballantine Quality-Assurance and Calibration-Traceability Procedures.

This chart describes the validation procedures by which all instruments used for the calibration of all Ballantine products are standardized, by systematic reference to NBS-traceable primary transfer standards. Complete details are available on request from the Applications Engineering Department.



Warranty

All Ballantine Laboratories, Inc. products are warranted against defects in materials and workmanship. This warranty applies for one year from date of delivery, except for vacuum tubes or batteries, or, in the case of certain major components listed in the instruction manual for the specified period. Ballantine will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

Ballantine Technical Literature

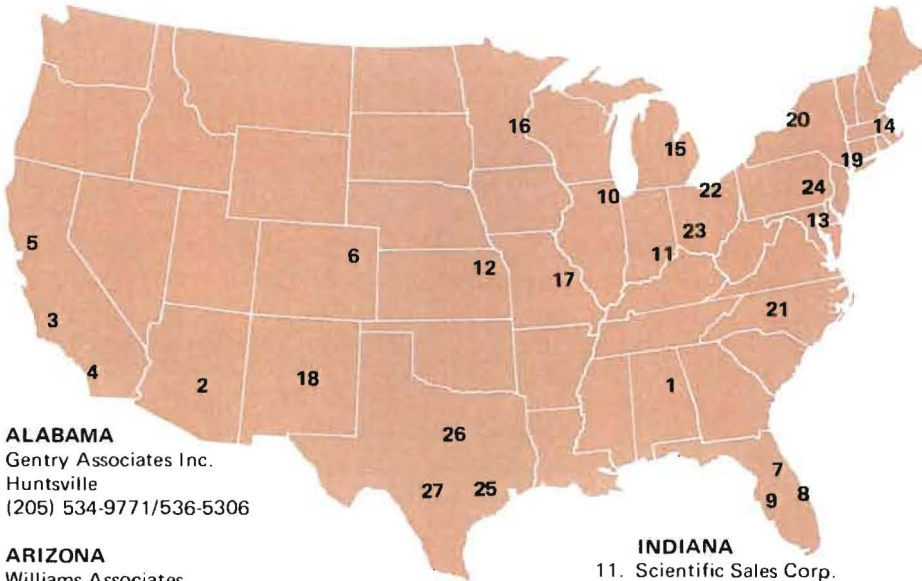


Your local Ballantine field engineering representative can furnish a variety of technical publications to assist you in your selection of the best instrumentation and the best technique for your requirements. These include technical data bulletins on individual Ballantine instruments, reprints of "landmark" technical articles by Ballantine engineers, and complete instruction/application manuals on Ballantine instruments and accessories. Tell him your measurement interests, and he will select pertinent publications for you.

PRICES:

Portable Models		Rack-mounting Models	
300E	\$395.	300E-S2	\$465.
300G	395.	300G-S2	425.
300C	475.	300C-S2	495.
305A	595.	305A-S2	625.
316	825.	316-S2	850.
317	565.	317-S2	595.
345	625.		

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