

TYPE 510
WIDE-RANGE AUDIO OSCILLATORS

The WAVEFORMS TYPE 510 Wide-Range Audio Oscillators are precision sources of distortion-free signals in the audio and ultrasonic range.

The TYPE 510 is intended for portable and bench use, and is small enough to be carried in a briefcase. It is operable from 50-400 cycle power lines, 115 or 230V. It is most convenient for airborne applications and for field maintenance and testing of sound or high fidelity systems. It is equally suitable for laboratory or production applications requiring a high degree of precision or reliability.

The 510C is identical to the 510B except for output impedance and output level. While both have the same power output the 510B has higher voltage and is intended for industrial electronic applications. The 510C features a 600 Ω single-ended output and output level calibration in dBm. It is recommended for broadcast and communications work.

The WAVEFORMS TYPE 510 Oscillator is a resistance-capacitance tuned oscillator with a frequency range of 18 cycles to 1.1 megacycles in five overlapping ranges. Amplitude is stabilized by heavy feedback in conjunction with a negative-resistance thermal element, so that the distortion is exceptionally low and the output amplitude is essentially independent of frequency over the entire tuning range. The oscillator is isolated from the load by a cathode follower which provides an internal impedance of about 400 ohms with a signal-current capability of 4 milliamperes.

The oscillator may be removed from its case for inspection and maintenance simply by removing two screws at the left rear. The three electrolytic capacitors required are held in plug-in sockets, and all three are of the same type; thus, only one capacitor type is required for replacement purposes.

SPECIFICATIONS

MODEL 510B

Range

18 cycles to 1.1 megacycles in five overlapping ranges: 18-210 cycles ($\times 1$), 180-2,100 cycles ($\times 10$), 1,800-21,000 cycles ($\times 100$), 18,000-210,000 cycles ($\times 1\text{KC}$), and 0.18-1.1 megacycles ($\times 1\text{MC}$).

Calibration Accuracy

The calibration error will not exceed $\pm (3\% + 1/10 \text{ cycle})$ from 18 cycles to 210 KC or $\pm 10\%$ from 0.18-1.1 MC ($\times 1\text{MC}$ Range).

Stability

$\pm 0.3\%$ for line voltage variations from 105 to 130 volts, and $\pm 0.5\%$ for ambient temperature range 0 to $+50^\circ\text{C}$ up to 200KC.

Output Level

10 volts open circuit. Maximum load current: 4 milliamperes. Maximum output:

Frequency Response

The output voltage is constant within $\pm 1 \text{ dB}$ from 18 cycles to 200 KC for any setting of the output control.

Distortion

	100 cycles to 20 KC	30 cycles
2 volts (10K load)	less than 0.2%	less than 0.5%
10 volts (10K load)	less than 0.5%	less than 0.8%

Hum and Noise Level

2 millivolt or 60 db below signal, whichever is greater.

Power Supply

40 watt, 117 volts or 234 volts (nominal), 50-400 cycles.

Tube Complement

1 6SJ7, 2 6AK6, 1 6X4

SPECIFICATIONS

MODEL 510C

Range

18 cycles to 1.1 megacycles in five overlapping ranges: 18-210 cycles (x1), 180-2,100 cycles (x10), 1,800-21,000 cycles (x100), 18,000-210,000 cycles (x1KC), and 0.18-1.1 megacycles (x1MC).

Calibration Accuracy

The calibration error will not exceed $\pm 3\%$ (+ 1/10 cycle) from 18 cycles to 210 KC or $\pm 5\%$ from 0.18-1.1 MC (x1MC Range).

Stability

$\pm 0.3\%$ for line voltage variations from 105 to 130 volts, and $\pm 0.5\%$ for ambient temperature range 0 to + 50° C up to 200 KC.

Output Level

5 volts open circuit. Maximum load current: 4 milliamperes. Maximum output: + 10 dBm into 600 Ω load (2.5V)

Frequency Response

The output voltage is constant within $\pm \frac{1}{2}$ dB from 18 cycles to 200 KC for any setting of the output control, and ± 1 dB from .18 mc - 1.1 mc (x1MC Range).

Distortion at 0 dBm	1/2%	400 c - 10 kc
	1%	10kc - 200 kc
	5%	200 kc - 1 mc

Hum and Noise Level

2 millivolt or 60 db below signal, whichever is greater.

Power Supply

20 watt, 117 or 234 volts (nominal), 50-400 cycles.

Tube Complement

1 6SJ7, 2 6AK6, 1 6X4, 1 6AH6

INSTRUMENTS FOR INSTALLATION

Type 510 oscillators are available in four mounting arrangements for inclusion in systems, racks, bays, consoles, etc. These arrangements are: (1) panel mount, (2) rack mount, (3) half-rack mount, and (4) custom mount.

Panel Mount "-P"

The oscillators front panel is actually an oversized mounting plate. The oscillator is slipped into a rectangular cut-out and bolted into place. Dimensions of the -P panel and drilling details for the cut-out and mounting holes are shown at the end of the catalog. -P oscillators are shipped less feet and handles. Price per -P oscillator: \$10.00 extra.

Rack and half-rack mount "-R and

The oscillator is assembled to a 7" high rack or half-rack panel. In the case of the full (19") rack mount, two type 510 oscillators can be installed on the same 7" high rack panel to conserve space in your system. In fact, a type 510, and any other Waveforms oscillator or voltmeter can both be built on the same rack panel. Price for one instrument installed: \$20.00 extra; price for two instruments installed (full-rack only): \$25.00

Custom Mount

This is the ultimate in flexibility. We provide a "custom" 7" x 19" rack panel with cut-out and mounting holes to receive from 1 to 4 type 510 panel-mount oscillators, or combinations of type 510 oscillators and other Waveforms instruments. Cost: \$20.00 for custom panel cut-out for 1 panel mount instrument, \$5.00 additional for each extra panel mount instrument. Thus the cost of a custom mount type 510 is \$30.00 additional, composed of \$20.00 for the custom rack panel and \$10.00 for the "-P" panel mount feature for the 510 instrument

SPECIALS

Waveforms is delighted to provide type 510 instruments with special mechanical and electrical features. This service is low in cost even for very small runs. Special features include, alternative frequency ranging, alterations in panel nomenclature, changes in mechanical connections, special paint and private branding. Quotations will be furnished promptly.

FINISH

The standard panel finish of the type 510 portable oscillator is a reverse etch technique with green paint fill. All instruments for installation (panel mount, rack mount, etc.) have a semi-gloss enamel finish (4.5 Munsell grey) with characters screened in white.

ACCESSORIES

Matching Transformers

Two models of Matching Transformers are available for operating the 510B Oscillator into balanced lines. Each is supplied in a case which fastens to the bottom of the 510B Oscillator, so that the transformer is always conveniently available. It is recommended that the Matching Transformer be ordered with the oscillator to take advantage of factory assembly of the complete instrument.

	<u>T10</u>	<u>T11</u>
Impedance	150/600	135/600
Max. output into rated load	± 8 dBm	± 10 dBm
Frequency Response	20 cycles-50 KC	20 cycles-200KC
Price	\$55.00	\$90.00

CONTROLS

Frequency

The output frequency is controlled by the large dial, in conjunction with the Range Switch. Frequency for the four lowest ranges (x1, x10, x100, x1KC) is read on the outer dial scale, while the frequency for the highest range (x1MC) is read on the inner scale.

Amplitude .

The output control is logarithmically tapered, so that accurate and convenient adjustment may be made over its entire range. The 510B is marked in terms of RMS output volts. The 510C control is marked in dBm (0 dBm = 1mW in 600 Ω). While this calibration is very convenient for many applications, it should not be relied upon if precision is required.

With the 510B control set at 10 (full), the open-circuit output voltage at 1000 cycles will be 10 volts $\pm 10\%$. With the 510C control set at +10 dBm (full) the open circuit output voltage is 5V $\pm 10\%$ or ± 1 dB.

Turning the output control all the way counter-clockwise turns the oscillator off.

Fuse

A 0.4 ampere so-blo fuse is located on the back of the instrument. (Bussman Manufacturing Company MDL 4/10).

OPERATION

Output

The output of the Type 510 Oscillator appears across the output binding posts. Under normal conditions of operation, the d-c potential difference appearing across these binding posts should be negligible. The "high" terminal is connected directly to the cathode of the cathode follower, and this terminal is held at the same d-c potential as the chassis. Electrically, the output of the oscillator may be represented by a resistance of approximately 400 ohms in series with a capacitance of 20 microfarads, for signal frequencies, and under linear operating conditions (output current less than 4 milliamperes). The d-c resistance across the output terminals is 56,000 ohms.

It is undesirable to connect the output terminals across a d-c potential of more than a few volts, as some increase in distortion may result. Potentials greater than 50 volts may damage the electrolytic capacitor in the output circuit. An external blocking capacitor should be used if it is necessary to operate the oscillator across a large d-c voltage.

510B Load Impedance

The output tube is a 6AK6 cathode follower, offering a source impedance of about 400 ohms. The cathode follower has a signal current capability of 4 milliamperes RMS at less than 2% distortion. Thus, it will deliver 8 volts across 2000 ohms, 4 volts across 1000 ohms, etc. At lower output currents the distortion is considerably reduced - at 2 volts across 2000 ohms, for example, the distortion will be less than 0.3%.

It should be noted that the output capability of the oscillator may be limited where the load is not predominately resistive, i.e., where significant reactive currents are drawn by capacitance or inductance in the load circuit.

510C Load Impedance

The output tube is a 6AH6 cathode follower, offering a source impedance of 600 Ω . The power capability of this circuit is +10 dBm maximum. At this level the distortion at 1 KC is less than 2%. Distortion is far less at lower levels. At 0 dBm it is only 1/2%.

Operation at Low Output Levels

Although the output control can be conveniently adjusted for output levels as low as 0.01 volt, it is suggested that an attenuator be used between the oscillator and the load when less than 0.1 volt is required to preserve a good signal-to-noise ratio.

Effects of High Humidity

All the critical surfaces of the 510B Oscillator are ceramic or other high grade insulating material, treated to repel moisture. However, if the oscillator has been left in a very moist atmosphere, erratic behavior may be noticed on the lowest ranges. This will usually clear up after the unit has been operated for a short time, and the moisture films have been vaporized.

If erratic behavior persists, the tuning capacitor and tuning capacitor mounting board should be cleaned to remove conductive dust particles. In cleaning, care should be taken not to change the adjustment of the trimmer capacitors, the amplitude rheostat, or the position of the tuning capacitor plates.

Hum

The type 510 power supply uses a full-wave rectifier and power transformer. No bypass capacitors are used across the primary to avoid bringing the chassis to any definite potential with respect to the a-c line. Some improvement in hum when making measurements may be obtained by experimenting with the power plug polarities of the oscillator, the equipment under test, and any other associated measuring equipment. The 510 should not be located too near low-level circuits, since the hum field of its power transformer may be disturbing.

MAINTENANCE

It is recommended that for any maintenance beyond tube replacement or similar routine servicing, the unit be returned to the factory.

When replacing tubes or the stabilizing lamp, it is desirable to measure the oscillator distortion on a sensitive distortion meter. A poor tube or lamp may increase the distortion without otherwise affecting performance.

Intermittent or erratic operation is usually due to a loose or defective 3-watt lamp, an electrolytic capacitor which has worked loose in its socket, or the effects of excessive humidity (see above).

High distortion on all ranges and at all output levels is generally caused by either the 3-watt lamp or the oscillator 6AK6. Distortion occurring only at high output levels will probably be due to the cathode follower, V3. Distortion occurring only on the lowest range is usually due to grid current in the 6SJ7.

POWER TRANSFORMER CONNECTIONS

110V		220V	
<u>Power to:</u>	Strap	<u>Power to:</u>	Strap
Black, Brown	Blue-Black White-Brown	Black, Brown	Blue-White

GUARANTEE

All WAVEFORMS instruments are manufactured to strict specifications with the best available components. They are carefully inspected, tested, calibrated and packed before shipment to the purchaser. If damage is noted upon receipt, a claim should be filed with the carrier and U.R.E.I. notified.

WARRANTY REPAIRS:

U.R.E.I. warrants all WAVEFORMS instruments to be free of defects in materials and workmanship. Our liability under this guarantee is limited to the repair and adjustment of any instrument returned, with an explanatory letter, to the factory within one year from the date of delivery to the purchaser; and to the replacement of any defective parts except tubes and fuses (tubes are subject to the standard EIA guarantee). This warranty is null and void for any instrument showing evidence of tampering, or adjustment and/or repair by anyone other than the manufacturer or their authorized repair stations.

NON-WARRANTY REPAIRS:

The purchaser may return the instrument to the factory at any time for servicing and/or calibration. The manufacturer will correct any malfunction and insure conformance to specifications. In addition, replacement will be made of any component which appears to be nearing the end of its useful life, or indicated probability of later failure. The one year new instrument performance warranty is renewed. The charge for this service is 40% of the purchase price of the instrument, except for the 452 series where the charge is \$200.00.

Equipment returned to the manufacturer must be carefully packed and shipped with the transportation charges prepaid. On in-warranty repairs, return shipment from the factory will be prepaid by U.R.E.I.

Communication with the manufacturer regarding any difficulties encountered in the operation or maintenance of the instrument is welcomed. Include details of the difficulty together with the Model and Serial Number of the instrument. Corrective information based upon the description of the difficulty, will be sent promptly by return mail.

WAVEFORMS

manufactured by
UNITED RECORDING ELECTRONICS INDUSTRIES
11922 Valerio Street
North Hollywood, California 91605
(213) 764-1500

TYPE 510 PARTS LIST

Stock No.	Symbol	Quantity	Unit	Description
		510B	510C	Cost
DCH19M	R1,2	2	2	\$4.20 Res., dep. carbon, 19M Ω , Phaotron CAH-1 $\pm 1\%$
DCN1.9M	R3,4	2	2	.34 " " " 1.9M Ω Electra DC $\frac{1}{2}$ B $\pm 1\%$
DCN190K	R5,6	2	2	.38 " " " 190K Ω " DC $\frac{1}{2}$ C $\pm 1\%$
DCN19K	R7,8	2	2	.38 " " " 19K Ω " " $\pm 1\%$
DCN1.75K	R9,10	2	2	.76 " " " 1.75K Ω " " $\pm 1\%$
RECL39-102	R11	1	1	.24 Rheostat, 1K Ω Wirt WC807
1051	R12	1	1	.58 Resistance lamp, GE Co. 3S6/5 110V
EB5631	R13,14,15	3	3	.04 Res., comp. A-B type EB 56K $\pm 10\%$
EB1051	R16	1	1	.04 " " " " 1 M Ω " "
EB1511	R17	1	1	.04 " " " " 150 Ω " "
5T4000	R18	1	1	.63 " WW, Ward Leonard type 5T 4000 $\Omega \pm 5\%$
PJA64626	R19	1	-	3.22 Pot. 100K Ω A taper, A-B CA1041 W. switch
PJS4N048	R19	-	1	4.50 " 5K Ω A taper, A-B CA5021 W. switch
EB1051	R20	1	1	.04 Res., Comp., A-B type EB 1M $\Omega \pm 10\%$
EB1811	R21	1	-	.04 " " " " 180 Ω " "
EB7505	R21	-	1	.10 " " " " 75 $\Omega \pm 5\%$
5T4000	R22	1	1	.63 " WW, Ward Leonard type 5T 4000 $\Omega \pm 5\%$
EB5631	R23	1	1	.04 " , Comp. A-B type EB 56K $\Omega \pm 10\%$
EB1511	R24	1	1	.20 " " " " " 150 Ω " "
5T1000	R25	1	1	.62 Res. WW, Ward Leonard type 5T 1000 $\Omega \pm 5\%$
ED2221	R26	1	1	.04 Res., Comp, A-B type EB 2.2K $\Omega \pm 10\%$
DCN2.37K	R27	1	1	.44 " , dep. carbon, 2.37K Ω Electra DC 1/2C $\pm 1\%$
PCL39-101	R28	1	1	.24 Pot. 100 Ω Wirt WC817B
DC4721	R29	-	1	.04 Res., comp., A-B type EB 4.7K $\Omega \pm 10\%$
DCN499	R30	-	1	.38 " dep. carbon, 499 Ω Electra DC 1/2C $\pm 1\%$
6SJ7	V1	1	1	1.44 Electron tube
6AK6	V2	1	1	1.50 " "
6AK6	V3	1	-	1.50 " "
6AE6	V3	-	1	2.50 " "
6X4	V4	1	1	1.14 " "
V2	C1	1	1	4.80 Tuning capacitor, All Star 2581
TS2A4-30	C2	1	1	1.50 Cap., variable, Erie TS2A 4-30 pf
TS2A1.5-7	C3	1	1	1.50 " " " " 1.5-7 pf
TCZ1.5	C4	1	1	.60 Cap., ceramic, 1.5pf Centralab TCZ
TCZ4.7	C5	1	1	.60 " " 4.7pf " "
TCZ3.3	C6	1	1	.60 " " 3.3pf " "
DM15-120K	C7	1	1	.16 " mica 12pf El-Menco IM15-120K
.1/200	C8	1	1	.24 Cap., paper, .1uf 200V Good-All type 630
FP227A	C9	1	1	.90 " electrolytic, 20-20uf, Mallory type FP
.1/200	C10	1	1	.24 " paper, .1uf 200V Good-All type 630
FP227A	C11,12	2	2	.90 " electrolytic, 20-20 μ f, Mallory type FP

TYPE 510 PARTS LIST

510B & 510C			
Stock No.	Qty.	Unit Cost	Description
1002	1	\$8.04	Power Transformer, Central X2680
1053	1	.16	Pilot Lamp, GE #51
1071	1	.18	Fuse, 4/10A, Bussman MDL
2012	2	.20	7 pin medium shield, Eby 9701
2013	1	.22	7 pin long shield, Eby 9702
2021	1	.18	Octal Socket, Cinch 13206
2023	1	.12	Resistance Lamp Socket, Dialco 6-12
2024	3	.36	Condenser Socket, Cinch 11523
2027	3	.28	7 pin Shield Base Socket, Eby 9735-11
2031	1	.30	Pilot Light, Dialco 755-621
2042	1	7.90	Case
2062	1	7.30	Chassis
2075	1	.56	Handle, Specialty Leather 282L
2082	1	.42	Name Plate
2112	1	.86	Dial Knob, Kurz-Kasch S311-64-BB-DD-X
2114	2	.14	Pointer Knob Kurz-Kasch S292-3L
2117	1	1.00	Index
2119	1	2.00	Dial
2136	1	.32	Fuse Holder, Bussman HKP
2137	2	.50	Binding Post, Johnson 111-103
2138	4	.02	Feet, Hart Mfg. Co. #11
2141	1	.02	Tie Point, Cinch 1513A
2148	1	3.18	Oscillator Board
2152	1	.86	Coupling, Millen 39006
2162	1	3.00	Range Switch, Oak 51976-F2C
2193	1	.64	Line Cord, Royal Electric 18 2 SV
2196	1	.04	Strain Relief, Heyman 5P
	1	2.78	Panel

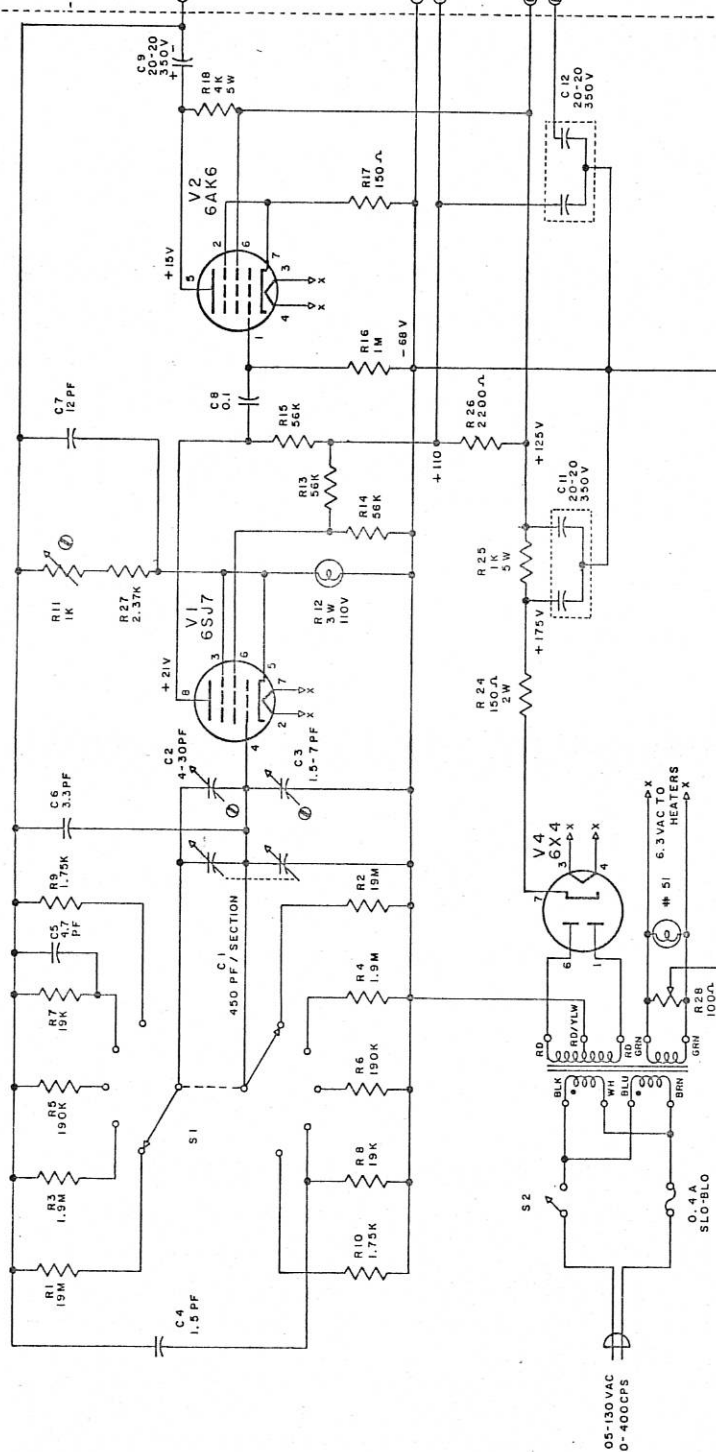
Notes

S1 SHOWN IN "X" POSITION
 R11 ADJUSTED FOR 10 VOLTS MAXIMUM
 OUTPUT ON "B" MODEL, 5 VOLTS MAXIMUM
 ON "C" MODEL
 ALL VOLTAGES MEASURED FROM CHASSIS
 WITH 20,000- Ω /VOLT METER
 AND LINE VOLTAGE OF 117
 CAPACITY IN μ F UNLESS OTHERWISE NOTED
 K=1000 OHMS
 M=1 MEGOHM

OUTPUT STAGE ON "C" MODEL

OUTPUT STAGE ON "B" MODEL

510 SERIES EXTENDED RANGE AUDIO OSCILLATOR



OSCILLATORS • VOLTMETERS • TRANSMISSION SETS

(½ c to 12 mc)

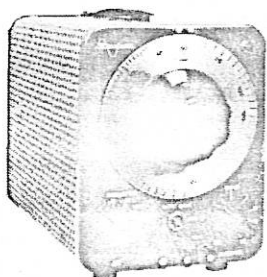
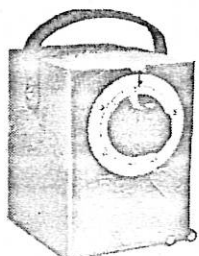
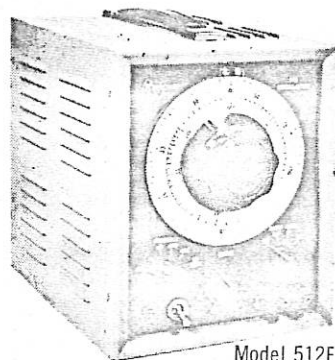
(10 c to 4 mc)

(30 c to 400 kc)



INCORPORATED

For LABORATORY, FIELD and SYSTEMS INSTALLATIONS

Model 401C
OscillatorModel 510B Extended
Range OscillatorModel 520A
Amplifier
VoltmeterModel 512F Sine Wave
Generator

400 SERIES OSCILLATORS—Stable, low distortion, Bridged-T oscillators. All 400's (and 470's below) have large, vernier-driven dials, calibrated attenuators, flat outputs, and sharply reduced switching and tuning transients. Standard options include frequency range, output power, sine or sine/square operation, calibration in volts or dBm, and portable or rack.

470 SERIES OSCILLATORS—*Precision Plus* counterparts of the 400 series oscillators. Used for unusually tight specifications: dial accuracy $\pm 1\%$, distortion $\frac{1}{4}\%$ at 1 kc, and output flatness $\pm \frac{1}{2}$ dB.

510 SERIES OSCILLATORS—Log control adjusts wide range, low distortion output. 510B calibrated in volts, 510C in dBm. All 510's deliver lab quality signals in the field! Briefcase portable with 520 meter. Bolt-on balancing transformers available.

511A AUDIO-VIDEO GENERATOR—A new, all solid state member of our briefcase portable family. Sine waves 10 c to 12 mc, square waves 10 c to 1 mc.

512F SINE WAVE GENERATOR—The only generator of its type to deliver high signal purity, wide range and high power from such a small package: distortion 1/10% at 1 kc, $\frac{1}{2}$ c to $\frac{1}{2}$ mc, 50 V, 2 W/6000 Ω . Output impedance of 6 Ω in series with 1000 ufd makes the 512F a virtual constant voltage generator. Especially useful for servo, electro-mechanical, and magamp work.

600 SERIES AUTOMATIC RESPONSE PLOTTING SYSTEMS—Custom designed to meet specific production test requirements.

610B AUDIO SWEEP GENERATOR—All electronic sweep signal source utilizing a voltage controlled oscillator. Sweep width 20 c to 20 kc. Speed variable 6 to 60 seconds. Characteristic logarithmic. Flatness ± 1 dB. Output 5 V, 100 mW, 6000 Ω . Programming internal or external. Built-in attenuator and frequency meter. Briefcase portable, too! \$1000.

620A DISPLAY DRIVE UNIT—Companion to the 610B sweeper. D-C outputs drive X and Y of scopes and recorders in production test stands. Contains a log a-c voltmeter with 40 dB range and a log frequency meter. Again, briefcase portable! \$600.

520 AMPLIFIER-VOLTMETER SERIES—Only 1/6 the size of equivalent instruments! Illuminated $4\frac{1}{4}$ " meter. Sensitive and wide range yet substantially unaffected by powerline transients. Use as amplifier does not affect meter accuracy.

452 SERIES TRANSMISSION SETS — Rapid, accurate measurements without computation at all levels mike to line: gain, loss, send/receive levels, noise, and frequency response. Continuous tuning and metering. Accuracy $\pm \frac{1}{4}$ dB, 15 c to 15 kc; accuracy $\pm \frac{1}{2}$ dB, 15 c to 50 kc. Output level continuously variable -70 to +20 dBm; meter reads -72 to +52 dBm. All common broadcast and telephone impedances. Less than 1/10% distortion. 7" relay-rack panel.

452A calibrated in dBm, \$1000. 452B calibrated in VU, \$1000. Telephone Carrier 452 models available.

461 SERIES TWO-TONE GENERATORS — For SSB measurement and intermodulation testing. Simple, reliable design for field use. Each tone available to +10 dBm or, after combining through the hybrid system, to +12 dBm. Total cross-modulation products 60 dB below combined output. Frequency ranges, level stability, impedance switching, etc., are selected by customer.

precision in miniature electronic instruments

OSCILLATORS • VOLTMETERS • TRANSMISSION SETS

SUMMARY OF SPECIFICATIONS

Generators	Frequency Range	Dial Accuracy	Bands	Frequency Response	Unloaded Output V	Output Power	Distortion 1 kc	Source Impedance	Power Drain	Weight Lbs.	Size (in) H W D			Price
401B	10c to 100kc	±3%	4 decades	±1 dB	20	160mw	1/4%	600Ω	60	12	8	x 6	x 10½	\$180.
401C	10c to 100kc	±3%	4 decades	±1 dB	20	500mw	1/2%	90Ω	60	12	8	x 6	x 10½	200.
401F	1c to 1mc	±3%	6 decades	±1 dB	20	160mw	1/4%	600Ω	60	12	8	x 6	x 10½	325.
401H	5c to 600kc	±2%	5 decades	±1/2 dB	20	160mw	1/4%	600Ω	60	12	8	x 6	x 10½	220.
402A	10c to 1.5mc	±2%	5 decades	±1/2 dB	16	100mw	1/10%	600Ω	60	12	8	x 6	x 10½	450.
403B	1c to 100kc	±3%	5 decades	±1 dB	20 sine; 20 pp sq	160mw	1/4%	600Ω	70	12	8	x 6	x 10½	350.
471B	10c to 100kc	±1%	4 decades	±1/2 dB	20	160mw	1/10%	600Ω	60	12	8	x 6	x 10½	250.
471F	1c to 1mc	±1%	6 decades	±1/2 dB	20	160mw	1/10%	600Ω	60	12	8	x 6	x 10½	385.
473B	1c to 100kc	±1%	5 decades	±1/2 dB	20 sine; 20 pp sq	160mw	1/10%	600Ω	70	12	8	x 6	x 10½	410.
473C	1c to 1mc	±1%	6 decades	±1/2 dB	20 sine; 20 pp sq	160mw	1/10%	600Ω	60	12	8	x 6	x 10½	560.
510B	20c to 1mc	±3% to 200kc ±10% to 1mc	4 decades +.2 to 1.1mc	±1 dB below 200kc	10 V	4 ma	1%	400Ω	40	6	6	x 4¼	x 6	180.
510C	20c to 1mc	±3%	4 decades +.2 to 1.1mc	±1/2 dB	8 V	+10dBm	1/4%	600Ω	40	6	6	x 4¼	x 6	200.
511A	10c to 12mc	±3%	6 decades	±1 dB	6 sine; 6 pp sq	200mw	1/4%	50Ω	30	6	6	x 4¼	x 6	700.
512F	1/2c to 500kc	±1%	6 decades	±1/2 dB*	50 V	2W(1kc)	1/10%	5Ω	110	18	9½	x 7¼	x 11½	475.
Voltmeter		Input Impedance		Voltage Ranges		Accuracy		Power	Weight	Size (in) H x W x D			Price	
Miniature AC VTVM		10MΩ shunted by 24 pf		.001 V to 300 V full scale (12 ranges)		(110 V - 120 V) 2% 20 cps-1 mc 5% 10 cps-2 mc 10 cps-4 mc (reduced accuracy) Null indication to 4MC		40 W	6	6 x 4½ x 7½			\$250.00 \$300.00	
520A linear														
520L logarithmic														

* ±2 db on lowest range

ADDITIONAL SPECIFICATIONS—ALL GENERATOR MODELS

HUM: Less than 0.01% rated output (—80 dB)

FREQUENCY STABILITY: ±½%, 110 to 120 V

LINE FREQUENCY BEAT: ¼ dB maximum excursion near supply frequency

SUPPLY POWER — A MODELS: 105 to 130 V or 210 to 260 V, 50 to 400 c

OPTIONAL FEATURES — Prices, weights and dimensions above are for portable instruments. See mounting section below for systems installations. Instruments of the 512, 401 and 402 type available with special decade ranging for non-recurring set-up charge of \$200. Frequency response may be held closer than ±½ dB over a portion of the range — eliminating the need for metering the output in production testing of amplifiers, etc. Send us your specifications for quotation.

RACK & PANEL MOUNTING

All Waveforms instruments are available for rack or panel mounting in systems.

PANEL MOUNT P

An oversized front panel is both mounting plate and escutcheon. Instrument installs in rectangular cut-out with 4 screws. Removable for field use. Add suffix P to instrument number. Price: \$10.

RACK MOUNT R

Instrument(s) are assembled on a 7" x 19" relay-rack panel. Up to 2 of any instrument described above. Add suffix R to instrument number. Price: One instrument: \$20. Two instruments: \$25.

HALF-RACK ½R

One instrument assembled on a 7" x 9½" panel. Add suffix ½R to instrument number. Price: \$20.

CUSTOM MOUNT PR

A 7" x 19" rack panel cut out to receive panel mount instruments. Add suffix PR to instrument number. Price: One instrument: \$20. Each additional instrument: \$5.

Waveforms
INCORPORATED

333 Sixth Avenue, New York, N. Y. 10014 • (212) 929-2795

MODELS 510B & 510B-P
WIDE-RANGE AUDIO OSCILLATORS

The WAVEFORMS Models 510B and 510B-P Wide-Range Audio Oscillators are precision sources of distortion-free signals in the audio and ultrasonic range.

The 510B is intended for portable and bench use, and is small enough to be carried in a briefcase. It is operable from 50-400 cycle power lines. It is most convenient for airborne applications and for field maintenance and testing of sound or high fidelity systems. It is equally suitable for laboratory or production applications requiring a high degree of precision or reliability.

The 510B-P is identical to the 510B electrically and mechanically, except that the 510B-P is intended for panel mounting. The front panel of the 510B-P Oscillator is wider by $\frac{1}{2}$ " and higher by 1" than that of the 510B. This overlap beyond the case permits the 510B-P to be bolted into any panel or console by using the mounting holes at the top and bottom of the panel.

The WAVEFORMS 510B Oscillator is a resistance-capacitance tuned oscillator with a frequency range of 18 cycles to 1.1 megacycles in five overlapping ranges. Amplitude is stabilized by heavy feedback in conjunction with a negative-resistance thermal element, so that the distortion is exceptionally low and the output amplitude is essentially independent of frequency over the entire tuning range. The oscillator is isolated from the load by a cathode follower which provides an internal impedance of about 400 ohms with a signal-current capability of 4 milliamperes.

The oscillator may be removed from its case for inspection and maintenance simply by removing two screws at the left rear. The three electrolytic capacitors required are held in plug-in sockets, and all three are of the same type; thus, only one capacitor type is required for replacement purposes.

SPECIFICATIONS

Range

18 cycles to 1.1 megacycles in five overlapping ranges: 18-210 cycles (x1), 180-2,100 cycles (x10), 1,800-21,000 cycles (x100), 18,000-210,000 cycles (x1KC), and 0.18-1.1 megacycles (x1MC).

Calibration Accuracy

The calibration error will not exceed $\pm (2\% + 1 \text{ cycle})$ from 18 cycles to 210 KC or $\pm 10\%$ from 0.18-1.1 MC (x1MC Range). Instruments especially calibrated to have percentage deviations no greater than 1% from 10 cycles to 200 KC may be identified by the letter "A" in their serial numbers.

Stability

$\pm 0.3\%$ for line voltage variations from 105 to 130 volts, and $\pm 0.5\%$ for ambient temperature range 0 to $+ 50^\circ \text{C}$.

Output Level

10 volts open circuit. Maximum load current: 4 milliamperes. Maximum output: $+ 15 \text{ dbm}$ into a 2,000 ohm load.

Frequency Response

The output voltage is constant within $\pm 0.5 \text{ db}$ from 18 cycles to 200 KC for any setting of the output control.

Distortion

	100 cycles to 20 KC	30 cycles
2 volts (10K load)	less than 0.2%	less than 0.4%
10 volts (10K load)	less than 0.4%	less than 0.8%
2 ma load current	less than 1.0%	less than 1.0%
4 ma load current	less than 2.0%	less than 2.0%

Hum and Noise Level

2 millivolt or 60 db below signal, whichever is greater.

Power Supply

40 watt, 117 volts (nominal), 50-400 cycles.

Tube Complement

1 6SJ7, 2 6AK6, 1 6X4.

ACCESSORIES

Matching Transformers

Two models of Matching Transformers are available for operating the 510B Oscillator into balanced lines. Each is supplied in a case which fastens to the bottom of the 510B Oscillator, so that the transformer is always conveniently available. It is recommended that the Matching Transformer be ordered with the oscillator to take advantage of factory assembly of the complete instrument.

	<u>T10</u>	<u>T11</u>
Impedance	150/600	135/600
Max. output into rated load	± 8 dbm	± 10 dbm
Frequency Response	20 cycles-50 KC	20 cycles-200 KC
Price	\$40.00	\$90.00

Attenuators

Although the output control can be conveniently adjusted for output levels as low as 0.01 volt, it is suggested that an attenuator be used between the oscillator and the load when less than 0.1 volt is required. The WAVEFORMS Series 100 Plug-In Attenuators are available in decade ranges for this application. This procedure will permit convenient voltage adjustment over a wider range, and preserve an excellent signal-to-hum ratio. Price: \$5.00 each.

RACK AND PANEL MOUNTING

510B-P Oscillator (Panel Mounting)

The small size of the 510B-P Oscillator permits its use in rack and console systems where conventional instruments are ruled out because of their bulk. The 510B-P Oscillator is intended for such use. It is identical to the 510B except that it is assembled on an oversize panel with mounting holes top and bottom for immediate installation. Mounting details are shown in the drawing at the back of this manual. Price: \$10.00 extra.

500 Rack Panel

The Series 500 Rack Panels are 7" by 19" steel panels designed to mount in a standard relay rack. On each, up to three 510B-P Oscillators and/or 520A-P Voltmeters can be mounted. All Series 500 Panel models are identical except for drilling. The 500A is drilled for one instrument, the 500B for two, and the 500C for three. Price: 500A \$20.00, 500B \$25.00, 500C \$30.00.

CONTROLS

Frequency: The output frequency is controlled by the large dial, in conjunction with the Range Switch. Frequency for the four lowest ranges (x1, x10, x100, x1KC) is read on the outer dial scale, while the frequency for the highest range (x1MC) is read on the inner scale.

Amplitude: The output control is logarithmically tapered, so that accurate and convenient adjustment may be made over its entire range. It is marked in terms of RMS output volts. While this calibration is very convenient for many applications, it should not be relied upon if precision is required.

With the output control set at 10 (full), the open-circuit output voltage at 1000 cycles will be 10 volts $\pm 10\%$.

Turning the output control all the way counter-clockwise turns the oscillator off.

Fuse: A 0.4 ampere sb-blo fuse is located on the back of the instrument. (Bussman Manufacturing Company MDL 4/10).

OPERATION

Output: The output of the 510B Oscillator appears across the output binding posts. Under normal conditions of operation, the d-c potential difference appearing across these binding posts should be negligible. The "high" terminal is connected directly to the cathode of the cathode follower, and this terminal is held at the same d-c potential as the chassis. Electrically, the output of the oscillator may be represented by a resistance of approximately 400 ohms in series with a capacitance of 20 microfarads, for signal frequencies, and under linear operating conditions (output current less than 4 milliamperes). The d-c resistance across the output terminals is 56,000 ohms.

It is undesirable to connect the output terminals across a d-c potential of more than a few volts, as some increase in distortion may result. Potentials greater than 50 volts may damage the electrolytic capacitor in the output circuit. An external blocking capacitor should be used if it is necessary to operate the oscillator across a large d-c voltage.

Load Impedance: The output tube is a 6AK6 cathode follower, offering a source impedance of about 400 ohms. The cathode follower has a signal current capability of 4 milliamperes RMS at less than 1% distortion. Thus, it will deliver 8 volts across 2000 ohms, 4 volts across 1000 ohms, etc. At lower output currents the distortion is considerably reduced - at 2 volts across 2000 ohms, for example, the distortion will be less than 0.3%.

It should be noted that the output capability of the oscillator may

be limited where the load is not predominately resistive, i.e., where significant reactive currents are drawn by capacitance or inductance in the load circuit.

Operation at Low Output Levels: Although the output control can be conveniently adjusted for output levels as low as 0.01 volt, it is suggested that an attenuator be used between the oscillator and the load when less than 0.1 volt is required. The WAVEFORMS Series 100 Plug-In Attenuators are available in decade ranges for this application. This procedure will permit convenient voltage adjustment over a wider range, and preserve an excellent signal-to-hum ratio.

Effects of High Humidity: All the critical surfaces of the 510B Oscillator are ceramic or other high grade insulating material, treated to repel moisture. However, if the oscillator has been left in a very moist atmosphere, erratic behavior may be noticed on the lowest ranges. This will usually clear up after the unit has been operated for a short time, and the moisture films have been vaporized.

If erratic behavior persists, the tuning capacitor mounting board should be cleaned to remove conductive dust particles. In cleaning this board, care should be taken not to change the adjustment of the trimmer capacitors or the amplitude rheostat.

Hum: The 510B power supply uses a full-wave rectifier and power transformer. No bypass capacitors are used across the primary to avoid bringing the chassis to any definite potential with respect to the a-c line. Some improvement in hum when making measurements may be obtained by experimenting with the power plug polarities of the oscillator, the equipment under test, and any other associated measuring equipment. The 510B should not be located too near low-level circuits, since the hum field of its power transformer may be disturbing.

MAINTENANCE

It is recommended that for any maintenance beyond tube replacement or similar routine servicing, the unit be returned to the factory.

When replacing tubes or the stabilizing lamp, it is desirable to measure the oscillator distortion on a sensitive distortion meter. A poor tube or lamp may increase the distortion without otherwise affecting performance.

Intermittent or erratic operation is usually due to a loose or defective 3-watt lamp, an electrolytic capacitor which has worked loose in its socket, or the effects of excessive humidity (see above).

High distortion on all ranges and at all output levels is generally caused by either the 3-watt lamp or the oscillator 6AK6. Distortion occurring only at high output levels will probably be due to the cathode follower 6AK6. Distortion occurring only on the lowest range is usually due to grid current in the 6SJ7.

GUARANTEE

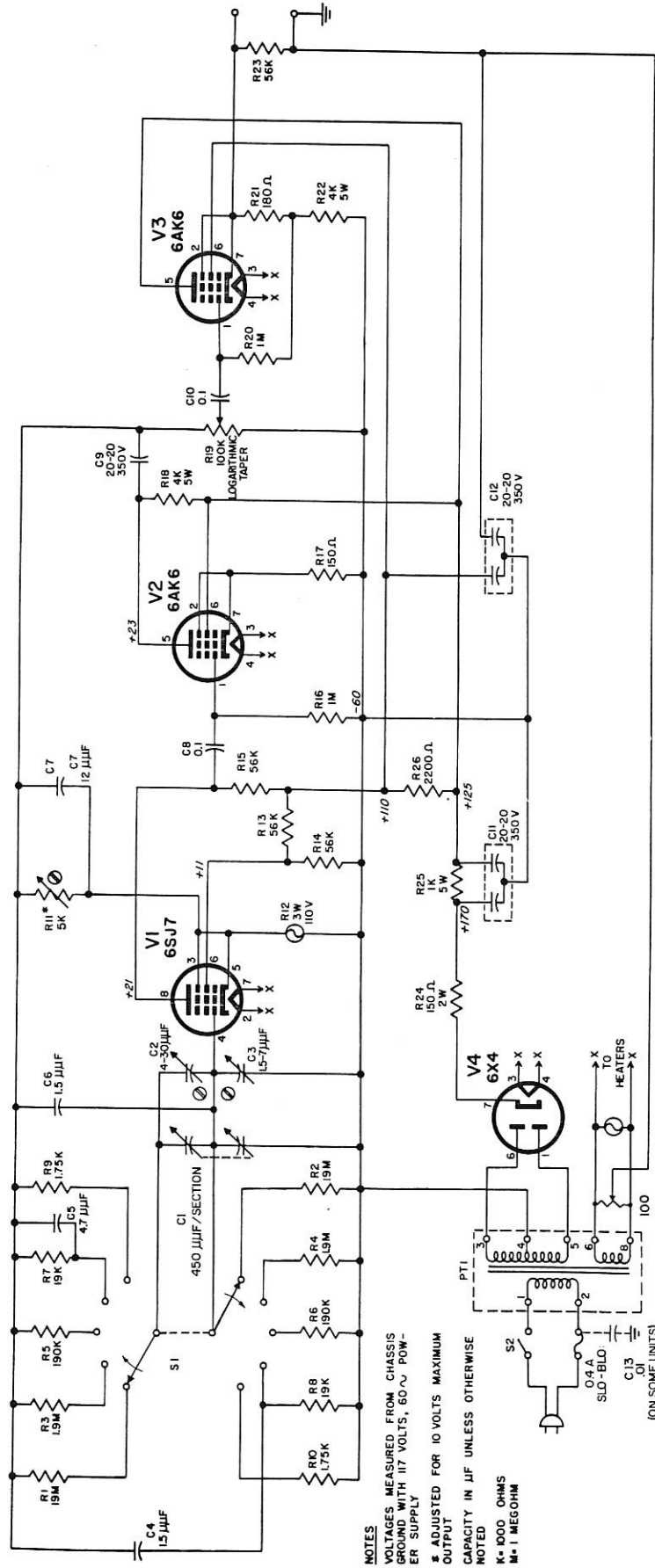
This instrument was carefully tested, inspected, and packed, and left our factory in perfect operating condition. It should be inspected and tested as soon as it is received. If damage is discovered, a claim should be filed with the carrier at once, and WAVEFORMS should be notified.

WAVEFORMS unconditionally guarantees its instruments to be free of defects in materials and workmanship. Our liability under this guarantee is limited to the replacement of parts in any instrument returned to the factory for that purpose within one year of the date of shipment. However, tubes are subject to the standard RMA guarantee. Equipment returned to us for servicing must be carefully packed and shipped with transportation charges prepaid.

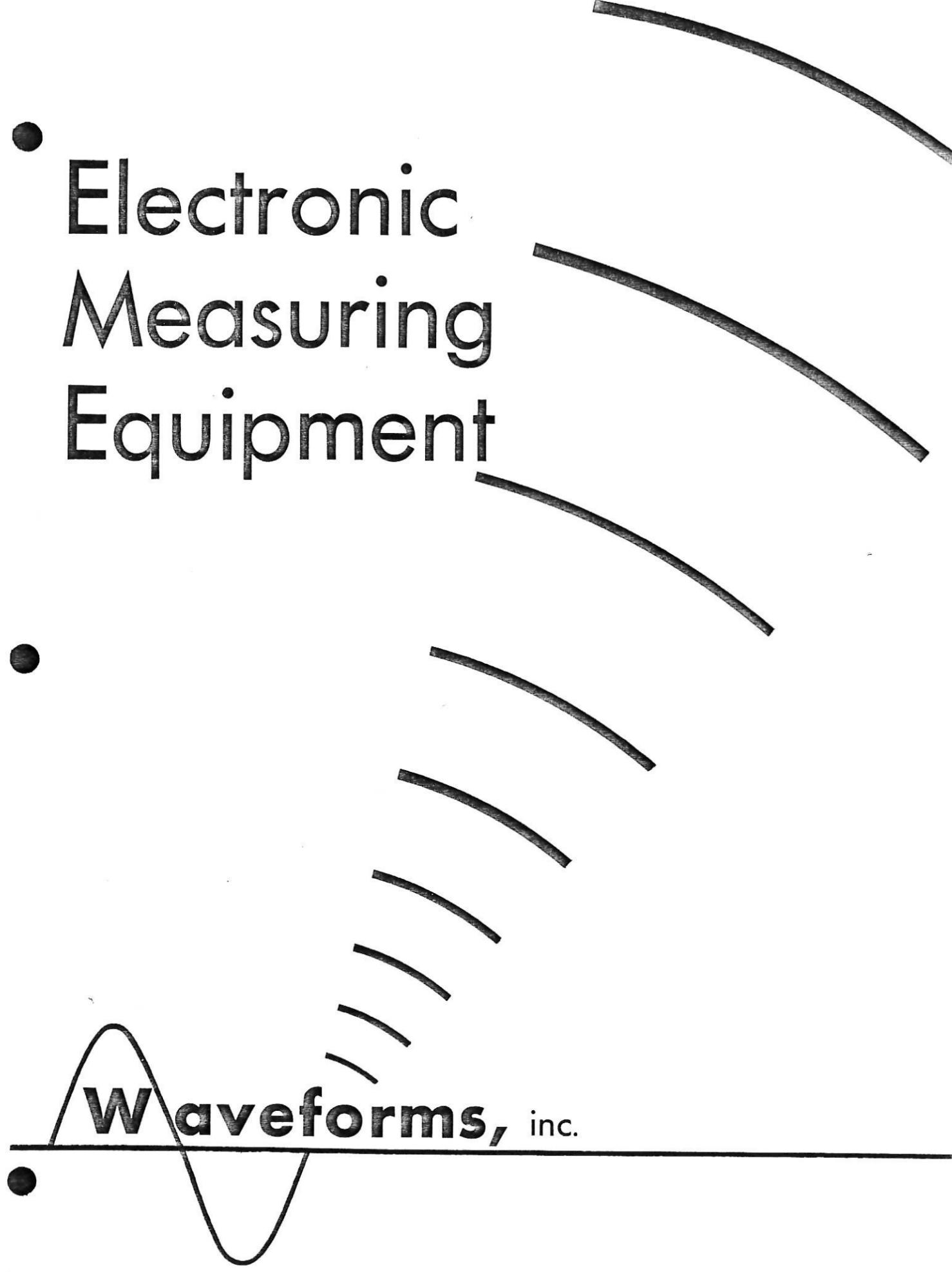
If any difficulty should develop with this instrument, please notify us giving details of the difficulty, and include the type and serial number of the instrument. We shall immediately reply, giving service information or shipping instructions.

If the difficulty proves to have been caused by misuse or abuse of the instrument, or if the guarantee has expired, we shall repair or replace all parts which are defective or are approaching the end of useful life, and re-calibrate the instrument. When returned to you, your instrument will fully meet all specifications of a new instrument. The charge for this service is \$22.

IF WE CAN BE OF ANY ASSISTANCE, PLEASE CALL ON US



510B EXTENDED RANGE AUDIO OSCILLATOR



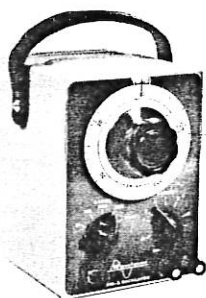
Electronic
Measuring
Equipment

Waveforms, inc.

Sine-Wave Generators

Waveforms, inc. offer a family of unique and high quality electronic measuring instruments. Unique, because we offer the smallest, lightest equipment of laboratory quality available. Waveforms instruments possess properties far superior to those of competitive design. The output level control system utilized in all Waveforms oscillators is the most flexible in the industry. All Waveforms instruments can be supplied for mounting compatible with *your* system requirements.

510B Extended Range Audio Oscillator



Model 510B Audio Oscillator is the smallest, most compact instrument of laboratory quality available anywhere. It, together with the companion Voltmeter (Model 520A), fits into an engineer's briefcase with *room to spare*. The output—maximum 10 volts—is adjustable by a logarithmically tapered control calibrated approximately in volts so that levels down to a few millivolts can be easily set. The distortion at mid frequencies at full output is less than 0.4%—less than 0.2% at 2 volts output. The rise at forty cycles is to 0.8% and 0.4% respectively. Noise is below 1 millivolt.

400 Series General and Special Purpose Oscillators

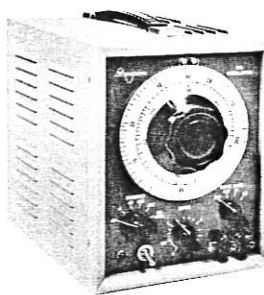
The 400 series general and special purpose sine-wave oscillators feature the Bridge T circuit in an advanced form. Switching and tuning transients are virtually eliminated. The customary steep rise in distortion at frequency extremes is absent. Distortion is less than 1/10%. Frequency stability is within $\pm 1/2\%$ for line voltage variations from 105-130 volts—temperature changes from 0° to 50° C. All 400 series instruments have extremely flexible output control systems. In addition, the oscillator output is brought to a separate SYNC terminal. This is a constant voltage source for driving counters or synchronizing oscilloscopes. In those models which include an amplifier, the SYNC is available for checking filters or where extreme signal purity is required. All 400 series instruments provide a vernier drive dial of at least 4 1/2" diameter.



MODEL 401B is an extremely pure sine-wave source over the range 9 cps-120 kc. It provides four decade ranges with 10% overlap at either end of dial. The Bridge T oscillator is not followed with an amplifier. Thus, the inherent high signal purity of the oscillator is not subject to deterioration due to amplifier tube or component aging. Field service problems are minimized by virtue of the simplicity of the circuitry. The instrument delivers 10 volts into a 600 Ω load (± 22 dbm). The output control system consists of a five position decade control and a logarithmically tapered fine output control. This system is calibrated in volts into 600 Ω and has a decade accuracy of $\pm 2\%$ —a fine

output accuracy of $\pm 10\%$. Any output voltage above 100 microvolts may be accurately selected without use of external pads, attenuator boxes and the like. To retain the output voltage calibration when working the instrument into a high impedance, an internal 600 Ω resis-

512 Series Sine-Wave Generators



The series 512 Sine-Wave Generators are actually three-in-one instruments featuring high power, low distortion, and wide tuning range—yet smaller and lighter than conventional audio oscillators of laboratory quality. They provide six tuning ranges and a vernier driven 5" dial. Output is 50 volts open circuit or a full 2 watts into a 600 Ω load (34.5 volts, ± 33 dbm). Output is constant within $\pm 1/2$ db above 5 cps and within ± 2 db below 5 cps. Power capability is reduced to 1 watt at 1/2 cps. Power capability may be reduced above 100 kc as a function of reactive components in the load. Distortion is below

1/10% over most of the tuning range for levels up to 3 db below maximum *both open circuit and loaded* and less than 2/10% at full output. The series 512 output system provides continuous control of output down to 1/2 millivolt. Output controls are calibrated in volts—the four step decade control $\pm 2\%$, the logarithmically tapered control $\pm 10\%$.

MODEL 512 includes five decade ranges from 1 cps and a sixth band spread range from 100-510 kc for carrier and filter measurements.

MODEL 512F offers six decade tuning ranges from 0.5 cps-510 kc. A single dial scale is tracked—a minimum of 10% overlapping is provided above and below the decading.

tor may be switched across the output terminals. When the 401B is operated into a high impedance without this 600 Ω load, the output voltage will be twice the calibrated marking or 20 volts at full output. The instrument may be so used without any sacrifice in performance in applications where voltages greater than 10 volts into a high impedance are required.

MODEL 401C differs from the 401B in that an amplifier follows the Bridge T oscillator. It is a low impedance source providing higher power signals of high purity. At full output, it delivers 20 volts into a high impedance or 1/2 watt into 600 Ω (± 27 dbm, 17.3 volts). The output control system consists of a 100:1 (40 db) switch attenuator and a logarithmically tapered control, calibrated in volts. Any output voltage above 1/2 millivolt may be accurately selected. Above 100 cps the distortion is less than 1/4% at any level or load of 600 Ω or above. Below 100 cps, the distortion is less than 1/4% with a 600 Ω load—at full output or into a high impedance at levels up to 10 volts.

MODEL 402A covers the range 9 cps to 1.5 mc. Four decade bands cover the range 9 cps-120 kc. A fifth band tunes from 120 kc to 1.5 mc. The wide tuning range, low distortion, flexible output system, and freedom from line frequency interference make the 402A an ideal instrument for field testing of telephone and telemetering carrier equipment. The 402A is extensively used in laboratories requiring the widest possible level control and frequency range. At full output the 402A delivers ± 20 dbm (8 volts) into a 600 Ω load. A five position step attenuator of 20 db/step in conjunction with a fine output control of from 0-30 db loss permits accurate setting to any level from -80 dbm to ± 20 dbm. The unique design of the attenuation system permits constant output within $\pm 1/2$ db over the entire tuning range for any attenuator setting. As with other 400 series instruments, the voltage output will be doubled if operated into a high impedance—without deterioration in performance. This method of operation may be convenient for laboratory applications requiring more than 8 volts. Distortion of a typical 402A is less than 0.07% over the audio range.

SPECIFICATIONS

Model	Frequency Range	Dial Accuracy	Bands	Frequency Response	Output Voltage	Output Power	Distortion	Source Impedance	Power Consumption	Weight	H.	Size W.	D.	Price*
401B	9 cps to 120 kc	±2%	4 decades	±½ db	16	+20 dbm into 600 Ω	1/10%	600 Ω	60 W	12	8	6	10½	\$125
401C	9 cps to 120 kc	±2%	4 decades	±½ db	20	½ W into 600 Ω	¼%	100 Ω	60 W	12	8	6	10½	\$150
402A	9 cps to 1500 kc	±2%	4 decades +120-1500 kc	±½ db	16	+20 dbm into 600 Ω	1/10%	600 Ω	60 W	12	8	6	10½	\$200
510B	18 cps to 1100 kc	±2% 18 cps-210 kc ±5% 210-1100 kc	4 decades +180-1100 kc	±½ db 18 cps-210 kc	10	4/ma into 2500 Ω	2/10%	400 Ω	40 W	6	6	4¼	6	\$150
512	9/10 cps to 510 kc	±2% 9 cps-510 kc ±5% .9-9 cps	5 decades +90-510 kc	±½ db	50	2 W into 600 Ω	1/10%	50 Ω	110 W	18	9½	7¼	11½	\$325
512F	½ cps to 510 kc	±2% 5 cps-510 kc ±5% .5-5 cps	6 decades	±½ db above 5 cps ±2 db below 5 cps	50	2 W into 600 Ω	1/10%	50 Ω	110 W	18	9½	7¼	11½	\$350

SPECIALS

Prices, weights and dimensions above for portable instruments. See Mountings section for instruments designed for systems installation. The 512, 401 and 402 type instruments may be obtained with special decade ranging for a non-recurring set-up charge of \$200. Instruments may be held to a response far closer than ±½ db over a portion of their range. This can eliminate the need for metering the output in production testing of amplifiers, etc. Send us your specification requirements for quotation.

*Price for ±2% calibration accuracy. Add \$25. for ±1—accuracy—any model. Price includes 6 ft. two conductor type SJ line cord. For three conductor line cord add \$5.

Additional Specifications—All Models

DIAL ACCURACY: ±2%; ±1% on special order

HUM: Less than 0.01% rated output (–80 db)

FREQUENCY STABILITY: ±0.5% 105-130 V 0-50° C.

SUPPLY POWER: 105-130 volts 50-400 cps

LINE FREQUENCY BEAT: ¼ db maximum excursion in vicinity of supply frequency

520A SENSITIVE AMPLIFIER-VOLTMETER

MODEL 520A is the smallest (less than 6 pounds) AC amplifier-voltmeter of laboratory quality available. It is at once briefcase portable, yet ideally suited for rack or console systems. The 520A is an average reading device calibrated in RMS volts for a sine-wave input. Equipped with a 4¼" Weston meter in illuminated case. Scales include 0-1 and 0-3 volts, –12 to +2 db. An output jack provides 1 v maximum output at 600Ω—usable without disabling the meter. Remarkably free from switching and line transients. 12 linear ranges are provided from 1 mv (–60 dbm) to 300 v (+50 dbm) in 12 overlapping ranges. Overall accuracy is ±3% of full scale 20 cps-1 mc and ±5% 10 cps-2 mc. Usable as a null indicator to 4 mc. Input impedance 10 MΩ shunted by 24 mmf. Power requirement is 105-130 volts, 50-400 cps, 40 watts. Price \$200.



452 SERIES TRANSMISSION MEASURING SETS

The series 452 Transmission measuring sets are designed by work with audio transmission systems in broadcasting facilities, recording studios, telephone systems and sound installations. They are self-contained and direct reading for all gain, response, loss, noise and signal to noise measurements from 15 cps to 50 kc. Price: 452A \$600. 452B \$700.

Unlike other types of transmission measuring instruments, the Series 452 sets combine both a measuring and a generating device into one compact and easily mounted unit requiring only 7¼" of height in a standard 19" rack. Neither external pads, generators or meters are required. The precision AC voltmeter incorporated in the sets permits direct measurement of all levels from noise to line, at any commonly used impedance either matching or bridging. The generator consists of a continuously variable oscillator of extreme signal purity, followed by a precision decade attenuator and fine output control. All levels from microphone to line may be fed to any commonly used impedance either balanced or unbalanced. A switch permits transfer of the voltmeter input from the signal generator to its own input system. The instruments are completely direct reading. No calculations or corrections are required regardless of the input or output

impedances of the equipment under test. Great care has been taken with the panel layout marking. No previous experience is required by operator. Errors of connection or reading are virtually impossible. The 452A is direct reading in power level at any commonly used impedance. The 452B is direct reading in voltage level at any commonly used impedance based on the standard: 0 VU = 0.7746 volts. The 452B scales are calibrated in VU and those of the 542A in dbm.

SPECIFICATIONS

GENERATOR

Frequency Range:	10 cps-120 kc
Frequency Accuracy:	±1%
Output Level Range:	±20 dbm to –70 dbm, continuously variable
Output Accuracy:	600Ω Unbalanced ±¼ db 10 cps-120 kc 600Ω and 150Ω Balanced ±¼ db 15 cps-15 kc 50Ω and 250Ω Balanced relative
Output Impedance Accuracy:	600Ω Unbalanced ±5% 10 cps-120 kc 600Ω and 150Ω Balanced ±5% 30 cps-15 kc 50Ω and 250Ω Balanced relative
Distortion:	Less than 0.1%
Noise:	80 db below full output

LEVEL-METER

Level Range:	Unbalanced (10M Ω) ±¼ db 10 cps-100 kc 600Ω and 150Ω Balanced ±¼ db 15 cps-15 kc 50Ω and 250Ω Balanced relative
Input Impedance:	600Ω and 150Ω Balanced ±5% 30 cps-15 kc
Matching:	50Ω and 250Ω Balanced relative
Bridging Impedance:	above 10 K Ω
Meter Ranges Full Scale (all common impedances):	–60 dbm to +50 dbm in 10 db steps

ACCESSORIES

For balanced output, two transforming units are available for use with the Model 510B Audio Oscillator. They are supplied in matching cases which fasten securely to the bottom of the Model 510B.

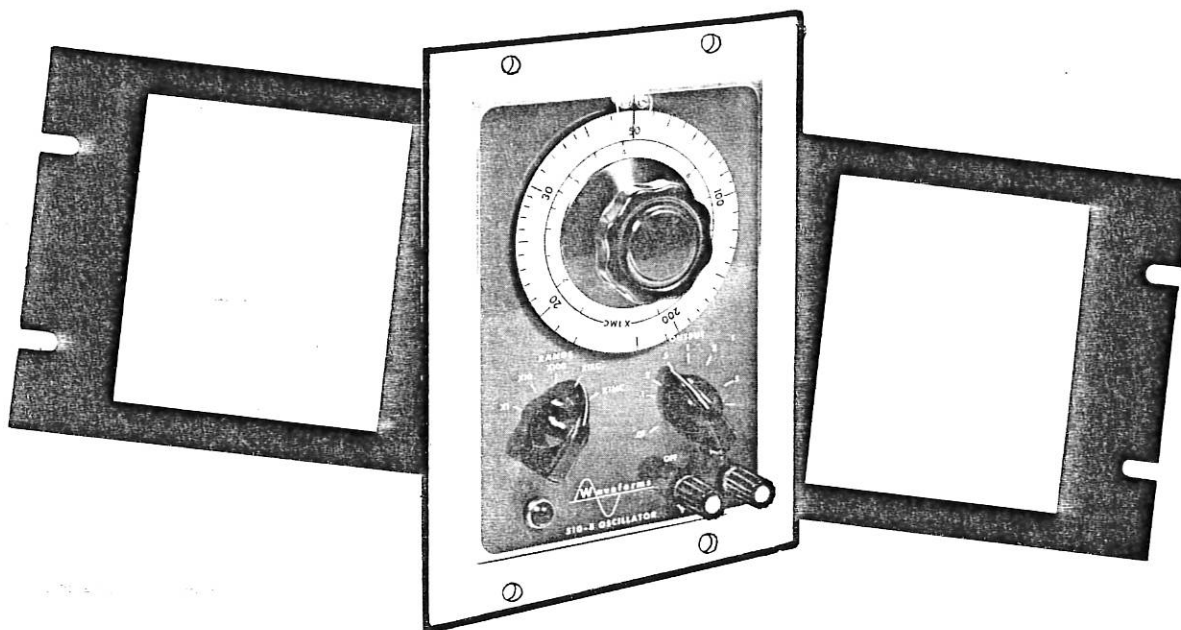
Transformer T10

+8 dbm
150/600
20-50,000 cps
\$40

Output level
Impedance
Range
Price

Transformer T11

+10 dbm
135/600
20-200,000 cps
\$90



INSTRUMENTS FOR INSTALLATION

All Waveforms instruments can be furnished for mounting compatible with *your* system requirements. Advanced packaging and tooling techniques enable us to provide this service at production—not custom—cost. One of the four plans described below should be ideal for your particular system needs. The instruments can also be furnished in panel size, material and finish of your specifications.

PANEL MOUNT "P" The instrument is assembled on an over-size panel which serves as both mounting plate and escutcheon. The instrument is easily installed in your system by means of a rectangular cutout and four screws. Drilling details and panel dimensions are shown below. The 400 and 512 series can be furnished with the long panel dimension either vertical or horizontal, designated "V" or "H" respectively. Price \$10. extra.

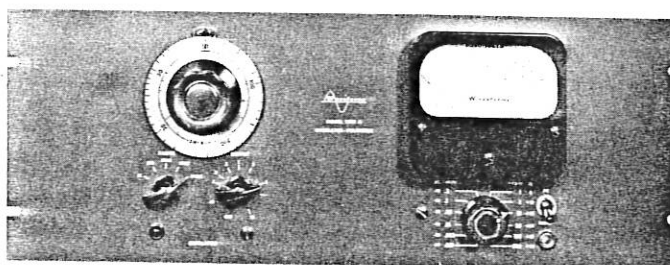
RACK MOUNT "R" The instrument(s) are supplied assembled on a 7" x 19" relay rack panel. Panel capacity is up to three 510B and/or 520A, up to two 400 or 512 series, or one 400 or 512 series and one 510B or 520A. One instrument: \$20., \$5. each additional instrument.

HALF RACK MOUNT "-1/2R" One instrument assembled to a 7" x 9 1/2" (half rack) panel. Price \$20. extra.

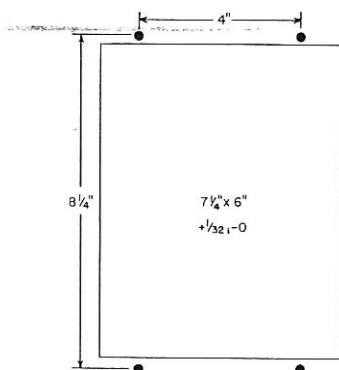
CUSTOM MOUNT "-P-R" The ultimate in flexibility. The Catalog number 500 7" x 19" Panel may be ordered cut out to receive up to three 510B and/or 520A in its left (A), center (B) or right (C) drilling positions. This Custom Mount permits instant availability of your instrument for bench servicing without removing the entire panel from the rack. In those cases where accessories must be installed on our panel, the instrument may be removed from the panel to avoid damage during drilling and wiring operations. The No. 500 Panel and its associated "P" instruments are usually ordered unassembled. However, they may be ordered as a complete assembly by the code "-P-R". Price \$20. drilled for one instrument, \$5. extra each additional instrument.

1501 ASSEMBLY

While Waveforms instruments can be assembled in almost any combination, customer demand has been greatest for an oscillator-voltmeter combination of small size. Waveforms has met this demand with the 1501 combination package consisting of a 510B and 520A assembled to a 7" x 19" relay rack panel. Signal connections to the 1501A via 3 ft. coaxial pig-tails to the rear of the instruments. Connections to the 1501B via binding posts on the front. Price (either model) \$385.

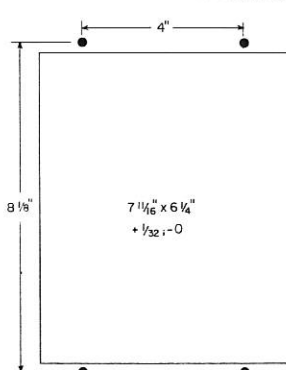


ORDERING EXAMPLES: 510B. Portable with feet and handle. \$150.; 510B-P. Panel mount to fit rectangular cutout. \$160.; 510B-R2. Two 510B's on a 7" rack panel. \$325.; 510B-P-RB. A model 510B-P bolted to a 500 Custom Mount in the center of the panel. \$180.; 401C-PH. Panel mount with long dimension horizontal. \$160.



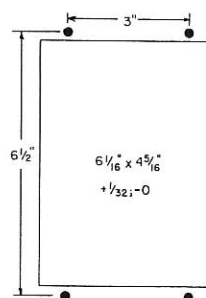
512-512F

Panel Size 8 1/2" x 6 1/2"



400 Series

Panel Size 8 3/4" x 6 1/2"



510B-520A

Panel Size 7" x 4 3/4"