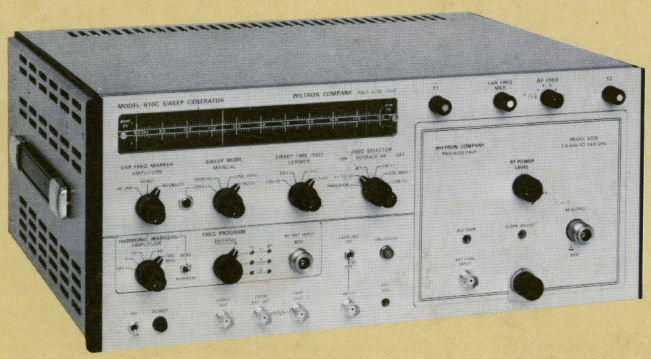
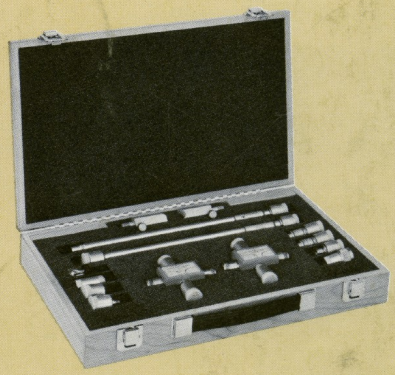
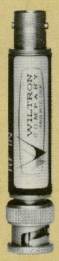
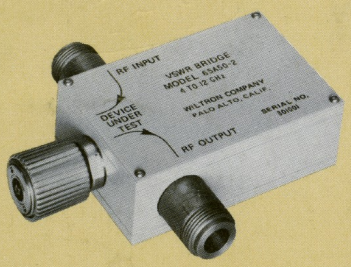
WILTRON '73

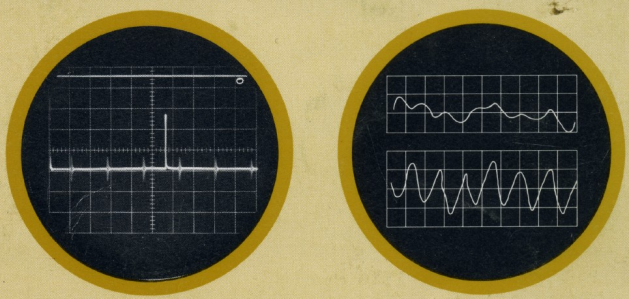
CATALOG OF GENERAL PURPOSE INSTRUMENTS

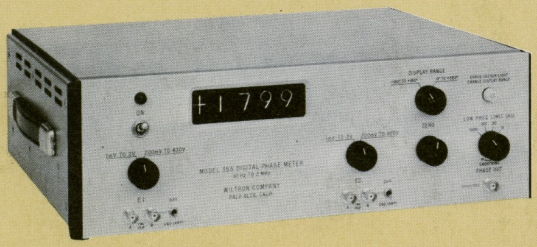












RF COMPONENTS

SWEEP GENERATORS

SWR AUTOTESTERS

AUDIO-VIDEO PHASE METERS

BETTER MEASUREMENTS FROM WILTRON

930 EAST MEADOW DRIVE, PALO ALTO, CALIFORNIA 94303

TEL. (415) 321-7428 • TWX 910-373-1156

Short Form Product Listing

Model 6200

Dual Band Sweep Generator Plug-ins

Model	Frequency Range GHz	Sweeps Entire Range Or Any Portion	Max Level Output mw/(dBm)	Max Level Variation Int. Level (dBm)	Slope Control	Page
6211	0.5-2.0	Yes	20 mw (+13 dBm)	±0.3	Yes	3
6215	1.0-4.0	Yes	20 mw (+13 dBm)	±0.3	Yes	3
6219	2.0-8.0	Yes	5 mw (+ 7 dBm)	±0.4	Yes	3
6223	4.0-12.4	Yes	5 mw (+ 7 dBm)	±0.5	Yes	3
6229	7.9-18.5	Yes	8 mw (+ 9 dBm)	±0.8	Yes	3

Sweep Generator Model 610C

Solid State Sweep Generator

Model	Frequency Range	Sweep Time	Variable Marker	Modulation	Frequency Control	Page
610C	100 kHz to over 18GHz	0.01 — 100 sec.	1% Accurate	FM, AM, 1 kHz	Slide rule dial, start-stop, ΔF, CW	4, 5, 6, 7

Harmonic Marker

Option 1 Generates Frequency Comb of 1, 10, 50, 100 MHz — Page 5

Sweep Generator Plug-Ins

MODEL 61083C
10 MHz TO 1220 MHz

MODEL 6110C
1 GHz to 2 GHz

MODEL 6128C
7.9 GHz TO 12.4 GHz

MODEL 6130C-1
12.4 GHz TO 18.0 GHz

Single Band Sweep Generator Plug-ins

Model	Plug-in Range (MHz)	Sweeps Entire Area Or Any Portion	Max Level Output mw/(dBm)	Max Level Variation Int. Level (dB)	Slope Control	Built-in Attenuator Calibrated in 1 dB Steps (dB)	Page
6104C	0.1-110	Yes	20 mw (1 Vrms)	±0.15	—	79	8, 9
61041C	0.1-110	Yes	1 watt (7 Vrms)	±0.25	—	59	8, 9
6106C	1-300	Yes	50 mw (1.6 Vrms)	±0.35	—	79	8, 9
61082C	10-1,220	Yes	20 mw (1 Vrms)	±0.35	Yes	—	8, 9
61083C	10-1,220	Yes	20 mw (1 Vrms)	±0.35	Yes	69	8, 9
6110C	1,000-2,000	Yes	20 mw (+13 dBm)	±0.35	Yes	—	8, 9
6112C	1,400-2,500	Yes	20 mw (+13 dBm)	±0.25	Yes	—	8, 9
6114C	2,000-4,000	Yes	20 mw (+13 dBm)	±0.35	Yes	—	8, 9
6120C	3,600-4,300	Yes	20 mw (1 Vrms)	±0.25	Yes	—	8, 9
6122C	5,900-6,500	Yes	20 mw (1 Vrms)	±0.25	Yes	—	8, 9
6124C	4,000-8,000	Yes	5 mw (+ 7 dBm)	±0.4	Yes	—	8, 9
6125C	4,000-6,000	Yes	10 mw (+10 dBm)	±0.35	Yes	—	8, 9
6127C	6,000-8,000	Yes	10 mw (+10 dBm)	±0.35	Yes	—	8, 9
6128C	7,900-12,400	Yes	10 mw (+10 dBm)	±0.45	Yes	—	8, 9
6130C	12,400-18,000	Yes	8 mw (+ 9 dBm)	—	Yes	—	8, 9

Model 80
1 GHz-12.4 GHz

Precision Reflectometer Set

A new standard of accuracy for the measurement of SWR over the frequency range of 2 to 12.4 GHz. 60dB effective directivity from a unique combination of bridges and precision air lines. Permits measurements of 50dB return loss accurately.

Page 10-13

SWR Autotester
Model 63N50

SWR Autotesters

Series	Description	Impedance	Frequency	Directivity	Page
63	Highest Performance	50 and 75 ohms	10 — 4000 MHz 10 — 2000 MHz	40 dB	16
67	Inexpensive	50 and 75 ohms	10 — 1000 MHz 10 — 1000 MHz	40 dB	16

and Index to 1973 Catalog

Wide Band SWR Bridge
Model 65A50-2 4-12.4 GHz

SWR Bridges

Series	Description	Impedance	Frequency	Directivity	Page
68	Baseband to RF	50 and 75 ohms	50 kHz – 32 MHz 50 kHz – 32 MHz	50 dB	17
66	Highest Directivity	75 ohms	50 – 100 MHz	60 dB	17
60	Wide band	50 ohms	10 – 2000 MHz	40 dB	17
64	Extended C band	50 ohms	3 – 8 GHz	36 dB	17
65	Extended X band	50 ohms	7 – 12.4 GHz	36 dB	17

Logarithmic Level Meter
Model 501

Logarithmic Amplifiers

Model	Frequency Range Swept or CW	Sensitivity	Dynamic Range	Calibrated Offset	Calibrated DC Output	Page
501	.01 – 18 GHz detector dependant	–40 dBm	–40 dBm to +20 dBm	More than 60 dB	10, 5, 2, 1 or 0.5 dB per volt	18
501A	1 – 2000 MHz 5 – 500 MHz	–40 dBm –80 dBm	–40 dBm to +20 dBm –80 dBm to –40 dBm	More than 60 dB	10, 5, 2, 1 or 0.5 dB per volt	18

General Purpose RF Detector
Model 71B50

Wide Frequency RF Detector
Model 74N50

RF Detectors

Model	Type	Frequency Range	Connectors IN	Connectors OUT	Flatness	Page
71 B50	General Purpose	100 kHz – 3 GHz	BNC Male	BNC Female	±0.5 dB	19
74 N50	Wide Band	10 MHz – 12.4 GHz	BNC Male	BNC Female	±0.5 dB 10 MHz – 8 GHz ±0.7 dB – 12.4 GHz	19
77 S50	Linear	100 kHz – 1 GHz	SMA (OSM) Male	SMA (OSM) Female	±0.7 dB	19

Model 3114

Line Stretcher

Model 3114 60 cm Line Length Variations with 0.1 mm resolution, dc to 18 GHz — Page 20

Programmable Attenuator

Model 655 125 dB Attenuation in either 1 dB steps to 1250 MHz or
Model 656 0.1 dB steps dc to 500 MHz — Page 21

Differential Input Phase Meter
Model 351

Audio Video Phase Meters

Model	Frequency Range	Differential or Single Ended Inputs	Readout Method	Input Levels	Page
350	10 Hz – 2 MHz	Single Ended	Meter	1 mV – 400 V	24
351	10 Hz – 2 MHz	Single Ended or Differential	Meter	1 mV – 400 V	25
352	0.5 Hz – 500 kHz	Single Ended or Differential	Meter	1 mV – 400 V	26
355	10 Hz – 2 MHz	Single Ended or Differential	Digital	1 mV – 400 V	27

Transmission Level
Return Loss Measuring
Set Model 9041

Portable Transmission Level and Return Loss Test Sets

Model 9041 is a portable test set which measures Transmission Level, Echo Return Loss and Singing Point on 2 or 4-wire circuits. Rack mount version is Model 9042.

Model 9031 is similar to Model 9041 but it does not include the direct measurement of Transmission Level.

Model 9032 is a rack mount version of Model 9031.

Page 30

(9301 and 9463)
ITMS

Integrated Transmission Measuring Systems

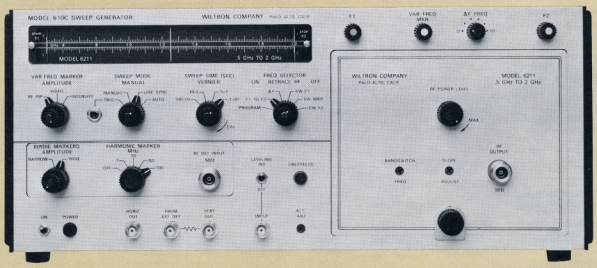
Model 9101 ITMS System (Integrated Transmission Measurement System) provides measurement functions at up to ten test positions.

Model 9102 DTMS System (Dedicated Transmission Measurement System) provides measurement functions dedicated to a given test position.

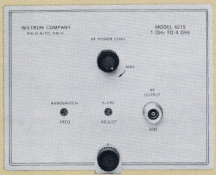
Readout is from digital displays, panel or aisle mounted. Control panels are designed to fit directly into test boards, using minimum space. They can be located up to 250 ft. from the measurement equipment.

Page 30

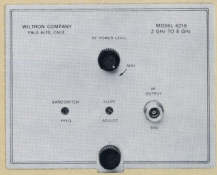
WILTRON 6200 Series
Sequentially Swept Plug-ins



The WILTRON 610C Sweep Generator with Model 6211
0.5 to 2.0 GHz Plug-in

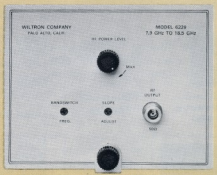


Model 6215 1.0 to 4.0 GHz:
Covers the popular 1-2 GHz and 2-4 GHz bands in one continuous sweep. No need to switch bands or exchange plug-ins.



Model 6219, 2.0 to 8.0 GHz:
Provides continuous coverage for important communication bands.

Model 6223 4.0 to 12.4 GHz:
Extends coverage to the C and X bands. When coupled with the Model 6215, coverage is extended from 1 to 12.4 GHz.



Model 6229, 7.9 to 18.5 GHz:
Excellent ECM unit. Covers X and Ku Bands generously. When coupled with the Model 6219, coverage is extended from 2 to 18.5 GHz.

Multiband Sweep Plug-ins 0.5 to 18.5 GHz

The WILTRON 6200 Series Solid State RF Plug-ins are the industry's first complete line of dual-band, sequentially swept units. They provide wide frequency coverage without switching between RF drawers or manual band selection within a drawer. The frequency range of 1 to 12.4 GHz or 2 to 18.5 GHz is covered by only two units; coverage from .01–12.4 or 0.5–18.5 in just three.

WILTRON Sweep Generators produce outputs of high power and exceptional spectral purity. Harmonics are substantially reduced through the use of built-in filtering. Spurious are typically 60 dB down. Residual FM is closely controlled, typically 0.0025% of band when swept and 0.0012% in the CW Mode.

All models have front panel slope control which allows the operator to compensate for the frequency response of the test setup. Each plug-in may be equipped for internal leveling. On the internally leveled units, external leveling is accomplished by applying the leveling signal to the Model 610C Sweep Generator Main Frame. The 6200 Series Plug-ins are compatible with both the 610B and 610C mainframes.

Band switching and RF multiplexing to produce sequential sweep is accomplished electronically within the individual plug-in. The band switch point may be moved by means of a front panel adjustment should it fall on a frequency of interest. There are no gaps in the display as the band switch point shows only as an intensity mark on the oscilloscope, and has no effect on X-Y plotters.

SEQUENTIALLY SWEPT DUAL BAND R.F. PLUG-INS COVERING 0.5 to 18.5 GHz

Plug-In Model		Power and Leveling			Frequency Accuracy*			Modulation	Signal Purity			Output 50Ω N	Price	
	Sequentially Swept Frequency Range (GHz)	Max. Output (Ext. Level Models)	Max. Level Output (Int. Level Models)	Max. Level Variation (Int. Level Models)	At 25°C	With 10% Line Voltage Change	Frequency Pulling 3:1 SWR	AM Depth	Residual FM (peak) CW Mode	Spurious	Harmonics (Note C)	Output SWR	Internal or External Leveling	External Leveling Only (Model-1)
6211	0.5 – 2.0	25 mw (+14 dBm)	20 mw (+13 dBm)	±0.3 dB	2%	.001%	.02%	20 dB	7 kHz	60 dB	30 dB	1.25	$2550	$2250
6215	1.0 – 4.0	25 mw (+14 dBm)	20 mw (+13 dBm)	±0.3 dB	2%	.001%	.02%	20 dB	10 kHz	60 dB	30 dB	1.35	$3350	$3000
6219	2.0 – 8.0	6 mw (+8 dBm)	5 mw (+7 dBm) Note A	±0.4 dB	2%	.001%	.02%	20 dB	15 kHz	60 dB	30 dB	1.50	$3950	$3650
6223	4.0 – 12.4	6 mw (+8 dBm)	5 mw (+7 dBm) Note B	±0.5 dB	2%	.001%	.02%	20 dB	15 kHz	60 dB	30 dB	1.80	$4300	$4000
6229	7.9 – 18.5	10 mw (+10 dBm)	8 mw (+9 dBm)	±0.8 dB	2%	.001%	.02%	20 dB	20 kHz	60 dB	30 dB	2.0	$4950	$4450

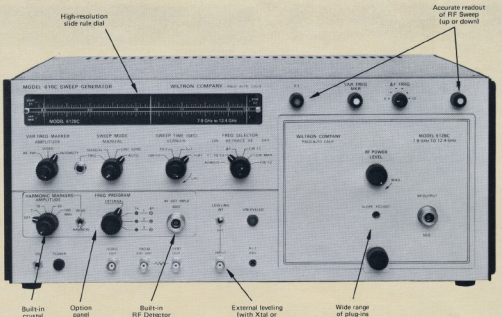
*Frequency accuracy of .01% available on models 6211, 6215, 6219 by means of Option 1 Model 610C. Crystal controlled harmonic markers at 1, 10, 50 and 100 MHz.

NOTES:
A. 20 mw (2 – 4 GHz)
B. 10 mw (7.9 – 12.4 GHz)
C. Excluding 5% band edges.

See following pages for the specifications of the WILTRON sweep generator main frame (Model 610C) which houses above plug-ins.

All Solid State Sweep Generators 100 kHz to Over 18 GHz

MODEL 610C



THE ONLY QUALITY MICROWAVE SWEEPER AVAILABLE WITH HARMONIC MARKER COMB

Besides being an all-solid-state sweeper with a wide range of plug-ins the WILTRON 610C is the only microwave sweeper available with the highly-desirable feature of harmonic markers (optional). Further, these markers are provided in the video output circuit rather than in the rf output to avoid introducing transient effects.

IMPORTANT FEATURES OF THE 610C INCLUDE:

Plug-ins to cover the 100 kHz to over 18 GHz range

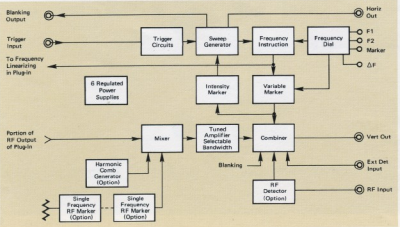
Transistor and Gunn-effect fundamental oscillators in plug-ins

Internal leveling

Built-in RF detector to 3 GHz

Amplitude and intensity markers (in addition to optional harmonic markers)

BLOCK DIAGRAM OF MAIN FRAME MODEL 610C



100 KHz to 18.5 GHz R.F. PLUG-INS

Single Band Plug-ins

- Frequency Coverage from 100 KHz to over 18 GHz
- Wide Selection of Over 14 Units
- All Solid State Construction
- Two Year Oscillator Warranty
- Unique Panel Slope Control
- Built-in Isolation and Filtering

Dual Band Plug-ins

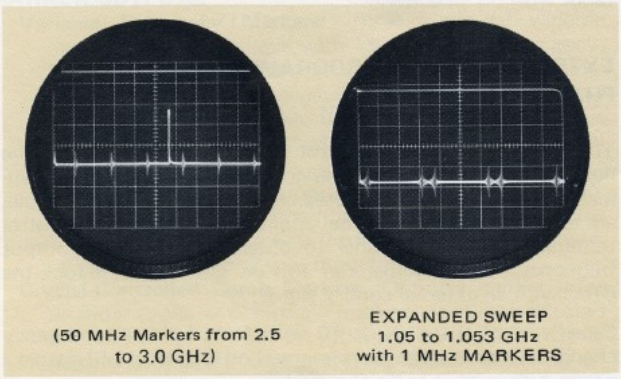
- Frequency Coverage from 0.5 to 18.5 GHz
- 2 to 18.5 GHz in two units
- 1 to 12.4 GHz in two units
- Highest Output Power

EXCLUSIVE WILTRON FEATURES GIVE YOU PRECISE FREQUENCY INFORMATION, CONVENIENT FREQUENCY MARKING, AND VERSATILE FM CAPABILITY.

HOW TO USE WILTRON CRYSTAL MARKERS IN SWEEP-FREQUENCY TESTING

Crystal marker combs are especially convenient in determining the frequency of points of interest in sweep-frequency displays. The WILTRON 610C system of built-in optional frequency markers is a precise but inexpensive system that provides a comb consisting of harmonics of 1, 10, 50 or 100 MHz, accurate within ±0.01%. The markers are usable to at least 8 GHz.

An important advantage of the WILTRON 610C marker arrangement is that the harmonics are provided as a video output signal (VERT. OUT terminal) rather than being provided on the rf output signal itself (see diagram). Thus, the markers can be viewed on an oscilloscope and are coincident in time with the appropriate rf signal but are not a possible source of disturbance to the external circuit being swept.



(50 MHz Markers from 2.5 to 3.0 GHz)

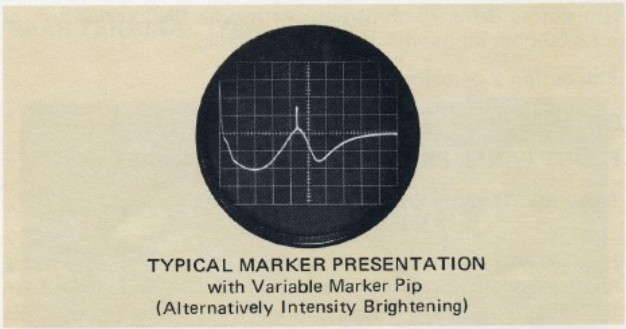
EXPANDED SWEEP
1.05 to 1.053 GHz
with 1 MHz MARKERS

In high-resolution testing the frequency of a point of interest can be quickly and easily measured to virtually the ±0.01% accuracy of the markers. Assume, for example, that a point at 500 MHz is to be measured. By merely setting the "ΔF" sweep control to 500 MHz so that the 500 MHz harmonic marker is in the center of the oscilloscope display and so that the 499 and 501 MHz markers are also displayed, a high-resolution display with virtually 0.01% frequency accuracy is obtained.

The harmonic markers are also useful in measuring frequency shifts or "FM" effects. Here it is only necessary to count the number of markers that pass a given point on the scope display. You thus obtain the amount of frequency change which has occurred from the external process being investigated without need for an expensive frequency counter.

USE THE EXCLUSIVE WILTRON INTENSITY MARKER WHERE ATTENUATION OR AGC ARE PRESENT

An intensity mark is extremely useful since it does not change the shape of the output waveform. WILTRON offers the only sweeper with a built-in Intensity Marking system which can be used with any oscilloscope and does not require 'Z' axis modulation of the scope.



TYPICAL MARKER PRESENTATION
with Variable Marker Pip
(Alternatively Intensity Brightening)

The WILTRON exclusive intensity dot is especially useful for indicators where attenuation or AGC is encountered in the RF path and z-axis modulation is not feasible. Since the dot is generated by merely stopping the sweep briefly and allowing the CRT brightness to build up, it operates independently of all external devices.

To examine an area of interest in detail you merely switch to "ΔF" sweep mode and the area around the marker is immediately displayed. The width of the "ΔF" presentation is independently adjustable and calibrated in % of the band of the plug-in.

TAKE YOUR CHOICE OF TWO FLEXIBLE MARKER OPTIONS

To offer you wide flexibility in marker selection, WILTRON has two optional marker arrangements (options 1 and 3).

Typical multi-option plate incorporating Option 1.

Option 1 provides harmonic markers at spacings of 1, 10, 50, and 100 MHz. Both the amplitude and width of these markers is adjustable, as indicated in the illustration. Marker accuracy is ±0.01%.

Note, too, on the next page how the various possible options may be combined for optimum grouping.

Typical multi-option plate incorporating Option 3.

Option 3 consists of a choice of up to 6 crystal frequency markers at separate frequencies of your choice. These markers may be at frequencies of up to 100 MHz at an accuracy of ±0.01%.

Note on the next page that it is even possible to choose both option 1 and option 3 in the same instrument to obtain a total of 10 different marker frequencies.

Options 1 and 3 are unrelated to and independent of the other markers (intensity, rf and video pips) that are standard in the Model 610C Sweep Generator. Thus, whether or not you choose harmonic markers, you still have these three markers which are positioned by the VAR FREQ MRKER control to a nominal ±1% accuracy.

See option details on next page.

OTHER OPTIONS

OPTION 2

50 Ω, 75 Ω, OR TYPE N DETECTOR

A popular and valuable option in the new 610C is the rf detector which simplifies your test setup and avoids the need to use an external rf detector of unknown performance. The rf detector, when provided, is located on the option plate (see photos below).

Typical multi-option plate incorporating Option 2

The detector is available in three sub-options A, B, or C to give you a choice of (a) a 50-ohm detector input using a type BNC connector, (b) a 75-ohm input with type BNC connector, or (c) a 50-ohm input with type N connector.

The option 2 detector is usable to 3 GHz.

OPTION 4

FRONT PANEL PROGRAMMED FREQUENCIES

(Also see "Remote Programming" at right)

Here is an option that can greatly assist you if your work involves repetitive testing at a few particular frequencies. With this option you have a panel switch that enables you to select any one of three preset rf output frequencies. In addition, you can preset the amount of deviation around these frequencies up to ±50% of the band in which they occur.

Typical multi-option plate incorporating Option 4

In programming the frequencies for these three switch positions, the harmonic markers (if provided) are helpful in obtaining high accuracy for the desired preset frequency. The frequency is preset merely by adjusting the screwdriver controls visible in the illustration.

Note that it is also easy to electrically program the 610C as discussed under "Remote Programming" in the next column.

Option 1 Option 2A

Typical option panels

FM SIGNAL SOURCE

A variety of FM signal source uses are possible with the Model 610C versatile FM modulation capabilities.

In the normal "External FM" setting the bandwidth is in excess of 1 MHz and the deviation is very linear with the applied voltage at all RF output frequencies up to ±2% of the band. This, together with the low residual FM permits easy checking of FM receivers, etc., since the center frequency can be swept slowly across the range of interest without need to re-adjust the modulating voltage level. Sensitivity in this mode is 10 volts for 1% of the band deviation. This also insures low FM modulation distortion of typically 2%.

For wider (FM) deviations, the modulating signal may be inserted into the remote frequency programming terminals on the rear. The entire band may be swept with a 10 volt peak-to-peak input signal. The bandwidth available will be determined by the source impedance driving the 1000 pF input capacitance. A "Fast" FM modulation input is also available on some units which permits deviations over the full range with 50 MHz BW.

EXTERNAL REMOTE PROGRAMMING AND PHASE-LOCKING

To facilitate automatic control of its output frequency, the new Model 610C has been designed to be frequency-programmable. Since the internal sweep oscillators are voltage tunable, an external voltage can be applied to the remote control terminal on the rear panel to obtain a desired CW output frequency. This terminal can also be used to phase lock the 610C with an external control signal.

Sensitivity of the 610C is 10 volts for a full-band frequency change. An ac voltage superimposed on a dc level will enable a sweep-type output to be obtained.

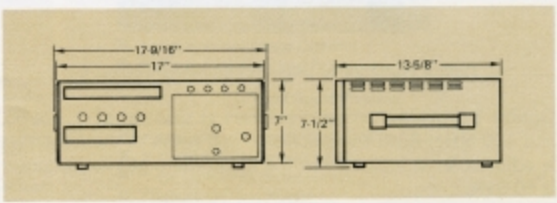
The 610C itself also provides a full-band dc signal at the rear panel which may be used in programming.

COMPLETE COMPATIBILITY WITH –hp– NETWORK ANALYZER

The WILTRON 610C sweep generator is compatible with -hp- network analyzers. In addition, the unique "Intensity" marker can be easily used with all types of network analyzers. Since it does not act on the RF to produce the indications, it can be used with circuits that would otherwise be adversely affected by having the markers pass through them. Order option 10.

LOCAL OSCILLATOR USAGE

Since the WILTRON plug-ins have a pure RF signal with a minimum of harmonics and spurious they are ideally useful as local oscillators in a test system.



Outline Drawing of the 610C

Model 610C Sweep Generator Main Frame Specifications

FREQUENCY RANGE: 100 kHz to over 18 GHz (determined by plug-in).

FREQUENCY DIAL: 7.3 inch linear scale; machine divided.

SWEEP CONTROLS:

Start-Stop: Sweep from F1 to F2. Both F1 and F2 are independently adjustable over full range and can produce either upward or downward sweeps.

ΔF Sweep: Sweeps centered at Variable Frequency Marker setting. Width is adjustable 0 to 10% of the band. Control reads directly in % of the band calibrated up to 10% with ±10% accuracy.

CW Operation: Single-frequency output may be switch-selected at either F1, F2 or Variable Marker settings.

Remote: Permits sweeping with external voltage or programming sweep ΔF and center frequency with external resistors or voltages. See Optional Frequency Programmer below.

MARKER OUTPUTS:

Variable Frequency Markers: Three types of variable marker outputs available with 1% of-the-band accuracy.

RF Pip: Reduces RF momentarily; amplitude adjustable.

Video Marker: Adds negative video pulse to vertical output to oscilloscope. Pip may be added to output of external detector as well as optional internal detector.

Intensity Marker: Develops brightened dot on oscilloscope trace by momentarily slowing sweep. This permits adding markers through AGC-type indicators without need for Z-axis modulation.

Crystal-Controlled Comb Markers: Optional marker units provide comb of "birdie" markers at switch-selected intervals of 1, 10, 50, or 100 MHz. Wide (200 kHz) or narrow widths (12 kHz) may be selected. Accuracy of markers is ±0.01%. All markers usable to 3 GHz, 10, 50 and 100 MHz combs to 8 GHz.

Fixed-Frequency Markers: Fixed markers may be installed on optional basis for up to 6 fixed frequencies up to 100 MHz. Harmonic rich fractional frequency oscillators are used for markers above 100 MHz.

SWEEP TIME: Continuously adjustable in four decade ranges 0.01 to 100 seconds per sweep.

SWEEP MODE:

Auto: Sweep occurs automatically.

Line Sync: Sweep occurs automatically synchronized with power line.

Manual: Front panel control provides continuous manual adjustment of frequency between the end frequencies set. The horizontal voltage out tracks this manual frequency.

Triggered: Single sweep is actuated by front panel push-button or external (>1 μs, +1 to +25 V) signal applied at rear.

RF RETRACE: The RF may be switched ON or OFF during the retrace period.

LEVELING: External leveling may be achieved with a negative detector. In addition, internal leveling is a standard feature on all plug-ins.

SWEEP OUTPUT: Direct coupled sawtooth 0 to +11.2 V concurrent with the sweep.

BLANKING: By means of front panel control the sweeper RF output can be turned off for blanking during the retrace or the RF can be left on during the retrace.

BLANKING OUTPUT: +6 V during retrace. (−4 or +30 on special order.) Near 0 volts during sweep.

MODULATION:

Internal AM: Square wave modulation at 1000 Hz, adjustable in frequency with ON/OFF ratio greater than 30 dB at rated output.

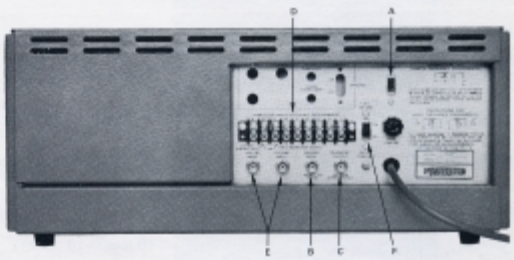
External AM: 60 kHz bandwidth typical. Input impedance approximately 15,000 ohms, ac coupled. Also, see section on external leveling which is dc coupled.

External FM: 1 MHz bandwidth, typical sensitivity 0.1% of full scale bandwidth per volt. Input impedance approximately 18K ohms, ac coupled. Also, see extra FM capability under plug-in specifications.

WEIGHT MODEL 610C MAIN FRAME: 18 pounds; Shipping Weight: 26 pounds.

PLUG-IN WEIGHT: 10 pounds; Shipping Weight: 14 pounds. (Typical)

REAR TERMINAL CONNECTIONS:



A 110/220 V switch operates from 50 to 60 Hz.
B TRIGGER IN permits external triggering of sweep with Pulse larger than 1 μs, +1 to +25 V.
C BLANKING OUT +6 V pulse during retrace. (−4 or +30 volts available on special order).
D REMOTE FREQUENCY PROGRAMMING +10 V for external resistive programming; also input for voltage programming for phase lock.
E EXT AM/FM Inputs
F INT AM

PRICE MODEL 610C: . . . . . $1285.
F.O.B. Palo Alto, Calif. See options below.

PRICE OF PLUG-INS: See Table pages 3, 8 and 9.

OPTIONAL FEATURES: (Provided on front panel option plate)

1. CRYSTAL-CONTROLLED FREQUENCY MARKER COMBS: 1, 10, 50 and 100 MHz marker spacing . . . . . $295.
2A. RF DETECTOR: 50 ohms; BNC jack . . . . . $65.
2B. RF DETECTOR: 75 ohms; BNC jack . . . . . $90.
2C. RF DETECTOR: 50 ohms; type N jack . . . . . $95.
2D. RF DETECTOR: 75 ohms; type N jack . . . . . $105.
3. FIXED FREQUENCY MARKERS: up to 100 MHz (6 maximum); specify frequencies desired . . . . . $95 + $75 per marker.
4. FRONT PANEL FREQUENCY PROGRAMMING CAPABILITY: enables setting up to 3 output frequencies and deviation on front panel . . . . . $80.

OPTIONAL FEATURES: (Terminals at the rear)

5. VERTICAL OUTPUT in parallel with front panel connector; output from internal crystal detector . . . . . $10.
6. HORIZONTAL OUT in parallel with front panel output +15 V sawtooth coincident with sweep . . . . . $10.
7. EXTERNAL INPUT in parallel with front panel input for amplitude modulation, frequency modulation, or leveling input $10.
8. VARIABLE MARKER OUT pulse in time coincidence with variable frequency marker . . . . . $10.
9. PEN LIFT CONTACTS give contact closure during sweep $15.
10. FREQ REF VOLTAGE 0 to 40V, −4V Blanking . . . . . $100.

OPTIONAL ACCESSORIES: Plug-in extender cable . . . . . $95.
Extender card for 610C PC boards . $25.

Industry's Most Complete Coverage of All Solid State Sweep Generator Plug-Ins

Plug-In Model	Frequency Range		Power and Leveling			Built-in Attenuator	Frequency Accuracy			
	Plug-In Range (MHz)	Sweeps Entire Area Or Any Portion	Max. Level Output mw/(dBm)	Max. Level Variation Int. Level	Slope Control	Calibrated in 1 dB Steps	At 25°C	Freq. Change Per °C	With 10% Line Voltage Change	Frequen Pulling 3:1 VS
6104C	0.1 – 110	Yes	20 mw (1 Vrms)	±0.15 dB	–	79 dB	1 MHz	± 50 kHz	.001%	1 kH
61041C	0.1 – 110	Yes	1 watt (7 Vrms)	±0.2 dB	–	59 dB	1 MHz	± 50 kHz	.001%	1 kH
6106C	1 – 300	Yes	50 mw (1.6 Vrms)	±0.3 dB	–	79 dB	3 MHz	± 150 kHz	.001%	10 kH
61082C	10 – 1,220	Yes	20 mw (1 Vrms)	±0.3 dB	Yes	–	8 MHz	± 600 kHz	.001%	1.5 MH
61083C	10 – 1,220	Yes	20 mw (1 Vrms)	±0.3 dB	Yes	69 dB	8 MHz	± 600 kHz	.001%	1.5 MH
6110C	1,000 – 2,000	Yes	20 mw (+13 dBm)	±0.3 dB	Yes	–	1%	± 0.05%	.001%	0.02%
6112C	1,400 – 2,500	Yes	20 mw (+13 dBm)	±0.2 dB	Yes	–	1%	± 0.05%	.001%	0.2%
6114C	2,000 – 4,000	Yes	20 mw (+13 dBm)	±0.3 dB	Yes	–	1%	± 0.05%	.001%	0.02%
6120C	3,600 – 4,300	Yes	20 mw (+13 dBm)	±0.25 dB	Yes	–	1%	± 0.05%	.001%	0.05%
6122C	5,900 – 6,500	Yes	10 mw (+13 dBm)	±0.25 dB	Yes	–	1%	± 0.05%	.001%	0.05%
6124C	4,000 – 8,000	Yes	5 mw (+7 dBm)	±0.4 dB	Yes	–	1%	±0.05%	.001%	0.05%
6125C	4,000 – 6,000	Yes	10 mw (+10 dBm)	±0.3 dB	Yes	–	1%	± 0.05%	.001%	0.05%
6127C	6,000 – 8,000	Yes	10 mw (+10 dBm)	±0.3 dB	Yes	–	1%	± 0.05%	.001%	0.05%
6128C	7,900 – 12,400	Yes	10 mw (+10 dBm)	±0.4 dB	Yes	–	1%	± 0.04%	.001%	0.02%
6130C	12,400 – 18,000	Yes	10 mw (+10 dBm)	±0.5 dB	Yes	–	1%	± 0.04%	.001%	0.02%

(See page 3 for dual frequency range plug-ins.)

OPTIONS:

No. 1. External Leveling Only (See Chart for details).

No. 20. FM Modulation modification to give constant frequency deviation sensitivity at all RF output frequencies up to 550 MHz, available on Models 6104C, 61041C, 6106C, 61082C, and 61083C . . . $275.00.

No. 21. 75 ohm output impedance for Models 6104C, 61041C, 6106C, and 61082C . . . $65.00.

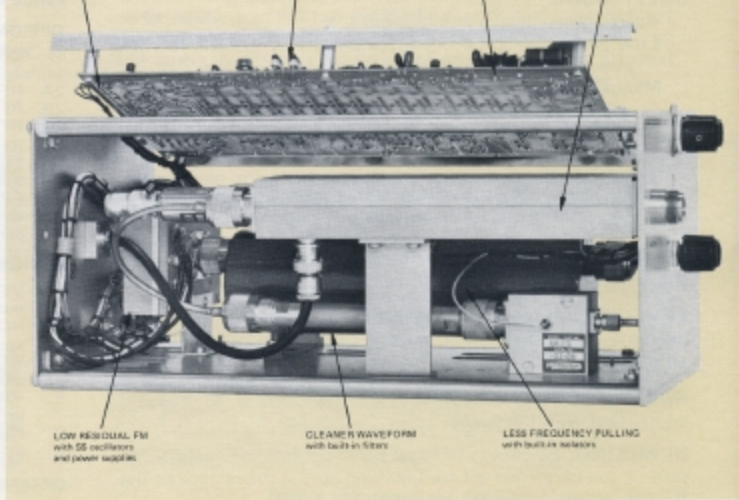
No. 22. 75 ohm output impedance on Model 61083C . . . $95.00.

NOTES:

A. Measured in 30 Hz to 28 KHz bandwidth at 115 vac 60 Hz; approximately twice the residual at 50 Hz.

B. FM is AC coupled thorugh frequency linearizer.

C. Low pass or band pass filters strongly suppress the harmonics inside the 5% band edges.

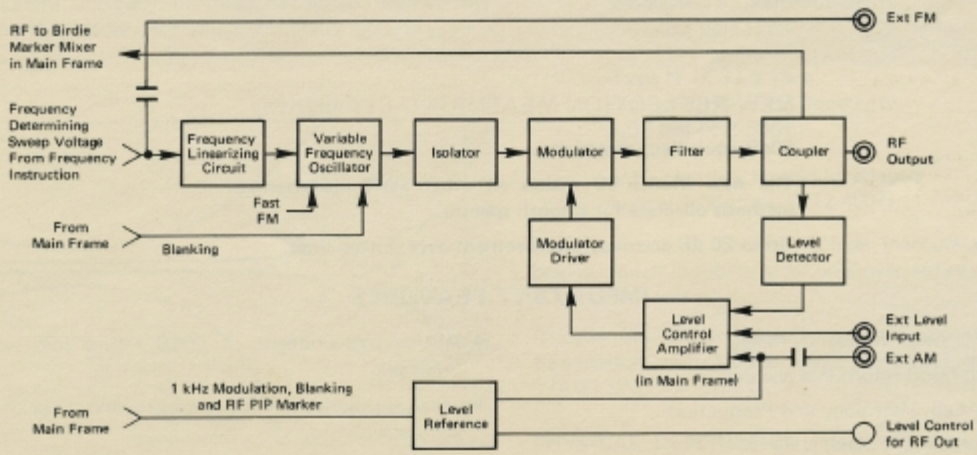


100 kHz to Over 18 GHz

(See page 3 for dual band plug-ins)

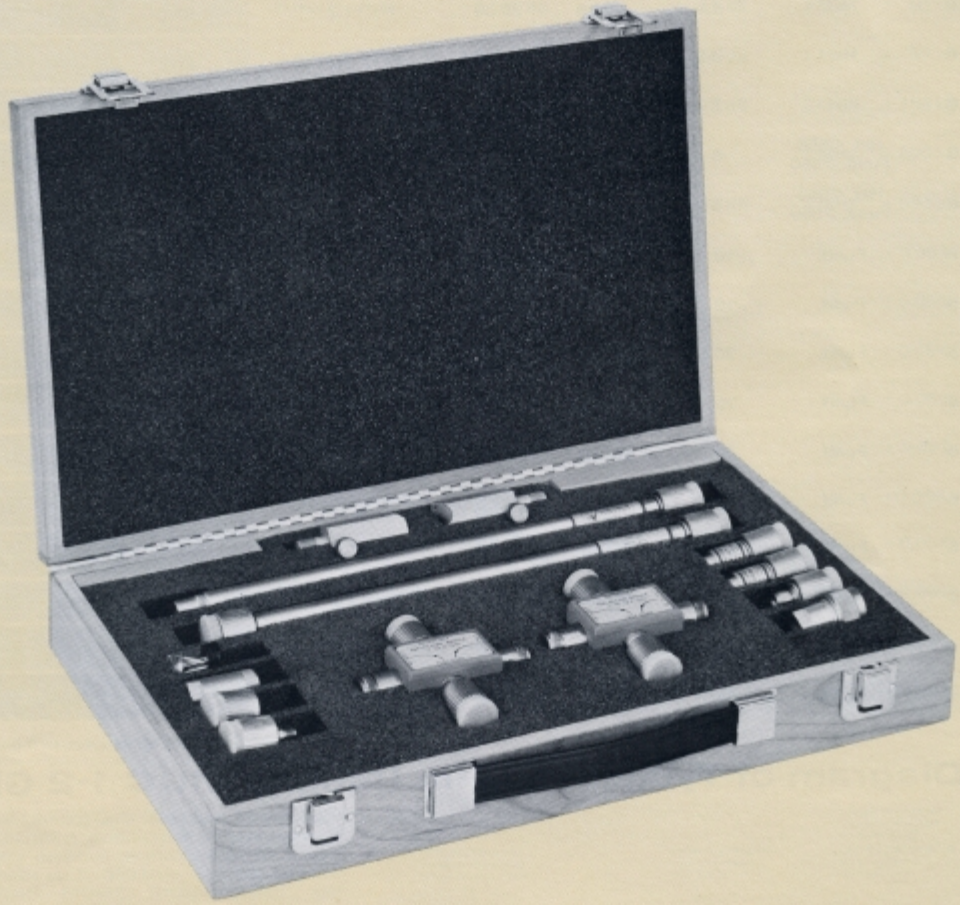
Modulation		Type Osc.	Signal Purity			Output		Price		Plug-In Model
AM Depth	FM(See Notes Below)		Residual fm max. kHz peak Note A CW Mode	Spurious	Harmonics	Output SWR 50 ohms nominal See Option 21, 22 below	Output Connector	Internal and Ext. Leveling	Ext. Leveling Only (Model–1)	
15 dB	B	Het.	0.6	40 dB	30 dB	1.2	BNC	$ 895	–	6104C
15 dB	B	Het.	0.6	30 dB	30 dB	1.2	BNC	$ 1700	–	61041C
30 dB	B	Het.	2	40 dB	30 dB	1.25	BNC	$ 1175	–	6106C
13 dB	B	Het. <550 Fund. >550	8	30 dB	30 dB	1.25	N	$ 1585	–	61082C
13 dB	B	Het. <550 Fund. >550	8	30 dB	30 dB	1.35	N	$ 1885	–	61083C
30 dB	B	Fund.	10	60 dB	30 dB (See Note C)	1.25	N	$ 1835	$ 1600	6110C
30 dB	B	Fund.	10	60 dB	30 dB (See Note C)	1.3	N	$ 1945	$ 1710	6112C
30 dB	B	Fund.	20	60 dB	20 dB (See Note C)	1.4	N	$ 2150	$ 1900	6114C
30 dB	B	Fund.	20	50 dB	30 dB	1.5	N	$ 2475	$ 2120	6120C
30 dB	B	Fund.	20	50 dB	30 dB	1.5	N	$ 2650	$ 2375	6122C
30 dB	B	Fund.	25	60 dB	24 dB (See Note C)	1.5	N	$ 2950	$ 2700	6124C
30 dB	B	Fund.	25	50 dB	20 dB (See Note C)	1.6	N	$ 2600	$ 2365	6125C
30 dB	B	Fund.	25	50 dB	20 dB (See Note C)	1.6	N	$ 2600	$ 2365	6127C
30 dB	–	Fund.	30	60 dB	30 dB	2.0	N	$ 2450	$ 2125	6128C
30 dB	–	Fund.	35	60 dB	30 dB	–	N	$ 3185	$ 2685	6130C

Block Diagram of Typical Plug-In (Model 6110C 1-2 GHz)



Precision Reflectometer Set

MODEL 80



NEW REFLECTION MEASURING STANDARD

60dB equivalent directivity.

The new Model 80 makes all other SWR measurement methods obsolete for smooth spectra.

Up to 20 dB accuracy improvement over slotted lines.

IMPORTANT FEATURES

- 2 to 12.4GHz ***swept*** frequency range.
- Measure 0 to 50dB return loss accurately.
- Suitable for Lab, Metrology and Production.
- Connectors APC-7, N Male, N Female.
- SMA Connectors – accuracy limited only by APC-7 SMA adaptor.
- Allows measurement of 50dB return loss with 5mW sweepers.
- Measures directivity of couplers and hybrids to new accuracies.
- Accuracy limited only by precision air line tolerances.
- No computer or other compensation necessary.

GENERAL DESCRIPTION

The Model 80 Precision Reflectometer Set will greatly increase the accuracy of measurement of smooth spectra reflections from 0 to 50dB return loss. It is equally suited to the most critical standards use and the most general production applications over the range of 2 to 12.4GHz. Directivity measurements can be made with unequaled accuracy by the effective 1.002 SWR termination achieved by the components. The equipment is easy to use, and accuracy may be confirmed by mechanical measurement of the air lines.

The Model 80 Reflection Set uses a beadless precision air line as its standard of accuracy. The air line separates the unknown reflection from the measurement device error, thus as the frequency is swept, the vectors interact causing an ***uncertainty*** ripple. The properties of the Model 80 system allow the unknown reflection to be separated from the error reflection to reduce the ***uncertainty*** to virtually zero.

The system coupled with a high quality sweeper, a precision log amplifier, and an oscilloscope is configured to make measurements both simple and accurate.

PRINCIPLES OF OPERATION

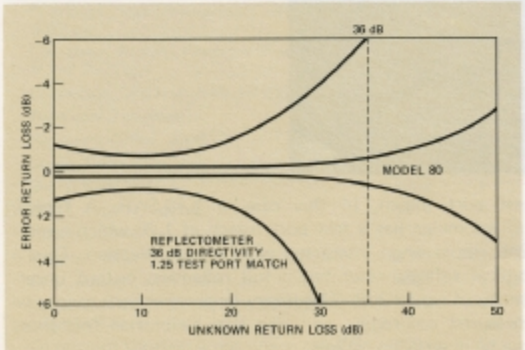
The Model 80 uses three well known basic principles:

1. Phasors separated by distance will display all resultant phases (ripple) when swept over a frequency range.
2. If the phasors are unequal in amplitude and one is known, the other can be readily determined.
3. If the distance separating them is a high precision line, (coaxial or waveguide), the accuracy is limited only by the dimensions of the line and surface effects.

The hardware consists of a precision directional bridge, a high precision beadless coaxial air line, a precision termination, and a selected mismatch.

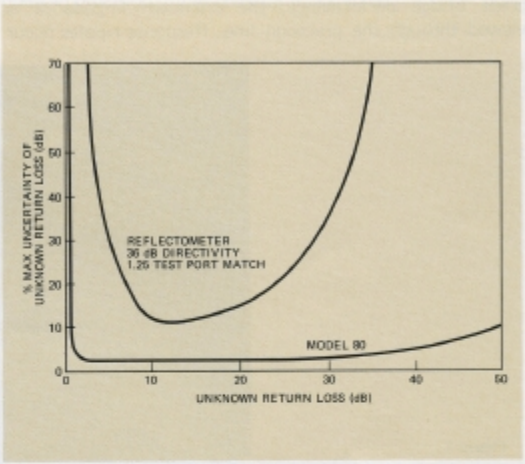
The key element of the system is a multi-wavelength precision coaxial air line which provides the reference impedance and also the phasor separation. At the measurement port a beadless precision connector is required. The other end uses a beaded connector for manipulative convenience.

The resultant accuracy of measurement is dramatically shown in the below plot which compares accuracy on a dB basis.



Return Loss Error vs. Unknown Return Loss in dB comparing standard Reflectometer with Model 80.

Another revealing way to compare accuracy is as a percentage as shown in the below plot. In each case the point of comparison is to a typical reflectometer where the accuracy is limited by coupler directivity and mismatch.



Uncertainty of unknown Return Loss as a percent of actual Return Loss, comparing Model 80 and old type Reflectometer. Shows dramatic accuracy improvement in high reflections as well as low reflections.

SYSTEM SPECIFICATIONS

FREQUENCY RANGE: 2 to 12.4GHz.
TEST CONNECTORS: APC-7, N Male, N Female. SMA male and Female with reduced accuracy.
RANGE OF MEASUREMENT: 0 to 50dB return loss.
ERROR AVERAGING MODE: 0 to 30dB return loss.
MAGNIFIED SWR MODE: 26 to 50dB return loss.
REFLECTION SMOOTHNESS: Data interpretation becomes difficult if reflection slope exceeds 3dB/400MHz or slope reversal occurs at less than 400MHz intervals.
OVERALL ACCURACY:

APC-7 .001 ± 1% ρ
Equivalent to 60dB directivity
1.02 test port SWR.

Type N .0032 ± 1% ρ
Equivalent to 50dB directivity
1.02 test port SWR.

SMA accuracy limited by adaptor —
typical 1.06 through 12.4GHz.

Above accuracies do not include inaccuracy of readout device, which is typically ±0.5dB over entire range of 0 to 50dB return loss.

Permits directivity measurements equivalent to using a termination with 1.0020 SWR for APC-7 connector and 1.0069 SWR for Type N.

PHYSICAL DESCRIPTION: Measuring elements mounted in attractive wood carrying case, 6 lbs. net weight. 10 lbs. shipping weight.
PRICE: $2450. F.O.B. Palo Alto, CA.

Further description on next 2 pages.

Precision Reflectometer Set Model 80 (cont.)

The swept precision reflectometer operates in two modes. The first is termed *"Error Averaging"*. Using normal high grade bridge performance, the unknown impedance is viewed through the precision line. Response ripples occur with frequency sweep. The average represents the true return loss virtually stripped of both directivity and test port match errors.

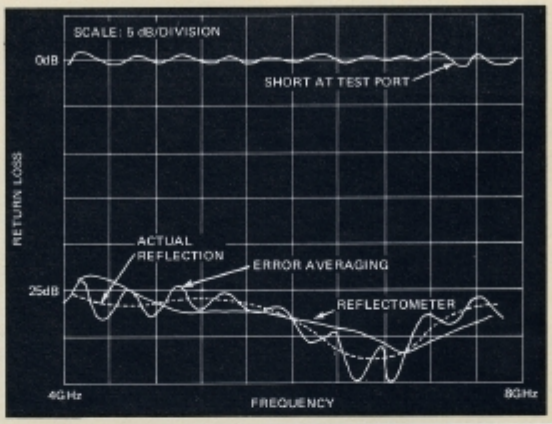


Figure 1

REFLECTION MEASUREMENT COMPARING A STANDARD REFLECTOMETER AND A MODEL 80 IN THE ERROR AVERAGING MODE.

In the above scope photo, a microwave component of moderate SWR is measured with a standard reflectometer and the Model 80 using the error averaging mode. Note the actual value varies as much as 4dB from the reflectometer value; if the acceptable limit was 25dB, the reflectometer would indicate the device was out of spec. The directivity of the reflectometer used was over 40dB compared to 35dB for a typical reflectometer.

In a standard reflectometer the directivity error interacts with the reflection to cause an error, the size of which is dependent on the ratio of the size of the reflection to the size of the directivity error. Typically this gives results with up to 5dB uncertainty in a 30dB return loss measurement.

Using error averaging the reflection interacts with the directivity error through the precision air line, forming a regular ripple pattern. The amplitude of the ripple is a manifestation of the directivity and the average of the ripple is the actual reflection.

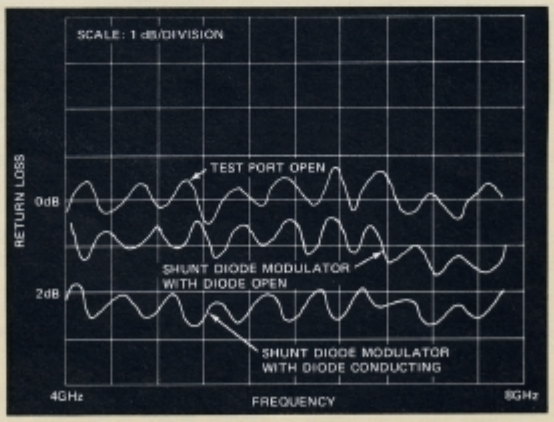


Figure 2

ERROR AVERAGING A LARGE REFLECTION

The above photo displays error averaging of an unterminated PIN Switch. The open trace labeled "Open Shunt Diode" shows twice the insertion loss of the device. The Conducting Diode trace (Modulator in a reflection state) shows how much of the incident energy the diode is absorbing in the off position. The actual return loss value may be readily obtained by averaging the ripples which are caused by the interaction of the large reflection with the test port match, in this case, a 1.10 SWR. A typical reflectometer has a test port match of 1.25 which gives a 2dB ripple when interacted with a full reflection. Thus a typical reflectometer has a full reflection output uncertainty of up to 2dB. This means large reflections cannot be measured accurately, and also that calibration references can be in error up to 2dB.

Refer to graph 2 to compare accuracies of the Wiltron Model 80 system to a standard reflectometer.

The second mode offsets the bridge directivity to a value less than the return loss to be measured. Then the swept response displays "Magnified SWR". Using the offset value and the peak-to-peak ripple, the high return loss (low reflection) may be calculated. As the response is about the offset signal level, low SWRs are measured at a higher RF level.

The method is limited to the measurement of smooth reflection spectra. The Model 80 Reflectometer Set represents a 10:1 improvement on the error due to test port match and has an effective directivity of approximately 60dB in precision 7-mm coax up to 12.4GHz.

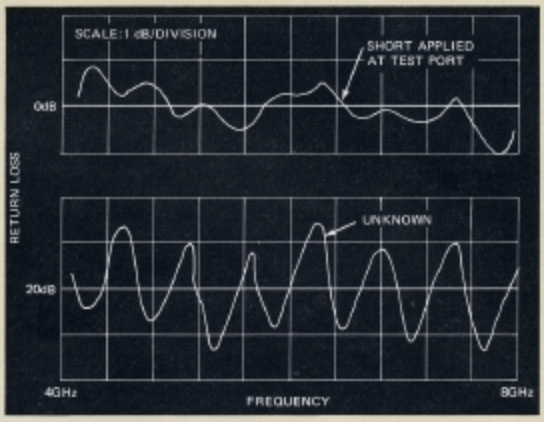


Figure 3

SCOPE PHOTO OF DATA USED TO MEASURE SMALL REFLECTIONS USING THE MAGNIFIED SWEPT SWR MODE OF OPERATION

The return loss of a 38dB termination, for example, is obtained by converting the ripple amplitude to a dB value by means of a chart and adding it to the average value of the ripple – in this case 20dB.

The magnified swept SWR mode of usage has the unique properties of being able to measure very small return loss, up to 50dB, while the information is at a signal level comparable to a 20dB return loss device; thus a magnification of up to 30dB is achieved.

To make this measurement the bridge termination was exchanged for a 20dB return loss mismatch or ***offset***. The offset is a large reflection value compared to the measured reflections. The ripple pattern in this mode represents the difference in dB between the offset value and the actual reflection. Since the accuracy of the measurement is dependent only on the precision air line, and the air line has a calculated return loss in excess of 60dB, the effective directivity of the system is 60dB. The accuracy of the air line can be confirmed by mechanical measurements.

EQUIPMENT LIST

Description	Model Number	Qty
Precision Reflection Bridge, 2 to 8 GHz	8084	1
Precision Reflection Bridge, 7 to 12.4 GHz	8085	1
7 mm Precision Line with LPC7 connectors	8010	1
7 mm Line with interchangeable LPC7 and Precision N connectors as listed below, Models 8021, 8024 and 8027	8020	1
Connector, Male, Precision N, with Model 8022 pin	8021	1
Connector, Female, Precision N, with Model 8025 pin	8024	1
Connector, GPC7, with Model 8028 pin	8027	1
Reference Termination	8040	1
Reference Offset, 20dB	8045	1
Short, 7 mm	8050	1
Short, Type N, Male	8052	1
Short, Type N, Female	8054	1
Adapter, SMA Male to GPC7	8060	1
Adapter, SMA Female to GPC7	8062	1
Case, wooden, with foam insert	8090	1
Conversion Chart (inside case lid) ripple amplitude to added dB value	8092	1
Component Location Guide (inside case lid)	8094	1
Stand, component support	8096	2
Wrench, connector fitting	8098	1

Accessory Equipment:

Designed to complement the 80 System as well as providing modern, solid-state general purpose test equipment.

610C Sweep Generator, WILTRON Model 610C .....Page 4.
Plug-In 1-4GHz, WILTRON Model 6215 .....Page 3.
Plug-In 4-12.4GHz, WILTRON Model 6223 .....Page 3.
Plug-In 2-8GHz, WILTRON Model 6219 .....Page 3.
Log Amplifier, WILTRON Model 501 .....Page 18.
Detector, WILTRON Model 74.....Page 19.

Write WILTRON *for*
Comprehensive technical article titled ***"A Precision Swept Reflectometer"*** reprinted from the Microwave Journal, April 1973.

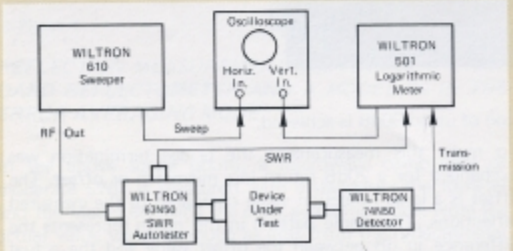
How to Form Wide-Band SWR/Return Loss Measuring

AN UNUSUAL DEVICE

An unusual — in a way, an almost remarkable — WILTRON instrument is the broadband untuned device described on the next few pages and called the "Autotester".

Esentially a resistive bridge that provides a signal proportional to the magnitude of the reflection coefficient of a measured load, this bridge may be combined with the 610C sweeper to form a SWR/return loss-measuring system that has outstanding advantages. For example, one such Autotester covers a very wide frequency span of from 10 MHz to 4 GHz, yet it is a small, light device that is cheaper by far than typical slotted lines. Again, Autotester performance is on a par with high-quality slotted lines, since its equivalent directivity is approximately 1.02 or better. Other advantages of the Autotester are discussed at the right.

How the Autotester and sweeper combine to form a wide-band measuring system is shown in the accompanying diagram. As indicated, transmission measurements can be made simultaneously, yielding a dual display of broadband SWR and transmission.

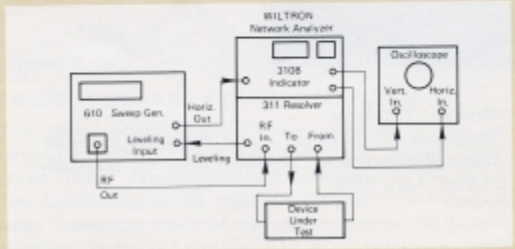


SWEPT SWR AND TRANSMISSION TESTING

SWEPT FREQUENCY PHASE, AMPLITUDE AND IMPEDANCE TESTING

For swept phase, amplitude and impedance measurements on CW or pulsed signals from 2MHz to 18GHz, use WILTRON'S Model 310B Phase, Amplitude, and Impedance Indicator with a selection of WILTRON'S 311 Resolvers. The WILTRON Network Analyzer System provides the answer to many systems requirements for the measurement of *complex* microwave signals. Transmission or reflection can be selected by turning a front panel switch. Phase, amplitude and impedance is available in XY or Polar Display. Most important, the system can measure CW or pulsed RF Signals. Both the test and reference channels may be pulsed or the reference channel may remain CW while the test channel is pulsed.

Send your systems requirements and ask for specifications, data and prices.

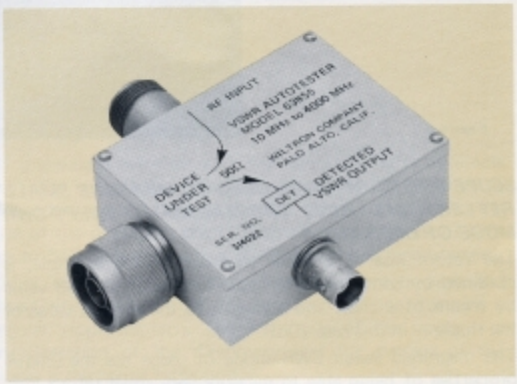


SWEPT FREQUENCY PHASE AND IMPEDANCE TESTING 2 MHz to 18 GHz

THE AUTOTESTER

Most engineers, when the need occurs for measuring standing-wave ratios or return loss, are likely to think of slotted lines or reflectometers. But SWR and return loss can be measured even faster, over wider frequency ranges, at lower cost, and with superior accuracy by use of a simple Wheatstone bridge device.

Such a bridge, developed by Wiltron Company, is shown in the photograph. It is an untuned, broadband device that covers a range from 10 MHz to 4 GHz, allowing sweep-frequency SWR/return loss measurements over any part or all of this range. It is typical of WILTRON'S family of SWR measuring bridges which cover the frequency ranges from 50 kHz to 12.4 GHz. Readout is made on an oscilloscope using a calibrated transparent overlay supplied by Wiltron or on a WILTRON 501 Logarithmic Level Meter.



DIRECT-READING CALIBRATED MEASUREMENTS

The basic circuit of the bridge appears in Fig. 1. In this circuit it can be shown that the voltage at the detector is proportional to the reflection coefficient of the load connected to the test port, thus allowing calibrated measurements.

A typical measurement system is calibrated by adjusting the oscilloscope gain so that a full-scale trace occurs with an 'open' at the bridge test port (infinite SWR). When a load is now connected, a lower voltage will be produced by the bridge. This voltage can be directly read on the calibrated overlay in SWR or return loss.

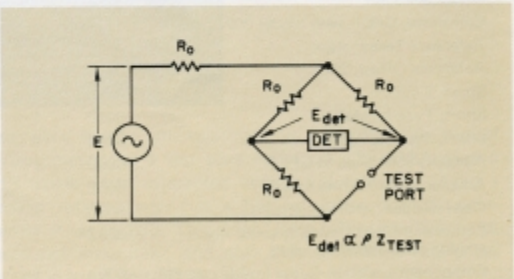


Fig. 1. Basic circuit of SWR bridge and sweeper in measurement setup.

Systems with the WILTRON Sweeper and "Autotester"

By using an attenuator to expand the calibration, readout scales with quite low full-scale SWR values can be achieved, enabling high-resolution measurements of low-SWR devices. Wiltron provides a group of overlays with full-scale values of 1.066, 1.22, 1.58, 1.93, and infinity; these values correspond to full-scale return loss values of 30, 20, 13, 10, and 0 dB.

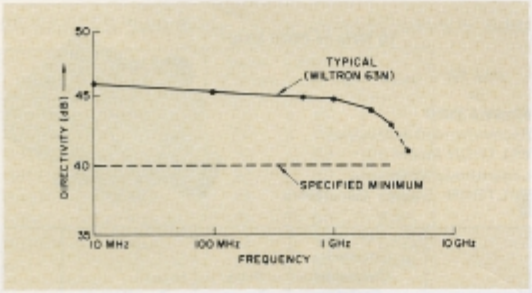


Fig. 2. Typical directivity of a group of Wiltron 63N bridges.

DIRECTIVITY

The quality of performance of the bridge can be related to that of a slotted line by comparing the bridge directivity to the residual SWR of a slotted line or the directivity of a reflectometer. For the bridge, directivity is the ratio of the signal level at the detector to the signal level at the test port when the test port sees a matched load. The Wiltron 63N bridge directivity (Fig. 2) is rated at 40 dB or better below 4.0 GHz. This corresponds to a slotted line residual SWR of 1.02. Another Wiltron bridge for telephone work in the telephone system IF band achieves a rated 60 dB directivity.

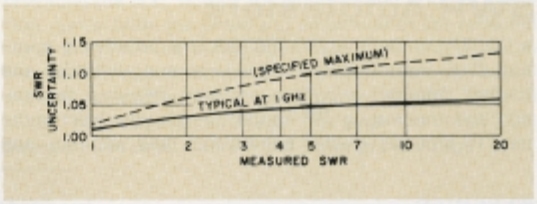


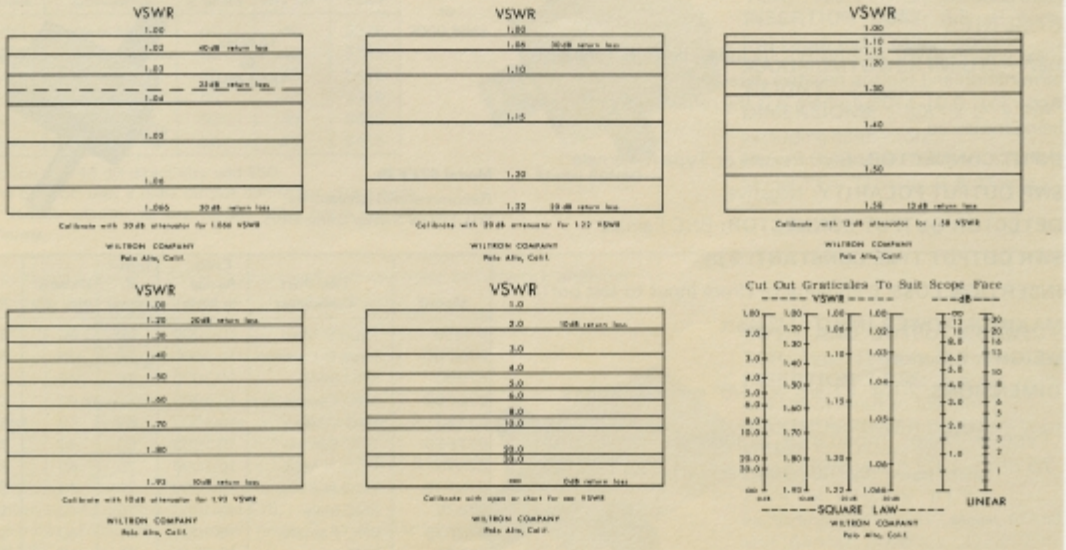
Fig. 3. Typical accuracty of measurements with Wiltron 63N SWR bridge.

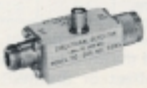
ACCURACY

Measurement accuracy with the bridge is typified by the curve in Fig. 3. For precision work in the region of, say, 1.15 or so, measurement uncertainty is only about 1.03. Even at very large SWR's uncertainty is only about 1.1. Rated accuracy is 0.01 ± 6% ρ,ρ being the load reflection coefficient.

Other interesting measurements that are possible with the bridges include SWR measurements at low signal levels such as the input SWR of a microwave low-level amplifier.

These plastic overlays are furnished as an accessory at no charge with each SWR Autotester or bridge. The six overlays include the composite overlay at right plus scales with SWR limits of 1.066, 1.22, 1.58, 1.93 corresponding to full scale return losses of 30 dB, 20 dB, 13 dB, 10 dB, 0 dB. Gradicule size is 4 in. x 3 in. Larger size available for Tektronic 7000 series oscilloscope. Price per sheet $10.00





710 SERIES LOW-COST DIRECTIONAL DETECTOR

For externally leveling sweepers from 1 MHz to 2 GHz. Flat within ±0.2 dB, 10 to 1220 MHz; within ±0.4 dB, 1 to 2000 MHz. Maximum insertion loss, 2 dB; directivity greater than 20 dB; coupling factor, 14 dB; 50-ohm type N connectors. Maximum SWR, 1.4. One watt max; 100 pF output C; negative output polarity $275

SWR Autotesters

A WILTRON SWR AUTOTESTER is a completely specified SWR measuring system, incorporating a bridge and internal detector, a built-in precision reference termination and the mating RF connector for your part under test. It provides greater convenience and accuracy and lower overall cost than any competing system such as a reflectometer, slotted line or a lesser type bridge device. Output is direct reading in SWR without the need for calibrated mismatches or terminations.

63 SERIES

Highest performance SWR Autotester. Directivity typically better than 43 dB. Accuracy typically .0075 ± 3% ρ. Can be further optimized for special frequency bands. Type N precision stainless steel connectors conform to MIL-G-39012. Includes built-in reference termination and built-in negative detector.

ACCURACY: 0.01 ± 6% ρ where ρ is the reflection coefficient being measured.

INPUT CONNECTOR: Type N Female, Stainless Steel

SWR OUTPUT POLARITY: Negative

DETECTOR OUTPUT CONNECTOR: BNC Female

SWR OUTPUT TIME CONSTANT: 2 μs

INSERTION LOSS: 6 dB nominal (from input to test port)

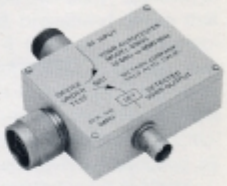
MAXIMUM POWER INPUT: 1/2 Watt

WEIGHT: 12 Ounces

DIMENSIONS: 2-5/8" x 2" x 7/8" excluding connectors

WILTRON'S accuracy specification includes the effect of the built-in precision termination.

10 MHz to 4000 MHz



Model 63N50
Recommended accessories:
WILTRON Model 501
Logarithmic Meter and
WILTRON Sweep Generators.

Model	Test Port Connector (Precision Stainless Steel)	Freq. Range in MHz	Input Z ohms	Directivity dB*	Price
63N50	Type N Male	10-4000	50	40	$395
63NF50	Type N Female	10-4000	50	40	$395
63S50	SMA Male	10-4000	50	40	$445
63SF50**	SMA Female	10-4000	50	40	$450
63G50	GR 900	10-4000	50	40	$565
63A50	APC 7	10-4000	50	40	$475
63N75	Type N Male	10-2000	75	40	$445
63NF75	Type N Female	10-2000	75	40	$445

*Option 1. 46 dB directivity add $75.
**The 63SF50 uses a male output connector plus a male to female adaptor as the female SMA has a limited lifetime.

67 SERIES

Inexpensive SWR autotester. Includes built-in reference termination and built-in negative detector.
Accuracy: 0.01 ±10% ρ where ρ is the reflection coefficient being measured

INPUT CONNECTOR: BNC Female or Type N Female

SWR OUTPUT POLARITY: Negative

DETECTOR OUTPUT CONNECTOR: BNC Female

SWR OUTPUT TIME CONSTANT: 2 μs

INSERTION LOSS: 6 dB nominal (from input to test port)

MAXIMUM POWER INPUT: 1/2 Watt

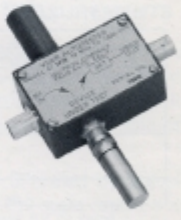
WEIGHT: 6 Ounces

DIMENSIONS: 2-1/4" x 1-3/8" x 1-1/8" excl. connectors

Type F Male Impedance Standard Termination 75 ohm, 1.02 max. SWR.....$40.00

Use Reply Card (page 31) to obtain your free comprehensive 8 page Technical Review titled *"Present-Day Simplicity in Broadband SWR Measurements".*

10 MHz to 1000 MHz



Model 67FF75
Recommended accessories:
WILTRON Sweep Generators

Model	Test Port Connector	Freq. Range in MHz	Input Z ohms	Directivity dB	Price
67N50	Type N Male	10-1000	50	40	$160
67NF50	Type N Female	10-1000	50	40	$160
67B50	BNC Male	10-1000	50	40	$150
67BF50	BNC Female	10-1000	50	40	$150
67T50	TNC Male	10-1000	50	40	$180
67TF50	TNC Female	10-1000	50	40	$180
67N75	Type N Male	10-1000	75	40	$165
67NF75	Type N Female	10-1000	75	40	$165
67B75	BNC Male	10-1000	75	40	$165
67BF75	BNC Female	10-1000	75	40	$165
67T75	TNC Male	10-1000	75	40	$180
67TF75	TNC Female	10-1000	75	40	$180
67FF75	Type F Female	10-1000	75	40	$155

*WILTRON'S accuracy specification is an overall statement of the measurement accuracy; it includes the effect of the built-in precision termination, the built-in detector, and the effect of the SWR of the Autotester connector.

SWR Bridges

The WILTRON SWR DIRECTIONAL BRIDGES are precision high directivity test instruments which are ideal for SWR and return loss measurements. They include a built-in precision reference termination which is not done by the competing units that require external terminations. These bridges can be used for low level SWR measurements by providing the R.F. output for amplification prior to detection. Since both the phase and amplitude of the reflected signal are preserved in the R.F. output, these bridges can also be used in accurate phase comparison systems. Recommended accessories for all SWR bridges are WILTRON'S Model 501 Logarithmic Meter (see page 18) WILTRON Sweepers (see pages 4 to 9) and Detectors (see page 19).

68 SERIES SWR Bridge for HF communications or video and baseband

Model	Test Port Connector	Input Z ohms	Directivity dB	Price
68B50	BNC Male	50	50	$195
68BF50	BNC Female	50	50	$195
68T50	TNC Male	50	50	$195
68TF50	TNC Female	50	50	$195
68B75	BNC Male	75	50	$195
68BF75	BNC Female	75	50	$195
68T75	TNC Male	75	50	$195
68TF75	TNC Female	75	50	$195

50 kHz to 32 MHz

Model 68BF75

INPUT AND OUTPUT CONNECTOR: BNC Female
INSERTION LOSS: 3.5 dB nominal (from input to test port)
MAXIMUM POWER INPUT: ½ Watt
WEIGHT: 6 Ounces
DIMENSIONS: 2-1/4" x 1-3/8" x 1-1/8" excluding connectors
Recommended Accessory: Wiltron Model 71B50 Detector or 71B75 for 75 ohm system.

66 SERIES IF Bridge has highest directivity, measures SWR to 1.001.

Model	Test Port Connector	Input Z ohms	Directivity dB	Price
66W75	WE 801A	75	60	*$445
66M75	WE 439A	75	60	*$445
66N75	N	75	60	*$485

*Standard external reference termination included, 1.001 SWR

50 MHz to 100 MHz

Model 66W75

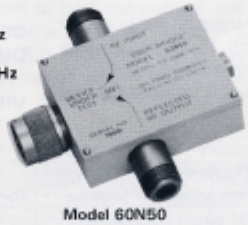
INPUT AND OUTPUT CONNECTOR: Western Electric 509A or 567A
INSERTION LOSS: 6.5 dB nominal (from input to test port)
MAXIMUM POWER INPUT: ½ Watt
WEIGHT: 13 Ounces
DIMENSIONS: 4"x2-5/8"x1-7/16" excluding connectors

60 SERIES SWR Bridge with largest band width.

Model	Test Port Connector	Input Z ohms	Directivity dB*	Price
60N50	Type N Male	50	40	$375
60NF50	Type N Female	50	40	$375
60S50	SMA Male	50	40	$415
60SF50	SMA Female**	50	40	$415
60G50	GR 900	50	40	$455
60A50	APC 7	50	40	$455

*Option 1. 46 dB directivity add $50.
**The 60SF50 uses a male output connector plus a male to female adaptor as the female SMA has a limited lifetime.

5 MHz to 2000 MHz



Model 60N50

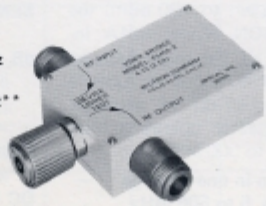
INPUT AND OUTPUT CONNECTOR: Type N Female Stainless Steel
INSERTION LOSS: 6.5 dB nominal (from input to test port)
MAXIMUM POWER INPUT: ½ Watt
WEIGHT: 12 Ounces
DIMENSIONS: 2-5/8" x 2" x 7/8" excluding connectors
Recommended Accessory: Wiltron Model 73 or 74 Series R.F. Detector.

64 and 65 SERIES SWR Bridge used with detector or network analyzer. Extends bridge accuracy and simplicity through X-band.

Model	Test Port Connector (Precision Stainless Steel)	Input Z ohms	Directivity dB*	Price
64G50	GR 900	50	36	$595
64A50	APC 7	50	36	$595

*Option 1. 42 dB directivity add $75.
**Option 2. Extended frequency range 2 to 8 GHz add $40.

3 GHz to 8 GHz**



Model 65A50

65A50	APC 7	50	36	$630

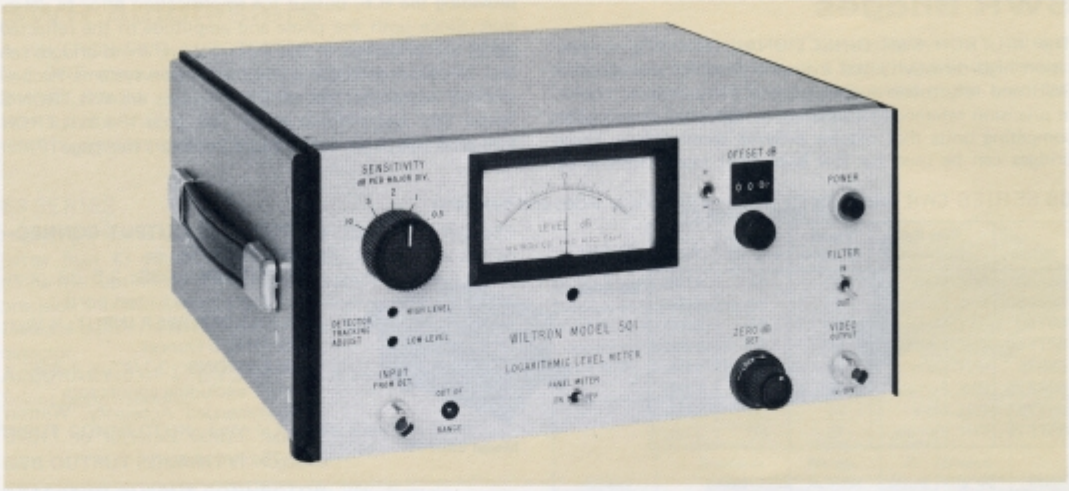
7 GHz to 12.4 GHz**

*Option 1. 40 Db directivity add $75.
**Option 2. Extended frequency range 4 to 12.4 GHz add $75.

INPUT AND OUTPUT CONNECTOR: Type N Female Stainless Steel
INSERTION LOSS: 6.5 dB nominal (from input to test port)
MAXIMUM POWER INPUT: ½ Watt
WEIGHT: 10 Ounces
DIMENSIONS: Model 64G50: 1-3/4" x 1-1/2" x 1-1/8" excluding connectors Model 65A50 and 64A50: 2-7/8" x 2" x 7/8" excluding connectors
Recommended Accessory: Wiltron Model 74N50 R.F. Detector.

Attractive wooden Storage Case supplied with Series 60, 63, 64 and 65.

WILTRON 501 Logarithmic Level Meter



- **Accurate low level RF measurements to −40 dBm**
- **Direct meter readout on a linear dB scale**
- **Calibrated offset**
- **60 dB of total dynamic range**

The WILTRON Model 501 Logarithmic Level Meter converts the DC voltage from an external crystal detector to an indication of RF power calibrated in dB per division. Two simple front panel adjustments permit calibration of a wide range of crystal detectors for operation from −40 dBm to +20 dBm. This results in an entire 60 dB dynamic measurement range. In addition, a calibrated offset control provides more than ±90 dB offset range.

A meter readout is provided for CW measurements or the simple addition of an oscilloscope with 1 volt per division sensitivity allows swept frequency measurements. Sensitivities of 10, 5, 2, 1 and 0.5 dB/div are available at the flick of the Panel Range Switch.

The Level Meter is an ideal accessory for use with WILTRON's complete line of SWR bridges and autotesters while WILTRON sweeper plug-ins span virtually any frequency band of interest. The Model 501 when coupled with the new WILTRON Model 80 (See pages 10 through 13) provides an extremely powerful measurement tool. Return loss measurements of 50 dB in the microwave range up to 12 GHz are possible.

SPECIFICATIONS

FREQUENCY RANGE: Limited only by the RF detector and connectors used. (The popular WILTRON 74N50 is ideal for wide band measurements to 12.4 GHz)

FLATNESS: Determined by the RF detector.

DYNAMIC RANGE: −40 to +20 dBm applied to external RF detector.

ACCURACY: ±0.3 dB ±1% of dB readout with Model 74N50 and most other detectors.

OFFSET: Calibrated over more than ±90 dB range.

DISPLAY SENSITIVITIES: 10, 5, 2, 1 or 0.5 dB per major meter division.

VIDEO OUTPUT: 5K ohms or less source impedance. When using an oscilloscope with 1 volt per division vertical sensitivity, the display becomes 10, 5, 2, 1 or 0.5 dB per division.

PHYSICAL DESCRIPTION: Dimensions: 12" wide x 5¼" high x 12" deep. Net weight 8 lbs.

PRICE: 501 . . . . . $895

WILTRON 501A Logarithmic Meter

For SWR Measurements of very small reflected RF signals (down to −80 dBm) the WILTRON Model 501A includes all the video features of the 501 but includes a built in 40 dB RF amplifier and detector operating from 5 MHz to 500 MHz.

- **Complete RF measurement system in one package**
- **Direct low level RF measurements, 5 to 500 MHz**
- **−80 dBm minimum level**
- **100 dB total dynamic range**
- **Flatness:**

	With Amp.	Without Amp.
501A 50Ω	±1.8 dB to 500 MHz	±0.3 dB to 2000 MHz
501A 75Ω	±2 dB to 500 MHz	±0.8 dB to 1000 MHz

SPECIFICATIONS

FREQUENCY RANGE: Without internal RF amplification, internal detector, 1-2000 MHz (1-500 MHz, 75 ohm)

SENSITIVITY: +20 to −80 dBm (internal RF amplification)
+20 to −40 dBm (without RF amplification)

dB ACCURACY: ±0.3 dB 1% of dB readout (without RF amplification). With internal RF amplification add compression of approximately −0.3 dB at −70 dBm and −1 dB at −80 dBm.

DISPLAYED SENSITIVITIES: 10, 5, 2, 1 or 0.5 dB per meter division.

DC OUTPUT: 5K ohms or less source impedance delivering lv/div for Displayed Sensitivities.

PHYSICAL DESCRIPTION: Dimensions: 17" wide x 5¼" high x 12" deep. Net weight 12 lbs.

PRICE: 501A, 50 ohm $1960.00
501A, 75 ohm $2160.00

DELIVERY: STOCK TO TWO WEEKS

RF Detectors and RF Sampling Directional Detectors

WILTRON offers the industry's most extensive line of R.F. detectors; models are included for general purpose applications with a variety of connectors, impedances, output polarities, frequency ranges and prices. In the special purpose category WILTRON has a unique "Fullwave" detector and a truly "Linear" detector. General description from the below selector chart. All units are offered with either negative or positive output voltage. (Negative is the more conventional.)

71 SERIES – WILTRON's popular general purpose detector offers unique low frequency performance down to 100 kHz and up to 3 GHz with characteristic input impedance of either 50 or 75 ohms and with positive *or* negative output voltage. The Model 71 B50 is WILTRON's most popular detector in this series. (It was formerly referred to as the Model 61D.)

73 SERIES–General Purpose, good high frequency coverage to 4 GHz Type N input connector, low SWR typically 1.1

74 SERIES – WILTRON's finest quality and widest frequency range model. Has matched input and shaped polyiron for careful frequency compensation. Better low frequency performance than competing manufacturers. The Model 74 N50 is the most popular model in this series.

76 SERIES – By means of a customer supplied dc bias this detector has a truly linear output over a wide dynamic range of input powers up to ¼ watt. Requires approximately 100 μA of dc bias current and 10K load resistance. Positive current for negative detector.

77 SERIES – Similar to 76 SERIES above except for higher input levels, up to 10W peak and different connector type.

78 SERIES – Lowest cost of the Quality WILTRON Detectors. Has somewhat relaxed specifications for ease of testing and does not include the ferrite slug for level compensation which is included on the 71, 73 and 74 SERIES.

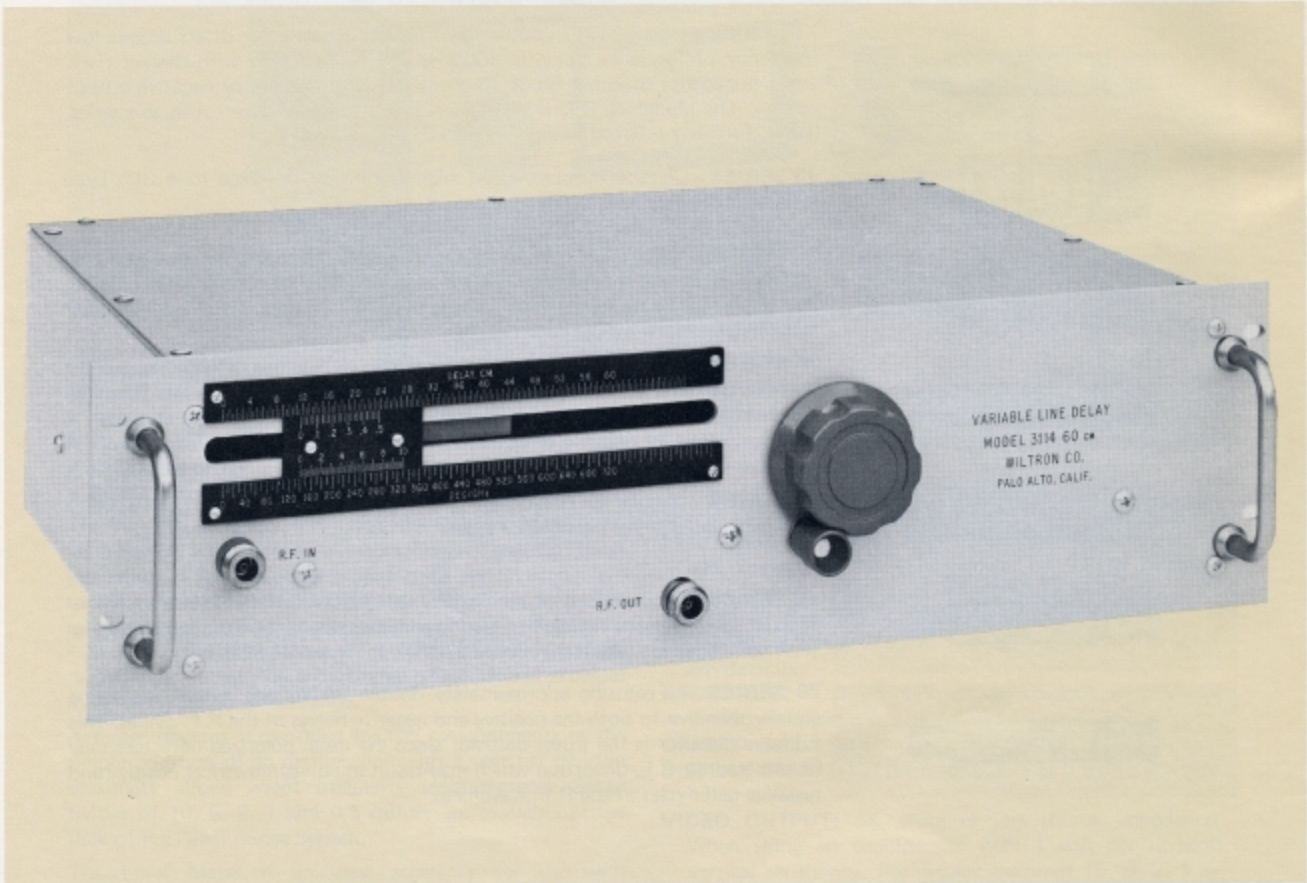
79 SERIES – Featuring approximately double the voltage output and being equally sensitive to both the positive and negative halves of the R.F. cycles. This fullwave detector is the truest detector since the usual polarized detectors may be affected by R.F. distortion which may result in non-symmetrical positive and negative half cycles of the R.F. waveform.

MODEL	DESCRIPTION	FREQ. RANGE	FLATNESS	CONNECTOR IN	CONNECTOR OUT	IMPEDANCE	MAX. SWR	LOW LEVEL SENSITIVITY AT −30 dBm	HIGH LEVEL SENSITIVITY AT +13 dBm	FIELD REPLACEABLE DIODE	MAX. INPUT	OUTPUT CAPACITANCE	OUTPUT VOLTAGE POLARITY	PRICE (Qty. Discounts Above 25 Units)
71 B50	Gen. Purpose (BNC Input)	100 kHz to 3 GHz	±0.5 dB	BNC Male	BNC Female	50 ohms	1.20	0.35mv/μW	1V min.	Yes	100mw	500pF	Neg	$ 65.00
71 B50P	"	"	"	"	"	"	"	"	"	"	"	"	Pos	$ 65.00
71 B75	"	100 kHz to 3GHz	"	"	"	75 ohms	1.25	"	"	"	60mw	"	Neg	$ 70.00
71 B75P	"	"	"	"	"	"	"	"	"	"	"	"	Pos	$ 70.00
73 N50	Gen. Purpose (Type N Input)	100 kHz to 4 GHz	±0.5 dB	N Male	BNC Female	50 ohms	1.20	0.35mv/μW	1V min.	Yes	100mw	500pF	Neg	$ 75.00
73 N50P	"	"	"	"	"	"	"	"	"	"	"	"	Pos	$ 75.00
74 N50	Wide Band Gen. Purpose	10 MHz to 12.4 GHz	±0.5 dB 10MHz–8GHz ±0.7–12.4GHz	N Male	BNC Female	50 ohms	1.25 from 10 MHz to 8 GHz 1.50 to 12.4 GHz	0.4mv/μW	1V min.	Yes	100mw	30pF	Neg	$145.00
74 N50P	"	"	"	"	"	"	"	"	"	"	"	"	Pos	$145.00
76 B50	Linear from +24 to −10dBm dc bias required	100 kHz to 1 GHz	±0.5 dB	BNC Male	BNC Female	50 ohms	1.35	—	—	Yes	250mw	*500pF	Neg	$ 80.00
76 B50P	"	"	"	"	"	"	"	—	—	"	"	"	Pos	$ 80.00
77 S50	Linear from +27 to −10dBm dc bias required	100 kHz to 1 GHz	±0.7 dB	SMA (OSM) Male	SMA (OSM) Female	50 ohms	1.60	—	—	Yes	500mw AV 10W Peak	*500pF	Neg	$115.00
77 S50P	"	"	"	"	"	"	"	—	—	"	"	"	Pos	$115.00
78 B50	Lowest cost Good Quality	100 kHz to 2 GHz	±0.5dB to 1GHz ±1.0dB to 2GHz	BNC Male	BNC Female	50 ohms	1.2 to 1 GHz 1.35 to 2 GHz 1.2 to 1 GHz	—	0.8V min.	Yes	100mw	500pF	Neg	$ 35.00
78 B50P	"	"	"	"	"	"	"	—	"	"	"	"	Pos	$ 35.00
79 B50	High Output Fullwave Det. Typer form of detector	100 kHz to 2 GHz	±0.5 dB	BNC Male	BNC Female	50 ohms	1.20	—	1.8 V min.	No	100mw	500pF	Neg	$ 95.00
79 B50P	"	"	"	"	"	"	"	—	"	"	"	"	Pos	$ 95.00
710	Directional detector	1 MHz to 2 GHz	±0.4 dB	N Female	N Male	50 ohms	1.40	—	—	No	1 Watt	1000pF	Neg	$275.00

*Other values by special order.

Line Stretcher...60cm, dc to 18 GHz

MODEL 3114



The Model 3114 is ideal for use as a **precision phase shifter** since it is calibrated in degrees per GHz as well as in tenths of millimeters and since it has controlled 50 ohm impedance and low SWR.

This line stretcher is especially useful as a **reference delay line** since in addition to changing the phase of an input signal it also varies a total electrical path length. This means that in a phase bridge it can be used to match the electrical length of a device under test as well as provide a vernier phase shifting action.

This calibrated line stretcher is useful as a precision reference for calibrating phase meters or for introducing a measured line length change into a system.

In impedance plotting bridges the Model 3114 can be used to vary the plane of reference of the Smith Chart.

The Model 3114 is the same line stretcher used in WILTRON's exacting phase resolvers. Long lifetime is obtained by a unique contacting plunger which does not employ the usual spring fingers.

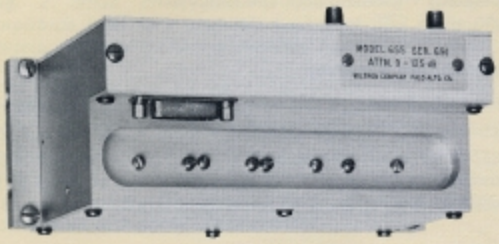
The ground plane is stepped so that, even though the line is being stretched, a constant 50 ohms is always maintained. Air dielectric is employed throughout.

SPECIFICATIONS

Total Line Length Variation 60 cm
Frequency Range dc to 12.4 GHz or 18 GHz (see below)
Accuracy of Calibration ±0.2 mm (equivalent to 0.25° at 1 GHz)
(Greater precision with Option 02 Dial Indicator, see below.)
Input SWR 1.4 dc to 12.4 GHz
Imput Impedance 50 ohms, constant impedance with line length variation
Insertion Loss <3.5 dB; VSWR <1.6
Power Handling 10 watts rms
Input and Output Connectors Type N Female
Physical Description Shipping Weight: 30 lbs.
Dimensions: 19" wide x 5-1/4" high x 12" deep
Price Standard unit tested to 12.4 GHz $750
OPTION 01 . . . Added testing to 18 GHz $50
(Note: Output connector on rear)
OPTION 02 . . . Addition of a dial indicator for greater precision (.04 mm) in setting length variations. Dial mounting adjustable to cover any 10 cm portion of 60 cm range. $250

Programmable Attenuator

MODELS 655/656



WILTRON's programmable attenuators provide a precise RF attenuation in response to an electrical control signal. This fast response time makes them ideal for use in automated and computer controlled test systems. They can also be useful for remote control by manual switches since they operate directly from contact closures.

The attenuators provide rugged operation since they are based on a military design. Careful design techniques have been also used to ensure long operating life. Gold switch contacts are used for long life, and the entire housing is shielded to ensure minimum RFI leakage.

The two basic models are as shown in the chart below. A militarized version meeting military environmental specs is also available.

SPECIFICATIONS

	MODEL 655	MODEL 656
ATTENUATION RANGE	125 dB in 1.0 dB steps.	125 dB in 0.1 dB steps.
FREQUENCY RANGE	dc to 1250 MHz.	dc to 500 MHz.
IMPEDANCE , 50 OHM	Less than 1.4 SWR	Less than 1.25 SWR
ATTENUATOR ELEMENTS	An eight line input actuates elements: 1, 2, 4, 8, 10, 20, 40 or 80 dB to achieve any attenuation to 125 dB in 1.0 dB steps.	A twelve line input actuates elements: 0.1, 0.2, 0.4, 0.8, 1, 2, 4, 8, 10, 20, 40 or 80 dB to achieve attenuation to 125 dB in 0.1 dB steps.
ACCURACY* 0.1 dB steps:	—	0.05 dB + 0.02 dB/.1dB
1.0 dB steps:	0.4 dB + 0.025 dB/dB	0.2 dB + 0.02 dB/dB
10 dB steps:	0.5 dB + 0.025 dB/dB	0.35 dB + 0.015 dB/dB
INSERTION LOSS	Less than 2.5 dB Typically zero at dc increases 0.16 dB per 100 MHz	Less than 1.6 dB Typically zero at dc increases 0.2 dB per 100 MHz
DIMENSIONS	2.6" x 7" x 4.5"	2.6" x 8" x 3.5"
WEIGHT	4.5 pounds.	6 pounds.
CONNECTORS	OSM for RF, Cannon DAM 15 P for programming.	TNC for RF, Cannon DAM 15 P for programming.
PRICE	Factory Quote	

THE FOLLOWING SPECIFICATIONS APPLY TO BOTH MODELS

RESPONSE TIME: The total time required to any desired attenuation is less than 40 milliseconds.

TEMPERATURE STABILITY: Changes less than ± 0.01 dB per °C over 0 to 65°C.

LONG TERM STABILITY: After a warmup period of 10 minutes, the attenuator operates within specified performance requirements for a minimum of 1200 hours continuously and without adjustment.

POWER RATING: 0.75 Watts to +50°C. The peak power is limited to 100 volt peak input voltage.

PROGRAMMING: A 28 volt supply is connected to one of the input pins and each of the attenuators is actuated by returning its pin to common negative. (The 40 and 80 dB pads cannot be used simultaneously.)

POWER SUPPLY REQUIREMENTS: +28 volts nominal, 120 mA per attenuation element at room temperature. The 80 dB element draws double current. Attenuator will operate from 26 to 30 volts.

Industry's Best Selection of Audio-Video Phase Meters

WILTRON is the leading manufacturer of general purpose phase meters, offering the best available commercial precision over the frequency ranges from 0.5 Hz to 2 MHz and with signal levels from 1 mv to 400 volts. Instruments are usable to 5 MHz!

WILTRON RANGE OF AUDIO-VIDEO PHASE METERS

Model	Frequency Range	Differential or Single Ended Inputs	Readout Method	Input Levels	Price
350	10 Hz - 2 MHz	Single Ended	Meter	1 mV - 400 v	$ 885
351	10 Hz - 2 MHz	Single Ended or Differential	Meter	1 mV - 400 v	$1090
352	0.5 Hz - 500 KHz	Single Ended or Differential	Meter	1 mV - 400 v	$1295
355	10 Hz - 2 MHz	Single Ended or Differential	Digital	1 mV - 400 v	$1865

TABLE 1

Principle of Operation of WILTRON Phase Meters

A phase meter measures the phase angle in degrees between a reference and a test sinusoidal signal. This may be the phase angle between the input and output of an amplifier, filter, etc., or the a.c. signals from two transducers for mechanical impedance measurements.

Block Diagram Models 350 to 355

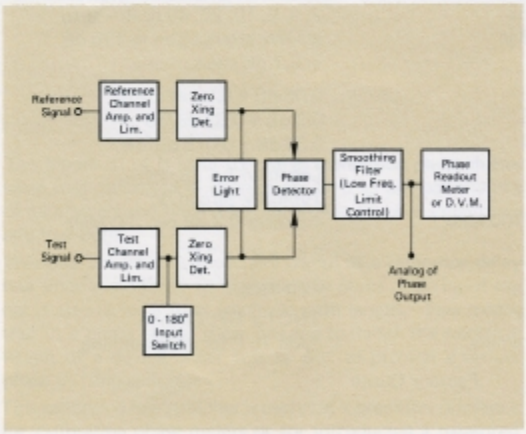


Figure 1

The reference and test channel amplifiers are identical with 1 mV rms sensitivity. As each channel signal goes through a negative going zero crossing, a trigger pulse is generated which is applied to the phase detector. The phase detector has an output signal whose duty cycle is proportional to the fraction of the input cycle between successive pulses from the reference and test channels. The phase detector output is integrated by the smoothing filter to produce a d.c. proportional to the phase angle between the two channels.

OVERALL ACCURACY OF WILTRON PHASE METERS

The worst case accuracy is: Phase output accuracy + (phase zero change due to amplitude change) x (multiplying factor due to frequency change) + (accuracy of 0 – 180° switch if operated) + (phase readout accuracy).

Phase Output Accuracy

After adjustment of the phase standardizing controls the accuracy of the phase detector = 0.05 + (ϕ/180 x 0.25) degrees for input phases from 0 to ± 180°, where ϕ is the measured phase angle. For example if the angle ϕ to be measured is 10° the maximum error is 0.06°.

Accuracy of 0 – 180° control = ± (0.1 + 0.3F)° where F is the test frequency in MHz, e.g., at 100 kHz, accuracy of the 0 – 180° control (or the display range switch of Model 355) is ± 0.13 degrees at nominal input levels with low distortion signals.

Phase Readout Accuracy

With the digital readout of phase provided in Model 355 the readout accuracy = ± 1 digit ± 0.1°. The meter readout Models 350, 351 and 352 have a unique meter offset circuit from 0 to ± 170° in 10° steps so that any phase angle can be measured on the most sensitive meter range (± 5° full scale).
Accuracy of meter = ± 2% of range (ranges are: ± 5, 10, 18, 50, 100 and 180°).
Offset accuracy = ± 0.5% of the offset.
Overall meter readout accuracy = range accuracy + offset accuracy.

Range of Phase Measurements

The purpose of the 'Error Sector Light' circuit shown in Figure 1 is to warn the operator when the Phase Detector circuit is receiving almost simultaneous trigger pulses from the Zero Crossing Detectors. This condition occurs when phase angles near to the range limits of the phase detector + or –180°, are being applied to the phase meter.

When the light comes on, the 0 – 180° switch should be operated so that the phase detector is working near to 0°.

The total range of phase measurement is determined by the finite width (0.1μS) of the trigger pulses from the Zero Crossing Detectors. The total range is expressed in the specifications as: (360 – 40F)° where F is the test frequency in MHz. This means that the phase detector range is 320° or ± 160° at 1 MHz, ± 178° at 100 kHz, etc. However, operating the 0 – 180° switch permits measurements of the same dynamic range about 180° so that phase measurements over the full 360° can readily be made to over 2 MHz.

For further technical information on Phase Measurements, ask for WILTRON Technical Review, Vol 2; No 1.

Typical Zero Change in Degrees Due to Signal Level and Frequency Variation for Models 350, 351, and 355.

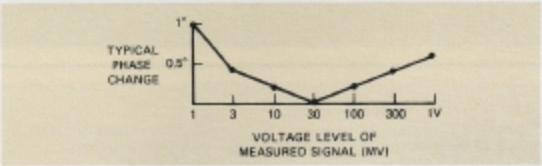


Fig. 2. Small phase reading change with change in amplitude level (one channel) typical of 350 series phase meters. Remaining channel operated from 30 mV signal.

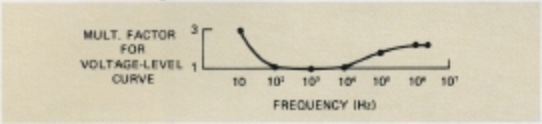


Fig. 3. Typical frequency effect in phase meter is correctable with panel 'Zero' control.

Setup for Bridged Impedance Measurements

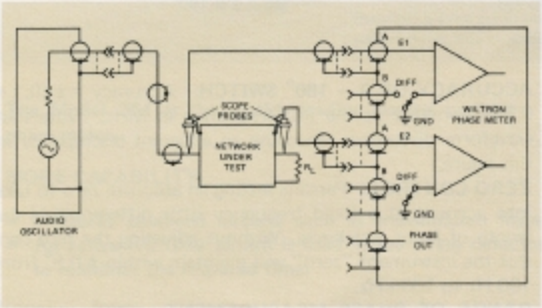


Fig. 4. The input impedance of the WILTRON Phase Meters has been designed to match standard oscilloscope probes, thereby permitting unusually high input impedance when desired. Bridged phase measurements may be made using (four) probes on the two A and B inputs.

Setup for Off-Ground Measurements

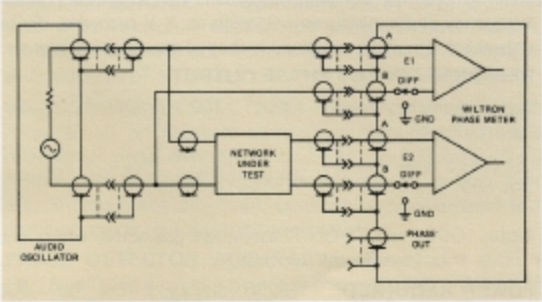


Fig. 5. The differential input circuits of the WILTRON Models 351, 352, and 355 Phase Meters permit off-ground measurements as shown above.

If there is even order harmonic distortion on the waveforms applied to this type of 'zero crossing' phasemeters, the readings can be in error by the following amount. (Unless corrected as explained below.)

$$\text{Error in phase reading} = \frac{D}{100} \times 57^\circ \qquad (1)$$

Where D = harmonic distortion in percent

Phase Measurements with Distorted Test Signals

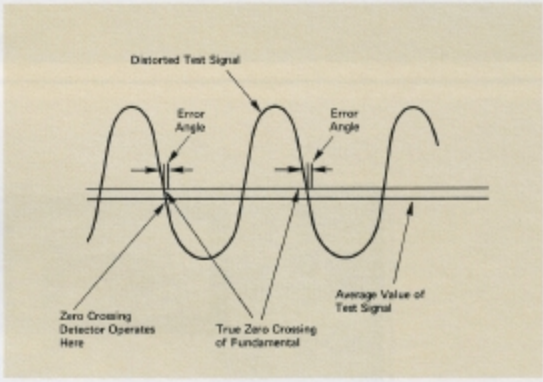


Figure 6

From eqn. (1), if ± 1° accuracy is desired the 2nd harmonic distortion of the test signal should be less than 2%. For 0.1° accuracy the distortion should be less than 0.2%.

Where the signal levels on each channel are similar, this source of error can be removed by the following method as shown in Figure 7.

Measure the phase angle of the Device Under Test by the normal method. Note the phase reading A. Transpose the input connections to E1 and E2 channels. Note the new phase reading B. The true phase angle $T = \frac{A + B}{2}$

Cancelling Effect of Distorted Test Signals

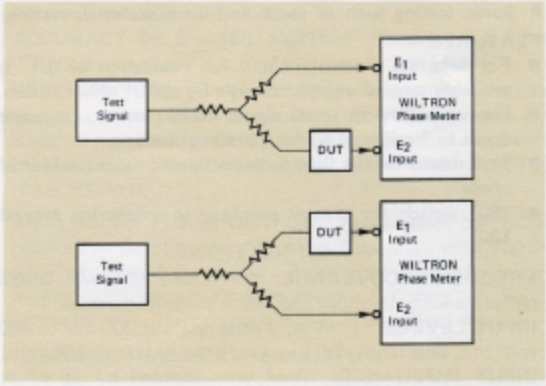
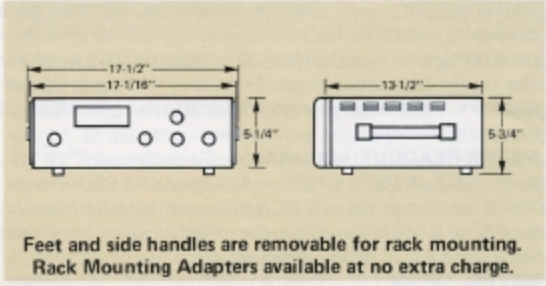


Figure 7

Outline Drawing of Wiltron Phase Meters

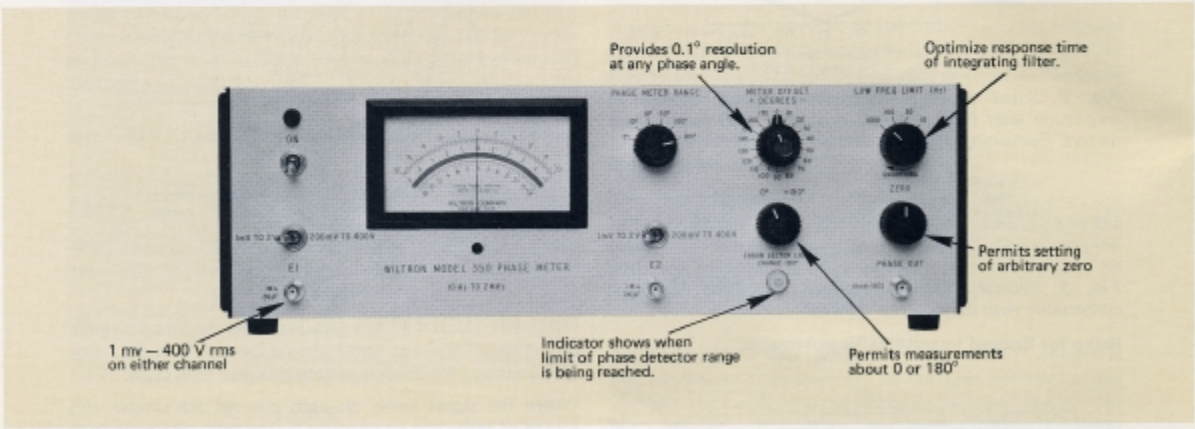


Feet and side handles are removable for rack mounting. Rack Mounting Adapters available at no extra charge.

Figure 8

Phase Meter 10 Hz to 2 MHz

MODEL 350



This general purpose phase meter makes accurate phase measurements from 10 Hz – 2 MHz with 1 mv sensitivity, and provides high input impedance and wide measurement capability.

USES

- **Measures electromechanical devices.**
- **Subaudio, audio, and high frequency electronic circuits for phase of feedback.**
- **Sonic testing such as sonar and sonic materials testing.**

FEATURES

- **For accurate measurement: full resolution of 0.1° is available around any phase angle by use of offset switch.**
- **For versatility in small signal measurement: measure down to 1 millivolt without preamplifiers.**
- **Save measurement time with automatic value readout of phase.**
- **180° switch for greater accuracy in measuring around 180°.**

SPECIFICATIONS:

FREQUENCY COVERAGE: 10 Hz to 2 MHz with usable performance both above and below these frequencies.

INPUT LEVELS: 1 mV to 2 volts rms and 200 mV to 400 volts rms, selectable. DC blocking provided up to 400 volts.

INPUT IMPEDANCE: 1 M ohm shunted by 26 pF or 10 M ohm shunted by 8 pF when used with Tektronix oscilloscope probes (Model P6006).

PHASE DETECTOR ACCURACY: Accuracy = 0.05 + (ϕ/180 x 0.25) degrees where ϕ is the measured phase angle between 0 and 180°. Note: This accuracy applies after standardization with input levels of 30 mV rms on the low or 6 V rms on the high input range. Frequency and signal level effects are shown on pages 22 and 23, also the effect of waveform distortion.

METER READOUT ACCURACY: Six ranges: ± 5°, ± 10°, ± 18°, ± 50°, ± 100°, ± 180°. Accuracy = ± 2% full scale. The offset circuit permits all measurements to be made on the ± 5° or ± 10° range. Thus the meter accuracy error need not exceed ± 0.2° at any phase angle.

METER OFFSET: 0 to ± 170° in 10° increments. Accuracy = ± 0.5% of the offset.

ACCURACY OF 0 – 180° SWITCH: Accuracy = ± (0.1 + 0.3F)° where F is the test frequency in MHz. Note that waveform distortion can cause an apparent discrepancy in this figure.

ZERO CONTROL: Permits setting an absolute zero to take into account at a fixed frequency little differences in the length of input test leads. Without adjusting the zero control the instrument "zero" will maintain within ± 0.5° from 100 Hz to 100 kHz.

RANGE OF PHASE MEASUREMENT: 360° – (40F)° where F is the test frequency in MHz., e.g., when on the ± 180° range at 100 kHz the phase measurement range is ± 178°. To measure angles around 180° one would operate the 0 – 180 switch.

ANALOG OF PHASE OUTPUT: Front panel connector provides an output proportional to phase angle with a sensitivity of 10 mV per degree. This is very useful for swept frequency phase measurements with an X-Y recorder, digital voltmeter, etc. The accuracy is that of the phase detector.

RESPONSE TIME OF PHASE OUTPUT:

Low Frequency Limit Switch position.	1 kHz	100 Hz	30 Hz	10 Hz
Response time approx. for 180° change to 0.1° of final value.	40 ms	3 sec.	10 sec.	30 sec.

Note: Other WILTRON Phasemeters use active filters and thus have faster response.

POWER REQUIRED: 115/230 volts a.c. ± 10%. 50 – 400 Hz 30 watts.

ORDERING INFORMATION: Model 350 – shipping weight 30 lbs. Dimensions 5-1/4" high by 17-1/2" wide by 14-1/2" deep. Supplied with tilt stand for bench mounting. Rack mount kit available at no charge if specified with order.

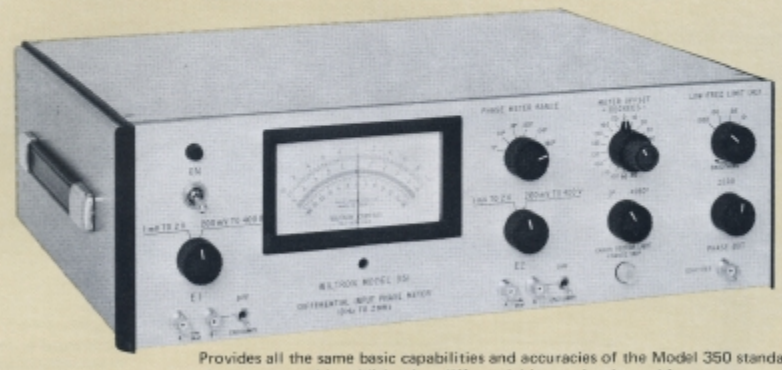
Price: Model 350 ..... $885.

Option 1. Rear input connectors in parallel with front connectors (input capacity approx. 80 pf)..... $25.

Option 2. Rear output connector in parallel with front output of analog voltage proportional to phase ..... $10.

Differential Input Phase Meter 10 Hz to 2 MHz

MODEL 351



Provides all the same basic capabilities and accuracies of the Model 350 standard input phase meter and in addition has differential input circuits and faster response.

The Model 351 is the worlds leading general purpose phase meter.

MORE CAPABILITY

- **Measures balanced circuits such as transmission lines.**
- **An active RC filter circuit is used in the phase detector to minimize the response time.**

SPECIFICATIONS:

FREQUENCY COVERAGE: 10 Hz to 2 MHz with usable performance both above and below these frequencies.

INPUT LEVELS: 1 mV to 2 volts rms and 200 mV to 400 volts rms, selectable. DC blocking provided up to 400 volts.

INPUT IMPEDANCE: 1 Megohm shunted by 26 pF or, when used with Tektronix oscilloscope probes (Model P6006), 10 Megohms and 8 pF. Differential impedance 2 Megohm shunted by 15 pF or 20 Megohm and 4 pF when using probes.

COMMON MODE REJECTION: A common signal to both terminals of an input is rejected at least 50 dB from a differential signal over the range 50 Hz to 100 kHz; 40 dB from 10 Hz to 1 MHz. Rejection maintained up to 2 V or 400 V depending on input range being used for sum of common mode plus differential signal.

PHASE DETECTOR ACCURACY: Accuracy = 0.05 + (ϕ/180 x 0.25) degrees where ϕ is the measured phase angle between 0 and 180°. Note: This accuracy applies after standardization at 0° with input levels of 30 mV rms on the low input range and 6 V rms on the high input range. Frequency and signal level effects out of this range are shown on pages 22 and 23. The effect of waveform distortion is described on page 23. Note that the analog of phase output is taken directly from the phase detector and has the same accuracy as the phase detector.

METER READOUT ACCURACY: Six ranges: ± 5°, ± 10°, ± 18°, ± 50°, ± 100°, ± 180°. Accuracy = ± 2% of full scale. Note that the offset circuit permits all measurements to be made on the ± 5° or ± 10° range. Thus the meter accuracy error need not exceed ± 0.2° at any phase angle.

RANGE OF PHASE MEASUREMENT: 360° – (40F)° where F is the test frequency in MHz, e.g., when on the ± 180° range at 100 kHz the phase measurement range is ± 178°. To measure angles around 180° one would operate the 0 – 180 switch.

METER OFFSET: 0 to ± 170° in 10° increments. Accuracy = ± 0.5% of the offset.

ACCURACY OF 0 – 180° SWITCH: Accuracy = ± 0.1 + 0.3F degreees where F is the test frequency in MHz.

ZERO CONTROL: Permits setting an absolute zero to take into account at a fixed frequency little differences in the length of input test leads. Without adjusting the zero control the instrument "zero" will maintain within ± 0.5° from 100 Hz to 100 kHz.

ANALOG OF PHASE OUTPUT: Front panel connector provides an output proportional to phase angle with a sensitivity of 10 mV per degree. This is very useful for swept frequency phase measurements with an X-Y recorder, digital voltmeter, etc. The accuracy is that of the phase detector.

RESPONSE TIME OF PHASE OUTPUT:

Low Frequency Limit Switch Position.	1 kHz	100 Hz	30 Hz	10 Hz
Response time approx. for 180° change to 0.1° of final value.	40 ms	400 ms	1.3 sec.	4 sec.

POWER REQUIRED: 115/230 volts a.c. ± 10%. 50 – 400 Hz 30 watts.

ORDERING INFORMATION: Model 351 – shipping weight 30 lbs. Dimensions 5-1/4" high by 17-1/2" wide by 14-1/2" deep. Supplied with tilt stand for bench mounting. Rack mount kit available at no charge if specified with order.

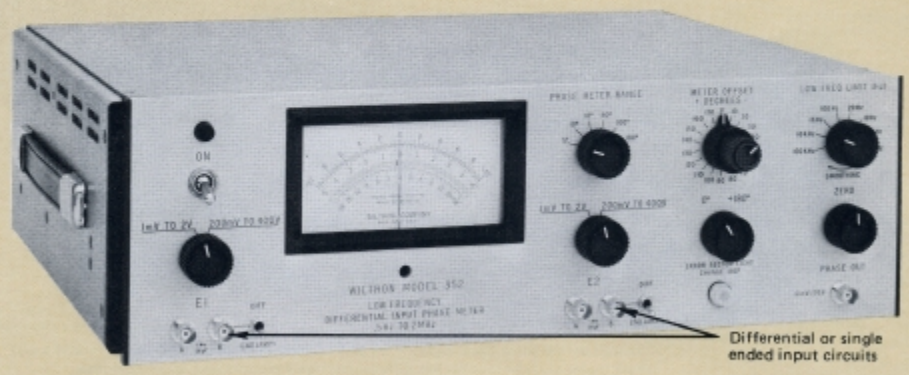
Price: Model 351 ..... $1090.

Option 1. Rear input connectors in parallel with front connectors (input capacity approx. 80 pf) ..... $50.

Option 2. Rear output connector in parallel with front output of analog voltage proportional to phase ..... $10.

Low Frequency Differential Input Phase Meter 0.5Hz to 500kHz

MODEL 352



The Model 352 Phase Meter in addition to being a precision high sensitivity instrument provides extended low frequency response to 0.5 Hz.

MORE CAPABILITY

- **Extended low frequency performance to 0.5 Hz.**
- **A 6 pole active RC filter circuit is used in the phase detector to minimize response time at low frequencies.**

SPECIFICATIONS:

FREQUENCY COVERAGE: 0.5 Hz to 500 kHz.
INPUT LEVELS: 1 mV to 2 volts rms and 200 mV to 400 volts rms, selectable. DC blocking provided up to 400 volts.
INPUT IMPEDANCE: 1 Megohm shunted by 26 pF or, when used with Tektronix oscilloscope probes (Model P6006), 10 Megohms and 8 pF.

COMMON MODE REJECTION: A common signal to both terminals of an input is rejected at least 50 dB from a differential signal over the range 50 Hz to 100 kHz; 40 dB from 0.5 Hz to 100 kHz. Rejection maintained up to 2 V or 400 V for sum of common mode plus differential signal.

PHASE DETECTOR ACCURACY: Accuracy = 0.05 + (ϕ/180 x 0.25) degrees where ϕ is the measured phase angle between 0 and 180°. Note: This accuracy applies after standardization at 0° with input levels of 30 mV rms on the low input range and 6 V rms on the high input range. Frequency and signal level effects are shown on pages 22 and 23. The effect of waveform distortion is described on page 23. Note that the analog of phase output is taken directly from the phase detector and has the same accuracy as the phase detector.

METER READOUT ACCURACY: Six ranges: ± 5°, ± 10°, ± 18°, ± 50°, ± 100°, ± 180°. Accuracy = ± 2% of full scale. Note that the offset circuit permits all measurements to be made on the ± 5° or ± 10° range. Thus the meter accuracy error need not exceed ± 0.2° at any phase angle.

METER OFFSET: 0 to ± 170° in 10° increments. Accuracy = ± 0.5% of the offset.

ACCURACY OF 0 – 180° SWITCH: Accuracy = ± (0.1 + 0.3F) degrees where F is the test frequency in MHz.

ZERO CONTROL: Permits setting an absolute zero to take into account at a fixed frequency little differences in the length of input test leads. Without adjusting the zero control the instrument "zero" will maintain within ± 0.5° from 100 Hz to 100 kHz.

RANGE OF PHASE MEASUREMENT: 360° – (40F)° where F is the test frequency in MHz; e.g., when on the ± 180° range at 100 kHz the phase measurement range is ± 178°. To measure angles around 180° one would operate the 0 – 180 switch.

ANALOG OF PHASE OUTPUT: Front panel connector provides an output proportional to phase angle with a sensitivity of 10 mV per degree. This is very useful for swept frequency phase measurements with an X-Y recorder, digital voltmeter, etc. The accuracy is that of the phase detector.

RESPONSE TIME OF PHASE OUTPUT:

Response Time for 180° change to 0.1° of final value

	Low Frequency Limit Switch Position							
100 kHz	10 kHz	1 kHz	100 Hz	20 Hz	10 Hz	2 Hz	0.5 Hz
500 μS	1.5 ms	15 ms	150 ms	0.75sec.	1.5 sec.	8 sec.	30 sec.

POWER REQUIRED: 115/230 volts a.c. ± 10%. 50 – 400 Hz 30 watts.

ORDERING INFORMATION: Model 352 – shipping weight 30 lbs. Dimensions 5-1/4" high by 17-1/2" wide by 14-1/2" deep. Supplied with tilt stand for bench mounting. Rack mount kit available at no charge if specified with order.
Price: Model 352..... $1295.
Option 1. Rear input connectors in parallel with front connectors (input capacity approx. 80 pF) ..... $50.
Option 2. Rear output connector in parallel with front output of analog voltage proportional to phase ..... $10.

Digital Phase Meter

MODEL 355

The top of WILTRON'S Phase Meter Line.

The Model 355 Digital Phase Meter is a wideband, high sensitivity instrument which provides automatic digital readout and can be connected directly into computer checkout systems for automatic measurements.

SPECIFICATIONS:

FREQUENCY RANGE: 10 Hz to 2 MHz with useful performance above and below these frequencies.

INPUT LEVELS (Both Inputs): 1 mV to 2 volts rms or 200 mV to 400 volts rms, selectable. DC blocking provided up to 400 volts.

INPUT IMPEDANCE: 1 Megohm shunted by 26 pF or, when used with Tektronix oscilloscope probes (Model P6006), 10 Megohms and 8 pF. Differential impedance 2 Megohm shunted by 15 pF for 20 Megohm and 4 pF when using probes.

ACCURACY OF PHASE READING: −180° to +180° Range:

Absolute Accuracy = $\pm 0.1 \pm \frac{\phi}{180} \times 0.25$ degrees

Where ϕ is the angle being measured. 0 to 360° Range:

Relative accuracy is the same as for the −180° to +180° range shown above. For absolute accuracy on the 360° range when 0° standardization is set on the 180° range then one must add the potential error of the range switch which is (0.1 + 0.3F) degrees where F is the test frequency in MHz.

Note: This accuracy applies over the frequency range 100 Hz to 20 kHz after standardization at 1 kHz with input levels of 30 mV rms on the low input range or 6 volts rms on the high input range. Frequency and signal level effects out of this range are shown on pages 22 and 23. The effect of waveform distortion is described on page 23.

RANGE OF PHASE MEASUREMENT: 360° − (4F)° where F is in MHz, e.g., when on the 0 − 360° range at 100 kHz the phase measurement range is 2° to 358°. To measure angles around 0° one would switch to the ± 180° range.

PHASE OUTPUT VOLTAGE: 10 mV per degree on the analog of phase voltage output. Range is −1.800 to +1.800 volts. A +180° phase shift (relative to the +180° to −180° range) is added to the phase output voltage when in the 0° to 360° position. Accuracy: Same as phase reading accuracy.

COMMON MODE REJECTION: A common signal to both terminals of an input is rejected at least 50 dB from a differential signal over the range 50 Hz to 100 kHz; 40 dB from 10 Hz to 1 MHz. Rejection maintained up to 2 V or 400 V for sum of common mode plus differential signal.

ZERO CONTROL: Permits setting an absolute zero to take into account at a fixed frequency little differences in the length of input test leads. Without adjusting the zero control the instrument "zero" will maintain within 0.5° from 100 Hz to 100 kHz.

RESPONSE TIME OF PHASE OUTPUT:

Low Frequency Limit Switch Position.	1 kHz	100 Hz	30 Hz	10 Hz
Response time approx. for 180° change to 0.1° of final value.	40 ms	400 ms	1.3 sec	4 sec

Option: Binary coded decimal output — the four digit decimal display has a resolution of 0.1°; when the BCD option is fitted the coded information is available on a 50 pin connector at the rear of the instrument.

Code used: 1248 positive one state.

Positive one state voltage, greater than +4.5 volts from 3.1 Kohms. Zero state voltage, between 0 and +0.4 volts from 3.1 Kohms. Continuous reading between samples provided by a storage register.

Positive phase indicated by positive one state.

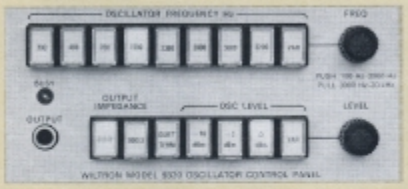
Print Command Signal: +16 volts, 30 ms duration pulse after the completion of each sampling cycle (approximately 4 per second).

PHYSICAL DESCRIPTION: Model 355 — shipping weight 30 lbs. Dimensions 5-1/4" high by 17-1/2" wide by 14-1/2" deep. Rack mounting ears supplied if requested with order. Power required: 115/230 volts ± 10%, 50/400 Hz, 35 watts.

Price: Model 355 ..... $1865.
Option: Binary coded decimal outputs ..... $45.
Option: Rear analog of phase ..... $10.
Option: Rear inputs to both channels in parallel with front inputs (input capacity approximately 80 pF) ..... $50.

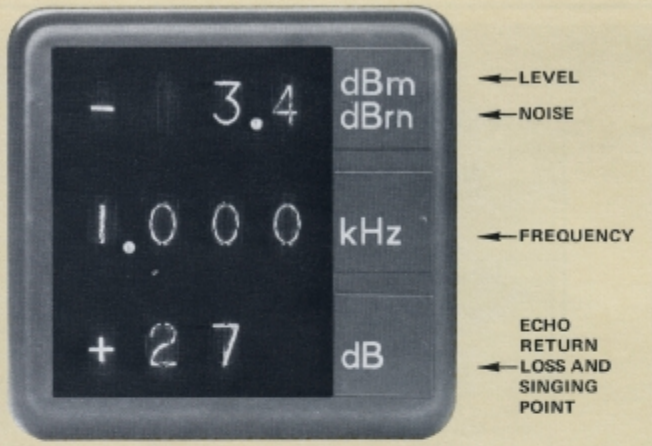
Telephone Test Equipment

Level/Noise Control Panel



Oscillator Control Panel

Return Loss Control Panel



WILTRON'S New Integrated and the Dedicated Transmission Measurement Systems use the above Control Panels and Displays

WILTRON manufactures a range of telephone office Transmission Measuring Sets built to Bell System and CCITT Standards. The following is a summary of this WILTRON telephone equipment. This equipment is described in detail on separate brochures.

Integrated Measuring Systems for Telephone Office Transmission Measurements

The Model 9101 is made up of customer selected measurement modules from the below list.

LEVEL: +10 to −52 dBm, ±0.1 dB accuracy
NOISE: 0 to 62 dBrn, with "C" message, 3 kHz Flat, 15 kHz Flat or Program Filters for Bell System, or −28 to −90 dBmp for CCITT measurements
FREQUENCY: 100 Hz to 20 kHz, 1 in 10^5 accuracy
AUDIO OSCILLATOR: 100 Hz − 20 kHz, +10 to −26 dBm
ECHO RETURN LOSS AND SINGING POINT: −10 to +50 dB return loss
VOLTS DC/AC: 0 − 200 V
CURRENT DC/AC: 0 − 200 mA
RESISTANCE: 0 − 100K ohms
CAPACITANCE: 0 − 19.9 μF

Readout is from digital displays, panel mounted or aisle mounted for viewing up to 30 ft. Control panels are designed to fit directly into test boards, using minimum space. They can be located up to 250 ft. from the measurement equipment.

The Model 9101 ITMS System (Integrated Transmission Measuring System) provides shared operation of the measurement functions. Up to ten test positions can share each function.

Typical ITMS applications are:
- Test boards in toll office (17C and many others)
- Carrier line up and patch bays

The Model 9102 DTMS System (Dedicated Transmission Measuring System) provides the same measurement functions as the Model 9101 above on a dedicated basis.

Typical DTMS applications are heavy usage test boards such as:
- SMAS equipped
- Private Line
- Circuit Order

Use the reply card on page 31 to request further information.

PORTABLE TEST SETS

Model Number	Title	Purpose	Measurement Range
9031 (rack mount version is Model 9032)	Return Loss Test Set	Echo Return Loss and Singing Point Measurements (ERL and SP)	10 dB of return gain to 50 dB of return loss
9041 (rack mount version is Model 9042)	Transmission Level and Return Loss Test Set	Transmission Level also ERL and SP measurements	Level from +12 to −48 dBm in 600 or 900 ohm circuits. Return loss from 10 dB return gain to 50 dB return loss

WARRANTY

All products are warranted against defects in materials and workmanship for one year from the date of shipment except sweep generator oscillators, which have a two-year warranty period. Our obligation covers repairing or replacing products which prove to be defective during the warranty period and which shall be returned with transportation charges prepaid to WILTRON. Obligation is limited to the original purchaser. We are not liable for consequential damages.

READ THE "WILTRON TECHNICAL REVIEW"

The **Wiltron Technical Review** is published quarterly as a service to those interested in electronics measurements and brings you engineering information from the WILTRON development laboratory.

To receive your complementary subscription, contact your local WILTRON representative, or send in the return card on page 31.

About WILTRON

WILTRON has steadily expanded its product line as well as its design and production facilities since its founding in 1960. It now owns a modern plant of 41,000 square feet in the Palo Alto Industrial Park. A front view of this plant is shown on the back cover of this catalog.

WILTRON's products have always been known for their technical integrity, with continued leadership in this area from the three founders in the photo below. Reading from right to left: Dr. Peter Lacy, chairman of the board, Bill Jarvis, president, and Duane Dunwoodie, vice president.

The cornerstone of WILTRON's product leadership and quality is its modern development laboratory where designs are being carried forward on a wide variety of sweep generators, phase meters, communication instruments, components and SWR measuring devices and systems.

The well equipped production plant makes it possible to produce quality products at economic prices. Milling and hole drilling is done with automatic numeric controlled equipment. Most other processes such as sheet metal, painting, engraving finishing and silk screening are all done at WILTRON's own facility.

WILTRON's products are well received the world over. They are designed to be universally compatible with the different line voltages, frequencies, and environmental conditions in other countries. WILTRON currently sells to customers in thirty-seven different countries and is a recent recipient of the E AWARD for its excellence in exporting.

Wiltron's export performance merits U.S. Department of Commerce E Award, presented to the company's president in December 1970.

Wiltron's three founders lend technical leadership.

Portion of Wiltron's modern production and quality assurance facilities.

Rental

All WILTRON instruments are available on short term or long term rental with 80% of rental payments applicable toward purchase. Rental rates are 8% of instrument cost per month.

Special Ordering Information

SPECIAL PAINT COLORS

Instrument front panels can be painted with standard gloss or semi-gloss finishes in special colors. An additional charge of $25.00 per panel will apply if paint is supplied by the customer. Charges when WILTRON supplies the paint will be $25.00 plus any special "batch" paint preparation costs.

RACK MOUNTING ADAPTERS

If specified on your original purchase order,
rack-mounting "ears" are available at no charge to adapt bench-type models for rack mounting.
This applies to Models 350, 351, 352, 355, 501A, 610C and 9271.

PLACING PURCHASE ORDERS

You may place your order through your representative listed on following pages,
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