

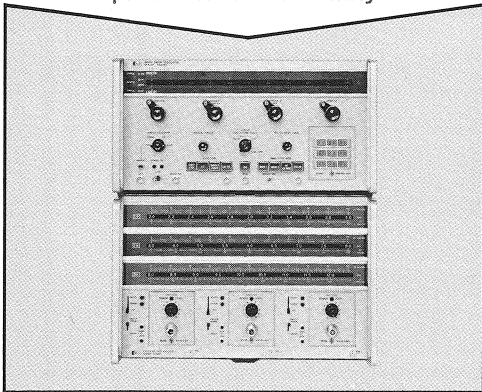


CONVERTIBLE SWEEP OSCILLATORS

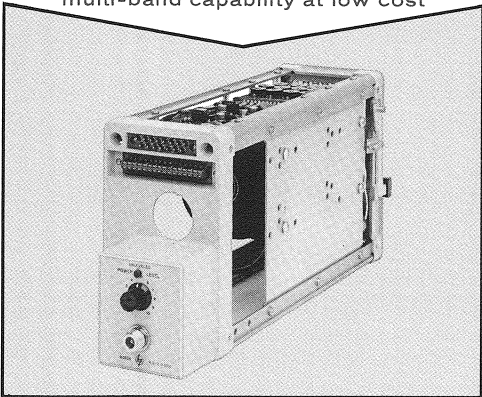
model
8690B
8691-8697
8706A, 8707A
8698B, 8699B

TECHNICAL DATA 1 MAR 70

Multi-band capability provides un-
precedented versatility



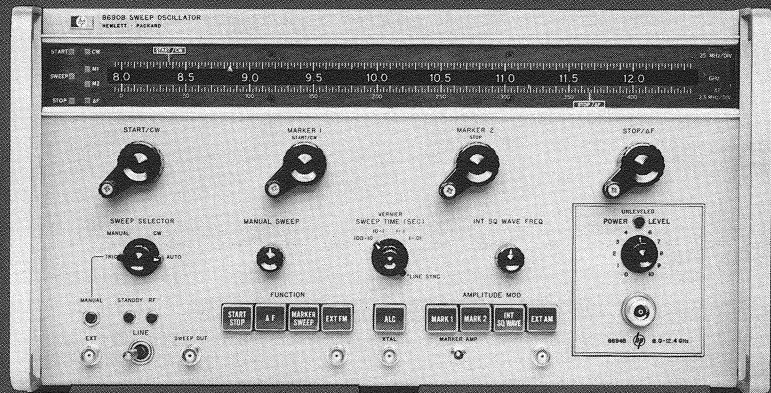
Interchangeable RF Units give you
multi-band capability at low cost



Dials are easy to change, keyed
for accurate positioning



- RF AND MICROWAVE COVERAGE
400 kHz-40 GHz
- SOLID-STATE SOURCES TO 4 GHz
- MULTIBAND SYSTEMS CAPABILITY
- EASY TO OPERATE
- RUGGED, RELIABLE, ACCURATE
- EXTREMELY LOW RESIDUAL FM
- UNCONDITIONAL 1-YEAR BWO WARRANTY



Introduction

The Hewlett-Packard 8690B Sweep Oscillator forms the basis of many types of swept-frequency systems. The 8690B Sweep Oscillator accepts nine RF units capable of covering the frequency range from 0.4 MHz to 40 GHz. An 8690B/RF Unit may be used alone or with a wide variety of accessory equipment. For example, multi-band sequentially swept coverage is provided by employing the HP 8706A Control Unit and up to three 8707A RF Unit Holders, permitting the 8690B Mainframe to drive as many as eight RF unit sweep oscillators.

8690B Sweep Oscillator

The Hewlett-Packard 8690B Sweep Oscillator combines interchangeable RF units with high accuracy, versatility, and ease of operation to bring you all the advantages of single unit sweep oscillators plus economical multi-band capability. With no adjustments required, the changing of RF units is quick and easy and the snap-in dial is keyed for accurate positioning. The front panel has a logical, straightforward layout for ease of operation. The frequency dial is the full width of the instrument for maximum resolution.

Careful design of all-new solid-state power supplies results in exceptionally low residual FM, and provides rugged protection against system transients.

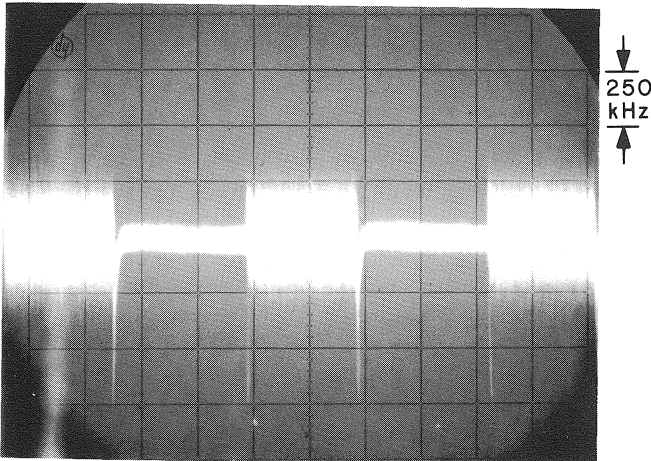


Figure 1. Low incidental FM of square-wave modulated 8693B is shown in this oscillogram. Measurement made with HP 2590B Microwave Frequency Converter.

RF Units

The HP 8698B (400 kHz - 110 MHz) and 8699B (100 MHz - 4 GHz) Solid-State RF Units provide four decades of frequency coverage with only two plug-ins. By use of heterodyne techniques, careful filtering, and advanced microcircuit technology, broadband coverage is achieved along with superior performance.

Microwave RF units employ high reliability Backward Wave Oscillator tubes (BWO) which carry an unconditional one-year warranty.

Two types of microwave RF units are available, permitting selection to meet any application requirement. HP PIN diode modulation and leveling are available in the

"B" type RF units from 1 to 12.4 GHz. The 8691-4B RF Units offer exceptional frequency accuracy (between 0.5% and 1%) over a wide range of modulation conditions. HP PIN diode RF units are the only RF units that specify full power frequency accuracy over a 10-dB dynamic range, considerably enhancing measurement accuracy. All modulation functions including leveling are performed independent of the backward-wave oscillator tube (BWO). The result is the virtual elimination of frequency pulling during either modulation or leveling, which, in turn, results in extremely high frequency accuracy and linearity and very low incidental FM. Figure 1 illustrates the low incidental FM associated with square-wave AM.

The "A" series of RF units employs conventional BWO grid modulation for AM functions. This series covers the entire 1-40 GHz spectrum in seven models (8691A-8697A) and is used in the bands above 12.4 GHz, where PIN attenuators are not available, and in lower bands when modulation requirements are less demanding.

Sweep Functions and Markers

The 8690B Sweep Oscillators provide a broadband "start-stop" sweep whose end points can be set anywhere in the band. Independent controls set the start and stop frequencies on the slide-rule scale. Thus the units can sweep up or down, depending only on the setting of the start frequency with respect to the stop frequency. There is no interaction between the start and stop control settings. Selecting the start-stop sweep is simply a matter of pushing a button.

Two independent frequency markers, set separately on the dial and direct-reading in GHz, can be positioned anywhere in the band. The markers amplitude-modulate the RF output, providing triangular markers. These markers have points sharp enough to give high resolution on narrow sweeps, yet are broad enough to be quite visible on even the broadest sweeps. Figure 2A shows that the markers are plainly visible on a full-band sweep. In addition, marker amplitude can be adjusted from the front panel. Adding the markers to the display is again a matter of pushing buttons.

The markers can also be used as end points for a second broadband sweep which starts at the Marker 1 frequency and ends at the Marker 2 frequency. Thus, the 8690B Sweep Oscillators have two independently adjustable broadband sweeps, providing a high degree of flexibility. For example, should the start-stop sweep reveal a particular area of interest, the markers can be adjusted to bracket the area; then a simple depression of the Marker Sweep button expands the bracketed area to cover the full horizontal scale of the indicating device—oscilloscope or X-Y recorder. Figure 2B illustrates this display expansion. The marker sweep need not be within the start-stop sweep. Thus the start-stop sweep can be set to cover one range, such as the passband of a filter, and the marker sweep can be set to cover another range, such as the stop band.

Besides sweeping from a start frequency to a stop frequency, the 8690's provide a calibrated narrow-band sweep which is symmetrical about a center frequency. Simply press the ΔF button, set the center frequency with the Start-CW control, and adjust the deviation with the Stop- ΔF control. Total swing is indicated on the bottom slide-rule

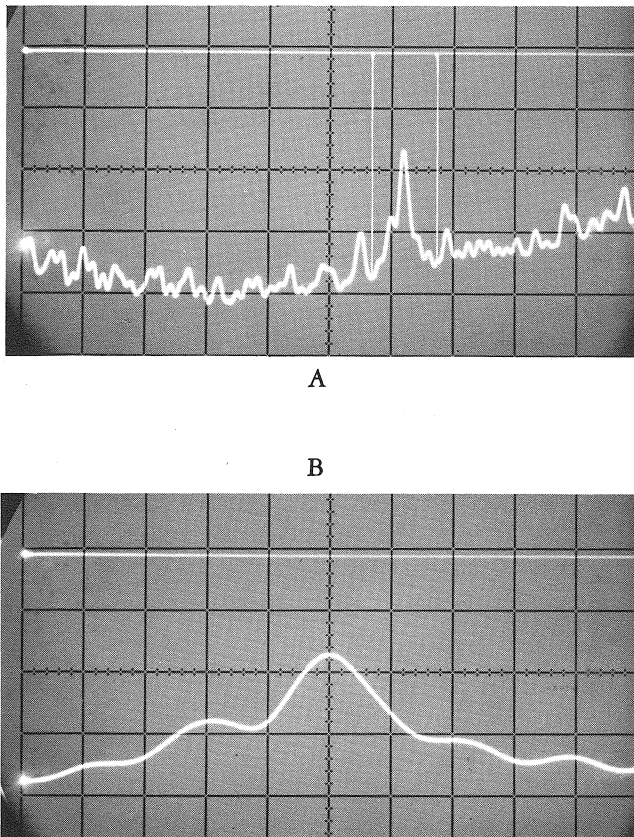


Figure 2. (A) Full-band start-stop sweep with markers. (B) Expansion of 2A display between markers on Marker Sweep.

scale. The frequency markers can be applied to the ΔF sweep as well as the start-stop sweep.

As noted above, the Start-CW and Stop- ΔF controls are used for the ΔF sweep. Thus the marker controls can be used for wideband sweep applications and the start-stop controls for ΔF operation. This provides independently adjustable wide and narrow band sweep modes with *full calibration* for both modes.

Sweep Modes

Recurrent, triggered, and manual sweeps are available. Recurrent and triggered sweep times are adjustable from 0.01 to 100 seconds, and the triggered sweeps can be synchronized from an external source or manually (front-panel pushbutton) for photography or X-Y recording. To enhance the clarity of oscilloscope presentations, RF power is blanked during retrace to produce a zero baseline; however, RF is restored before the start of the subsequent sweep to eliminate transients during the early part of the sweep. Blanking can be disabled, when desired, with a rear-panel switch. Oscilloscope photography of slow sweeps is simplified by a front-panel sweep indicator. This indicator turns on automatically at the start of the sweep and turns off at the end. Thus there is no guesswork about when to close the shutter and remove the film and no time wasted waiting to be sure the sweep is finished.

For X-Y recorder presentation, an automatic pen-lift circuit is provided. The circuit drops the pen during the stabilizing period prior to the sweep and lifts the pen during the second stabilizing period which occurs at the end of

the sweep just before retrace. Thus transients and retrace lines are eliminated from X-Y plots.

On manual sweep, a front-panel control varies the RF frequency between the limits set on the selected sweep function. With the use of the manual sweep, X-Y recorder setup time is reduced to seconds.

The sweepers provide their own voltage ramp concurrently with the RF sweep for driving the horizontal systems of oscilloscopes and X-Y recorders. While this ramp varies somewhat from unit to unit, it remains the same within a given unit regardless of sweep mode, duration, or direction. Once the sweep end points have been set on the recording device, they will remain the same for any sweep. Thus the broad flexibility and simple push-button operation of these units can be fully utilized.

In addition to the sweep voltage from the sweep oscillator, the RF units provide a reference voltage which is proportional to the output frequency. This reference is about zero at the lowest frequency and increases about 40 volts per octave. The reference, available at the rear of the RF units, can be used to drive an external monitor when a continuous indication of frequency is required. It is also especially useful with the new HP 8410A Network Analyzer system to enable accurate phase-lock synchronization at high sweep speeds.

Leveling

The 8690B Sweep Oscillators are designed for external, closed-loop leveling. This technique minimizes the variations in output amplitude with frequency which are inherent in backward-wave oscillators. A basic leveling setup is shown in Figure 3. The leveling signal, the result of RF sampling by the directional coupler and detection by a crystal detector, is applied to a leveling amplifier built into the sweep oscillator. The amplified signal is applied to the PIN diode attenuator in the "B" series of RF units and to the BWO grid in the "A" series to maintain a constant power *at the output of the directional coupler*. External leveling therefore eliminates the frequency-dependent transmission characteristics of any components (cables, connectors, amplifiers, filters, etc.) between the oscillator and sampling point.

External leveling with directional couplers has the further advantage of virtually eliminating source mismatch. Thus leveled power can be established at any point in a system, even though it is remote from the source. The degree of leveling is determined primarily by the characteristics of the directional coupler and detector.

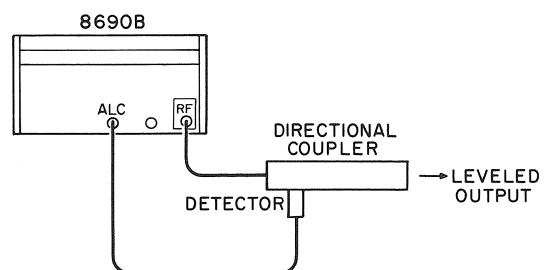


Figure 3. Basic leveling configuration in coax.

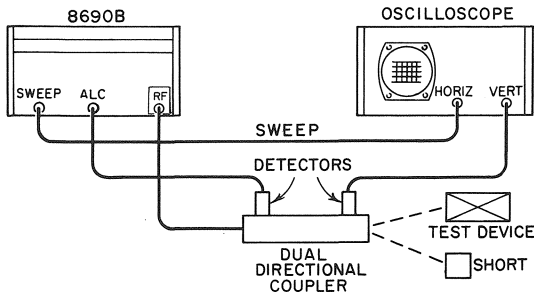


Figure 4. Coaxial reflectometer.

Internal leveling is available as Option 001 on most RF units operating below 12.4 GHz. The directional coupler and detector of Figure 3 are located within the RF unit and the output of the coupler becomes the output of the sweep oscillator. Internally leveled units are useful in less critical applications in which transmission variations between oscillator and test point are not significant or a package free of external elements is desired.

Modulation

All modulation functions are selected by pushbutton and can be used simultaneously. Included is internal square-wave modulation, with a range of 950 to 1050 Hz, plus external AM and FM. The external AM input is dc-coupled to permit dc control of amplitude and can be utilized even during leveled operation. The external FM input is also dc-coupled to permit external frequency programming, and the response to a full-band step change is typically less than 2 milliseconds. The frequency response to sinusoidal FM is 150 Hz for full-band swing. Maximum swing decreases to about 1% of the band at 20 kHz. Greater-than-specified deviations at modulating signals above 150 Hz can be obtained at a sacrifice in linearity.

Swept Systems Applications

The range of application for swept-frequency techniques covers all microwave measurement areas: impedance, attenu-

ation, power, frequency, etc. The most widely used swept-frequency system has been the reflectometer, which, in measuring return loss and SWR, provides impedance information. Figure 4 illustrates the basic reflectometer setup in coax; the waveguide setup is similar. Above 4 GHz, the low directivity of coaxial directional couplers has been a serious limitation in the coaxial reflectometer. Hewlett-Packard, therefore, recently developed the Model 817A Swept Slotted Line system capable of measuring very low standing-wave ratios with a high degree of accuracy from 1.8 to 18 GHz. The design simplicity of the 817A Swept Slotted Line system shown in Figure 5 provides broadband, precision, coaxial SWR measurements at roughly a third of the cost of previously available hardware.

Frequency response, whether in the form of attenuation in a passive device or gain in an active device, is another parameter readily measured on a swept-frequency basis. A typical measurement setup in waveguide is shown in Figure 6.

The new Hewlett-Packard Model 8410A Network Analyzer provides one simple system capable of measuring both amplitude and phase of all network parameters from 110 MHz to 12.4 GHz. The 8410A Network Analyzer is shown in Figure 7, with the HP 8690B Sweep Oscillator measuring both the amplitude and phase transmission characteristics of a YIG filter. The 8410A is capable of measuring phase, gain, loss, impedance, admittance, reflection coefficient, and angle. Phase and amplitude output data may be obtained either from a linear meter readout or in polar form with the HP 8414A Polar Display.

The HP sweeper has been designed to be especially compatible with the advanced 8410A Network Analyzer system. The 8690B supplies a sweep reference voltage output which is used to synchronize the 8410A sampling phase-lock oscillator permitting phase-lock operation at the fastest sweep speeds, providing a flicker-free oscilloscope readout. The 8690B Oscillator has been designed to provide a delayed sweep start-up, enabling the 8410A Network Analyzer system to phase-lock before the initiation of the sweep. This delayed sweep start-up capability is also especially useful

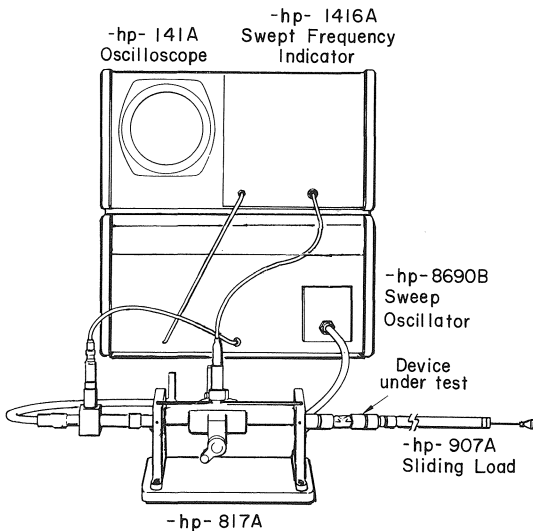


Figure 5. The 817A Swept Slotted Line system provides inexpensive and precise SWR measurement from 1.8 to 18 GHz.

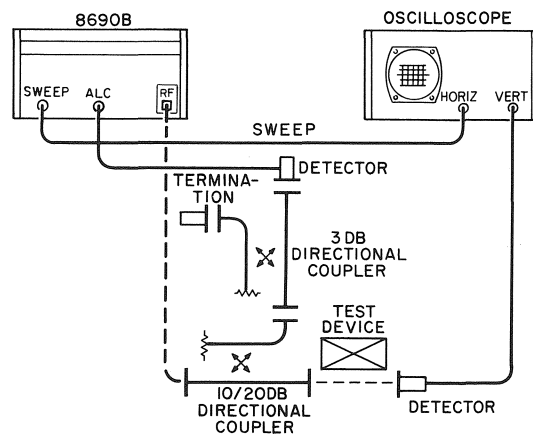


Figure 6. Frequency response setup.

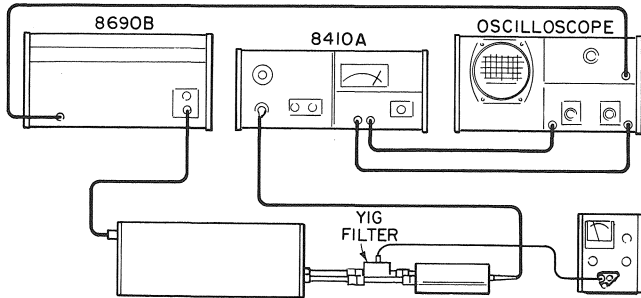


Figure 7. HP 8410A Network Analyzer (110 MHz to 12.4 GHz) shown measuring phase and amplitude response of YIG filter.

in driving X-Y recorders, permitting recorder stabilization before the initiation of the sweep ramp. The B Model 8691 through 4 plug-ins incorporates the unique HP PIN diode leveling capability, providing greater dynamic range.

This enables an operator to reduce swept output signal to a level that will not overdrive the 8410A Network Analyzer system.

8706A Control Unit/8707A RF Unit Holder

The Hewlett-Packard 8706A Control Unit and 8707A RF Unit Holder provide you with an inexpensive solution to the need for broadband sweep capability. The Model 8706A Control Unit substitutes for the normal RF unit in the 8690B Mainframe and is capable of programming up to three 8707A RF Unit Holders, providing up to eight bands of frequency coverage from one HP 8690B Mainframe. The HP 8706A/8707A is described on page 10.

Applications Literature

HP Application Note 65, titled "Swept-Frequency Techniques," provides an up-to-date discussion and error analysis of the most frequently used swept-frequency setups and measurements techniques. Copies of Application Note 65 are available at all Hewlett-Packard field offices.

Summary of Specifications

Sweep Oscillator/ RF Unit	Frequency Range	Max. Levelled Power Output	Frequency Accuracy	Price
8690B	—	—	—	\$1,600.00
8698B	0.4 - 110 MHz	≥ 20 mW	± 1%	1,550.00
8699B	} 0.1 - 2.0 GHz 2 - 4 GHz	≥ 20 mW	± 10 MHz	3,600.00
8691A		≥ 100 mW		
8691B	1 - 2 GHz	≥ 70 mW	± 10 MHz	2,375.00
8692A	2 - 4 GHz	≥ 70 mW	± 1%	1,825.00
8692B	2 - 4 GHz	≥ 40 mW	± 20 MHz	2,175.00
8692B Opt. 100	1.7 - 4.2 GHz	≥ 15 mW	± 25 MHz	2,475.00
8693A	4 - 8 GHz	≥ 30 mW	± 1%	1,625.00
8693B	4 - 8 GHz	≥ 15 mW	± 40 MHz	2,025.00
8693B Opt. 100	3.7 - 8.3 GHz	≥ 5 mW	± 45 MHz	2,325.00
8694A	8 - 12.4 GHz	≥ 50 mW	± 1%	1,625.00
8694A Opt. 100	7 - 12.4 GHz	≥ 25 mW	± 1%	1,900.00
8694A Opt. 200	7 - 11 GHz	≥ 25 mW	± 1%	1,650.00
8694B	8 - 12.4 GHz	≥ 30 mW	± 40 MHz	2,050.00
8694B Opt. 100	7 - 12.4 GHz	≥ 15 mW	± 50 MHz	2,325.00
8694B Opt. 200	7 - 11 GHz	≥ 15 mW	± 40 MHz	2,075.00
8695A	12.4 - 18 GHz	≥ 40 mW	± 1%	1,800.00
8696A	18 - 26.5 GHz	≥ 10 mW	± 1%	2,700.00
8697A	26.5 - 40 GHz	≥ 5 mW	± 1%	4,500.00

Specifications

Models 8691A, 8691B, RF Units* (Installed in 8690B Sweep Oscillator)

	8691A	8691B
Frequency Range	1 to 2 GHz	1 to 2 GHz
Frequency Accuracy (at max. leveled power)	± 1%	± 10 MHz
Maximum Leveled Power	At least 100 mW	At least 70 mW
RF Power Control	BWO Grid	PIN Line
Frequency Stability		
With Temperature	± 0.01%/°C	± 0.01%/°C
With 10% Change in Line Voltage	± 500 kHz	± 500 kHz
With Power Level Change	Typically < 20 MHz (for 6 dB) ¹	± 500 kHz (for 10 dB)
Residual FM (CW mode)***	< 30 kHz peak	< 10 kHz peak
Power Variation, External Leveling**	± 0.2 dB	± 0.1 dB
Output Impedance and/or Connector	50 ohms/Type N	50 ohms/Type N
Price	\$2,025.00	\$2,375.00
Option 01. Internal Leveling		
Power Variation	± 0.4 dB	
Equivalent Source Match	1.13:1	¹ Down from max. leveled power.
Price	Add \$315.00	

Models 8692A/B, 8692B Opt. 100 RF Units* (Installed in 8690B Sweep Oscillator)

	8692A	8692B	8692B Opt. 100
Frequency Range	2 to 4 GHz	2 to 4 GHz	1.7 to 4.2 GHz
Frequency Accuracy (at max. leveled power)	± 1%	± 20 MHz	± 25 MHz
Maximum Leveled Power	At least 70 mW	At least 40 mW	At least 15 mW
RF Power Control	BWO Grid	PIN Line	PIN Line
Frequency Stability			
With Temperature	± 0.01%/°C	± 0.01%/°C	± 0.01%/°C
With 10% Change in Line Voltage	± 500 kHz	± 500 kHz	± 500 kHz
With Power Level Change	Typically < 40 MHz (for 6 dB) ¹	± 4 MHz (for 10 dB)	± 4 MHz (for 10 dB)
Residual FM (CW mode)***	< 30 kHz peak	< 15 kHz peak	< 20 kHz peak
Power Variation, External Leveling**	± 0.2 dB	± 0.1 dB	± 0.1 dB
Output Impedance and/or Connector	50 ohms/Type N	50 ohms/Type N	50 ohms/Type N
Price	\$1,825.00	\$2,175.00	\$2,475.00
Option 01. Internal Leveling			
Power Variation	± 0.4 dB		
Equivalent Source Match	1.16:1		
Price	Add \$315.00		¹ Down from max. leveled power.

Models 8693A/B, 8693B Opt. 100 RF Units* (Installed in 8690B Sweep Oscillator)

	8693A	8693B	8693B Opt. 100
Frequency Range	4 to 8 GHz	4 to 8 GHz	3.7 to 8.3 GHz
Frequency Accuracy (at max. leveled power)	± 1%	± 40 MHz	± 45 MHz
Maximum Leveled Power	At least 30 mW	At least 15 mW	At least 5 mW
RF Power Control	BWO Grid	PIN Line	PIN Line
Frequency Stability			
With Temperature	± 0.01%/°C	± 0.01%/°C	± 0.01%/°C
With 10% Change in Line Voltage	± 1 MHz	± 1 MHz	± 1 MHz
With Power Level Change	Typically < 80 MHz (for 6 dB) ¹	± 1 MHz (for 10 dB)	± 1 MHz (for 10 dB)
Residual FM (CW mode)***	< 50 kHz peak	< 15 kHz peak	< 20 kHz peak
Power Variation, External Leveling**	± 0.2 dB	± 0.1 dB	± 0.1 dB
Output Impedance and/or Connector	50 ohms/Type N	50 ohms/Type N	50 ohms/Type N
Price	\$1,625.00	\$2,025.00	\$2,325.00
Option 01. Internal Leveling			
Power Variation (into matched load)	± 0.5 dB	± 0.4 dB	± 0.4 dB
Equivalent Source Match (approx.)	1.25:1	1.25:1	1.25:1
Price	Add \$350.00	Add \$350.00	Add \$350.00

¹ Down from max. leveled power.

* See page 8 for common specifications.

** Excluding coupler and detector variation.

Specifications

8694A, 8694A Opt. 100, 8694A Opt. 200 RF Units
(Installed in 8690B Sweep Oscillator)

	8694A	8694A Opt. 100	8694A Opt. 200
Frequency Range	8 to 12.4 GHz	7 to 12.4 GHz	7 to 11 GHz
Frequency Accuracy (at max. leveled power)	± 1%	± 1%	± 1%
Maximum Leveled Power	At least 50 mW	At least 25 mW	At least 25 mW
RF Power Control	BWO Grid	BWO Grid	BWO Grid
Frequency Stability			
With Temperature	± 0.01%/°C	± 0.01%/°C	± 0.01%/°C
With 10% Change in Line Voltage	± 1 MHz	± 1 MHz	± 1 MHz
With 6-dB Power Level Change down from max. leveled power	Typically < 160 MHz	Typically < 160 MHz	Typically < 160 MHz
Residual FM (CW mode)***	< 60 kHz peak	< 60 kHz peak	< 60 kHz peak
Power Variation, External Leveling**	± 0.2 dB	± 0.2 dB	± 0.2 dB
Output Impedance and/or Connector	50 ohms/Type N	50 ohms/Type N	50 ohms/Type N
Price	\$1,625.00	\$1,900.00	\$1,650.00
Option 01. Internal Leveling			
Power Variation (into matched load)	± 0.75 dB	± 0.75 dB	± 0.75 dB
Equivalent Source Match (approx.)	1.5:1	1.5:1	1.5:1
Price	Add \$450.00	Add \$450.00	Add \$450.00

Models 8694B, 8694B Opt. 100, 8694B Opt. 200 RF Units*
(Installed in 8690B Sweep Oscillator)

	8694B	8694B Opt. 100	8694B Opt. 200
Frequency Range	8 to 12.4 GHz	7 to 12.4 GHz	7 to 11 GHz
Frequency Accuracy (at max. leveled power)	± 40 MHz	± 50 MHz	± 40 MHz
Maximum Leveled Power	At least 30 mW	At least 15 mW	At least 15 mW
RF Power Control	PIN Line	PIN Line	PIN Line
Frequency Stability			
With Temperature	± 0.01%/°C	± 0.01%/°C	± 0.01%/°C
With 10% Change in Line Voltage	± 1 MHz	± 1 MHz	± 1 MHz
With 10-dB Power Level Change	± 1 MHz	± 1 MHz	± 1 MHz
Residual FM (CW mode)***	< 15 kHz peak	< 20 kHz peak	< 20 kHz peak
Power Variation, External Leveling**	± 0.1 dB	± 0.1 dB	± 0.1 dB
Output Impedance and/or Connector	50 ohms/Type N	50 ohms/Type N	50 ohms/Type N
Price	\$2,050.00	\$2,325.00	\$2,075.00
Option 01. Internal Leveling			
Power Variation (into matched load)	± 0.75 dB	± 0.75 dB	± 0.75 dB
Equivalent Source Match (approx.)	1.5:1	1.5:1	1.5:1
Price	Add \$450.00	Add \$450.00	Add \$450.00

Models 8695A, 8696A, 8697A RF Units*
(Installed in 8690B Sweep Oscillator)

	8695A	8696A	8697A
Frequency Range	12.4 to 18 GHz	18 to 26.5 GHz	26.5 to 40 GHz
Frequency Accuracy (at max. leveled power)	± 1%	± 1%	± 1%
Maximum Leveled Power	At least 40 mW	At least 10 mW	At least 5 mW
Frequency Stability			
With Temperature	± 0.01%/°C	± 0.01%/°C	± 0.01%/°C
With 10% Change in Line Voltage	± 10 MHz	± 15 MHz	± 20 MHz
With 6-dB Power Level Change down from max. leveled power	Typically < 0.25 GHz	Typically < 0.36 GHz	Typically < 0.53 GHz
Residual FM (CW mode)***	< 150 kHz	< 200 kHz	< 350 kHz
Power Variation, External Leveling**	± 0.2 dB	± 0.2 dB	± 0.2 dB
Output Connector	UG-419/U	UG-595/U	UG-599/U
Price	\$1,800.00	\$2,700.00	\$4,500.00

*** Residual FM specifications give peak deviations for modulating components within a 10-kHz bandwidth. Peak deviation may vary ±50% for a 10% line voltage change. Specifications apply for unleveled operation of A Model RF Units, and both leveled and unleveled operation in B Model RF Units. Specifications for all B Model RF Units are typically the same as above when used in an 8707A RF Unit Holder. However, the maximum B Model RF Unit specifications are twice the above for use in the 8707A.

* See page 8 for common specifications.

** Excluding coupler and detector variation.

For All 8691-8697 RF Units

Magnetic Shielding: All 8691-8697 RF Units except 8691A/B have shielded BWO's. All BWO's are unconditionally warranted for 1 year.

Residual AM: At least 40 dB below CW output.

Spurious Signals: Harmonics, at least 20 dB below CW output; non-harmonics, at least 40 dB below CW output.

Reference Output: Direct-coupled voltage proportional to RF frequency, approximately 0 V at the low end of the band, increasing approximately 40 V/octave. Output impedance, 25,000 ohms.

Leveling Indicator: Front-panel indicator lights when power level set too high to permit leveling over entire selected sweep range or when operating in un-leveled mode.

Equivalent Source Match:

Externally Leveled: Depends upon coupler.

Unleveled: Less than 2.5:1.

Power Variation, Unleveled: Less than 10 dB over the entire band.

Weight:

8691A, 8692A: Net, 17 lb (7,6 kg). Shipping, 25 lb (11,3 kg).

8691B, 8692B: Net, 20 lb (9 kg). Shipping, 28 lb (12,6 kg).

8693A-8697A: Net, 10 lb (4,5 kg). Shipping, 18 lb (8,1 kg).

8693B, 8694B: Net, 12 lb (5,4 kg). Shipping, 20 lb (9 kg).

Rear Panel Output: Specify Option 004; price, add \$75.00 for 8691-4, add \$150.00 for 8695-7.



Specifications

8690B Sweep Oscillator

(with RF Unit installed)

Frequency Range: Determined by RF unit.

Sweep Functions

Start-Stop Sweep: Sweeps from "start" to "stop" frequency setting.

Range: Both settings continuously and independently adjustable over the entire frequency range; can be set to sweep either up or down in frequency.

End-point Accuracy: Same as RF unit frequency accuracy.

Marker Sweep: Sweeps from "Marker 1" to "Marker 2" frequency setting.

Range: Both settings continuously and independently adjustable over the entire frequency range; can be set to sweep either up or down in frequency.

End-point Accuracy: Same as RF unit frequency accuracy.

ΔF Sweep: Sweeps upward in frequency, centered on CW setting.

Width: Continuously adjustable from zero to 10% of the frequency band; calibrated directly in MHz.

Width Accuracy:¹ $\pm 10\%$ of ΔF being swept $\pm 1\%$ of maximum ΔF ($\pm 20\% \pm 2\%$ respectively with 8691A/B RF Units).

Center-frequency Accuracy: Same as RF unit frequency accuracy.

Frequency Markers: Two frequency markers, independently adjustable over the entire frequency range, amplitude-modulate the RF output. Amplitude is adjustable from the front panel. The markers are also available for external use.

Accuracy: 1% of full scale for all RF units.

Resolution: Better than 0.05% of RF unit bandwidth.

Marker Output: Triangular pulse, typically — 5 V peak into 1000-ohm load.

CW Operation: Single-frequency RF output selected by START/CW or MARKER 1 control, depending upon sweep function selected.

Accuracy: Same as RF unit frequency accuracy.

Preset Frequencies: Start-stop sweep end points and marker frequencies can be used as four preset CW frequencies.

Sweep Mode

Auto: Sweep recurs automatically.

Manual: Front-panel control provides continuous manual adjustment of frequency between end frequencies set in any of the above sweep functions.

Triggered: Sweep is actuated by front-panel push button or by externally applied signal $< - 25$ V peak, $> 1 \mu s$ pulse width, and > 0.1 V/ μs rise.

Sweep Time: Continuously adjustable in four decade ranges, 0.01 to 100 seconds. Can be synchronized with the power line frequency.

Sweep Indicator: Front-panel indicator lights during the sweep to provide indication of sweep duration on slower sweep times.

Sweep Output: Direct-coupled sawtooth, zero to approx. + 15 V, concurrent with swept RF output. Zero at start of sweep, approximately + 15 V at end of sweep regardless of sweep width or direction. Source impedance, 10,000 ohms.

Frequency Linearity:^{1, 2} Same as RF unit frequency accuracy.

Blanking: RF automatically turned off during retrace, turned on after completion of retrace. On automatic sweeps, RF is on long enough before sweep starts

Specifications

8690B Sweep Oscillator (with RF Unit installed)

to stabilize external circuits and equipment whose response is compatible with the selected sweep rate. Blanking disable switch provided.

Blanking Output: Direct-coupled rectangular pulse approximately — 4 V coincident with RF blanking. Source impedance approximately 3000 ohms.

Pen Lift: For use with X-Y graphic recorders. Pen-lift terminals shorted during sweep, open during retrace.

Power Leveling Amplifier: Internal dc-coupled leveling amplifier provided (not used with 8698B).

Crystal Input: Approximately — 20 to — 350 mV for specified leveling at rated output; for use with negative-polarity detectors such as 780 Series Directional Detectors, 423A and 424 Series Crystal Detectors.

Modulation¹

Internal AM: Square-wave modulation continuously adjustable from 950 to 1050 Hz on all sweep times. On/off ratio greater than 20 dB at rated output.

External AM

Frequency Response: dc to 350 kHz unlevelled, dc to 50 kHz levelled.

Sensitivity: — 10 V reduces RF output level at least 30 dB below rated CW output (A Model RF Units); 25 dB below rated CW output (B Model RF Units).

Input Impedance: Approximately 1000 ohms.

External FM

Frequency Response: dc to 3 kHz.

Sensitivity: Deviation from CW setting approximately 6% of the frequency band per volt.

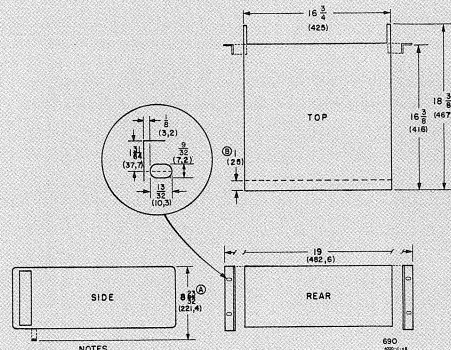
Maximum Range: Full band for modulation frequencies up to 150 Hz (approximately 17 V pp input), decreases to about 20% of the band for 3 kHz modulation.

Input Impedance: Approximately 100,000 ohms.

Furnished: 7½-foot (2290 mm) power cable with NEMA plug; rack-mounting kit.

Power: 115 or 230 volts ± 10%, 50 to 60 Hz. Approximately 350 watts.

Dimensions:

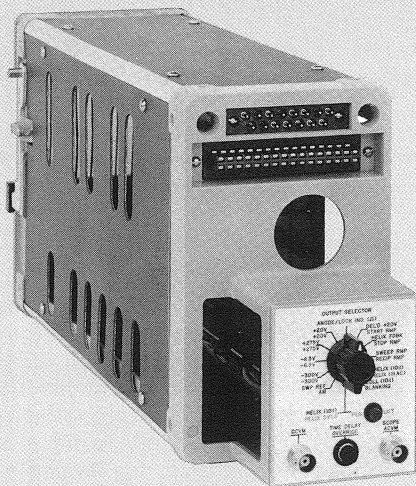


NOTES
DIMENSIONS IN INCHES AND (MILLIMETERS)
① EIA RACK HEIGHT
FOR CABINET HEIGHT (INCLUDING FEET) ADD 5/16 (8,0) TO EIA RACK HEIGHT
② REAR APRON RECES

Weight (not including RF unit): Net, 53 lb (23,9 kg).
Shipping, 71 lb (32 kg).

Price: Model 8690B, \$1,600.00.

¹ Listed separately for 8698B and 8699B, see pages 12 and 14.
² Correlation between frequency and both the sweep and reference output.

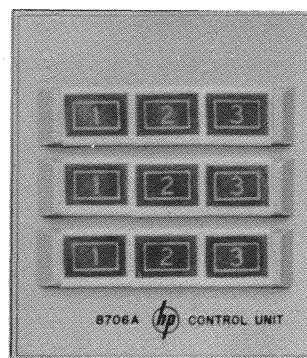
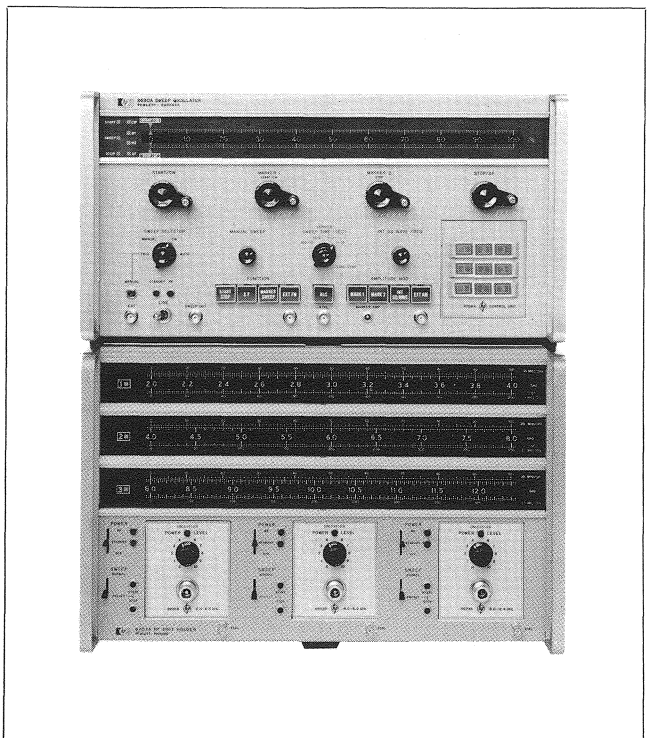


Accessory Equipment

The Model 11531A Test Unit facilitates 8690B Sweep Oscillator calibration and trouble-shooting. The unit plugs into the 8690B like an RF unit. Circuit points sampled during the calibration procedure are presented on front-panel BNC connectors. The unit switches in standard calibrating circuits, equivalent to those in the RF units, to ensure interchangeability of all 8690 Series RF Units in the 8690B Sweep Oscillator. Price: 11531A, \$350.00.

CONTROL UNIT RF UNIT HOLDER

models
8706A
8707A



DESCRIPTION

The first simple and relatively inexpensive solution to the problem of broadband sweep capability (more than an octave) is offered by Hewlett-Packard's Model 8706A Control Unit with the Model 8707A RF Unit Holder. When used with the HP Model 8690B Sweep Oscillator and appropriate RF units, a compact, bench-top multi-band source is formed.

The Model 8706A Control Unit with its nine band selector buttons, replaces the usual RF unit as a plug-in for the sweep oscillator mainframe. It supplies power for and controls as many as three Model 8707A RF Unit Holders, each of which accommodates three RF units. Thus it is possible to obtain complete frequency coverage from 400 kHz to 40 GHz with one easy-to-use system.

Units may be programmed either by front panel control unit pushbutton selection, or sequentially by remote contact closure to ground. The 8706A also can provide voltages for control of remote circuits, relays, etc. By utilizing these voltages to program a coaxial switch, for example, you can channel the output signals of several RF units through a single system output connector. Multi-band tests can then be made quickly

and easily; changing RF units and cable connections is handled automatically at the touch of a button.

Switching time between bands is one second, with no degradation of BWO life. This is an exclusive new accomplishment. Two separate types of sweep capability are available in each band. If normal sweep is selected for one or more of the RF units in the 8707A RF Unit Holder, the breadth of the RF unit sweep will correspond to the setting of the start/stop cursor on the sweeper mainframe—100% if 0 and 100 are selected, or any proportion as designated on the start/stop dial. A second preset mode is available for one or more RF units by pre-adjusting start/stop frequency settings made on potentiometers adjacent to each RF unit plug-in in the 8707A RF Unit Holder.

Unnecessary operation of BWO tubes should be avoided to prolong their life. At the same time, it is desirable to have the output of any RF unit quickly available. The 8707A sweep system maintains the BWO's on standby, removing the high voltage when not in use to extend tube life. When a single band is not to be used over some period of time, for example during a laboratory set-up procedure, an individual RF unit may easily be turned off, minimizing all aging effects.

SPECIFICATIONS

Specifications 8706A

Compatibility: The 8706A controls up to three 8707A RF Unit Holders. Selection of RF units is by front-panel pushbutton or remote contact closure (see Remote Control below).

Switching Time Between RF Units: 1 second.

Remote Control: Connector on rear panel permits selection of RF units from remote location or control of remote circuits or switches from the 8706A. There are nine control pins, each corresponding to a front-panel pushbutton, plus a common ground pin. Mating connector (not supplied), Amphenol 57-30140 (also available from HP under part number 1251-0142).

RF Unit Selection: Momentary grounding of appropriate control pin.

Control Pin Voltage: Pins are at 0 V (ground) when RF unit is selected, otherwise at - 5 V when RF unit is not in use (standby). These voltages can be used to program external devices such as coaxial switches.

Minimum External Resistance (per control pin) for Unselected RF Units: 50 Ω.

Maximum External Resistance for Positive Selection of RF Unit: 2 Ω.

Maximum Current per Control Pin: 100 mA.

Weight: Net, 16 lb (7,3 kg). Shipping, 22 lb. (10 kg).

Price: Model 8706A, \$600.00.

Specifications 8707A

Compatibility: Accepts up to three 8692-8699 RF Units.* No modification of the RF units is necessary.

Frequency Range: 400 kHz to 40 GHz.

* Caution: Nonshielded 8691A/B's are not compatible with and should not be installed in the 8707A.

Frequency Accuracy: Same as RF unit accuracy.

Maximum Leveled Power: Same as 8692-8699 RF Units.

Leveling Capability: Same as 8692-8699 RF Units.

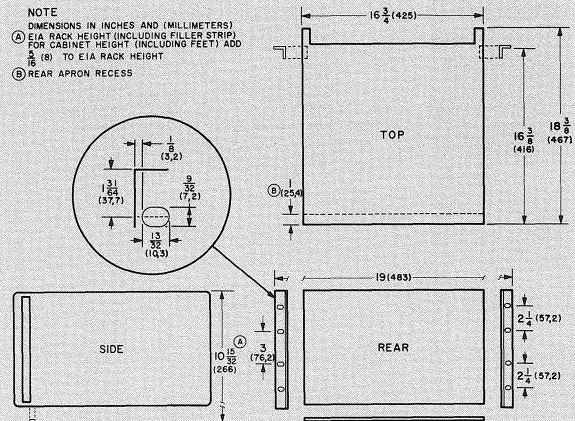
Output Impedance and Connector: Same as RF units.

Sweep Functions:

Normal: Permits any sweep function available from the 8690B.

Preset: Provides start-stop sweep determined by preset adjustments on the 8707A. Sweep endpoints can be set independently for each RF unit.

Dimensions:



Power: Approximately 385 W for system with one each 8690B, 8706A, 8707A, and three RF units; approx. 25 W for each additional RF unit.

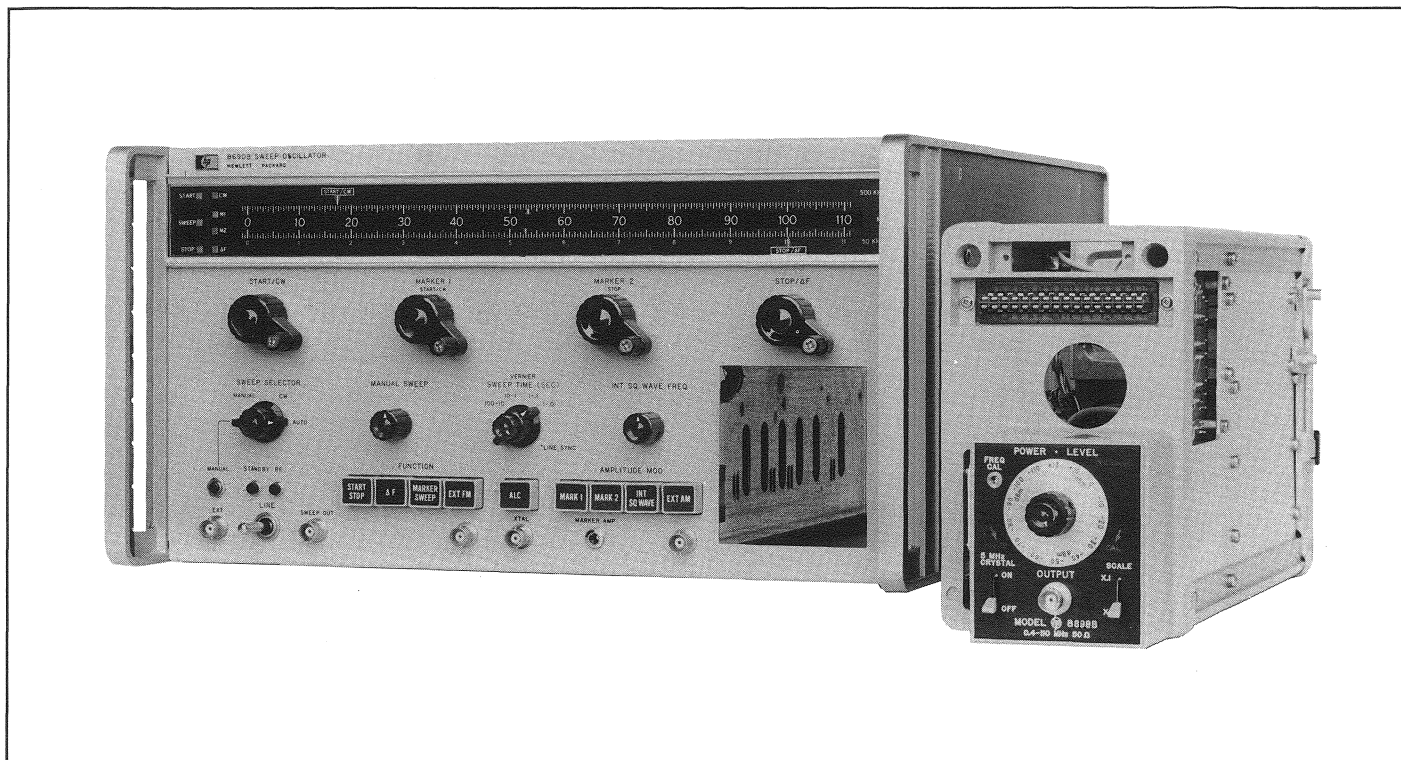
Weight: Net, 28 lb (12,7 kg). Shipping, 34 lb (15,4 kg).

Accessory Available: 11531A Test Unit.

Price: Model 8707A, \$1,450.00.

SOLID-STATE RF UNIT 0.4 - 110 MHz

model
8698B



Description

The Hewlett-Packard 8698B RF Unit for the HP 8690B Sweep Oscillator covers a frequency range from 400 kHz to 110 MHz in two ranges. The all solid-state plug-in allows swept measurements to be made easier and more accurately for the following reasons:

Sweep linearity is $\pm 0.5\%$ of sweep width and frequency accuracy of the start and stop points is nominally 1% of frequency. With the plug-in's high linearity and frequency accuracy, the operator can use the internal graticule markings on his oscilloscope as a frequency scale and can then accurately define the frequency response of amplifiers, filters, and other devices.

Maximum output is +13 dBm (20 milliwatts) into a 50-ohm system. Output power is calibrated in 10 dB steps from +13 to -110 dBm with vernier adjustment between steps. Calibrated power makes it easier to define gain and loss in networks and amplifiers.

A built-in leveling circuit holds the output flat within ± 0.3 dB throughout the maximum sweep width, providing accuracy in measuring a device's amplitude response.

Residual FM is less than 300 Hz on the 0.4 - 11 MHz range and less than 1 kHz on the 4 - 110 MHz range, assuring clean, stable displays when testing narrow band devices.

Harmonics are at least 30 dB down and spurious responses 35 dB down over the entire frequency range.

There are many convenient sweep functions: START-STOP, MARKER SWEEP, and ΔF . All sweeps are calibrated and accurate.

The 8698B can be voltage-programmed in both amplitude and frequency and is capable of AM and FM.

Other significant features are a 0.4 - 11 MHz auxiliary output which allows the user to monitor frequency up to 110 MHz with an 11 MHz counter (such as the HP 5321), a 5 MHz crystal calibrator, an uncalibrated RF output, a sweep reference output, and a 200.4 - 310 MHz VTO output.

The HP 8698B RF Unit is all solid-state throughout, incorporating thin-film microcircuit amplifiers in its design. Power consumption is thus held low and reliability high.

8698B Specifications

(Installed in 8690B Sweep Oscillator)

FREQUENCY CHARACTERISTICS

Range: Low range, 0.4 - 11 MHz; high range, 4 - 110 MHz.

Accuracy: (CW, ΔF center frequency, end points of start-stop and marker sweep; except when 8690B is in Ext FM mode.)

Low Range: $\pm 1\%$ of frequency ± 50 kHz.

High Range: $\pm 1\%$ of frequency ± 500 kHz.

Linearity: $\pm 0.5\%$ of sweep width.

Harmonics and Spurious Responses:

Non-Harmonics: At least 35 dB below CW output.

Harmonics: (Output levels below +10 dBm) At least 30 dB below CW output.

Residual FM: (CW and Sweep)

Noise in a 10 kHz bandwidth including line related components:

Less than 300 Hz rms, low range.

Less than 1 kHz rms, high range.

Combined Incidental and Residual FM with internal square wave modulation:

Less than 600 Hz rms, low range.

Less than 2 kHz rms, high range.

Residual AM: AM noise modulation index (rms, 10 kHz bandwidth) is less than -40 dB.

OUTPUT CHARACTERISTICS

Level: +13 to -110 dBm. Output is calibrated in 10 dB steps and at +13 dBm. Uncalibrated vernier provides continuous level settings over entire range.

Accuracy: ± 1.5 dB at any calibrated level.

Flatness: ± 0.3 dB over full range.

Impedance: 50 Ω , SWR < 1.2 on 0 dBm step and below.

RF Leakage: Conducted and radiated leakage limits are below those specified in MIL-I-6181D.

SWEEP CHARACTERISTICS

(Operating controls are located on the 8690B)

Start-Stop Sweep: Sweeps from "start" to "stop" dial setting.

Marker Sweep: Sweeps from "Marker 1" to "Marker 2" dial setting.

In both Start-Stop and Marker Sweep, dial settings are continuously and independently adjustable over the entire frequency range and can be set to sweep either up or down in frequency.

ΔF Sweep: Sweeps upward in frequency, centered on CW dial setting.

ΔF Width Accuracy:

Low Range: $\pm 3\%$ of sweep width or ± 20 kHz, whichever is greater.

High Range: $\pm 3\%$ of sweep width or 200 kHz, whichever is greater.

Sweep Speeds: Continuously adjustable in four decade ranges 0.01 to 100 seconds/sweep, or with manual control from front panel, providing continuous tuning over preset limits.

Sweep Modes: Automatic (free running), line synchronized, or triggered by either front panel pushbutton or external pulse.

Sweep Indicator: Front panel indicator lights during sweep duration.

MARKERS

(Controls on 8690B)

Two frequency markers, independently adjustable over the entire frequency range, amplitude modulate the RF output. Marker amplitude is adjustable from the front panel.

Marker Accuracy:

Low Range: $\pm 1\%$ of frequency ± 50 kHz.

High Range: $\pm 1\%$ of frequency ± 500 kHz.

Resolution:

Low Range: ± 5 kHz.

High Range: ± 50 kHz.

Marker Output: Triangular pulse, typically -5 V peak into 1 k Ω .

MODULATION

Internal AM: Square wave modulation continuously adjustable from 950 to 1050 Hz. On-off ratio (level vernier in calibrated position) is 20 dB.

External AM:

Bandwidth: DC to 5 kHz at 30% modulation.

Sensitivity: -10 V reduces RF output at least 20 dB (level vernier in calibrated position).

Input Impedance: Approximately 1 k Ω .

External FM: (Sweep selector in "manual" position)

Bandwidth: Deviations to the band edges are possible for rates to 100 Hz. Smaller deviations possible at rates up to 10 kHz.

Sensitivity: Deviation from CW setting is approximately 6% of frequency band per volt.

CRYSTAL CALIBRATOR

Internal 5 MHz crystal allows frequency calibration to $\pm 0.01\%$ at any 5 MHz multiple using front panel frequency vernier.

AUXILIARY OUTPUTS

(Rear Panel)

Sweep Reference Output: Provides voltage analog to frequency output. Approximately 1 V/MHz on low range, 1 V/10 MHz on high range.

Uncalibrated RF Output: -5 dBm minimum.

VTO Output: -15 dBm minimum. 200.4 - 310 MHz.

Auxiliary Output: Always 0.4 - 11 MHz, for low frequency counter monitoring.

GENERAL

Power: Supplied by HP 8690B Sweep Oscillator.

Weight: Net, 11 lb (5,0 kg). Shipping, 18 lb (8,2 kg).

Dimensions: 4½ in. wide, 7¼ in. high, 17½ in. deep (115 mm x 185 mm x 445 mm).

Price: Model 8698B, \$1,550.00.

Options:

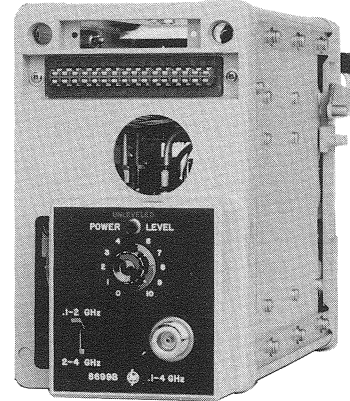
001: 75 Ω output impedance (BNC), add \$50.00.

004: Rear panel RF output, add \$75.00.

SOLID-STATE RF UNIT
0.1 - 4 GHz

model
8699B

- ULTRA-BROADBAND — 5 OCTAVES
- ALL SOLID STATE
- LINEAR SWEEP
- PIN LEVELING/MODULATION
- LOW RESIDUAL FM
- LOW SPURIOUS CONTENT
- ECONOMICAL AND CONVENIENT

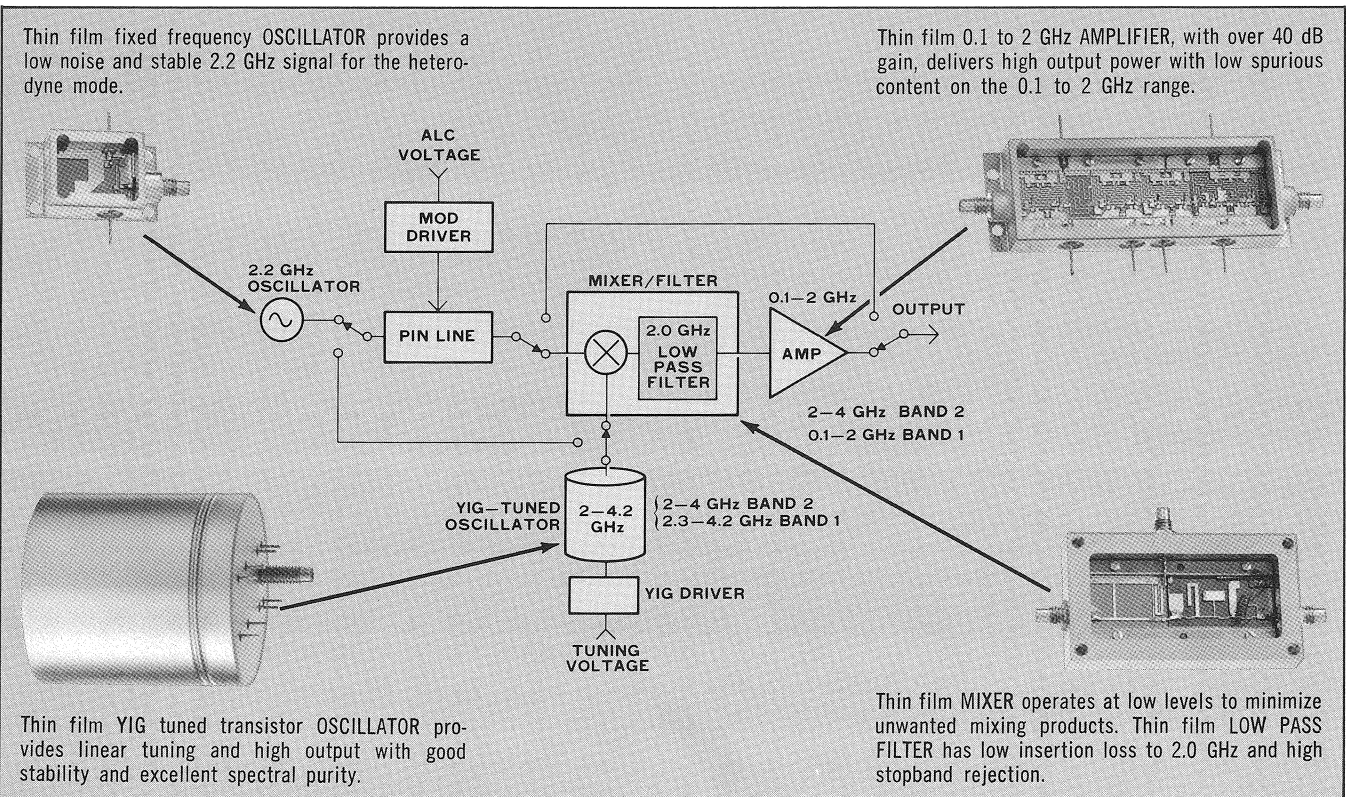


The Hewlett-Packard 8699B RF Unit is a completely solid-state 0.1 to 4 GHz plug-in unit for the HP 8690B Sweep Oscillator. It is extremely versatile and can be used for a wide range of applications requiring an accurate, stable, easy-to-use swept frequency source.

BROAD FREQUENCY COVERAGE: Five octaves of frequency coverage, together with good stability and low residual FM, make the 8699B useful for testing both broadband and narrowband devices. With this single RF unit, fast and accurate swept measurements can be made from VHF through S band, bringing con-

venience and economy to lab and production test applications.

COMPLETELY SOLID-STATE: Outstanding performance and high reliability have been achieved through state-of-the-art design and advanced hybrid integrated circuit technology. The result is broad frequency coverage and high output power while frequency stability and low spurious output are maintained. This completely solid-state RF source eliminates the expense of BWO replacement, resulting in additional operational economies.



8699B DESCRIPTION

Broad frequency coverage on the 0.1 to 2 GHz band is achieved with a heterodyne design. The output of a YIG oscillator, tuned from 2.3 to 4.2 GHz, is mixed with a fixed 2.2 GHz signal. The 0.1 to 2 GHz difference frequency is amplified by a broadband, thin film amplifier. Undesired higher order signals are eliminated before the amplifier by a low pass filter having a sharp cutoff and low insertion loss at 2.0 GHz.

The thin film amplifier is the key element in the heterodyne design. With over 40 dB gain, it can deliver high power to the load while maintaining low spurious and harmonic content. Even at maximum leveled power, spurious outputs are below the level where they would affect the accuracy of most measurements.

A PIN modulator is used to control the output of the 2.2 GHz oscillator, thus providing external leveling capability down to 100 MHz. By placing the PIN modulator before the mixer, spurious output is reduced when less than maximum leveled power is required. Frequency pulling with level or load change is low since the PIN modulator presents a constant load to the 2.2 GHz oscillator.

On the 2 to 4 GHz band the mixer and amplifier are switched out of the circuit and the YIG oscillator is tuned from 2 to 4 GHz. The PIN modulator remains in the circuit for leveling and to provide AM modulation capability. The inherent linearity of the YIG oscillator results in a very linear swept output and leads to accurate frequency displays on both bands.

SPECIFICATIONS

(HP 8699B RF Unit Installed in HP 8690B Sweep Oscillator Mainframe)

Frequency Characteristics

Range: 0.1 to 4 GHz in 2 bands (0.1-2 GHz and 2-4 GHz).

Accuracy (at 25°C): CW ± 10 MHz¹. All other modes ± 20 MHz².

Linearity: $\pm 0.5\%$ of sweep width².

Stability:

With temperature (from 0 to 55°C): ± 750 kHz/°C.

With 10 dB change from max. leveled power: Frequency shift is less than 500 kHz.

With 10% line voltage change: Less than 50 kHz instantaneous change.

With load impedance change (for any impedance change): 0.1-2 GHz, less than 100 kHz; 2-4 GHz, less than 500 kHz.

With time (after 15 min. warmup): Less than 500 kHz/10 min.

Residual FM (in CW): Less than 3 kHz rms noise in a 10 kHz bandwidth.

Output Characteristics

Max. Leveled Power (at 25°C): 0.1-2 GHz, at least +13 dBm; 2-4 GHz, at least +8 dBm. The temperature coefficient is typically -0.1 dB/°C.

Flatness:

Leveled: ± 0.1 dB plus coupler and detector variation at max. leveled power.

Unleveled: 0.1-2 GHz, less than ± 7 dB; and 2-4 GHz, less than ± 3 dB.

Spurious Signals:

0.1-2 GHz: At rated power, harmonics are more than 25 dB down and nonharmonics, more than 30 dB down (from CW output). At 0 dBm, all spurious signals are typically more than 40 dB down.

2-4 GHz: At max. leveled power or below, harmonics are more than 20 dB down and nonhar-

monics more than 40 dB down (typically nonharmonics are more than 60 dB down since a fundamental oscillator is used).

Residual AM: AM noise modulation index (rms in 10 kHz bandwidth) is less than -40 dB.

Modulation

External FM (through PHASE-LOCK INPUT on 8699B rear panel).

Frequency Response: Sensitivity of approximately -1 MHz/volt (negative voltage increases frequency) from dc to 500 kHz.

Max. Deviation: Approximately ± 30 MHz from dc to 100 Hz and ± 3 MHz to 200 kHz. (See Figure 8 for plot of maximum deviation vs. modulation rate.)

Internal AM (from 8690B mainframe): Square wave modulation, continuously adjustable from 950 to 1050 Hz. On/off ratio greater than 20 dB at rated output.

External AM (through 8690B mainframe).

Frequency Response: Dc to 350 kHz unleveled, dc to 50 kHz leveled.

Sensitivity: -10 V reduces RF output at least 25 dB below rated CW output (unleveled).

Weight: Net, 11 lb. Shipping, 20 lb.

Price: \$3,600.00.

Option 004: Rear panel RF output. Add \$75.00.

¹ Approach the desired CW frequency from the low-frequency end of the band.

² On the fastest sweep range, there is an added constant frequency offset due to time delay between the SWEEP OUTPUT and the actual RF OUTPUT. The amount of offset depends on both the SWEEP TIME and sweep width:

$$\text{Max. frequency offset} = 0.25 \text{ ms} \times \text{sweep width (MHz)} / \text{SWEEP TIME (ms)}$$

This offset affects linearity only on the first 10% of the sweep width.

8699B SUPPLEMENTAL OPERATING INFORMATION

REMOTE PROGRAMMING: For digital programming of CW frequency, a special version of the 8690B Sweep Oscillator is available (8690B Opt. H26) that incorporates a Digital-to-Analog converter and accepts 12-line BCD input.

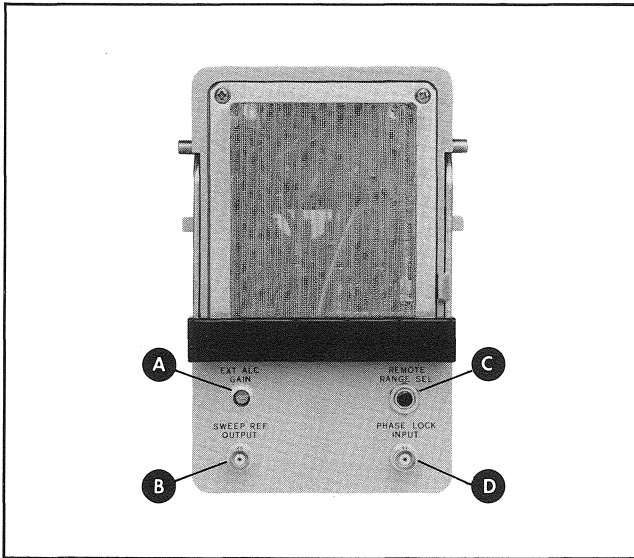
MULTIBAND OPERATION: When the 8699B is installed in an RF Unit Holder (HP 8707A) and the HP 8706A Control Unit is used, the frequency range of operation must be selected manually with the switch on the front panel of the 8699B. To switch ranges remotely, use a modified Control Unit (8706A Opt. H25).

LEVELING: With a directional coupler and crystal detector, the power variations across the frequency band of interest will depend primarily on the frequency

response of the coupler and detector used. An alternative scheme, useful in the frequency range of the 8699B, is to use a power splitter instead of a coupler to sample RF power. With this technique, the maximum leveled power available at the output will be lower, but overall flatness will be improved.

EXTERNAL FM: Modulating signals may be applied to either the front panel EXT FM input on the 8690B Sweep Oscillator (with the SWEEP SELECTOR in MANUAL) or to the rear panel PHASE LOCK input of the 8699B. For best performance, the latter technique should be used. The front panel EXT FM input should be used mainly for remote frequency control or for modulation at wide deviations and very low rates (<1 kHz).

REAR PANEL CONNECTIONS



A EXT ALC GAIN:
Adjust ALC gain for optimum leveling across the band.

B SWEEP REFERENCE OUTPUT:
Voltage output proportional to RF frequency. Approximately 0 to +40 V output on 2 to 4 GHz range only (compatible with HP 8410A Network Analyzer). There is no output on the 0.1 to 2 GHz range.

C REMOTE RANGE SELECT:
Permits remote range selection by a contact closure to ground. A 3-prong phone plug inserted into this rear panel input will disable the MANUAL range switch on the front panel. For 0.1 to 2 GHz, the plug tip is grounded; for 2 to 4 GHz, the tip is opened.

D PHASE LOCK INPUT:
Input terminal for phase-locking control voltage or external FM signal. For phase-locking, the input sensitivity of 1 MHz/volt is compatible with the HP 8709A Synchronizer. For FM modulation, Figure 8 shows the maximum deviation that typically results when the input level is held constant and the modulation rate is varied.

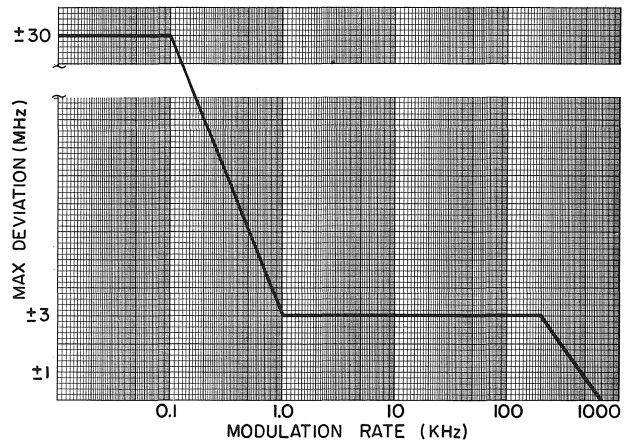


Figure 8