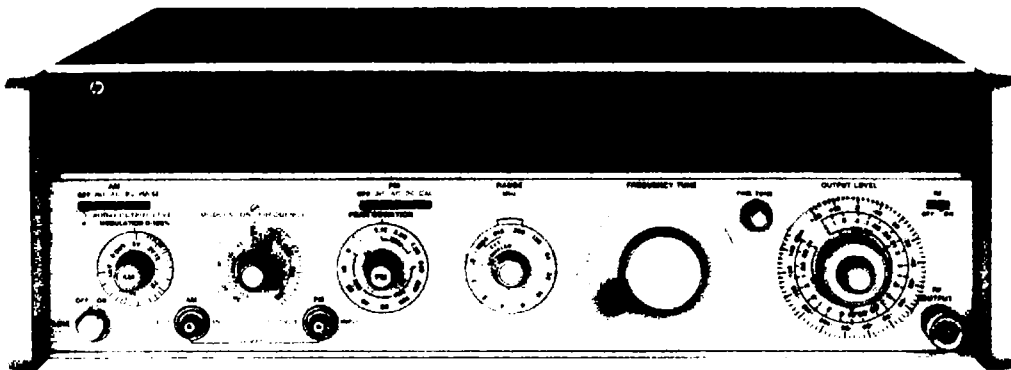


# SIGNAL GENERATORS

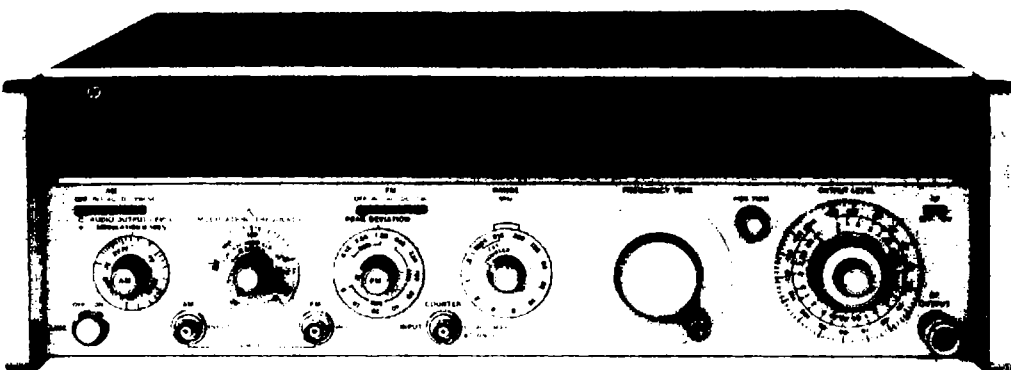
Precision, high stability, AM-FM, 0.5 to 1024 MHz  
 Models 8640A, 8640B

- Wide frequency and power range
- Low broadband and close-in noise
- Calibrated, metered AM and FM

- All 8640A features plus
- Internal pushbutton synchronizer
- External counter to 550 MHz



8640A



8640B

## Description

The 8640 signal generator covers the frequency range 500 kHz to 512 MHz (450 kHz to 550 MHz with band overrange) and can be extended to 1100 MHz with an internal doubler (option 002). An optional audio oscillator is also available to extend the CW output range of the generator down to 20 Hz. This broad coverage, together with calibrated output and modulation, provides for complete RF and IF performance tests on virtually any type of HF, VHF, and UHF receivers.

Both solid state generators 8640A and B have an output level range of +19 to -145 dBm (2 V to 0.013  $\mu$ V) which is calibrated, metered, and leveled to within  $\pm 0.5$  dB across the full frequency range of the instrument.

The 8640A/B generators provide AM, FM, and pulse modulation for a wide range of receiver test applications. This modulation is calibrated and metered for direct readout under all operating conditions.

Other significant features of the 8640A/B signal generators include: extremely low noise, built-in phase lock and counter (B version only) and front panel controls designed for operating convenience and flexibility.

### Spectrally pure output signals

Noise performance of the 8640 is state-of-the-art for a solid-state generator. The high-Q cavity oscillator has been optimized with use of a low-noise microwave transistor for spectrally pure output signals.

At 20 kHz offsets from 230 to 450 MHz, SSB phase noise is  $> 130$  dB/Hz below the carrier level and rises to 122 dB/Hz at 550 MHz. This signal-to-noise ratio increases by approximately 6 dB for each division of the output frequency down to the broadband noise floor of better than 140 dB/Hz. This exceptional noise performance is also preserved during FM modulation and in the phase-locked mode of the 8640B.

### Mechanical dial or built-in counter

There are two versions of the 8640 Signal Generators. One, the 8640A, has an easy-to-read slide rule dial with scales for each of the 10 output frequency ranges. There is an additional scale, to provide direct readout of the output frequency even in the INTERNAL DOUBLER band, 512-1024 MHz.

The 8640B has the same performance features as the 8640A, but incorporates a built-in 550 MHz frequency counter and phase lock synchronizer.

The built-in 6-digit counter displays the output frequency and can also be used to count external input signals from 20 Hz to 550 MHz. This eliminates the need for a separate frequency counter in many measurement systems.

### Internal pushbutton synchronizer

At the push of a button, the 8640B built-in phase lock synchronizer locks the RF output frequency to the crystal time base used in the counter. In this locked mode, the output stability is better than  $5 \times 10^{-6}$  /hr and the spectral purity and FM capability of the unlocked mode are preserved. For higher stability, it is possible to lock to an externally applied 5 MHz standard. Two 8640B's can also be locked together for various 2-tone measurements.

### FM while phase locked

When phase locked, full FM capability is preserved down to modulation rates of 50 Hz. The narrow bandwidth of the phase lock loop ( $< 5$  Hz) provides for FM modulation up to 250 kHz rates and assures no degradation in noise from the unlocked mode. This crystal stability, coupled with the precision modulation and low noise, makes the 8640B ideal for testing narrowband FM or crystal-controlled receivers.

## 8640A/B Specifications

(See Technical Data Sheet for Complete Specifications) All specifications apply over the nominal Frequency Bands and over the top 10 dB of the output level vernier range unless otherwise specified.

### Frequency characteristics

**Range:** 500 kHz to 512 MHz in 10 octave bands (to 1024 MHz with option 002 internal frequency doubler).

**Bands and band overlap:** bands extend 10% below and 7% above the nominal frequency bands shown below.

Frequency bands (MHz)		
0.5 - 1	8 - 16	128 - 256
1 - 2	16 - 32	256 - 512
2 - 4	32 - 64	512 - 1024
4 - 8	64 - 128	(opt 002)

### Fine tuning:

**8640A and 8640B unlocked:** >200 ppm total range.

**8640B locked mode:** >±20 ppm by varying internal time base vernier.

### Counter resolution (8640B):

Frequency Bands (MHz)	Normal Mode	Expand X10	Expand X100
0.5 - 1	10 Hz	1 Hz	0.1 Hz
1 - 16	100 Hz	10 Hz	1 Hz
16 - 128	1 kHz	100 Hz	10 Hz
128 - 1024	10 kHz	1 kHz	100 Hz

### Accuracy:

8640A, mechanical dial; accuracy better than 0.5%, resettability better than 0.1%.

8640B, 6-digit LED display with X10 and X100 expand; accuracy depends on internal or external reference used.

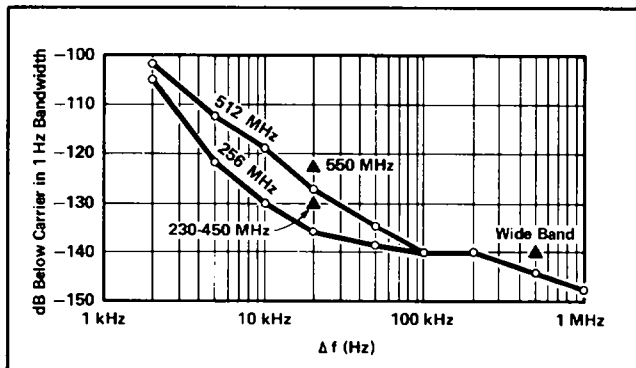
$$\left[ \begin{array}{c} \text{Total} \\ \text{Count} \\ \text{Accuracy} \end{array} \right] = \left[ \begin{array}{c} \text{Counter} \\ \text{Resolution} \\ (\pm 1 \text{ count}) \end{array} \right] + \left[ \begin{array}{c} \text{Reference} \\ \text{Error} \\ (\text{INT or EXT}) \end{array} \right]$$

**Internal reference error (15°C to 35°C):** <±2 ppm when calibrated at 25° every 3 months and operated between 15°C and 35°C.

### Stability (after 2-hr warm-up):

**Normal:** <10 ppm/10 min.

**Locked:** (8640B) <0.05 ppm/hr.



Measured SSB Noise vs. Offset from Carrier. Markers indicate specified limits.

### Restabilization time after frequency change:

**Normal:** <15 min.

**Locked (8640B):** 1 min after relocking to be within 0.1 ppm of steady state frequency.

### Output characteristics

**Range:** continuously selectable from +19 to -145 dBm (2 V to 0.013 μV) into 50Ω.

**Level accuracy:** (worst case as indicated on level meter) +19 to -7 dBm, ±1.5 dB; -7 to -47 dBm, ±2.0 dB; -47 to -137 dBm, ±2.5 dB; -137 to -145 dBm, ±3.0 dB.

**Level flatness:** <±0.5 dB from 0.5 to 512 MHz referred to output at 50 MHz. (Flatness applies to +13 dBm to -7 dBm output range and for top 10 dB of vernier range.)

**Impedance:** 50Ω, VSWR <2.0 on 2 V and 1 V output ranges. VSWR <1.3 on all other ranges.

**Auxiliary output:** rear panel BNC output is >-5 dBm into 50Ω, source impedance is approximately 500Ω.

**Leakage (with all unused outputs terminated properly):** leakage limits are below those specified in MIL-I-6181D. Furthermore, less than 3 μV is induced in a 2-turn, 1-inch diameter loop 1 inch away from any surface and measured into a 50Ω receiver, and less than 1 μV, 2 inches away. This permits receiver sensitivity measurements to at least <0.03 μV in a shielded system.

### Spectral purity

**Harmonics:** (at 1 volt (+13 dBm) output range and below) >35 dB below fundamental of 0.5 to 128 MHz. >30 dB below fundamental of 128 to 512 MHz.

**Subharmonics and nonharmonic spurious:** (excluding line-related sidebands)

**8640A:** none detectable.

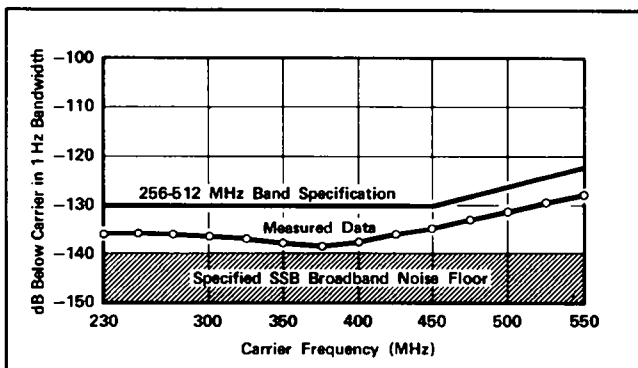
**8640B:** >100 dB below carrier.

**Noise:** averaged RMS noise level below carrier stated in a 1 Hz bandwidth. SSB phase noise at 20 kHz offset from carrier.

**256 MHz to 512 MHz:** >130 dB down from 230 to 450 MHz increasing linearly to >122 dB down at 550 MHz.

**0.5 MHz to 256 MHz:** decreases 6 dB for each divided frequency range until it reaches SSB broadband noise floor of >140 dB down.

Residuals	Post-detection Bandwidth	
	300 Hz to 3 kHz	20 Hz to 15 kHz
Residual AM:	>85 dB down	>78 dB down
Residual FM:		
CW and up to ¼ ΔF	<5 Hz	<15 Hz
max. peak dev. (ΔF)	<15 Hz	<30 Hz



Specified Signal to Phase Noise Ratio at 20 KHz Offset vs. Carrier Frequency.

## Modulation characteristics

### General

**Types:** Int AM and FM, Ext AM, FM and PULSE.

**Internal modulation sources:** (independently adjustable output is available at front panel).

**Standard:** 8640A or 8640B.

**Frequency:** fixed 400 Hz and 1 kHz,  $\pm 2\%$ .

**Output level:** 10 mV to 1 V. Accuracy  $\pm 20\%$ .

**Optional:** (internal variable audio oscillator Option 001, 8640A or 8640B).

**Frequency:** variable 20 Hz to 600 kHz,  $\pm 10\%$  plus fixed 400 Hz and 1 kHz  $\pm 3\%$ .

**Output level:** 10 mV to 3 V. Accuracy  $\pm 20\%$ .

### Amplitude modulation

(AM specifications apply to the top 10 dB of output vernier range unless otherwise specified.)

**Depth:** 0 to 100% for output level range of +13 dBm and below and for top 10 dB of vernier range.

**AM rates:** INT and EXT ac; 20 Hz to AM 3 dB bandwidth below. EXT dc; dc to AM 3 dB bandwidth below.

#### AM 3 dB bandwidth:

Freq. Bands	0 to 50% AM	50 to 90% AM
0.5 - 2 MHz	25 kHz	12.5 kHz
2 - 8 MHz	40 kHz	25 kHz
8 - 512 MHz	60 kHz	50 kHz

**AM distortion:** (at 400 Hz and 1 kHz rates).

Freq. Bands	0 to 50% AM	50 to 90% AM
0.5 - 512 MHz	<1%	<3%

**External AM sensitivity:** 0.1%  $\pm 0.005\%$  AM per mV peak into 600 $\Omega$  with AM vernier at full cw position.

**Indicated AM accuracy:** (400 Hz and 1 kHz rates using internal meter)  $\pm 8\%$  of meter reading on 0-10 scale,  $\pm 9\%$  of meter reading on 0-3 scale (for greater than 10% of full scale).

**Peak incidental PM:** (at 30% AM)

Less than 0.15 radians, 0.5 to 128 MHz.

Less than 0.3 radians, 128 to 512 MHz.

**Peak incidental FM:** equals peak incidental PM  $\times$  modulation frequency.

### Pulse modulation:

Frequency Bands (MHz)	0.5 - 1	1 - 2	2 - 4	4 - 8	8 - 32	32 - 512
Rise and Fall Times	<9 $\mu$ S	<4 $\mu$ S	<2 $\mu$ S	<1 $\mu$ S		
Pulse Repetition Rate	50 Hz to 50 kHz		50 Hz to 100 kHz	50 Hz to 250 kHz	50 Hz to 500 kHz	
Pulse Width Minimum <sup>1</sup>	10 $\mu$ S		5 $\mu$ S	2 $\mu$ S		
ON/OFF ratio at max vernier	>40 dB					
Peak Input Required	Nominally +0.5 V (5 V max) Sinewave or Pulse return to zero into 50 $\Omega$ schmitt trigger.					

<sup>1</sup>For level accuracy within 1 dB of CW (<0.1% duty cycle)

### Frequency modulation

**Deviation:** maximum allowable deviation equals 1% of lowest frequency in each nominal output frequency band.

Frequency Band (MHz)	Maximum Peak Deviation (kHz)
0.5 - 1	5
1 - 2	10
2 - 4	20
4 - 8	40
8 - 16	80
16 - 32	160
32 - 64	320
64 - 128	640
128 - 256	1280
256 - 512	2560
512 - 1024	5120

#### FM 3 dB bandwidth:

Internal and external ac; 20 Hz to 250 kHz.

External dc; dc to 250 kHz.

**FM distortion:** (at 400 Hz and 1 kHz rates)

<1% for deviations up to  $\frac{1}{4}$  maximum allowable.

<3% for maximum allowable deviation.

**External FM sensitivity:** 1 volt peak yields maximum deviation indicated on PEAK DEVIATION switch with FM vernier at full CW position.

**Indicated FM accuracy:** (using internal meter)  $\pm 10\%$  of meter reading, above 10% of full scale.

**Incidental AM:** (at 400 Hz and 1 kHz rates)

<0.5% AM for FM up to  $\frac{1}{4}$  max. allowable deviation.

<1% AM for FM at maximum allowable deviation.

## Counter characteristics (8640B)

### External RF input:

**Frequency range:** 20 Hz to 550 MHz.

**Sensitivity:**  $\geq 100$  mV rms into 50 $\Omega$ .

**Resolution:** 6-digit LED DISPLAY.

Mode	Normal	Expand X10	Expand X100
0 - 10 MHz	100 Hz	10 Hz	1 Hz
0 - 550 MHz	10 kHz	1 kHz	100 Hz

**Internal reference characteristics:** (after 2-hr warmup).

**Accuracy:** (after calibration at 25°C)

Better than  $\pm 1$  ppm for 15° to 35°C.

Better than  $\pm 3$  ppm for 0° to 55°C.

**Drift rate:** (constant temperature and line voltage) <0.05 ppm per hour; <2 ppm per year.

**Frequency tuning:**

$> \pm 20$  ppm using internal time base vernier.

**Rear output:**  $> 0.5$  V p-p into 500 $\Omega$ . This will drive another 8640B.

**External reference input:** 5 MHz, nominally  $> 0.5$  V (5 V max) into 1 k $\Omega$ .

## General characteristics

**Operating temperature range:** 0 to 55°C.

**Power requirements:** 100, 120, 220, and 240 volts, +5%, -10%, 48 to 440 Hz; 175 VA maximum.

**Weight:** 8640A and 8640B: net, 20.4 kg (45 lb); shipping 24.1 kg (53 lb).

**Dimensions:** 134 mm high  $\times$  425 mm wide  $\times$  476 mm deep (5 $\frac{1}{4}$ "  $\times$  18 $\frac{1}{2}$ ").

### Model number and name

8640A Signal Generator

8640B Signal Generator

Option 001: (internal variable audio oscillator, 20 Hz to 600 kHz) 8640A or 8640B

Option 002: (internal doubler 512-1024 MHz)

Option 004: (Avionics option)

Price

\$4200

\$5700

add \$200

add \$750

add \$515

# SIGNAL GENERATORS

## Internal doubler option, 512 to 1024 MHz

### 8640A/B option 002

NEW

- 8640A/B Option 002 Internal Doubler

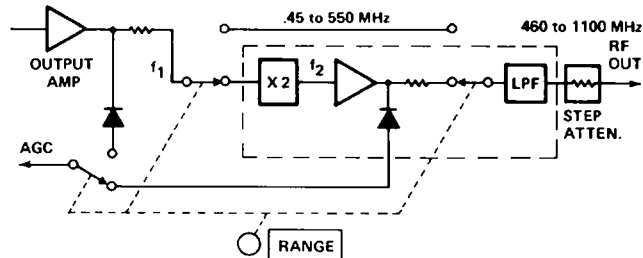


Figure 1. Internal Doubler Block Diagram

Option 002 of the 8640A and 8640B signal generators is an internal passive doubler which extends the generator frequency range another octave, from 512-1024 MHz. Thus, when an 8640A or 8640B is fitted with this doubler, it covers the frequency range from 0.5 to 1024 MHz (0.45-1100 MHz with overrange). Figure 1 shows a simplified doubler block diagram. The doubler is available in an accessory kit so it can be retrofitted into standard 8640A or B. (See HP11698A, Page 363).

The output level range of the Option 002 is +13 dBm to -145 dBm (1 volt to 0.013  $\mu$ V) and is leveled within  $\pm 1.5$  dB. In the doubled band, AM and FM can be performed independently or simultaneously in either the internal or external mode. Pulse on/off ratio increases to >60 dB. The FM peak deviation is calibrated and metered for direct readout up to 5.12 MHz. The AM percent is metered, its accuracy is not specified, however, a procedure is available to calibrate each generator individually.

The 8640A has a dial scale for the 512-1024 MHz internal doubler band to indicate the correct doubled output frequency. The 8640B also anticipates the use of an internal doubler by displaying the correct doubled output frequency when the 512 to 1024 MHz range is selected.

### Option 002 Specifications

#### Internal doubler

The internal doubler can be ordered factory-installed as 8640A/B Option 002 or as an accessory kit HP Model 11698A. When an internal doubler is installed in the 8640A/B, some output level characteristics change. These changes are noted with a star (\*). All other specifications remain unchanged. All specifications apply over the nominal frequency level and over the top 10 dB of the output level vernier range unless otherwise specified.

#### Frequency characteristics

**Range:** 512-1024 MHz (460 to 1100 MHz with overlap)

**Fine tuning:** same as 8640 A/B

**Stability:** same as 8640A/B, except

	Normal	Locked (8640B)
Mode Change (CW to FM)	<1% of selected peak deviation, or 400 Hz whichever is greater.	None measurable

**Restabilization time:** same as 8640A/B.

#### Spectral purity

**Harmonics:** (at 1 volt, +13 dBm output range and below) >12 dB below fundamental, 512-1024 MHz.

**Subharmonics and nonharmonics:** (excluding frequencies within 15 kHz of the signal whose effects are specified in residual AM and FM).

**Subharmonic related:** >20 dB below carrier (8640A and 8640B)

**Nonharmonic spurious:** none detectable (8640A); >100 dB down (8640B).

**Noise:** Averaged RMS noise level below carrier stated in a 1 Hz bandwidth.

**SSB phase noise at 20 kHz offset from carrier:** >124 dB down from 460 to 900 MHz increasing linearly to >116 dB at 1100 MHz.

**SSB broadband noise floor at maximum vernier greater than 500 kHz offset from carrier:** >137 dB down.

**Residual AM:** same as 8640A/B.

**Residual FM:** (Averaged RMS) twice the value of the 8640A/B in the 230-550 MHz range.

#### Output level characteristics

**Range:** 10 dB steps and 18 dB vernier provide output power settings from +13 dBm to -145 dBm (1 V to 0.013  $\mu$ V) into 50 $\Omega$ .

**Level flatness:** referred to output at 50 MHz and applies to 1 V range and below. < $\pm 0.5$  dB, 0.5-64 MHz; \* < $\pm 1$  dB, 64-512 MHz; < $\pm 1.5$  dB, 512-1024 MHz

**Impedance:** 50 $\Omega$ , ac coupled, 40 V dc maximum, VSWR (see table)

Frequency Range	Output Level Range	Signal Frequency VSWR <sup>2</sup>	Broadband VSWR <sup>3</sup>
0.5 - 512	2 V & 1 V 0.3 V & below	2 1.3	*2.5 <sup>4</sup> 1.3 <sup>4</sup>
512 - 1024	1 V 0.3 V & below	2 1.5	2.5 <sup>5</sup> 1.5 <sup>5</sup>

**Auxiliary output:** same as 8640A/B (not doubled)

**Leakage:** same as 8640A/B

#### Level accuracy:

**Total accuracy as indicated on level meter:** 0.5-64 MHz: +19 to -7 dBm,  $\pm 1.5$  dB; -7 to -47 dBm,  $\pm 2$  dB; -47 to -137 dBm,  $\pm 2.5$  dB. \*64-512 MHz: +19 to -7 dBm,  $\pm 2$  dB; -7 to -47 dBm,  $\pm 2.5$  dB; -47 to -137 dBm,  $\pm 3$  dB. 512-1024 MHz: +13 to -7 dBm,  $\pm 2.5$  dB; -7 to -47 dBm,  $\pm 3$  dB; -47 to -127 dBm,  $\pm 3.5$  dB.

#### Modulation characteristics

**General:** same as 8640A/B

#### Amplitude modulation

**Depth:** 0 to 100% for output levels of +13 dBm\* and below and for top 16 dB of vernier range.

**AM rates:** INT and EXT ac: 20 Hz to AM 3-dB bandwidth, EXT dc: dc to AM 3-dB bandwidth.

**AM 3 dB bandwidth:** 60 kHz, 0-50%; 30 kHz, 50-90%.

**AM distortion:** (at 400 Hz and 1 kHz rates) <5%, 0-30%; <10%, 30-90%

**External AM sensitivity:** (400 Hz and 1 kHz rates)

Nominal 0.1% AM per mV peak into 600 $\Omega$  with AM vernier at full cw position.

**Indicated AM accuracy:** Not specified, each generator can be individually calibrated.

**Peak incidental PM (at 30% AM):** <0.6 radians

**Pulse modulation:** same as 8640A/B in the 32-512 MHz band except on/off ratio at max vernier: >60 dB

**Frequency modulation:** same as 8640A/B

**Deviation:** 5.12 MHz maximum allowable deviation

**Incidental AM:** (at 400 Hz and 1 kHz rates)

<1% AM for FM up to  $\frac{1}{2}$  maximum allowable deviation.

<7% AM for FM up to maximum allowable deviation.

#### Model number and name

Option 002 Internal Doubler

11698A Internal Doubler Retrofit Kit

Price

add \$750

\$750

\*This specification applies below 512 MHz when Internal Doubler is installed.

<sup>1</sup> in the doubler range, subharmonically related signals are 1/2F (i.e. oscillator fundamental), 3/2F, 5/2F, etc.

<sup>2</sup> also known as in-band VSWR

<sup>3</sup> also known as out of band VSWR

<sup>4</sup> applies only for frequencies within 0.5-512 MHz

<sup>5</sup> applies only for frequencies within 512-1024 MHz

\*the peak envelope power (carrier output plus AM depth) may not exceed the maximum cw output level of any output level range.