

**1.3 PERFORMANCE SPECIFICATIONS**

**1.3.1 CW Operation**

RANGES: .01 to 20 GHz, .01 to 26.5 GHz, .01 to 40 GHz, 2 to 20 GHz, 2 to 26.5 GHz, or 2 to 40 GHz (consult instrument's serial number tag).

RESOLUTION: 1 Hz (2 Hz above 20 GHz in instruments to 40 GHz).

ACCURACY AND STABILITY: Identical to time base oscillator.

TIME BASE (internal): 10 MHz

AGING RATE:  $<1 \times 10^{-9}$ /day after 72 hours continuous operation.

TEMPERATURE STABILITY:  $< \pm 2 \times 10^{-10}/^{\circ}\text{C}$  (0 to +50°C)

TIME BASE (external): 10 MHz  $\pm 1 \times 10^{-6}$  or better (Option 11 provides for 5 MHz external time base.)

SWITCHING TIME: <50 ms (20 ms, typical) to within specified frequency accuracy.

**1.3.2 Spectral Purity**

HARMONICS (up to max. frequency and max. leveled power): <-55 dBc, 0.05 to 40 GHz; <-25 dBc, 0.01 to 0.05 GHz (<-20 dBc .01 to .05 GHz, in instruments to 40 GHz).

SUB-HARMONICS: None in instruments to 20 or 26.5 GHz (<-55 dBc above 20 GHz in instruments to 40 GHz).

NON-HARMONICS: <-55 dBc (<-49 dBc above 20 GHz in instruments to 40 GHz).

POWER LINE/FAN ROTATION RELATED (dBc, CW mode):

Frequency Range (GHz)	Offset from Carrier		
	<300 Hz	300 Hz to 1 kHz	>1 kHz
.01 to < 2	-45	-55	-55
2 to < 8	-50	-55	-55
8 to <20	-45	-55	-55
20 to 26.5 (26.5 GHz units)	-40	-50	-55
20 to 40 (40 GHz units)	-39	-49	-49

SINGLE-SIDEBAND PHASE NOISE (dBc/Hz noise bandwidth, CW mode, all power levels):

<b>Frequency Range (GHz)</b>	<b>Offset from Carrier</b>				
	<b>30 Hz</b>	<b>100 Hz</b>	<b>1 kHz</b>	<b>10 kHz</b>	<b>100 kHz</b>
.01 to <2	-60	-75	-80	-75	-100
2 to <8	-65	-75	-80	-80	-105
8 to <20	-60	-65	-75	-75	-100
20 to 26.5 (26.5 GHz units)	-55	-65	-70	-70	-95
20 to 40 (40 GHz units)	-54	-59	-69	-69	-94

RESIDUAL FM (Hz, RMS; CW mode):

<b>Frequency Range (GHz)</b>	<b>Post-detection Bandwidth</b>	
	<b>.3 to 3 kHz</b>	<b>.05 to 15 kHz</b>
.01 to <2	30	200
2 to <8	20	150
8 to <20	40	300
20 to 26.5 (26.5 GHz units)	60	450
20 to 40 (40 GHz units)	80	600

### 1.3.3 RF Output Power

MAXIMUM LEVELED OUTPUT:

>+10 dBm (instruments to 26.5 GHz).

For instruments to 40 GHz:

>+10 dBm, 10 MHz to <18 GHz,

>+8 dBm, 18 to <20 GHz,

>+5 dBm, 20 to <35 GHz,

>+2 dBm, >35 to 40 GHz.

INCREMENTAL LEVEL RANGE:

-20 to +15 dBm

RESOLUTION:

0.01 dB, entry and display to -99.99 dBm

(display is 0.1 dB at <-100.0 dBm).

MINIMUM OUTPUT LEVEL:

-130 dBm (-110 dBm, instruments to 26.5

or 40 GHz).

RF OFF:

Typically attenuates a 0 dBm signal to <-140 dBm

at the output connector.

OUTPUT ACCURACY (internally

leveled, CW or frequency

sweep mode, AM off):

±1 dB to 20 GHz, ±2 dB to 40 GHz (±0.1 dB per

attenuation step); ±2 dB from 10 to 20 MHz in

instruments to 40 GHz.

OUTPUT FLATNESS: Included in accuracy.  
 OUTPUT SWITCHING TIME: Typically <1 ms (20 ms with attenuator change).  
 OUTPUT IMPEDANCE: 50  $\Omega$ , nominal  
 OUTPUT SWR: <2:1  
 EXTERNAL LEVELING: Output power may be externally leveled by positive or negative ZBS detectors or power meters.

### 1.3.4 Analog Frequency Sweep

Continuous sweep, generated within the instrument, which is phase-lock corrected at start and band crossing frequencies; may be operated simultaneously with digital or analog power sweep.

RANGE: From FA (minimum frequency of instrument) to FB (maximum frequency of instrument).  
 SWEEP TIME (any sweep mode): 2 ms to 200 s in five ranges. Minimum sweep time is determined by the sweep width and the maximum sweep speed.

Range	Resolution
2 ms to 20 ms	10 $\mu$ s
20 ms to 200 ms	100 $\mu$ s
200 ms to 2 s	1 ms
2 s to 20 s	10 ms
20 s to 200 s	100 ms

MINIMUM SWEEP WIDTH: 1 MHz  
 MAXIMUM SWEEP SPEED: 600 MHz/ms  
 BAND CROSSING DEAD TIME (at 2, 8, 20, & 28 GHz): 50 ms, nominal  
 SWEEP WIDTH RESOLUTION (any sweep mode): 0.1% of sweep width (0.2% of sweep width above 20 GHz in instruments to 40 GHz).  
 START FREQUENCY ACCURACY (any sweep mode):  $\pm 0.5$  MHz, in instruments to 20 or 26.5 GHz ( $\pm 1$  MHz above 20 GHz in instruments to 40 GHz).  
 SWEEP LINEARITY (relative to a linear RAMP OUT voltage, sweep time  $\geq 100$  ms, any sweep mode):  $\pm 1\%$  of sweep width or  $\pm 50$  MHz, whichever is less ( $\pm 2\%$  of sweep width or  $\pm 100$  MHz, whichever is less, in instruments to 40 GHz).

### 1.3.5 Analog Sweep Modes

START/STOP ( $FA \leq [F1 \neq F2] \leq FB$ ):	Sweeps up or down from a preset start frequency (F1) to a preset stop frequency (F2).
START/ $\Delta$ ( $FA \leq [F1 \pm \Delta F] \leq FB$ ):	Sweeps up or down from a preset start frequency (F1) through a preset sweep width ( $\Delta F$ ).
CTR/ $\Delta$ ( $FA \leq [CF \pm (\Delta F/2)] \leq FB$ ):	Sweeps up or down through a preset sweep width ( $\Delta F$ ) centered symmetrically about a preset center frequency (CF).
$\Delta$ MKR ( $FA \leq [Mx \neq My] \leq FB$ ):	Sweeps up or down from any preset marker (Mx) to any other preset marker (My).

### 1.3.6 Analog Sweep Functions

AUTO:	Continuous cycle of the preset sweep.
SINGLE:	A single cycle of the preset sweep, initiated by manual operation of the front panel pushbutton.
EXT:	A single cycle of the preset sweep, initiated by a trigger input from an external source.
STOP/RESET:	Stops the sweep when activated by the front panel pushbutton, to permit manual tuning of the frequency at any point in the sweep. Pressing the pushbutton a second time resets the sweep to the initial conditions.

### 1.3.7 Analog Sweep Frequency Markers

Eight intensity or amplitude markers, individually selectable from the front panel or via the GPIB.

RESOLUTION:	Sweep width $\div$ 4,000
ACCURACY:	Same as sweep linearity except marker may vary $\pm 25$ mV relative to the linear 0 to +10V RAMP OUT.
AMPLITUDE MARKERS:	Approximately -3 dB change in RF output power during analog frequency sweep markers.

### 1.3.8 Digital (Step/Dwell) Frequency Sweep

RANGE:	FA (minimum frequency of instrument) to FB (maximum frequency of instrument).
STEP SIZE:	Any increment within the instrument's frequency resolution.
DWELL TIME:	May be set in 10 ms increments from approximately 10 ms to 200 s.
ACCURACY AND STABILITY:	Same as in CW when locked at each step during dwell time.

### 1.3.9 Digital Sweep Modes

- START/STOP ( $FA \leq [F1 \neq F2] \leq FB$ ): Sweeps up or down from a preset start frequency (F1) to a preset stop frequency (F2).
- START/ $\Delta$  ( $FA \leq [F1 \pm \Delta F] \leq FB$ ): Sweeps up or down from a preset start frequency (F1) through a preset sweep width ( $\Delta F$ ).
- CTR/ $\Delta$  ( $FA \leq [CF \pm (\Delta F/2)] \leq FB$ ): Sweeps up or down through a preset sweep width ( $\Delta F$ ) centered symmetrically about a preset center frequency (CF).
- START/STEPS  
( $FA \leq [F1 \pm (\text{step size} \times \text{no. of steps})] \leq FB$ ): Sweeps up or down from a preset start frequency (F1) through a preset number of frequency steps.

### 1.3.10 Digital Sweep Functions

- AUTO: Continuous cycle of the preset sweep.
- SINGLE: A single cycle of the preset sweep or (with stop activated) a single preset step, initiated by manual operation of the front panel pushbutton.
- EXT: A single cycle of the preset sweep or (with stop activated) a single preset step, initiated by a trigger input from an external source.
- STOP/RESET: Stops the sweep when activated by the front panel pushbutton, to permit manual tuning of the frequency at any point in the sweep. Pressing the pushbutton a second time resets the sweep to the initial conditions.

### 1.3.11 Analog Power Sweep

Continuous sweep, generated within the instrument. May be operated simultaneously with analog or digital frequency sweep.

- RANGE: 20 dB maximum, up or down, within incremental level range (maximum output power to -20 dBm, minus attenuator setting).
- SWEEP TIME (any sweep mode): 2 ms to 200 s in five ranges. Minimum sweep time is determined by the sweep width and the maximum sweep speed.

<i>Range</i>	<i>Resolution</i>
2 ms to 20 ms	10 $\mu$ s
20 ms to 200 ms	100 $\mu$ s
200 ms to 2 s	1 ms
2 s to 20 s	10 ms
20 s to 200 s	100 ms

- MINIMUM SWEEP WIDTH: 0.01 dB
- MAXIMUM SWEEP SPEED: 1 dB/ms

SWEEP LEVEL RESOLUTION (any sweep mode):	0.01 dB
START LEVEL ACCURACY (any sweep mode):	±0.5 dB
SWEEP LEVEL LINEARITY (any sweep mode):	±5% of sweep width

### 1.3.12 Analog Power Sweep Modes

START/STOP ( $LA \leq [L1 \neq L2] \leq LB$ ):	Sweeps up or down from a preset start level (L1) to a preset stop level (L2).
START/ $\Delta$ ( $LA \leq [L1 \pm \Delta L] \leq LB$ ):	Sweeps up or down from a preset start level (L1) through a preset sweep width ( $\Delta L$ ).
CTR/ $\Delta$ ( $LA \leq [CL \pm (\Delta L/2)] \leq LB$ ):	Sweeps up or down through a preset sweep width ( $\Delta L$ ) centered symmetrically about a preset center level (CL).

### 1.3.13 Analog Power Sweep Functions

AUTO:	Continuous cycle of the preset sweep.
SINGLE:	A single cycle of the preset sweep, initiated by manual operation of the front panel pushbutton.
EXT:	A single cycle of the preset sweep, initiated by a trigger input from an external source.
STOP/RESET:	Stops the sweep when activated by the front panel pushbutton, to permit manual adjustment of the level at any point in the sweep. Pressing the pushbutton a second time resets the sweep to the initial conditions.

### 1.3.14 Digital (Step/Dwell) Power Sweep

RANGE:	LA (minimum level of instrument) to LB (maximum level of instrument).
STEP SIZE:	Any multiple of 0.01 dB up to maximum sweep range.
DWELL TIME:	May be set in 10 ms increments from approximately 10 ms to 200 s.
ACCURACY & STABILITY:	Same as in CW when leveled at each step during dwell time.

### 1.3.15 Digital Power Sweep Modes

START/STOP ( $LA \leq [L1 \neq L2] \leq LB$ ):	Sweeps up or down from a preset start level (L1) to a preset stop level (L2).
START/ $\Delta$ ( $LA \leq [L1 \pm \Delta L] \leq LB$ ):	Sweeps up or down from a preset start level (L1) through a preset sweep width ( $\Delta L$ ).
CTR/ $\Delta$ ( $LA \leq [CL \pm (\Delta L/2)] \leq LB$ ):	Sweeps up or down through a preset sweep width ( $\Delta L$ ) centered symmetrically about a preset center level (CL).

**START/STEPS**

( $LA \leq [L1 \pm(\text{step size} \times \text{no. of steps})] \leq LB$ ):

Sweeps up or down from a preset start level (L1) through a preset number of level steps.

**EXT STEP:**

A single step of a preset sweep initiated by a trigger input from an external source.

**1.3.16 Digital Power Sweep Functions**

**AUTO:**

Continuous cycle of the preset sweep.

**SINGLE:**

A single cycle of the preset sweep or (with stop activated) a single preset step, initiated by manual operation of the front panel pushbutton.

**EXT:**

A single cycle of the preset sweep or (with stop activated) a single preset step, initiated by a trigger input from an external source.

**STOP/RESET:**

Stops the sweep when activated by the front panel pushbutton, to permit manual adjustment of the level at any point in the sweep. Pressing the pushbutton a second time resets the sweep to the initial conditions.

**1.3.17 PM Envelope Parameters**

Pulse/Square Wave Modulation (PM) specifications apply with AM and FM off. PM may be operated with FM.

**ON/OFF RATIO:**

>80 dB

**RISE/FALL TIMES:**

<10 ns

**OVERSHOOT, UNDERSHOOT & RINGING:**

±2 dB, maximum

**SETTLING TIME (to within 1 dB):**

<100 ns

**LEVELED PULSED OUTPUT POWER (referenced to leveled CW output power):**

±0.5 dB, typical (≥ 100 ns pulse width);  
± 1 dB typical (< 100 ns pulse width).

**1.3.18 Internally Generated PM Repetition Rate**

**REPETITION RATE:**

<b>Range</b>	<b>Resolution</b>
5 Hz to 100 Hz	0.1 Hz
100 Hz to 1 kHz	1 Hz
1 kHz to 10 kHz	10 Hz
10 kHz to 100 kHz	100 Hz
100 kHz to 1 MHz	1 kHz

ACCURACY:  $\pm 0.02\%$  of range maximum value.  
JITTER: Same as instrument time base.

**1.3.19 Internally Generated PM Delay (referenced to Sync Output)**

RANGE: 0 to 2 s  
RESOLUTION: 10 ns  
ACCURACY:  $\pm 1\%$  of setting or 20 ns, whichever is greater.  
JITTER: 0.01% of setting or 100 ps, whichever is greater.

**1.3.20 Internally Generated PM Width**

RANGE: 50 ns to 2 s  
RESOLUTION: 10 ns  
ACCURACY:  $\pm 1\%$  of setting or 20 ns, whichever is greater.  
JITTER: 0.01% of setting or 100 ps, whichever is greater.

**1.3.21 Externally Triggered PM Envelope (one envelope produced by each trigger supplied)**

REPETITION RATE: 5 Hz to 5 MHz  
PULSE DELAY: Set by internal delay control.  
PULSE WIDTH: Set by internal width control.  
INPUT TRIGGER REQUIRED: Positive or negative-going TTL level trigger pulse,  $>25$  ns wide.

**1.3.22 Externally Generated PM Envelope (one envelope produced by each pulse supplied)**

REPETITION RATE: 5 Hz to 5 MHz, leveled output; DC to 10 MHz, unleveled output.  
PULSE DELAY (output envelope leading edge referenced to input pulse leading edge): 50 ns, typical  
INPUT PULSE REQUIRED: Positive or negative-going TTL level pulse,  $\geq 50$  ns wide (leveled output);  $\geq 20$  ns wide (unleveled output).

### 1.3.23 AM Envelope Parameters

Amplitude Modulation (AM) specifications apply for waveforms whose envelope peak is at least 1 dB below maximum specified output power when the instrument is internally leveled, FM and PM off. AM may be operated simultaneously with FM.

DEPTH RANGE:	0 to 90%
DEPTH RESOLUTION:	0.1% increments
DEPTH ACCURACY:	±5%
BANDWIDTH (30% depth):	DC coupled, 3 dB points >50 kHz.
FREQUENCY RESPONSE (flatness relative to 1 kHz rate at 30% depth):	±0.2 dB, DC to 10 kHz.
HARMONIC DISTORTION (relative to externally supplied AM envelope):	2% (1% typical), at ≤50% depth, ≤1 kHz rate; 10%, at ≤50% depth, ≤50 kHz rate.
INCIDENTAL PHASE MODULATION (rates <10 kHz, 30% depth, 50 Hz to 15 kHz measurement bandwidth):	<0.2 radians, peak, typical
INCIDENTAL FM:	Incidental Phase Modulation × AM rate

### 1.3.24 AM Indicator

READOUT:	3 digits
RESOLUTION:	0.1%
ACCURACY:	±5%

### 1.3.25 Internally Generated AM Envelope

WAVEFORM:	Sine, square, or triangle wave.
RATE:	1 Hz to 100 kHz
RESOLUTION:	1 Hz
ACCURACY:	± 0.01 Hz

### 1.3.26 Externally Supplied AM Envelope

WAVEFORM:	Any waveform compatible with bandwidth considerations.
RATE:	DC to 100 kHz
SENSITIVITY:	1 V <sub>p</sub> , for 100% depth.
INPUT IMPEDANCE:	600 Ω, nominal

### 1.3.27 FM Envelope Parameters

Frequency Modulation (FM) specifications apply with AM and PM off. FM may be operated simultaneously with AM or PM.

MAX DEVIATION (WIDE MODE):	10 MHz, peak (20 MHz, peak, above 20 GHz in instruments to 40 GHz).
FLATNESS:	$\pm 1$ dB for rates from 10 Hz to 1 MHz; $\pm 3$ dB from 1 to 5 MHz
RESIDUAL FM (50 Hz to 15 kHz post-detection bandwidth):	$< 3$ kHz rms typical ( $< 6$ kHz rms typical, above 20 GHz in instruments to 40 GHz).
MAX DEVIATION (narrow mode):	The lesser of $100 \times F_{\text{mod}}$ or 10 MHz, peak ( $200 \times F_{\text{mod}}$ or 20 MHz, peak, above 20 GHz, in instruments to 40 GHz).
FLATNESS:	$\pm 1$ dB for rates from 20 kHz to 1 MHz; $\pm 3$ dB from 1 to 5 MHz.
RESIDUAL FM:	Same as CW
DISTORTION:	$< 5\%$
INCIDENTAL AM:	$< \pm 0.2\%$ + MHz of deviation

### 1.3.28 FM Indicator

READOUT:	3 digits
RESOLUTION:	10 kHz
ACCURACY:	$\pm 5\%$

### 1.3.29 Internally Generated FM Envelope

WAVEFORM:	Sine, square, or triangle wave.
RATE:	10 Hz to 1 MHz
RESOLUTION:	1 Hz
ACCURACY:	$\pm 0.01$ Hz

### 1.3.30 Externally Supplied FM Envelope

WAVEFORM:	Any waveform compatible with bandwidth considerations.
RATE:	10 Hz to 5 MHz
SENSITIVITY:	1 V, peak, for maximum deviation
INPUT IMPEDANCE:	50 $\Omega$ , nominal

### 1.3.31 Program Store/Recall

Ten complete front panel set-ups of frequency, frequency sweep, output level, power sweep, PM, AM, and FM may be stored in the instrument's non-volatile memory for future recall.

### 1.3.32 Special Functions

Special functions are accessible via the data entry keyboard.

ADRS:	Allows setting of the instrument's IEEE-488 bus address via the data entry keyboard and displays it at the entry menu.
LOCAL:	Returns control of all parameters to the instrument's front panel.
RESET:	Initializes all parameters.
ALT:	Alternates between any two or more stored sweeps.
ATTEN:	Fixes the 10 dB step attenuator at a particular attenuation step; the RF output level may then be adjusted over a range extending from 20 dB below the attenuation value to 10 dB (15 dB, typ.) above the attenuation value; the power display shows actual output power.
TEST:	Initiates the instrument's self-test routines.
ALC:	Allows selection of a level control mode using an external detector or power meter, or 'unleveled' max. power mode.
MULT:	Allows division of the instrument's frequency by any integer to provide proper signals for external frequency multipliers.
OFFSET:	Allows frequency readout to be offset from the output frequency.
SPECIAL:	Allows user-defined and/or future special functions and features.

### 1.3.33 Front Panel Inputs/Outputs

All connectors are type BNC unless otherwise stated.

RF OUT:	The generator's RF output signal, on a type SMA connector (2.92 mm connector on instruments to 40 GHz). Option 22 relocates the connector to the rear panel.
SWP TRIG IN:	TTL level, $\geq 50$ ns wide trigger input to initiate a sweep or step.
RAMP OUT:	0 to +10 V ramp out, proportional to frequency between set sweep limits.
AM IN:	Input signal for external amplitude modulation.
FM IN:	Input signal for external frequency modulation.
PM IN:	Input signal for external pulse modulation.

### 1.3.34 Rear Panel Inputs/Outputs

All connectors are type BNC unless otherwise stated.

ALC IN:	Input signal for remote leveling of output power by positive or negative polarity ZBS detectors or by applicable power meters. Range: 500 $\mu$ V to 2 V Loop Bandwidth: 50 kHz, nominal (ZBS detector), 0.7 Hz, nominal (power meter). Input Impedance: 10 k $\Omega$ , nominal
REF IN:	External time base input signal, 10 MHz $\pm 1 \times 10^{-6}$ or better, 0.5 to 5 Vpp, overrides internal time base. Input Impedance: 100 $\Omega$ , nominal
REF OUT:	Buffered time base output, 10 MHz, 2 Vpp into 50 $\Omega$ , sine wave, derived from internal or external timebase.
5-6 MHz IN:	5-6 MHz input signal for controlling the frequency of the signal generator (permits fine frequency resolution control from an external synthesized source); 2 Vpp into 50 $\Omega$ .
STOP SWEEP IN/OUT:	TTL level signal, low input to stop frequency sweep or low output to indicate that sweep has been stopped.
LOCK/LEVEL OUT:	TTL high indicating that frequency is phase locked and output power is leveled.
PEN LIFT OUT:	TTL low during sweep, high during retrace.
PM VIDEO OUT:	TTL high level (approximately 1 V into 50 $\Omega$ ) pulse modulation envelope waveform.
PM SYNC OUT:	TTL high level (approximately 1 V into 50 $\Omega$ ) 50 ns wide trigger pulse output, coincident with the leading edge of the pulse modulation envelope waveform.
AM SIG OUT:	2 Vpp amplitude modulation waveform output.
FM SIG OUT:	2 Vpp frequency modulation waveform output.

BLANK/MKR OUT: +5 V during band changes, filter changes, and retrace; 0 V during sweep; -5 V during markers.

NEG BLANK OUT: 0 V during sweep, -5 V during band changes, filter changes, and retrace.

.5 V/GHz OUT: Signal directly proportional to the output frequency (.25 V/GHz in instruments to 40 GHz)

**1.3.35 General Specifications**

REMOTE INTERFACE: IEEE STD 488-1978 (all parameters except AC power on/off).

OPERATING TEMPERATURE: 0 to 50°C.

ENVIRONMENTAL: Complies with MIL-T-28800E, Type III, Class 5, Style E.

POWER: 100/120/220/240 VAC  $\pm$ 10%, 50-400 Hz, 350 Watts, nominal.

WEIGHT AND DIMENSIONS:

<b><i>Dimension</i></b>	<b><i>Net</i></b>	<b><i>Packed for air shipment</i></b>
Width	16.75 in (42.5 cm)	24 in (60.9 cm)
Depth	24 in (60.9 cm)	31 in (76.7 cm)
Height	5.25 in (13.3 cm)	11.25 in (28.6 cm)
Volume	1.22 ft <sup>3</sup> (.0345 m <sup>3</sup> )	4.84 ft <sup>3</sup> (.1372 m <sup>3</sup> )
Weight	65 lbs (29.6 kg)	80 lbs (36.3 kg)