



Model 288 20 MHz Synthesized Function Generator

SECTION 1 GENERAL

1.1 INTRODUCTION

The Model 288 Signal Generator is a precision source of sine, triangle, and variable symmetry (ramp and pulse) waveforms for use in the installation and maintenance of radio receivers, transmitters, and other electronic equipment.

- Push button control for easy operation.
- Indicator lights give constant equipment status.
- Large, 16 character (fourteen segments/ character), display for all parameters.
- Programmed interface for remote operation.
- Programmable sine, triangle, square, and dc outputs.
- Variable symmetry provides pulse and ramp waveforms.
- Balanced and unbalanced outputs.
- Built-in calibration and fault analysis programs with extensive self-adjustment.
- Battery backup for saving system setups.

1.1.1 List of Abbreviations

This list identifies abbreviations and descriptions used in this manual that are not contained in MIL-STD-12. For abbreviations used in this manual but not contained in this list refer to MIL-STD-12.

Abbreviation	Term
dBc	dB relative to carrier
dBm	dB relative to 1 milliwatt
fc	carrier frequency
fm	modulating frequency
GPIB	General Purpose Interface Bus
VCF	Voltage Controlled Frequency
VFD	Vacuum Fluorescent Display

1.2 OPTIONS

001: Special 24-pin extender card when used in conjunction with Option 002 permits user access to test points and components on the various circuit cards with or without power being applied.

002: 40-pin Extender Card – Special 40-pin extender card when used in conjunction with Option 001 permits user access to test points and components on the various circuit cards with or without power being applied.

003: Rack Mounting Kit

1.3 SPECIFICATIONS

1.3.1 Waveforms (Functions)

Sine, triangle and square; variable symmetry for pulse and ramp waveforms; and dc.

1.3.2 Operational Modes

Continuous (CW): Synthesized frequency output with selected parameters.

Amplitude Modulation (AM): Same as CW except that maximum amplitude limited to 15 Vp-p (open circuit) and external signal modulates the amplitude of the selected output.

Frequency Modulation (FM and VCF): External input modulates the frequency output.

Sweep Modulation: All symmetrical waveforms swept over 3 decades from Start to Stop frequency (up or down) at programmed rate.

Rate: 100 ms to 100s.

Start/Stop Accuracy: $< \pm 3\%$.

Phase Lock: Frequency, stability and purity controlled by external reference. In all modes except FM and Sweep, generator will lock to applied external 20 Hz to 20 MHz sine wave.

Lock Phase Angle: $\pm 180^\circ (\pm \pi \text{ radians})$.

Resolution: 1° .

Accuracy: 50 Hz to 10 MHz, $\pm (4^\circ + 20 \text{ ns})$.

1.3.3 Waveform Quality

Sine Distortion: Unbalanced output, Total Harmonic Distortion.

2 mHz to 20 Hz: -40 dB.
20 Hz to 100 kHz: -46 dB.
100 kHz to 1 MHz: -40 dB.
1 MHz to 6 MHz: -34 dB.
6 MHz to 20 MHz: -26 dB.

Time Symmetry: Programmable from 5% to 95% in 1% steps to 2 MHz, linearly decreasing to 50% fixed at 20 MHz.

Accuracy: $< \pm (2\% + 20 \text{ ns})$. At 50%, $< \pm (0.1\% + 20 \text{ ns})$.

Square Wave Transition Time: $< 13 \text{ ns}$, 10% to 90%, full output, from 50Ω source into 50Ω load.

Square Wave Aberrations: Overshoot and ringing $< (5\% + 20 \text{ mV})$ of p-p amplitude.

Triangle Linearity: From 10% to 90% points:

2 mHz to 100 kHz: $\pm 1\%$.
100 kHz to 2 MHz: $\pm 2\%$.
2 MHz to 5 MHz: $\pm 10\%$.

1.3.4 Frequency

Range: 2 mHz to 20 MHz.

Synthesized: 20 Hz to 20 MHz.

600 Ω or Balanced Output: 2 mHz to 1 MHz.

Amplitude Modulation: 0.1 Hz to 20 MHz.

Resolution: 3 1/2 digits (200 to 2000 counts in the display).

Accuracy: Percent of setting:

2 mHz to 20 Hz and FM or Sweep Modes: $\pm 3\%$.
20 Hz to 20 MHz: $\pm 0.05\%$.

Stability

Within 10 Minutes:

$\leq 20 \text{ Hz}$ and FM or Sweep Modes: $\pm 0.1\%$
 $> 20 \text{ Hz}$: $\pm 0.001\%$.

Within 24 Hours:

$\leq 20 \text{ Hz}$ and FM or Sweep Modes: $\pm 0.5\%$
 $> 20 \text{ Hz}$: $\pm 0.002\%$.

Line Voltage Variation:

For $\pm 10\%$ line variation and $\leq 20 \text{ Hz}$ and all frequencies in FM and Sweep Modes: $\pm 0.1\%$.
 $> 20 \text{ Hz}$: $\pm 0.001\%$.

Temperature:

$\leq 20 \text{ Hz}$ and all frequencies in FM and Sweep Modes:
 $< 100 \text{ ppm}/^\circ\text{C}$.
 $> 20 \text{ Hz}$: $< 2 \text{ ppm}/^\circ\text{C}$.

Output level Variation:

$\leq 20 \text{ Hz}$ and all frequencies in FM and Sweep Modes:
 $\pm 0.1\%$
 $> 20 \text{ Hz}$: $\pm 0.001\%$.

1.3.5 Amplitude

Range:

Open Circuit: 2 mVp-p to 30 Vp-p.

Impedance Terminated: 1 mVp-p to 15 Vp-p.

Resolution:

 With no offset:

2 mVp-p to 20 Vp-p Open Circuit, (1 mVp-p to 10 Vp-p Terminated): 3 digits.
To 30 Vp-p (15 Vp-p Terminated): 3 1/2 digits.

Accuracy:

 % of Setting:

Sine :

To 999 mVp-p: $\pm 2\% + 2 \text{ mV}$.

To 30 Vp-p: $\pm 2\% + 10 \text{ mV}$.

Triangle and Square :

To 999 mVp-p: $\pm 3\% + 4 \text{ mV}$.

To 30 Vp-p: $\pm 3\% + 20 \text{ mV}$.

Flatness:

 To accuracy percent of setting:

For 100 kHz to 1 MHz: Additional $\pm 2\%$.

To 5 MHz: Additional $\pm 3\%$.

To 20 MHz: Additional $\pm 10\%$.

1.3.6 Offset

Range

$\pm 10\text{V}$ ($\pm 5\text{V}$ terminated).

Resolution

3 digits; may be reduced if both offset and waveform amplitude are programmed.

Accuracy

0.5V to 10V: $\pm 1\%$ of setting + 20 mV.

1 mV to 500 mV: $\pm 1\%$ of setting + 5 mV.

1.3.7 Outputs

Sync (Trigger) Output

Pulse at frequency of and in phase with square wave.

Low Level: $< 0.4\text{V}$.

High level: $> 1.8\text{V}$ into 50Ω .

10-90% Transition Times: $< 13 \text{ ns}$.

Horizontal Output

Ramp indicates sweep position.

Level: Fixed 0V to approx. +5V (open circuit).

Source Impedance: 600Ω .

Unbalanced Output

Source Impedance:

To 1 MHz: $600\Omega \pm 1\%$.

To 20 MHz: $50\Omega \pm 1\%$ or $75\Omega \pm 1\%$.

Balanced Output

Banana jacks for differential output of sine wave; universal binding post for common.

Source Impedance:

To 1 MHz: $135\Omega \pm 0.5\%$ or $600\Omega \pm 1\%$

Output Unbalance:

10 Hz to 1 MHz: < 1% referenced to 1 kHz.

1.3.8 Inputs

External Trigger/Freq In

Input Impedance: $10\text{ k}\Omega \pm 2\%$.

Range (Sine Wave): 600 mVp-p to 30 Vp-p (into 10 k Ω), 20 Hz to 20 MHz.

Modulation In

Input Impedance: $10\text{ k}\Omega \pm 2\%$.

Bandwidth: DC to 100 kHz

Max Level: $\pm 20\text{ Vp-p}$ (into 10 k Ω).

FM Mode: $\pm 10\text{V}$ gives 1000:1 change. Apply as DC for VCF or AC for FM.

AM Mode: 4 Vp-p into 10 k Ω gives 100% AM.

1.3.9 Displays

Amplitude: V or mV peak-to-peak or peak. For symmetrical waveforms with no offset, displays amplitude in RMS or dBm.

Resolution: 100 to 999 counts or 0.1 dBm.

Offset: V or mV.

Resolution: 100 to 999 counts.

Frequency Including Sweep Start/Stop): mHz, Hz, kHz or MHz.

Resolution: 3 1/2 digits.

Period: sec, ms, μs or ns.

Resolution: 4 digits.

Symmetry: In %.

Resolution: ≥ 10 counts.

Resolution: resolves in 1° (deg) increments, displays radians in 4 digits.

Sweep Time: sec or ms with ≥ 100 counts.

1.3.10 GPIB Programming

Address: 0-30 selectable, battery backed.

Subsets: SH1, AH1, SR1, RL1, PP0, DC1, DT0, C0, T6, L4, TE0, LE0 and E1.

1.3.11 General

MIL-T-28800 Class 5 qualified.

Temperature Range: 0 to $+50^\circ\text{C}$, - 40 to $+70^\circ\text{C}$ for storage.

Warm-up Time: 20 minutes for specified operation at $25 \pm 10^\circ\text{C}$ ambient temperature.

Humidity: 0 to $+25^\circ\text{C}$ at 95% RH, 0 to $+40^\circ\text{C}$ at 75% RH, and 0 to 50°C at 45% RH.

Altitude: 3050m (10,000 ft.); non-operating to 12,000m (40,000 ft.).

Vibration: 0.013 in. from 5 to 55 Hz (2g acceleration at 55 Hz).

Shock: Non-operating; 30g, 11 ms half-sine.

Electromagnetic Compatibility: MIL-STD-461A Notice 4 (EL). Emission and susceptibility requirements of CE02, CE04, CS02, CS06, RE02, RE02.1 and RS03.

Dimensions: 35.6 cm (14.00 in.) wide, 13.3 cm (5.219 in.) high and 43.2 cm (17.00 in.) deep.

Weight: Approximately 11.4 kg (25 lb) net; 13.6 kg (30 lb) shipping.

Power: 90 to 108, 108 to 126, 198 to 231, or 216 to 252 Vrms; 48 to 440 Hz; 1 phase; < 60 VA.

1.4 EQUIPMENT SUPPLIED

The Model 288 is supplied with a shielded power cord, spare fuse, and manual.

1.5 EQUIPMENT REQUIRED BUT NOT SUPPLIED

All items required for the Model 288 are supplied.