GPIB MATE

MODEL 178 PROGRAMMABLE FUNCTION GENERATORS

Programmable Waveform Synthesizer

- 1 μHz to 50 MHz Frequency Range
- Synthesized 8 Digit Accuracy
- Trigger, Gate, Burst, Lin/Log Sweep
- 20 Volts Peak-to-Peak Output into 50Ω
- Sine, Triangle, Square, Ramps, and DC
- Optional MATE Interface

High Performance Generator
Model 178 Waveform Synthesizer, a bench top or ATE programmable instrument, combines the precision of an 8 digit, 50 MHz synthesizer with the versatility of a function and sweep generator. In addition to sine and square wave to 50 MHz, Model 178 includes the useful triangle, ramps and haverwaves.

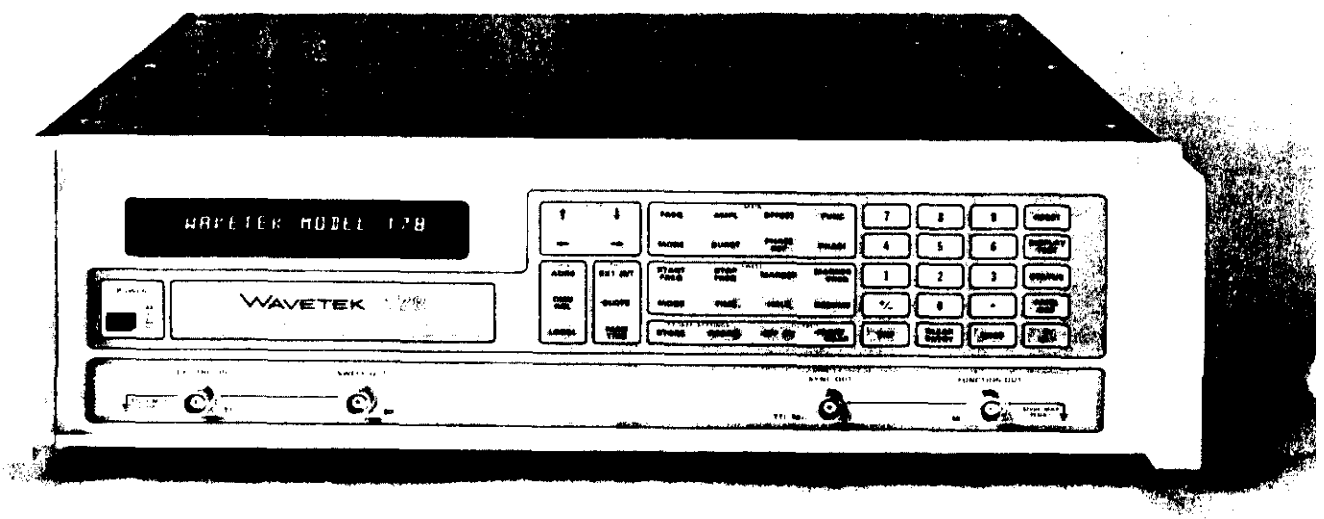
Innovative design gives synthesized triggering, gating, frequency sweep, burst counts and combinations of these modes for application flexibility. The output drives your 50Ω load to a full 20 volts peak-to-peak. The microprocessor design lets you program the level in convenient terms of Vrms, Vp-p or dBm.

Careful software design has resulted in a flexible, easy to program format. You may implement a change of only one instruction or completely change all settings in a few milliseconds.

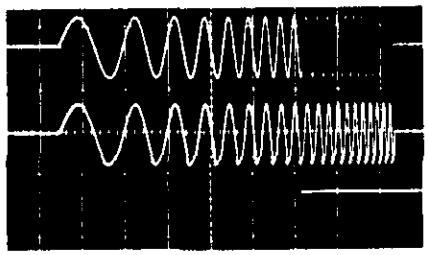
Additional features include amplitude and phase modulation, stored settings, variable waveform phase and programmable frequency markers.

Main Generator
Fifty megahertz synthesized performance to 8 digit resolution places your output precisely where you want it—and with a spectrally pure and accurate signal. Stimulus diversity includes the function generator waveforms of sine and square waves (less than 8 ns rise/fall) to 50 MHz, triangles to 500 kHz and ramps to 20 kHz. Useful haverwaves, based on sine or triangle waveforms, extend precision performance to include low frequency medical and mechanical stimulations.

Sweep Generator
Choose from linear or true log frequency sweeps, up or down and at virtually any sweep times. The sweeper may be operated by itself or combined with the main generator to provide continuous, triggered, gated, hold at start or stop, and even burst counted sweeps. Ten preset markers, available one at a time, flag critical sweep frequencies and provide start or stop triggers. Sweep is synthesized at all frequencies and



remains phase continuous even if the sweep is interrupted with a hold and later resumed.

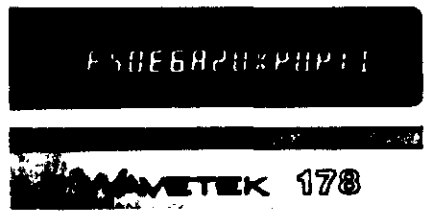


Sweep with Marked Frequency, Sweep without Marker, and Marker Pulse

Pulse
The 178 is a versatile pulse generator with precision pulses, available to a full ± 10 volt swing. Independent width and rate controls remain fully synthesized even in triggered, gated and burst operation.

Precision Output
Now you can drive your 50Ω load from as low as 1 millivolt to a full 20 volts peak-to-peak (flat even to 50 MHz), without the need for additional amplifiers. All waveforms may be combined with dc offset to the full ± 10V output window. Three digit amplitude and offset controls provide top performance in repeatability, accuracy and wideband flatness. Output is conveniently available either front or rear (selectable) and safely defaults to a 1 Vp-p level upon power-up and reset.

GPIB Compatibility
All of the 178's useful features may be programmed via the IEEE 488-1978 standard General Purpose Interface Bus (GPIB) system. Programming is just as easy as the GPIB as it is from the front panel. Any one parameter may be changed individually or several instructions may be entered for a simultaneous output change. Extremely high speed GPIB response and fast settling ensures fast ATE test times and greater production throughputs. For convenience, the GPIB coding string of recent manual and remote programming is displayed at a push of a button or placed on the bus in talker mode. Other GPIB features include expanded terminator characters, SRQ messages, error listings and sweep hold flags.



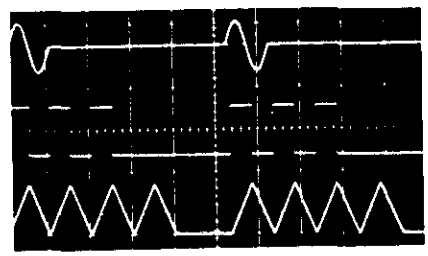
Programming String Display

Stored Settings
Time saving internal registers permit recall of complete instrument setups within milliseconds. Each setup may be loaded into any of the five storage areas of dynamic memory for later recall. Storage may be optionally expanded to forty additional registers with battery backup. Single commands permit rapid sequencing through all stored settings. Fast recall of stored settings is particularly well suited for repetitive testing both on the bench with front panel controls and also via the GPIB.

Amplitude Conversion
Enter and display amplitude entires in convenient volts peak-to-peak, volts rms or in dBm—all into 50Ω. The 178 performs these conversions automatically on any waveform.

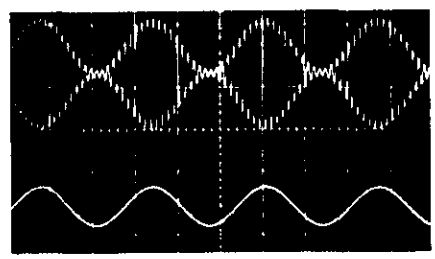
Variphase Synchronization
Incrementally shift the 178's main output in phase steps as fine as 0.01°. Locking the 178 synthesizer with another generator or external clock expands our stimulus capability to high resolution servo positioning and phase coherency.

Innovative Trigger
Trigger, gate and burst count (to 2^{16}) the 178's synthesizer up to 200 kHz rate. Full synthesizer performance guaranteed on all your stimulus applications.



Synthesizers Output in Triggered Burst Mode

Amplitude Modulation
In addition to all these features, the 178 may be externally phase modulated at any time or externally amplitude modulated up to 200 percent.



Sine Wave Amplitude Modulation

Optional MATE Interface

Model 178 is available with a factory-installed MATE interface per USAF Standard 2806763 (Option 010). The MATE interface consists of both hardware and software. The software accepts GPIB commands in Control Interface Intermediate Language (CIIL) as well as the "native" Model 178 language. The hardware includes expanded memory to support the additional software, shallower handles to allow the instrument to be mounted in a rack equipped with a front door, and a status monitor interface to report catastrophic failures to the control computer in real-time. The status monitor interface is independent of the GPIB.

MODEL 178 PROGRAMMABLE FUNCTION GENERATORS

VERSATILITY

Waveforms
Sine ∿, square ⊓, triangle △, ramps ◿, ◺, haversine ⌒, ⌣, havertriangles ⌒, ⌣, AM (sine) ◇◇, and DC.

Operational Modes
NOTE: All modes are synthesized.
Continuous: Generator runs continuously.
Triggered: Generator is quiescent until triggered by an external signal, internal sweep signal, GPIB or manual trigger, then generates one cycle at selected frequency.
Gated: As triggered mode, except generator oscillates for the duration of the gate signal plus the remainder of the waveform in progress.
Triggered Haverwave: *As triggered* mode, except output is a sine or triangle waveform starting at − 90° (or + 90°).
Gated Haverwave: As gated mode, except output is a sine or triangle waveform starting at − 90° (or + 90°).
Triggered Burst: As triggered mode, except the number of cycles output for each trigger input is selected from 1 to *65,536 (2^{16}) counts.*
Triggered Haverwave Burst: As *triggered* burst, except output is a sine or triangle waveform starting at − 90° (or + 90°).
NOTE: See Frequency Range Section for frequency capability in each mode.
Frequency Sweep: Output frequency can be swept by internal sweep generator. (See Sweep Generator for *sweep modes.*)

Frequency Range
Low end for all waveforms is 1 μHz.
Continuous Mode:
∿, ⊓, ◇◇ to 50 MHz.
△ to 500 kHz.
◿, ◺ to 20 kHz.
All Triggered Gated and Burst Modes:
∿, ⊓, △, ◇◇ to 200 kHz.
◿, ◺ to 20 kHz.
Frequency Sweep: (See Sweep *Generator).*

Main Output
All waveforms are available to 20 Vp-p maximum into 50Ω load. Combined amplitude/dc offset not to exceed ± 10V peak into 50Ω. Output voltage into an open circuit is double indicated voltage when a voltage less than ± 5V peak is selected. Output available on front or rear (selectable) BNC.
Phase Offset: Output phase may be *changed to any angle in 0.01° resolu*tion steps to 500 kHz and 0.1° (or better) resolution steps above 500 kHz.

Amplitude Conversion
Permits entry and display of amplitude for all waveforms in units of Vrms, Vp-p and dBm, all into 50Ω load.

DC Offset and DC Voltage Output
0 to ± 10 Vdc into 50Ω. Output voltage is double into open circuit when voltage less than ± 5 Vdc is selected. DC offset is attenuated by the amplitude range attenuator.

Auxiliary Outputs
TTL and $\overline{TTL}$ Sync Outputs: *At* generator frequency, 50Ω source *impedance, 50% duty cycle. Less than* 5 ns transition time.
Sweep Ramp Output: (See Sweep Generator).
Reference Output: 10 MHz, 1 Vp-p sine, 50Ω source impedance.
Frequency Marker Output: (See Sweep Generator).

Inputs
Trigger Input: A TTL level transition can trigger or gate both main generator and internal sweep generator. Triggering slope up (◿) or down (◺) is selectable.
Reference Input: An external 0.5V to 10 Vp-p sine or pulse clock of ± 5 ppm or better stability and accuracy automatically locks the internal reference. External clock may be 1, 2, 3, . . . 9 or 10 MHz. A message "REFERENCE NOT LOCKED" is displayed if external reference is present but internal reference is not synchronized to it. Input impedance is 1 kΩ.
Amplitude Modulation Input: Rates from DC to 10 MHz minimum. Input impedance is 600Ω. 5 Vp-p input gives 100% modulation. Main output halved with no modulation. 200% modulation permitted. Sync output not affected by *modulation.*
Phase Modulation: *Rates from DC to* 10 kHz minimum. Input impedance is 10 kΩ. ± 5V input delivers approx. ± 360° shift. Output deviation is − 100 for main output frequencies 500 kHz and below.

Data Entry
Front panel keyboard with display and GPIB programming.

MAIN GENERATOR

FREQUENCY RESOLUTION

8 digits or 1 μHz.

FREQUENCY PRECISION

Accuracy
Better than 0.0005% of program setting, ± 0.01 μHz.

Stability
Long Term: *$\pm 1 \times 10^{-6}$ of frequency* per month.
Temperature: 1.2×10^{-7} per °C.

Signal to Phase Noise
Greater than 46 dB in a 30 kHz band centered on carrier but excluding a ± 1 Hz band around the carrier.

Spurious
− 60 dBc or 30 μV whichever is greater, 1 μHz to 500 kHz.
− 50 dBc or 30 μV whichever is greater, 500 kHz to 50 MHz.

AMPLITUDE PRECISION

Resolution and Accuracy
Specified for 1 kHz sine wave, or for dc output into a precision 0.1% 50Ω load.
NOTE: DC offset range is 0 to ± 10 Vdc.

Amplitude Range		Accuracy (Amplitude)
10.02	to 20.00 Vp-p	± 1% ± 20 mV
1.01	to 10.0 Vp-p	± 1% ± 10 mV
0.101	to 1.00 Vp-p	± 3% ± 2 mV
10.1	to 100 mVp-p	± 4% ± 100 μV
1.00	*to 10.0 mVp-p*	*± 5% ± 20 μV*

Resolution: 3 digit, less than or equal to 10.0 Vp-p. 4 digit (20 mV), greater than 10Vp-p.
DC Offset: ± 1% of setting ± 40 mV (worst case).
NOTE: Amplitude and dc offset share the output attenuator.

Frequency Response
Specified relative to 1 kHz sine wave.

Frequency Range	Response
1 μHz to 20 kHz	± 1%
20 kHz to 500 kHz	± 3%
500 kHz to 25 MHz	± 7%
25 MHz to 50 MHz	± 15%

NOTE: ⊓, △ add 1% to above ◿, ◺ add 5%.

Amplitude and Offset Stability
Measured at room temperature.
Short Term: 0.1% for 10 min.
Long Term: *0.5% for 6 months.*

WAVEFORM CHARACTERISTICS

Sine Distortion
Specified for 1 Vrms (2.82 Vp-p) sine wave. Harmonically related signals less than:
− 55 dBc to 50 kHz.
− 40 dBc to 500 kHz.
− 30 dB to 50 MHz.

Square Wave Rise and Fall Time
Less than 8 ns, 1.01 to 10.00 Vp-p.
Less than 10 ns, greater than 10 Vp-p.

SWEEP GENERATOR

Sweep generator is fully synthesized and may be used independently or for frequency sweeping and triggering the main generator. Frequency sweep may be selected linear or logarithmic, and up or down. Sweep may be triggered, gated, burst, interrupted with hold, and continued with resume.

SWEEP MODES

Continuous Sweep: Sweep generator sawtooth runs continuously.

Triggered Sweep: Incoming trigger causes a single sweep and reset to start frequency.
Triggered Sweep/Triggered Reset: As in triggered sweep, but sweep ends at stop frequency. Next trigger returns frequency to start.

SWEEP CHARACTERISTICS

Sweep Time
0.01 to 600.00s, 0.01s resolution.

Sweep Output
0 to +5V ramp synthesized to 2000 steps per sweep. 600Ω output impedance.

Frequency Marker Output
TTL levels. One of the ten preset markers can be selected. Output is low when the main generator frequency is below marker frequency; output is high when above.

Maximum Sweep Range
Low Band: 1 μHz to 500 kHz.
High Band: 5 kHz to 50 MHz.

Minimum Sweep Range
Log: Any start and stop frequencies with ratio greater than 2.
Linear: Any start and stop frequencies with a minimum separation of:
Low Band: 200 mHz per 1s of sweep time.
High Band: 2 Hz per 1s of sweep time.

Sweep Resolution
Frequency Resolution including Start, Stop, Hold, Markers: 8 digits or 1 μHz.
Frequency Update: Every 5 μs (lin and log).
Log Slope Update: Every 2 ms.

PULSE

Fully synthesized. Pulse period and width parameters entered by sweep time and main generator frequency respectively. Includes continuous, single, burst, gated and complement pulses.

Period
10 μsec to 600s (10 min.);
4 digit resoution (sweep time control);
Less than 1% jitter.

Width
5 μs to 500,000s (5 days); 8 digit resolution (frequency control);
Less than 0.05% jitter.

NOTE: Width usable to 1 μs.

GENERAL

Stored Settings
Up to 5 complete instrument setups can be stored and recalled by number from volatile (RAM) memory. Settings may be modified or deleted.

GPIB Programming
Standard Purpose Interface Bus (GPIB) programming per IEEE Standard 488-1978. Interface is optically isolated from signal ground. Interface includes Listener (AH1 and L4), Talker (SH1 and T6), SRQ (SR1), Local Lockout (RL1), Device Clear (DC1), and Group Execute Trigger (DT1) Capabilities and Open Collector Logic (E1).

Parameter	Time
Command Handshake	15 μs
Data Handshake	65 μs
Frequency	11 ms
Amplitude	14 ms
DC Offset	14 ms
Mode	4 ms
Function	5 ms
Output	4 ms
Execute	8 ms

Environment
Accuracy applies for 25°C ±10°C after 30 minutes warm-up unless otherwise noted. Instrument will operate from 0°C to 50°C, to 10,000 ft altitude and to 90% relative humidity. Storage temperature from −25°C to +65°C.

Dimensions
44.5 cm (17.5 in.) wide; 13.3 cm (5¼ in.) high; 53.4 cm (21 in.) deep. Supplied with rack mount adapters.

Weight
14.7 kg (32.4 lb) net; 18.2 kg (40 lb) shipping.

Power
90 to 105V, 108 to 126V, 198 to 231V or 216 to 252V; 48 to 67 Hz; less than 180 watts.

OPTIONS

001: Additional Stored Settings
Provides nonvolatile memory for up to 40 additional stored settings. Memory is battery backed up (internall recharged) for 60 day (minimum) retention of settings.

002: High Stability Frequency Reference
An additional frequency reference crystal for greater accuracy. Standard or High Stability crystal selectable by rear panel switch.
Accuracy: $\pm 5 \times 10^{-8}$.
Aging Rate: 5×10^{-9}/day (average), $<4 \times 10^{-8}$/week.

010: MATE Interface
Factory installed MATE interface per USAF Standard 2806763.

FACTORY/FOB

San Diego, CA