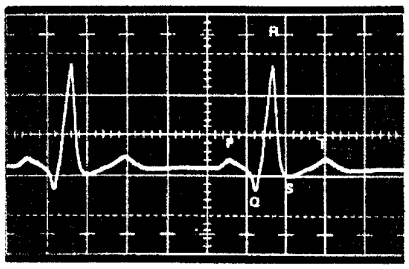
Arbitrary Waveform Generator



- **Generate Any Custom Waveform**
- **Programmable-GPIB Compatible**
- **Full 20 Volt Output**
- **Crystal Controlled Accuracy**
- **Microprocessor Simplified Data Entry**

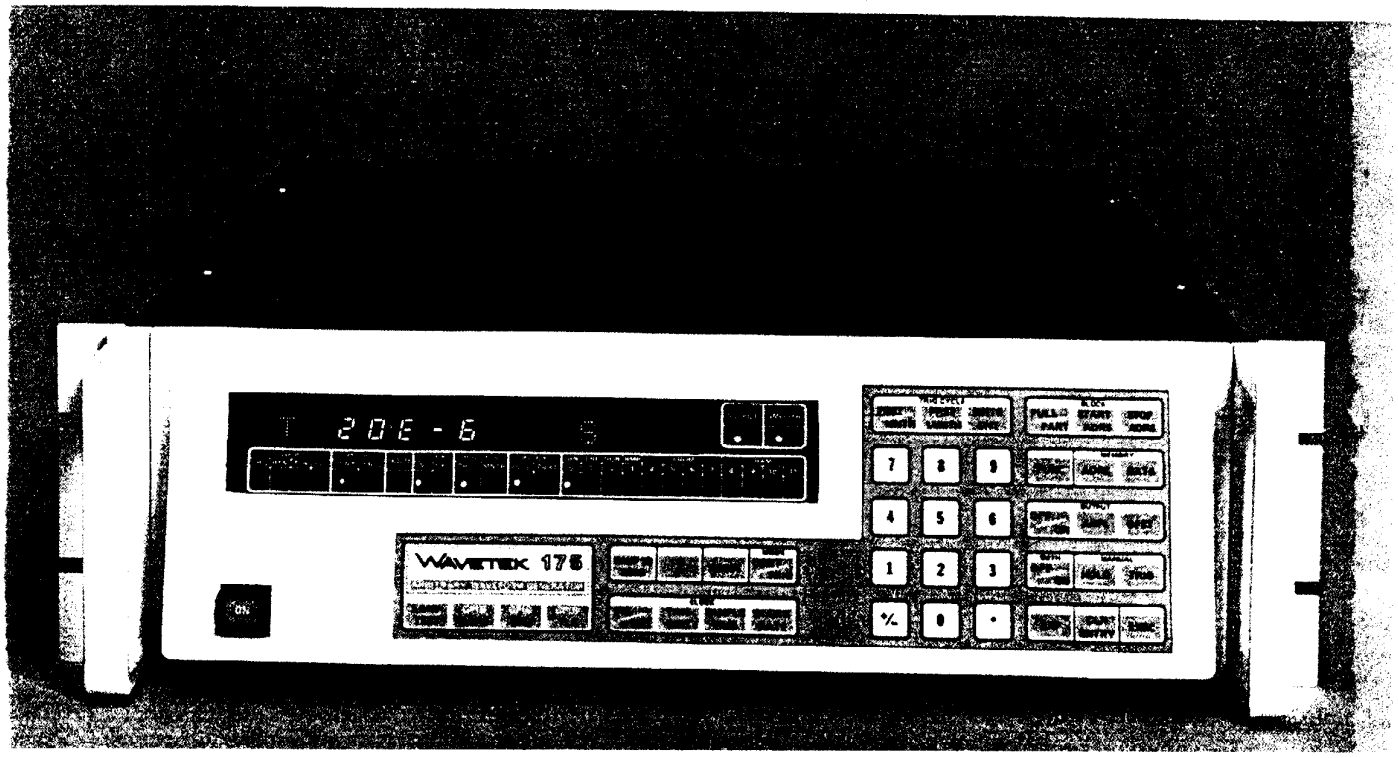
Generate Custom Waveforms
The new Wavetek Model 175 gives you the solution for your complex waveform problems. This programmable Arbitrary Waveform Generator lets you custom tailor your own waveforms. Any waveform that can be drawn can be entered into this new instrument and then generated as an output.

This new concept in signal generation stores waveforms as digital points on a 256 by 255 data grid. These points are sampled by a crystal-controlled clock at selectable times up to 200 nanoseconds. You can also vary the amplitude with 3 digit resolution up to a full 20 volt peak-to-peak output.

You can easily enter your data in any one of four RAM memories by the front panel keyboard or the General Purpose Interface Bus (GPIB). You enter the data for each change-of-slope location, and the internal microprocessor connects the points. In addition, plug-in sockets are provided for four PROMs so that you may have a permanent library of your most used waveforms.

Irregular waveforms required in medical, biological and materials research can be easily generated and controlled with the Arbitrary Waveform Generator.

Monitor or Preset Triggering
A unique trigger control capability is incorporated in the arbitrary waveform generator. When your application requires a certain number of signal cycles, you can use the preset mode. Simply select the number of cycles necessary and trigger the generator; it will output the precise number of cycles, then stop. The 175 can also be triggered to run in the monitor mode. In this mode, the generator will run until stopped by an external control signal. The number of cycles that have been generated, up to 9999, can then be displayed by calling up monitor count (MNTR CNT).

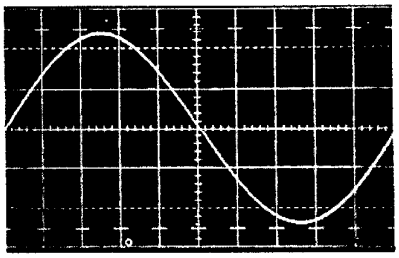


Ramp-to-Zero and Hold

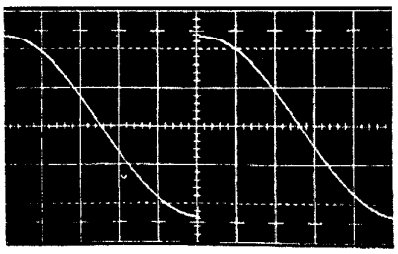
Some test situations require a hold or a controlled ramp-to-zero condition; for example, holding or ramping to zero at the time of a structure failure during a mechanical test. With the 175, you can either hold the waveform at its instantaneous level or ramp the waveform to zero in approximately 15 seconds. Control is via the bus, a front panel key, or remotely, using a BNC connection at the 175.

Full or Partial Block Playback

Several of your arbitrary waveform applications may require evaluation using only a portion of the selected waveform. By selecting partial block operation and start/stop addresses, it is possible to use only a selected segment of the arbitrary waveform. This feature also allows you to store several different waveforms in each of the RAM or PROM memories to further increase your waveform library.



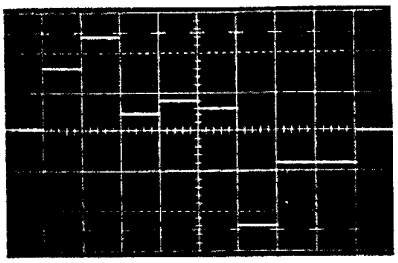
Full Block Operation
19.5 kHz Sine Wave
Using All 256 Points
Distortion Less Than 0.8%
NOTE: Four RAMs can be used to achieve distortion as low as 0.2%



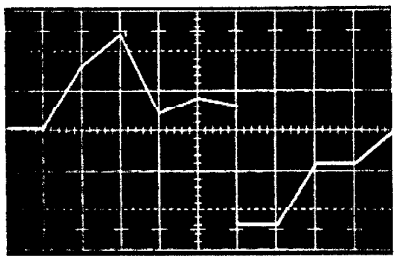
Partial Block Operation
With Start Address 64
and Stop Address 192

Output Waveform Smoothing

Certain low frequency applications require that the digital step size is an absolute minimum. For these applications, the 175 features a digital interpolation type of waveform smoothing. Each step between addresses is divided into 100 smaller steps. This selectable smoothing process assures you that the point-to-point transitions are an absolute minimum.



Unsmoothed RAM Waveform
Using Only 10 Data Points



Same Waveform With Smoothing

Fully GPIB Compatible

The standard Model 175 is fully compatible with the requirements of IEEE Standard 488-1975 for simple integration into your General Purpose Interface Bus (GPIB) system. Front panel controls can be implemented by simple prefix/value commands. For example, X 120 Y 73, where X and Y are prefixes for point coordinate values of 120 and 73. This command gives the X time data and the Y amplitude data that make up a point on the waveform. All other parameters are similarly programmed by a simple easy-to-understand format. Program errors are detected and can be transmitted on the GPIB, and the RAM stored data can be transmitted on the GPIB for recording.

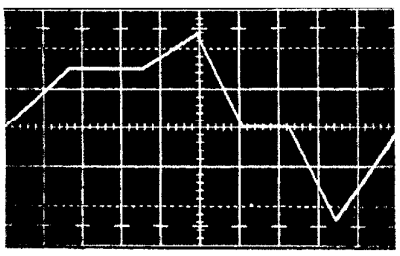
Versatile Timing Control

The frequency of your output waveform can be accurately controlled by selecting the sample time per step. Sample time can be programmed from 200 ns per step to 999.9s per step for PROM stored memory (500 ns to 999.9s for RAM). Waveform frequency is then a function of the number of steps used. For example, a square wave using only two steps has a maximum frequency of 2.5 MHz, while a waveform using all 256 steps in the block has a maximum frequency of 19.5 kHz. If you prefer to program the block frequency, the unit will choose the best sample time for you.

Microprocessor Control for Simplified Data Entry

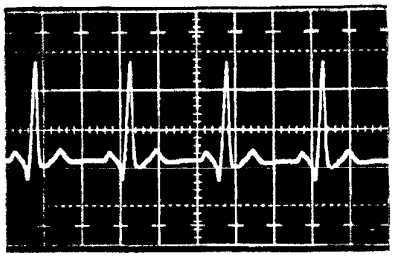
The 175's hard working microprocessor interpolates between adjacent data entries to compute the final waveform. This means that you do not have to enter each of the 256 data points, only those which represent a change of slope. The waveform below was completely defined by the following eight simple data entries.

X	0	Y	0
X	42	Y	80
X	90	Y	80
X	125	Y	127
X	154	Y	0
X	183	Y	0
X	213	Y	−127
X	0	Y	0

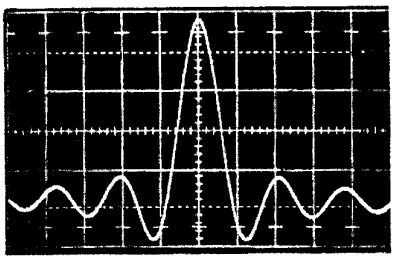


Arbitrary Waveform Entered With
Only Eight ADRS/DATA Points

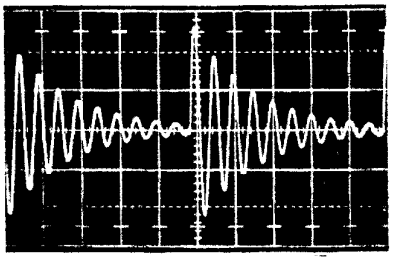
A Few Sample Waveforms Generated With the 175



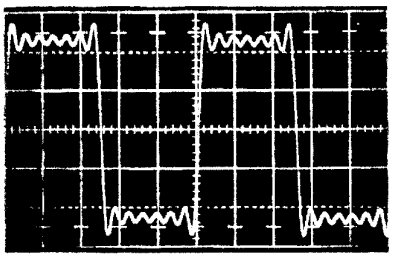
Simulated EKG Heartbeat



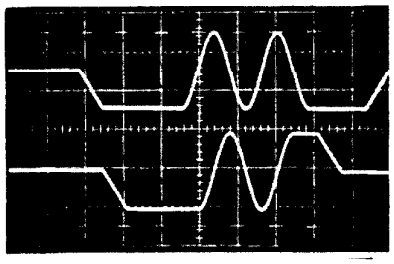
(sin x)/x



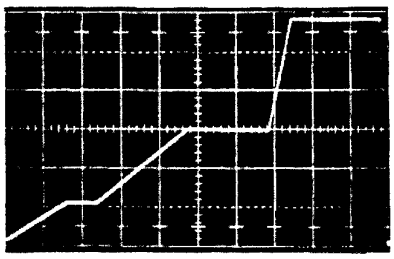
Impulse Shock Simulation



Fourier Waveform Synthesis



Bubble Memory Magnetic Stimulus



Ramp and Hold Waveform for Materials Testing

Full Storage of Twelve Different Waveforms

SIN	TRI	SQR	RMP
0	1	2	3

The Arbitrary Waveform Generator has been configured to give you maximum waveform storage and recall convenience. Each generator features fixed sine, triangle, square and ramp waveforms, as well as PROM and RAM storage capability.

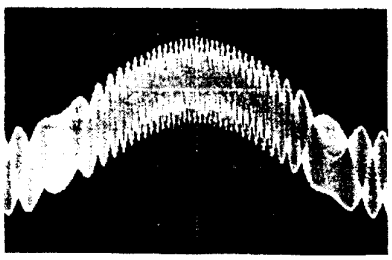
PROM			
4	5	6	7

PROM storage capability is also provided for four PROMs. Program your own waveforms on PROMs (74S471 or equivalent) and insert them in the four convenient sockets provided. These waveforms can then be called up via the front panel or via the GPIB.

The working RAMs can be individually addressed and programmed, either from the front panel or via the GPIB. Simple data entry procedures assure that you can enter your custom waveform quickly and accurately.

RAM			
8	9	10	11

For greater waveform resolution, the PROMs or RAMs can also be stacked. A single waveform can be placed in one, two, three or four "blocks" of RAM or PROM for an increase in address resolution from 256 points to 1024 points.



Complex Aircraft VOR Signal Using 1024 Data Points

VERSATILITY

Fixed Waveforms
Sine ∿, square ⊓, triangle ∧ and ramp ◿.

Arbitrary Waveforms
Arbitrary waveforms are stored on four 256 X 255 point RAM matrices and four 256 X 255 user-supplied PROM matrices. Each PROM or RAM block can be addressed individually or they can be addressed in sequence; e.g., PROMs 1 and 2, PROMs 1, 2 and 3 or PROMs 1, 2, 3 and 4. This feature allows additional address resolution of custom waveforms. Block length can be from 2 to 256 address points, or when blocks are stacked, up to 1024 address points.

Digital Smoothing
When smoothing is selected, each change in amplitude data is subdivided into 100 substeps per sample time. Smoothing is automatically limited to 20 μs or slower sampling times and to point-to-point data differentials less than 64.

Sync Output
TTL level pulse with a trailing edge coincident with the start address. Pulse width is one sample time. Available at rear panel BNC.

Cursor Output
TTL level output coincident with a selected data address. Available at rear panel BNC.

Operational Modes
Continuous: Generator operates continuously at selected frequency.
Preset Triggered: Generator quiescent until triggered via front panel key, GPIB program or TTL pulse at rear panel BNC; then a preset number of cycles to 9999 are generated at a selected frequency.
Monitor Triggered: As for Preset Triggered, except the cycles are output continuously after triggering, until a hold command (via front panel key, GPIB program or TTL low at rear panel BNC) is given. The number of cycles generated up to 9999 can be displayed.
Hold Control: Front panel key, GPIB program or TTL low at rear panel BNC can stop the waveform asynchronously to the reference clock. Triggered modes only. (Restart from the held level by trigger signal.)
Ramp-to-Zero: Front panel key, TTL low at rear panel BNC or GPIB program can step output linearly to 0V in approximately 15 seconds.

TIMING PRECISION

Sample Time
The stepping time from data point to adjacent data point is selectable as 200 ns to 999.9s for fixed waveforms and optional PROM stored data points (500 ns to 999.9s for RAM stored data points). Sample time accuracy is ±0.03% of setting. Resolution is 100 ns (10 μs when smoothing). Output frequency is 19.5 kHz to 3.90 μHz (71 hr/cycle) rate for a 256 word block. Sample time can be displayed and programmed in seconds, minutes, hours or as data block rate in hertz.

Reference Clock
Internal 10 MHz crystal controlled oscillator or external TTL compatible frequency source input at rear panel BNC. TTL compatible reference clock output provided.

External Clock
TTL compatible signal applied at rear panel BNC. Permissible external clock frequency is dc to 11 MHz for continuous modes. Ratio of external clock to reference clock determines output frequency.

AMPLITUDE PRECISION

Main Output (Attenuated, 50Ω Source)
∿, ⊓, ∧, ◿ and arbitrary waveform selectable. Full block amplitude variable from 2 mV to 20V p-p into open circuit (10V p-p into 50Ω) with 3 digit resolution. Amplitude accuracy with 0 Vdc offset between 2 and 20V p-p is ±2% of setting plus 2 digits. Signal offset is from 0 to ±10V into open circuit (0 ±5V into 50Ω) with 3 digit resolution. Offset accuracy is ±2% of setting plus 2 digits.

Auxiliary Output (<1Ω Source)
Same waveform as main output from 0 to 10V peak (at fixed 0 dB attenuation). Same offset as main output and limited to 100 mA peak.

Output Amplifier Rise/Fall Time
Less than 500 ns, 50Ω termination main output.

GENERAL

Display
LED seven segment display with alphabetical index of key functions and units. All status, modes and functions are shown by LED annunciator displays.

Keyboard
Membrane type with acoustic feedback. Acoustic tone may be turned off by front panel key.

External Program Interface
IEEE Standard 488-1975 compatible General Purpose Interface Bus (GPIB). Connector and address switch on rear panel. The interface provides listener (AH1 and L4), talker (SH1 and T6), service request (SR1), remote/local (RL1), device clear (DC1) and device trigger (DT1) capabilities. Handshake rate is 2 μs per character in command mode (10 μs typical for command sequence) and 220 μs per character in data mode, with data storage of up to 80 characters. The following table may be used to determine particular through-put times. Measurements were made with a 175 and an HP9825 controller. Data rates will follow the slowest listener on the bus and vary with different controllers.

Parameter	Time
Command Handshake	2 μs
Data Handshake	220 μs
Sample Time	35 ms
Block Rate	50 ms
Amplitude Setting	65 ms
DC Offset Setting	65 ms
Burst Length	20 ms
Function	20 ms
Int/Ext Clock	20 ms
Time Unit	25 ms
Mode CONT/TRIG	20 ms
PRST/MNTR Trigger	20 ms
FULL/PART Block	25 ms
Start Address	25 ms
Stop Address	25 ms
Output OFF/ON	20 ms
X Address	30 ms
Y Data	40 ms
Smoothing OFF/ON	35 ms
Execute	16 ms*
GET	1.6 ms

*2 ms when via GET

Stability
Amplitude and DC Offset
Measured at full output and 25 ±1°C. Change is less than ±0.25% per day. Change with temperature is less than ±0.2% over 0 to 50°C.
Frequency
Crystal aging rate is less than 2×10^{-5} per year. Temperature coefficient is 1×10^{-6}/°C.

Environmental
Specifications apply for 25 ±10°C after ½ hour. Instrument will operate from 0 to 50°C to 10,000 ft altitude at 95% relative humidity.

Dimensions
Fits standard 48.3 cm (19 in.) rack. Dimensions behind front panel are 43.2 cm (17 in.) wide; 13.3 cm (5¼ in.) high; 51.4 cm (20¼ in.) deep. Supplied with rack adapters.

Weight
15.9 kg (35 lb) net; 20.4 kg (45 lb) shipping.

Power
90 to 105V, 108 to 126V, 198 to 231V or 216 to 252V; 48 to 66 Hz; less than 120 watts.