Models 2020/40/45

Polynomial Waveform Synthesizers

The Analogic Model 2020, 2040, and 2045 Polynomial Waveform Synthesizers generate complex arbitrary waveforms directly from mathematical equations with unparalleled accuracy. With their front-panel keypad for programming and equation entry, they offer full standalone capability, unlike any other arbitrary waveform generator available. These waveform generators can easily be integrated into practically any computer-controlled test system via RS-232 or high-speed IEEE interfaces. No other single instrument can offer the performance or versatility of Analogic Polynomial Waveform Synthesizers.

The Model 2020 offers the most affordable solution to generating high-speed, high-quality waveforms. Highly accurate output waves are produced with 12-bit vertical resolution, using 24-bit floating-point calculations and a 12-bit D/A converter (DAC). This vertical resolution is maintained independently of output amplitude by scaling the waveform to drive the full D/A range, and by adding up to 63 dB of attenuation, as necessary, to produce the required output. The 2020 generates output waves at speeds of up to 100 MHz.

Models 2040 and 2045 generate standard functions and arbitrary waveforms at very high speeds (up to 800 MHz) with point-to-point resolution as fine as 1.25 ns. Several times faster than previous arbitrary signal generators, these instruments provide accurate simulations and thorough testing at frequencies up to which only rough approximations were previously feasible. These synthesizers are especially effective for complex radar and video signal simulations, and for testing high-density/high-speed disk drives and digital fiber-optic communications links.

To make the world's fastest waveform synthesizers even more powerful, the new Models 2040B and 2045B each have a 2 megasample output memory that enables the generation of long, high-definition waveforms at high frequencies. With this capacity and outputs of up to 800 megasamples/second, the 2040B and 2045B offer unbeatable performance in benchtop instrumentation and ATE.

FEATURES

- ❑ World's Fastest Arbitrary Waveform Generation – up to 800 MS/s (1000 MS/s Optional)
- ❑ Very High Resolution – up to 12 bits at 100 MS/s
- ❑ Math Equation Entry
- ❑ Full Dynamic Range Independent of Amplitude
- ❑ Dynamic Looping Capabilities (2020)
- ❑ Phase-locked Loop Capability for up to Eight 2020s
- ❑ Up to 2048k Points of Output Waveform Memory
- ❑ Non-volatile Waveform Equation Library
- ❑ One-key Generation of Standard Functions
- ❑ Full Programmability for ATE via IEEE or RS-232
- ❑ DPCOM™ PC Software Utilities Support

APPLICATIONS

- ❑ General Electronics Test
- ❑ Magnetic and Optical Disk Drives
- ❑ Avionics
- ❑ Fiber Optics
- ❑ Sonar and Radar
- ❑ Mechanical Analysis
- ❑ EMI/RFI Testing
- ❑ Telecommunications
- ❑ Acoustics and Speech
- ❑ Video and HDTV
- ❑ Medical and Ultrasonics Research

ANALOGIC®
The World Resource for Precision Signal Technology

Family of Polynomial Waveform Synthesizers

	2020-25	2020-100	2040	2045
Max. Output Rate	25 MS/s	100 MS/s	800 MS/s Optional 1000 MS/s*	800 MS/s Optional 1000 MS/s*
Analog Outputs **(Vp-p into 50Ω)**	10V (2V p-p with Diff. Output Opt.)		1V True 1V Complement	5V 1V
Vertical Resolution	12 bits		8 bits	8 bits
Output Memory (#points)	64k up to 512k	128k or 512k	512k 2048k (2040B)	512k 2048k (2045B)
Equation Memory	30k or 78k	30k or 78k	78k	78k
Math Co-Processor	Optional		Standard	
Systems Interface	IEEE-488, with High-Speed DMA or RS-232 (all optional)		IEEE-488 with High-Speed DMA and RS-232 (standard)	

** Contact factory for 1000 MS/s option*

High Performance

Analogic Polynomial Waveform Synthesizers produce analog signal emulation with more accuracy than other arbitrary signal generators. A waveform is synthesized from thousands of data points that are precisely calculated from a polynomial equation. This includes sums and products of trigonometric LOGs and exponential functions. All fundamental operations are readily accessible from the front keypad.

Although the 2020 has a standard 512k-point output memory, two innovative techniques – Dynamic Looping and Constant Compression – are used to ensure that memory space is not exhausted when generating long waveforms. Dynamic Looping allows production of periodic waveforms using real-time looping through portions of output memory. Because of Constant Compression, DC values of any required duration use only a few words of output memory. These methods enable the unit to generate a close approximation of the complex NTSC-7 composite video test signal, using just a few thousand words of memory.

To provide the full benefit of 800 MS/s synthesis, both the 2040 and 2045 provide a 1V output with a typical 1 GHz bandwidth and 500 ps rise time, and 7 ns settling time to within 1% of final value. The 2040 has a second output, opposite in phase, for differential applications. The Model 2045 has a 5V output with a 200 MHz bandwidth, a programmable filter, an attenuator, and a DC offset source. All outputs retain full 8-bit resolution over the specified range of amplitude.

High-Speed, High-Quality Signals

These synthesizers guarantee high resolution and linearity for signal amplitudes from millivolts to full scale by automatically driving the output DAC over its full range and attenuating the output to the required level. The resulting wide dynamic range is not affected by even a large DC offset, as the instrument adds this to the output from a separate 12-bit DAC. An output amplitude as large as 10V p–p into 50Ω is available with absolute accuracy better than 1%. The output doubles with a high-impedance load.

Arbitrary Waveform Generation Made Easy

Complex waveforms required for thorough, effective simulation and testing can be generated quickly and easily using Math Equation Entry. With this method, hundreds of waveform equations can be stored in a non-volatile waveform equation library and quickly regenerated when needed.

One instrument can replace a full rack of expensive signal sources and conditioning gear, and can meet changing test requirements with new easily defined waveforms.

The exact waveform needed can be generated by keying in a mathematical equation [Y = f(t)] that precisely describes the waveform amplitude, frequency, shape and duration. With a few more keystrokes, noise, glitches, and other forms of distortion can be added to simulate virtually any real-world signal. Function keys such as SIN, Y^x, INTegral, LOG, and ARCTAN minimize the number of keystrokes required. Mnemonics such as FOR, AT, and TO simplify the description of complex, multi-segment waveforms. Scientific notation and the metric prefixes M, K, m, µ, and n not only ease numeric entry, they also allow the equation to be written in the user's language.

The waveforms illustrated in Figures 1 through 4 show the creation of complex wave shapes by adding or multiplying ordinary math functions. These examples show the relative ease of mathematically defining complex waveforms that precisely simulate natural phenomena. The Analogic Model 2020 introduced Math Equation Entry to the instrumentation marketplace, and has proven its versatility and simplicity in a great variety of lab and manufacturing applications.

While Math Equation Entry enables the operator to produce nearly any desired waveform, several other methods of definition are provided: computer download; data download from the Model 6500 Waveform Analyzer, standard functions with real-time menu control of amplitude, symmetry, etc.; quantified noise added to a waveform; point and line segment entry; and scope draw for waveform touchups.

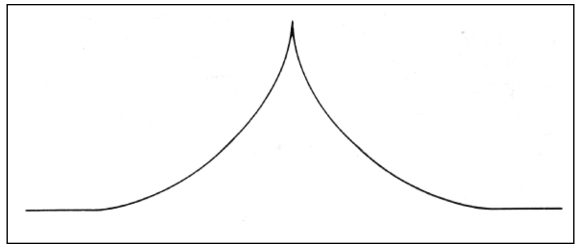


Figure 2. Natural Transient envelope with peak at 1 ms: FOR 1m ARCSIN(a*t) FOR 1m ARCSIN(a*(1m–t)2). Where "m" means millisecond and "a" determines envelope amplitude.

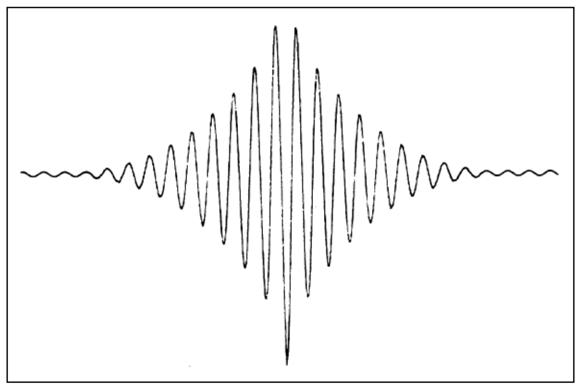


Figure 3. Product of sine wave and envelope of Figures 1 and 2.

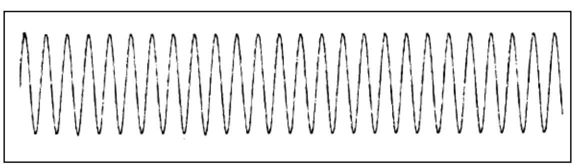


Figure 1. Basic 10 kHz sine wave: F1 = SIN(10K*t)

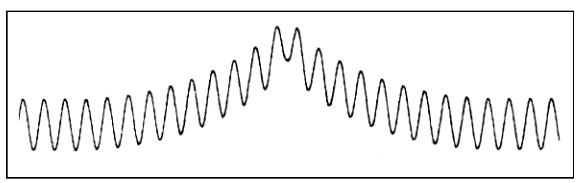


Figure 4. Sum of sine wave and envelope of Figures 1 and 2.

ANALOGIC®
The World Resource
for Precision Signal Technology

Flexibility in Creating Waveforms

While Math Equation Entry enables the operator to easily produce nearly any desired waveform, the following methods of definition are provided to suit particular user needs and preferences.

Computer Download

Previously calculated and uploaded waveforms may be quickly downloaded through the high-speed GPIB interface. Analogic's DPCOM software enables off-line creation and storage of an unlimited number of waveforms that can be downloaded as needed.

Model 6500 Capture

Quite often it is necessary to reproduce a real-world waveform or transient glitch. This is easily accomplished using the Analogic Model 6500 Waveform Analyzer to capture the signal and download it to the synthesizer, after which signal parameters may be varied for marginal testing.

Point and Line Segment Entry

Output waveforms may be constructed point by point or, where linear interpolation is adequate, by the specification of the linear endpoints only.

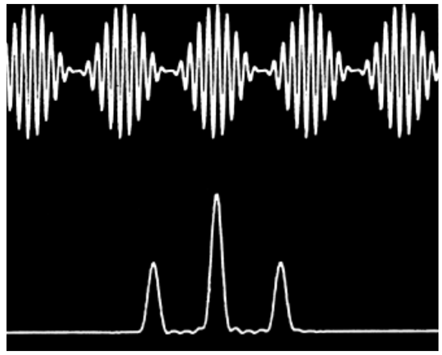
Scope Draw

Any waveform in Output Memory can be displayed on an oscilloscope and edited point by point. It is also useful for adding special glitches or cleaning up a captured waveform.

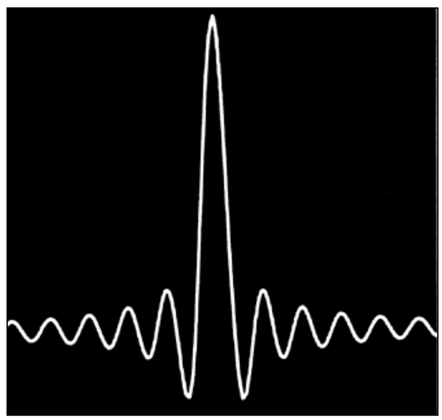
Sophisticated Systems Capabilities

For automation in lab and production test environments, RS-232 and IEEE-488 communications and versatile rear-panel timing capabilities are provided. Units can be synchronized with each other through their external clock and trigger inputs and Sync and programmable Marker outputs. For example, the Model 2020 features phase-locked loop clocking of a master and up to 8 slave units.

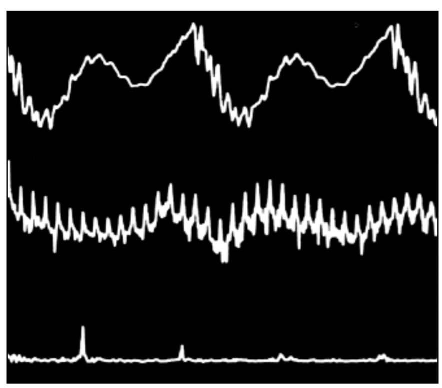
Analogic Polynomial Waveform Synthesizers can reproduce virtually any waveform equation, algorithm, or captured signal required for testing. For additional flexibility, several synthesizers may run in unison, providing multiple signals of a different nature for situations with complex timing diagrams that require high speeds and/or high fidelities. The parameters may be the same or totally different, allowing for independent parameter margining and analysis. Adding the Model 6500 Waveform Analyzer to the test system allows phase synchronous stimulus and capture/analysis using external clocking from a common source.



Amplitude Modulation is Mathematically Precise



SIN(X)/X Function is Useful for Signals as well as Envelopes



Spoken Vowel "e" was Downloaded from the Model 6100 Analyzer; also Log Spectrum and Linear Cepstrum

SPECIFICATIONS

	Models 2020 & 2000	**Model 2045**	**Model 2040**
Analog Output Configuration	High level output with attenuator, offset, and noise source	• Low level output • High level output with attenuator and offset	• True low level output • Inverted low level output
Data Point Update Rate Internal Clock	100 MHz on Version 100 25 MHz on Version 25 0.0015 Hz min. (687s) Accuracy: 50 ppm Frequency resolution: ≤ 0.05%	800 MHz down to 50 Hz (1.25 ns to 20 ms/point) Accuracy: ± 0.005% @ ≤ 100 MHz, ±0.025% @ > 100 MHz Jitter: < 15 ps RMS @ > 3 MHz, <75 ps RMS @ < 3 MHz Optional 1000 MS/s using External Clock	
External Clock	DC to 100 MHz on Version 100 DC to 25 MHz on Version 25	50 to 250 MHz with EXT CLK 50 to 800 MHz with ECL CLK	
ANALOG OUTPUTS	**Models 2020 & 2000**	**High Level Output (Model 2045 only)**	**Low Level Output(s) (2045 & 2040)**
Analog Resolution	12 bits	8 bits	8 bits with output 0.5 to 1V p-p
Maximum Amplitude	10V p-p into 50Ω, 20V p-p open circuit	5V p-p into 50Ω, 10V p-p open circuit	1V p-p into 50Ω, 2V p-p open circuit
Amplitude Range	10V to 5 mV p-p in 0.024% steps, with waveform resolution preserved	5V to 3 mV p-p in 0.024% steps with waveform resolution preserved	1V to 0.5V p-p in <0.3 mV steps with waveform resol. preserved
Amplitude Accuracy	± 1%	± 3% (attenuator accuracy: ± 1%)	± 2% at 0.8V p-p output, ± 3% at 1V, Model 2040 (±4%, Model 2045)
Non-Linearity	± 0.025% integral	< 0.22% differential < 1% integral	< 0.22% differential < 0.44% integral
DC Drift	± (0.06% of p-p signal + 0.2 mV)/°C	± 2.0 mV/°C	± 0.4 mV/°C
DC Offset Control (user selected or internally compared)	0 to ± 5V in 1.25 mV steps Accuracy: ± 2% ± 10 mV	0 to ± 3.5V in 2 mV steps Accuracy: ± 2% ± 10 mV ±(0.8% x waveform peak-peak)	0 to ± 0.5V; Accuracy: ± 2% at 1V p-p output, Model 2040 (± 4%, 2045) ± 3 mV
Output Compliance	—	—	-1.4 to 1.1V with ext. applied offset
FS Step Response **Rise and Fall Time (10-90%)**	< 10 ns	< 2.2 ns, DC offset = 0 ±2V < 3.3 ns, DC offset = 0 ±3.5V	< 500 ps
Overshoot	< 1%	< 3%	< 7%
Settling Time	< 60 ns to within 1% of final value	< 50 ns to within 2% of final value	< 7 ns to within 1% of final value
Amplitude Flatness	± 0.1 dB from DC to 500 kHz ± 1.5 dB to 25 MHz –3 dB to 35 MHz	± 0.24 dB from DC to 1 MHz ± 0.5 dB, 1–10 MHz ± 1.0 dB, 10–30 MHz ± 2.5 dB, 30–100 MHz	± 0.2 dB from DC to 10 MHz ± 1.0 dB, 10–100 MHz ± 2.0 dB, 100–200 MHz
Output Bandwidth	> 35 MHz	> 160 MHz, 200 MHz typical	> 700 MHz, 1000 MHz typical
Output Low-Pass Filters	20 kHz to 20 MHz selectable	2 or 20 MHz selectable	—
Sinewave Purity (harmonic amplitude and spurious signals)	< –60 dBc below 100 kHz < –50 dBc below 1 MHz < –40 dBc below 3.125 MHz, Version 25 < –35 dBc below 6.25 MHz, Version 100	< –40 dBc, DC to 10 MHz < –30 dBc, 10–30 MHz < –20 dBc, 30–100 MHz (DC offset = 0 ± 2V; for offset > 2V add 10 dBc)	< –46 dBc, DC to 10 MHz < –25 dBc, 10–30 MHz < –15 dBc, 30–100 MHz (at higher frequencies aliased spectra are dominant)
Residual Noise	< 0.5 mV RMS, < 4 mV pk at max. signal output	< (0.1% Vo p-p + 0.6 mV) RMS < (0.2% Vo p-p + 4 mV) p-p	< 1.5 mV RMS < 6 mV p-p
DAC Glitch Energy	< 500 mV-ns for clock ≥ 40 ns < 750 mV-ns for clock < 40 ns at max. signal output level 5 to 10 ns effective width	< 125 pV-s at max. signal output level 2.5 ns effective width, typ.	< 25 pV-s 0.5 ns effective width, typ.
Output Impedance	50Ω ± 2%, active; >10 MΩ, inactive	50Ω ± 10%	50Ω ± 10%
Output Protection	No damage from a short circuit or connection of 125 VAC at 50/60 Hz	Indefinite short circuit to ground	Up to ± 100 mA externally applied (clamping diodes at ± 2V)

	Models 2020 and 2000	**Models 2040 and 2045**
MEMORY & PROCESSING		
Waveform Output Memory (RAM)	Up to 512K 16-bit data points, segmentable to hold multiple downloaded waveforms	512K data points (2048K, B version), segmentable to hold multiple downloaded waveforms

Maximum Waveform Length	Dynamic (Repeat) Looping, up to 32,767 times, and DC data compression for waveforms exceeding output memory length	512k data points (2048k, B version)
Minimum Waveform Length	8 Data points on Version 25 16 Data points on Version 100	64 Data points
Waveform Equation Memory (Stores waveform descriptions by filename)	30 kbytes non-volatile, expandable to 78k 1280 characters maximum file length	78 kbytes non-volatile 1280 characters maximum file length
Waveform Equation Memory Retention	Memory Retention: >2 years with supplied lithium batteries and a 50% power-on duty cycle (provision is made for field replacement with more conventional Alkaline batteries)	

AUXILIARY INPUTS/OUTPUTS (Menu driven setup)

External Clock Input	DC to max. update rate of version	DC to 800 MHz update rate
External Trigger Input	Trigger Modes: Free Run, Manual, Triggered Start, Triggered Stop, Gated by Trigger, and Triggered Start/Stop Delay: < 100 ns +1 clock period Jitter: < 10 ns	Trigger Modes: Free Run, Manual, Triggered Start, Triggered Stop, Gated by Trigger, and Triggered Start/Stop; Delay: < (40 ns + 2 clock periods); Jitter: < (100 ps + 1 clock period).
Trigger and External Clock Input Parameters	Threshold: 0V or 1V; Slope: plus or minus; Impedance: 1 MΩ || 25 pF; Sensitivity: ± 500 mV about selected threshold; Maximum input: ± 30V;	Threshold: 0V or 1.5V; Slope: plus or minus; Impedance: 10 kΩ || 50 pF; Sensitivity: ± 500 mV about selected threshold; Maximum input: ± 30V;
Marker Output	Negative transition at waveform start, positive transition at Mark Time or Mark Count (TTL, 10 unit loads)	Positive pulse at user selected Mark Time or Mark Count from start of waveform; Pulse duration: 32 data point clocks (TTL, drives a grounded 50Ω load)
Sync Output	Positive pulse at waveform start (TTL, 10 unit loads)	Positive pulse at waveform start; Pulse duration: 32 data point clocksTTL, drives a grounded 50Ω load)
Multi-Unit Synchronization	Via phase locked internal clocks and ganged trigger functions in a Master/Slave configuration, up to 8 units, with rear panel adjustments for cable delays	Via auxiliary inputs and outputs
Digital Waveform Output	16 bits plus clock, simultaneous with Analog Output; TTL on Version 25; ECL (diff.) on Version 100 (opt.)	—

REMOTE INSTRUMENT CONTROL

Interface	Optional IEEE-488 and/or RS-232	Standard IEEE-488 and RS-232
Transfer Data Rates	IEEE-488: 2 kbytes/s standard 300 kbytes/s with High Speed DMA opt. RS-232: up to 9600 baud	IEEE-488: 300 kbytes/s using High Speed DMA RS-232: up to 9600 baud

WAVEFORM GENERATION MODES

Mathematical (Polynomial) Notation	By Front Panel entry or by remote communications	
Standard Functions	By Front Panel entry or by remote communications: Standard Functions include sine wave, square wave, pulse, triangle, sawtooth, and random noise	
Internal Noise Source	Pseudo-random white noise with a normal amplitude distribution; Cycle time: 168 seconds Bandwidth: 0.006 Hz to selectable 20 kHz, 200 kHz, or 2 MHz; Maximum Amplitude (RMS): 2.7V for 2 MHz BW, 0.95V for 200 kHz BW, 0.31V for 20 kHz BW Amplitude range: 60 dB in 1 dB steps	Random noise with approx. normal amplitude distribution can be added to waveforms in memory, with selectable noise amplitude, bandwidth, seed (starting point), and signal+noise amplitude. Signal may be repeated in memory so different noise values occur over each signal cycle.
Direct Waveform Data Download	Via IEEE-488 or RS-232	
Captured Data Reproduction	With Analogic Model 6100 or 6500 Waveform Analyzer (except Model 2000)	
Scope Draw with Cursor Control	For point by point waveform editing	

GENERAL

Specification Conditions	0 to 40°C operating temperature; 50Ω resistive termination on both analog outputs, unless specified otherwise; Open circuit output will double (± 5%) in amplitude, but with some degradation in high frequency/speed performance	
Power Requirements	90-130 VAC or 180-260 VAC at 48-62 Hz; 100W max	90-130 VAC or 180-260 VAC at 48-62 Hz; 200W max
Dimensions	5.5"H x 16.5"W x 17"D (13.97 x 41.91 x 43.18 cm)	5.5"H x 16.5"W x 17"D (13.97 x 41.91 x 43.18 cm)
Weight	25 lb (11.3 kg)	25 lb (11.3 kg)