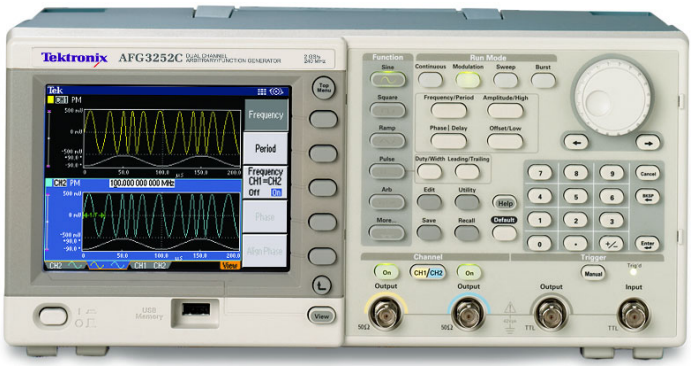
Arbitrary Function Generators

AFG3000C Series Datasheet



Features & Benefits

- 10 MHz, 25 MHz, 50 MHz, 100 MHz, or 240 MHz Sine Waveforms
- 14 bits, 250 MS/s, 1 GS/s, or 2 GS/s Arbitrary Waveforms
- Amplitude up to 20 V_{p-p} into 50 Ω Loads
- 5.6 in. Color TFT LCD Display for Full Confidence in Settings and Waveform Shape
- Multilanguage and Intuitive Operation Saves Setup Time
- Pulse Waveform with Variable Edge Times
- AM, FM, PM, FSK, PWM
- Sweep and Burst
- Dual-channel Models Save Cost and Bench Space
- USB Connector on Front Panel for Waveform Storage on Memory Device
- USB, GPIB, and LAN
- LabVIEW and LabWindows/IVI-C Drivers

Applications

- Electronic Test and Design
- Sensor Simulation
- Functional Test
- Education and Training

Product Description

Unmatched performance, versatility, intuitive operation, and affordability make the AFG3000C Series of Function, Arbitrary Waveform, and Pulse Generators the most useful instruments in the industry.

Superior Performance and Versatility

Users can choose from 12 different standard waveforms. Arbitrary waveforms can be generated up to 128 K in length at high sampling rates. On pulse waveforms, leading and trailing edge time can be set independently. External signals can be connected and added to the output signal. Dual-channel models can generate two identical or completely different signals. All instruments feature a highly stable time base with only ±1 ppm drift per year.

Intuitive User Interface Shows More Information at a Single Glance

Color TFT LCD screen on all models shows all relevant waveform parameters and graphical wave shape at a single glance. This gives full confidence in the signal settings and lets you focus on the task at hand. Shortcut keys provide direct access to frequently used functions and parameters. Others can be selected conveniently through clearly structured menus. This reduces the time needed for learning and relearning how to use the instrument. Look and feel are identical to the world's most popular TDS3000 Oscilloscopes.

ArbExpress™ Software Included for Creating Waveforms with Ease

With this PC software waveforms can be seamlessly imported from any Tektronix oscilloscope, or defined by standard functions, equation editor, and waveform math.

Tektronix®

Characteristics

AFG3000C Series Characteristics

Characteristic	AFG3011C	AFG3021C AFG3022C	AFG3051C AFG3052C	AFG3101C AFG3102C	AFG3251C AFG3252C
Channels	1	1 / 2	1 / 2	1 / 2	1 / 2
Waveforms	Sine, Square, Pulse, Ramp, Triangle, Sin(x)/x, Exponential Rise and Decay, Gaussian, Lorentz, Haversine, DC, Noise				
Sine Wave	1 µHz to 10 MHz	1 µHz to 25 MHz	1 µHz to 50 MHz	1 µHz to 100 MHz	1 µHz to 240 MHz
Sine wave in Burst Mode	1 µHz to 5 MHz	1 µHz to 12.5 MHz	1 µHz to 25 MHz	1 µHz to 50 MHz	1 µHz to 120 MHz
Effective maximum frequency out	10 MHz	25 MHz	50 MHz	100 MHz	240 MHz
Amplitude Flatness (1 V_{p-p})	<5 MHz: ±0.15 dB ≥5 MHz to 10 MHz: ±0.3 dB	<5 MHz: ±0.15 dB ≥5 MHz to 20 MHz: ±0.3 dB ≥20 MHz to 25 MHz: ±0.5 dB	<5 MHz: ±0.15 dB ≥5 MHz to 45 MHz: ±0.3 dB ≥45 MHz to 50 MHz: ±0.5 dB	<5 MHz: ±0.15 dB ≥5 MHz to 25 MHz: ±0.3 dB ≥25 MHz to 100 MHz: ±0.5 dB	<5 MHz: ±0.15 dB ≥5 MHz to 25 MHz: ±0.3 dB ≥25 MHz to 100 MHz: ±0.5 dB ≥100 MHz to 200 MHz: ±1.0 dB ≥200 MHz to 240 MHz: ±2.0 dB
Harmonic Distortion (1 V_{p-p})	10 Hz to 20 kHz: < -60 dBc ≥20 kHz to 1 MHz: < -55 dBc ≥1 MHz to 5 MHz: < -45 dBc ≥5 MHz to 10 MHz: < -45 dBc	10 Hz to 20 kHz: < -70 dBc ≥20 kHz to 1 MHz: < -60 dBc ≥1 MHz to 10 MHz: < -50 dBc ≥10 MHz to 25 MHz: < -40 dBc	10 Hz to 20 kHz: < -70 dBc ≥20 kHz to 1 MHz: < -60 dBc ≥1 MHz to 5 MHz: < -50 dBc ≥5 MHz to 50 MHz: < -40 dBc	10 Hz to 1 MHz: < -60 dBc ≥1 MHz to 5 MHz: < -50 dBc ≥5 MHz to 100 MHz: < -37 dBc	10 Hz to 1 MHz: < -60 dBc ≥1 MHz to 5 MHz: < -50 dBc ≥5 MHz to 25 MHz: < -37 dBc ≥25 MHz to 240 MHz: < -30 dBc
THD	<0.2% (10 Hz – 20 kHz, 1 V_{p-p})				
Spurious (1 V_{p-p})	10 Hz to 1 MHz: < -60 dBc ≥1 MHz to 10 MHz: < -50 dBc	10 Hz to 1 MHz: < -60 dBc ≥1 MHz to 25 MHz: < -50 dBc	10 Hz to 1 MHz: < -60 dBc ≥1 MHz to 50 MHz: < -50 dBc	10 Hz to 1 MHz: < -60 dBc ≥1 MHz to 25 MHz: < -50 dBc ≥25 MHz to 100 MHz: < - 50 dBc + 6 dBc/octave	10 Hz to 1 MHz: < -50 dBc ≥1 MHz to 25 MHz: < -47 dBc ≥25 MHz to 240 MHz: < - 47 dBc + 6 dBc/octave
Phase noise, typical	< -110 dBc/Hz at 10 MHz, 10 kHz offset, 1 V_{p-p}	< -110 dBc/Hz at 20 MHz, 10 kHz offset, 1 V_{p-p}			
Residual clock noise	-63 dBm	-63 dBm	-63 dBm	-57 dBm	-57 dBm
Square Wave	1 µHz to 5 MHz	1 µHz to 25 MHz	1 µHz to 40 MHz	1 µHz to 50 MHz	1 µHz to 120 MHz
Rise/Fall time	≤50 ns	≤9 ns	≤7 ns	≤5 ns	≤2.5 ns
Jitter (RMS), typical	500 ps	500 ps	300 ps	200 ps	100 ps
Ramp Wave	1 µHz to 100 kHz	1 µHz to 500 kHz	1 µHz to 800 kHz	1 µHz to 1 MHz	1 µHz to 2.4 MHz
Linearity, typical	≤0.2% of peak output	≤0.1% of peak output	≤ 0.1% of peak output	≤0.15% of peak output	≤0.2% of peak output
Symmetry	0.0% to 100.0%				
Pulse Wave	1 mHz to 5 MHz	1 mHz to 25 MHz	1 mHz to 40 MHz	1 mHz to 50 MHz	1 mHz to 120 MHz
Pulse width	80.00 ns to 999.99 s	16.00 ns to 999.99 s	12 ns to 999.99 s	8.00 ns to 999.99 s	4.00 ns to 999.99 s
Resolution	10 ps or 5 digits				
Pulse duty	0.001% to 99.999% (Limitations of pulse width apply)				
Edge transition time	50 ns to 625 s	9 ns to 625 s	7 ns to 625 s	5 ns to 625 s	2.5 ns to 625 s
Resolution	10 ps or 4 digits				
Lead delay					
Range	(Continuous Mode): 0 ps to Period (Triggered/Gated Burst Mode): 0 ps to Period – [Pulse Width + 0.8 * (Leading Edge Time + Trailing Edge Time)]				
Resolution	10 ps or 8 digits				
Overshoot, typical	<5%				
Jitter (RMS), typical	500 ps	500 ps	300 ps	200 ps	100 ps

Characteristic	AFG3011C	AFG3021C AFG3022C	AFG3051C AFG3052C	AFG3101C AFG3102C	AFG3251C AFG3252C
Other Waveforms	1 µHz to 100 kHz	1 µHz to 500 kHz	1 µHz to 800 kHz	1 µHz to 1 MHz	1 µHz to 2.4 MHz
Noise Bandwidth (-3 dB)	10 MHz	25 MHz	50 MHz	100 MHz	240 MHz
Noise type	White Gaussian				
Internal Noise Add	When activated, output signal amplitude is reduced to 50%				
Level	0.0% to 50% of amplitude (V_{p-p}) setting				
Resolution	1%				
DC (into 50 Ω)	-10 V to +10 V	-5 V to +5 V	–5 V to +5 V	-5 V to +5 V	-2.5 V to +2.5 V
Arbitrary Waveforms	1 mHz to 5 MHz	1 mHz to 12.5 MHz	1 mHz to 25 MHz	1 mHz to 50 MHz	1 mHz to 120 MHz
Arbitrary waveforms in Burst Mode	1 mHz to 2.5 MHz	1 mHz to 6.25 MHz	1 mHz to 12.5 MHz	1 mHz to 25 MHz	1 mHz to 60 MHz
Effective analog bandwidth (-3 dB)	8 MHz	70 MHz		100 MHz	225 MHz
Nonvolatile memory	4 waveforms				
Memory: Sample rate (1K=1024 points)	2 to 128 K: 250 MS/s	2 to 128 K: 250 MS/s	2 to 16 K: 1 GS/s >16 K to 128 K: 250 MS/s	2 to 16 K: 1 GS/s >16 K to 128 K: 250 MS/s	2 to 16 K: 2 GS/s >16 K to 128 K: 250 MS/s
Vertical resolution	14 bits				
Rise/Fall time	≤80 ns	≤14 ns	≤10 ns	≤8 ns	≤3 ns
Jitter (RMS), typical	4 ns	4 ns	1 ns at 1 GS/s 4 ns at 250 MS/s	1 ns at 1 GS/s 4 ns at 250 MS/s	500 ps at 2 GS/s 4 ns at 250 MS/s
Amplitude					
Range (50 Ω load)	20 mV_{p-p} to 20 V_{p-p}	10 mV_{p-p} to 10 V_{p-p}	10 mV_{p-p} to 10 V_{p-p}	20 mV_{p-p} to 10 V_{p-p}	≤200 MHz: 50 mV_{p-p} to 5 V_{p-p} >200 MHz: 50 mV_{p-p} to 4 V_{p-p}
Range (open circuit or High Z)	40 mV_{p-p} to 40 V_{p-p}	20 mV_{p-p} to 20 V_{p-p}	20 mV_{p-p} to 20 V_{p-p}	40 mV_{p-p} to 20 V_{p-p}	≤200 MHz: 100 mV_{p-p} to 10 V_{p-p} >200 MHz: 100 mV_{p-p} to 8 V_{p-p}
Accuracy	±(2% of setting +2 mV) (1 kHz sine wave, 0 V offset, >20 mV_{p-p} amplitude)	±(1% of setting +1 mV) (1 kHz sine wave, 0 V offset, >10 mV_{p-p} amplitude)			
Resolution	0.1 mV_{p-p}, 0.1 mV_{RMS}, 1 mV, 0.1 dBm or 4 digits				
Units	V_{p-p}, V_{RMS}, dBm (sine wave only) and Volt (high/low setting)				
Output impedance	50 Ω				
Load impedance setting	Selectable: 50 Ω, 1Ω to 10.0 kΩ, High Z (Adjusts displayed amplitude according to selected load impedance)				
Isolation	<42 V_{pk} maximum to earth				
Short-circuit protection	Signal outputs are robust against permanent shorts against floating ground				
External voltage protection	To protect signal outputs against external voltages use fuse adapter 013-0345-xx				
DC Offset					
Range (50 Ω load)	±(10 V_{pk} – $Amplitude_{pp}$/2)	±(5 V_{pk} – $Amplitude_{pp}$/2)	±(5 V_{pk} – $Amplitude_{pp}$/2)	±5 V_{pk} DC	±2.5 V_{pk} DC
Range (open circuit or High Z)	±(20 V_{pk} – $Amplitude_{pp}$/2)	±(10 V_{pk} – $Amplitude_{pp}$/2)	±(10 V_{pk} – $Amplitude_{pp}$/2)	±10 V_{pk} DC	±5 V_{pk} DC
Accuracy	±(2% of |setting| + 10 mV + 1% of amplitude (V_{p-p}))	±(1% of |setting| + 5 mV + 0.5% of amplitude (V_{p-p}))			
Resolution	1 mV				

System Characteristics

Characteristic	Description		
Frequency Resolution	1 µHz or 12 digits		
Internal Frequency Reference			
Stability	All except ARB: ±1 ppm, 0 °C to 50 °C ARB: ±1 ppm ± 1 µHz, 0 °C to 50 °C		
Aging	±1 ppm per year		
Phase (except DC, Noise, Pulse)			
Range	-180° to +180°		
Resolution	0.01° (sine), 0.1° (other waveforms)		
	When activated, output signal amplitude is reduced to 50%		
Level	0.0% to 50% of amplitude (V_{p-p}) setting		
Resolution	1%		
Main Output	50 Ω		
Remote Programming	GPIB, LAN 10BASE-T / 100BASE-TX, USB 1.1 Compatible with SCPI-1999.0 and IEEE 488-2 standards		
Configuration times, max typical	**USB**	**LAN**	**GPIB**
Function change	81 ms	81 ms	81 ms
Frequency change (except Pulse)	2.5 ms	6 ms	3.2 ms
Frequency change (Pulse)	40 ms	37 ms	32 ms
Amplitude change	90 ms	97 ms	90 ms
Select user ARB (4k points from USB Memory)	48 ms	50 ms	49 ms
Select user ARB (128k points from USB Memory)	260 ms	266 ms	240 ms
Data download time for 4000 point waveform data, typical	47 ms	78 ms	320 ms
Power Source	100-240 V, 47-63 Hz, or 115 V, 360-440 Hz		
Power Consumption	Less than 120 W		
Warm-up Time, typical	20 minutes		
Power-on Self Diagnostics, typical	<10 s		
Acoustic Noise, typical	<50 dBA		
Display	5.6 in. Color TFT LCD		
User Interface and Help Languages	English, French, German, Japanese, Korean, Portuguese, Simplified and Traditional Chinese, Russian (user selectable)		

Modulation

AM, FM, PM

Characteristic	Description
Carrier Waveforms	All, except Pulse, Noise, and DC
Source	Internal/External
Internal Modulating Waveform	Sine, square, ramp, noise, ARB (AM: maximum waveform length 4,096; FM/PM: maximum waveform length 2,048)
Internal Modulating Frequency	2 mHz to 50.00 kHz
AM Modulation Depth	0.0% to +120.0%
Min FM Peak Deviation	DC
Max FM Peak Deviation	See following table, *Modulation: Max FM Peak Deviation*
PM Phase Deviation	-360.0° to +360.0°

Pulse Width Modulation

Characteristic	Description
Carrier Waveform	Pulse
Source	Internal/External
Internal Modulating Waveform	Sine, square, ramp, noise, ARB (maximum waveform length 2,048)
Internal Modulating Frequency	2 mHz to 50.00 kHz
Deviation	0% to 50.0% of pulse period

Modulation: Max FM Peak Deviation

Characteristic	AFG3011C	AFG3021C AFG3022C	AFG3051C AFG3052C	AFG3101C AFG3102C	AFG3251C AFG3252C
Sine	5 MHz	12.5 MHz	25 MHz	50 MHz	120 MHz
Square	2.5 MHz	12.5 MHz	20 MHz	25 MHz	60 MHz
ARB	2.5 MHz	6.25 MHz	12.5 MHz	25 MHz	60 MHz
Others	50 kHz	250 kHz	400 kHz	500 kHz	1.2 MHz

Sweep: Max Start/Stop Frequency

Characteristic	AFG3011C	AFG3021C AFG3022C	AFG3051C AFG3052C	AFG3101C AFG3102C	AFG3251C AFG3252C
Sine	10 MHz	25 MHz	50 MHz	100 MHz	240 MHz
Square	5 MHz	25 MHz	40 MHz	50 MHz	120 MHz
ARB	5 MHz	12.5 MHz	25 MHz	50 MHz	120 MHz
Others	100 kHz	500 kHz	800 kHz	1 MHz	2.4 MHz

Frequency Shift Keying

Characteristic	Description
Carrier Waveforms	All, except Pulse, Noise, and DC
Source	Internal/External
Internal Modulating Frequency	2 mHz to 1.000 MHz
Number of Keys	2

Sweep

Characteristic	Description
Waveforms	All, except Pulse, Noise, and DC
Type	Linear, logarithmic
Sweep Time	1 ms to 300 s
Hold/Return Time	0 ms to 300 s
Max Total Sweep Time	300 s
Resolution	1 ms or 4 digits
Total Sweep Time Accuracy, typical	≤0.4%
Min Start/Stop Frequency	All except ARB: 1 µHz ARB: 1 mHz
Max Start/Stop Frequency	See chart, below

Burst

Characteristic	Description
Waveforms	All, except Noise and DC
Type	Triggered, gated (1 to 1,000,000 cycles or Infinite)
Internal Trigger Rate	1 µs to 500.0 s
Gate and Trigger Sources	Internal, external, remote interface

Auxiliary Inputs

Characteristic	Description
Modulation Inputs Channel 1, Channel 2	
Input range	All except FSK: ±1 V FSK: 3.3 V logic level
Impedance	10 kΩ
Frequency range	DC to 25 kHz (122 kS/s)
External Triggered/Gated Burst Input	
Level	TTL compatible
Impedance	10 kΩ
Pulse width	100 ns minimum
Slope	Positive/Negative, selectable
Trigger delay	0.0 ns to 85.000 s
Resolution	100 ps or 5 digits
Jitter (RMS), typical	Burst: <500 ps (Trigger input to signal output)
10 MHz Reference Input	
Impedance	1 kΩ, AC coupled
Required Input Voltage Swing	100 mV_{p-p} to 5 V_{p-p}
Lock Range	10 MHz ±35 kHz
External Add Input (CH1)	AFG3101C, AFG3102C, AFG3251C, AFG3252C only
Impedance	50 Ω
Input range	-1 V to +1 V (DC + peak AC)
Bandwidth	DC to 10 MHz (-3 dB) at 1 V_{p-p}

Auxiliary Outputs

Characteristic	Description
Trigger Output (Channel 1)	
Level	Positive TTL level pulse into 1 kΩ
Impedance	50 Ω
Jitter (RMS), typical	AFG3011C/21C/22C: 500 ps AFG3051C/52C: 300ps AFG3101C/02C: 200 ps AFG3251C/52C: 100 ps
Max Frequency	4.9 MHz (4.9 MHz to 50 MHz: A fraction of the frequency is output; >50 MHz: no signal is output)
Clock Reference Out (10 MHz)	AFG3101C, AFG3102C, AFG3251C, AFG3252C only
Impedance	50 Ω, AC coupled
Amplitude	1.2 V_{p-p} into 50 Ω load

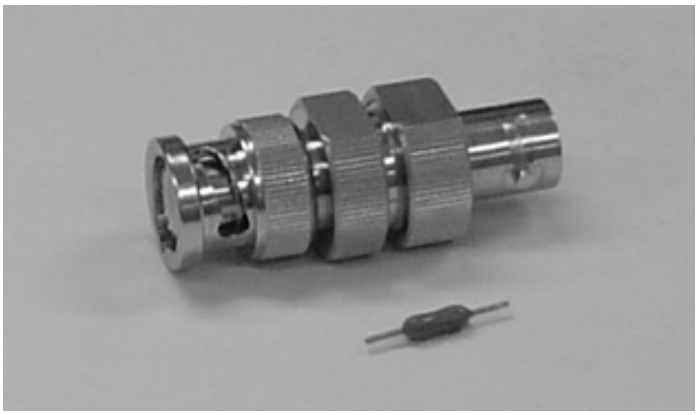
Physical Characteristics

Benchtop Configuration

Dimensions	mm	in.
Height	156.3	6.2
Width	329.6	13.0
Depth	168.0	6.6
Weight	**kg**	**lb.**
Net	4.5	9.9
Shipping	5.9	12.9

Environmental and Safety Characteristics

Characteristic	Description
Temperature	
Operating	0 °C to +50 °C
Nonoperating	-30 °C to +70 °C
Humidity	
Operating	≤ +40 °C: ≤80% > +40 °C to 50 °C: ≤60%
Altitude	Up to 10,000 ft./3,000 m
EMC Compliance	
European Union	EU Council Directive 2004/108/EC
Safety	UL 61010-1:2004 CAN/CSA C22.2 No. 61010-1:2004 IEC 61010-1:2001



BNC Fuse Adapter and 0.125 A Fuse

Ordering Information

AFG3011C, AFG3021C, AFG3022C, AFG3051C, AFG3052C, AFG3101C, AFG3102C, AFG3251C, AFG3252C

Arbitrary Function Generator

Includes: Quick-start user manual, power cord, USB cable, CD-ROM with specifications and performance verification manual, programmer manual, service manual, LabView and IVI drivers, CD-ROM with ArbExpress™ software, and NIST-traceable calibration certificate. Please specify power plug when ordering.

International Power Plugs

Option	Description
Opt. A0	North America power
Opt. A1	Universal EURO power
Opt. A2	United Kingdom power
Opt. A3	Australia power
Opt. A5	Switzerland power
Opt. A6	Japan power
Opt. A10	China power
Opt. A11	India power
Opt. A12	Brazil power
Opt. A99	No power cord or AC adapter

Note: Includes front-panel overlay.

Manual Options

Option	Description
Opt. L0	English (071-1631-xx)
Opt. L1	French (071-1632-xx)
Opt. L2	Italian (071-1669-xx)
Opt. L3	German (071-1633-xx)
Opt. L4	Spanish (071-1670-xx)
Opt. L5	Japanese (071-1634-xx)
Opt. L6	Portuguese (071-3042-xx)
Opt. L7	Simple Chinese (071-1635-xx)
Opt. L8	Traditional Chinese (071-1636-xx)
Opt. L9	Korean (071-1637-xx)
Opt. L10	Russian (071-1638-xx)
Opt. L99	No manual

Service

Option	Description
Opt. C3	Calibration Service 3 Years
Opt. C5	Calibration Service 5 Years
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 Years (with Opt. C3)
Opt. D5	Calibration Data Report 5 Years (with Opt. C5)
Opt. R5	Standard Warranty Extended to 5 Years
Opt. R5DW	Repair Service Coverage 5 Years
Opt. SILV200	Standard Warranty Extended to 5 Years (AFG3011C, AFG3021C, AFG3022C, AFG3101C, and AFG3102C)
Opt. SILV400	Standard Warranty Extended to 5 Years (AFG3251C and AFG3252C)

Warranty

Three-year warranty on parts and labor.

Recommended Accessories

Accessory	Description
Rackmount Kit	RM3100
Fuse adapter, BNC-P to BNC-R	013-0345-xx
Fuse set, 3 pcs, 0.125 A.	159-0454-xx
BNC cable shielded, 3 ft.	012-0482-xx
BNC cable shielded, 9 ft.	012-1256-xx
GPIB cable, double shielded	012-0991-xx
50 Ω BNC terminator	011-0049-02

CE

Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

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