Arbitrary/Function Generators

AFG 3011 / 3021B / 3022B / 3101 / 3102 / 3251 / 3252 Datasheet

Features & Benefits

- 10 MHz, 25 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. 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 AFG3000 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

A large screen 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

AFG3000 Series Characteristics

Characteristic	AFG3011	AFG3021B AFG3022B	AFG3101 AFG3102	AFG3251 AFG3252
Channels	1	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 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 50 MHz	1 µHz to 120 MHz
Effective maximum frequency out	10 MHz	25 MHz	100 MHz	240 MHz
Amplitude Flatness (1 V_{p-p})				
<5 MHz	±0.15 dB	±0.15 dB	±0.15 dB	±0.15 dB
5 MHz to 10 MHz	±0.3 dB	—	—	—
5 MHz to 20 MHz	—	±0.3 dB	±0.3 dB	±0.3 dB
20 MHz to 25 MHz	—	±0.5 dB	±0.3 dB	±0.3 dB
25 MHz to 100 MHz	—	—	±0.5 dB	±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	< -70 dBc	< -60 dBc	< -60 dBc
20 kHz to 1 MHz	< -55 dBc	< -60 dBc	< -60 dBc	< -60 dBc
1 MHz to 5 MHz	< -45 dBc	< -50 dBc	< -50 dBc	< -50 dBc
5 MHz to 10 MHz	< -45 dBc	< -50 dBc	< -37 dBc	< -37 dBc
10 MHz to 25 MHz	—	< -40 dBc	< -37 dBc	< -37 dBc
>25 MHz	—	—	< -37 dBc	< -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	< -60 dBc	< -60 dBc	< -50 dBc
1 MHz to 10 MHz	< -50 dBc	—	—	—
1 MHz to 25 MHz	—	< -50 dBc	< -50 dBc	< -47 dBc
>25 MHz	—	—	< -50 dBc + 6 dBc/octave	< -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	-57 dBm	-57 dBm
Square Wave	1 µHz to 5 MHz	1 µHz to 12.5 MHz	1 µHz to 50 MHz	1 µHz to 120 MHz
Rise/Fall time	≤50 ns	≤18 ns	≤5 ns	≤2.5 ns
Jitter (RMS), typical	500 ps	500 ps	200 ps	100 ps
Ramp Wave	1 µHz to 100 kHz	1 µHz to 250 kHz	1 µHz to 1 MHz	1 µHz to 2.4 MHz
Linearity, typical	≤0.2% of peak output	≤0.1% of peak output	≤0.15% of peak output	≤0.2% of peak output
Symmetry	0.0% to 100.0%		0.0% to 100.0%	
Pulse Wave	1 mHz to 5 MHz	1 mHz to 12.5 MHz	1 mHz to 50 MHz	1 mHz to 120 MHz
Pulse width	80.00 ns to 999.99 s	30.00 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	18 ns to 625 s	5 ns to 625 s	2.5 ns to 625 s
Resolution	10 ps or 4 digits		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	200 ps	100 ps

Characteristic	AFG3011	AFG3021B AFG3022B	AFG3101 AFG3102	AFG3251 AFG3252
Other Waveforms	1 µHz to 100 kHz	1 µHz to 250 kHz	1 µHz to 1 MHz	1 µHz to 2.4 MHz
Noise Bandwidth (-3 dB)	10 MHz	25 MHz	100 MHz	240 MHz
Noise type	White Gaussian			
DC (into 50 Ω)	-10 V to +10 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 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 25 MHz	1 mHz to 60 MHz
Effective analog bandwidth (-3 dB)	8 MHz	34 MHz	100 MHz	225 MHz
Nonvolatile memory	4 waveforms	4 waveforms	4 waveforms	4 waveforms
Memory: Sample rate	2 to 128 K: 250 MS/s	2 to 128 K: 250 MS/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
Vertical resolution	14 bits	14 bits	14 bits	14 bits
Rise/Fall time	≤80 ns	≤20 ns	≤8 ns	≤3 ns
Jitter (RMS)	4 ns	4 ns	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, 50 Ω Load	20 mV_{p-p} to 20 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}
Amplitude, Open Circuit	40 mV_{p-p} to 40 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)			
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} DC	±2.5 V_{pk} DC
DC offset range, open circuit	±(20 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			

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 chart, below

Modulation: Max FM Peak Deviation

Characteristic	AFG3011	AFG3021B AFG3022B	AFG3101 AFG3102	AFG3251 AFG3252
Sine	5 MHz	12.5 MHz	50 MHz	120 MHz
Square	2.5 MHz	6.25 MHz	25 MHz	60 MHz
ARB	2.5 MHz	6.25 MHz	25 MHz	60 MHz
Others	50 kHz	125 kHz	500 kHz	1.2 MHz

PM Phase Deviation – 0.0° to +180.0°

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

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

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

Sweep: Max Start/Stop Frequency

Characteristic	AFG3011	AFG3021B AFG3022B	AFG3101 AFG3102	AFG3251 AFG3252
Sine	10 MHz	25 MHz	100 MHz	240 MHz
Square	5 MHz	12.5 MHz	50 MHz	120 MHz
ARB	5 MHz	12.5 MHz	50 MHz	120 MHz
Others	100 kHz	250 kHz	1 MHz	2.4 MHz

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 Channel 1 Add Input	AFG3101, AFG3102, AFG3251, AFG3252 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
Channel 1 Trigger Output	
Level	Positive TTL level pulse into 1 kΩ
Impedance	50 Ω
Jitter (RMS), typical	AFG3011/21B/22B: 500 ps AFG3101/02: 200 ps AFG3251/52: 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)
10 MHz Reference Out	AFG3101, AFG3102, AFG3251, AFG3252 only
Impedance	50 Ω, AC coupled
Amplitude	1.2 V_{p-p} into 50 Ω load

Common Characteristics

Characteristic	Description		
Frequency Setting Resolution	1 µHz or 12 digits		
Phase (except DC, Noise, Pulse)			
Range	-180° to +180°		
Resolution	0.01° (sine), 0.1° (other waveforms)		
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%		
Main Output	50 Ω		
Effective Frequency Switching Speed	2 ms using remote control (sequencing not available)		
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		
Remote Programming	GPIB, LAN 10BASE-T / 100BASE-TX, USB 1.1 Compatible with SCPI-1999.0 and IEEE 488-2 standards		
Configuration times, typical	**USB**	**LAN**	**GPIB**
Function change	95 ms	103 ms	84 ms
Frequency change	2 ms	19 ms	2 ms
Amplitude change	60 ms	67 ms	52 ms
Select user ARB	88 ms	120 ms	100 ms
Data download time for 4000 point waveform data, typical	20 ms	84 ms	42 ms
Power Source	100 to 240 V, 47 to 63 Hz, or 115 V, 360 to 440 Hz		
Power Consumption	Less than 120 W		
Warm-up Time, typical	20 minutes		
Power-on Self Calibration, typical	<16 s		
Acoustic Noise, typical	<50 dBA		
Display	AFG3021B: 5.6 in. Monochrome LCD All others: 5.6 in. Color LCD		
User Interface and Help Language	English, French, German, Japanese, Korean, Simplified and Traditional Chinese, Russian (user selectable)		

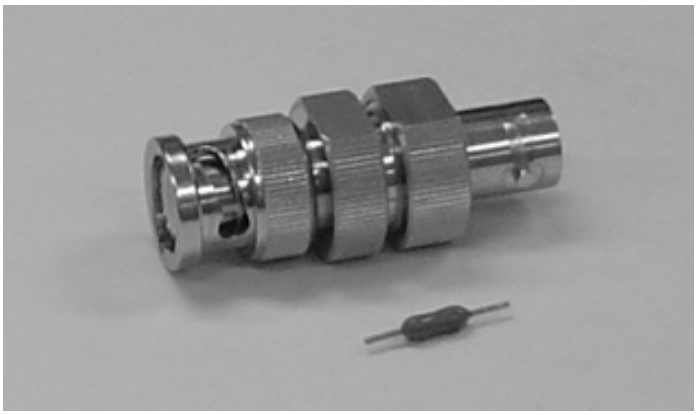
Physical Characteristics

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	EN 61326:1997 Class A EN 61000-3-2:2000, and EN 61000-3-3:1995 IEC 61000-4-2:1999, -4-3:2002, -4-4:2004, -4-5:2005, -4-6:2003, -4-11:2004
Australia	EN 61326:1997
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

AFG3011, AFG3021B, AFG3022B, AFG3101, AFG3102, AFG3251, AFG3252

Arbitrary/Function Generator

Includes: Quick-start user manual, power cord, USB cable, CD-ROM with 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. 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. 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. CA1	Single calibration event or coverage for the designated calibration interval, whichever comes first
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	Repair Service 5 Years
Opt. SILV200	Standard Warranty Extended to 5 Years (AFG3011, AFG3021B, AFG3022B, AFG3101, and AFG3102)
Opt. SILV400	Standard Warranty Extended to 5 Years (AFG3251 and AFG3252)

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

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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For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit **www.tektronix.com**

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