

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 μ Hz to 10 MHz	1 μ Hz to 25 MHz	1 μ Hz to 100 MHz	1 μ Hz to 240 MHz
Sine wave in Burst Mode	1 μ Hz to 5 MHz	1 μ Hz to 12.5 MHz	1 μ Hz to 50 MHz	1 μ Hz 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 μ Hz to 5 MHz	1 μ Hz to 12.5 MHz	1 μ Hz to 50 MHz	1 μ Hz 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 μ Hz to 100 kHz	1 μ Hz to 250 kHz	1 μ Hz to 1 MHz	1 μ Hz to 2.4 MHz
Linearity, typical	$\leq 0.2\%$ of peak output	$\leq 0.1\%$ of peak output	$\leq 0.15\%$ of peak output	$\leq 0.2\%$ 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

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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	
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	
Impedance	50 Ω, AC coupled
Amplitude	1.2 V _{p-p} into 50 Ω load

Common Characteristics

Characteristic	Description
Frequency Setting Resolution	1 μ Hz 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_{pp}) 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 μ Hz, 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	$\leq +40$ °C: $\leq 80\%$ $> +40$ °C to 50 °C: $\leq 60\%$
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