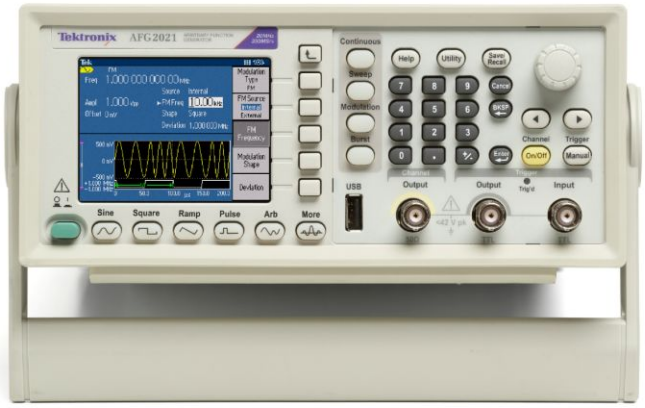
Tektronix®

Arbitrary/Function Generator

AFG2021 Datasheet



The AFG2021 Arbitrary Function Generator gives you the power to create the signals you need at an entry-level price. With 20 MHz bandwidth, 14-bit resolution, and 250 MS/s sample rate, you can generate all manner of signals -- from complex serial data streams to simple audio frequencies or clock signals to the output of an airbag sensor during a crash. With 12 standard waveforms, modulation capability, and a built-in noise generator, you can quickly create the signal you need to thoroughly exercise your designs.

Key performance specifications

- 20 MHz sine, 10 MHz pulse waveforms provide coverage for your most common applications
- 250 MS/s sampling rate and 14-bit vertical resolution enable the creation of high-fidelity signals

Key features

- The innovative UI reduces setup and evaluation time with direct access to frequently used functions and parameters
- The internal 4 × 128 kS memory and the USB memory expansion capability provide substantial capacity for defining complex waveforms
- USB remote control port and USB flash drive port are included. GPIB and LAN interfaces are available as an option
- Built-in Modulation, Noise Generator, Burst, and Sweep modes for greater versatility
- Built-in waveforms provide quick access to commonly used signals
- Large 3.5 inch color screen displays both graphical and numeric waveform information simultaneously
- Menu and online help in 8 languages
- 2U height and half-rack width fits both benchtop and rack-mounted applications
- Free ArbExpress software makes waveform editing and downloading extremely easy
- Free SignalExpress software combines Tektronix bench instruments into a low-cost solution for automatic testing

Applications

- Electronic test and design
- Sensor simulation
- Education and training
- Functional test
- System integration

Superior performance at an affordable price

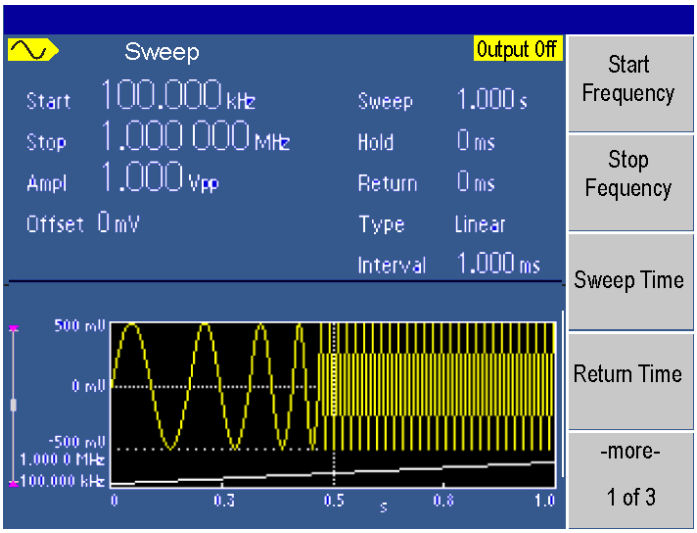
Most electronic devices, circuits, and systems are designed to handle some form of a signal. These signals can be simple like an audio frequency or clock signal or more complex like a serial data stream or the output of an airbag sensor during a crash. With 20 MHz bandwidth, 14-bit resolution, and 250 MS/s sample rate, the AFG2021 Arbitrary Function Generator can create both simple and complex signals at an entry-level price. With 12 standard waveforms, modulation capability, and a built-in noise generator, you can quickly create the signal you need to thoroughly exercise your designs.

Intuitive user interface

The innovative ease-of-use features first seen on the AFG3000 Series arbitrary/function generators are the building blocks for the AFG2021, providing quick access to setup and operational features. Experienced AFG3000 users will find it especially easy to set up the new AFG2021. A 3.5 inch color TFT screen shows relevant parameters in both graphic and text formats, so you can have full confidence in your settings and focus on the task at hand. The front-panel shortcut buttons and rotary knob provide quick access to the most frequently used functions and settings.

Excellent frequency agility

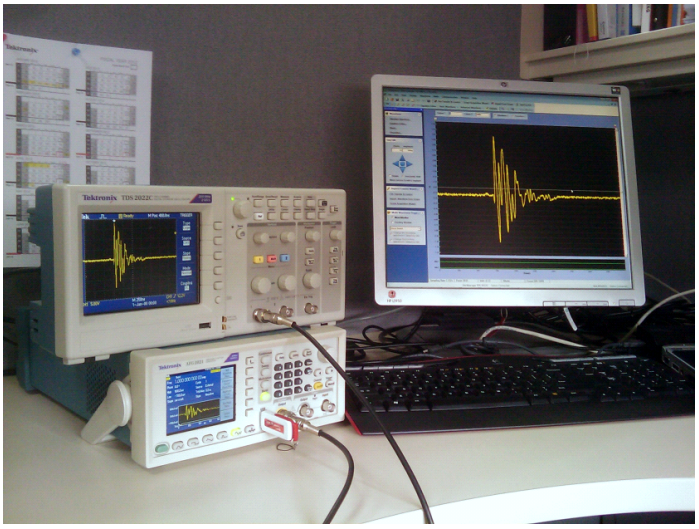
Traditional function generators created their output signals using analog oscillators and signal conditioning. The Tektronix AFG2021 relies on Direct Digital Synthesis (DDS) techniques. DDS technology synthesizes waveforms by using a single clock frequency to generate any frequency within the instrument's range. DDS architecture provides exceptional frequency agility, making it possible to program fast frequency and phase changes, which is useful for testing radio and satellite system components, amplifiers, and filters.



Frequency range from 1 µHz to 20 MHz, supports a wide range of amplifier and filter testing applications.

ArbExpress for real-world waveforms with minimal effort

With ArbExpress software, you can quickly create waveforms that can be copied to the AFG2021 to meet custom stimulus requirements. ArbExpress supports direct connection to Tektronix oscilloscopes and AFGs through USB, GPIB, or LAN. The software allows you to import real-world signals captured with an oscilloscope onto a PC, then edit and download them onto an AFG to duplicate the captured waveform. This is extremely useful for automotive, medical, and industrial applications where recreating sensor output is critical to analyzing the integrity of the design.



ArbExpress software helps you easily duplicate real-world signals.

Insert productivity with SignalExpress

Every AFG2021 ships with a free copy of the Tektronix Edition of National Instrument's LabVIEW SignalExpress software for basic instrument control, data logging, and analysis. SignalExpress supports the range of Tektronix bench instruments enabling you to connect your entire test bench. You can then access each instrument from one intuitive software interface. This allows you to automate complex measurements requiring multiple instruments, log data for an extended period of time, time-correlate data from multiple instruments, and easily capture and analyze your results, all from your PC. Only Tektronix offers a connected test bench of intelligent instruments to simplify and speed debug of your complex design.

Connectivity

Using the front-panel USB host port, you can save your customized waveforms or instrument settings onto a USB memory stick. Reloading the data is easily done by plugging the device back into the USB host port. The USB device port and optional GPIB/LAN ports provide multiple alternatives for connecting the AFG2021 to your PC for waveform download and remote control.

Compact form factor

The 2U height and half-rack width form factor allow the AFG2021 to be stacked on other bench instruments, such as digital multimeters, power supplies, and frequency counters, saving valuable bench space. With the optional RMU2U rackmount kit, GPIB interface, and full SCPI support, the AFG2021 is a perfect solution for automated test systems.

Specifications [1]

All specifications are guaranteed unless noted otherwise. All specifications apply to all models unless noted otherwise.

Model overview

	AFG2021
Channels	1
Waveforms	Sine, Square, Pulse, Ramp, Noise, DC, Sin(x)/x, Gaussian, Lorentz, Exponential Rise, Exponential Decay, and Haversine

General characteristics

Sine wave	1 µHz to 20 MHz
Sine wave in Burst Mode	1 µHz to 10 MHz
Effective maximum frequency out	20 MHz
Amplitude flatness (1 V_{p-p})	
<5 MHz	±0.15 dB (±0.05 dB, typical)
5 MHz to 20 MHz	±0.3 dB(±0.02 dB, typical)
Harmonic distortion (1 V_{p-p})	
10 Hz to 20 kHz	<-70 dBc (<-77 dBc, typical)
20 kHz to 1 MHz	<-60 dBc (<-72 dBc, typical)
1 MHz to 10 MHz	<-50 dBc (<-55 dBc, typical)
10 MHz to 20 MHz	<-40 dBc (<-55 dBc, typical)
THD	<0.2% (<0.15%, typical) 10 Hz to 20 kHz, 1 V_{p-p}
Spurious (1 V_{p-p})	
10 Hz to 1 MHz	<–60 dBc (<–71 dBc, typical)
1 MHz to 20 MHz	<–50 dBc (<–68 dBc, typical)
Phase noise, typical	20 MHz: <–110 dBc/Hz at 10 kHz offset, 1 V_{p-p}
Residual clock noise	–63 dBm
Square wave	1 µHz to 10 MHz
Rise/fall time	≤18 ns
Jitter (RMS)	<500 ps (<60 ps, typical)
Ramp wave	1 µHz to 200 kHz
Linearity	≤0.1% of peak output at 10% to 90% of amplitude range
Symmetry	0.0% to 100.0%
Pulse wave	1 mHz to 10 MHz
Pulse width	30.00 ns to 999.99 s
-- Resolution	10 ps or 5 digits
Pulse duty	0.001% to 99.999% (Limitations of pulse duty width apply)
Edge transition time	18 ns to 0.625 × Pulse Period

1 The given typical values are not warranted. But 80% or more manufactured units will perform to the level indicated at room temperature (approximately 25 °C).

General characteristics

-- Resolution	10 ps or 4 digits
Lead delay	
-- Range	Continuous Mode: 0 ps to Period Trigger/Gate Burst Mode: 0 ps to Period – [Pulse Width + 0.8 × (Leading Edge Time + Trailing Edge Time)]
-- Resolution	10 ps or 8 digits
Overshoot	<5%, typical
Jitter (RMS)	<500 ps (<90 ps, typical)
Other waveforms	1 µHz to 200 kHz
Noise bandwidth (-3 dB)	20 MHz
Noise type	White Gaussian
DC (into 50 Ω)	–5 V to +5 V
Arbitrary waveforms	1 mHz to 10 MHz
Arbitrary waveforms in Burst Mode	1 mHz to 5 MHz
Effective analog bandwidth	34 MHz
Nonvolatile memory	4 waveforms
Memory: sample rate	2 to 128 k: 250 MS/s
Vertical resolution	14 bits
Rise/fall time	≤20 ns
Jitter (RMS)	4 ns
Amplitude	
Range	50 Ω load: 1 mV_{p-p} to 10 V_{p-p}
	Open circuit: 2 mV_{p-p} to 20 V_{p-p}
Accuracy	±(1% of setting + 1 mV), (1 kHz sine waveform, 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, 1 Ω to 10.0 kΩ, high Z (adjusts displayed amplitude according to selected load impedance)
Isolation	<42 V_{peak} 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 013-0345-00
DC offset	
Range	50 Ω load: ±(5 V_{peak} – amplitude V_{p-p}/2)
	Open circuit: ±(10 V_{peak} – amplitude V_{p-p}/2)
-- Accuracy	±(1% of |setting| + 5 mV + 0.5% of amplitude (V_{p-p}))
-- Resolution	1 mV

Modulation characteristics

AM, FM

Carrier waveforms	All, including ARB, except pulse, noise, and DC
Source	Internal/external
Internal modulating waveform	Sine, square, ramp, noise, ARB (AM: maximum waveform length 4,096; FM: 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	10 MHz

Pulse width modulation

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

Waveforms	All, including ARB, 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 (Sweep + hold + return)	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	Sine: 20 MHz
	Square: 10 MHz
	ARB: 10 MHz
	Others: 200 kHz

Burst

Waveforms	All, including ARB, 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, manual trigger

Auxiliary input characteristics

Modulation input

Input range	All except FSK: ±1 V full scale
	FSK: 3.3 V logic level
Impedance	10 kΩ
Frequency range	DC to 25 kHz (122 kS/s sample rate)

External triggered/gated burst input

Level	TTL compatible
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

Auxiliary output characteristics

Trigger output

Level	Positive TTL level pulse into 1 kΩ
Impedance	50 Ω
Jitter (RMS), typical	500 ps
Max frequency	4.9 MHz (4.9 MHz to 20 MHz: A fraction of the frequency is output)

Common characteristics

Remote programming (GPIB, LAN 10BASE-T/100BASE-TX, USB 1.1, compatible with SCPI-1999.0 and IEEE 488-2 standards)

Characteristic	USB	LAN [2]	GPIB [2]
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 4k point ARB waveform data (8 KB), typical	20 ms	84 ms	42 ms

2 GPIB and LAN interfaces are only available on the instrument with Option GL.

System characteristics

Frequency setting resolution	1 µHz or 12 digits
Phase (except DC, Noise, Pulse)	
Range	–360° to +360°
Resolution	Sine: 0.01°
	Other Waveforms: 0.1°
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
Internal frequency response	
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
Power source	100 V to 240 V, 50 Hz to 60 Hz or 115 V, 400 Hz
Power consumption	60 W
Warm up time, typical	20 minutes
Power on self diagnostics, typical	<10 s
Accoustic noise, typical	<50 dBA
Display	3.5 in. Color TFT LCD
User interface and help language	English, French, German, Japanese, Korean, Simplified and Traditional Chinese, Russian (user selectable)

Physical characteristics

Dimensions	
Height	104.2 mm (4.10 in.)
Width	241.8 mm (9.52 in.)
Depth	419.1 mm (16.50 in.)
Weight	
Net	2.87 kg (6.3 lb.)
Shipping	4.72 kg (10.4 lb.)

EMC, environmental, and safety characteristics

Temperature	
Operating	0 °C to +50 °C
Non-operating	-30 °C to +70 °C
Humidity	
Operating	≤80%, +0 °C to +40 °C, noncondensing
	≤60%, +40 °C to +50 °C, noncondensing
Non-operating	5% to 90%, <+40 °C, noncondensing
	5% to 80%, ≥+40 °C to ≤+60 °C, noncondensing
	5% to 40%, >+60 °C to ≤+70 °C, noncondensing
Altitude	
Operating	Up to 3,000 m (9,842 ft.)
Non-operating	Up to 12,000 m (39,370 ft.)
EMC compliance	EU Council Directive 2004/108/EC
Safety	UL61010-1; 2004
	CAN/CSA C22.2 No. 61010-1; 2004
	EN61010-1; 2001
	IEC61010-1; 2001

Ordering information

Models

AFG2021	Arbitrary/function generator
Includes:	User manual, power cord, USB cable, CD-ROM with programmer manual, service manual, Labview and IVI Drivers, CD-ROM with ArbExpress® software, NIST-traceable calibration certificate.
	Please specify power cord and local language for user manual when ordering.

Instrument options

Configuration options

Opt GL	GPIB and LAN interfaces

Language options

Opt. L0	English manual
Opt. L1	French manual
Opt. L2	Italian manual
Opt. L3	German manual
Opt. L4	Spanish manual
Opt. L5	Japanese manual
Opt. L6	Portuguese manual
Opt. L7	Simplified Chinese manual
Opt. L8	Traditional Chinese manual
Opt. L9	Korean manual
Opt. L10	Russian manual
Opt. L99	No manual

Language options include translated front-panel overlay for the selected language(s).

Power plug options

Opt. A0	North America power plug (115 V, 60 Hz)
Opt. A1	Universal Euro power plug (220 V, 50 Hz)
Opt. A2	United Kingdom power plug (240 V, 50 Hz)
Opt. A3	Australia power plug (240 V, 50 Hz)
Opt. A5	Switzerland power plug (220 V, 50 Hz)
Opt. A6	Japan power plug (100 V, 50/60 Hz)
Opt. A10	China power plug (50 Hz)
Opt. A11	India power plug (50 Hz)

Opt. A12	Brazil power plug (60 Hz)
Opt. A99	No power cord

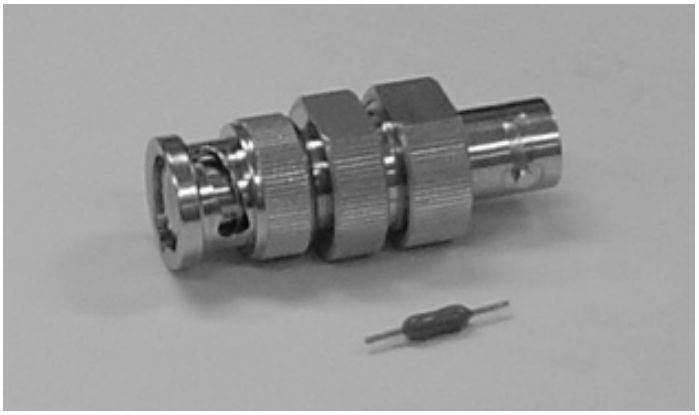
Service options

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	Repair Service 5 Years (including warranty)
Opt. R5DW	Repair Service Coverage 5 Years (includes product warranty period). 5-year period starts at time of instrument purchase

Accessories

Recommended accessories

RMU2U	Rackmount kit
013-0345-00	Fuse adapter, BNC-P to BNC-R
159-0454-00	Fuse set, 3 pcs, 0.125 A
012-0482-00	BNC cable shielded, 3 ft.
012-1256-00	BNC cable shielded, 9 ft.
012-0991-00	GPIB cable, double shielded
011-0049-02	50 Ω BNC terminator



Warranty

Three-year warranty on parts and labor.

CE

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

ASEAN / Australasia (65) 6356 3900
Belgium 00800 2255 4835*
Central East Europe and the Baltics +41 52 675 3777
Finland +41 52 675 3777
Hong Kong 400 820 5835
Japan 81 (3) 6714 3010
Middle East, Asia, and North Africa +41 52 675 3777
People's Republic of China 400 820 5835
Republic of Korea +822 6917 5084, 822 6917 5080
Spain 00800 2255 4835*
Taiwan 886 (2) 2656 6688

Austria 00800 2255 4835*
Brazil +55 (11) 3759 7627
Central Europe & Greece +41 52 675 3777
France 00800 2255 4835*
India 000 800 650 1835
Luxembourg +41 52 675 3777
The Netherlands 00800 2255 4835*
Poland +41 52 675 3777
Russia & CIS +7 (495) 6647564
Sweden 00800 2255 4835*
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Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777
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Denmark +45 80 88 1401
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Norway 800 16098
Portugal 80 08 12370
South Africa +41 52 675 3777
Switzerland 00800 2255 4835*
USA 1 800 833 9200

* European toll-free number. If not accessible, call: +41 52 675 3777

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.tek.com.

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