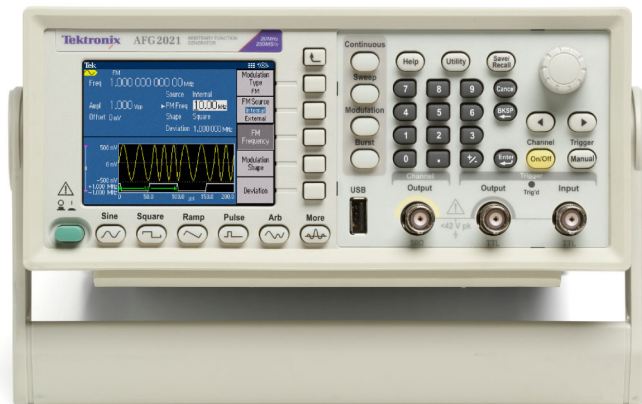


# Arbitrary/Function Generator

## AFG2021 Data Sheet



### Features & Benefits

- 20 MHz sine wave, 10 MHz square and pulse wave provides a cost-effective solution for most applications
- 250 MS/s sampling rate and 14-bit vertical resolution provide best-in-class signal fidelity
- The intuitive and AFG3000-like UI shorten the learning curve and customers' time to market
- 4 × 128 kS built-in and USB memory expansion for user-defined arbitrary waveforms
- Standard USB host/device, optional GPIB and LAN interfaces keep the best balance between cost and versatility
- Multiple run modes and modulation modes cover most customer requirements to finish the job
- Menu and online help are in 8 languages
- 2U height and half-rack width fit both benchtop and rack-mounted applications
- Free ArbExpress makes user-defined waveform editing and downloading extremely easy
- Free SignalExpress combines Tektronix bench instruments into a low-cost solution for automatic testing

### Applications

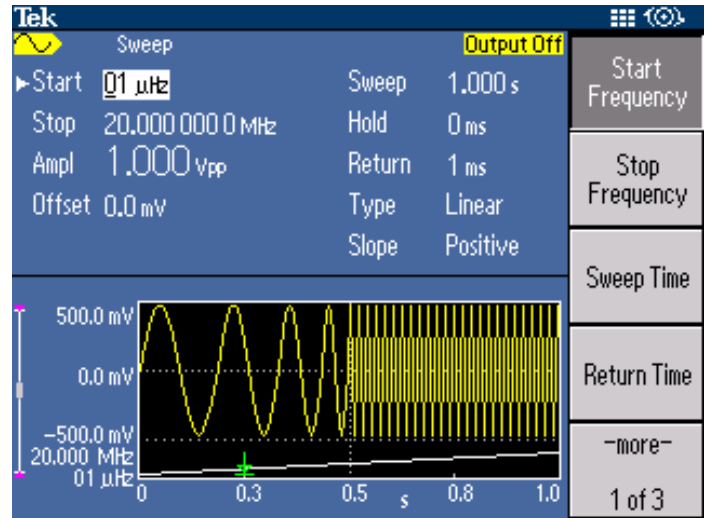
- Electronic test and design
- Sensor simulation
- Education and training
- Functional test
- System integration

## Superior Performance at an Affordable Price

Nearly all consumer products today have circuits or devices that require the input of specific electronic signals in order for the product to perform correctly. These signals can be as simple as an audio frequency or clock signal or more complex such as a serial data stream or signal from 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 Inherited from the AFG3000

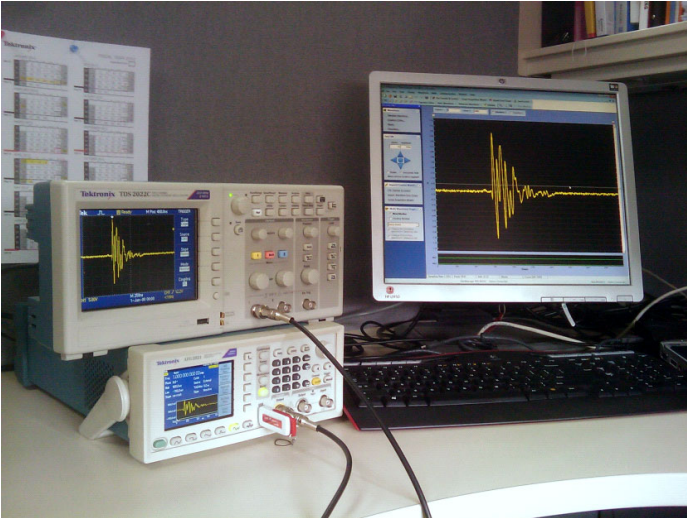
The innovative ease-of-use features first seen on the AFG3000 Series arbitrary/function generators are the building blocks for the AF2021, providing quick access to setup and operational features. Additionally, AFG3000 customers can easily migrate to the new AFG2021 without having to learn a new UI. To easily see waveform information, a 3.5 in. color TFT screen shows relevant parameters in both graphic and text formats, which gives users full confidence in their settings, and lets them focus on the task at hand. The front-panel shortcut buttons and rotary knob allow access to the most frequently used functions and settings with minimum effort and time.



Frequency range from 1  $\mu$ Hz to 20 MHz, fits for most amplifier and filter testing cases.

## Efficient Shortcuts to High Frequency

Traditional function generators created their output signals using analog oscillators and signal conditioning. The Tektronix AFG2021 relies on Direct Digital Synthesis (DDS) techniques to determine the rate at which samples are clocked out of their memory. DDS technology synthesizes waveforms by using a single clock frequency to spawn any frequency within the instrument's range. DDS architecture provides exceptional frequency agility, making it easy to program both frequency and phase changes on the fly, which is useful to test any type of frequency-related DUT – radio and satellite system components, amplifiers, or filters for example.



ArbExpress makes real-world signal replication almost with no effort.

## ArbExpress® Makes Real-world Waveform Replication with Minimum Efforts

With the ArbExpress software, you can quickly create waveforms that can be transferred to the AFG2021 to meet custom stimulus requirements.

ArbExpress supports direct connection to Tektronix oscilloscopes and AFGs through USB, GPIB, or LAN. With the software, users can import real-world signals captured with an oscilloscope onto a PC, then edit and download them onto an AFG to replicate the captured waveform. This is extremely useful for automotive, medical, and industrial applications where recreating sensor data is critical to analyzing the integrity of the design.

## Increase Productivity with SignalExpress

Every AFG2021 ships with a free copy of the Limited Tektronix Edition of National Instrument's LabVIEW SignalExpress 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 the feature-rich tools packed into 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 USB host socket, users can save their 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 socket. The USB connector and optional GPIB/LAN functionality offers a way for users to connect the instrument to a PC for waveform download and remote control.

## Compact Form Factor

The 2U height and half-rack width form factor enables the AFG2021 to be stacked on other bench instruments, such as digital multimeters, power supplies, and frequency counters, saving valuable bench space. Together with the standard RMU2U rackmount kit, GPIB interface, and full SCPI support the AFG2021 is also a perfect option for rackmount applications, such as ATE configuration in manufacturing environments.

## Characteristics

### General

Characteristic	Description
Channels	1
Waveforms	Sine, Square, Pulse, Ramp, Noise, DC, Sin(x)/x, Gaussian, Lorentz, Exponential Rise, Exponential Decay, and Haversine
Sine Wave	1 $\mu$ Hz to 20 MHz
Sine Wave in Burst Mode	1 $\mu$ Hz to 10 MHz
Effective Maximum Frequency Out	20 MHz
Amplitude Flatness (1 $V_{p-p}$ )	
<5 MHz	$\pm 0.15$ dB
5 MHz to 20 MHz	$\pm 0.3$ dB
Harmonic Distortion (1 $V_{p-p}$ )	
10 Hz to 20 kHz	$< -70$ dBc
20 kHz to 1 MHz	$< -60$ dBc
1 MHz to 10 MHz	$< -50$ dBc
10 MHz to 20 MHz	$< -40$ dBc
THD	$< 0.2\%$ (10 Hz to 20 kHz, 1 $V_{p-p}$ )
Spurious (1 $V_{p-p}$ )	
10 Hz to 1 MHz	$< -60$ dBc
1 MHz to 20 MHz	$< -50$ dBc
Phase Noise, Typical	20 MHz: $< -110$ dBc/Hz at 10 kHz offset, 1 $V_{p-p}$
Residual Clock Noise	$-63$ dBm
Square Wave	1 $\mu$ Hz to 10 MHz
Rise/Fall Time	$\leq 18$ ns
Jitter (RMS), Typical	$< 500$ ps
Ramp Wave	1 $\mu$ Hz to 200 kHz
Linearity	$\leq 0.1\%$ 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 $0.625 \times$ Pulse Period
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 $\times$ (Leading Edge Time + Trailing Edge Time)]
Resolution	10 ps or 8 digits
Overshoot, Typical	$< 5\%$
Jitter (RMS), Typical	$< 500$ ps

Characteristic	Description
Other Waveforms	1 $\mu$ Hz to 200 kHz
Noise Bandwidth ( $-3$ dB)	20 MHz
Noise Type	White Gaussian
DC (into 50 $\Omega$ )	$-5$ V to $+5$ V
Arbitrary Waveforms	1 mHz to 10 MHz
Arbitrary Waveforms in Burst Mode	1 mHz to 5 MHz
Effective Analog Bandwidth ( $-3$ dB)	34 MHz
Nonvolatile Memory	4 waveforms
Memory: Sample Rate	2 to 128k: 250 MS/s
Vertical Resolution	14 bits
Rise/Fall Time	$\leq 20$ ns
Jitter (RMS)	4 ns
Amplitude, 50 $\Omega$ Load	10 m $V_{p-p}$ to 10 $V_{p-p}$
Amplitude, Open Circuit	20 m $V_{p-p}$ to 20 $V_{p-p}$
Accuracy	$\pm(1\%$ of setting + 1 mV), (1 kHz sine waveform, 0 V offset, $> 10$ m $V_{p-p}$ amplitude)
Resolution	0.1 m $V_{p-p}$ , 0.1 mV <sub>RMS</sub> , 1 mV, 0.1 dBm, or 4 digits
Units	$V_{p-p}$ , V <sub>RMS</sub> , dBm (sine wave only)
Output Impedance	50 $\Omega$
Load Impedance Setting	Selectable: 50 $\Omega$ , 1 $\Omega$ to 10.0 k $\Omega$ , High Z (adjusts displayed amplitude according to selected load impedance)
Isolation	$< 42$ V <sub>Peak</sub> 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 $\Omega$ Load	$\pm(5$ V <sub>Peak</sub> – amplitude $V_{p-p}/2)$
DC Offset Range, Open Circuit	$\pm(10$ V <sub>Peak</sub> – amplitude $V_{p-p}/2)$
Accuracy	$\pm(1\%$ of  setting  + 5 mV + 0.5% of amplitude ( $V_{p-p}$ ))
Resolution	1 mV

**Modulation****AM, FM, PM**

Characteristic	Description
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/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	10 MHz

**Frequency Shift Keying**

Characteristic	Description
Carrier Waveforms	All, including ARB, 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, 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 $\mu$ Hz ARB: 1 mHz
Max Start/Stop Frequency	Sine: 20 MHz Square: 10 MHz ARB: 10 MHz Others: 200 kHz

**Burst**

Characteristic	Description
Waveforms	All, including ARB, except Noise and DC
Type	Triggered, Gated (1 to 1,000,000 cycles or Infinite)
Internal Trigger Rate	1 $\mu$ s to 500.0 s
Gate and Trigger Sources	Internal, External, Manual Trigger, and Remote Interface

**Auxiliary Input****Modulation Input**

Characteristic	Description
Input Range	All except FSK: $\pm 1$ V full scale FSK: 3.3 V logic level
Impedance	10 k $\Omega$
Frequency Range	DC to 25 kHz (122 kS/s sample rate)

**External Triggered/Gated Burst Input**

Characteristic	Description
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**

Characteristic	Description
Impedance	1 k $\Omega$ , AC coupled
Required Input Voltage Swing	100 mV <sub>p-p</sub> to 5 V <sub>p-p</sub>
Lock Range	10 MHz $\pm 35$ kHz

**Auxiliary Output****Trigger Output**

Characteristic	Description
Level	Positive TTL level pulse into 1 k $\Omega$
Impedance	50 $\Omega$
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*1	GPIB*1
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

\*1 GPIB and LAN interfaces are only available on the instrument with Option GL.

## General

Characteristic	Description
Frequency Setting Resolution	1 $\mu$ Hz 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 $\Omega$
Effective Frequency Switching Speed	2 ms through remote control
Internal Frequency Reference	
Stability	All except ARB: $\pm 1$ ppm, 0 °C to 50 °C ARB: $\pm 1$ ppm, $\pm 1$ $\mu$ Hz, 0 °C to 50 °C
Aging	$\pm 1$ 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
Acoustic 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

### Benchtop Configuration

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

## Environmental and Safety Characteristics

Characteristic	Description
Temperature	
Operating	0 °C to +50 °C
Nonoperating	-30 °C to +70 °C
Humidity	
Operating	$\leq 80\%$ , +0 °C to +40 °C, noncondensing $\leq 60\%$ , +40 °C to +50 °C, noncondensing
Nonoperating	5% to 90%, <+40 °C, noncondensing 5% to 80%, $\geq +40$ °C to $\leq +60$ °C, noncondensing 5% to 40%, >+60 °C to $\leq +70$ °C, noncondensing
Altitude	
Operating	Up to 3,000 m (9,842 ft.)
Nonoperating	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

### 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.

## Configuration Options

Option	Description
Opt. GL	GPIB and LAN interfaces

## Language Options

Option	Description
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

**Power Plug Options**

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

**Service Options**

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	Repair Service 5 Years
Opt. R5DW	Repair Service Coverage 5 Years (starts at time of customer instrument purchase)

**Recommended Accessories**

Accessory	Description
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 $\Omega$ BNC terminator

**Warranty**

Three-year warranty on parts and labor.

**Contact Tektronix:**

**ASEAN / Australasia** (65) 6356 3900  
**Austria** 00800 2255 4835\*  
**Balkans, Israel, South Africa and other ISE Countries** +41 52 675 3777  
**Belgium** 00800 2255 4835\*  
**Brazil** +55 (11) 3759 7627  
**Canada** 1 800 833 9200  
**Central East Europe and the Baltics** +41 52 675 3777  
**Central Europe & Greece** +41 52 675 3777  
**Denmark** +45 80 88 1401  
**Finland** +41 52 675 3777  
**France** 00800 2255 4835\*  
**Germany** 00800 2255 4835\*  
**Hong Kong** 400 820 5835  
**India** 000 800 650 1835  
**Italy** 00800 2255 4835\*  
**Japan** 81 (3) 6714 3010  
**Luxembourg** +41 52 675 3777  
**Mexico, Central/South America & Caribbean** 52 (55) 56 04 50 90  
**Middle East, Asia, and North Africa** +41 52 675 3777  
**The Netherlands** 00800 2255 4835\*  
**Norway** 800 16098  
**People's Republic of China** 400 820 5835  
**Poland** +41 52 675 3777  
**Portugal** 80 08 12370  
**Republic of Korea** 001 800 8255 2835  
**Russia & CIS** +7 (495) 7484900  
**South Africa** +41 52 675 3777  
**Spain** 00800 2255 4835\*  
**Sweden** 00800 2255 4835\*  
**Switzerland** 00800 2255 4835\*  
**Taiwan** 886 (2) 2722 9622  
**United Kingdom & Ireland** 00800 2255 4835\*  
**USA** 1 800 833 9200

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

Updated 10 February 2011

**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](http://www.tektronix.com)



Copyright © Tektronix, Inc. All rights reserved. Tektronix products are covered by U.S. and foreign patents, issued and pending. Information in this publication supersedes that in all previously published material. Specification and price change privileges reserved. TEKTRONIX and TEK are registered trademarks of Tektronix, Inc. All other trade names referenced are the service marks, trademarks, or registered trademarks of their respective companies.

31 May 2012

75W-28089-0

