

Arbitrary/Function Generator

AFG2021 Datasheet



Features & Benefits

- 20 MHz sine, 10 MHz square and 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
- 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

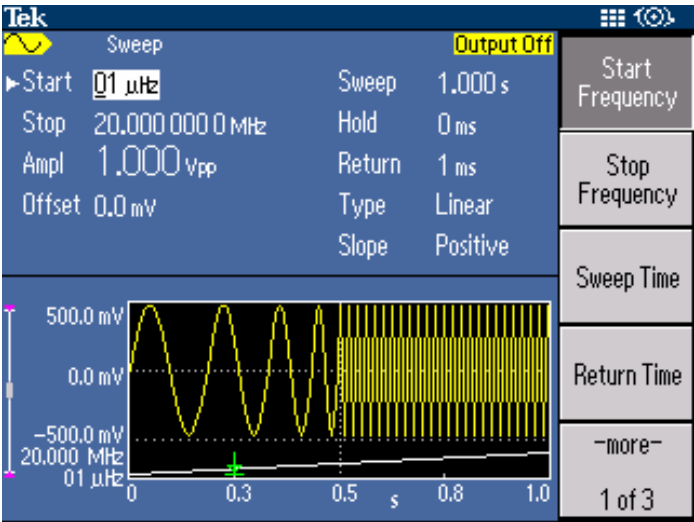
Tektronix®

Superior Performance at an Affordable Price

Most electronic devices, circuits, and systems are designed to handle some form of 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

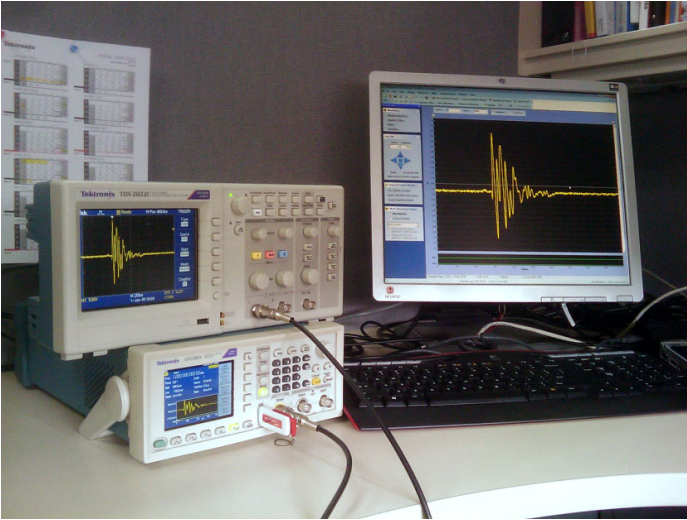
The innovative ease-of-use features first seen on the AFG3000 Series arbitrary/function generators are the building blocks for the AFG2021, providing quick access to setup and operational features. Experienced AFG3000 users will find it especially easy to set up the new AFG2021. A 3.5 inch color TFT 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.



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

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.



ArbExpress software helps you easily duplicate real-world signals.

ArbExpress® for Real-world Waveforms with Minimal Effort

With 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. 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.

Increase 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.

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 μ Hz to 20 MHz |
| Sine Wave in Burst Mode | 1 μ Hz to 10 MHz |
| Effective Maximum Frequency Out | 20 MHz |
| Amplitude Flatness (1 V_{p-p}) | |
| <5 MHz | ± 0.15 dB |
| 5 MHz to 20 MHz | ± 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 μ Hz to 10 MHz |
| Rise/Fall Time | ≤ 18 ns |
| Jitter (RMS), Typical | < 500 ps |
| Ramp Wave | 1 μ 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 μ Hz 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 (-3 dB) | 34 MHz |
| Nonvolatile Memory | 4 waveforms |
| Memory: Sample Rate | 2 to 128k: 250 MS/s |
| Vertical Resolution | 14 bits |
| Rise/Fall Time | ≤ 20 ns |
| Jitter (RMS) | 4 ns |
| Amplitude, 50 Ω Load | 10 mV $_{p-p}$ to 10 V $_{p-p}$ |
| Amplitude, Open Circuit | 20 mV $_{p-p}$ to 20 V $_{p-p}$ |
| Accuracy | $\pm(1\%$ 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 k Ω , 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 | $\pm(5$ V $_{Peak}$ – amplitude V $_{p-p}/2$) |
| DC Offset Range, Open Circuit | $\pm(10$ V $_{Peak}$ – 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 μ 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 μ 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: ± 1 V full scale FSK: 3.3 V logic level |
| Impedance | 10 k Ω |
| 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 Ω , AC coupled |
| Required Input Voltage Swing | 100 mV _{p-p} to 5 V _{p-p} |
| Lock Range | 10 MHz ± 35 kHz |

Auxiliary Output

Trigger Output

| Characteristic | Description |
|-----------------------|--|
| Level | Positive TTL level pulse into 1 k Ω |
| 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*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 μ 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 Ω |
| Effective Frequency Switching Speed | 2 ms through remote control |
| 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 |
| 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

Benchmark 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 | GPIO cable, double shielded |
| 011-0049-02 | 50 Ω BNC terminator |

Warranty

Three-year warranty on parts and labor.

Contact Tektronix:

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

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