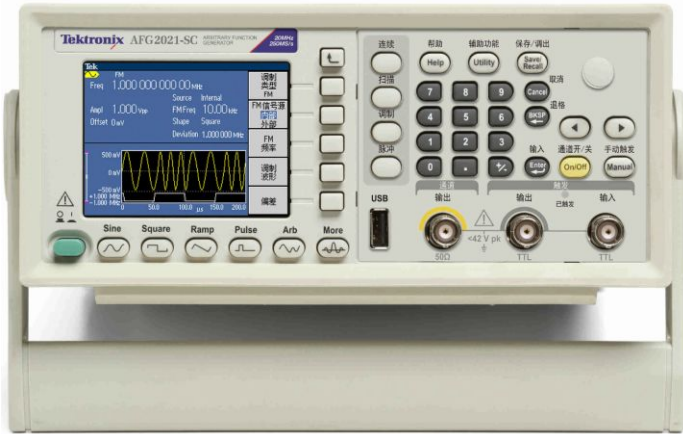


Arbitrary Function Generator

AFG2021-SC Datasheet



The AFG2021-SC 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 9 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 × 16 kS memory and the USB memory expansion capability provide substantial capacity for defining complex waveforms
- USB host port on front panel for saving/reloading arbitrary waveforms and instrument settings
- 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 Simplified Chinese and English

- 2U height and half-rack width fits benchtop applications
- Free ArbExpress software makes waveform editing extremely easy

Applications

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

Superior performance at an affordable price

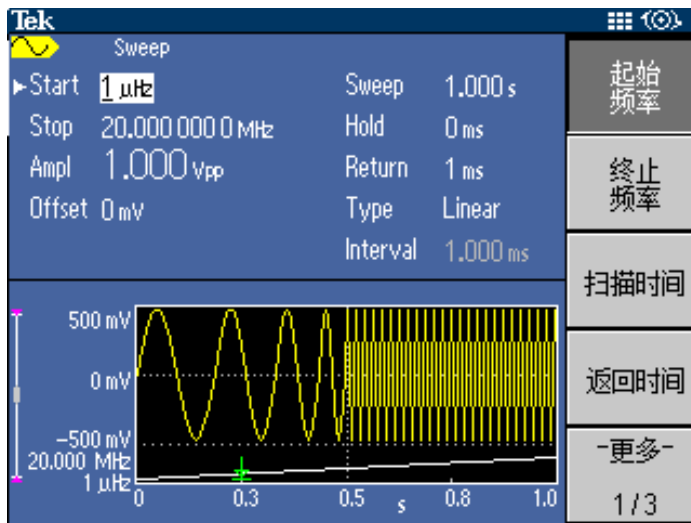
Most electronic devices, circuits, and systems are designed to handle some form of a signal. These signals can be simple like an audio frequency or clock signal or more complex like a serial data stream or the output of an airbag sensor during a crash. With 20 MHz bandwidth, 14-bit resolution, and 250 MS/s sample rate, the AFG2021-SC Arbitrary Function Generator can create both simple and complex signals at an entry-level price. With 9 standard waveforms, 25 built-in application 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-SC, providing quick access to setup and operational features. Experienced AFG3000 users will find it especially easy to set up the new AFG2021-SC. 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

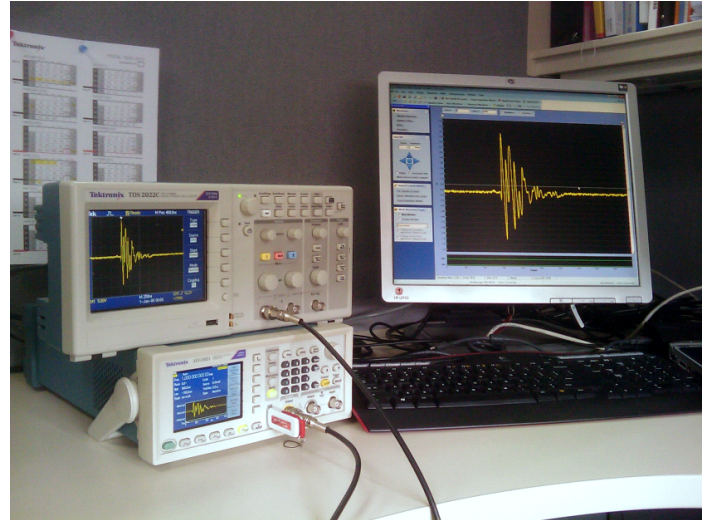
Traditional function generators created their output signals using analog oscillators and signal conditioning. The Tektronix AFG2021-SC relies on Direct Digital Synthesis (DDS) techniques. DDS technology synthesizes waveforms by using a single clock frequency to generate any frequency within the instrument's 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 μ Hz 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-SC to meet custom stimulus requirements. ArbExpress supports direct connection to Tektronix oscilloscopes and AFGs through USB, GPIB, or LAN (connection type is model dependent). The software allows you to import real-world signals captured with an oscilloscope onto a PC, then edit and copy them onto an AFG through a USB memory device 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.

Connectivity

Using the front-panel USB host port, you can save your customized waveforms or instrument settings onto a USB memory device. Reloading the data is easily done by plugging the device back into the USB host port.

Compact form factor

The 2U height and half-rack width form factor allow the AFG2021-SC to be stacked on other bench instruments, such as digital multimeters, power supplies, and frequency counters, saving valuable bench space.

Specifications ¹

All specifications are guaranteed unless noted otherwise.

Model overview

| AFG2021-SC | |
|------------|--|
| Channels | 1 |
| Waveforms | Sine, Square, Pulse, Ramp, More (Noise, DC, Gaussian, Exponential Rise, Exponential Decay, Air Flow Meter, Knock Sensor, ABS Sensor, Distributor Inductive, Fuel Pressure Sensor, COP Ignition, Primary Ignition, Secondary Ignition, Throttle Potentiometer, Fuel Injector Voltage, Starter Current, Single Tone AM, Single Tone FM, Mono AM, Mono FM, DTMF, Voice, Pulse Diagram, ECG, Fetal Heart Picture, Damped Oscillation, Shock, Full-wave Rectification, Half-wave Rectification, Angle Ctrl(Sine)) |

General characteristics

| | |
|---------------------------------|----------------------|
| 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 (± 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 μ Hz to 10 MHz |
| Rise/fall time | ≤ 18 ns |
| Jitter (RMS) | <500 ps (<60 ps, typical) |

| | |
|-----------|--|
| 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% |

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

| | |
|--|--|
| 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 | <5%, typical |
| Jitter (RMS) | <500 ps (<90 ps, typical) |
| 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 | 34 MHz |
| Nonvolatile memory | 4 waveforms |
| Memory: sample rate | 2 to 16 k: 250 MS/s |
| Vertical resolution | 14 bits |
| Rise/fall time | ≤ 20 ns |
| Jitter (RMS) | 4 ns |
| Amplitude | |
| Range | 50 Ω load: $10 \text{ mV}_{\text{p-p}}$ to $10 \text{ V}_{\text{p-p}}$ Open circuit: $20 \text{ mV}_{\text{p-p}}$ to $20 \text{ V}_{\text{p-p}}$ |
| Accuracy | $\pm(1\%$ of setting + 1 mV), (1 kHz sine waveform, 0 V offset, $>10 \text{ mV}_{\text{p-p}}$ amplitude) |
| Resolution | $0.1 \text{ mV}_{\text{p-p}}$, $0.1 \text{ mV}_{\text{rms}}$, 1 mV, 0.1 dBm, or 4 digits |
| Units | $\text{V}_{\text{p-p}}$, 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 | $<42 \text{ V}_{\text{peak}}$ 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 |

General characteristics**DC offset**

| | |
|----------------------|---|
| Range | 50 Ω load: $\pm(5 V_{\text{peak}} - \text{amplitude } V_{\text{p-p}}/2)$ Open circuit: $\pm(10 V_{\text{peak}} - \text{amplitude } V_{\text{p-p}}/2)$ |
| -- Accuracy | $\pm(1\% \text{ of } \text{setting} + 5 \text{ mV} + 0.5\% \text{ of amplitude } (V_{\text{p-p}}))$ |
| -- 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 μ Hz 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 μ s to 500.0 s |
| Gate and trigger sources | Internal, external, manual trigger |

Auxiliary input characteristics

Modulation input

| | |
|-----------------|-------------------------------------|
| Input range | ± 1 V full scale |
| Impedance | 10 k Ω |
| 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 k Ω , AC coupled |
| Required input voltage swing | 100 mV _{p-p} to 5 V _{p-p} |
| Lock range | 10 MHz \pm 35 kHz |

Auxiliary output characteristics

Trigger output

| | |
|-----------------------|--|
| 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) |

System characteristics

| | |
|------------------------------|-------------------------|
| Frequency setting resolution | 1 μ Hz or 12 digits |
|------------------------------|-------------------------|

Phase (except DC, Noise, Pulse)

| | |
|------------|--|
| Range | -360° to $+360^\circ$ |
| Resolution | Sine: 0.01 $^\circ$ Other Waveforms: 0.1 $^\circ$ |

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 $^\circ$ C to 50 $^\circ$ C ARB: ± 1 ppm ± 1 μ Hz, 0 $^\circ$ C to 50 $^\circ$ C |
| Aging | ± 1 ppm per year |

Power source 100 V to 240 V, 50 Hz to 60 Hz or 115 V, 400 Hz

System characteristics

| | |
|------------------------------------|--|
| 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 | Simplified Chinese (default) and English (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-SC 1 μ Hz to 20 MHz sine wave, 1-channel arbitrary function generator, Simplified Chinese

Instrument options

Language options

Opt. L7 Simplified Chinese manual

Opt. L99 No manual

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

Power plug options

Opt. A10 China power plug (50 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. 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

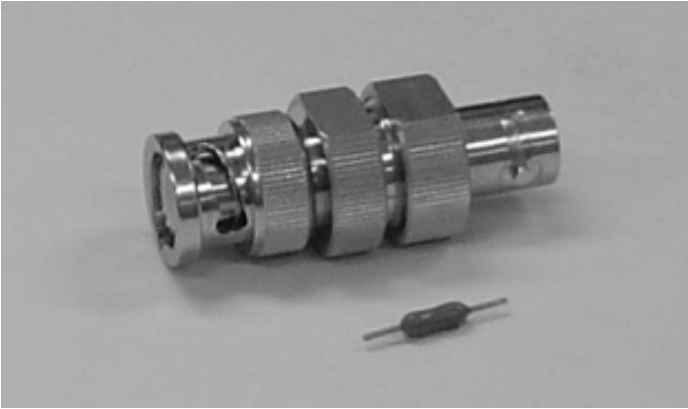
Accessories

Standard accessories

— User manual
 — Power cord
 — CD-ROM with Specifications and Performance Verification Technical Reference manual

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.
 011-0049-02 50 Ω BNC terminator



Warranty

Three-year warranty on parts and labor.



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

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