

## ARBITRARY WAVEFORM GENERATOR

AWG 510 • AWG 520



### FEATURES AND BENEFITS

- External Clock Input Permits Jitter Insertion and Synchronization
- One or Two Channels with 10-bit Vertical Resolution
- 10-Channel, 1 GHz Digital Data Generation (Opt. 03)
- Real-time Noise Generation
- Supports Direct External Clock and 10 MHz Reference Input
- Waveform Transfers from DSO
- File Transfers from GPIB, Floppy Disk, or 10Base-T Ethernet
- On-Screen Waveform Editing for Ease-of-Use
- Unique Real-time Sequencing Links Multiple Waveform Files Creating Waveforms of Nearly Infinite Length
- Built-in 3 GB Hard Drive for Mass Data Storage
- User Modified Isolation Pulse for Disk Drive Testing
- Optional 78 MB Flash Disk for ATE Applications

### APPLICATIONS

- Communications Design and Test:
  - Low Frequency Modulated RF
  - Digital Information Encoding Using FSK, PSK and QAM (Quadrature Modulation) for Cellular, Fax and Modem Communications
- Optical Communications Design and Test:
  - Reflections, Crosstalk, and Ground Bounce Simulation
- Real-world Simulations:
  - Corrupt Ideal Waveforms
  - Add Jitter to Waveforms with Jitter Editor
  - EMP/EMI and Other System Noise
  - Power Supply Noise and Ripple
  - Transducer Simulation

As a member of the Tektronix family of arbitrary generators, the AWG 500 Series is a high performance, mixed-signal source. The AWG 500 Series provides 1 GS/s sample clock rate and 4 Mword execution memories.

Its unique design integrates a graphical editing display with the most powerful hardware output capabilities available. This allows on-screen viewing

of waveform editing and simplifies “what-if” test scenarios by easily allowing the creation of composite signals.

The AWG 500 uses a graphical user interface to overcome the historical difficulties associated with developing arbitrary and complex waveforms. Several intuitive and powerful techniques are built-in to develop and edit custom waveforms.

**Tektronix**<sup>®</sup>

The standard AWG 510 configuration provides up to 2 V output or 4 V into a differential input with the complementary output, each with 10-bits vertical resolution. Option 03 adds an indepen-

dent 10-bit-wide digital data port which can be used in conjunction with the marker outputs for data generation up to 12-bits wide at up to 1 GHz (14-bits AWG 520).

The standard AWG 520 configuration provides 2 channels. Each channel provides 10-bit vertical resolution with amplitudes up to 2 V<sub>p-p</sub>.

## CHARACTERISTICS

### OPERATING MODES

**Continuous** – Waveform is iteratively output. If a sequence is defined, the sequence order and repeat functions are applied.

**Triggered** – Waveform is output only once when an external, internal GPIB/Ethernet, or manual trigger is received.

**Gated** – Waveform begins output when gate is true and resets to beginning when false.

**Enhanced** – Waveform is output as defined by the sequence.

### ARBITRARY WAVEFORMS

**Waveform Length** – 256 to 4,194,048 points in multiples of four.

**Sequence Length** – 1 to 8,000 steps. Both CH1 and CH2 operate from the same sequence (AWG 520).

**Sequence Repeat Counter** – 1 to 65,536 or infinite.

### CLOCK GENERATOR

**Sampling Frequency** – 50.000000 kHz to 1.0000000 GHz.

**Resolution** – 8 digits.

**Internal Clock** –

Accuracy: ±1 ppm.

Phase Noise:

At 1 GHz, 10 kHz offset: –80 dBc/Hz.

At 1 GHz, 100 kHz offset: –100 dBc/Hz.

### INTERNAL TRIGGER GENERATOR

**Internal Trigger Rate** –

Range: 1.0 μs to 10.0 s.

Resolution: 3 digits, 0.1 μs minimum.

Accuracy: ±0.1%.

### MAIN OUTPUT

**Output Signal** –

AWG 510: Complementary; CH1 and  $\overline{\text{CH1}}$ .

AWG 520: Single-ended; CH1 and CH2.

**DA Converter** –

Resolution: 10 bits.

Differential Non-Linearity: ±1 LSB.

Integral Non-Linearity: ±1 LSB.

**Normal Out** –

Pulse Response (–1 and 1 waveform data, 0 V offset, Through filter):

Rise time (10 to 90%): Amplitude >1.0 V,

≤2.5 ns; Amplitude ≤1.0 V, ≤1.5 ns.

Fall time (10 to 90%): Amplitude >1.0 V,

≤2.5 ns; Amplitude ≤1.0 V, ≤1.7 ns.

Aberrations (at 500 MHz): Amplitude >1.0 V,

±10%; Amplitude ≤1.0 V, ±7%.

Flatness (after 50 ns from rise/fall edge): ±3%.

Small signal bandwidth (–3 dB, Amplitude

0.5 V): 300 MHz.

Sinewave Characteristics (1 GS/s clock, 32 waveform points, 31.25 MHz signal frequency, 1.0 V amplitude, 0 V offset, Through filter):

Harmonics: ≤–50 dBc, DC to 400 MHz.

Noise: ≤–53 dBc, DC to 400 MHz.

Phase Noise: ≤–90 dBc/Hz at 10 kHz offset.

Filter:

Type: 10, 20, 50, 100 MHz Bessel low-pass.

Rise time (10 to 90%): 10 MHz, 35 ns; 20 MHz,

17 ns; 50 MHz, 7.0 ns; 100 MHz, 3.5 ns.

Delay from trigger: 10 MHz, 77 ns + 1 clock;

20 MHz, 57 ns + 1 clock; 50 MHz, 45 ns + 1

clock; 100 MHz, 42 ns + 1 clock; Through, 37 ns

+1 clock.

**Direct DA Out** –

Output Voltage: 0.5 V<sub>p-p</sub> (with –0.27 V offset) into 50 Ω.

Amplitude Accuracy: 0.5 V<sub>p-p</sub> ±10%.

DC Offset Accuracy: –0.27 V ±10% (waveform data = 0).

Pulse Response (–1 and 1 waveform data):

Rise time (10 to 90%): ≤700 ps.

Fall time (10 to 90%): ≤700 ps.

**Output Impedance** – 50 Ω.

**Connector** – Front Panel BNC.

### AUXILIARY OUTPUTS

**Marker** –

Number:

AWG 510: 2.

AWG 520: 4.

Level:

Hi/Lo: –2.0 V to 2.0 V (0.05 V<sub>p-p</sub> to 4 V<sub>p-p</sub>) into

50 Ω; –4.0 V to 4.0 V (0.1 V<sub>p-p</sub> to 8 V<sub>p-p</sub>) into

1 MΩ.

Resolution: 0.05 V.

Accuracy: Within ±0.1 V ±5% of setting.

Rise/Fall Time (10 to 90%):

At 1 V<sub>p-p</sub>, Hi +0.5 V/Lo –0.5 V: 0.5 ns.

At 2 V<sub>p-p</sub>, Hi +1 V/Lo –1 V: 1.0 ns.

At 4 V<sub>p-p</sub>, Hi +2 V/Lo –2 V: 2.0 ns.

Variable Delay:

Range: 0 ns to +2 ns.

Resolution: 20 ps.

Marker Skew: 32 ps.

Connector: Rear-panel SMB.

**Clock Out** –

Level: ECL 100 K compatible.

Connector: Front-panel BNC.

**Noise** –

Level:

Range: –145 dBm/Hz to –105 dBm/Hz.

Resolution: 1 dB.

Accuracy: ±2.5 dB at 100 MHz.

Flatness: ±2.5 dB, 1 MHz to 300 MHz

(referenced to –105 dBm/Hz at 100 MHz).

Type: Gaussian.

Connector: Front-panel BNC.

**Digital Data Out (Opt. 03)** –

Output Signals: D0 to D9 (10 bits).

Level:

Hi/Lo: –2.0 V to 2.0 V (0.1 V<sub>p-p</sub> to 4 V<sub>p-p</sub>) into

50 Ω; –4.0 V to 4.0 V (0.2 V<sub>p-p</sub> to 8 V<sub>p-p</sub>) into

1 MΩ.

Resolution: 0.1 V.

Accuracy: Within ±0.1 V ±5% of setting.

Rise/Fall Time (10 to 90%):

At 1 V<sub>p-p</sub>, Hi +0.5 V/Lo –0.5 V: 0.5 ns.

At 2 V<sub>p-p</sub>, Hi +1 V/Lo –1 V: 1.0 ns.

At 4 V<sub>p-p</sub>, Hi +2 V/Lo –2 V: 2.0 ns.

Skew Between Data: ≤1 ns, 330 ps typical.

Delay:

Data to marker: 4.4 ns.

Clock to data: 3.7 ns.

Connector: Rear-panel SMB.

**CHARACTERISTICS**

**AUXILIARY INPUTS**

**Trigger In –**

Impedance: 1 k $\Omega$  or 50  $\Omega$ .  
Polarity: POS or NEG.  
Input Voltage Range:  
1 k $\Omega$ :  $\pm 10$  V.  
50  $\Omega$ :  $\pm 5$  V.

**Threshold:**

Level: -5.0 V to 5.0 V.  
Resolution: 0.1 V.

Accuracy:  $\pm$ (5% of level + 0.1 V).  
Pulse Width (0.2 V amplitude): 10 ns minimum.  
Trigger Holdoff: 500 ns maximum.  
Delay to Marker: 30 ns + 1 clock.  
Connector: Front-panel BNC.

**Event Trig Input –**

Number of Events: 4 bits.  
Input Signals: 4 event bits, strobe.  
Threshold: TTL level.  
Pulse Width: 64 clocks minimum.  
Maximum Input: 0 V to +5 V (DC + peak AC).  
Delay to Analog Out:  $\leq 384$  clock + 20 ns.  
Impedance 2.2 k $\Omega$ , pull-up to +5 V.  
Connector: Rear-panel 9-Pin D-sub.

**CH1 ADD Input –**

Input Voltage Range: -1 V to 1 V (DC + peak AC).  
Impedance: 50  $\Omega$ .  
Bandwidth (-3 dB): DC to 200 MHz at 1 V<sub>p-p</sub> input.  
Amplitude Accuracy:  $\pm 5\%$ .  
Connector: Front-panel BNC.

**Reference 10 MHz Clock IN –**

Input Voltage Range: 0.2 V to 3.0 V<sub>p-p</sub>,  $\pm 10$  V maximum.  
Impedance: 50  $\Omega$ , AC coupled.  
Frequency Range: 10 MHz  $\pm 0.1$  MHz.  
Connector: Rear-panel BNC.

**EXTERNAL SAMPLE CLOCK IN**

**Input Voltage Range –** 0.25 V<sub>p-p</sub> to 1 V<sub>p-p</sub>.  
**Maximum Input Voltage Range –**  $\pm 10$  V<sub>max</sub>.  
**Impedance –** 50  $\Omega$ , AC coupling.  
**Frequency Range –** 10 MHz to 1 GHz.  
**Duty Cycle Ratio –** 40% to 60%.  
**Pulse Width –** 0.5 ns minimum.  
**Connector –** Rear panel BNC.

**DATA STORAGE**

**Internal Hard Disk Drive –** 3 GB (standard).  
**Floppy Disk Drive –** 3.5 in., 1.44 MB.  
**Opt. 10 –** Substitute Flash Disk (78 MB) for HDD, add standby switch.

**ENVIRONMENTAL, EMC, SAFETY**

**Temperature –**

Operating: 10°C to +40°C.  
Nonoperating: -20°C to +60°C.

**Humidity –**

Operating: 20 to 80%, non-condensing.  
Nonoperating: 5 to 90%, non-condensing.

**Altitude –**

Operating: Up to 4,500 m. (15,000 ft). Maximum operating temperature decreases 1°C per 300 m above 1.5 km.  
Nonoperating: Up to 15,000 m (50,000 ft).

**Vibration (test limits) –**

Operating: 0.27 g RMS from 5 to 500 Hz, 10 minutes duration.  
Nonoperating: 2.28 g RMS from 5 to 500 Hz, 10 minutes duration.

**Shock (test limits) –**

Nonoperating: 294 m/s<sup>2</sup> (30 g), half-sine, 11 ms duration.

**EMC Compliance –**

EN50081-1.  
EN50082-1.  
FCC Part 15, Subchapter B Class A.  
AS/NZS 20641/2.  
**Safety –** UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

**POWER**

**Source Power –**

Line Voltage Range: 100 to 240 VAC.  
Line Frequency: 48 to 63 Hz.

**Power Consumption –**

AWG 510: 400 W at 5 A (standard).  
AWG 520: 600 W at 8 A maximum.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in.
Height	178	7.6
Width	422	17.5
Depth	560	25.8
Weight	kg	lb.
Net	17	37.5

**WARRANTY**

One year parts and labor.

**OTHER**

**Programmable Interface –**

GPIO: 24-Pin IEEE488.1 connector.  
Ethernet: 10Base-T, RJ-45 connector.

**Keyboard Connector –** 6-Pin mini-DIN connector.

## ORDERING INFORMATION

### AWG510

Programmable Single-channel Arbitrary Waveform Generator.

### AWG520

Programmable Dual-channel Arbitrary Waveform Generator.

**Both Include:** User Manual (071-0099-00), Programmer Manual (071-0100-00), GPIB Programming Examples Disk (063-2982-00), Sample Waveform Library Disk (063-2981-00), Performance Verification Disk (063-2983-00), Power Cable (U.S. 115 V), Fuse (159-0239-00).

### OPTIONS

**Opt. 03** – Ch 2 10-bit output up to 1 GHz.

**Opt. 10** – Flashdisk (78 MB) and standby switch – removes HDD.

**Opt. 1R** – Rack mount.

### INTERNATIONAL POWER PLUGS

**Opt. A1** – Universal Euro 220 V, 50 Hz.

**Opt. A2** – UK 240 V, 50 Hz.

**Opt. A3** – Australian 240 V, 50 Hz.

**Opt. A4** – North American 240 V, 60 Hz.

**Opt. A5** – Switzerland 220 V, 50 Hz.

### RECOMMENDED ACCESSORIES

**Service Manual** – Order 071-0101-01.

**Protective Cover** – Order 200-3696-01.

**GPIB Cable** – Order 012-0991-01.

**50 Ω BNC Cable** – Order 012-1341-00.

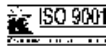
**Keyboard** – IBM-compatible 4-Pin mini DIN connector.

### For further information, contact Tektronix:



Worldwide Web: for the most up-to-date product information visit our web site at: [www.tektronix.com/Measurement/signal\\_sources/](http://www.tektronix.com/Measurement/signal_sources/)

ASEAN Countries (65) 356-3900; Australia & New Zealand 61 (2) 9888-0100; Austria, Central Eastern Europe, Greece, Turkey, Malta, & Cyprus +43 2236 8092 0; Belgium +32 (2) 715 89 70; Brazil and South America 55 (11) 3741-8360; Canada 1 (800) 661-5625; Denmark +45 (44) 850 700; Finland +358 (9) 4783 400; France & North Africa +33 1 69 86 81 81; Germany + 49 (221) 94 77 400; Hong Kong (852) 2585-6688; India (91) 80-2275577; Italy +39 (2) 25086 501; Japan (Sony/Tektronix Corporation) 81 (3) 3448-3111; Mexico, Central America, & Caribbean 52 (5) 666-6333; The Netherlands +31 23 56 95555; Norway +47 22 07 07 00; People's Republic of China 86 (10) 6235 1230; Republic of Korea 82 (2) 528-5299; South Africa (27 11)651-5222; Spain & Portugal +34 91 372 6000; Sweden +46 8 477 65 00; Switzerland +41 (41) 729 36 40; Taiwan 886 (2) 2722-9622; United Kingdom & Eire +44 (0)1344 392000; USA 1 (800) 426-2200.



From other areas, contact: Tektronix, Inc. Export Sales, P.O. Box 500, M/S 50-255, Beaverton, Oregon 97077-0001, USA 1 (503) 627-6877.

Copyright © 2000, 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.

02/00 HB/XBS 76W-11846-2

**Tektronix**