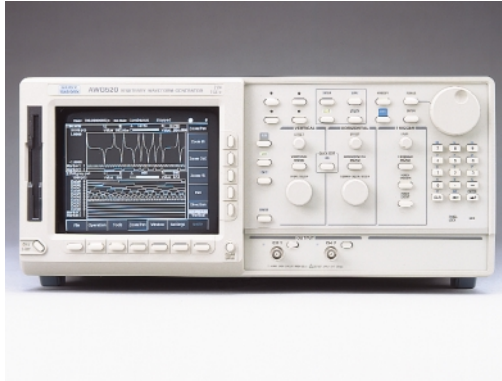


# ARBITRARY WAVEFORM GENERATOR

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  $2 V_{p-p}$ .

## 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:  $\pm 1$  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  $\mu$ s to 10.0 s.

Resolution: 3 digits, 0.1  $\mu$ s minimum.

Accuracy:  $\pm 0.1\%$ .

### 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:  $\pm 1$  LSB.

Integral Non-Linearity:  $\pm 1$  LSB.

**Normal Out** –

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

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

$\leq 2.5$  ns; Amplitude  $\leq 1.0$  V,  $\leq 1.5$  ns.

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

$\leq 2.5$  ns; Amplitude  $\leq 1.0$  V,  $\leq 1.7$  ns.

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

$\pm 10\%$ ; Amplitude  $\leq 1.0$  V,  $\pm 7\%$ .

Flatness (after 50 ns from rise/fall edge):  $\pm 3\%$ .

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:  $\leq -50$  dBc, DC to 400 MHz.

Noise:  $\leq -53$  dBc, DC to 400 MHz.

Phase Noise:  $\leq -90$  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:  $0.5 V_{p-p}$  (with  $-0.27$  V offset) into  $50 \Omega$ .

Amplitude Accuracy:  $0.5 V_{p-p} \pm 10\%$ .

DC Offset Accuracy:  $-0.27$  V  $\pm 10\%$  (waveform data = 0).

Pulse Response (–1 and 1 waveform data):

Rise time (10 to 90%):  $\leq 700$  ps.

Fall time (10 to 90%):  $\leq 700$  ps.

**Output Impedance** –  $50 \Omega$ .

**Connector** – Front Panel BNC.

### AUXILIARY OUTPUTS

**Marker** –

Number:

AWG 510: 2.

AWG 520: 4.

Level:

Hi/Lo:  $-2.0$  V to  $2.0$  V ( $0.05 V_{p-p}$  to  $4 V_{p-p}$ ) into  $50 \Omega$ ;  $-4.0$  V to  $4.0$  V ( $0.1 V_{p-p}$  to  $8 V_{p-p}$ ) into  $1 M\Omega$ .

Resolution: 0.05 V.

Accuracy: Within  $\pm 0.1$  V  $\pm 5\%$  of setting.

Rise/Fall Time (10 to 90%):

At  $1 V_{p-p}$ , Hi +0.5 V/Lo  $-0.5$  V: 0.5 ns.

At  $2 V_{p-p}$ , Hi +1 V/Lo  $-1$  V: 1.0 ns.

At  $4 V_{p-p}$ , 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:  $\pm 2.5$  dB at 100 MHz.

Flatness:  $\pm 2.5$  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 ( $0.1 V_{p-p}$  to  $4 V_{p-p}$ ) into  $50 \Omega$ ;  $-4.0$  V to  $4.0$  V ( $0.2 V_{p-p}$  to  $8 V_{p-p}$ ) into  $1 M\Omega$ .

Resolution: 0.1 V.

Accuracy: Within  $\pm 0.1$  V  $\pm 5\%$  of setting.

Rise/Fall Time (10 to 90%):

At  $1 V_{p-p}$ , Hi +0.5 V/Lo  $-0.5$  V: 0.5 ns.

At  $2 V_{p-p}$ , Hi +1 V/Lo  $-1$  V: 1.0 ns.

At  $4 V_{p-p}$ , Hi +2 V/Lo  $-2$  V: 2.0 ns.

Skew Between Data:  $\leq 1$  ns, 330 ps typical.

Delay:

Data to marker: 4.4 ns.

Clock to data: 3.7 ns.

Connector: Rear-panel SMB.

**AUXILIARY INPUTS**

**Trigger In –**

Impedance: 1 kΩ or 50 Ω.

Polarity: POS or NEG.

Input Voltage Range:

1 kΩ: ±10 V.

50 Ω: ±5 V.

Threshold:

Level: –5.0 V to 5.0 V.

Resolution: 0.1 V.

Accuracy: ±(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: ≤384 clock + 20 ns.

Impedance 2.2 kΩ, 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 Ω.

Bandwidth (–3 dB): DC to 200 MHz at 1 V<sub>p-p</sub> input.

Amplitude Accuracy: ±5%.

Connector: Front-panel BNC.

**Reference 10 MHz Clock IN –**

Input Voltage Range: 0.2 V to 3.0 V<sub>p-p</sub>, ±10 V maximum.

Impedance: 50 Ω, AC coupled.

Frequency Range: 10 MHz ±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** – ±10 V<sub>max</sub>.

**Impedance** – 50 Ω, 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
<b>Weight</b>	<b>kg</b>	<b>lb.</b>
Net	17	37.5

**WARRANTY**

One year parts and labor.

**OTHER**

**Programmable Interface –**

GPIB: 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:



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