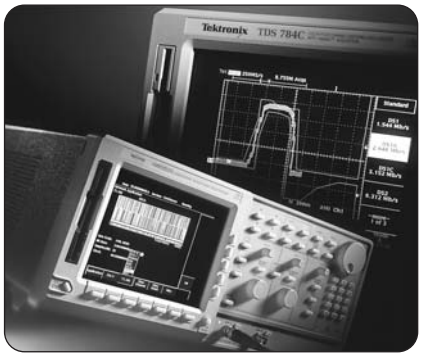
Arbitrary Waveform Generators

AWG520

AWG520.

AWG520 Solves Communications Physical Layer and Media Storage Design and Test Challenges

The AWG520's unique design combines a graphical editing display with powerful output capabilities to simplify the creation of arbitrary and complex waveforms and enable easy on-screen waveform editing. With the AWG520's many built-in intuitive and powerful features, you can easily develop and edit custom waveforms. Option 03 adds an independent 10-bit-wide digital data port that can be used in conjunction with marker outputs for data generation up to 14-bits wide at up to 1 GHz (14-bits, AWG520). Direct waveform transfer capability makes the AWG520 the perfect complement to selected Tektronix oscilloscopes.



The AWG520 can easily generate telecom signals which complement masks from a digital oscilloscope.

Features & Benefits

Two Channels with 10-Bit Vertical Resolution

Independent 10-Channel, 1 GHz Digital Data Generation (Opt. 03)

Built-in Independent Real-time Noise Generation

External Clock Input Permits Jitter Insertion and Synchronization

Supports Direct External Clock and 10 MHz Reference Input

Unique Real-time Sequencing Links Multiple Waveform Files Creating Waveforms of Nearly Infinite Length

Built-in Application Generates Jitter, Data Communication and Disk Drive Waveforms

User Modified Isolation Pulse for Disk Drive Testing

Built-in 10 GB Hard Drive for Mass Data Storage that Can Optionally Be Made Removable for Secure Applications (using Opt. 11)

Optional 128 MB Flash Disk for ATE Applications (Opt. 10)

Replace Standard Function and Sweep Generators in Wide Range of Applications

Applications

Communications Design and Test:
- Low Frequency Modulated RF with Components Using AM and FM Modulation
- 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

Pulse Generation:
- Duty Cycle Ranges from 0% to 100% for NRZ Data
- Testing Clock/Gating Width Variations

Real-world Simulations:
- Corrupt Ideal Waveforms
- Add Jitter to Waveforms
- EMP/EMI and Other System Noise
- Power Supply Noise and Ripple
- Transducer Simulation

Tektronix
Enabling Innovation

▶ 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.

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

Function Generator Waveforms

Operation Mode – Continuous mode only.

Waveform Shape – Sine, Triangle, Square, Ramp, Pulse, or DC.

Frequency – 1.000 Hz to 100.0 MHz.

Amplitude –
Range: 0.020 V_{p-p} to 2 V_{p-p} into 50 Ω.
Resolution: 1 mV.

Offset –
Range: –1.000 V to +1.000 V into 50 Ω.
Resolution: 1 mV.

DC Level – DC waveform only.
Range: –1.000 V to +1.000 V into 50 Ω.
Resolution: 1 mV.

Phase –
Range: –360º to +360º.
Resolution:
- 1.000 Hz to 100.0 kHz: 0.036º step.
- 100.01 kHz to 1.000 MHz: 0.36º step.
- 1.001 MHz to 5.000 MHz: 1.8º step.
- 5.001 MHz to 10.00 MHz: 3.6º step.
- 10.001 MHz to 20.00 MHz: 7.2º step.
- 20.001 MHz to 25.00 MHz: 9º step.
- 25.001 MHz to 40.00 MHz: 14.4º step.
- 40.001 MHz to 50.00 MHz: 18º step.
- 50.001 MHz to 100.0 MHz: 36º step.

Polarity – Normal, Invert.

Duty Cycle –
Range: 0.1% to 99.9%, Pulse waveform only.
Resolution:
- 1.000 Hz to 1.000 MHz: 0.1% step.
- 1.001 MHz to 5.000 MHz: 0.5% step.
- 5.001 MHz to 10.00 MHz: 1% step.
- 10.01 MHz to 20.00 MHz: 2% step.
- 20.01 MHz to 25.00 MHz: 2.5% step.
- 25.001 MHz to 40.00 MHz: 4% step.
- 40.01 MHz to 50.00 MHz: 5% step.
- 50.01 MHz to 100.00 MHz: 10% step.

Marker Out –
Marker1 Pulse Width: Hi/Lo: 20%/80% of Period.
Marker2 Pulse Width:
- Hi/Lo: 50%/50% of Period, except 5.001 MHz to 8.000 MHz.
- Hi/Lo: 52%/48% of Period, at 5.001 MHz to 8.000 MHz.

Marker Level:
- Hi Level: 2 V into 50 Ω.
- Lo Level: 0 V into 50 Ω.

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 – Single-ended; CH1 and CH2.

DA Converter –
Resolution: 10-Bit.
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_{p-p} (with –0.27 V offset) into 50 Ω.
Amplitude Accuracy: 0.5 V_{p-p} ±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.

Channel Output Summary

Output Type	AWG520
Analog	2
Complement	N/A
Marker	CH1: M1, M2 CH2: M1, M2
Digital (Opt. 03)	2 Analog (CH2 Analog = D0 to D9, CH1 and CH2 Analog independent), D0 to D9, 4 Markers

Auxiliary Outputs

Marker –
Number: AWG520: 4.
Level:
Hi/Lo: –2.0 V to 2.0 V (0.05 V_{p-p} to 4 V_{p-p}) into 50 Ω; –4.0 V to 4.0 V (0.1 V_{p-p} to 8 V_{p-p}) into 1 MΩ.
Resolution: 0.05 V.
Accuracy: Within ±0.1 V ±5% of setting.
Rise/Fall Time (10 to 90%, typical):
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: ±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_{p-p} to 4 V_{p-p}) into 50 Ω; –4.0 V to 4.0 V (0.2 V_{p-p} to 8 V_{p-p}) into 1 MΩ.
Resolution: 0.1 V.
Accuracy: Within ±0.1 V ±5% of setting.
Rise/Fall Time (10 to 90%) typical:
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: ≤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_{p-p} input.
Amplitude Accuracy: ±5%.
Connector: Front-panel BNC.

Reference 10 MHz Clock IN –
Input Voltage Range: 0.2 V to 3.0 V_{p-p}, ±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_{p-p} to 1 V_{p-p}.

Maximum Input Voltage Range – ±10 V_{max}.

Impedance – 50 Ω, AC coupling.

Frequency Range – 10 MHz to 900 MHz.

Duty Cycle Ratio – 40% to 60%.

Pulse Width – 0.5 ns minimum.

Connector – Rear panel BNC.

Display

Area – 13.2 cm (5.2 in.) horizontal by 9.9 cm (3.9 in.) vertical.

Resolution – 640 horizontal by 480 vertical pixels.

Data Storage

Internal Hard Disk Drive – 10.0 GB (standard).

Floppy Disk Drive – 3.5 in., 1.44 MB.

Option 10 – Substitute flash disk (128 MB) for HDD, add standby switch. (Opt. 10 is best suited for ATE and system usage requiring 7x24 hour operation.)

Option 11 – Substitute Internal Hard Disk Drive with removable 10.0 GB Hard Disk Drive mounted on top of the instrument

Environmental, EMC, Safety

Temperature –
Operating: 10 ºC to +40 ºC.
Nonoperating: –20 ºC to +60 ºC.

Humidity –
Operating: 20 to 80%, noncondensing.
Nonoperating: 5 to 90%, noncondensing.

Altitude –
Operating: Up to 4,500 m. (15,000 ft). Maximum operating temperature decreases 1 ºC 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^2 (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 – 600 W at 8 A maximum.

Physical Characteristics

Dimensions	**mm**	**in.**
Height	178	7.0
Height with Opt. 11	215.5	8.48
Width	422	17.5
Depth	560	25.8
Weight	**kg**	**lbs.**
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

AWG520

Programmable Dual-channel Arbitrary Waveform Generator.

Includes: User manual (071-0099-00), Programmer manual (071-0100-00), GPIB programming examples disk (063-2982-00), sample waveform library disk (063-2981-00), AXW100 ArbExpress Software Utility CD (063-3763-00), performance verification disk (063-2983-00), power cord, fuse (159-0239-00). Please specify power plug when ordering.

Recommended Accessories

Service Manual – Order 071-0101-01.

Protective Cover – Order 200-3696-01.

GPIB Cable – Order 012-0991-01.

50 Ω BNC Cable (36-inch) – Order 012-1341-00.

50 Ω BNC Cable (98-inch) – Order 012-1256-00.

50 Ω SMB Cable – Order 012-1458-00.

50 Ω SMB-to-BNC Cable – Order 012-1459-00.

50 Ω BNC Termination – Order 011-0049-02.

800 MHz BNC Low-pass Filter – Order 015-0660-00.

400 MHz BNC Low-Pass Filter – Order 015-0659-00.

200 MHz BNC Low-Pass Filter – Order 015-0658-00.

100 MHz BNC Low-Pass Filter – Order 015-0657-00.

Rackmount Conversion Kit – Order 016-1675-01.

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

Spare Removable Hard Disk Kit – Order 650-4643-00 (Opt. 11 must be installed).

Options

Opt. 03 – CH. 2 10-Bit output up to 1 GHz.

Opt. 10 – Flashdisk (128 MB) and standby switch – removes HDD.

(Opt. 10 is best suited for ATE and system usage requiring 7x24 hour operation.)

Opt. 11 – Removable Hard Disk (exclusive to Option 10 and/or Option 3).

Opt. 1R – Rackmount.

Power Plug Options

Opt. A0 – North America Power.

Opt. A1 – Universal EURO Power.

Opt. A2 – United Kingdom Power.

Opt. A3 – Australia Power.

Opt. A4 – 240 V, North America Power.

Opt. A5 – Switzerland Power.

Service

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 Option C3).

Opt. D5 – Calibration Data Report 5 Years (with Option C5).

Opt. R3 – Repair Service 3 Years.

Opt. R5 – Repair Service 5 Years.

Warranty

One year parts and labor.

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Our most up-to-date product information is available at:
www.tektronix.com

Product Area Assessed: The planning, design/development and manufacture of electronic Test and Measurement instruments.

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

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