Arbitrary Generators
Signal Sources

Couple these ARB's with our 2200, 2400 or TDS Series Digital Scopes for complete test application requirements. Additional flexibility with the AWG 2020 built-in controller and 3.5 inch PC compatible disk.

AWG 2020

- Arbitrary Waveform Generation
- 256K (262,144 Points) Record Length
- Built-in PC-Compatible 3.5 in. 1.4 Mbyte Floppy Disk for Storage and Transfer
- Digital Signal Processing (Opt. 09)
- 12-bit Digital Output (Opt. 03)
- DOS-like Waveform File Management
- Formula Entry of Parameters for Mathematically Precise Waveforms

AFG 2020

- Synthesized Arbitrary Function Generation using Direct Digital Synthesis Techniques
- 1K (1024 points) Record Length
- 100 MHz Sinewave Generation
- 50 MHz Square Wave
- 31.2 MHz Triangle, Ramp, and Pulse
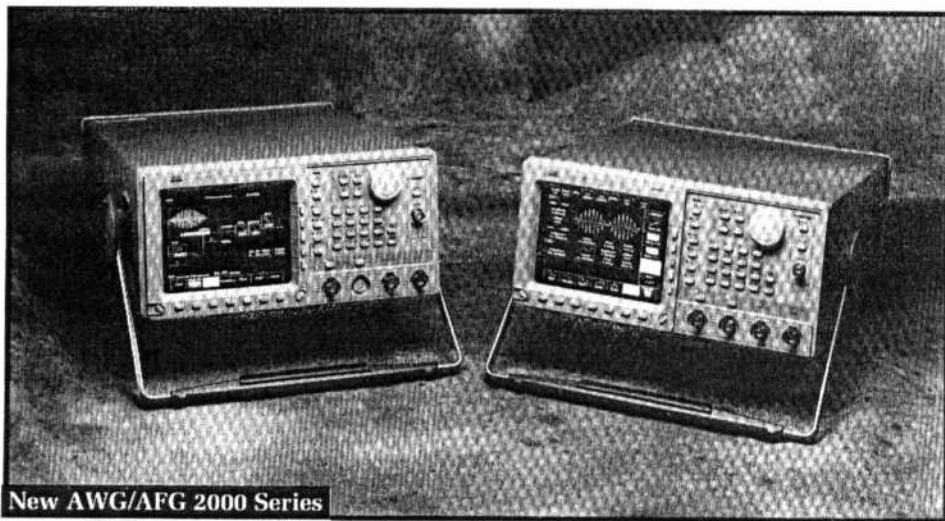- AM/FM/PSK/FSK Modulation
- Built-in Linear/Log Sweep

To order, contact your local sales office (listed on the inside back cover) or call the National Marketing Center at 1-800-426-2200, Ext. 99.

New AWG/AFG 2000 Series

New AWG/AFG 2000 Series

The Tektronix AWG 2020 and AFG 2020 Arbitrary Generators combine the function of an arbitrary generator with a controller and a graphical user interface. A built-in high-resolution monitor facilitates waveform definition.

The AWG 2020 and AFG 2020 share a common user interface design and monolithic platform. While the basic operation is similar, each unit provides unique benefits. The AWG 2020 is ideal for generating complex waveforms requiring long record lengths – up to 256K. It also includes a built-in 3.5 inch floppy disk to facilitate data storage and waveform transfers. An MS-DOS compatible file management system allows waveform generation and transfer without an external controller for most operations.

The AFG 2020 is ideal for applications requiring both precision functions and limited arbitrary waveform generation. It uses Direct Digital Synthesis (DDS) to generate highly accurate waveforms that can be defined in a 1K record length. It can generate standard sinewaves up to 100 MHz, square waves up to 50 MHz, and triangle, ramp, and pulse waveshapes up to 31.2 MHz.

GENERATE A VARIETY OF WAVEFORMS WITHOUT A CONTROLLER

Standard waveshapes available include sine, square, triangle, ramp, pulse, and DC. Coupled with flexible triggering, gating, and modulation capabilities, you have complete control over waveform generation. In addition, you can precisely define waveforms using polynomial formula entry of mathematical parameters.

GRAPHICAL USER INTERFACE SIMPLIFIES OPERATION

A unique windows-like graphical user interface (GUI) provides a familiar user environment and simplifies operation. The icon-based GUI features soft-key menu selections. As you enter data to build your waveform, you can view the resultant signal on the integral display.

USE STANDARD WAVEFORMS OR CREATE YOUR OWN

You can use any of several methods to create a new arbitrary waveform. You can select one of the standard waveshapes from the library and modify it to produce the desired waveshape using the graphical waveform editing tools. Or, waveforms can be acquired with a companion digital oscilloscope (DSO) and transferred to the AWG 2020 or AFG 2020 via the GPIB – an external controller is **not** required for transfer. A series of waveforms can be executed via the internal DOS-like file manager.

Unique waveforms can be created in exacting detail using the graphical editing features to define waveshapes. Or you can use the formula entry mode to precisely define waveforms based upon mathematical equations, timing diagrams, or timing tables.

THE PERFECT COMPANION FOR YOUR TEKTRONIX SCOPE

The AWG 2020 and AFG 2020 feature direct communication with the Tektronix 2200, 2400, and TDS series digitizing oscilloscopes. Waveforms acquired with these scopes can be transferred to the AFG 2020 or AWG 2020, edited for desired features, and used as testing sequences. All of this can be done without the need for an external controller.

FULLY PROGRAMMABLE VIA GPIB

The AWG 2020 and AFG 2020 are fully programmable via a GPIB interface (IEEE 488.2). As a result, they are ideal additions to provide stimulus and arbitrary waveform generation for your measurement system.

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AFG 2020
AWG 2020

ARBITRARY GENERATORS

AWG 2020 Characteristics

SYNTHESIZED WAVESHAPES
Sine, square, triangle, ramp, pulse, arbitrary, and DC.

ARBITRARY WAVEFORMS
Waveform Memory – Memory Length: 256K x 12 bits for waveform data; 256K x 1 bit for Marker 1 data; 256K x 1 bit for Marker 2 data. Waveform: 64 to 256K in multiples of 8 data points.

Sequence Memory – 8K.

Scan Counter – 1 to 64K (16 bits).

Burst Counter – 1 to 64K (16 bits).

RATE CLOCK
Frequency Range – 10 Hz to 250 MHz.

Display – 4 digit.

Accuracy – +10°C to +40°C: 0.01%. +15°C to +30°C: 0.005%.

Resolution – 0.1% to 0.01% typical.

Skew between CH 1 and CH 2 (Opt. 02 only) – Within 4 ns.

MAIN OUTPUTS
Amplitude (excluding ADD and Multiply Operation) – Range: 0.05 V to 5 Vp-p into 50 Ω. Resolution: 1/4096 (12 bits). DC Accuracy: 0.05 V to 0.5 V, ±(0.5% of amplitude +5 mV); 0.501 V to 5 V, ±(1% of amplitude +25 mV).

Offset – Range: –2.5 V to +2.5 V into 50 Ω, (–100 mA to +100 mA). Resolution: 0.2 mA. Accuracy: ±(1% of offset +0.2 mA).

Pulse Response – +15°C to +30°C: Flatness, within 3% after 20 ns from rise/fall edges; Aberrations, within 7% +10 mV. +10°C to +40°C: Rise/Fall Time, <4 ns; Flatness, within 5% after 20 ns from rise/fall edges; Aberrations, within 9% +10 mV.

Impedance – Typically 50 Ω.

Harmonic Distortion (at 250 MHz clock, 0.5 V amplitude, 5000 points for sinewave data, no offset, no filter) – Second Harmonics: At least –40 dBc. Third Harmonics: At least –50 dBc.

OPERATING MODES
Continuous – Output continuous at programmed waveshape, frequency, amplitude, and offset.

Triggered – Output quiescent until triggered by an external, GPIB, or manual trigger; then generates a sequence only one time.

Gated – Same as triggered mode except period is executed only for the duration of the gated signal until the sequence started is completed.

Burst – Output quiescent until triggered by an external, GPIB, or manual trigger; then generates "n" sequences or cycles.

Waveform Advance – Continuously generates the waveform in the predefined sequence; the next trigger advances to the next waveform in the sequence.

Autostep – Generates the predefined waveform in the Autostep File; the next trigger advances the waveform.

ARITHMETIC OPERATION
AM (Multiply) (Opt. 02 only) – Output: Within 5%. Frequency Response: DC to 30 MHz.

External AM – Sensitivity: 2 Vp-p (±5%) signal produces 100% modulation. Frequency Response: CH 1, DC to 30 MHz; Ext Signal, DC to 4 MHz.

Add (Opt. 02 only) – Output: Within 5%. Frequency Response: DC to 30 MHz.

FILTERS
3 dBcutoff frequency – 1 MHz: Within 20%. 5 MHz: Within 20%. 20 MHz: Within 20%. 50 MHz: Within 20%.

Delay – 1 MHz: Typically 390 ns. 5 MHz: Typically 78 ns. 20 MHz: Typically 18 ns. 50 MHz: Typically 11 ns.

AUXILIARY OUTPUTS
Sync – Amplitude: 1 V ±0.3 V typical into 50 Ω. Impedance: 50 Ω typical. Sync to Signal Delay: Within 15 ns.

Marker 1 – Amplitude: 1 V ±0.3 V typical into 50 Ω. Impedance: 50 Ω typical. Marker to Signal Delay: Within 15 ns.

Marker 2 – Amplitude: 1 V ±0.3 V typical into 50 Ω. Impedance: 50 Ω typical. Marker to Signal Delay: Within 15 ns.

Clock – Amplitude: 1 V ±0.3 V typical into 50 Ω. Impedance: 50 Ω typical.

Digital Data Out (Opt. 03 only) – Level: ECL compatible. Output Signals: Data (D0 to D11). Skew Between Data: Within 1 ns. Clock to Data Delay: Within 3 ns. Connector: 68-pin mini-D sub.

AUXILIARY INPUTS
Trigger – Threshold Level: –5 V to +5 V. Resolution: 0.1 V. Accuracy: ±(5% x Level + 0.1 V). Pulse Width: 15 ns minimum. Input Swing: 0.2 V minimum. Maximum Input Volts: 10 Vp-p when 1 MΩ selected; 5 V RMS when 50 Ω selected. Impedance: 1 MΩ with 30 pF max. Trigger to Signal Delay: Internal Clock, 100 ns maximum; External Clock, 100 ns maximum +1 clock. Trigger Holdoff: 1 sec maximum (except Auto Step Mode).

AM – Range: 2 Vp-p (–1 V to +1 V) for 100% modulation. Maximum Input: ±5 Vp-p, 10 kΩ typical impedance.

Clock – Threshold Level: 0.3 V ±0.1 V typical. Input Swing: 0.8 V minimum. Pulse Width: 2 ns minimum. Maximum Input Voltage: ±2 Vp-p. Impedance: 50 Ω typical. Frequency Range: Up to 250 MHz.

PROGRAMMABLE INTERFACE
GPIB – IEEE-488.2-1987 compatible.

AFG 2020 Characteristics

WAVESHAPES
Sine, square, triangle, ramp, pulse, and arbitrary.

FREQUENCY/PHASE (SYNTHESIZER ON)
Clock – 250 MHz.

Frequency – 10 digits. Range: Sine, 0.5 Hz to 100.00 MHz; Other, 0.5 Hz to 2.5 MHz. Resolution: 0.5 Hz. Accuracy: ±(Reference Oscillator Accuracy + 0.12 Hz).

Period – Same digit as frequency, 2.0 sec to 10.00000000 ns.

Points/Cycle – 5 digits, 250 MHz divided by frequency for <100 MHz, up to 1024 or 2048.

Phase – 4 digits. Range: ±360°. Resolution: 0.1°.

FREQUENCY/PHASE (SYNTHESIZER OFF)
Frequency – 3 digits. Range: Square, 0.500 Hz to 50.00 MHz; Other, 0.500 Hz to 31.2 MHz. Accuracy: ±0.1%.

Period – Same digit as frequency, 2.00 sec to 40.0 ns.

Points/Cycle – 5 digits.

Clock/Rate – 512 Hz to 250 MHz.

AMPLITUDE/OFFSET
Amplitude – 4 digits. Resolution: 0.4 Vp-p, 1 mVp-p; 2 Vp-p, 2 mVp-p; 10 Vp-p, 10 mVp-p. Max. Amplitude: 10 Vp-p into 50 Ω; 20 Vp-p open circuit.

DC Accuracy – Range: 0.4 Vp-p, ±(1.0% of setting +1 mVp-p); 2.0 Vp-p, ±(1.0% of setting +5 mVp-p); 10 Vp-p, ±(2.5% of setting +50 mVp-p).

Offset – 4 digits. Resolution: 0.4 Vp-p, 1 mV; 2 Vp-p, 2 mV; 10 Vp-p, 10 mV. Max Offset: ±5 V into 50 Ω; ±10 V open circuit. Accuracy: 0.4 Vp-p, ±(1.0% of setting +1 mV); 2.0 Vp-p, ±(1.0% of setting +5 mV); 10 Vp-p, ±(2.5% of setting +50 mV).

Noise Floor – Range: 0.4 Vp-p, –128 dBm/Hz at 10 MHz; 2.0 Vp-p, –114 dBm/Hz; 10 Vp-p, –100 dBm/Hz.

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SINE

Maximum Points – 2048; 1024 with synthesizer off.

SSB Phase Noise – Synthesizer On: –90 dBc/Hz. Synthesizer Off: –80 dBc/Hz.

Harmonics – Synthesizer On with 100 MHz LPF:

	10 Vp-p	2 Vp-p, 0.4 Vp-p
<100 kHz	–40 dBc	–60 dBc
1 MHz	–40 dBc	–55 dBc
10 MHz	–35 dBc	–55 dBc
100 MHz	–25 dBc	–30 dBc

Synthesizer Off with 50 MHz LPF:

	10 Vp-p	2 Vp-p, 0.4 Vp-p
<100 kHz	–40 dBc	–55 dBc
1 MHz	–40 dBc	–55 dBc
10 MHz	–35 dBc	–40 dBc
100 MHz	–35 dBc	–40 dBc

Spurious –

	Synthesizer On	Synthesizer Off
<50 kHz	–60 dBc	–55 dBc
500 kHz	–55 dBc	–55 dBc
5 MHz	–45 dBc	–45 dBc
31.2 MHz	–40 dBc	–35 dBc
50 MHz	–40 dBc	
100 MHz	–30 dBc	

Amplitude – Flatness: Synthesizer On with 100 MHz LPF

	10 Vp-p	2 Vp-p, 0.4 Vp-p
≥100 kHz to ≤50 MHz	±0.5 dB	±0.5 dB
≤100 MHz	±1.0 dB	±0.5 dB

Synthesizer Off with 50 MHz LPF

	All
≥100 kHz to ≤10 MHz	±1.0 dB
≤31.2 MHz	±3.0 dB

Accuracy: 0.4 Vp-p and 2.0 Vp-p, DC accuracy ±3.0% + Flatness; 10 Vp-p, DC accuracy ±5.0% + Flatness. Power: 4 digits up to 23.98 dBm.

SQUAREWAVES

Maximum Points – 2048; 1024 with synthesizer off.

Amplitude – Flatness:

	50 MHz LPF	Full Pass
≤100 kHz to	±2.0%	±2.0%
≤2.5 MHz	±5.0%	±5.0%
≤15.6 MHz	±5.0%	±5.0%
≤50 MHz	–30%	±10%

Accuracy: DC accuracy ±2% + Flatness.

Rise/Fall Time – With 50 MHz LPF: Within 9.0 ns. With Full Pass: Within 4.0 ns.

Aberrations – With 50 MHz LPF: 0.4 Vp-p and 2 Vp-p, within 5% + 2 mVp-p; 10 Vp-p, within 7% + 10 mVp-p. With Full Pass: 0.4 Vp-p and 2 Vp-p, within 7% + 2 mVp-p; 10 Vp-p, within 12% + 10 mVp-p.

TRIANGLE WAVES

Maximum Points – 2048; 1024 with synthesizer off.

Amplitude – Flatness with 50 MHz LPF: ≤100 kHz, ±2.0%; ≤2.5 MHz, –7.0%; ≤15.6 MHz, –20%; ≤31.2 MHz, –40%. Accuracy: DC accuracy ±4.0% + Flatness.

RAMP

Maximum Points – 1024.

Timing – Rise/Fall: 4 digits, 0% to 100% of period.

Amplitude – Flatness with 50 MHz LPF: ≤100 kHz , ±2.0%; ≤2.5 MHz, –8.0%; ≤15.6 MHz, –25%; ≤31.2 MHz, –45%. Accuracy: DC accuracy ±4.0% + Flatness.

PULSE

Maximum Points – Gaussian: 2048; 1024 with synthesizer off. Exponential: 1024. Linear: 2048; 1024 with synthesizer off.

Pulse Width – 20% to 50.0% of period.

Transition – 0% to 35.0% of pulse width.

Amplitude – Flatness with 50 MHz LPF: ≤100 kHz , ±2.0%; ≤2.5 MHz, –5.0%; ≤15.6 MHz, –5.0%; ≤31.2 MHz, –20%. Accuracy: DC accuracy ±2% + Flatness.

ARBITRARY

Maximum Points – Any periodic waveform described with 12 bits and 1024 points.

Number of Waveforms – 16.

SWEEP

Spacing – Linear, log.

Frequency – 5 digits. Start, stop: Sine, 1.0 Hz to 100 MHz; Others, 1.0 Hz to 2.5 MHz.

Step (Linear) – Within 2.5 MHz, 5 digits.

Points/decade (Log) – 10 to 1000, 1-2-5 sequence; 1.0 Hz to 10 Hz, ≤10; 10 Hz to 100 Hz, <100; 100 Hz to 1 kHz, <1000; 1 kHz to 100 MHz, ≤1000.

Dwell Time – 4 digits. Sweep: 0.5 µs to 100 sec. Return: 0.5 µs to 100 sec.

Marker – Number: 3. Frequency: Between Start and Stop. Time: 0.5 µs to 100 sec.

Points – Sweep: 2 to 5001. Return: 1 to 5000.

Maximum Period – 2048 seconds ≤ Sweep + Return Time.

MODULATION

Amplitude Modulation – Amplitude: 4 digits, –10.00 Vp-p to +10.00 Vp-p. External CH 2 Amplitude, 1 Vp-p typical. Depth: 3 digits, 0 to 100%. Double Sideband Suppressed Carrier: ON/OFF. Modulation Rate: Period, 10 µs to 1 sec every 0.2 µs; Accuracy, ±0.1%. Risetime: Within 2 µs. AM Noise: Within 1% of range.

Offset Modulation – High, Low: 4 digits, –5.000 Vp-p to +5.000 V. Modulation Rate: Period, 10 µs to 1 sec every 0.2 µs; accuracy, ±0.1%. Risetime: Within 2 µs. Modulation Noise: Within 1% of range.

Frequency Modulation – Center Frequency: 9 digits. Deviation: 6 digits. Modulation Rate: Period, 10 µs to 1 sec every 0.2 µs; accuracy, ±0.1%.

Frequency Shift Keying (FSK) – Key: Number of Keys, 2 to 256: Frequency, within 100 MHz (sine) or 2.5 MHz (other); Amplitude, within 10 Vp-p; Offset, within ±5 V. Data: Number of Data, 2 to 2,048. Frequency Transition Time: 4 ns. Data Rate: 1 to 2,500,000; Period, 1 sec to 0.4 µs, every 0.1 µs.

Phase Shift Keying (PSK) – Key: Number of Keys, 2 to 256: Phase, within ±360.0°; Amplitude, within 10 Vp-p; Offset, within ±5 V. Data: Number of Data, 2 to 2,048. Phase Transition Time: 800 ns (200 clocks). Data Rate: 1 to 50,000; Period, 1 sec to 20 µs, every 0.1 µs.

CLOCK

Reference Oscillator – Type: TCXO. Nominal Frequency: 10 MHz. Accuracy: ±1 ppm (0°C ~ 50 °C). Stability: ±1 ppm/year (20°C ~ 30°C).

MAIN OUTPUT

Filters – 100 MHz Brick Wall: Within 1 dB to 100 MHz; less than –40 dB, 125 MHz to 1 GHz. 50 MHz Linear Phase: –3 dB ±0.5 dB at 50 MHz.

Output Impedance – 50 Ω typical.

Output Protection – The instrument is non-destructively protected against short circuits or accidental voltage of up to ±5 VDC plus peak AC applied to the main output connector.

AUXILIARY OUTPUTS

Sync Output – Positive TTL level. Min. Pulse Width: 400 ns. Output Impedance: 51 Ω nominal.

Marker Output – Positive TTL level. Min. Pulse Width, 100 ns. Output Impedance: 51 Ω nominal.

10 MHz Output – TTL level square wave. Duty Cycle: 50% to 75%. Output Impedance: 51 Ω nominal.

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AUXILIARY INPUTS

Trigger/Gate In – Sensitivity: 200 mVp-p min. Bandwidth: DC to 10 MHz. Amplitude: 30 ns, 200 mVp-p amplitude. Input Impedance: 1 kΩ ±5%. Max. Input Voltage: ≤10 VDC + peak AC. Threshold: Positive slope for Arming and Time Burst, and positive true for Gate. Negative slope for Arming and Time Burst, and negative true for Gate. Range: ±9.90 V. Resolution: 0.1 V. Accuracy: ±10% ±100 mV.

AM Input – Input Impedance: 10 kΩ ±5%. Max. Input Voltage: 10 VDC + peak AC.

REF IN – TTL compatible. Range: 10 MHz ±10 kHz. Input Impedance: 10 kΩ ±5%. Max. Input Voltage: 0 V to +5 V.

OPERATING MODES

Continuous – Generates the waveform continuously.

Triggered Continuous – Output quiescent until triggered by an external, GPIB, or manual trigger; then generates a sequence after pre-defined delay and stops by STOP command or GPIB command.

Gated – Same as triggered mode except period is executed after the pre-defined delay for the duration of the gated signal. The last sequence started is completed.

Time Burst – Output quiescent until triggered by an external, GPIB, or manual trigger; then generates "n" sequences or cycles.

TRIGGER

Trigger Delay – 5 digits, 0.7 μs to 100 sec. Accuracy: Synthesizer On, ±(0.1 μs + 0.01%); Synthesizer Off, ±(0.2 μs + 0.01%).

Time – 3 digits, 0.4 μs to 100 sec. Accuracy: ±0.1 μs.

PROGRAMMABLE INTERFACE

GPIB – IEEE-488.2-1987 compatible.

RS-232C – 25-pin D connector.

General Characteristics (applies to both the AWG 2020 and AFG 2020)

ENVIRONMENTAL

Temperature – Operating: +10°C to +40°C. Non-operating: –20°C to +45°C.

Temperature Change – Operating: ≤15°C per hour (no condensation). Non-operating: ≤30°C per hour (no condensation).

Humidity – Up to 80% RH.

Altitude – Operating: 4.6 km (15,000 ft.). Non-operating: 15 km (50,000 ft.).

Vibration – 0.003 in. p-p, 5 Hz to 55 Hz (0.5g at 55 Hz).

Shock – 20 g (1/2 sine) 11 ms duration.

EMC – Within limits of FCC Regulations, Part 15, Subpart J, Class A; VDE 0871/6.78, Class B.

Electrical Discharge – Operating max test voltage: 15 kV (150 pF through 150 Ω).

Safety – Designed to meet UL 1244 and CSA 22.2 No. 231.

POWER

Source Power – Voltage Ranges: Selectable from 90-127 VAC or 180-250 VAC with internal jumper. Line Frequency: 48-63 Hz.

Power Dissipation – 300 W.

Maximum Current – 5 amps.

PHYSICAL

Dimensions	mm	in.
Height	164	6.4
Width (with handle)	362	14.25
Length	491	19.25
Weight	**kg**	**lbs.**
Net	9.0	19.8

OTHER

Display – 7 in. diagonal, electro-magnetic deflection CRT.

Recommended Adjustment Interval – 1000 hours or 6 months, whichever occurs first.

ORDERING INFORMATION

AWG 2020
Programmable Arbitrary Waveform Generator $11,995
Includes: User Manual, Programmers Manual, Waveform Data Format Conversion Software, Sample Waveform Library Disk, Power Cable.

Opt. 02 – Add Second Channel	+$4,250
Opt. 03 – 12-bit Digital Out	+$705
Opt. 09 – Digital Signal Processing	+$1,070
Opt. 1R – Rackmount	+$655
Opt. 1B – Service Manual	*1

AFG 2020
Programmable Arbitrary Function Generator $7,995
Includes: User Manual, Programmers Manual.

Opt. 02 – Add Second Channel	+$2,950
Opt. 1R – Rackmount	+$550
Opt. 1B – Service Manual	*1

ADDITIONAL ACCESSORIES

Rackmount Kit – Order 016-1166-00	$350
Accessory Pouch – Order 016-1159-00	$60
Front Cover – Order 200-3232-00	$11.75
Differential Amplifier – Order AM502	$1,795
Programmable Multiplexer – Order SI5010	$2,750

RECOMMENDED OSCILLOSCOPES
Tektronix TDS Series, 2400 Series, or 2200 Series Digital Storage Oscilloscopes.

TEST SOFTWARE
The following optional IBM compatible test software is available for use with the AWG 2020 and AFG 2020:

WaveWriter/AWG – Order S3FT400	$795
TEKTMS/IPG – Order S3FT100	$595
EZ-TEST PC – Order S45F030	$595

INTERNATIONAL POWER PLUG OPTIONS

Opt. A1 – Universal Euro 220 V, 50 Hz	NC
Opt. A2 – United Kingdom 240 V, 50 Hz	NC
Opt. A3 – Australian 240 V, 50 Hz	NC
Opt. A4 – North American 240 V, 60 Hz	NC
Opt. A5 – Switzerland 220 V, 50 Hz	NC

*1Contact your local Tektronix representative for price information.

To order, contact your local sales office (listed on the inside back cover) or call the National Marketing Center at 1-800-426-2200, Ext. 99.

GPIB IEEE-488 The AFG 2020 and AWG 2020 complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.