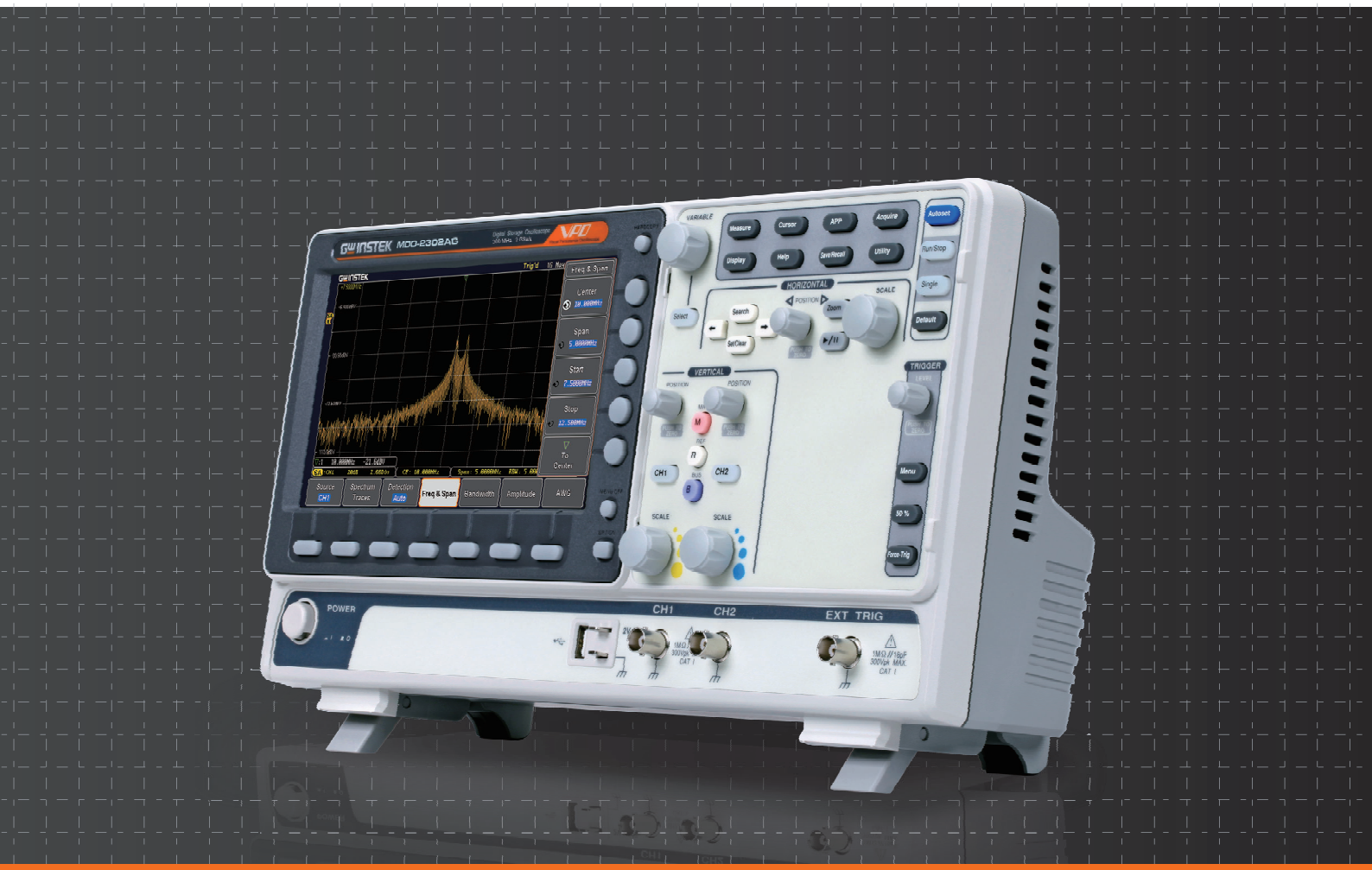


MDO-2000A Series

VPO
Visual Persistence Oscilloscope

300/200/100MHz Mixed-Domain Oscilloscope

FEATURES

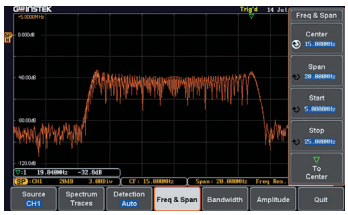
- 300/200/100MHz Bandwidth Selections: 2 Channels
- Maximum Real Time Sampling Rate: 2 GSa/s
- MDO-2000A Equips with a Spectrum Analyzer
  MDO-2000AG Equips with a Spectrum Analyzer ; a Dual Channel 25MHz AWG
- Per Channel 20M Memory Depth and VPO Waveform Display Technology
- Waveform Update Rate up to 120,000 wfm/s
- 8 ” WVGA TFT LCD
- MDO-2000AG Provides Frequency Response Analysis Function
- Maximum 1M FFT Provides Higher Frequency Domain Resolution Measurements
- High Pass, Low Pass and Band Pass Filter Functions
- 29,000 Segmented Memory Sections and Waveform Search Function
- I^2C/UART/CAN/LIN Serial Bus Trigger and Decoding Functions
- Data Log Function is able to Track Signal Changes up to 1000 Hours
- Mask Test Function
- Network Storage Function

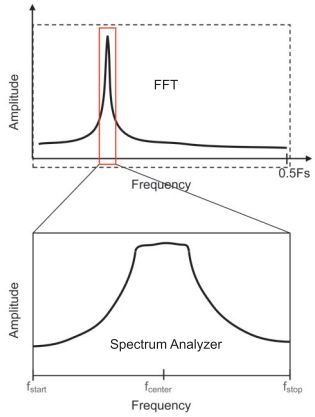
GW INSTEK
Simply Reliable

One Oscilloscope ,Two Domains

MDO-2000A is an advanced version of MDO-2000E. The selectable bandwidth range is upgraded to 300MHz. The full bandwidth ranges include 300MHz, 200MHz and 100MHz. The sampling rate has upgraded to Max. 2GSa/s and the memory depth has also been upgraded to 20M/CH. Hence, the three major specifications of oscilloscopes have been improved. The new models of the series feature 2 channels including MDO-2000A and MDO-2000AG. The entire series offers the functions of oscilloscope and spectrum analyzer. On top of that, MDO-2000AG features a dual-channel 25MHz arbitrary waveform generator. The new generation MDO-2000A series provides better sampling rate and memory depth for users to obtain more realistic signal integrity, and higher bandwidth selections meet the measurement requirements of higher frequencies.

In addition to advanced oscilloscope specifications, the MDO-2000A series is also a dual-domain test platform. For frequency domain analysis, the spectrum analyzer measurement mode is provided to allow users to have frequency domain analysis with higher resolution. The FFT operation on the oscilloscope is limited by the horizontal level setting (sampling rate), and most oscilloscopes only provide 1k FFT points, so users often cannot get the correct frequency domain display. The frequency domain provided by MDO-2000A has an operation interface the same as the general spectrum analyzer. Its fast frequency domain update is like a real time spectrum analyzer. While operating the spectrum analyzer of MDO-2000A, users can input Center frequency, Span, Start frequency, and Stop frequency based upon test requirements so as to rapidly and intuitively observe required frequency range that allows users to experience the user interface of a real spectrum analyzer. While observing frequency domain display, engineers can observe waveform characteristics, which are not easily to be seen from time domain waveforms, for instance, the harmonic composition of a waveform and the frequency characteristics of a modulation signal.





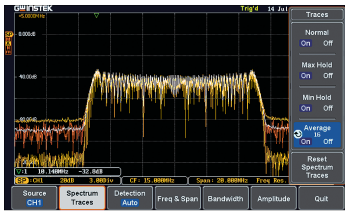
The figure on the right shows why the resolution of the spectrum analysis is better than that of the FFT of the general oscilloscope. Therefore, using the frequency domain signal of the spectrum analysis, the frequency domain peaks and the components of each composition can be correctly captured, which is impossible for the general FFT. Conventional DSO's FFT always calculates the entire signal bandwidth up to half the sampling rate (Fs). However, the insufficient calculation capability can't conduct FFT calculation with more points. Users can't have the signal's detailed frequency information due to the insufficient frequency resolution from the calculation result. Whereas MDO-2000A analyzes signal spectrum of interest. The start frequency and stop frequency of the spectrum analyzer can be selected according to the characteristics of the test signal, so that the frequency domain signal can be displayed on the screen. Compared with oscilloscope' FFT, MDO-2000A series allows engineers to effectively conduct signal measurements on frequency domain. Right illustration shown the conventional DSO's FFT (above figure) VS. MDO-2000A's Spectrum analyzer (below figure).

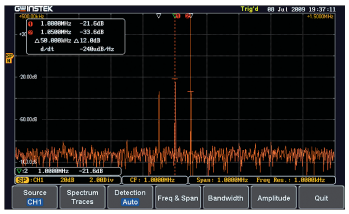
MDO-2000A's spectrum analyzer's frequency measurement range is from DC to 1GHz, which can meet the requirements of the low frequency test of audio and vibration. The general spectrum analyzer cannot measure the signals below 9kHz. The highest frequency of 1GHz is shown on the right. MDO-2000A uses a BNC Cable to connect to the RF Signal Generator to obtain the maximum 1GHz signal frequency. Although the 1GHz signal has attenuated in the time domain, the inut signal can still be obtained in the frequency domain.

The spectrum analyzer of MDO-2000A can automatically adjust to the most appropriate sample rate according to users' input frequency range. The required data for calculation is also from the same sampling. By the tremendous calculation efficiency of Zynq SoC, a large amount of calculation can be done in a very short period of time. Therefore, MDO-2000A can complete a spectrum faster tan a conventional spectrum analyzer . The screen display on the right shows the spectrum results of MDO-2000A's spectrum analyzer of FSK signal. The parameters of FSK signal: 500mVpp sine wave, fmax: 10.2MHz, fmin: 10.0MHz, bit rate: 10.0kHz. Users can directly input Center and Span Frequency by an intuitive and swift setting. Fmax and fmin can be clearly identified from the screen display.

When the same signal is tested by FFT (the left display was the result tested by Keysight DSOX2000A), most users do not know the correlation between the sampling rate of the time domain signal and the frequency of the DUT signal, so the FFT waveform display is not easy to adjust correctly. The slow update, time domain waveform overlapping with the frequency domain waveform, and most DSOs do not provide the search function together make it impossible to clearly analyze the frequency domain waveform and simultaneouslymeasure the components of more than two modulated signals. FFT without RBW setting does not allow users to adjust the output waveform with the best resolution according to the characteristics of the actual waveform.

MDO-2000A's Spectrum Analyzer also includes Spectrum Trace Type settings (Normal, Max-hold, Min-hold, and Average). Users can freely select various Spectrum Traces for simultaneous display. Detection method (Sample, +Peak, -Peak, and Average) can be individually set for each Trace. Additionally, users, via Cursor, can manually mark the corresponding positions to reflect Frequency and Amplitude. The Search function can also be applied to log spectrum's Peak Table. Amplitude is displayed with dB and Marker can obtain measurement data. Display on the right is a FM signal's spectrum.

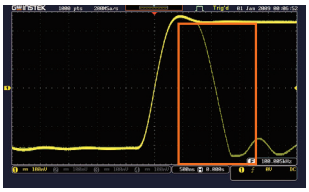




Users can use the Search function to search and mark several amplitudes and frequencies. Search methods include Max. peak and threshold. Measurement results can be displayed and saved.

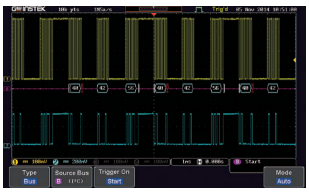
The display on the right shows the frequency domain display of the AM signal. Via the Search function, users can easily capture more than two spectral components

A. 120,000wfm/s WAVEFORM UPDATE RATE AND VPO WAVEFORM DISPLAY TECHNOLOGY



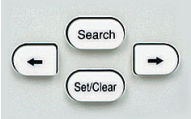
The MDO-2000A series oscilloscope allows users to easily and completely observe inrush signals and rare transient waveforms to increase waveform debugging efficiency by using features, including advanced VPO (Visual Persistence Oscilloscope) signal processing technology, waveform update rate as high as 120,000 wfm/s, and multi-layered afterglow display to enhance waveform display efficiency. Oscilloscope with VPO technology displays signals with three dimensional waveforms constructed by amplitude, time and signal strength to show each waveform point. 256 color gradients yield clear waveform changes. Comparing with the conventional digital storage oscilloscope, the MDO-2000A series provides more natural and more genuine signal display effect which is very close to the original analog signal.

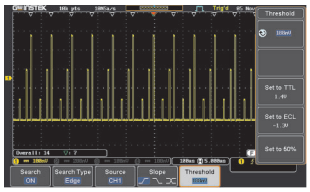
B. SUPPORT I²C, UART, CAN, LIN BUS TRIGGER AND DECODING FUNCTIONS



The serial bus technology has been widely applied in the present embedded application design. The IoT devices connecting sensors and the peripheral components are using serial bus such as UART, I^2C. To rapidly and correctly trigger and analyze serial bus data has posed a difficult challenge to engineers.The MDO-2000A series provides serial bus analysis function with 20M long memory depth. Users can trigger, decode, and analyze frequently used I^2C and UART serial bus and CAN/LIN bus, which is often used by automotive communications.

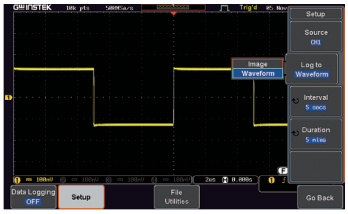
C. WAVEFORM SEARCH FUNCTION





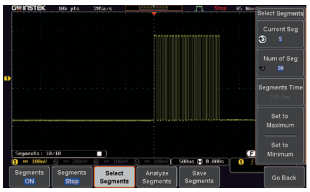
Users can rapidly search desired waveforms according to the trigger condition. After activating the search function, hollow inverted triangles will show the location met the trigger condition. The upper left hand corner Overall will show the total number of waveforms met the trigger condition. Users can set waveform search by the trigger ondition such as Edge, pulse width, Runt, Rise/Fall, and Bus. When the trigger condition is met, hollow inverted triangles will appear. Users can save all marks to compare with the next input signal. The front panel of the MDO-2000A series controls waveform zoom-out and play/pause function to swiftly identify each desired event. The function allows users to conveniently complete waveform search and save marks for rapid comparison and analysis.

D. DATA LOG FUNCTION



Users, via the data log function, can observe waveform changes in long periods of time to ensure product reliability or measure sporadically appeared signals. The data log function, based on the requirements, can set record time and interval. Record time can be selected from 5 minutes to 1000 hours, and record interval is 2 seconds, the minimu. W aveform type for record data and CSV file format for each channel can also be selected. Data can be stored in USB drive, the MDO-2000A series or the remote computer via LAN.

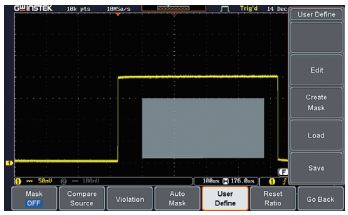
E. SEGMENTED MEMORY FUNCTION



Users Can Select "Analyze Segments" to Conveniently Obtain The Analysis Results.

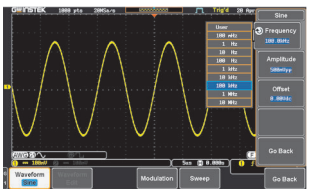
To achieve the most ideal application for memory depth, the MDO-2000A series has the built-in segmented memory function. The segmented memory function allows users to select the desired important signals for observation. Hence, insignificant signals can be neglected and serial bus decoding; pulse or inrush signals can be identified when retrieving signals. The segmented memory function of the MDO-2000A series allows users to select the number of sections. The maximum sections can be selected are 29,000. After activating the function, users can select and observe waveform for each segment by turning the Variable knob. The ultimate application of memory depth, therefore, is completely realized.

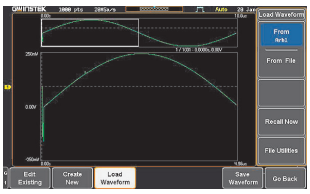
F. MASK FUNCTION



The MDO-2000A series provides the Mask function, which allows users to apply Auto Mask and user-defined Mask to determine whether the quality of the product meets the regulation. Via user-defined mask, users can set up to 8 areas and each area is up to 10 points to meet test requirements. Users can also refer to the examples from user manual to edit Mask by the PC to satisfy all test needs. By setting Save On, users can log and monitor signals, which violate test conditions.

G. 25MHz DUAL CHANNEL ARBITRARY WAVEFORM GENERATOR

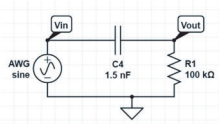


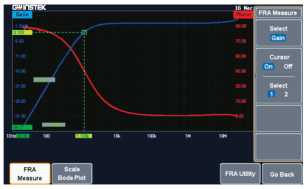


*** MDO-2000AG only**

With respect to signal source, MDO-2000AG features a built-in dual channel 25MHz arbitrary waveform generator with modulation capability and also provides 14 bits vertical resolution; sample rate of 200MSa/s; 13 output waveforms (Sine, Square, Pulse, Ramp, DC, Noise, Sinc, Gaussian, Lorentz, Exponential Rise, Exponential Fall, Haversine, Cardiac); and AM/FM/FSK modulation and sweep function. The friendly user interface is the ideal choice for education and applications such as circuit simulation tests. Arbitrary waveform generator provides users with 16k memory length. The arbitrary waveform can be edited through the PC software, and the edited arbitrary waveform(CSV file) can be recalled by the AWG function.

H. PROVIDE FREQUENCY RESPONSE ANALYSIS (FRA) FUNCTION





*** MDO-2000AG only**

FRA (bode plot) has a very wide application range ,including product circuit and component performance verification and analysis, such as negative feedback networks of switch mode power supplies design (loop response), feedback of circuit design, filter design, amplifier design, resonant Circuit design, cable frequency response and signal transformer performance etc. The diagram above is a RC high pass filter. The -3dB cut-off frequency= 1.06kHz(F=1/2*π*R*C) and the measurement result is 1.1kHz which is quite close to the theoretical value. The frequency test range of FRA and the max. 90 points per decade of test point are higher than that of Keysight InfiniiVision 3000T's option. More points per decade allow users to get higher accurate test results.

PANEL INTRODUCTION

CE | USB high Speed | PC Software | Labview Driver | Ethernet | PictBridge Compatible

1. Hardcopy Key
2. Autoset, Run/Stop, Single & Default Keys
3. Search and Zooming Controls
4. Trigger Controls
5. Math, Reference & Bus Keys
6. Probe Calibration Output
7. USB Host Port
8. Option Key
9. Menu Off Key
10. USB Device Port
11. LAN Port
12. Go-NoGo Output
13. Calibration Output
14. Dual Channel Arbitrary Waveform Generator (MDO-2000AG only)

SELECTION GUIDE

Model	MDO-2302AG	MDO-2202AG	MDO-2102AG	MDO-2302A	MDO-2202A	MDO-2102A
Bandwidth	300MHz	200MHz	100MHz	300MHz	200MHz	100MHz
Channels	2	2	2	2	2	2
Record Length	20M / ch	20M / ch	20M / ch	20M / ch	20M / ch	20M / ch
Real-time Sampling Rate	Max. 2 GSa/s	Max. 2 GSa/s	Max. 2 GSa/s	Max. 2 GSa/s	Max. 2 GSa/s	Max. 2 GSa/s
Built-in	MDO-2000A : Spectrum Analyzer MDO-2000AG : Spectrum Analyzer ; Dual Channel 25MHz Arbitrary Waveform Generator					

SPECIFICATIONS

		MDO-2102A/G	MDO-2202A/G	MDO-2302A/G
VERTICAL SENSITIVITY	Channels	2Ch+EXT	2Ch+EXT	2Ch+EXT
	Bandwidth Calculated Rise Time Bandwidth Limit	DC~100MHz(-3dB) 3.5ns 20MHz	DC~200MHz(-3dB) 1.75ns 20M/100MHz	DC~300MHz(-3dB) 1.17ns 20M/100M200MHz
	Vertical Resolution Input Coupling Input Impedance DC Gain Accuracy Polarity Maximum Input Voltage Offset Position Range Waveform Signal Process	8 bits : 1mV ~ 10V/div AC, DC, GND 1MΩ// 16pF approx. ±(3% when 2mV/div or greater is selected ; ±(5%) when 1mV/div is selected Normal & Invert 300Vrms , CAT I 1mV/div ~ 20mV/div : ±0.5V ; 50mV/div ~ 200mV/div : ±5V ; 500mV/div ~ 2V/div : ±25V ; 5V/div~10V/div : ±250V + , - , × , ÷ , FFT , User Defined Expression FFT : 1Mpts ; FFT : Spectral magnitude. Set FFT Vertical Scale to Linear RMS or dBV RMS and FFT Window to Rectangular, Hamming , Hanning, or Blackman		
TRIGGER	Source Trigger Mode Trigger Type Trigger Holdoff Range Coupling Sensitivity	Ch1 ,CH2, Line, EXT Auto (Supports Roll Mode for 100 ms/div and slower), Normal, Single Sequence Edge, Pulse Width(Glitch), Video, Pulse Runt, Rise & Fall(Slope), Alternate, Time out, Event-Delay(1~65,535 events),Time-Delay(Duration;4ns~10s), Bus 4ns ~ 10s AC, DC, LF rej. , Hf rej. , Noise rej. 1div		
EXT TRIGGER	Range Sensitivity Input Impedance	±15V DC ~ 100MHz Approx. 100mV; 100MHz ~ 200Mz Approx. 150mV; 200MHz ~ 300MHz Approx. 150mV 1MΩ±3%, ~16pF		
HORIZONTAL	Time Base Range Pre-trigger Post-trigger Time Base Accuracy Real Time Sample Rate Record Length Acquisition Mode Peak Detection Average	1ns/div ~ 100s/div (1-2-5 increments); ROLL : 100ms/div ~ 100s/div 10 div maximum 2,000,000 div maximum ±50 ppm over any ≥ 1 ms time interval Max. : 2GSa/s (shared) Per Channel 20Mpts Normal, Average, Peak Detect, Single 2ns (typical) Selectable from 2 to 256		

SPECIFICATIONS

X-Y MODE	**X-Axis Input**	Channel 1
	Y-Axis Input	Channel 2
	Phase Shift	±3° at 100kHz
CURSORS AND MEASUREMENT	**Cursors**	Amplitude, Time, Gating Available; Unit : Seconds(S), Hz(1/S), Phase (Degrees), Ratio(%)
	Automatic Measurement	38 sets : Pk-Pk, Max, Min, Amplitude, High, Low, Mean, Cycle Mean, RMS, Cycle RMS, Area, Cycle Area, ROVShoot, FOVShoot, RPREShoot, FPREShoot, Frequency, Period, RiseTime, FallTime, +Width, -Width, Duty Cycle, +Pulses, -Pulses, +Edges, -Edges, %Flicker, Flicker Idx., FRR, FRF, FFR, FFF, LRR, LRF, LFR, LFF, Phase
CONTROL PANEL FUNCTION	**Auto Counter**	6 digits, range from 2Hz minimum to the rated bandwidth
	Autoset	Single-button, automatic setup of all channels for vertical, horizontal and trigger systems, with undo Autoset
	Save Setup	20 sets
	Save Waveform	24 sets
DISPLAY SYSTEM	**TFT LCD Type**	8" TFT LCD WVGA color display
	Display Resolution	800 horizontal x 480 vertical pixels (WVGA)
	Interpolation	Sin(x)/x
	Waveform Display	Dots, Vectors, Variable persistence(16ms~4s), Infinite persistence
	Waveform Update Rate	120,000 waveforms per second, maximum
	Display Mode	YT ; XY
	Display Graticule	8 x 10 divisions
INTERFACE	**USB Port**	USB 2.0 High-speed host port x 1, USB 2.0 High-speed device port x 1
	Ethernet Port (LAN)	RJ-45 connector, 10/100Mbps with HP Auto-MDIX
	Go/NoGo BN	5V Max/10mA TTL open collector output
	Kensington Style Lock	Rear-panel security slot connects to standard Kensington-style lock
SPECTRUM ANALYZER SPECIFICATIONS	**Frequency Range**	DC~1GHz(Max.) (Max. bandwidth ~1GHz uncalibrated)
	Span	1kHz ~ 1GHz(Max.)
	Resolution Bandwidth	1Hz ~ 1MHz(Max.)
	Reference Level	-50 dBm to +40dBm in steps of 5dBm
	Vertical Units	dBV RMS; Linear RMS; dBm
	Vertical Position	-12divs to +12divs
	Vertical Scale	1dB/div to 20dB/div in a 1-2-5 Sequence
	Display Average Noise Level	1V/div < -50dBm, Avg : 16 ; 100mV/div < -70dBm, Avg : 16 ; 10mV/div < -90dBm, Avg : 16
	Spurious Response	2nd harmonic distortion< 40dBc ; 3rd harmonic distortion< 45dBc
	Frequency Domain	Normal ; Max Hold ; Min Hold ; Average (2 ~ 256)
	Trace Types	
	Detection Methods	Sample ; +Peak ; -Peak ; Average
	FFT Windows	FFT Factor : Hanning 1.44 ; Rectangular 0.89 ; Hamming 1.30 ; Blackman 1.68
AWG SPECIFICATIONS (MDO-2000AG only)	**Channels**	2
	Sample Rate	200 Msa/s
	Vertical Resolution	14 bits
	Max. Frequency	25 MHz
	Waveforms	Sine, Square, Pulse, Ramp, DC, Noise, Sinc, Gaston, Lorentz, Exponential Rise, Exponential Fall, Haversine, Cardiac
	Output Range	20 mVpp to 5 Vpp, High Z; 10 mVpp to 2.5 Vpp, 50Ω
	Output Resolution	1mV
	Output Accuracy	2% (1 kHz)
	Offset Range	±2.5 V ac+dc, High Z; ±125 V ac+dc, 50 Ω
	Offset Resolution	1mV
	Sine	Frequency Range: 100mHz~25MHz ; Flatness(relative to 1kHz): ±0.5 dB<15MHz; ±1 dB 15MHz~25MHz; Harmonic Distortion: -40 dBc ; Stray(Non-harmonic): -40 dBc ; Total Harmonic Distortion:1% ; S/N Ratio: 40 dB
	Square/Pulse	Frequency Range : 100mHz~15MHz ; Rise/Fall time : <15ns ; Overshoot : <3% ; Duty cycle Square : 50% & Pulse : 0.4%~99.6% ; Min. Pulse Width : 30 ns ; Jitter : 500 ps
	Ramp	Frequency Range :100mHz~1MHz ; Linearity : 1% ; Symmetry : 0~100%
FREQUENCY RESPONSE ANALYSIS (MDO-2000AG only)	**Dynamic Range**	> 80 dB (typical)
	Input and Output Sources	Channel 1 or 2
	Frequency Range	20 Hz to 25 MHz
	Number of Test Points	10 to 90 points per decade
	Test Amplitude	20 mVpp to 5 Vpp into High-Z ; Fixed test amplitude or custom amplitude for each decade
	Test Results	Logarithmic overlaid gain and phase plot
	Manual Measurements	Two pairs of tracking gain and phase markers
	Plot Scaling	Auto-scaled during test
MISCELLANEOUS	**Line Voltage Range**	AC 100V ~ 240V, 50Hz ~ 60Hz, auto selection
	Multi-Language Menu	Available
	On-Line Help	Available
	Time Clock	Time and date, provide the date/time for saved data
	Operation Environment	Temperature: 0°C to 50°C. Relative Humidity: ≤80% at 40°C or below; ≤45%, 41°C ~ 50°C
	Dimensions & Weight	384(W) X 208(H) x 127.3(D) mm, Approx. 3kg

Note : Three-year warranty, excluding probes & LCD display panel.

Specifications subject to change without notice. **MDO2000AGD1BH**

ORDERING INFORMATION

MDO-2302AG 300MHz, 2-channel, Digital Storage Oscilloscope, Spectrum Analyzer, dual channel 25MHz AWG
MDO-2202AG 200MHz, 2-channel, Digital Storage Oscilloscope, Spectrum Analyzer, dual channel 25MHz AWG
MDO-2102AG 100MHz, 2-channel, Digital Storage Oscilloscope, Spectrum Analyzer, dual channel 25MHz AWG
MDO-2302A 300MHz, 2-channel, Digital Storage Oscilloscope, Spectrum Analyzer
MDO-2202A 200MHz, 2-channel, Digital Storage Oscilloscope, Spectrum Analyzer
MDO-2102A 100MHz, 2-channel, Digital Storage Oscilloscope, Spectrum Analyzer

ACCESSORIES

Power cord x 1,
GTL-110 BNC-BNC cable x 2 (only on MDO-2000AG)
GTP-100B-4:100MHz(10:1/1:1)Switchable passive probe for MDO-2102A/2102AG(one per channel)
GTP-200B-4:200MHz(10:1/1:1)Switchable passive probe for MDO-2202A/2202AG(one per channel)
GTP-300B-4:300MHz(10:1/1:1)Switchable passive probe for MDO-2302A/2302AG(one per channel)

OPTIONAL ACCESSORIES

GRA-426 Rack Adapter Panel
GAK-003 50Ω Impedance Adapter
GSC-008 Soft Carrying Case
GTL-246 USB Cable, USB 2.0, A-B Type, 1200mm
GTP-033A Oscilloscope Probe, 35MHz 1:1 Passive Probe
GDP-025 Differential Probe, 25M High Voltage Differential Probe
GDP-050 Differential Probe, 50M High Voltage Differential Probe
GDP-1020P 1 GHz/20 V High Frequency Differential Probe
GDP-2035H 200 MHz/3500 Vpk High Voltage Differential Probe
GCP-300 300kHz/200A Current probe
GCP-530 50MHz/30A Current probe
GCP-500 500kHz/150A Current probe
GCP-1030 100MHz/30A Current probe
GCP-1000 1MHz/70A Current probe
GCP-206P Power supply for current probe (2 input channel)
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