

# 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 wfms/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<sup>2</sup>C/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

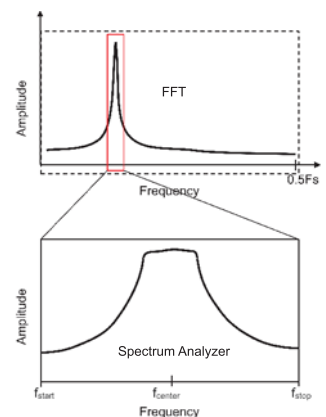
MDO-2000A is an advanced version of MDO-2000E. The selectable bandwidth range is upgraded to 300MHz. The full bandwidth ranges include 300MHz, 200MHz and 100MHz. The sampling rate has upgraded to Max. 2GSa/s and the memory depth has also been upgraded to 20M/CH. Hence, the three major specifications 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 ( $F_s$ ). 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 input 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 than 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,  $f_{max}$ : 10.2MHz,  $f_{min}$ : 10.0MHz, bit rate: 10.0kHz. Users can directly input Center and Span Frequency by an intuitive and swift setting.  $f_{max}$  and  $f_{min}$  can be clearly identified from the screen display.

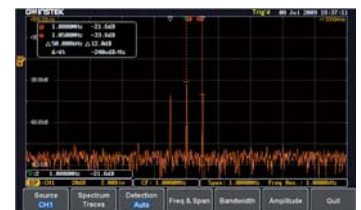


When the same signal is tested by FFT (the left display was the result tested by Keysight DSOX2000A), most users do not know the correlation between the sampling rate of the time domain signal and the frequency of the DUT signal, so the FFT waveform display is not easy to adjust correctly. The slow update, 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 simultaneously measure 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.

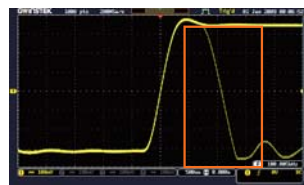
MDO-2000A's Spectrum Analyzer also includes Spectrum Trace Type settings (Normal, Max-hold, Min-hold, and Average). Users can freely select various Spectrum Traces for simultaneous display. Detection method (Sample, +Peak, -Peak, and Average) can be individually set for each Trace. Additionally, users, 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



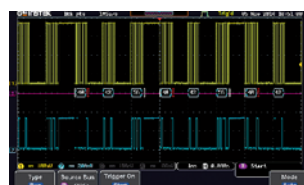
## A. 120,000wfm/s WAVEFORM UPDATE RATE AND VPO WAVEFORM DISPLAY TECHNOLOGY



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.

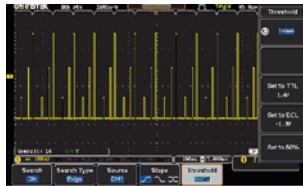
## B. SUPPORT I<sup>2</sup>C, UART, CAN, LIN BUS TRIGGER AND DECODING FUNCTIONS



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<sup>2</sup>C. To rapidly and correctly trigger and analyze serial bus data has posed a difficult challenge to engineers. The MDO-2000A series

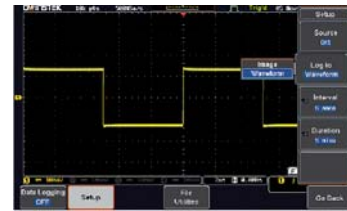
provides serial bus analysis function with 20M long memory depth. Users can trigger, decode, and analyze frequently used I<sup>2</sup>C and UART serial bus and CAN/LIN bus, which is often used by automotive communications.

## C. WAVEFORM SEARCH FUNCTION



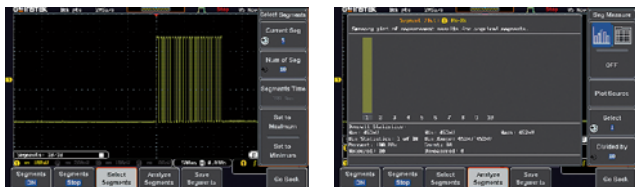
Users can rapidly search desired waveforms according to the trigger condition. After activating the search function, hollow inverted triangles will show the location met the trigger condition. The upper left hand corner Overall will show the total number of waveforms met the trigger condition. Users can set waveform search by the trigger condition 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 minimum. Waveform 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.

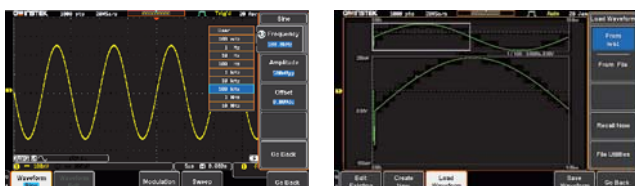
To achieve the most ideal application for memory depth, the MDO-2000A series has the built-in segmented memory function. The segmented memory function allows users to select the desired important signals for observation. Hence, insignificant signals can be neglected and serial bus decoding; pulse or 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

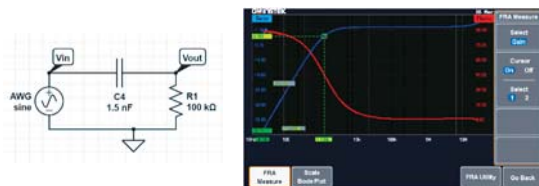


\* MDO-2000AG only



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 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 ( $F=1/2\pi RC$ ) 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 InfiniVision 3000T's option. More points per decade allow users to get higher accurate test results.



## PANEL INTRODUCTION



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	DC~100MHz(-3dB)	DC~200MHz(-3dB)	DC~300MHz(-3dB)
	Rise Time	3.5ns	1.75ns	1.17ns
	Bandwidth Limit	20MHz	20M/100MHz	20M/100M200MHz
	Vertical Resolution	8 bits : 1mV ~ 10V/div		
	Input Coupling	AC, DC, GND		
	Input Impedance	1MΩ // 16pF approx.		
	DC Gain Accuracy	±(3% when 2mV/div or greater is selected ; ±(5%) when 1mV/div is selected		
	Polarity	Normal & Invert		
	Maximum Input Voltage	300Vrms , CAT I		
	Offset Position Range	1mV/div ~ 20mV/div : ±0.5V ; 50mV/div ~ 200mV/div : ±5V ; 500mV/div ~ 2V/div : ±25V ; 5V/div~10V/div : ±250V		
	Waveform Signal Process	+ , - , × , ÷ , 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	Ch1 , CH2, Line, EXT		
	Trigger Mode	Auto (Supports Roll Mode for 100 ms/div and slower), Normal, Single Sequence		
	Trigger Type	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		
	Trigger Holdoff Range	4ns ~ 10s		
	Coupling	AC, DC, LF rej. , Hf rej. , Noise rej.		
	Sensitivity	1div		
EXT TRIGGER	Range	±15V		
	Sensitivity	DC ~ 100MHz Approx. 100mV; 100MHz ~ 200MHz Approx. 150mV; 200MHz ~ 300MHz Approx. 150mV		
	Input Impedance	1MΩ±3%, ~16pF		
HORIZONTAL	Time Base Range	1ns/div ~ 100s/div (1-2.5 increments); ROLL : 100ms/div ~ 100s/div		
	Pre-trigger	10 div maximum		
	Post-trigger	2,000,000 div maximum		
	Time Base Accuracy	±50 ppm over any ≥ 1 ms time interval		
	Real Time Sample Rate	Max. : 2GSa/s (shared)		
	Record Length	Per Channel 20Mpts		
	Acquisition Mode	Normal, Average, Peak Detect, Single		
	Peak Detection	2ns (typical)		
	Average	Selectable from 2 to 256		

## SPECIFICATIONS

<b>X-Y MODE</b>	X-Axis Input Y-Axis Input Phase Shift	Channel 1 Channel 2 ±3° at 100kHz
<b>CURSORS AND MEASUREMENT</b>	Cursors Automatic Measurement	Amplitude, Time, Gating Available; Unit : Seconds(S), Hz(1/S), Phase (Degrees), Ratio(%) 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
<b>CONTROL PANEL FUNCTION</b>	Auto Counter Autoset Save Setup Save Waveform	6 digits, range from 2Hz minimum to the rated bandwidth Single-button, automatic setup of all channels for vertical, horizontal and trigger systems, with undo Autoset 20 sets 24 sets
<b>DISPLAY SYSTEM</b>	TFT LCD Type Display Resolution Interpolation Waveform Display Waveform Update Rate Display Mode Display Graticule	8" TFT LCD WVGA color display 800 horizontal x 480 vertical pixels (WVGA) Sin(x)/x Dots, Vectors, Variable persistence(16ms~4s), Infinite persistence 120,000 waveforms per second, maximum YT; XY 8 x 10 divisions
<b>INTERFACE</b>	USB Port Ethernet Port (LAN) Go/NoGo BNC Kensington Style Lock	USB 2.0 High-speed host port x 1, USB 2.0 High-speed device port x 1 RJ-45 connector, 10/100Mbps with HP Auto-MDIX 5V Max/10mA TTL open collector output Rear-panel security slot connects to standard Kensington-style lock
<b>SPECTRUM ANALYZER SPECIFICATIONS</b>	Frequency Range Span Resolution Bandwidth Reference Level Vertical Units Vertical Position Vertical Scale Display Average Noise Level Spurious Response Frequency Domain Trace Types Detection Methods FFT Windows	DC~1GHz(Max.) (Max. bandwidth ~1GHz uncalibrated) 1kHz ~ 1GHz(Max.) 1Hz ~ 1MHz(Max.) -50 dBm to +40dBm in steps of 5dBm dBV RMS; Linear RMS; dBm -12divs to +12divs 1dB/div to 20dB/div in a 1-2-5 Sequence 1V/div < -50dBm, Avg : 16 ; 100mV/div < -70dBm, Avg : 16 ; 10mV/div < -90dBm, Avg : 16 2nd harmonic distortion< 40dBc ; 3rd harmonic distortion< 45dBc Normal ; Max Hold ; Min Hold ; Average (2 ~ 256)  Sample ; +Peak ; -Peak ; Average FFT Factor : Hanning 1.44 ; Rectangular 0.89 ; Hamming 1.30 ; Blackman 1.68
<b>AWG SPECIFICATIONS (MDO-2000AG only)</b>	Channels Sample Rate Vertical Resolution Max. Frequency Waveforms Output Range Output Resolution Output Accuracy Offset Range Offset Resolution Sine  Square/Pulse  Ramp	2 200 Msa/s 14 bits 25 MHz Sine, Square, Pulse, Ramp, DC, Noise, Sinc, Gaston, Lorentz, Exponential Rise, Exponential Fall, Haversine, Cardiac 20 mVpp to 5 Vpp, HighZ; 10 mVpp to 2.5 Vpp, 50 Ω 1mV 2% (1 kHz) ±2.5 V, HighZ; ±1.25 V, 50 Ω 1mV Frequency Range : 100mHz~25MHz ; Flatness : ±0.5 dB ; Harmonic Distortion : -40 dBc ; Stray (Non-harmonic) : -40 dBc ; Total Harmonic Distortion : 1% ; S/N Ratio : 40 dB 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 Frequency Range : 100mHz~1MHz ; Linearity : 1% ; Symmetry : 0~100%
<b>FREQUENCY RESPONSE ANALYSIS (MDO-2000AG only)</b>	Dynamic Range Input and Output Sources Frequency Range Number of Test Points Test Amplitude Test Results Manual Measurements Plot Scaling	> 80 dB (typical) Channel 1 or 2 20 Hz to 25 MHz 10 to 90 points per decade 20 mVpp to 5 Vpp into High-Z ; Fixed test amplitude or custom amplitude for each decade Logarithmic overlaid gain and phase plot Two pairs of tracking gain and phase markers Auto-scaled during test
<b>MISCELLANEOUS</b>	Line Voltage Range Multi-Language Menu On-Line Help Time Clock Operation Environment Dimensions & Weight	AC 100V ~ 240V, 50Hz ~ 60Hz, auto selection Available Available Time and date, provide the date/time for saved data Temperature: 0°C to 50°C. Relative Humidity: ≤ 80% at 40°C or below; ≤ 45%, 41°C ~ 50°C 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

User manual CD x 1, 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

<b>GRA-426</b> Rack Adapter Panel	<b>GCP-100</b> Current Probe, DC~100kHz, 100A, Current Probe
<b>GAK-003</b> 50Ω Impedance Adapter	<b>GCP-1030</b> Current Probe, DC~100MHz, 30Arms, Current Probe
<b>GSC-008</b> Soft Carrying Case	<b>GCP-206P</b> Current Probe - Power Supply, 2 Channel Power Supply for GCP-530/1030
<b>GTL-246</b> USB Cable, USB 2.0, A-B Type, 1200mm	<b>GCP-425P</b> Current Probe - Power Supply, 4 Channel Power Supply for GCP-530/1030
<b>GDB-03</b> Oscilloscope Education & Training Kit	<b>GCP-530</b> Current Probe, DC~50MHz, 30Arms, Current Probe
<b>GCP-020</b> Current Probe, 40Hz~40kHz, 240A, Current Probe	<b>GDP-025</b> Differential Probe, 25M High Voltage Differential Probe
<b>GTP-033A</b> Oscilloscope Probe, 35MHz 1:1 Passive Probe	<b>GDP-050</b> Differential Probe, 50M High Voltage Differential Probe

## FREE DOWNLOAD

<b>PC Software</b>	OpenWave software	<b>Driver</b>	USB driver ; LabView driver
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**GW INSTEK**  
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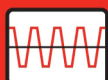
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