

GDS-3000A

Roger Lee

GW INSTEK

Made to Measure

固緯電子實業股份有限公司

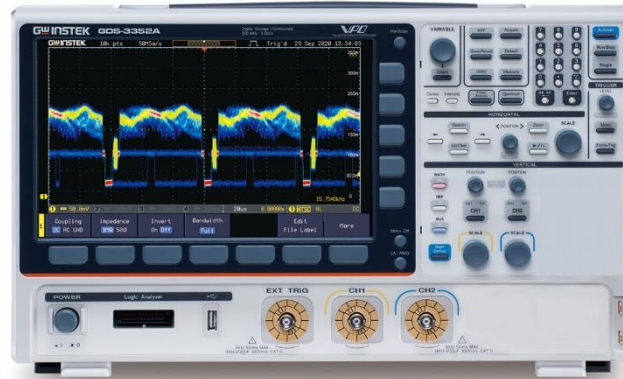


GDS-3000A Digital Storage Oscilloscope



- Bandwidth: **650MHz / 350MHz**
- Max Sampling Rate:
5GSa/s(one CH);2.5GSa/s(Dual CHs)
- Record Length: **200 M pts/ch**
- Spectrum Analyzer with Spectrogram (Dual Channel)
- 13 sets of Power Measurements and Analysis(Optional)

GDS-3000A Digital Storage Oscilloscope



2 Channels

Advanced Spectrum Analysis

1M points FFT with Spectrogram

13 parameters

Optional Power Analysis

Switching Loss, SOA, BH Curve...

GDS-3000A Series

Bandwidth	Record Length	Analog Channels	Sample Rate	Waveform Update Rate
Up to 650 MHz	Per CH 200 M points	2	Up to 5 GS/s	Up to 200,000 Waveform/s

-
- Higher bandwidth at the same DSO Segmented.

650MHz > 500MHz

- The per channel longest memory depth

200Mpts/CH

- Frequency and time domain signals are nowhere to hide

Dual channel spectrum analyzer(DC~2.5GHz)

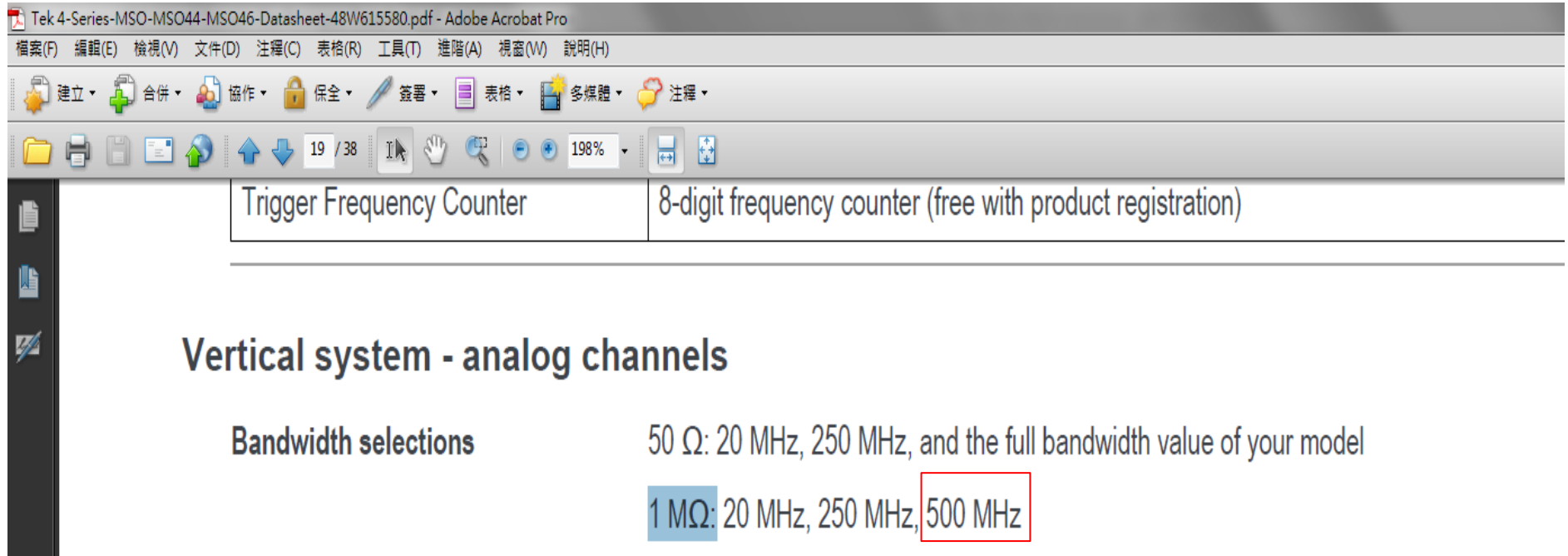
With spectrogram

GDS-3000A Main Specs.

Bandwidth	650/350MHz(@50ohm input impedance) 500/350MHz(@1Mohm input impedance)
Analog Channels	2 / 4 +Ext
Record Length	200M pts /CH
Real Time Sample rate	5GSa/s one channel , 2.5GSa/s dual channels
Vertical Resolution	8 bits (Max. 12 bits with high resolution)
LCD Display	10.2" (800*480)
Waveform Update Rate	200,000 wfms/s maximum
Horizontal Range	1ns/div ~ 1000s/div
Acquisition Mode	Normal, Average, Hi Resolution, Peak Detect
Vertical Range	1mV/div ~ 10V/div @ 1M Ω , 1mV/div ~ 1V/div @ 50 Ω
Maximum Input Voltage	300Vrms, CAT I
Math Function	+, -, \times , \div , FFT, User Defined Expression (Max. 1M points FFT)
Trigger Mode	Auto, Normal, Single
Trigger Type	Edge, Pulse Width(Glitch), Video, Pulse Runt, Rise & Fall(Slope), Alternate, Time out, Event Delay, Time Delay, Bus

Auto Measurement Function	38 sets: Pk-Pk, Max, Min, Amplitude, High, Low, Mean, Cycle Mean, RMS, Cycle RMS, Area, Cycle Area, ROV Shoot, FOV Shoot, RPRE Shoot, FPRE Shoot, Frequency, Period, Rise Time, Fall Time, +Width, -Width, Duty Cycle, +Pulses, -Pulses, +Edges, -Edges, %Flicker ,Flicker Idx, FRR, FRF, FFR, FFF, LRR, LRF, LFR, LFF, Phase
Power Measurement (Option)	13 items: Power Quality, Switching Loss, Harmonics, Ripple, Inrush Current, Modulation, SOA, Transient, Efficiency, B-H Curve, Turn On/Off, PSRR, Control Loop Response(Bode)
Spectrum Analyzer	DC~2.5GHz Max, Dual channel (Based on Advanced FFT), with spectrogram function (Frequency which exceeds analog front end bandwidth is uncalibrated)
Segmented Memory	490,000
Waveform Search	Yes
Serial Bus Decoder	UART, SPI, I2C, CAN, LIN, Parallel
Logic Analyzer	16 Channels, 1GSa/s (Option)
RS232, USB Host, USB Device, LAN, VGA	Yes
GPIB	Option (factory install)
Function Gen.	Dual channel, 25MHz
Special features	Go/No-Go APP, DVM APP, Digital Filter APP, Data Log APP, Mask APP, FRA APP

Bandwidth specs of Tek 4 series MSO and Rigol MSO-8000

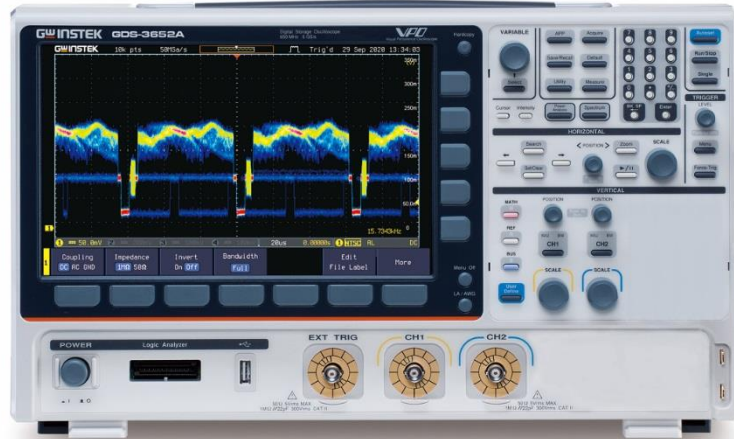


Overview of the MSO8000 Series Technical Specifications

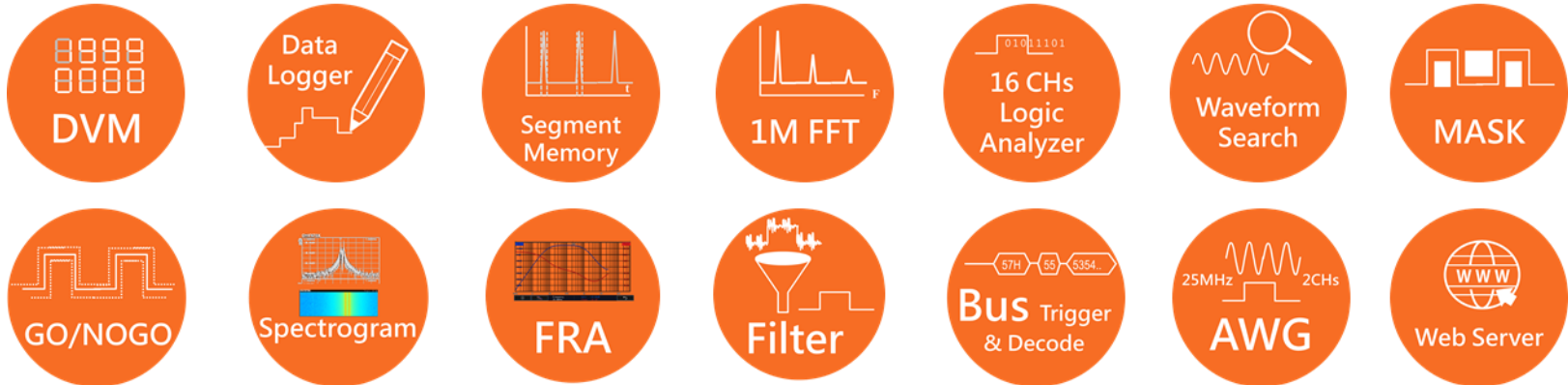
Model	MSO8064	MSO8104	MSO8204
Analog Bandwidth (50 Ω, -3 dB) ⁽¹⁾	600 MHz	1 GHz	2 GHz
Analog Bandwidth (1 MΩ, -3 dB)		500 MHz	

@1Mohm impedance, the max. bandwidth is 500MHz

Features



One Oscilloscope with Time Domain,
Frequency Domain and Power Measurement



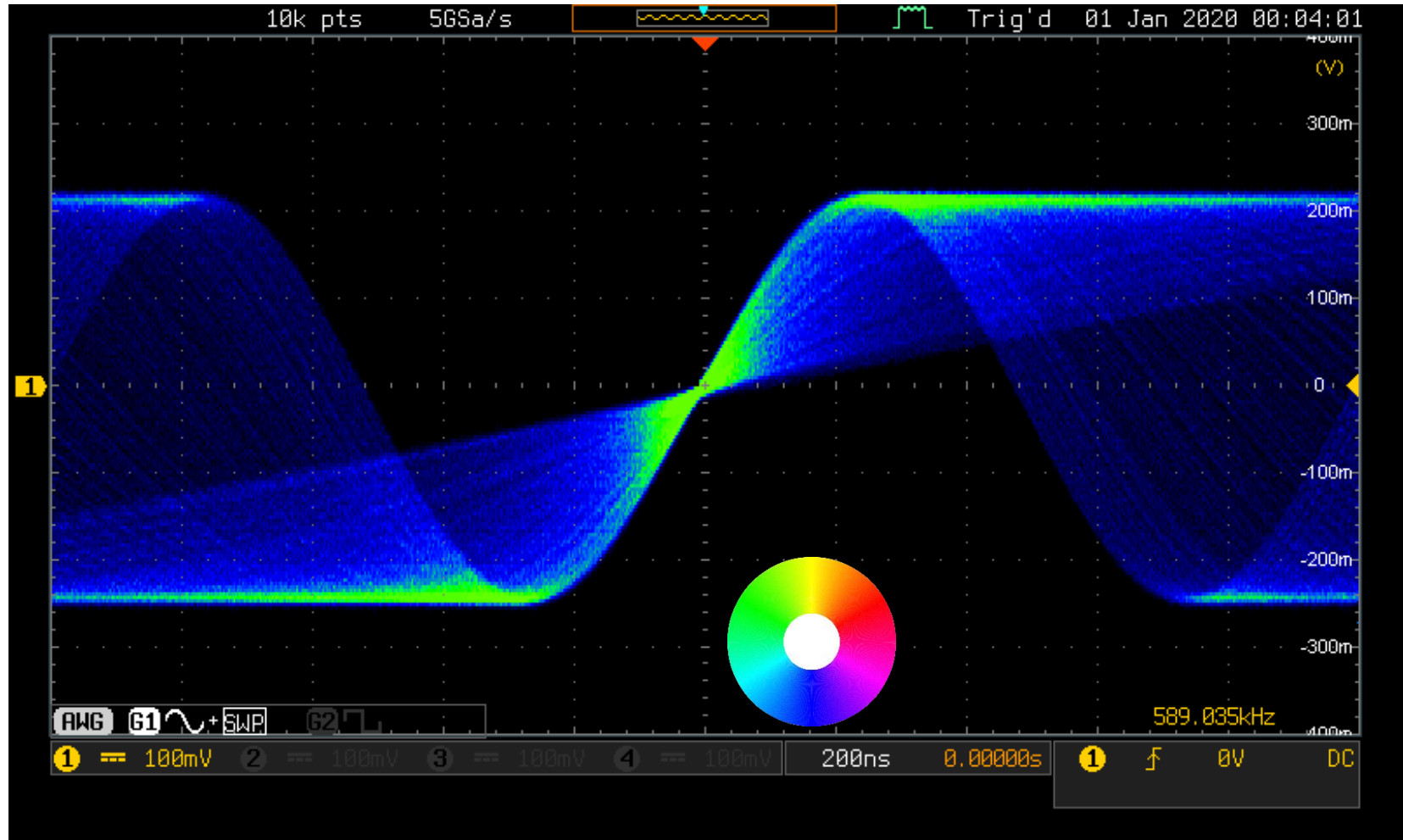
More evolved functions

- Waveform capture
650MHz, 5GSa/s, 200M/CH memory depth
- Display
- Analysis
- Save (interface and software)

More evolved functions

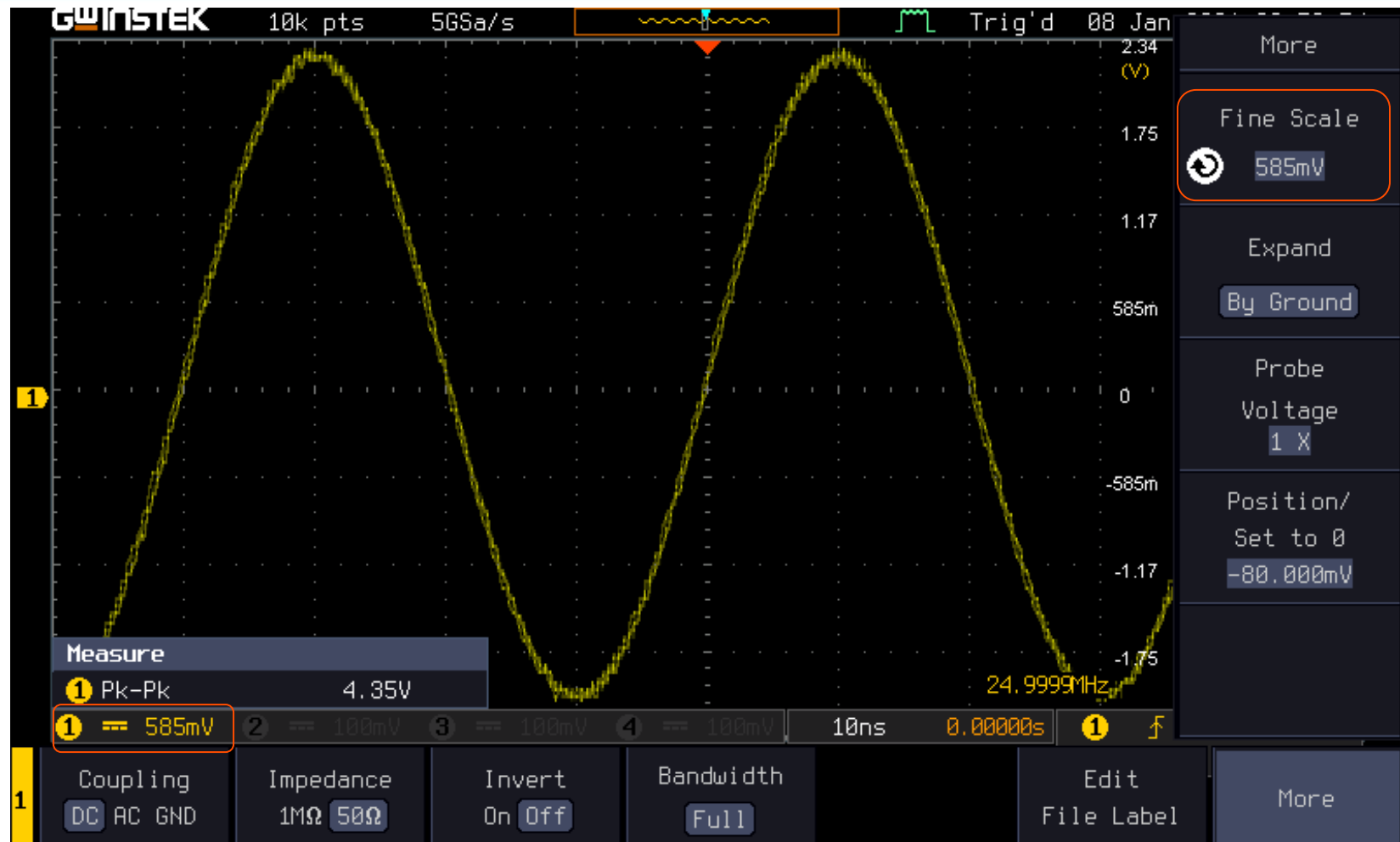
- **Waveform capture**
650MHz, 5GSa/s, 200M/CH memory depth
- **Display**
- **Analysis**
- **Save (interface and software)**

Waveform Color



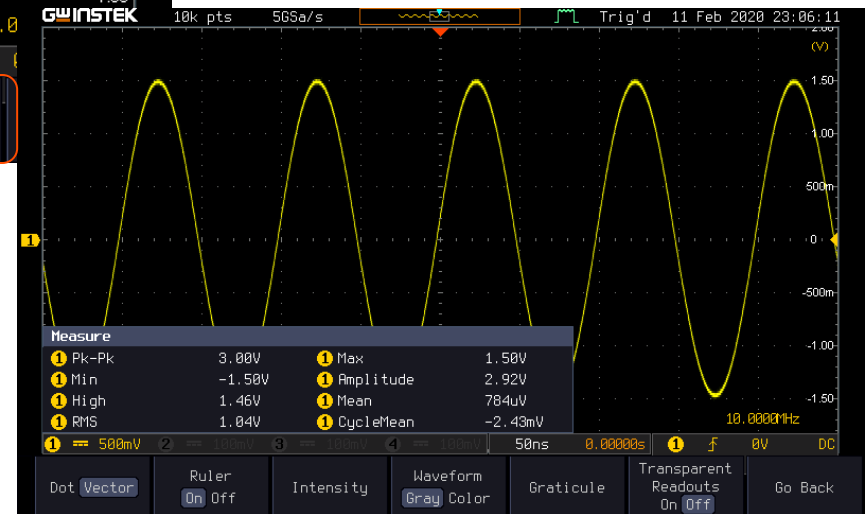
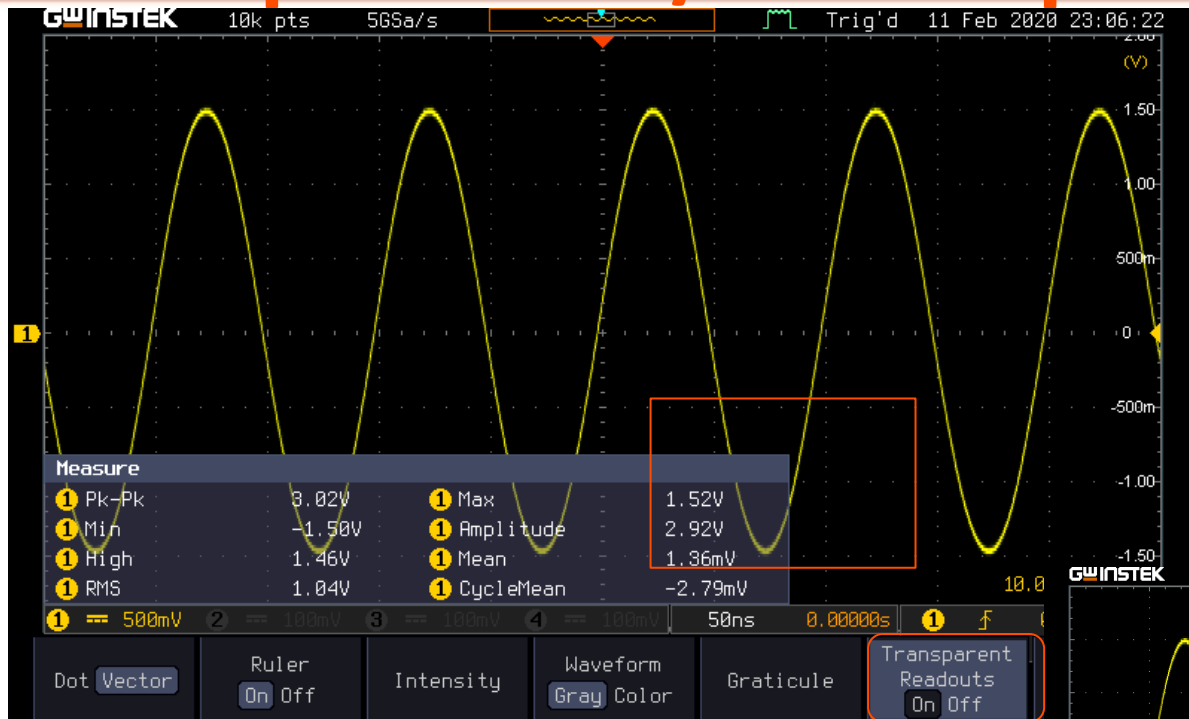
10.2" WVGA display

Fine Scale



Allow to fine tune vertical range to increase the measure accuracy

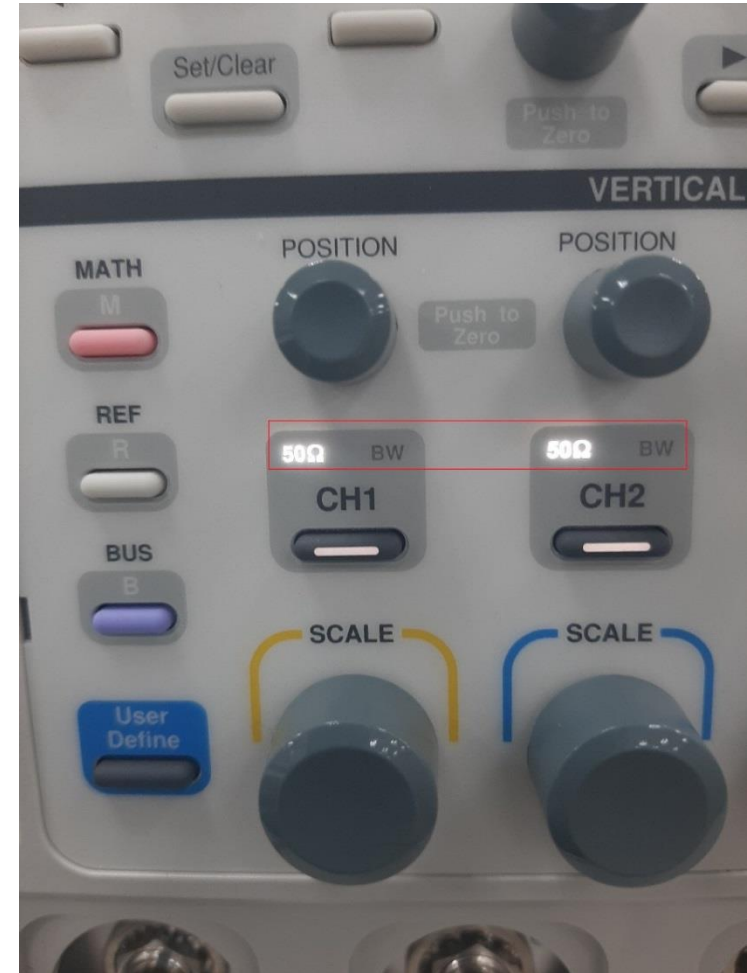
Transparent on/off setup



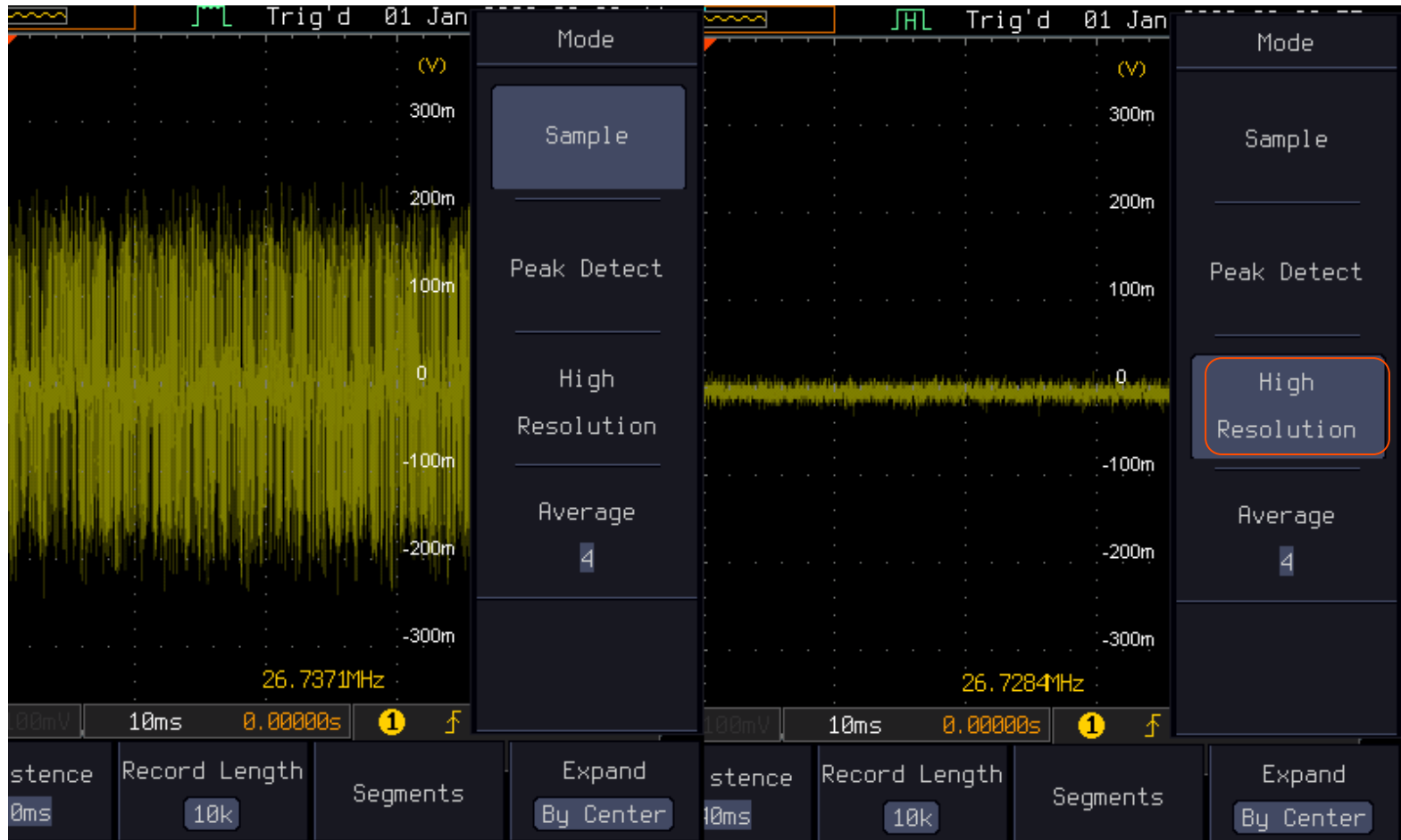
More evolved functions

- **Waveform capture**
650MHz, 5GSa/s, 200M/CH memory depth
- **Display**
- **Analysis**
- **Save (interface and software)**

50 ohm impedance selection

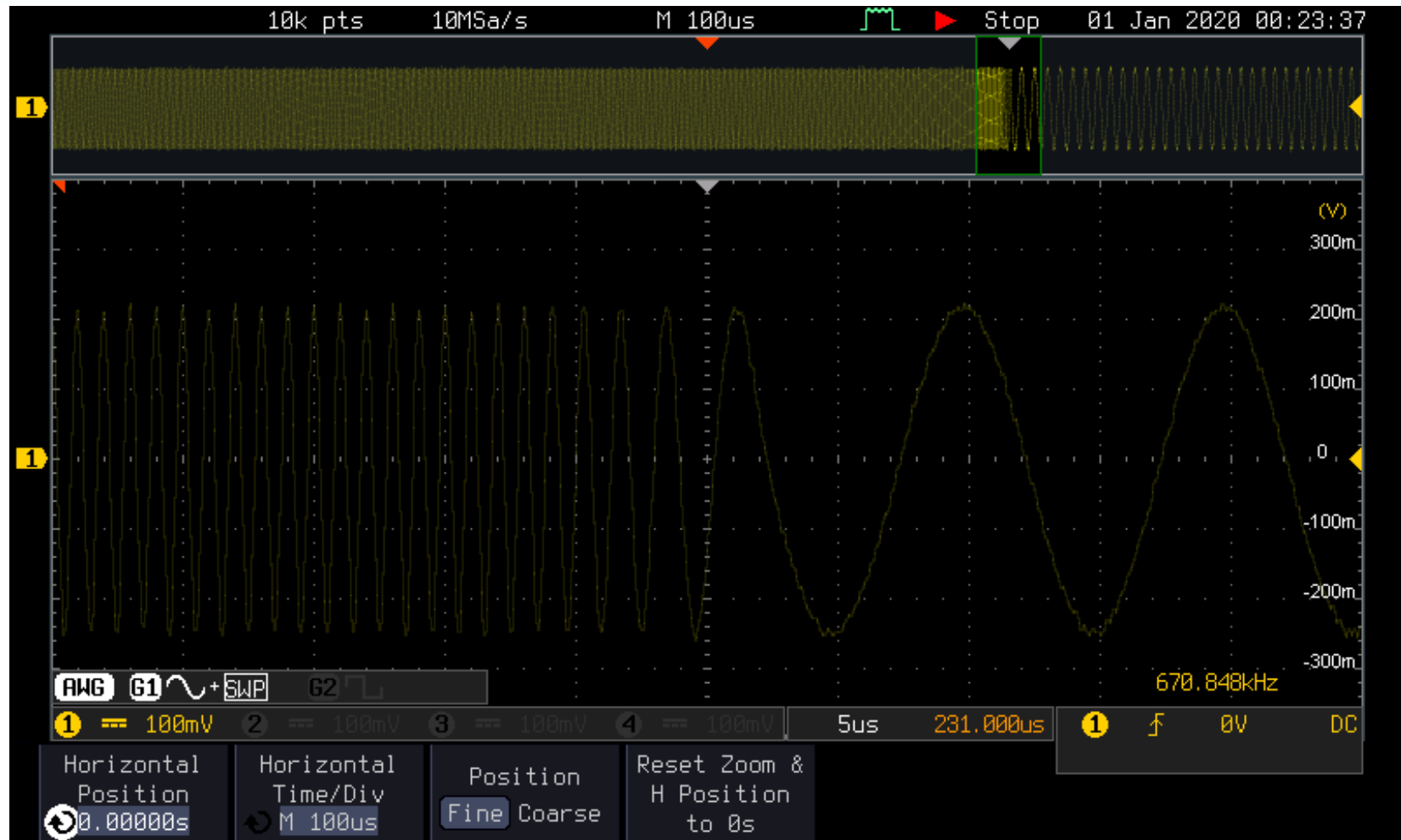


High Resolution mode

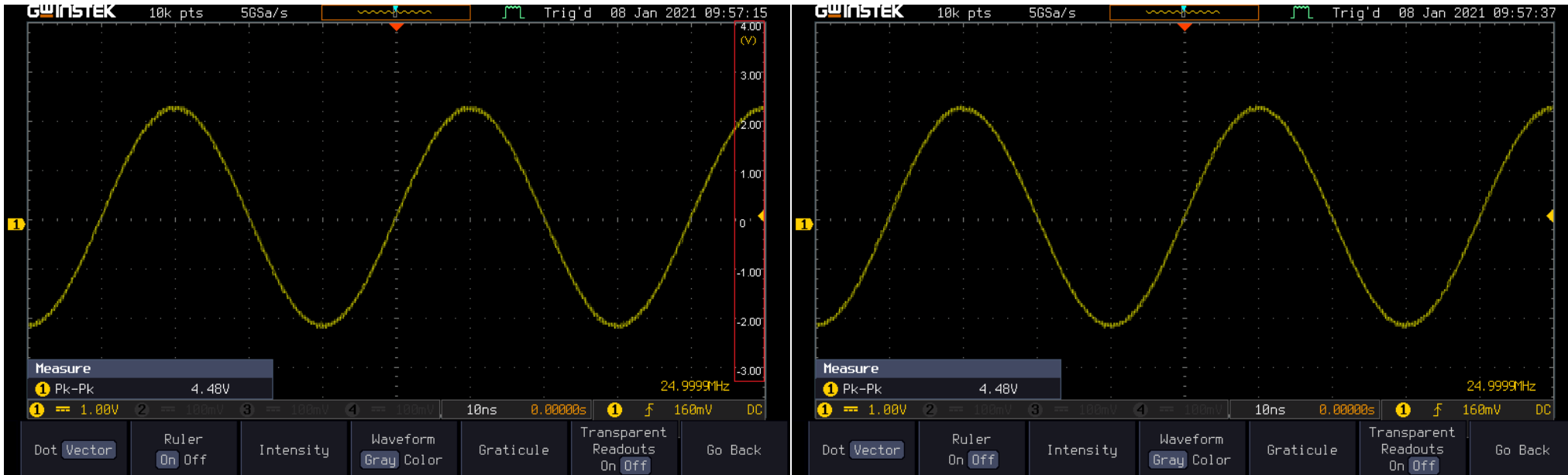


- The high resolution mode allow low-noise signals under high-bandwidth measurements
- Max. 12 bits

Zoom play mode



New ruler marker



- New ruler marker, let users know the amplitude information clearly
- Users can turn off as needed

Segment 490,000



Through the statistical analysis function, users can understand if the collected statistical signals are as expected.

Segment on Mask

The image displays three sequential screenshots from a GW Instek oscilloscope interface, demonstrating the 'Segment on Mask' feature.

Top Screenshot (16:02:49): Shows a waveform with a mask. The 'Segment Mask Results' table is visible, showing 63 segments. The 'Failed' count is 2/1644. The 'Current Seg' is #1.

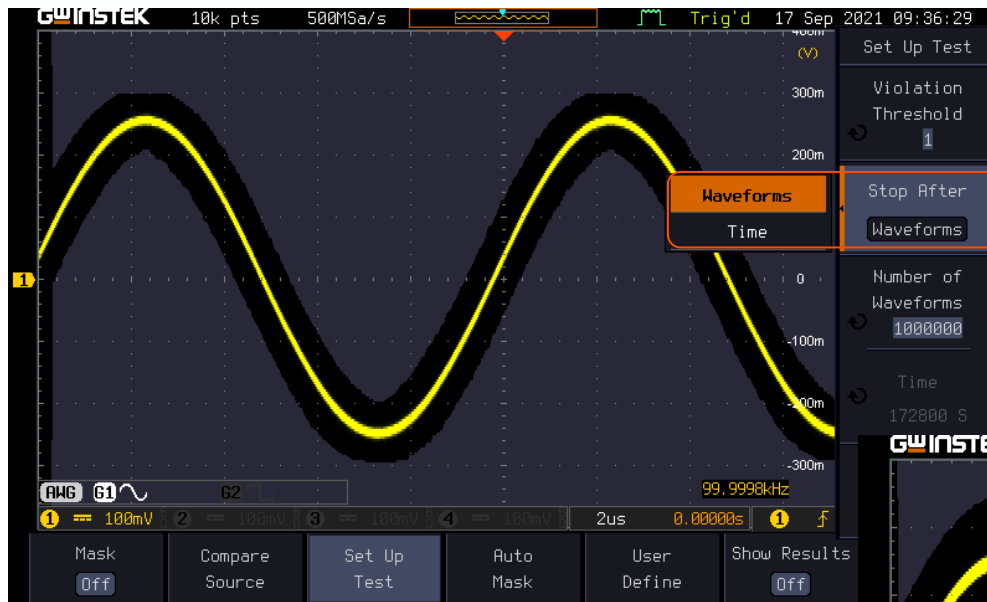
Passed#	Failed#
#1	#10
#2	#11
#3	#12
#4	#13
#5	#14
#6	#15
#7	#16
#8	#17
#9	#18
	#19
	#20
	#21
	#22
	#23
	#24
	#25
	#26
	#27
	#28
	#29
	#30
	#31
	#32
	#33
	#34
	#35
	#36
	#37
	#38
	#39
	#40
	#41
	#42
	#43
	#44
	#45
	#46
	#47
	#48
	#49
	#50
	#51
	#52
	#53
	#54
	#55
	#56
	#57
	#58
	#59
	#60
	#61
	#62
	#63

Middle Screenshot (16:33:25): Shows the 'Segment Mask Results' table with the 'Failed' count still 2/1644. The 'Current Seg' is #1643. The 'Failed#' list shows #1643 and #1644.

Bottom Screenshot (16:33:25): Shows a zoomed-in view of the failed segment, highlighting the signal that does not meet the specifications.

- Users can quickly find out the signals that does not meet the specifications through the Mask function of segment

Mask function

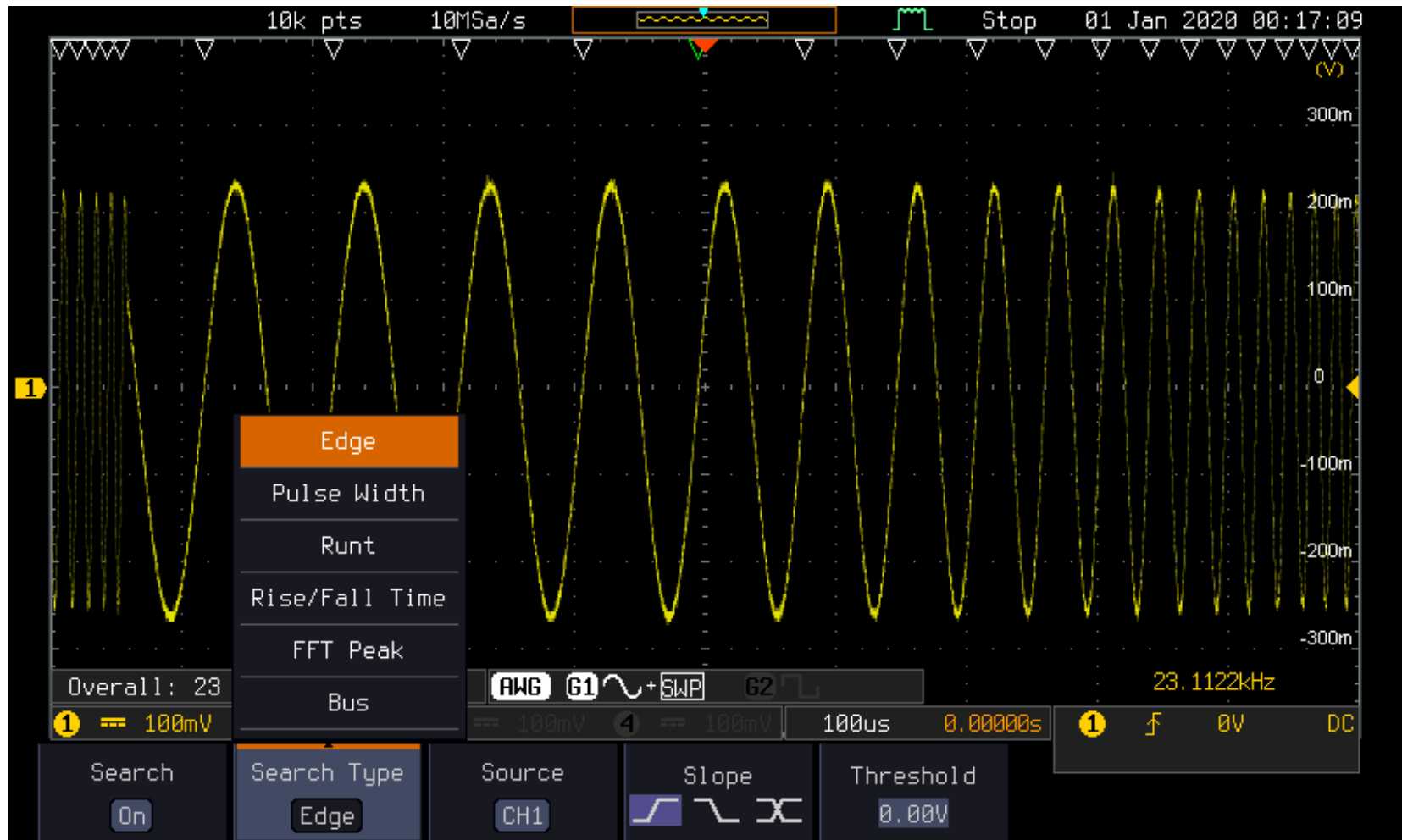


- Allow to set stop after waveforms or time.

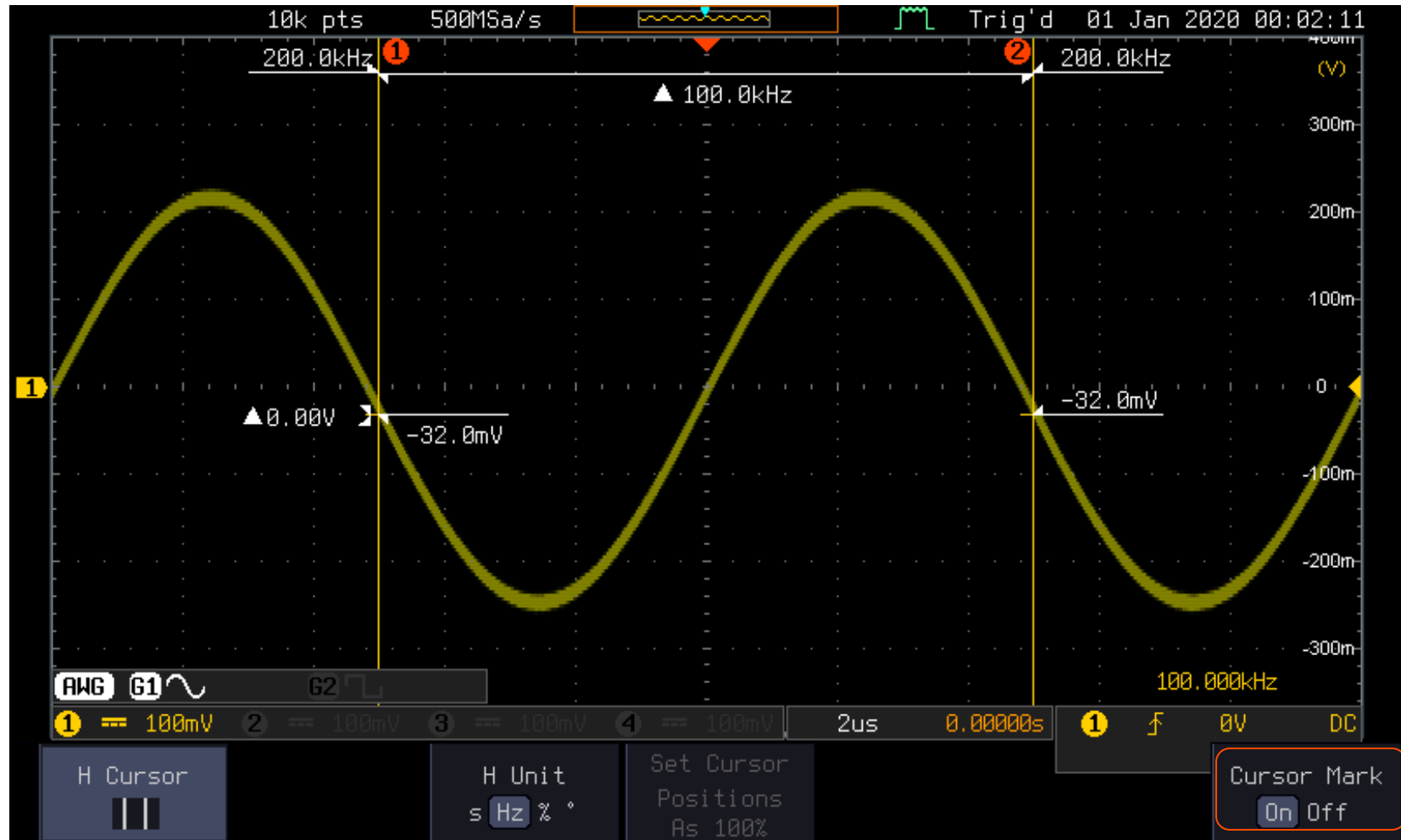
- When “set action on failure to on”, There are 5 actions the user allow to select.



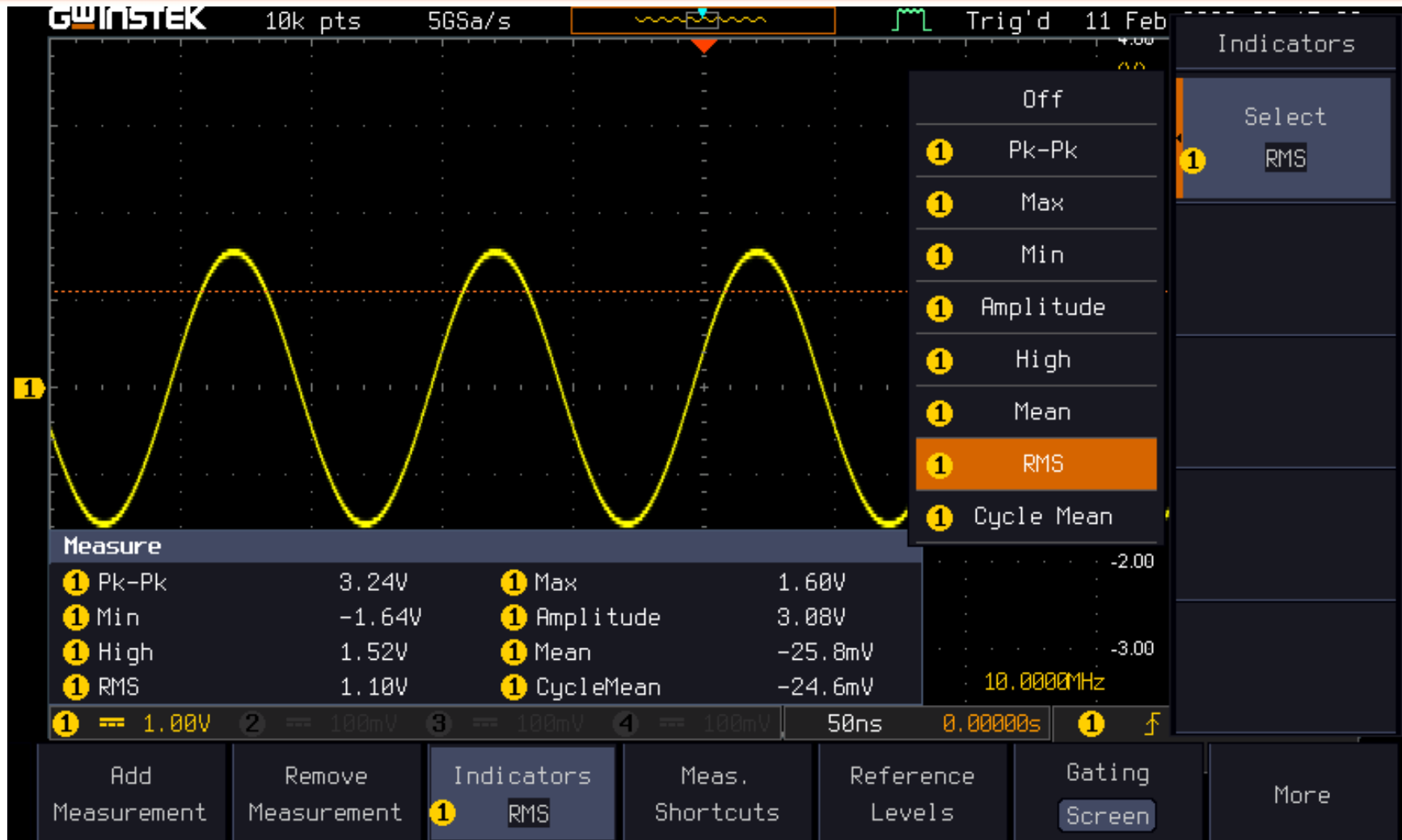
Search



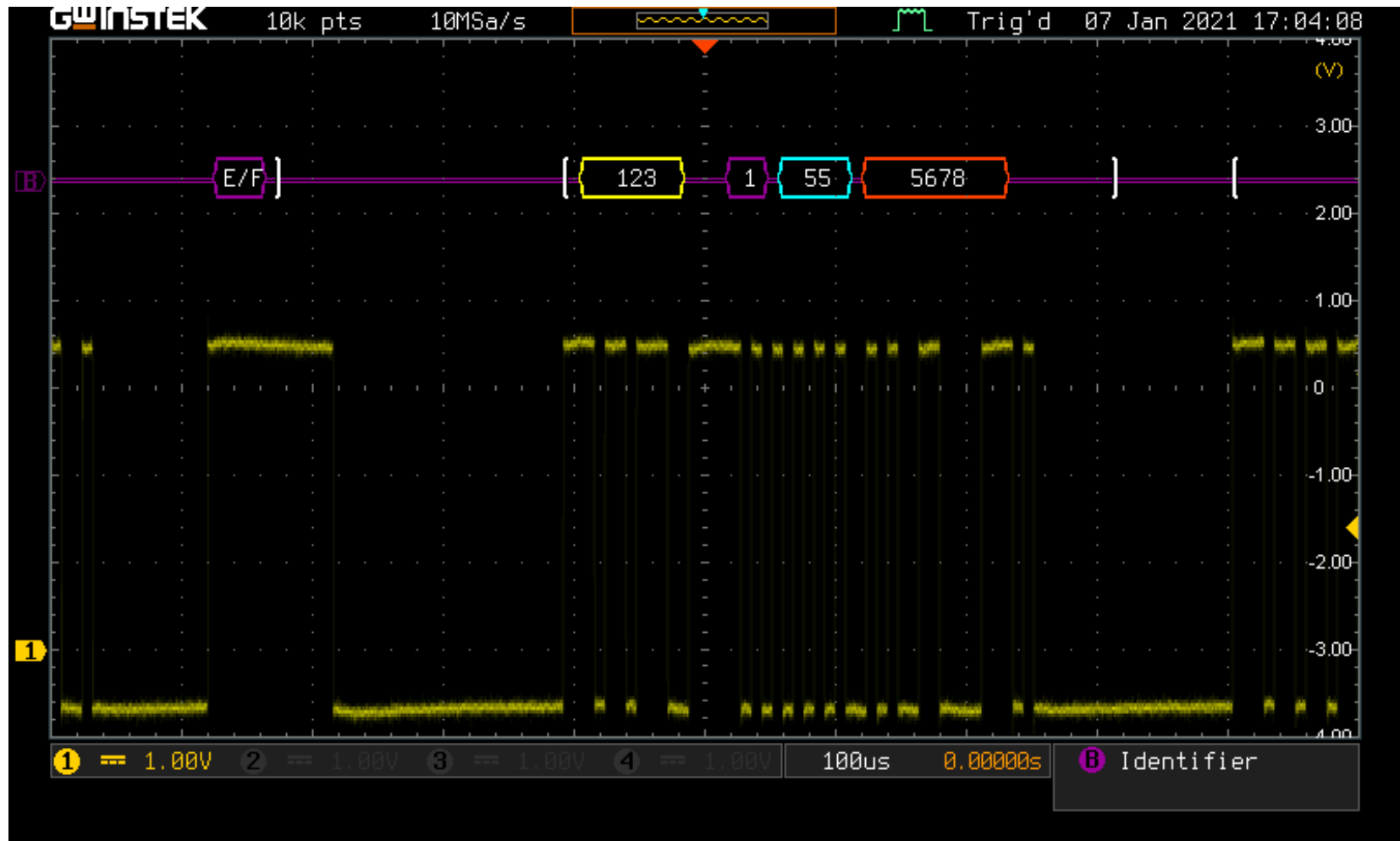
Cursor Mark



Measure Indicators



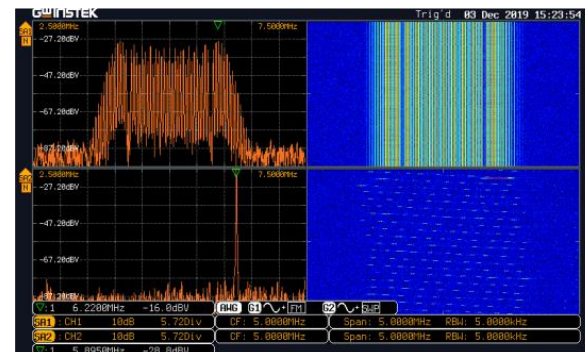
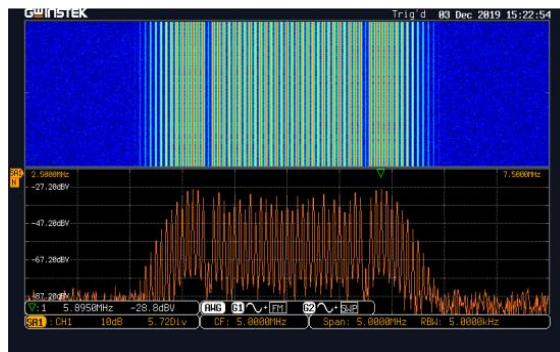
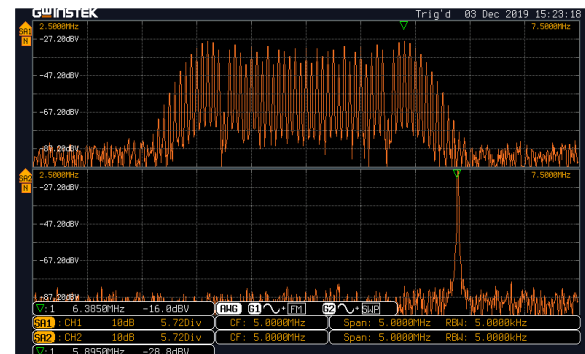
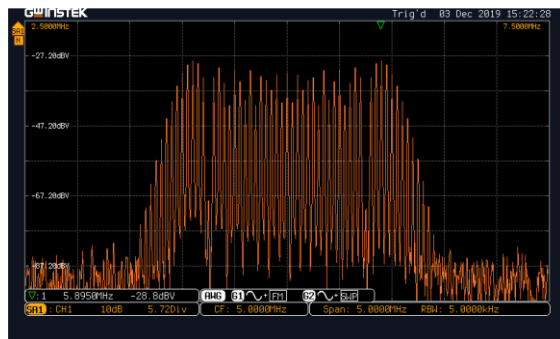
Bus decode function



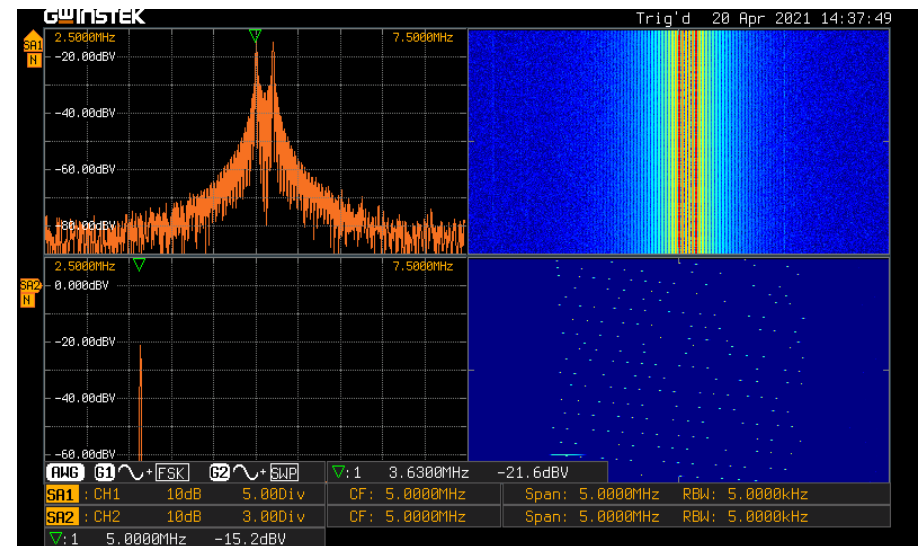
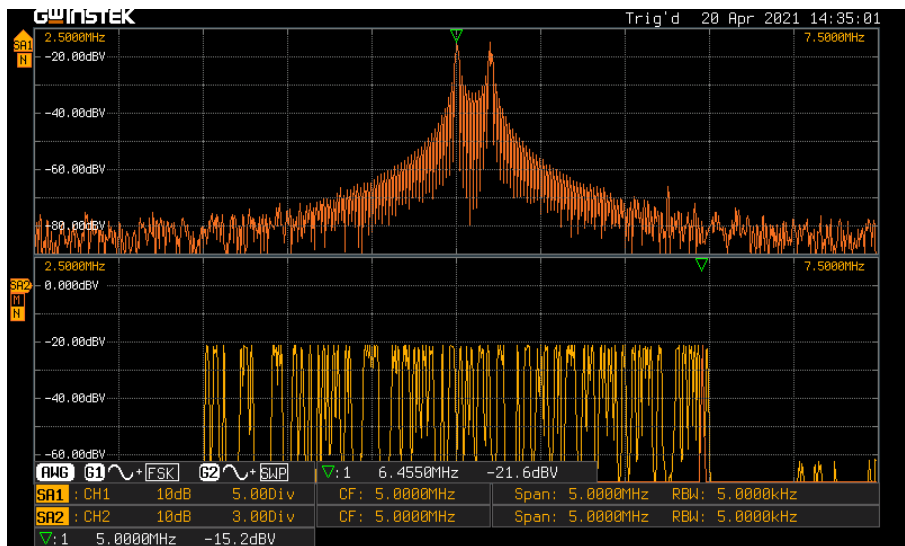
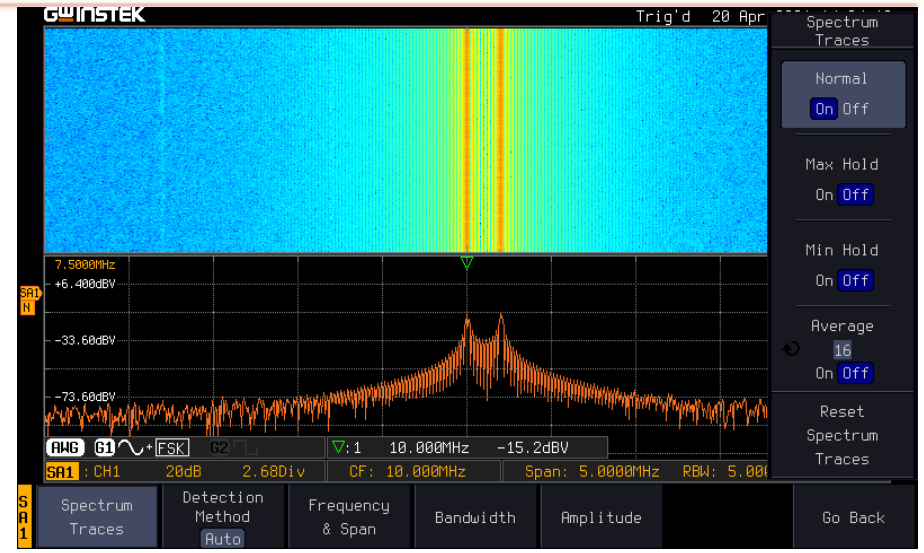
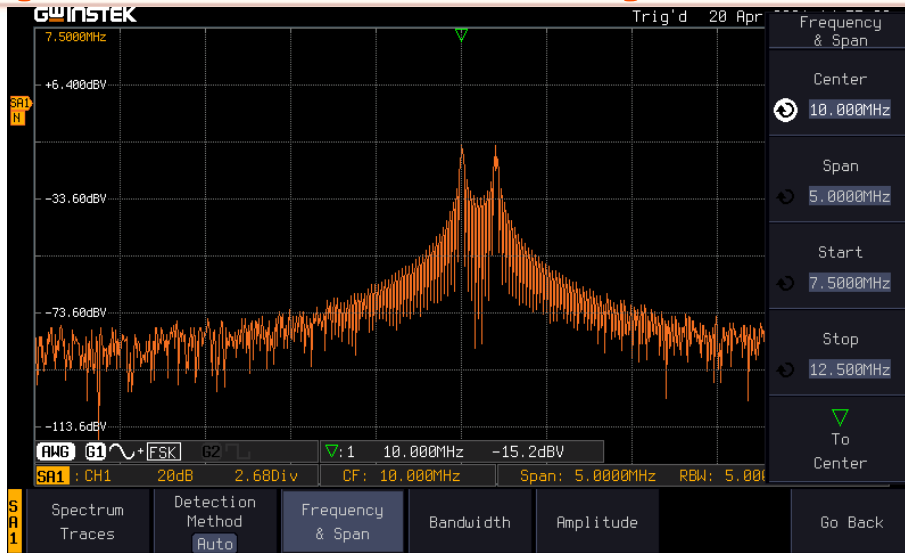
Including I2C,SPI,UART,CAN and LIN bus trigger and decode

Spectrum Analyzer

- Dual channel 2.5GHz spectrum analyzer
- New function: spectrogram
 - Allow users to observe complex frequency fluctuations are scaled down into simple wave superimposed .
 - Observe the distribution or characteristics of the frequency domain



Spectrum Analyzer demo 1~4

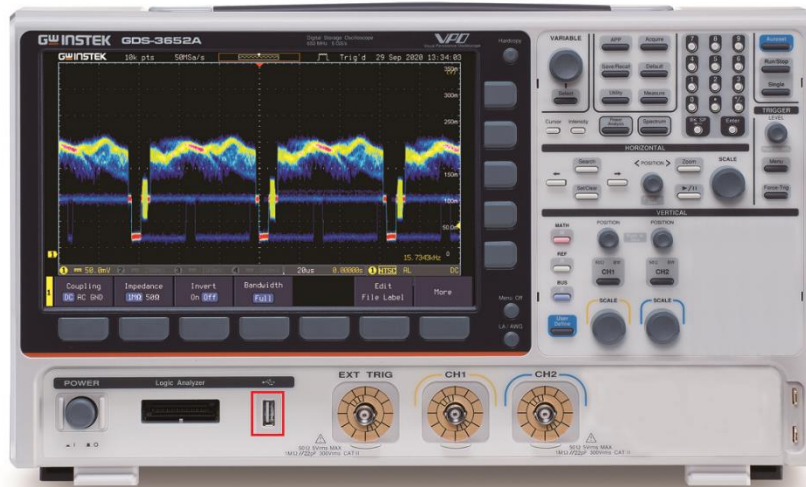


More evolved functions

- Waveform capture
650MHz, 5GSa/s, 200M/CH memory depth
- Display
- Analysis
- Save (interface and software)

Interface

Interface: RS232C, USB TMC host port, device port, LAN port, VGA output and GPIB(option)

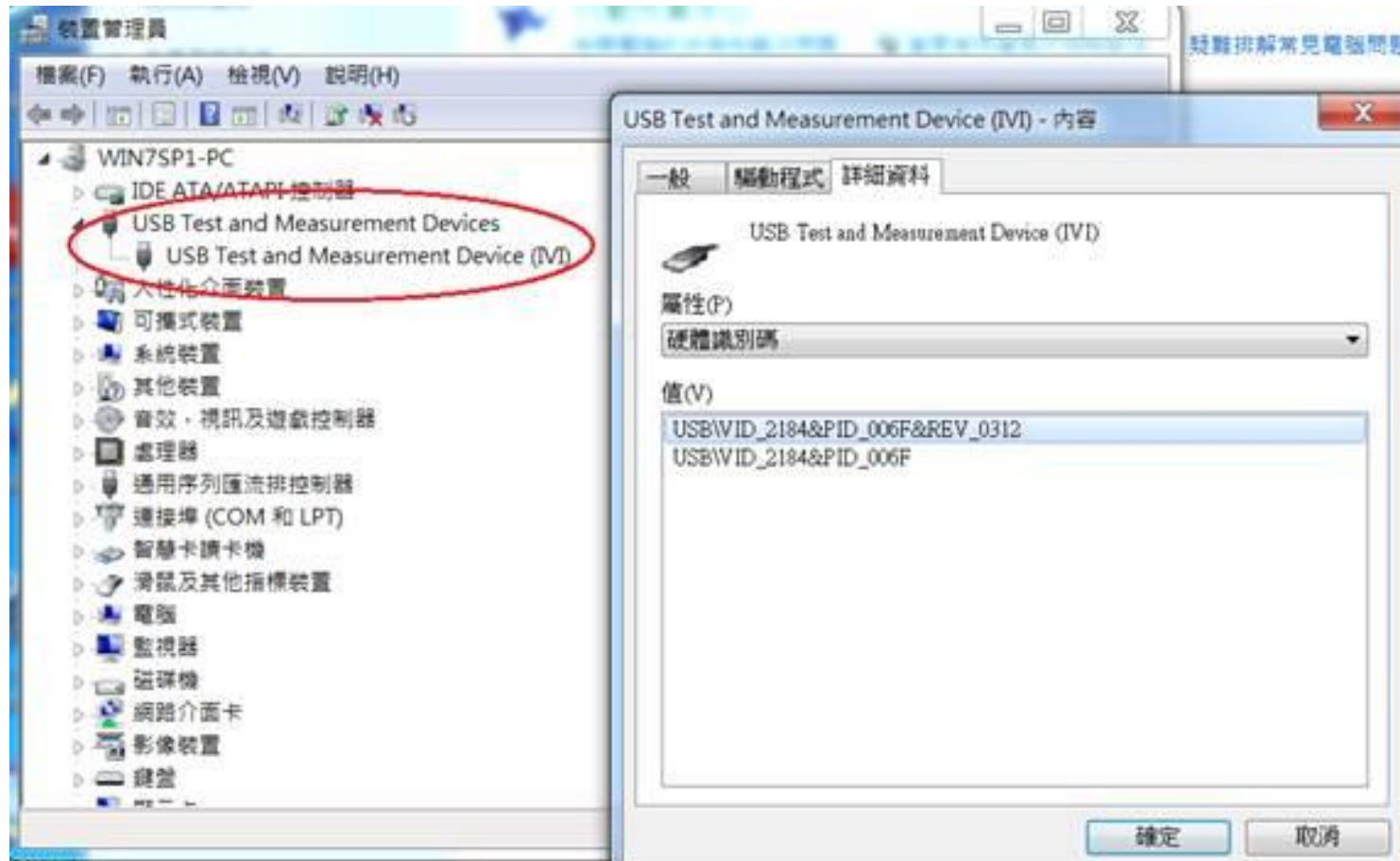


Software: Openwave

Others: Socket server(for direct two-way communication with a client PC or device over LAN)

Web server (capture waveform image by LAN)

USB TMC port



Without USB driver. Please install NI-VISA first.

<https://github.com/OpenWave-GW/OpenWave-3KA>

PC remote control (Web Server function)

GW INSTEK Welcome Page Network Configuration Get image File Exchange SCPI command Web control Visit Our Site

GW INSTEK Trig'd 10 Aug 2021 17:28:11

SR1
2.5000MHz
-20.00dBV
-40.00dBV
-60.00dBV
9d.00dB 20.00MHz -15.20dBV
SR1 : CH1 10dB 3.00Div CF: 5.0000MHz Span: 5.0000MHz RBW: 5.0000kHz

SR2
2.5000MHz
0.00dBV
-20.00dBV
-40.00dBV
AMG : G1 ~ FSK G2 ~ SUP
SR2 : CH2 10dB 3.00Div CF: 5.2600MHz -21.6dBV Span: 5.0000MHz RBW: 5.0000kHz

App Deno Mount Remote Disk

Hardcopy
Variable
App Acquire
Save/Recall Default
Utility Measure
Power Spectrum
Cursor
Intensity
1 2 3 Autoset
4 5 6 Run/Stop
7 8 9
0 +/- Single
TRIGGER
LEVEL
50%
Menu
Force

HORIZONTAL
Position
Search Set/Clear
Zoom
Scale
Push
Push

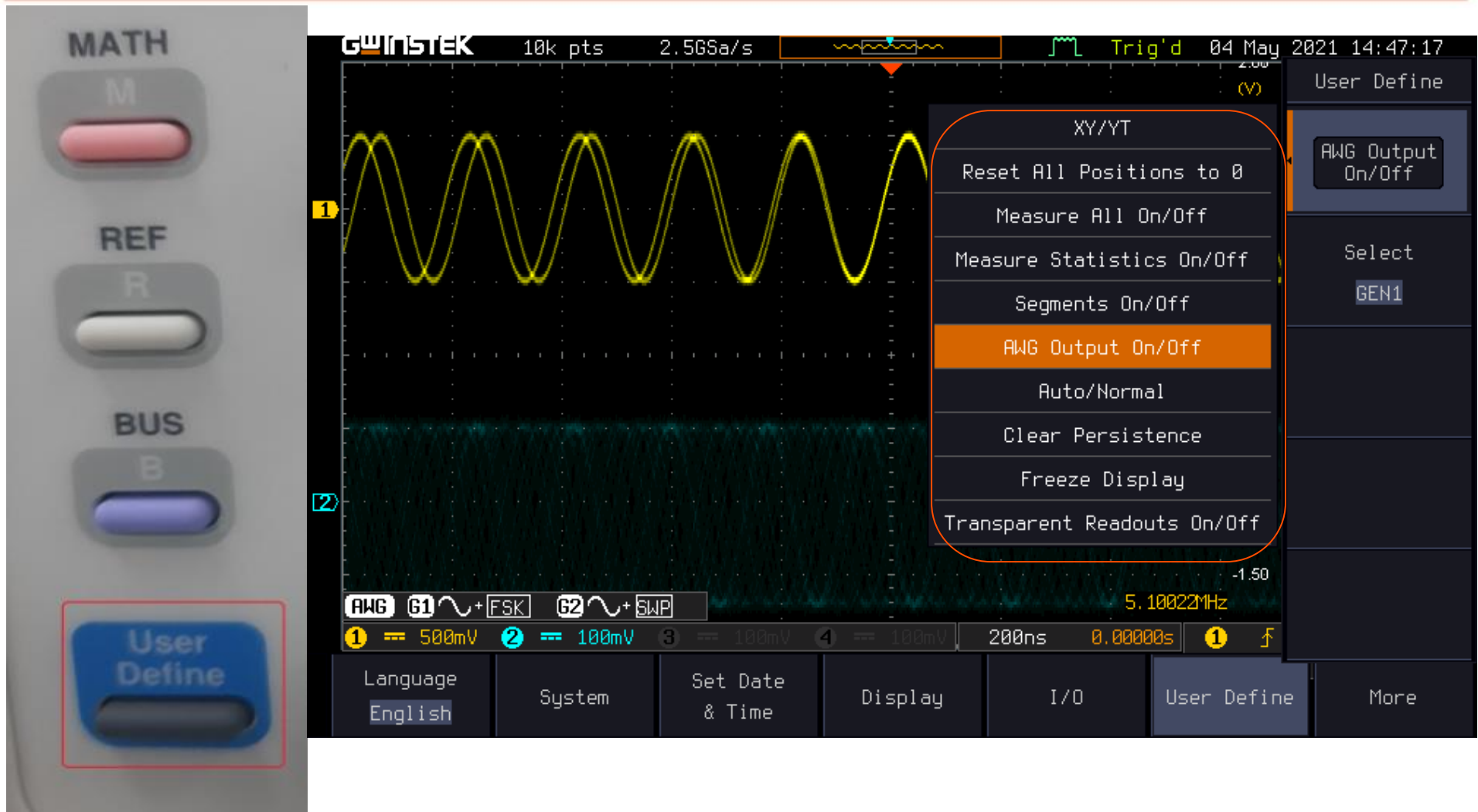
VERTICAL
CH1 CH2 CH3 CH4
Position Position Position Position
MATH REF CH1 CH2 CH3 CH4
SCALE SCALE SCALE SCALE
Coarse Coarse Coarse Coarse

Menu off
Option
User Define

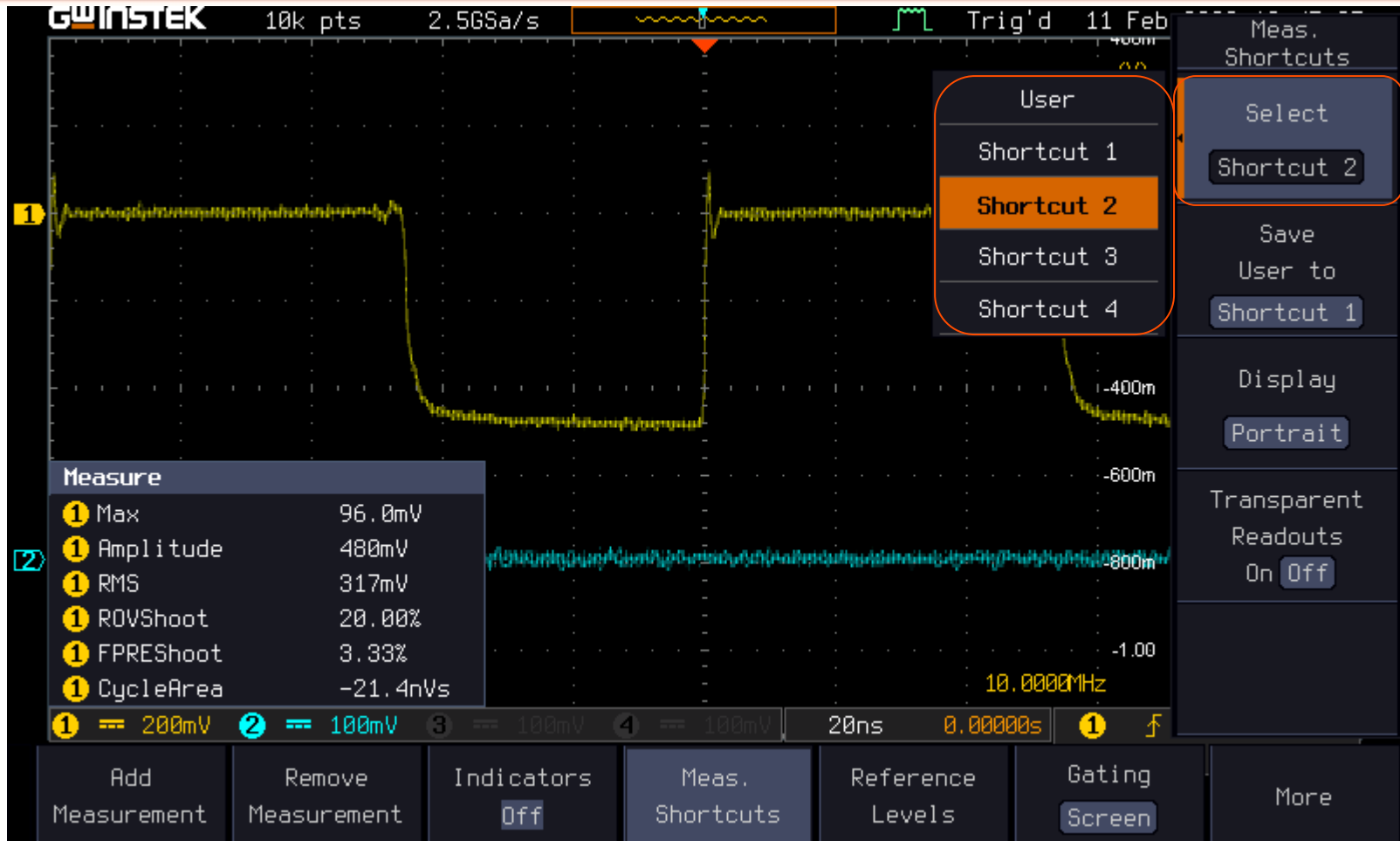
Copyright 2020 © Good Will Instrument Co., Ltd All Rights Reserved.

New shortcut key

User define key

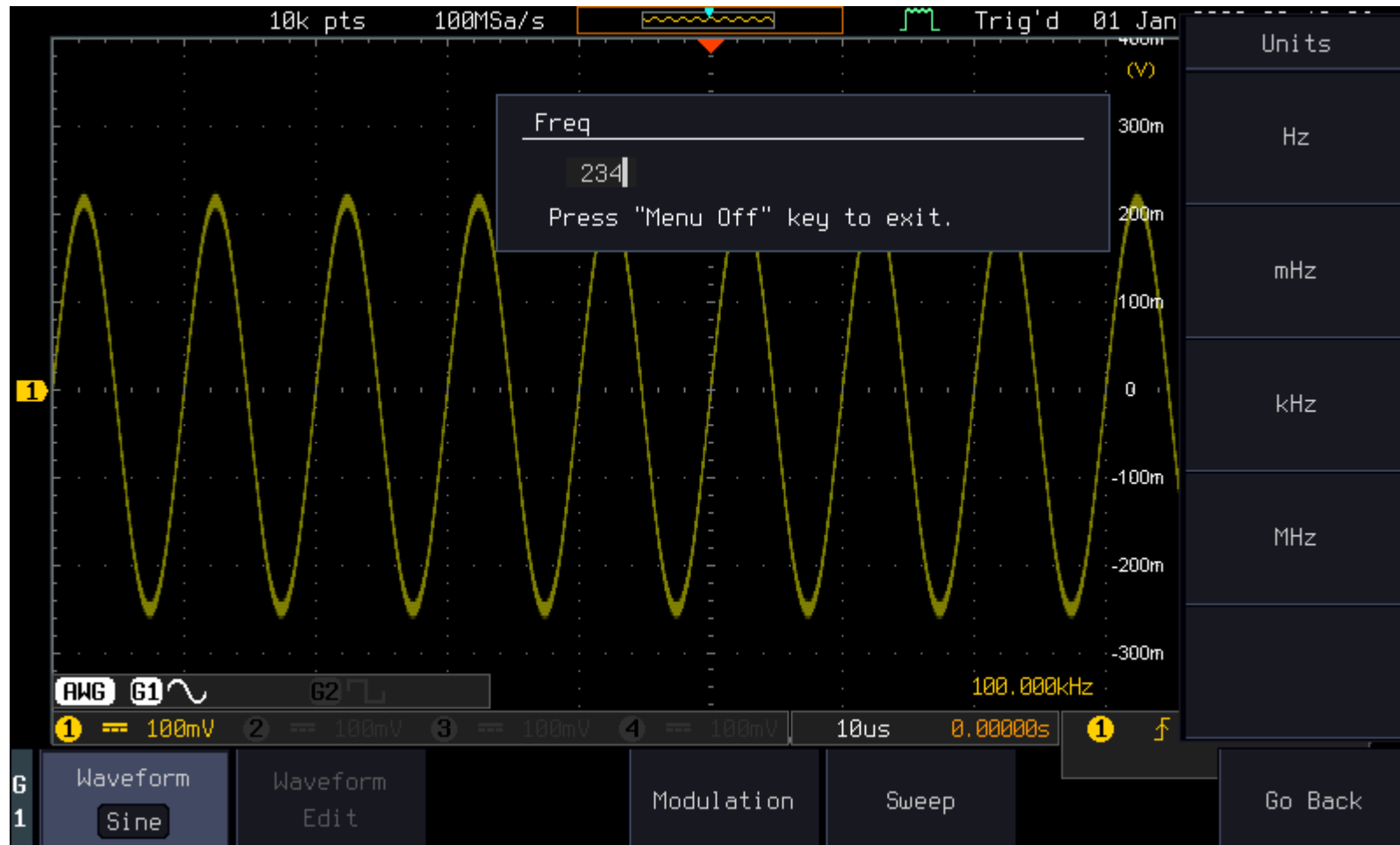


Measure shortcut key



Allow to memorize the user's measure items.

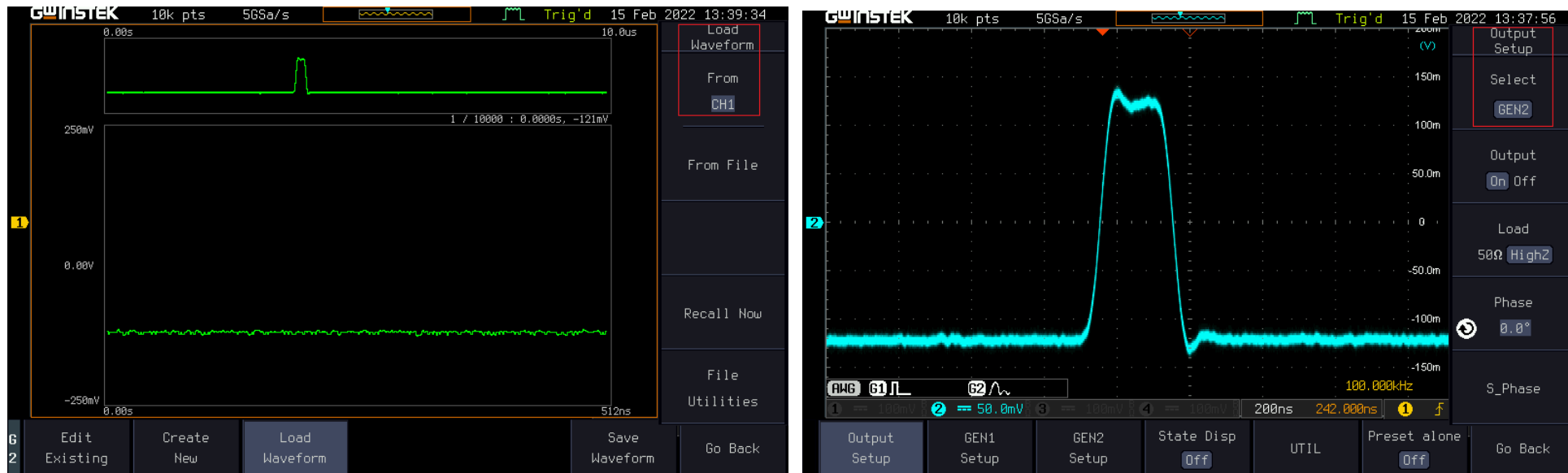
Numeric Key



Operations that require digital input can be used, but Variable rotation fine-tuning is no longer supported.

Incidental functions

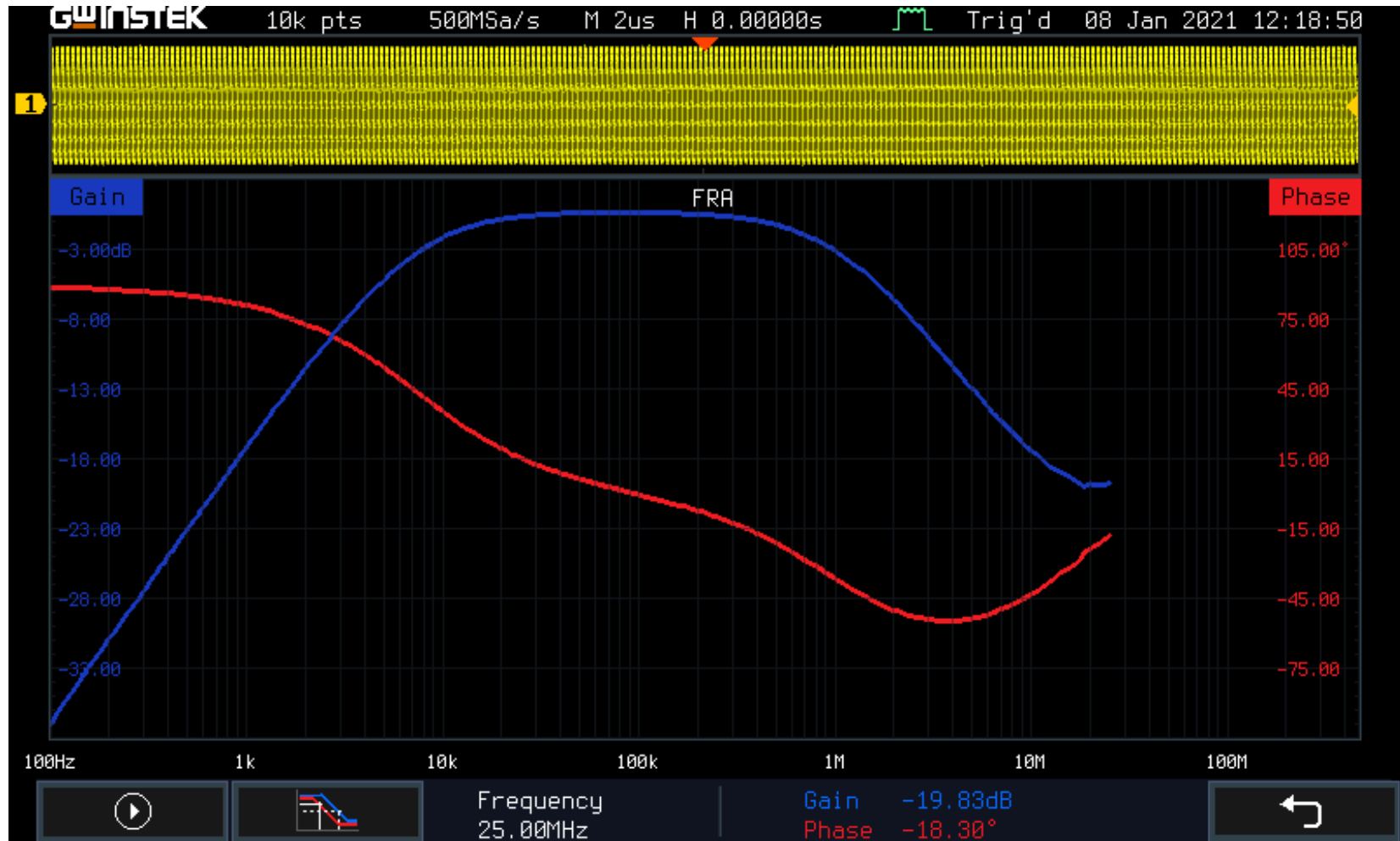
Dual Channel 25MHz arbitrary waveform generator



Added the ARB function to capture the waveforms tested by CH1~CH4.

- Allow user to load and save the ARB file from captured waveform(CH1~CH4).
- Easily to re-generate and simulate captured waveforms.

Frequency response analysis

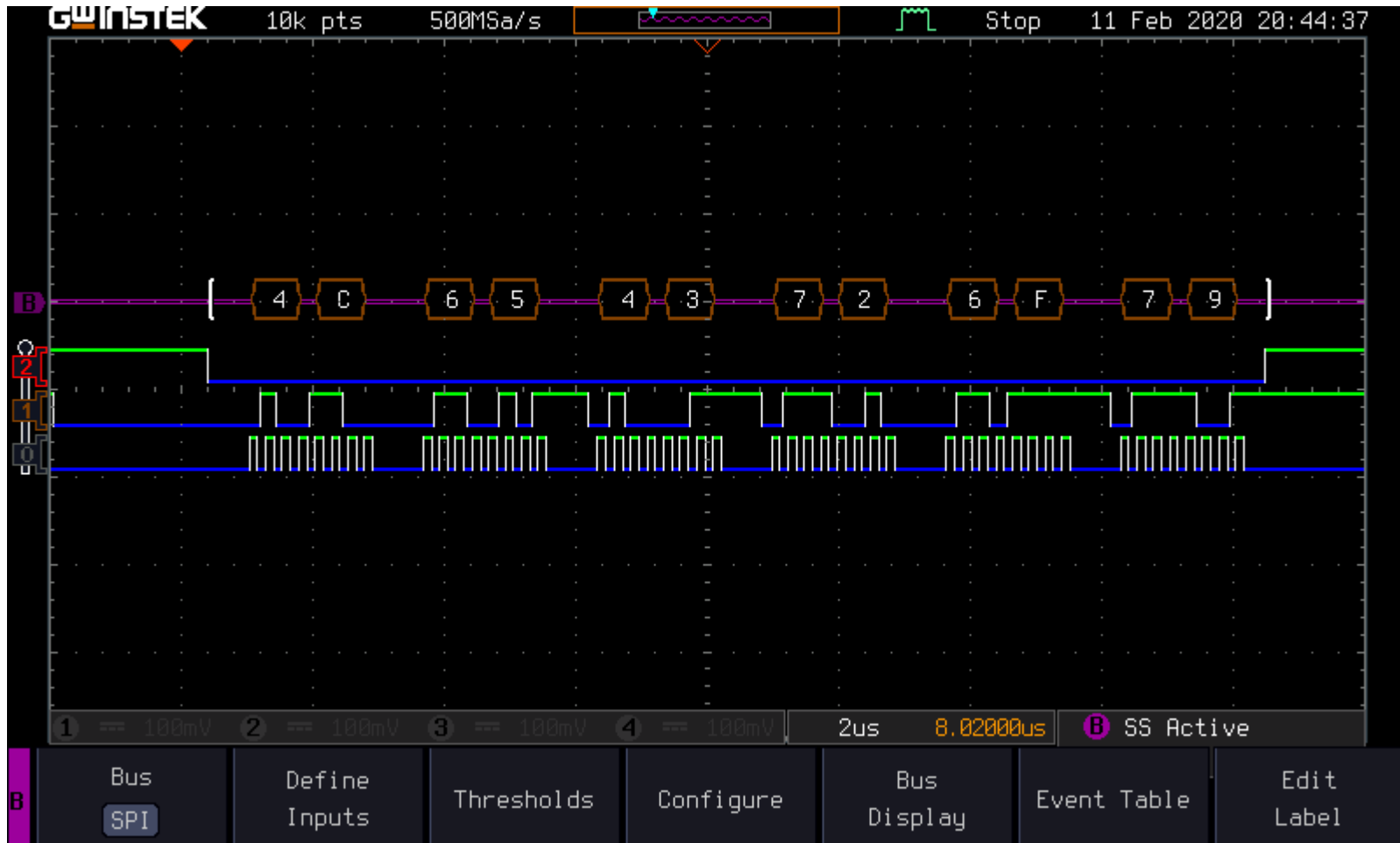


Optional 16 CH logic analyzer



- Optional:DS3A-16LA
- Without USB license, one option allow to install to any GDS-3000A

Bus decode by digital channel



APP

10k pts 100MSa/s Auto 01 Jan

GO_NOGO DVM 986mV DataLog DigitalFilter FRA

Mask

1 Rotating the **VARIABLE** Knob to select the different applications.
Press **Select** button to enable the application.

Go/No-Go Application:
The Go/No-Go application can determine whether the input waveform is within the preset range and performs a predetermined action when the decision is GO or No-Go.

- 1/1 -

1 == 100mV 2 == 100mV 3 == 100mV 4 == 100mV 10us 0.00000s 1

App Demo Mount Remote Disk

App Uninstall

13 sets of Power Analysis measurements



Power analysis test items

AC Line input analysis :

- Power Quality
- Current Harmonics
- In-rush Current

DC output analysis:

- Ripple/Noise
- Transient
- Turn On/Off
- Efficiency

Switching component analysis:

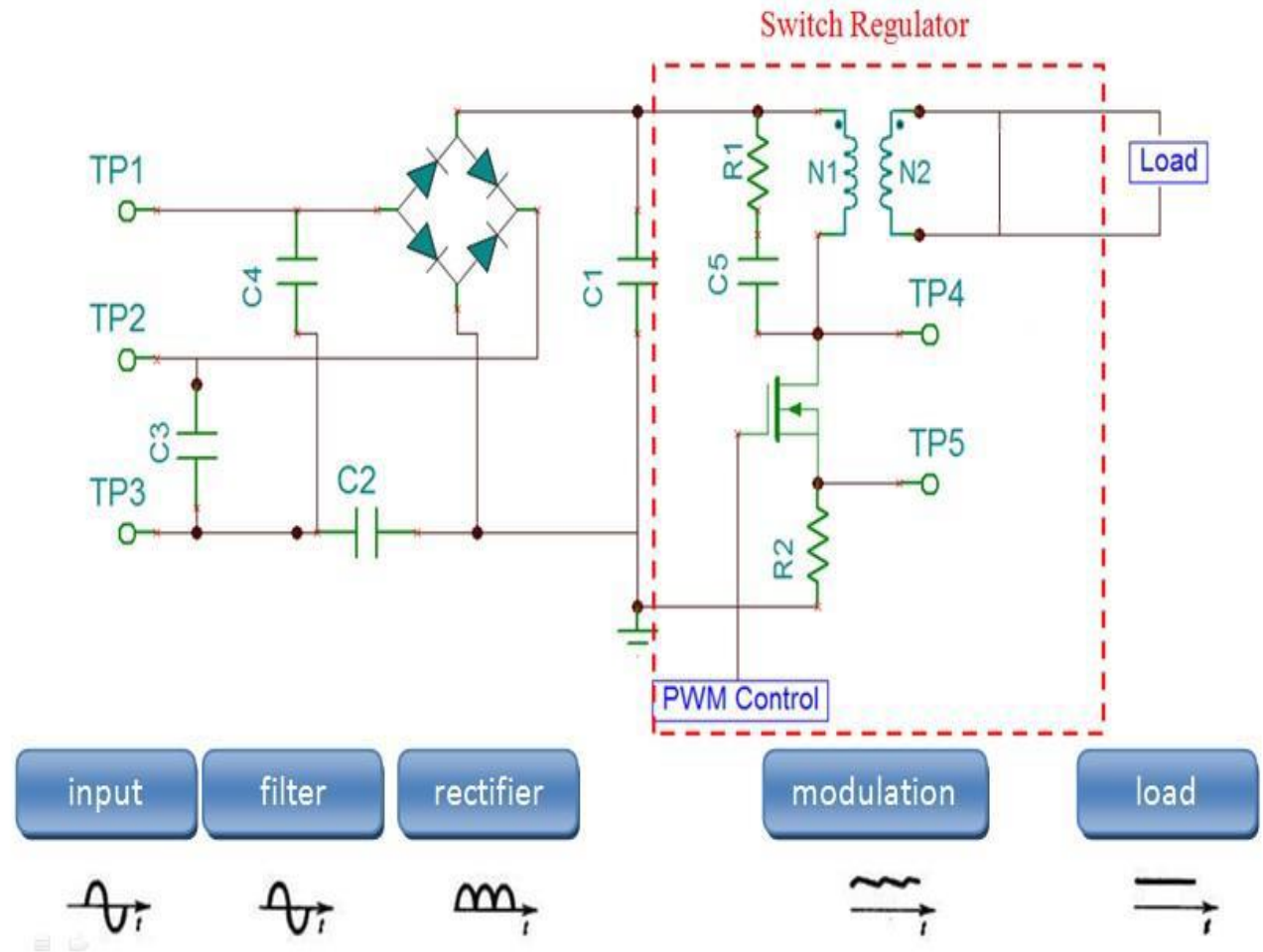
- SOA (safe operation area)
- Switching loss
- Modulation

Frequency Response:

- PSRR
(Power supply rejection ratio)
- Control loop response

Magnetics analysis:

- B-H Curve



Before power measurement – Adjustment

GDS-3000A

- Make sure the time base is not drift after 30 mins warm up, or run SPC to compensation
- Check whether there is a time gap between the voltage channel and the current channel. If there is, use the fixture GKT-100 to perform Deskew correction

Current Probe

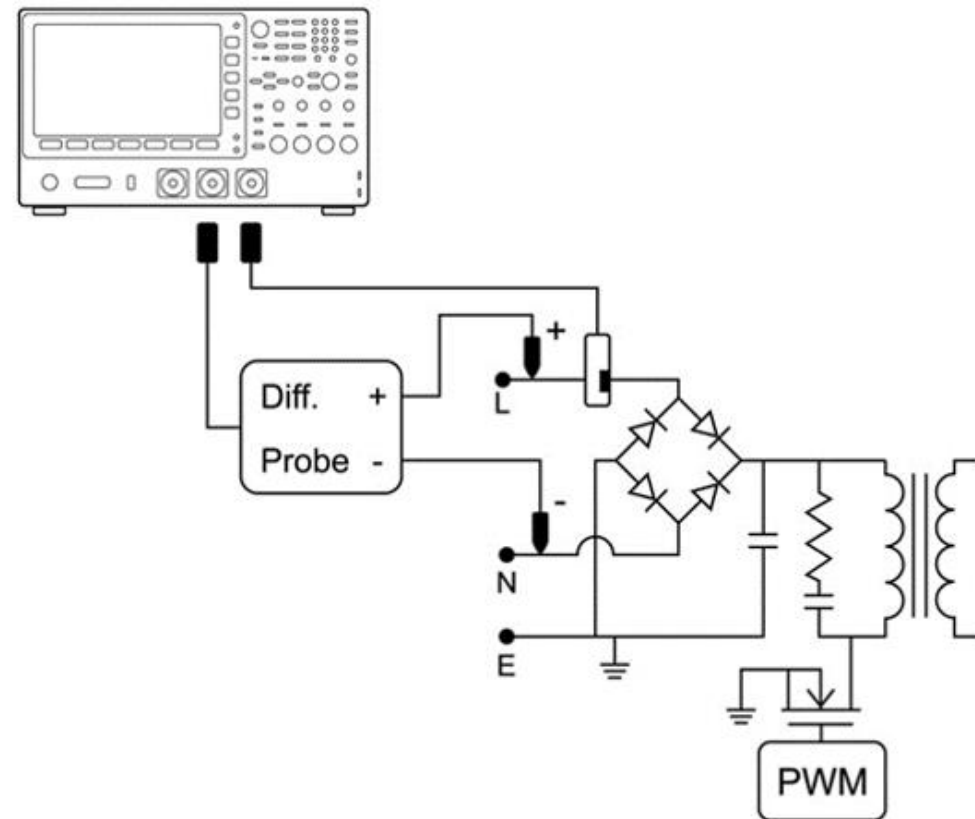
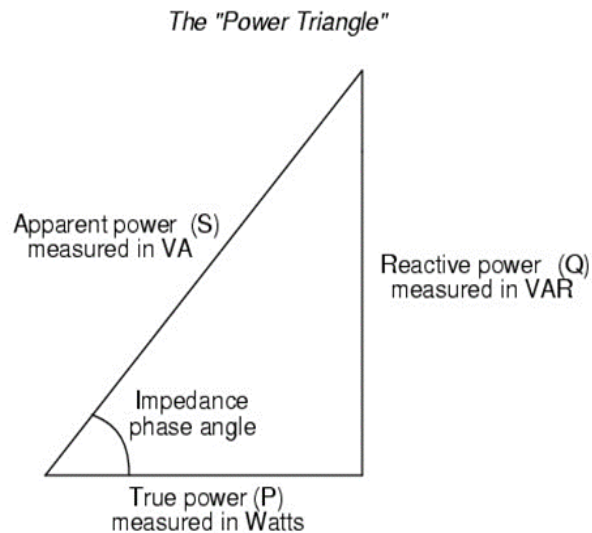
- Set to Zero
- Degauss

AC Line input analysis

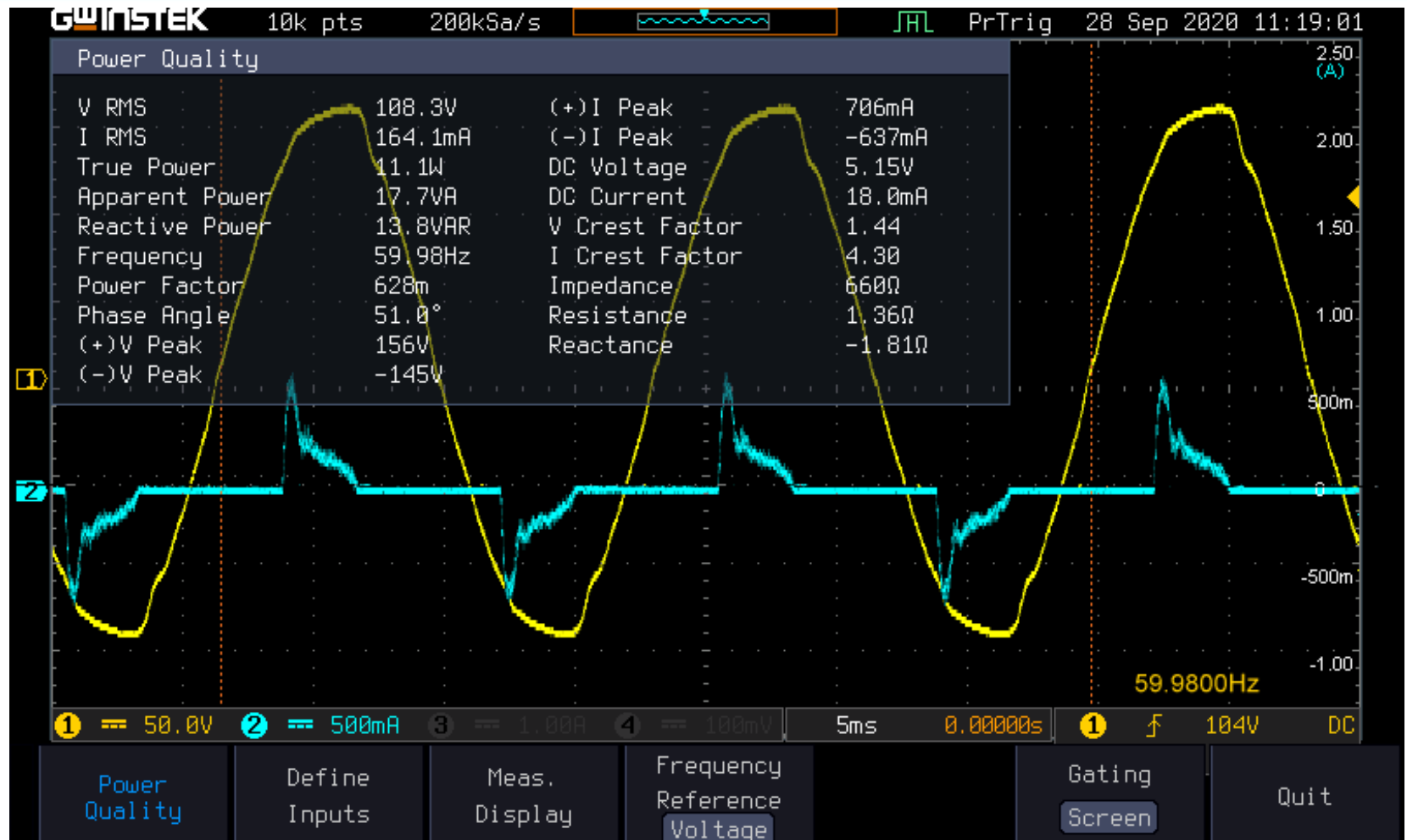
- Power Quality
- Harmonics
- Inrush Current

Power Quality

- Power Quality analysis measures the quality of the input AC line signal
- Connect differential probe to (L, black) and (N, white); current probe to (L) of AC input.
- To measure power triangle.

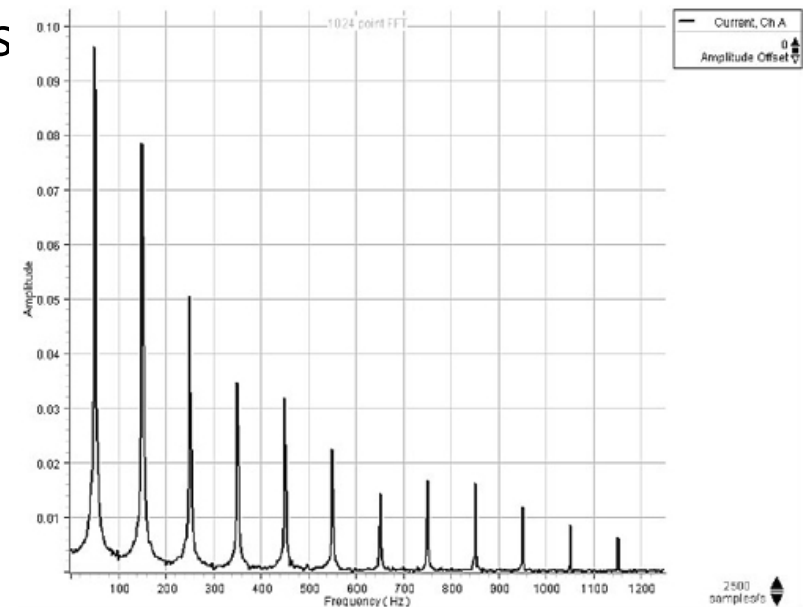


Power Quality



Current Harmonics

- Power line harmonics are generated when a load draws a non-linear current from a sinusoidal voltage.
- Normally caused by magnetic components such as motors, transformers, etc.
- There is an international standard IEC61000-3-2 to test the compatibility
- Measured against the IEC/EN61000-3-2(Class A/B/C/D) standard(Y2018).
- Limits are defined up to 40th harmonics



IEC61000-3-2 A/B/C/D

Class A:

Equipment not specified as belonging to Class B, C or D shall be considered as Class A equipment.

- balanced three-phase equipment;
- household appliances, excluding those specified as belonging to Class B, C or D;
- vacuum cleaners;
- high pressure cleaners;
- tools, excluding portable tools;
- independent phase control dimmers;
- audio equipment;
- professional luminaires for stage lighting and studios;

Class B:

- portable tools;
- arc welding equipment which is not professional equipment.

Class C:

- lighting equipment.

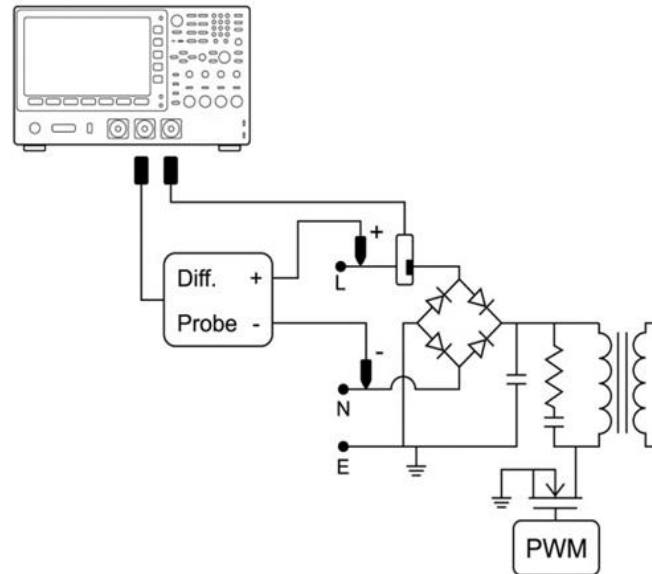
Class D:

Equipment having a specified power less than or equal to 600 W, of the following types:

- personal computers and personal computer monitors;
- television receivers;
- refrigerators and freezers having one or more variable-speed drives to control compressor motor(s).

Current Harmonics

- Caused by magnetic components such as motors, transformers, etc.
- The measurement are including: freq (Hz), Mag (%), Mag RMS (A), Limit (A), Max all windows (A), 200% limit, POHC Limit, THD-F (%), RMS (A), Overall (PASS/FAIL), POHC (A), POHL (A).
- Use differential probe to probe (L) and (N); current probe to (L) of AC input.



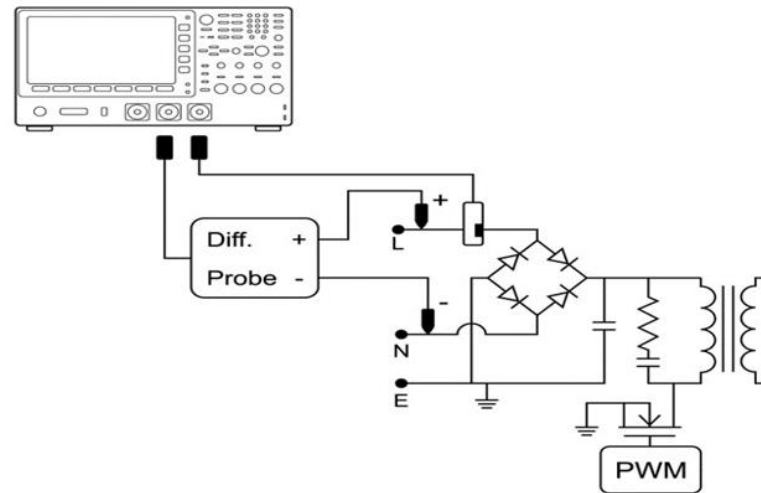
Current Harmonics



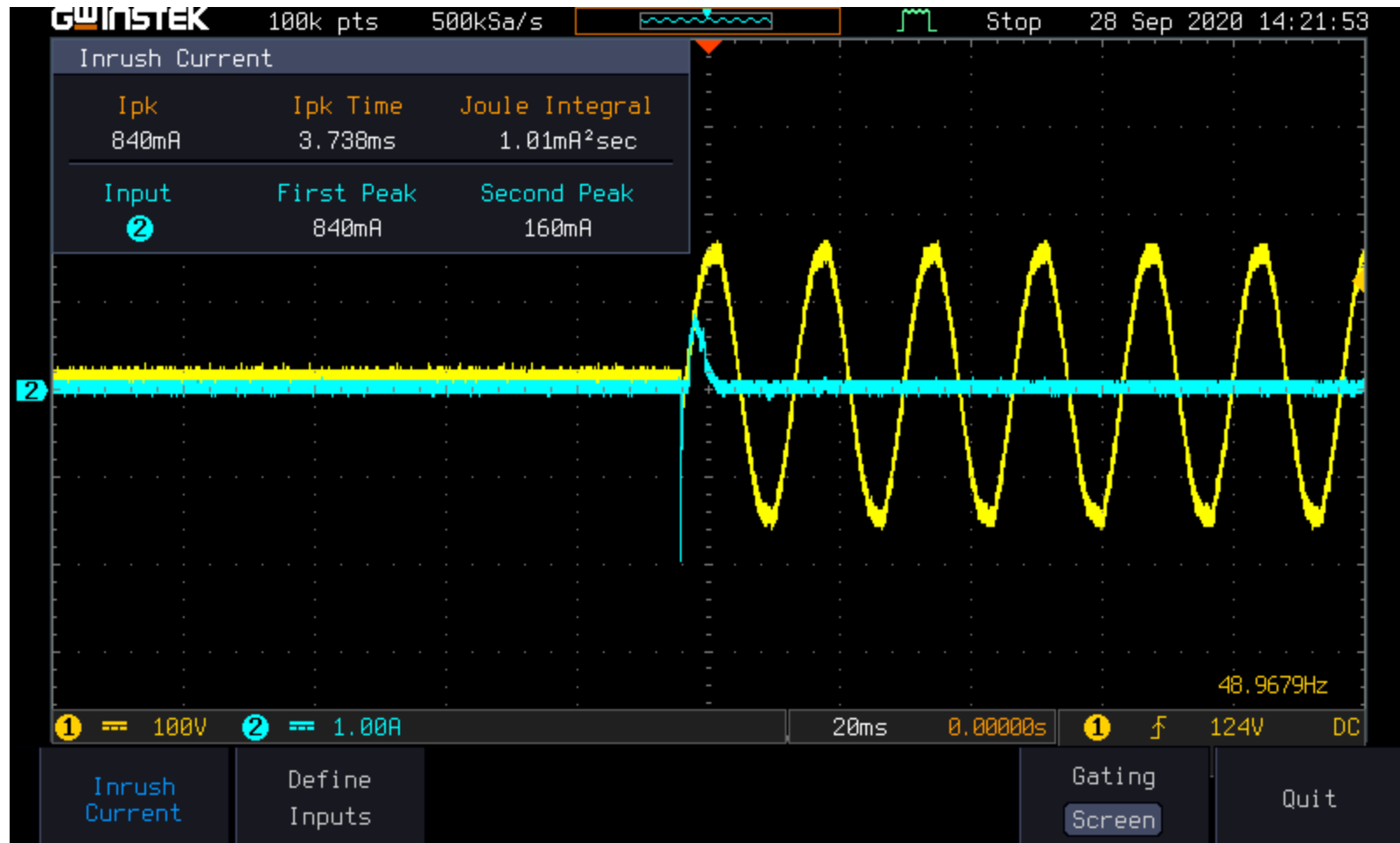
Allow to save measure result as .csv file

In-rush current

- Inrush Current Analysis measures the peak input current (positive or negative) when power is initially turned on.
- The measurement are including : I_{pk} (A), I_{pk} Time (s), Joule Integral (A^2s), First Peak (A), Second Peak(A)
- Use current probe to probe (L) of AC input.
- The Joule integral value (I^2T) is usually used to evaluate whether the fuse can withstand the surge current impact.



In-rush Current

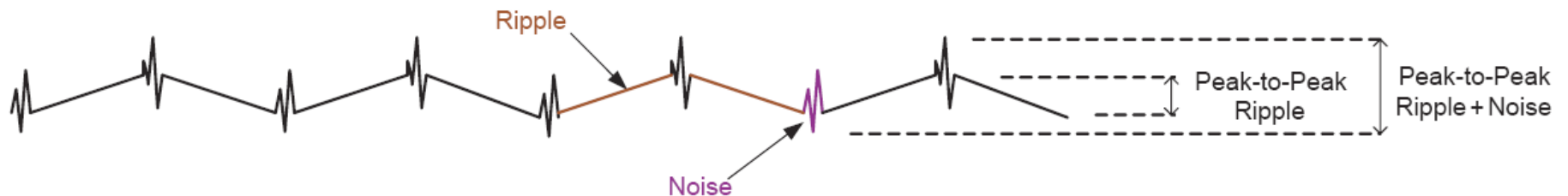


DC output analysis

- Ripple/Noise
- Transient
- Turn On/Off
- Efficiency

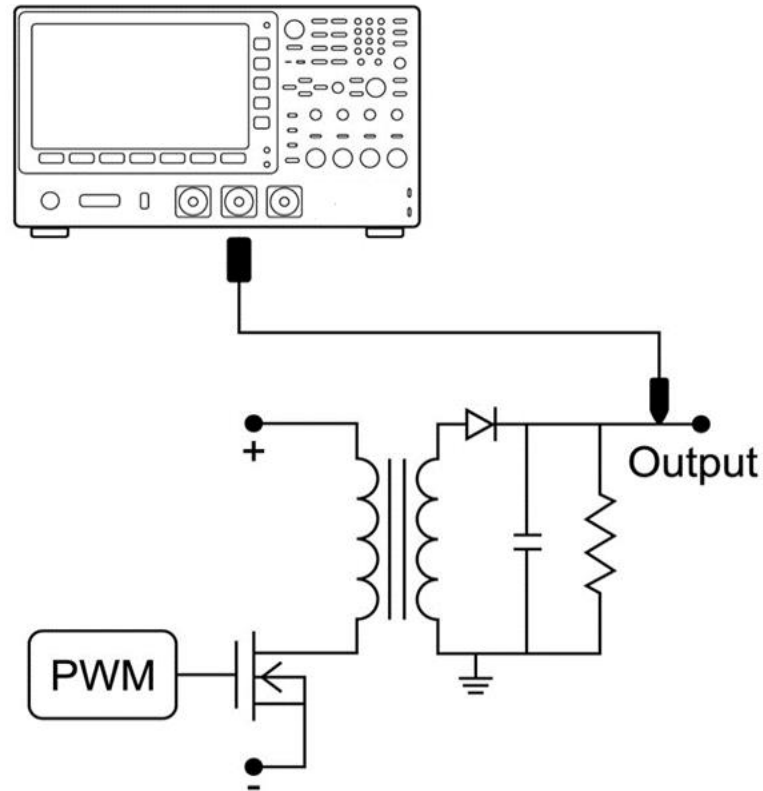
Ripple and Noise

- SMPS output noise can be categorized as having ripple and noise content.
- Ripple is the output voltage fluctuation associated with charge and discharge events of the SMPS, and is often referred to as V_{rms} and V_{pp} .
- Noise spikes occur at the SMPS turn-on and turn-off events, the amplitude is dependent on SMPS topology, circuit parasitic, and PCB layout.

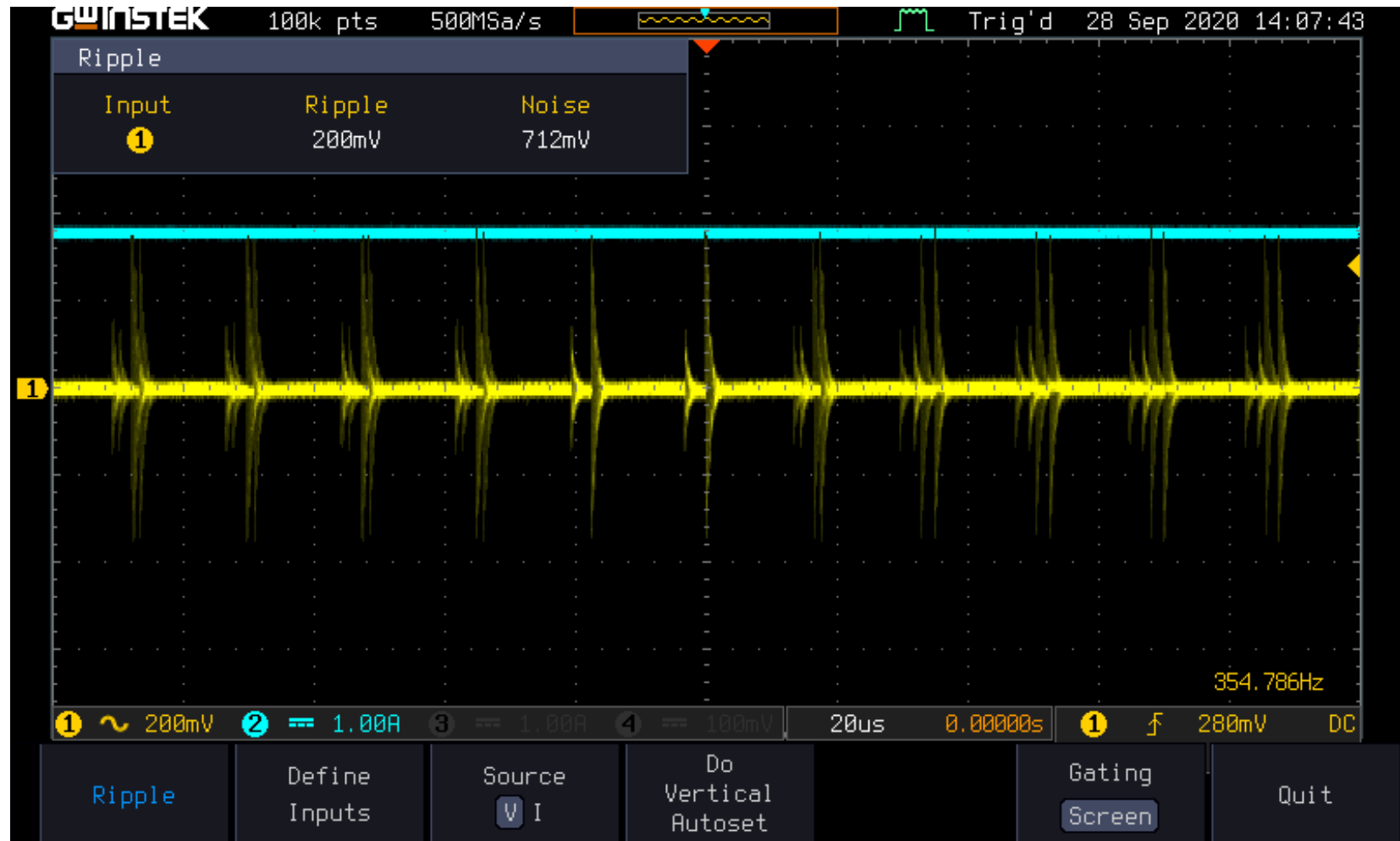


Ripple

- Output ripple analysis measures the peak-to-peak extremes of the output DC signal of the power supply.
- Test items: Ripple (V/A), Noise (V/A)
- Use current probe or differential probe to probe the DC output.

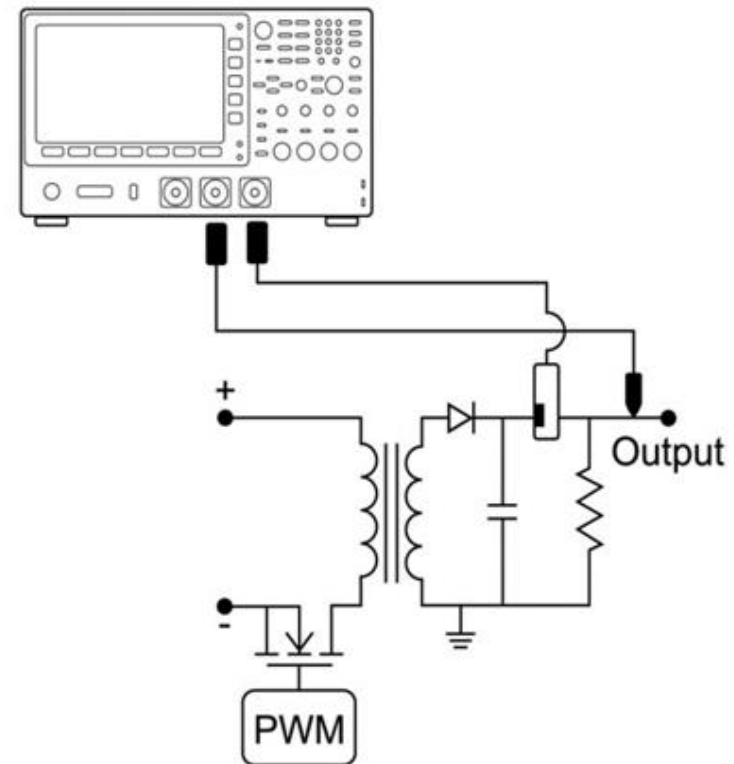
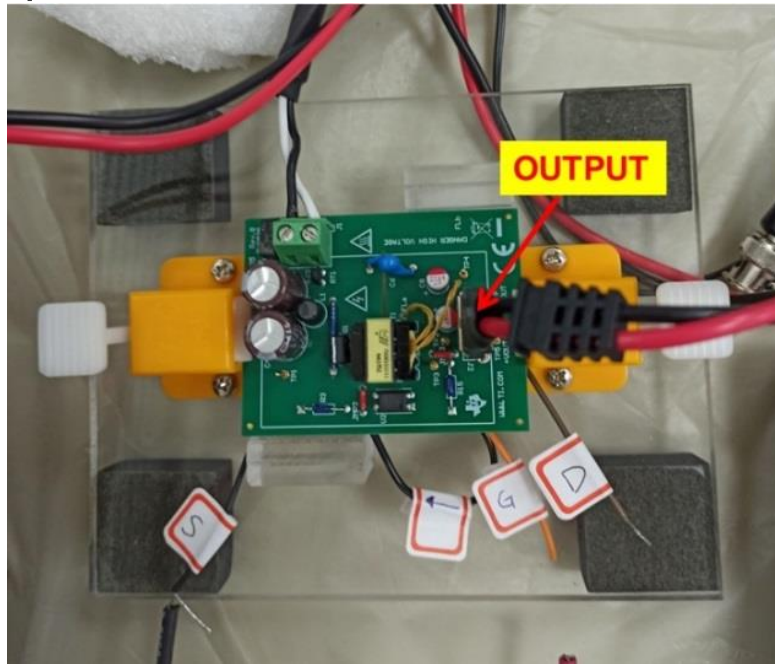


Ripple



Transient

- This function can determine the response speed of the output voltage vs. load change of the power supply device
- Test item: Transient time(s).
- Use passive or differential probe and current probe to probe the DC output.



Transient

1. Setup

- (1). Steady V_{out} : Stable DC voltage value (Mean of CH1)
- (2). Low Current (Low value of CH2)
- (3). High Current: (High value of CH2)



Transient Response

Transient

2. Adjust duration

(1). To observe only one transient voltage waveform

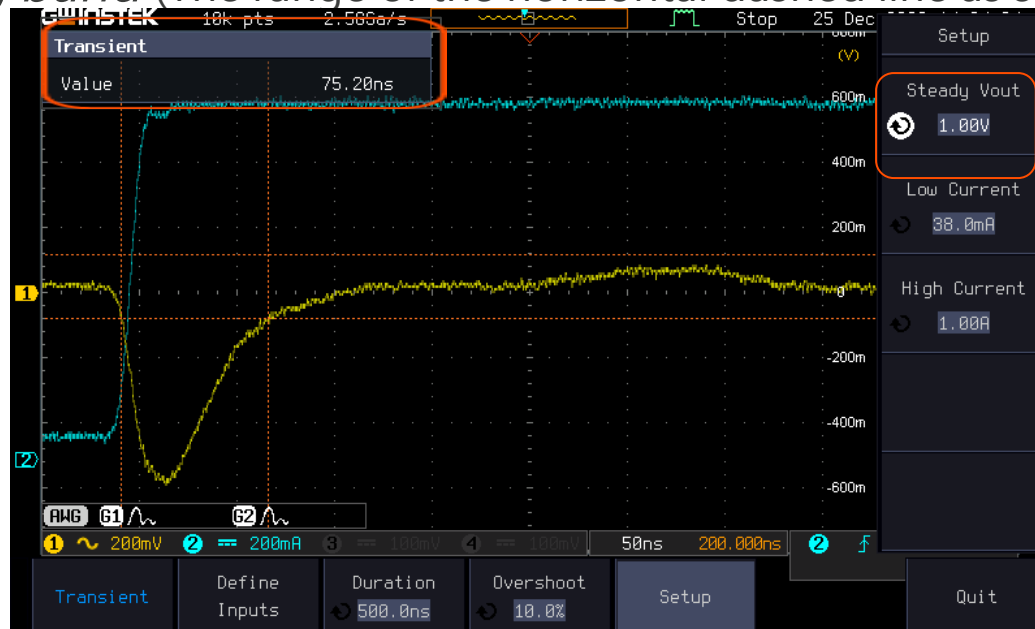
3. Adjust overshoot

(1). If Overshoot set to 10% ,

Steady Vout(1V) x Overshoot(10%) = 100mV

(It' s mean settling band=100mV*2=200mV)

**settling band* (The range of the horizontal dashed line as shown in the figure below)

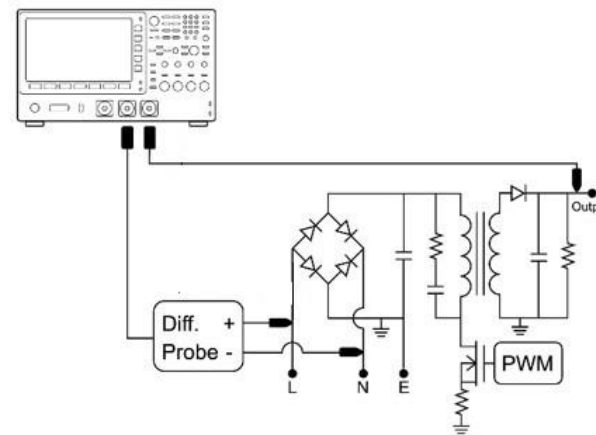
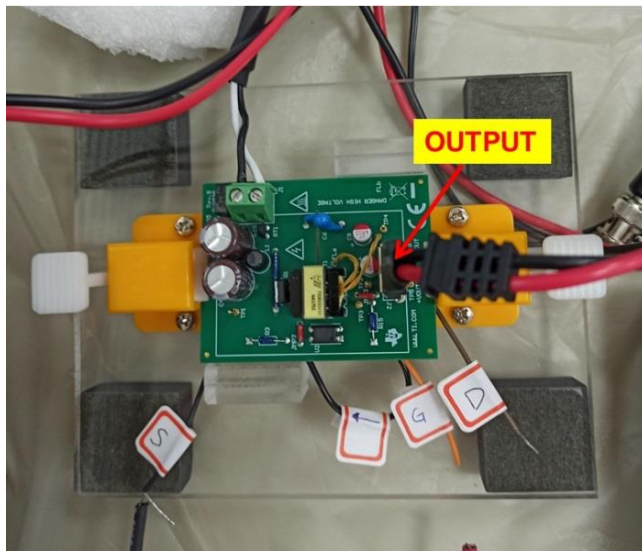


Mean Value
Setup

Transient Response Time

Turn on/off

- Turn-on analysis measures the time from when power is initially switched on until the dc output reaches 85% of its expected steady-state level; Turn-off analysis measures the time from when power is switched off until the DC output decays to 15% of the steady-state on level.
- Test items: T_d (s), T_r (s), V_{out} (v), V_{in} (V), I_c (A)
- Use differential probe to probe (L) and (N) of AC input and passive probe to probe DC output.
- For I_c (A) test, please use current probe to probe (L).



Turn on/off

- Turn On

To measure the time of the power supply to reach 85% of its voltage stabilization output

- Turn Off

To measure the time of the power to turned off until it drops to 15% of the maximum voltage

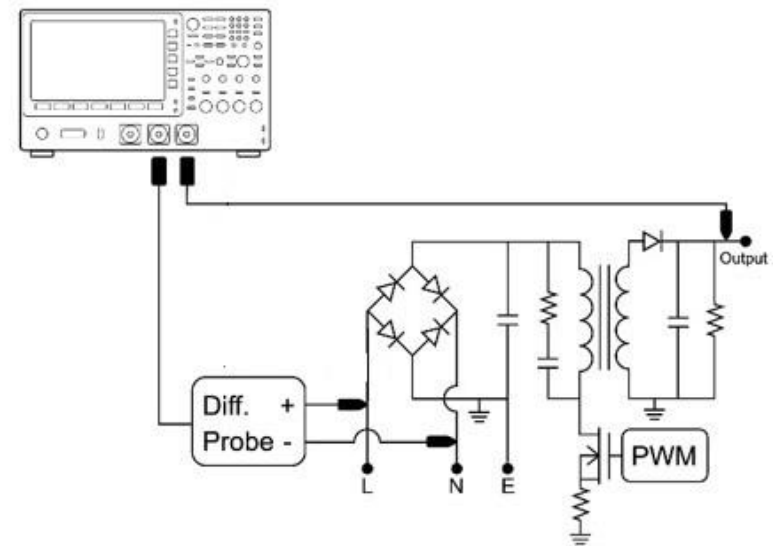
- Measure items:

Delay Time - T_d (s)

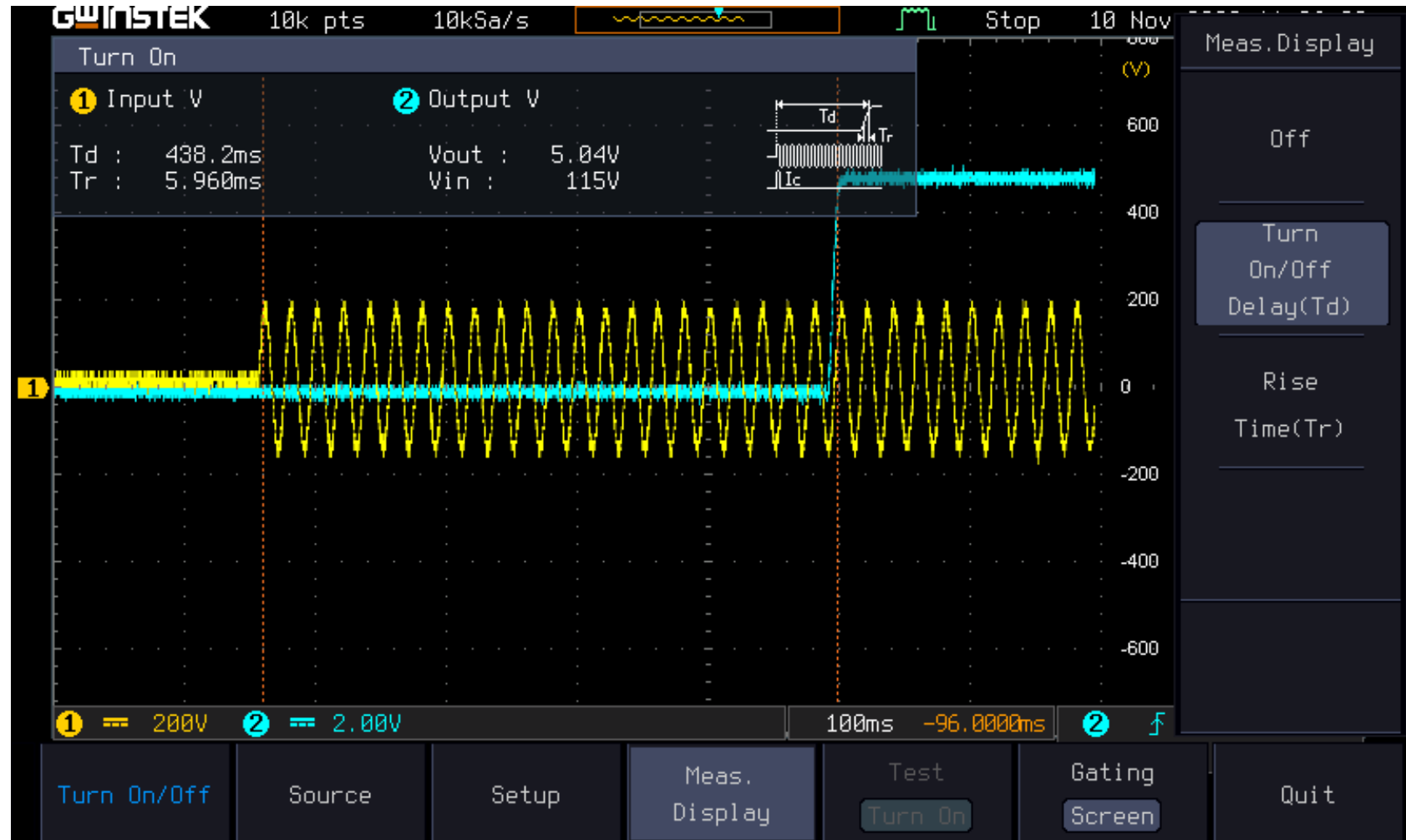
Rise Time - T_r (s)

Output voltage- V_{out} (v)

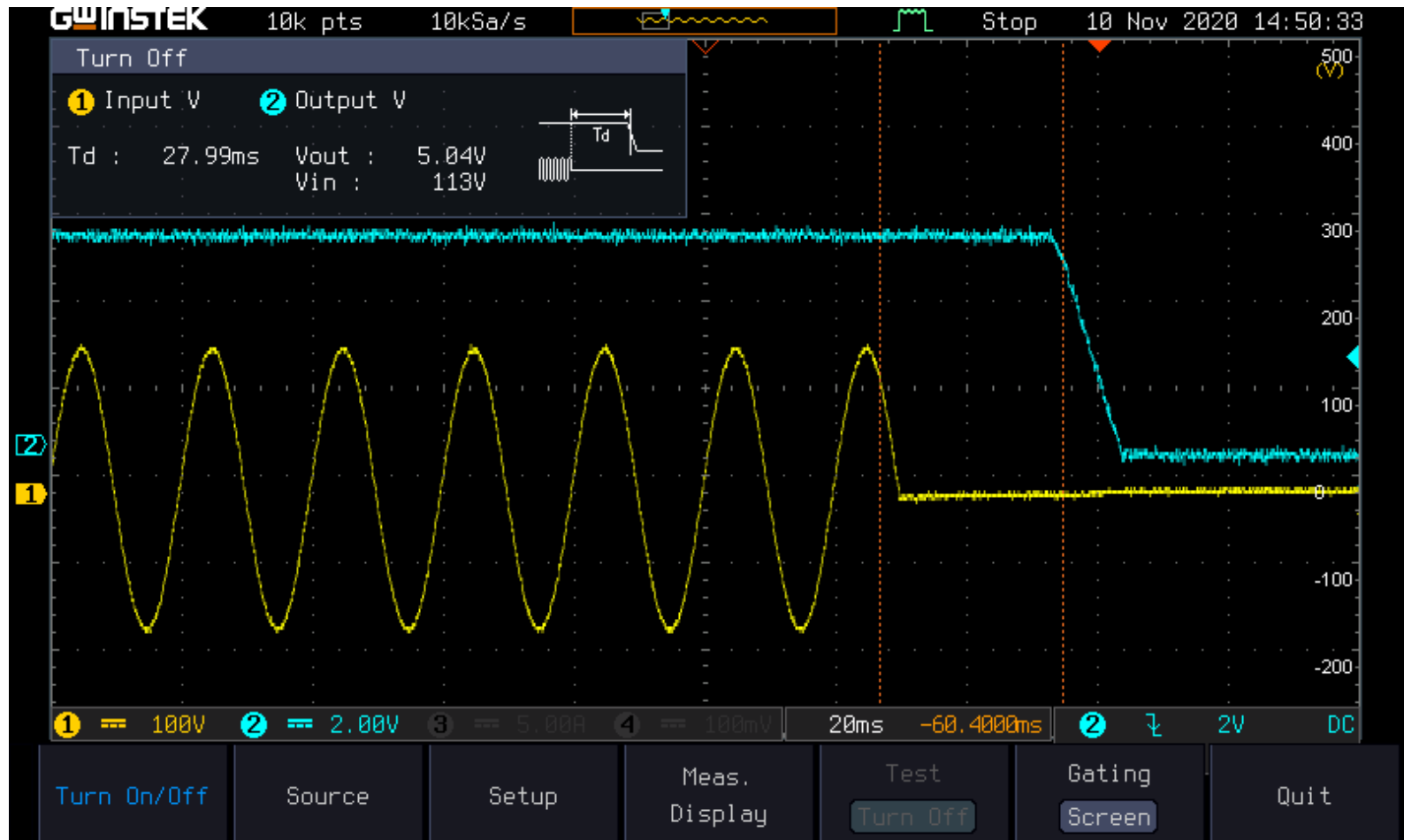
Input Voltage- V_{in} (V)



Turn on time

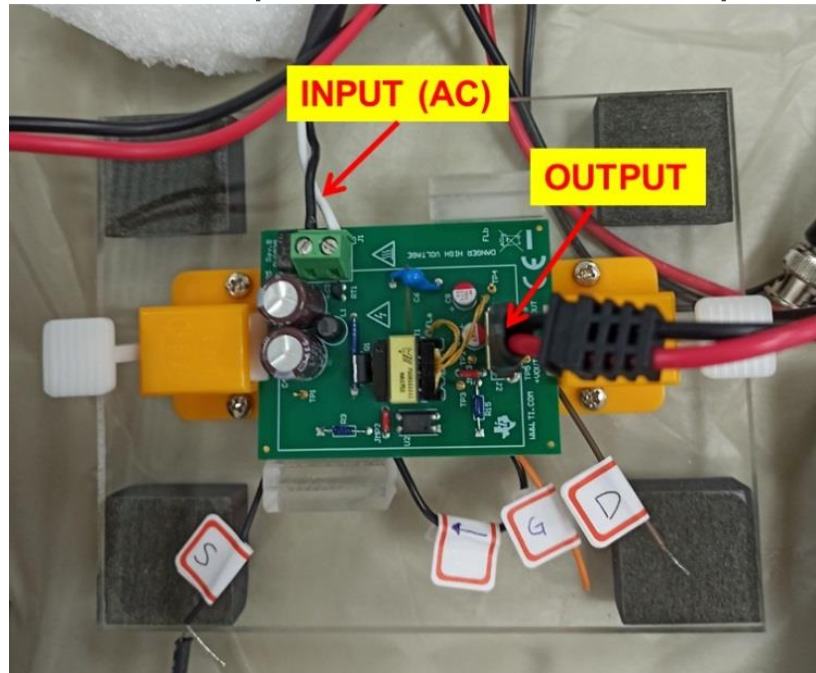


Turn off time



Efficiency

- Efficiency analysis measures the input real power and output power in order to compute the efficiency of your power supply
- Recommend to use 4CH models. (Efficiency = $P_{out}/P_{in} * 100\%$.)
- Test items: input power (W), output power (W), efficiency (%).
- To probe (L) and (N) of AC input by differential probe and (L) by current probe; another differential probe and current probe to probe DUT output as well.



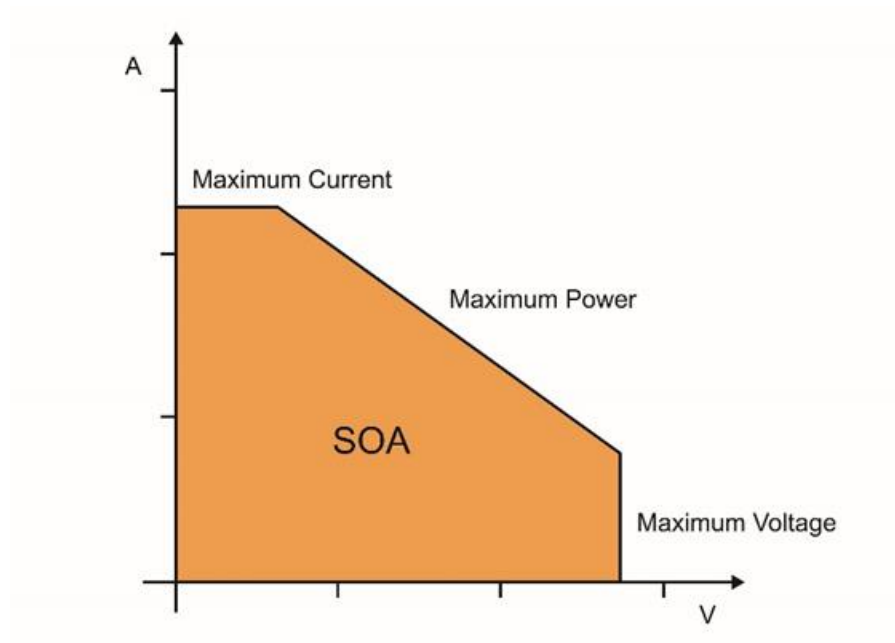
Switching component analysis

IGBT or MOSFET

- SOA(safe operating area)
- Switch loss
- Modulation

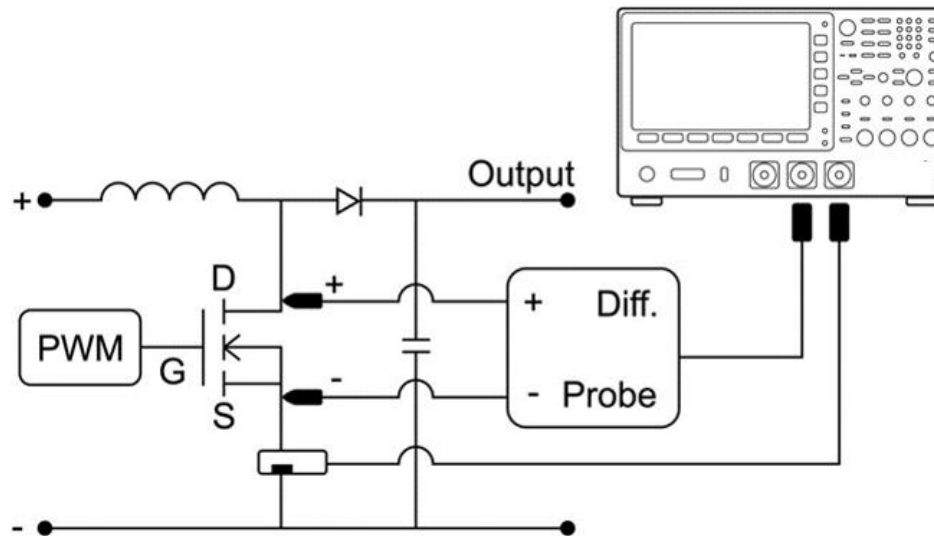
Safe Operation Area (SOA)

- Switching components are tested for maximum voltage and current safety specifications
- Define as **drain-source voltage, drain current and time duration** conditions over which the device can be expected to operate without self-damage.

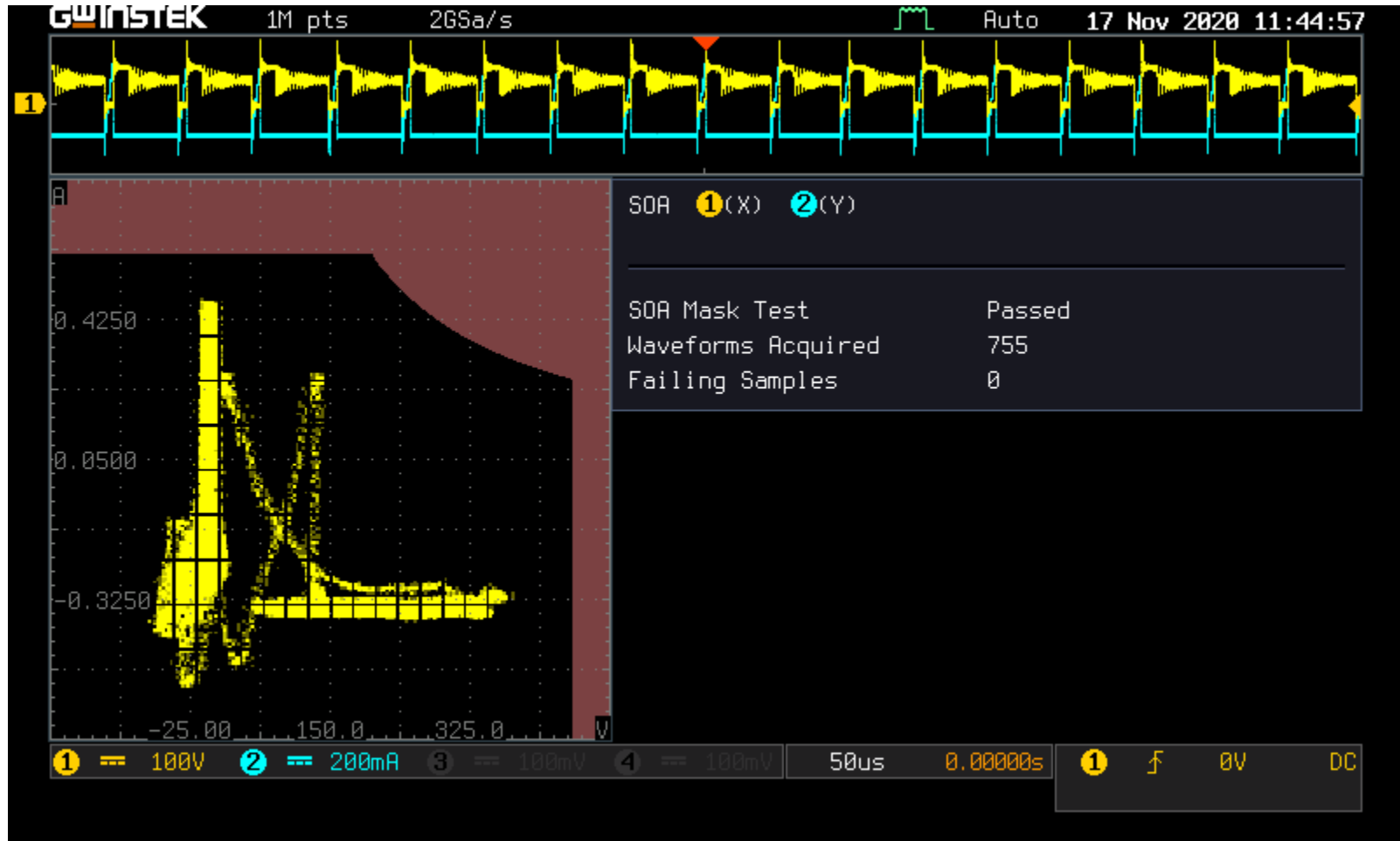


SOA

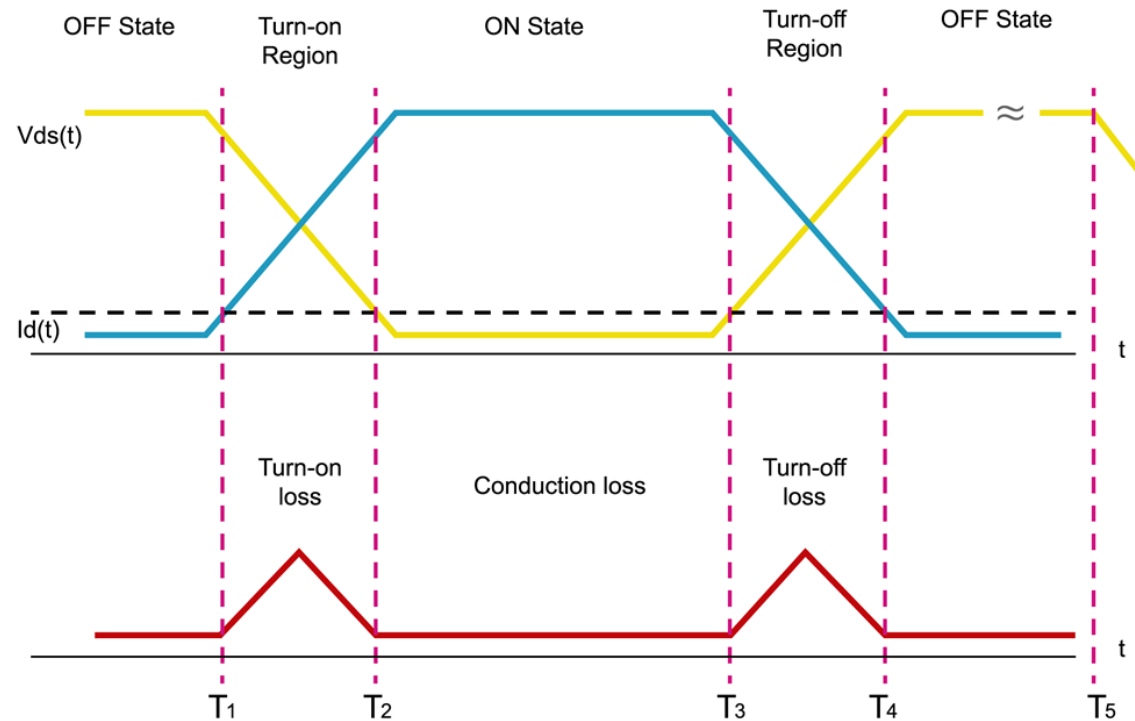
- The **safe operating area (SOA)** plot is a graphical technique for evaluating a switching device to ensure that it is not being stressed over its maximum specifications
- Use GDS-3000A long memory depth to plot SOA, the user will easy to observe where the device is abnormal.
- To use differential probe to probe Drain and Source and current probe to probe Source of IGBT or MOSFET.



SOA



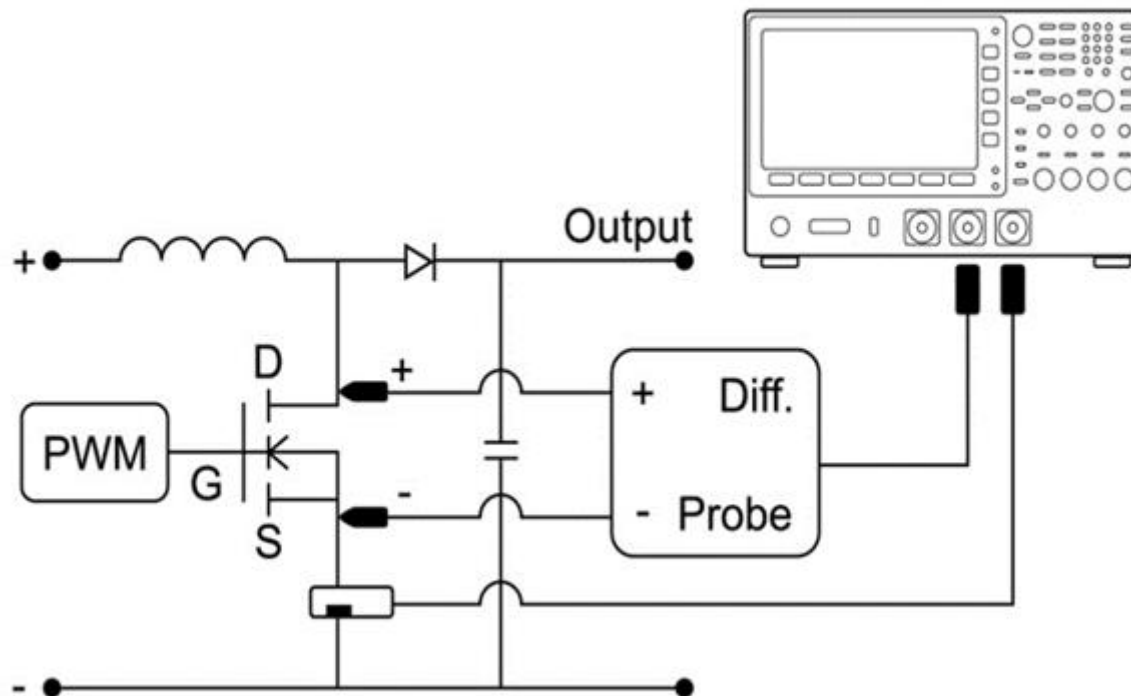
Switching Loss



- To analyze the voltage drop and current flowing through the switching device (MOSFET or IGBT) in the power supply to measure the switching loss of the device.
- Including Turn-on switching loss, Turn-off switching loss and Conduction loss.

Switching loss

- Test items: power loss(W), energy loss(J), $R_{ds(on)}/V_{ce(sat)}$
- To use differential probe to probe Drain and Source and current probe to probe Source of IGBT or MOSFET.

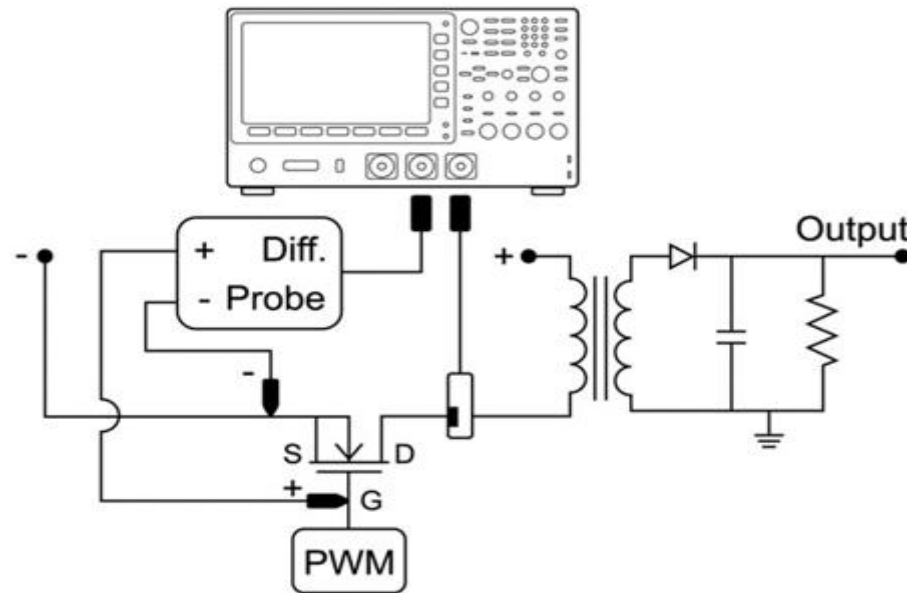


Switching loss

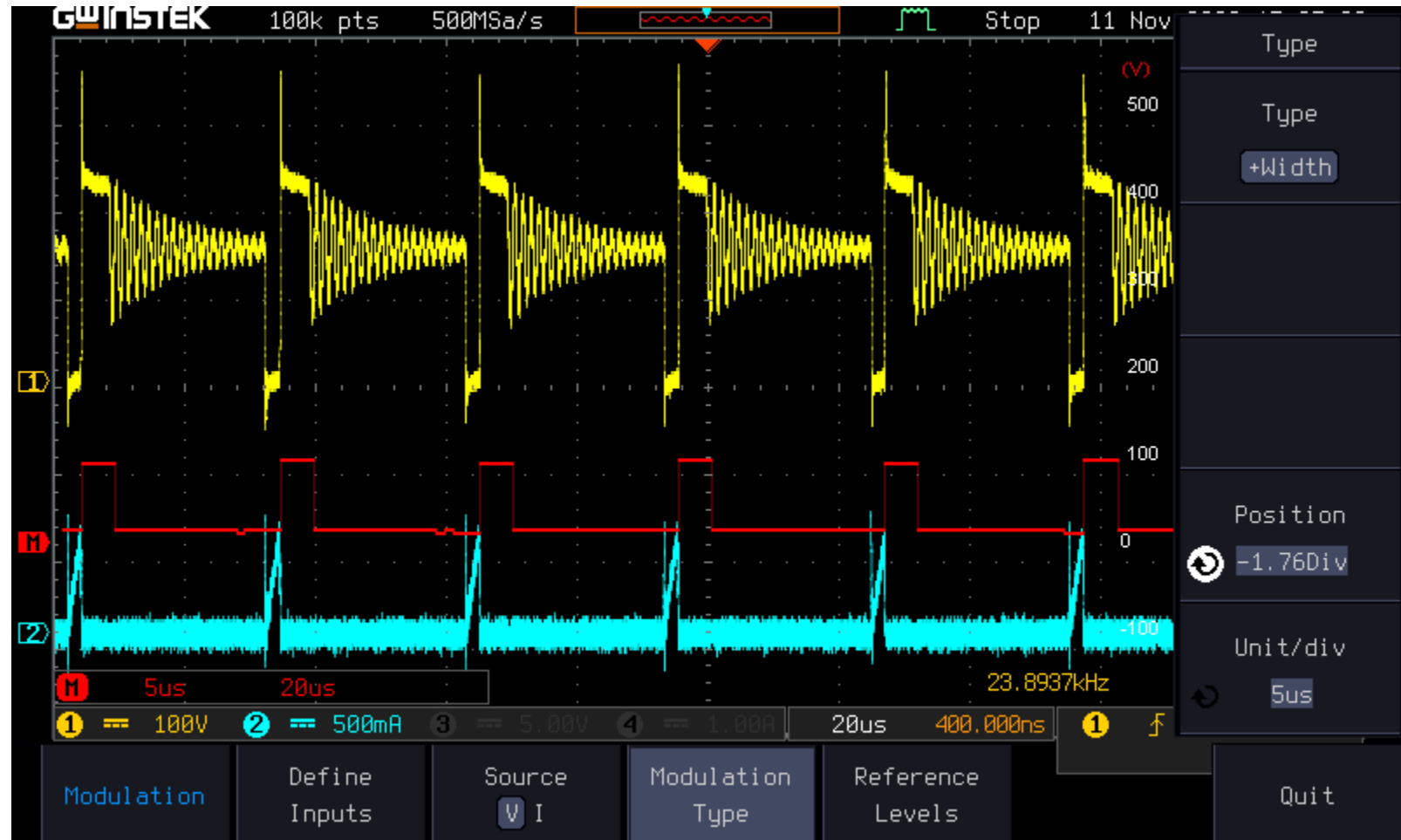


Modulation

- Measure the turn-on and turn-off time information of the PWM signal in switching device(MOSFET or IGBT)
- Test items(plot): Pulse width vs Time, Working period vs Time, Duty cycle vs Time and Frequency vs Time
- To use current probe to probe Drain and differential probe to probe Gate and Source of MOSFET or IGBT.



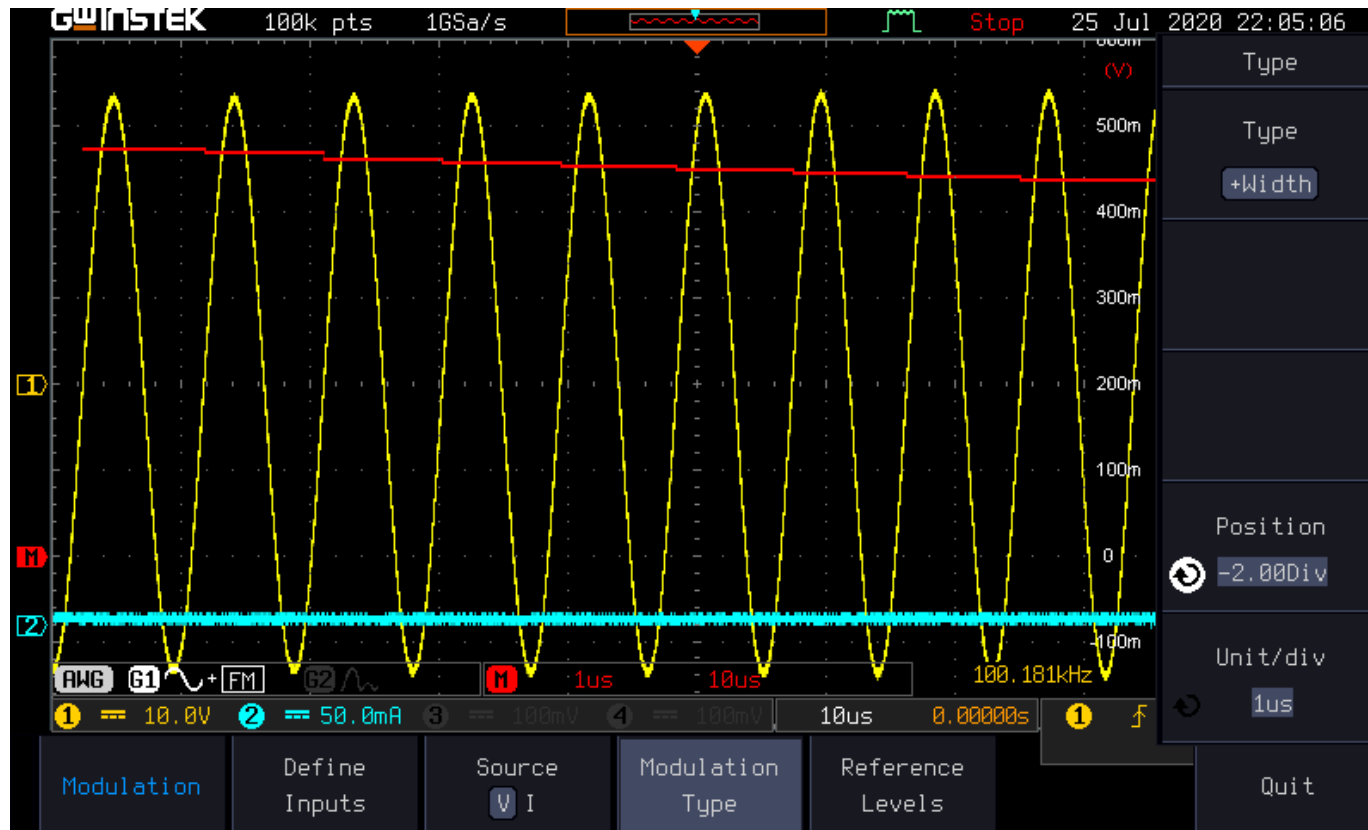
Modulation



Modulation

Explanation of the schematic diagram of the previous modulation display

When the measurement is +width, and input a modulation signal whose width gradually decreases, then the math waveform will show a gradual downward trend. Each large division of this math is 1us, and the actual width is: the number of divisions x1us..



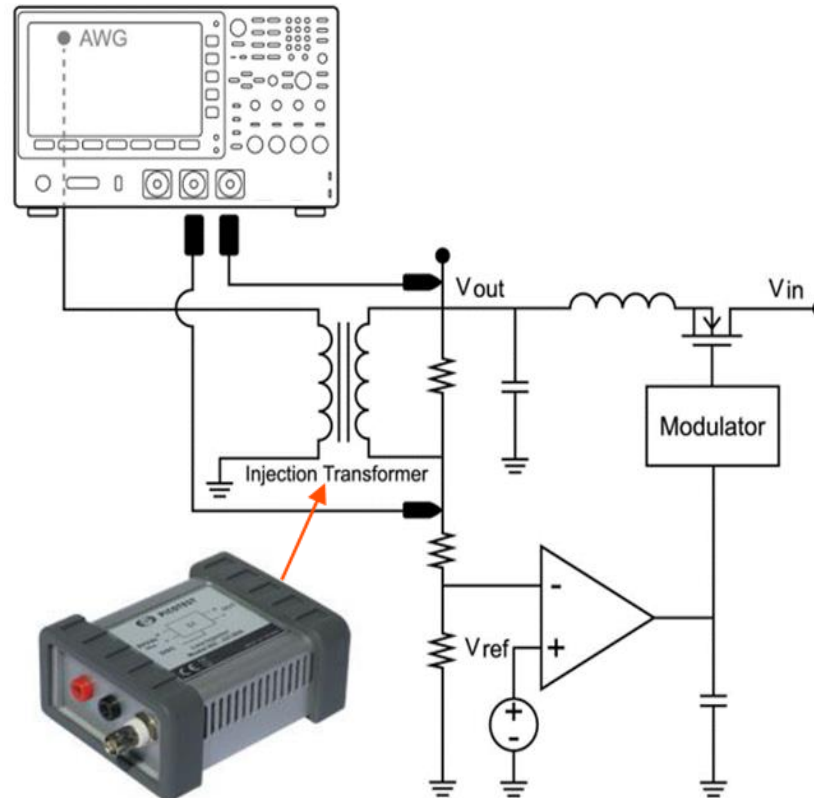
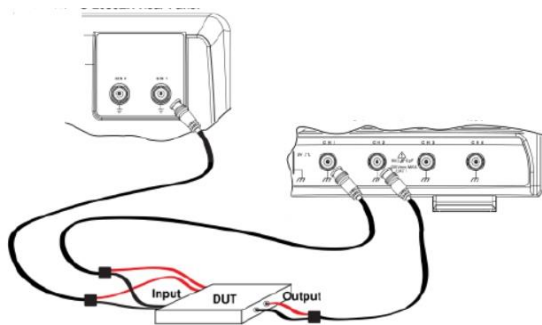
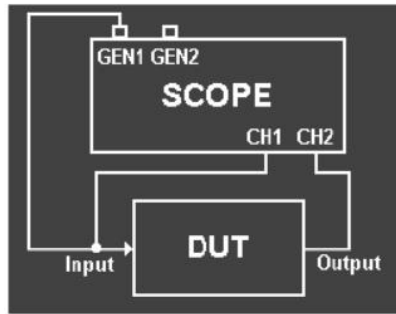
Measure trend waveform of +width

Frequency Response

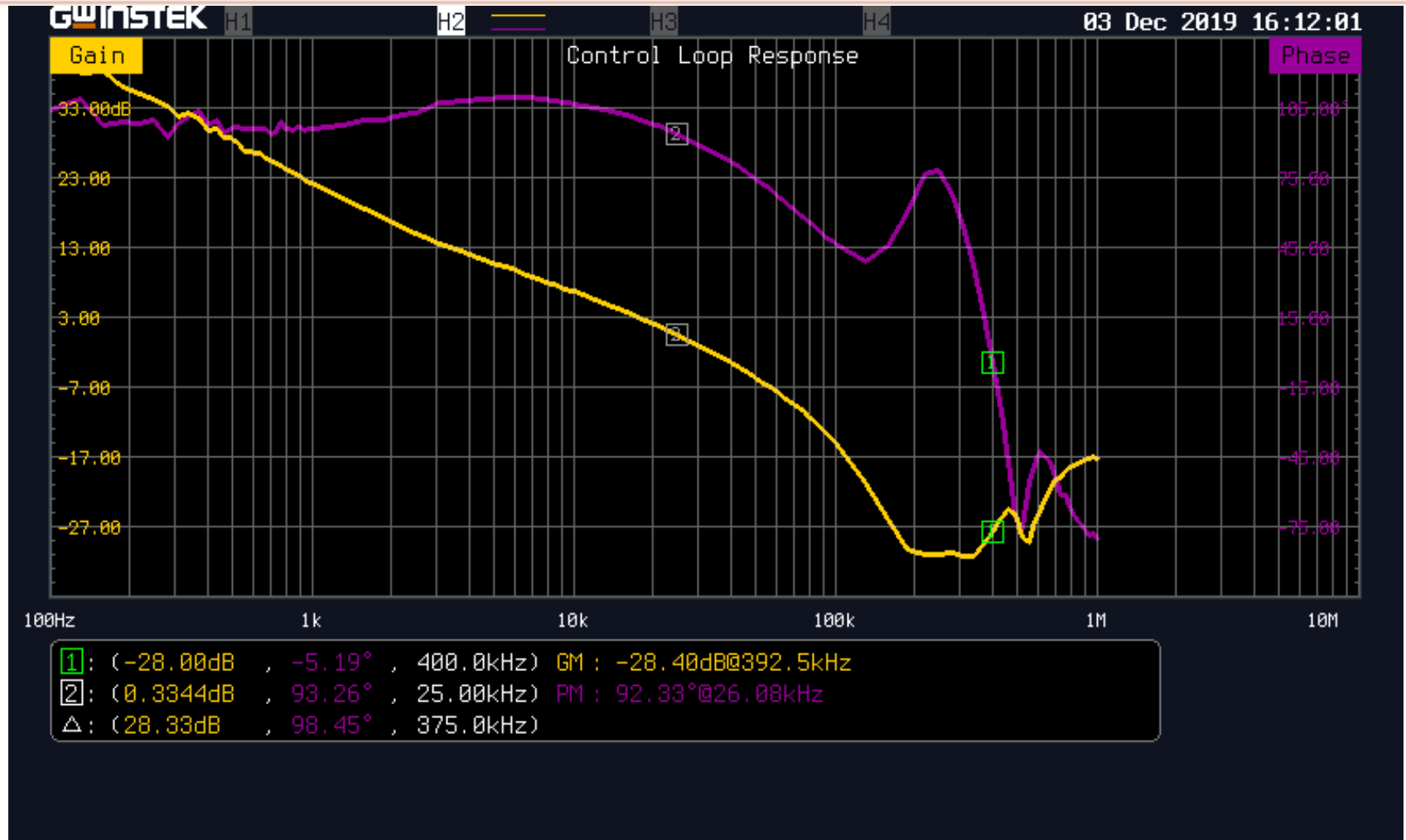
- PSRR(Power supply rejection ratio)
- Control loop response

Control Loop Response

- Bode analysis performs a gain/phase plot over a specified frequency sweep
- Test items: Bode Gain and Phase
- To use differential probe to probe input/output side of DUT, connect AWG to DUT input.



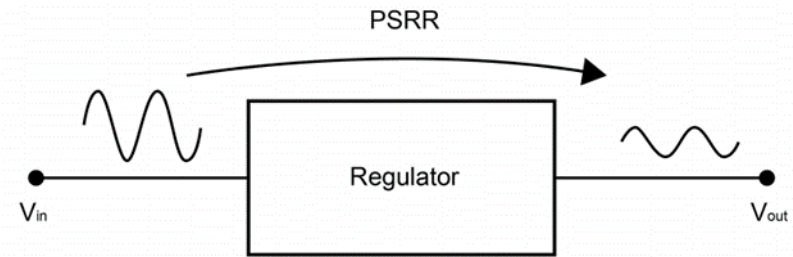
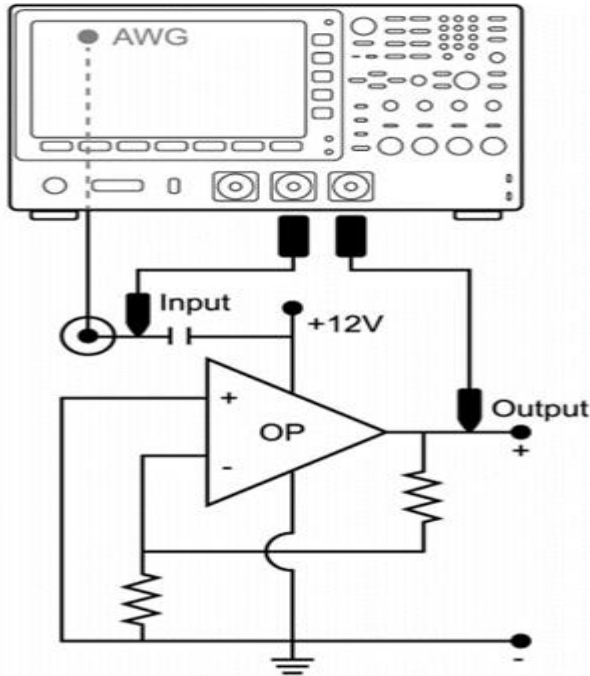
Control Loop Response



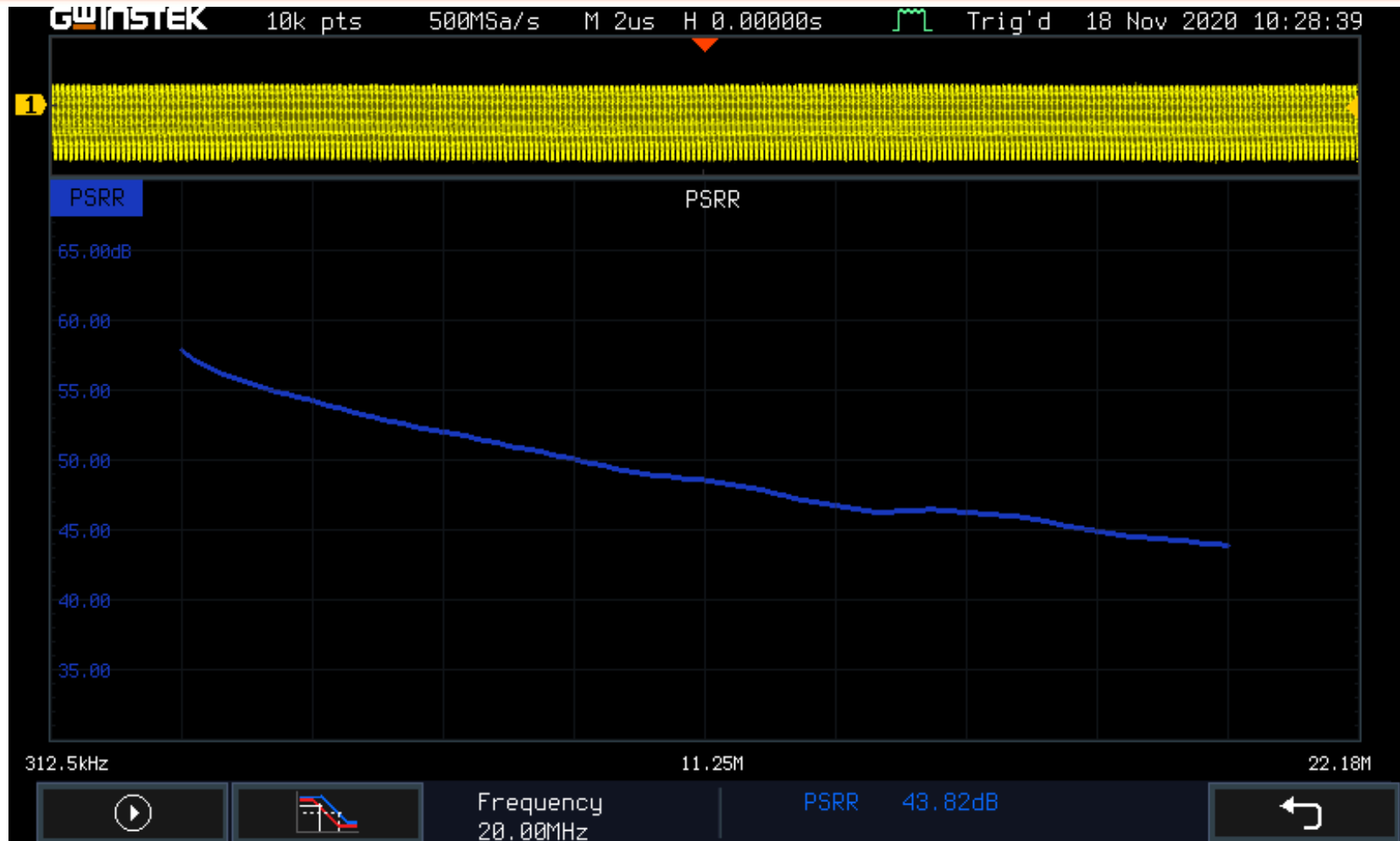
Can be used to characterize the stability of your power supply

PSRR

- The power supply rejection ratio(PSRR) test is used to confirm that the power supply equipment suppresses ripple noise in different frequency ranges.
- Test items: Frequency and PSRR (dB). $PSRR = 20\log(\text{Ripple in}/\text{Ripple out})$
- To use differential probe to probe input and output by CH1 and CH2. AWG generator to DUT input.

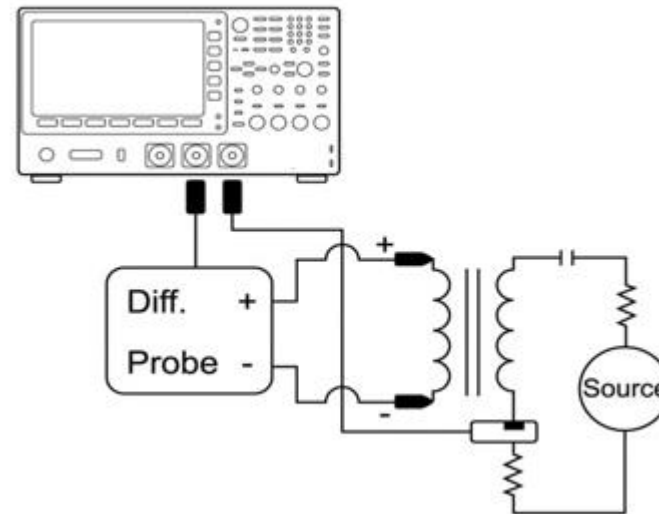
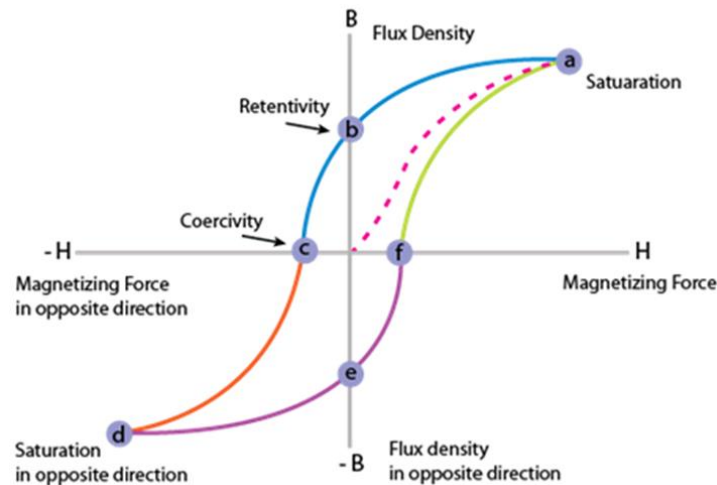


PSRR



B-H curve

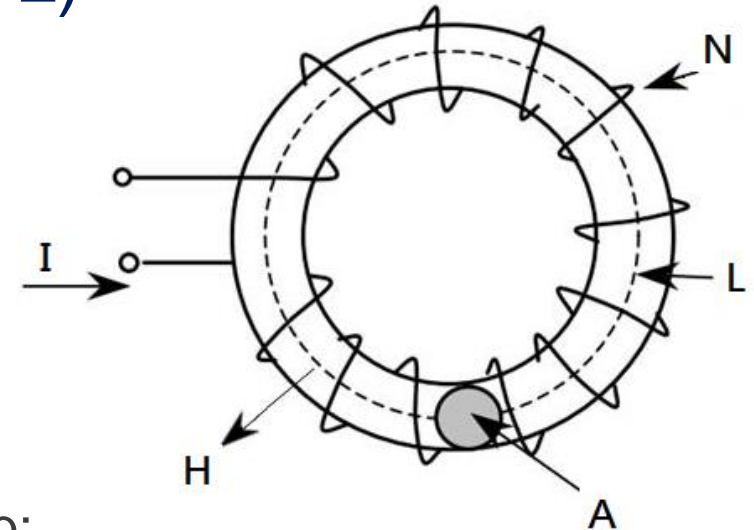
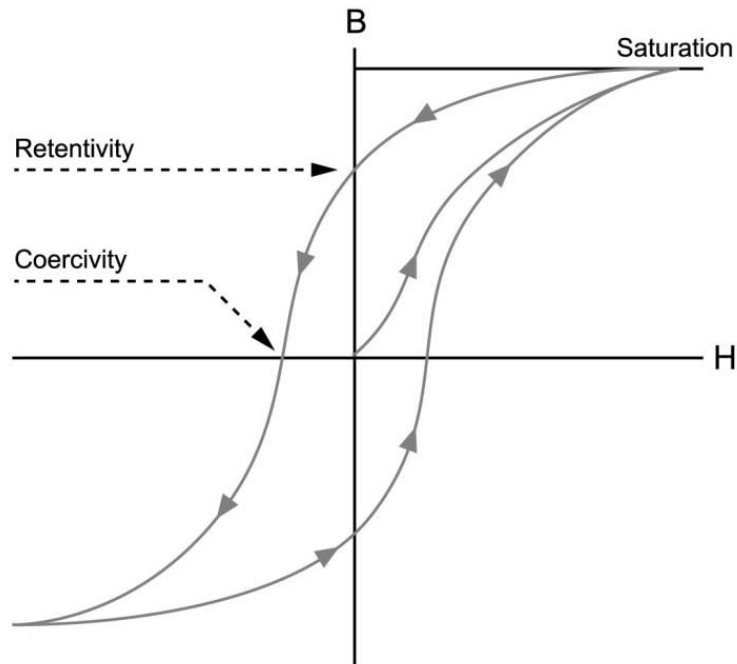
- B is “magnetic flux density ”and H is “magnetic field strength” .
- B-H curve plots are often used to verify the saturation of the magnetic component
- Test items: measure the voltage and current flowing through the magnetic component and draw a B-H diagram.
- To measure primary side(N1) voltage by differential probe and test secondary side(N2) current by current probe.



B-H curve

Magnetic field strength $H = I * (N / L)$

Magnetic flux density $B = \int V / (N * A)$



Setup:

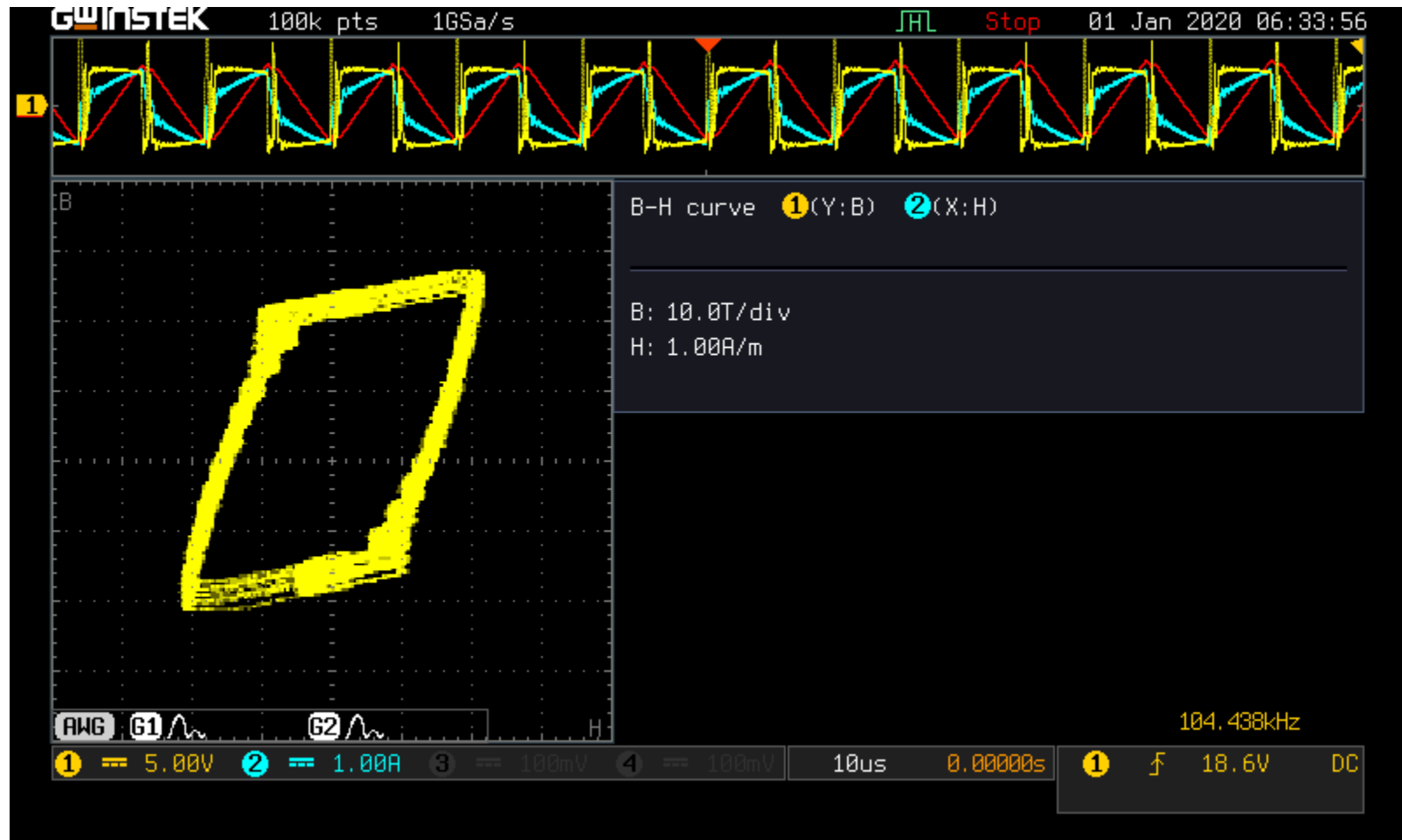
N: 線圈匝數(Windings)

L: 磁路長度(Magnetic length)

A: 截面積(Cross Section Area)

- The goal is to avoid saturation and operate in the linear region of the hysteresis curve

B-H curve



B-H curve plots are often used to verify the saturation (or lack thereof) of the magnetic elements in a switching supply.

Built-in DC Power Adapter for current probe



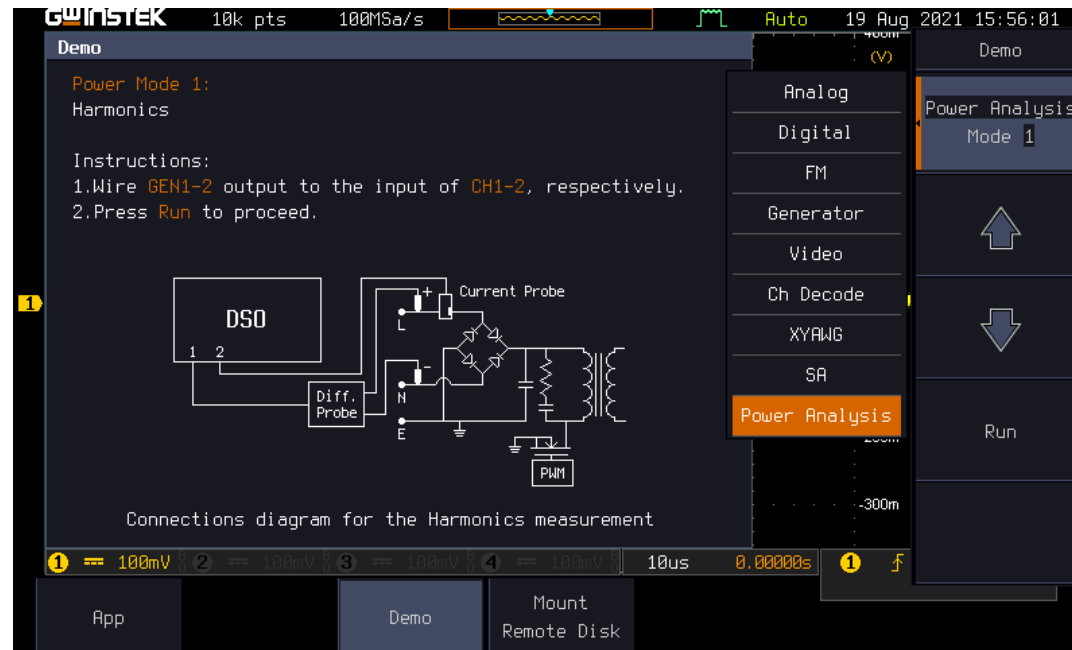
For GCP-530 or GCP-1030 usage, its not necessary to purchase GCP-206P or GCP-425P.

Power Analysis Demo APP

GDS-3000A provide 3 Demo functions for Power Analysis

Including Harmonics, Switching loss, B-H curve and transient response

- Connect CH1 to AWG GEN1 and CH2 to GEN2 by BNC cable
- Press APP > Demo > F1 key > use Variable to select Power analysis
- Press F2 or F3 to select demo 1~4
- Press F4 " Run " to execute power analysis demo.



1. Harmonics Demo



Power Analysis Demo APP

2. Switching Loss of SMPS:

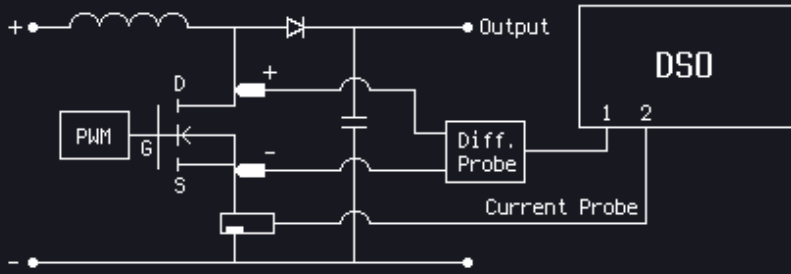
GW INSTEK 10k pts 100MSa/s Auto 19 Aug 2021 15:56:19

Demo

Power Mode 2:
Switching loss of SMPS

Instructions:
1. Wire GEN1-2 output to the input of CH1-2, respectively.
2. Press Run to proceed.

1



Connections diagram for the Switching Loss measurement

1 == 100mV 2 == 100mV 3 == 100mV 4 == 100mV 10us 0.00000s 1

App Demo Mount Remote Disk

Power Analysis Mode 2

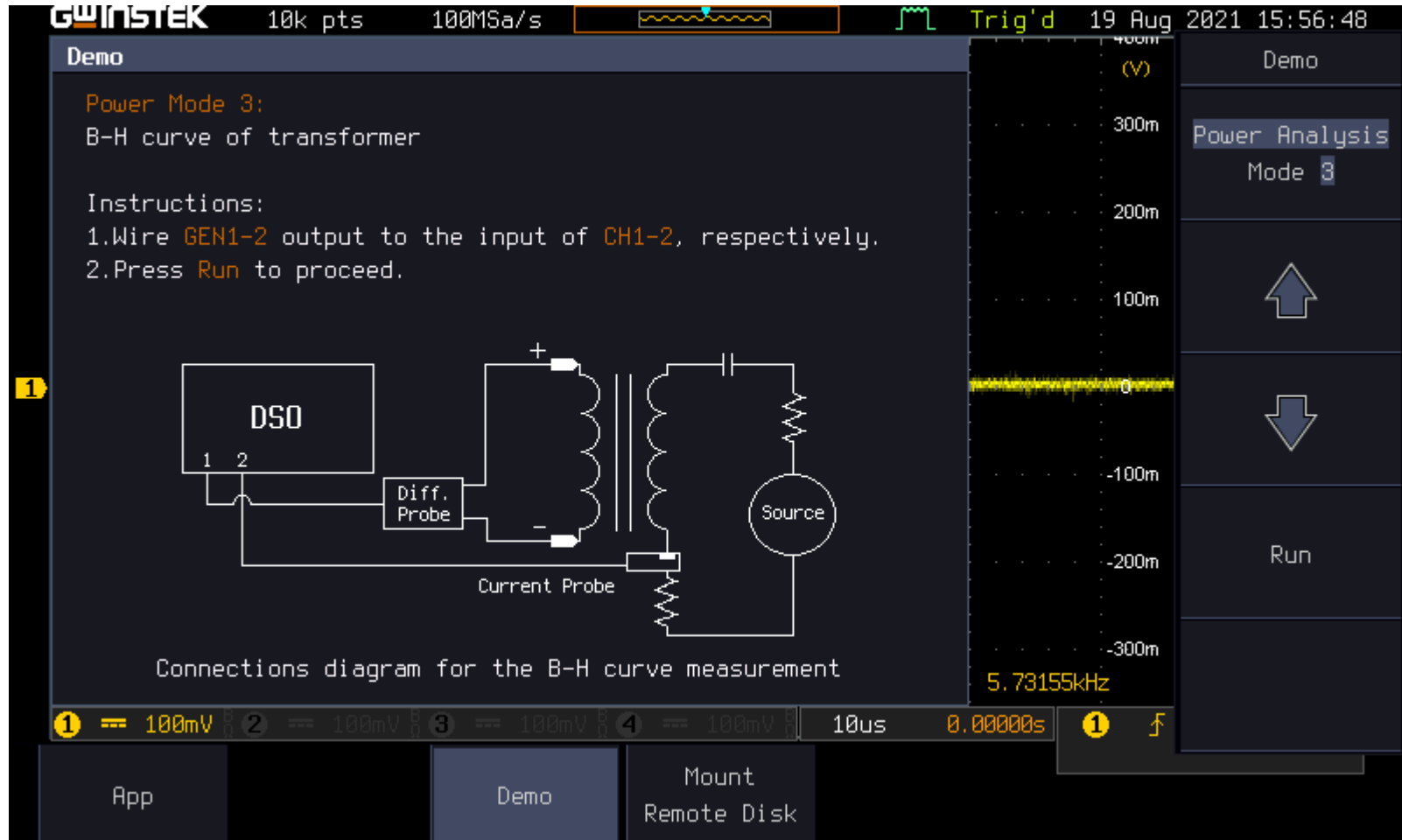
Run

2.Switching Loss Demo

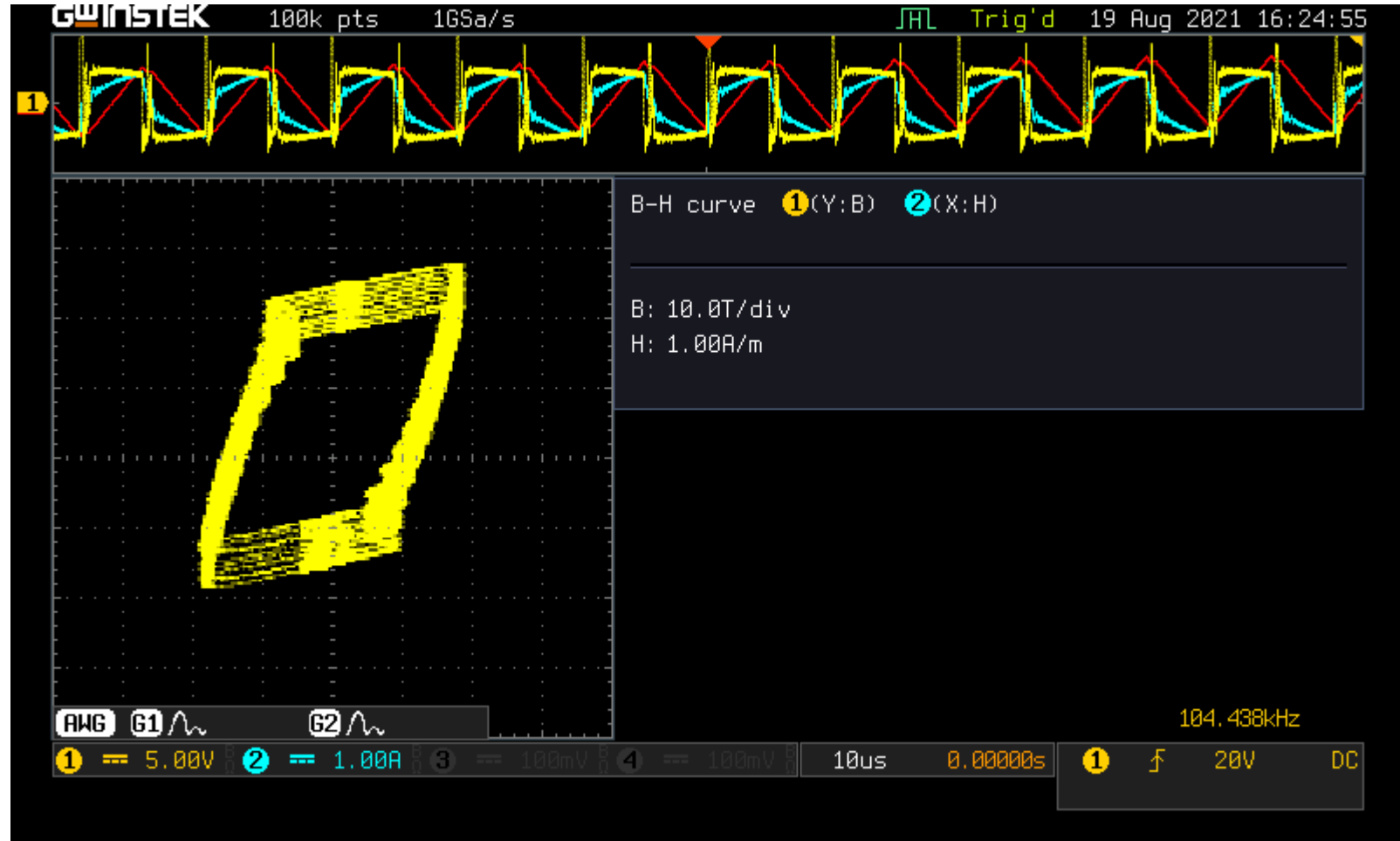


Power Analysis Demo APP

3. B-H curve of transformer:

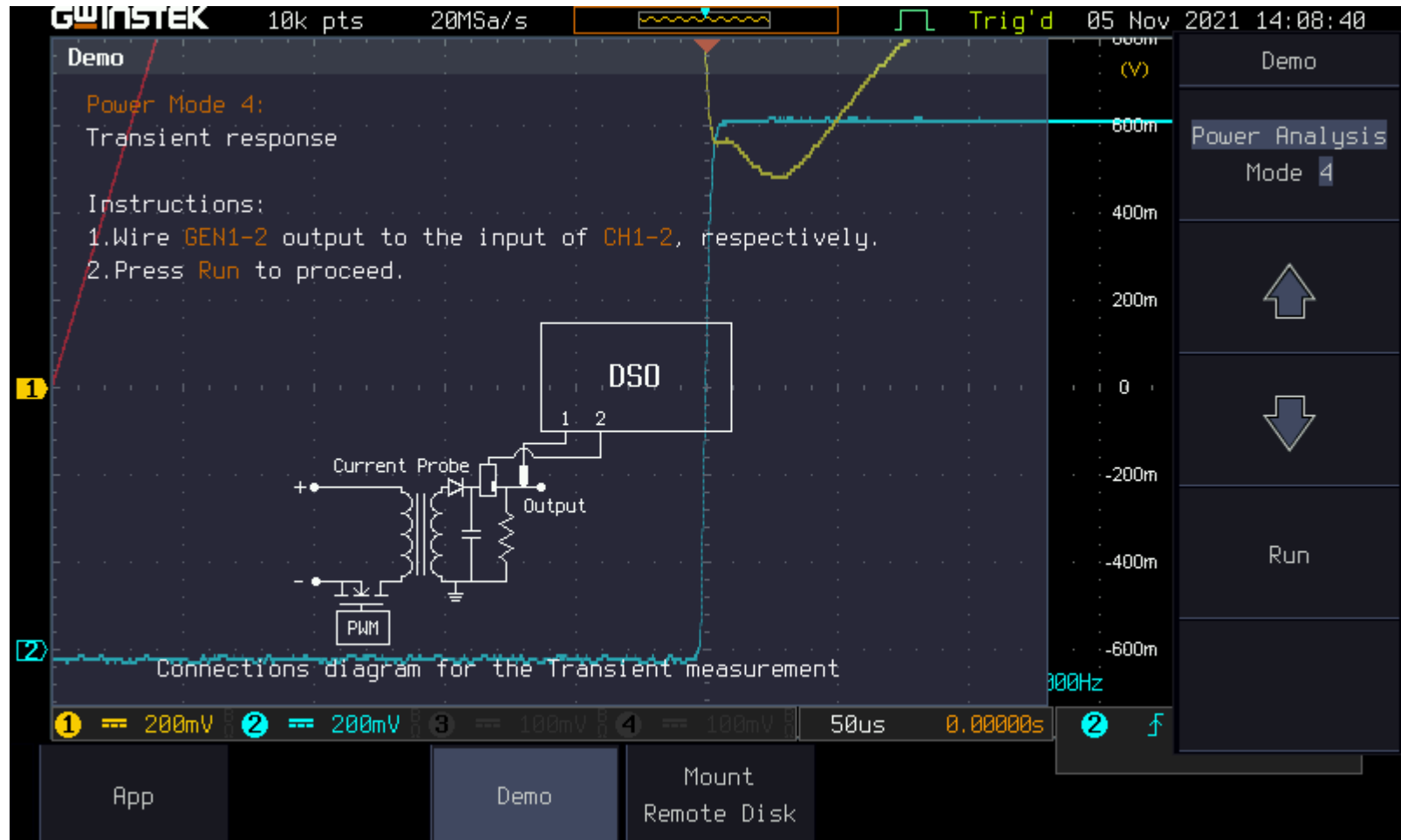


3.B-H curve Loss Demo



Power Analysis Demo APP

3. Transient response:



4. Transient response demo



Q&A