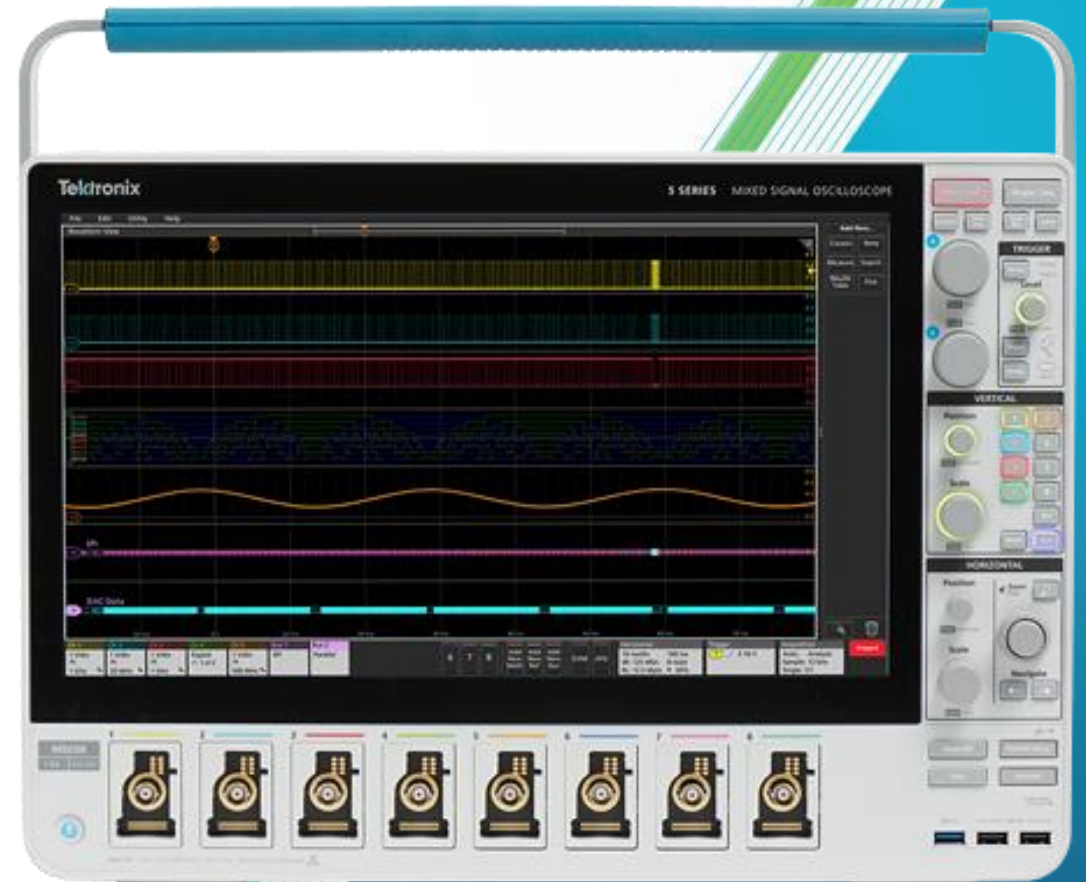


# Tektronix

## 5 Series MSO

### Mixed Signal Oscilloscopes

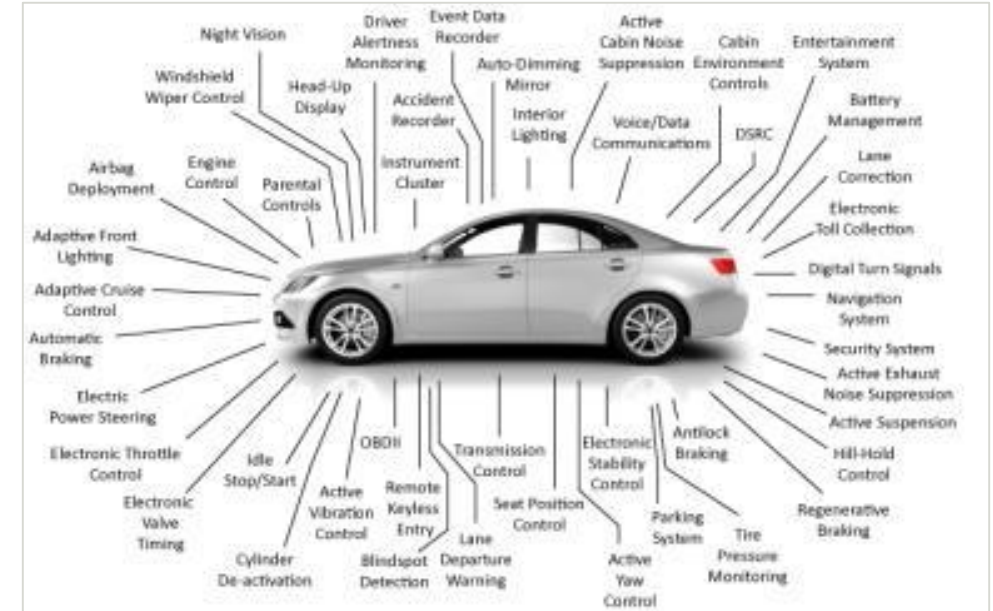
구병준 차장



# Market Trends

## COMPLEXITY & TIME PRESSURES INCREASING

- **Increased system complexity drives the need to observe broader system**
  - Multiple processors, microcontrollers, FPGAs for distributed computing
  - Multiple independent clocks
  - Multiple serial buses
  - Host of sensor inputs
  - Increasing number of power rails & power conversion circuits
- **Faster signaling and quest for ever greater power efficiency driving new signal acquisition challenges**
  - Faster signals with lower voltage rails (lower amplitude)
  - Timing (jitter) or amplitude (noise) errors becoming more significant as SNR drops
- **Gone are the days of the dedicated engineering specialists**
  - Modern Engineer must have a combined skillset across analog, digital, RF, power, jitter, etc.
- **Tighter project timelines and fewer resources mean engineers need to solve problems faster to stay on schedule**
  - Development window was 2-4 years, now 12-18 months



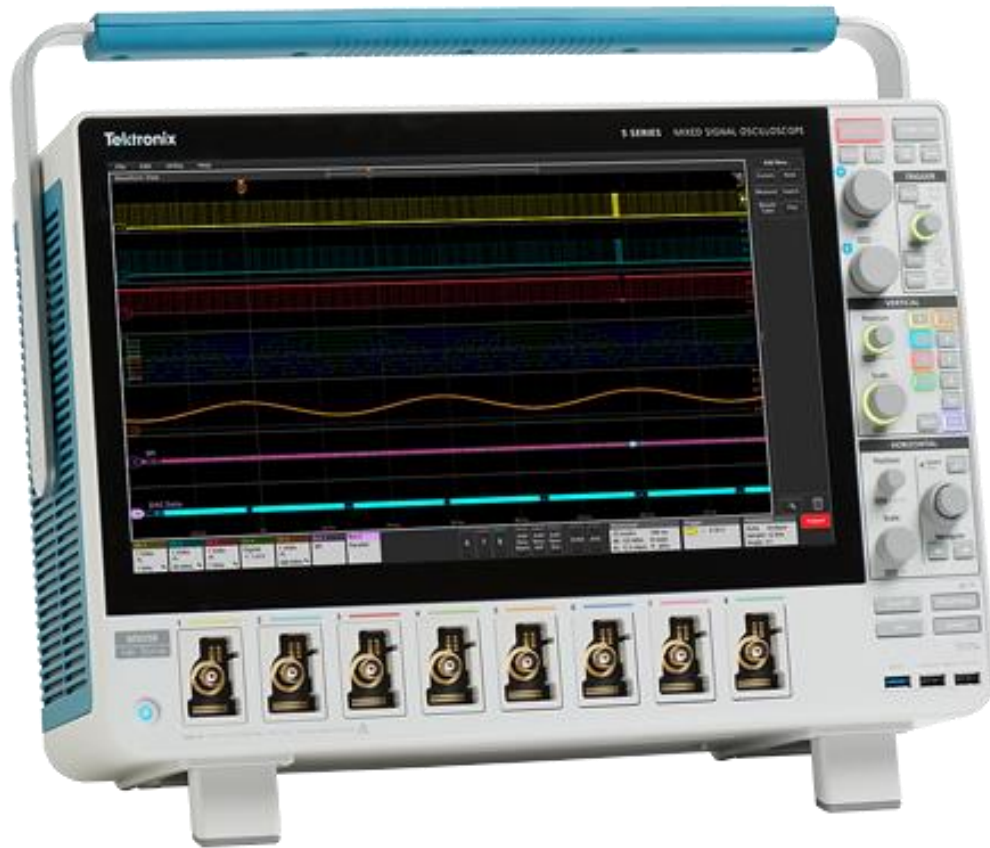
# Trends Drive Designers' Needs

## ENGINEERS FEEL THE PAIN

- **4 analog channels simply aren't enough for many designs**
- **Tight timing tolerances demand better integration between digital and analog waveforms**
  - Previous MSOs have had different sampling performance on analog and digital channels
  - Previous MSOs forced tradeoffs in sample rate or record length
- **Lower SNR drives the need for greater vertical resolution**
- **Higher clock rates and faster signaling call for sophisticated jitter analysis that doesn't require a PhD**
- **Engineer's tool-of-choice, the oscilloscope, needs to incorporate basic functionality from more specialized (but generally less available) types of test equipment**
  - The scope has to be easy to learn and use
    - Cannot be the bottleneck in a customer's effort to get their design out the door
- **Test equipment needs to be future-ready**
  - Is it flexible enough?
  - Is it capable enough?
  - Can it easily be upgraded in the future?
  - Will it meet my needs 2, 3, 4, 5 years down the road?

# 5 Series MSO Changes Everything

THE LARGEST DISPLAY. THE MOST CHANNELS. THE GREATEST EXPERIENCE



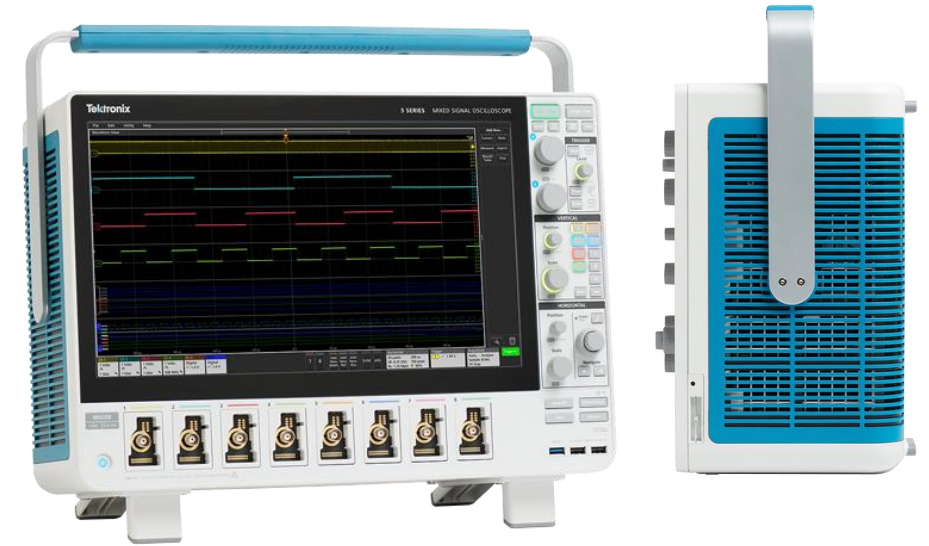
## Five Industry Firsts

- 1 Reconfigurable scope inputs (FlexChannel® inputs)
- 2 4, 6, and 8 channel product family
- 3 15.6" HD (1,920 x 1,080) display with capacitive touch
- 4 User interface actually designed for touch
- 5 Optional Windows 10 operating system

# Key Specifications

## STRENGTH IN NUMBERS

5 Series MSO	MSO54	MSO56	MSO58
Bandwidth	350 MHz, 500 MHz, 1 GHz, 2 GHz		
Maximum Analog Channels	4	6	8
Maximum Digital Channels (optional in 8 channel increments)	32	48	64
Sample Rate (all A&D ch.)	6.25 GS/s		
Standard Record Length (all A&D ch.)	62.5 M		
Max. Opt. Record Length (all A&D ch.)	125 M		
Waveform Capture Rate	500,000 wfms/s		
ADC Resolution	12 bits		
Vertical Resolution	8 bits at 6.25 GS/s 12 bits at 3.125 GS/s Up to 16 bits w/ High Res		
Arbitrary/Function Generator	Up to 50 MHz (opt.)		
Integrated DVM & Trigger Freq. Counter	Free with product registration		



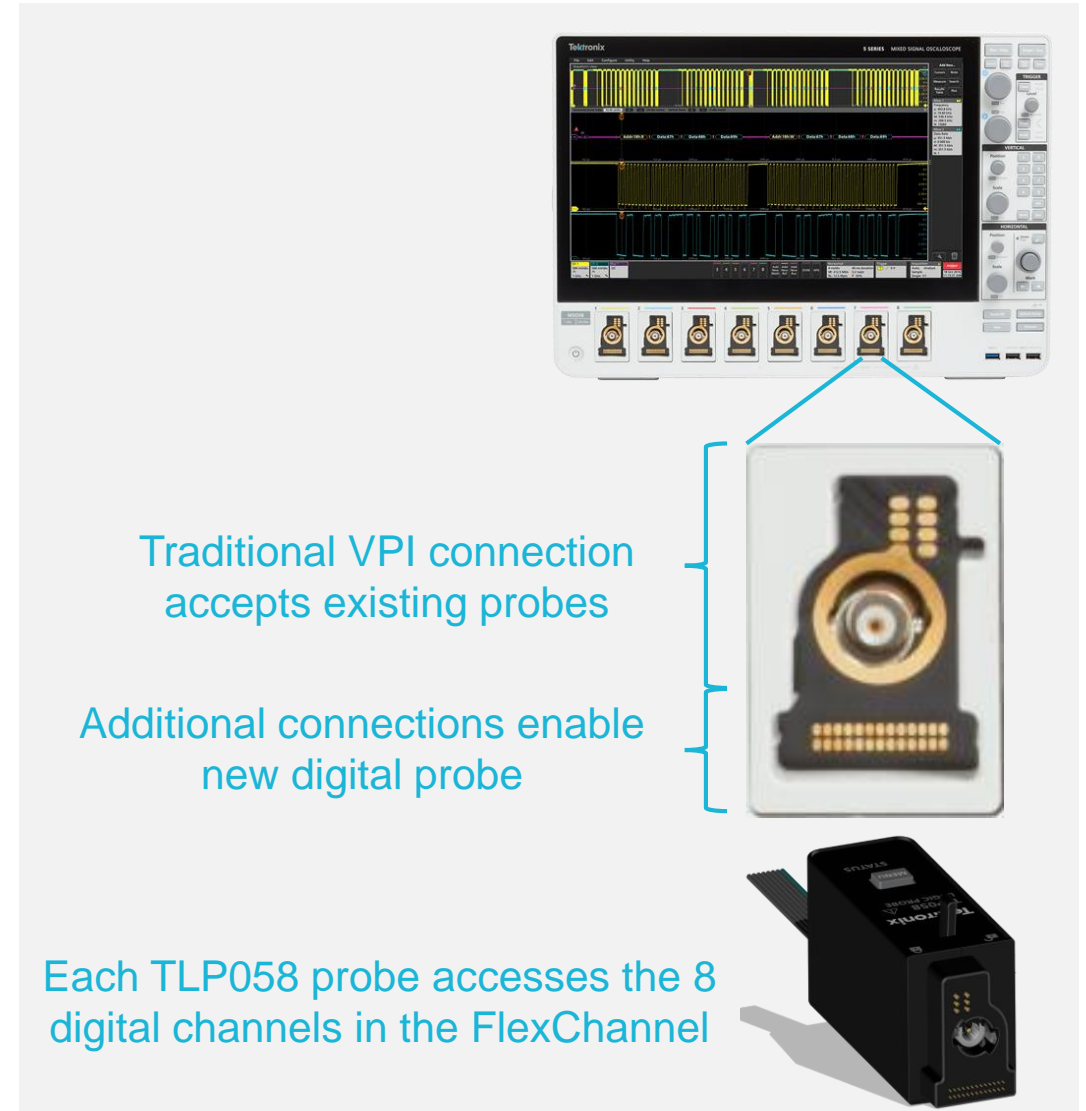
Oscilloscope  
Logic Analyzer  
Arbitrary/Function Generator  
Protocol Analyzer  
DVM  
Trigger Frequency Counter



# Industry First FlexChannel Inputs

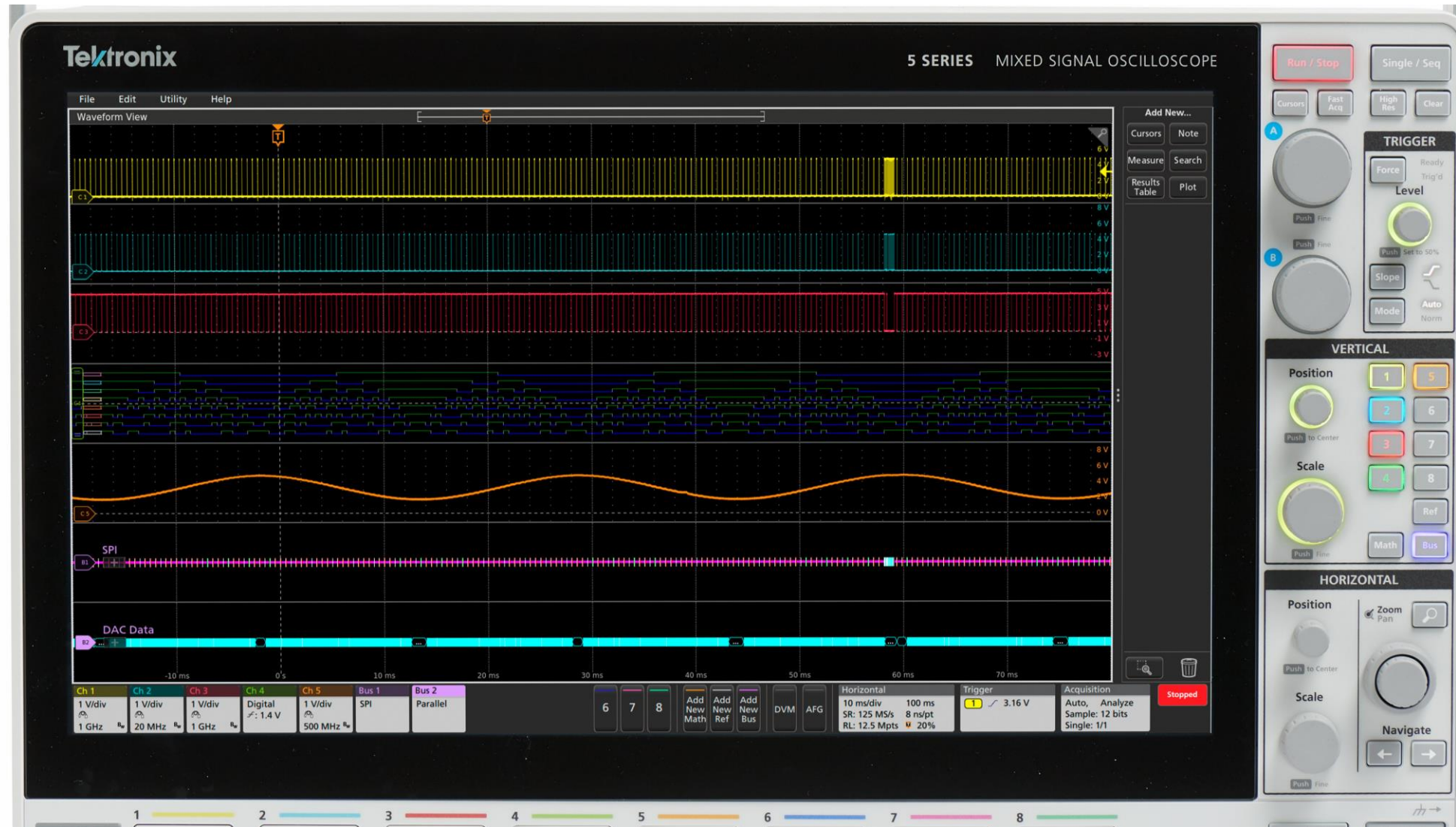
## MORE CHANNELS WHEN NEEDED

- New FlexChannel technology enables each input to be configured as either:
  - (1) analog channel
  - (8) digital channels
- A FlexChannel input is configured simply by plugging an analog or digital probe into that input
- Any combination of analog and digital probes is supported
- Enables unprecedented flexibility and adaptability to the debug task at hand

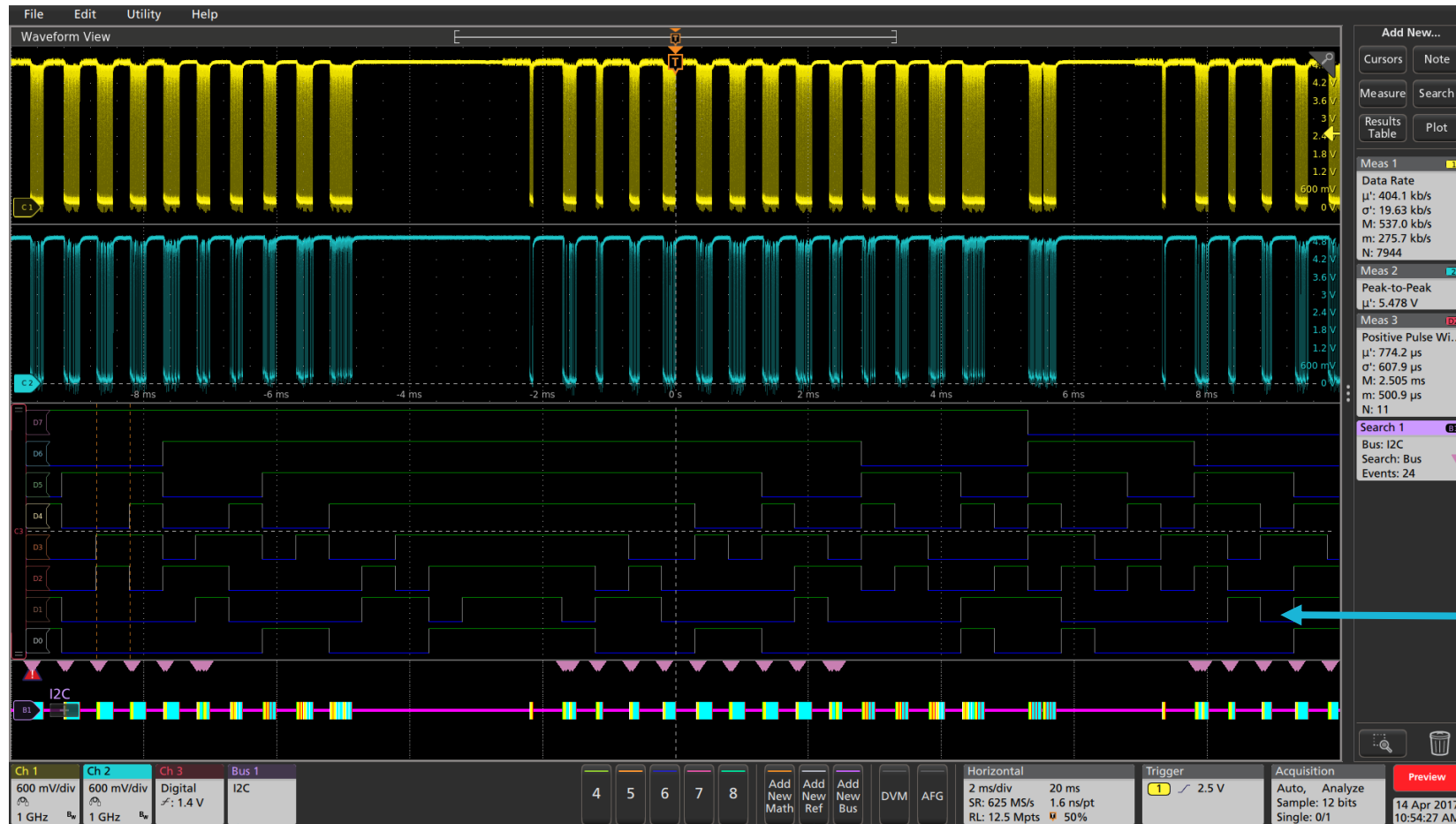


# Industry First 15.6-inch Hi-Def Capacitive Touch Display

PINCH. ZOOM. SWIPE USER INTERFACE OPERATES AS YOU THINK IT SHOULD



# Immediate Access to Most Common Features



Immediate access to cursors, notes, measurements, searches, results tables or plots

Measurement and Search results badges are displayed in Results Bar

Massive waveform viewing area!

Waveform badges show relevant info for all displayed waveforms

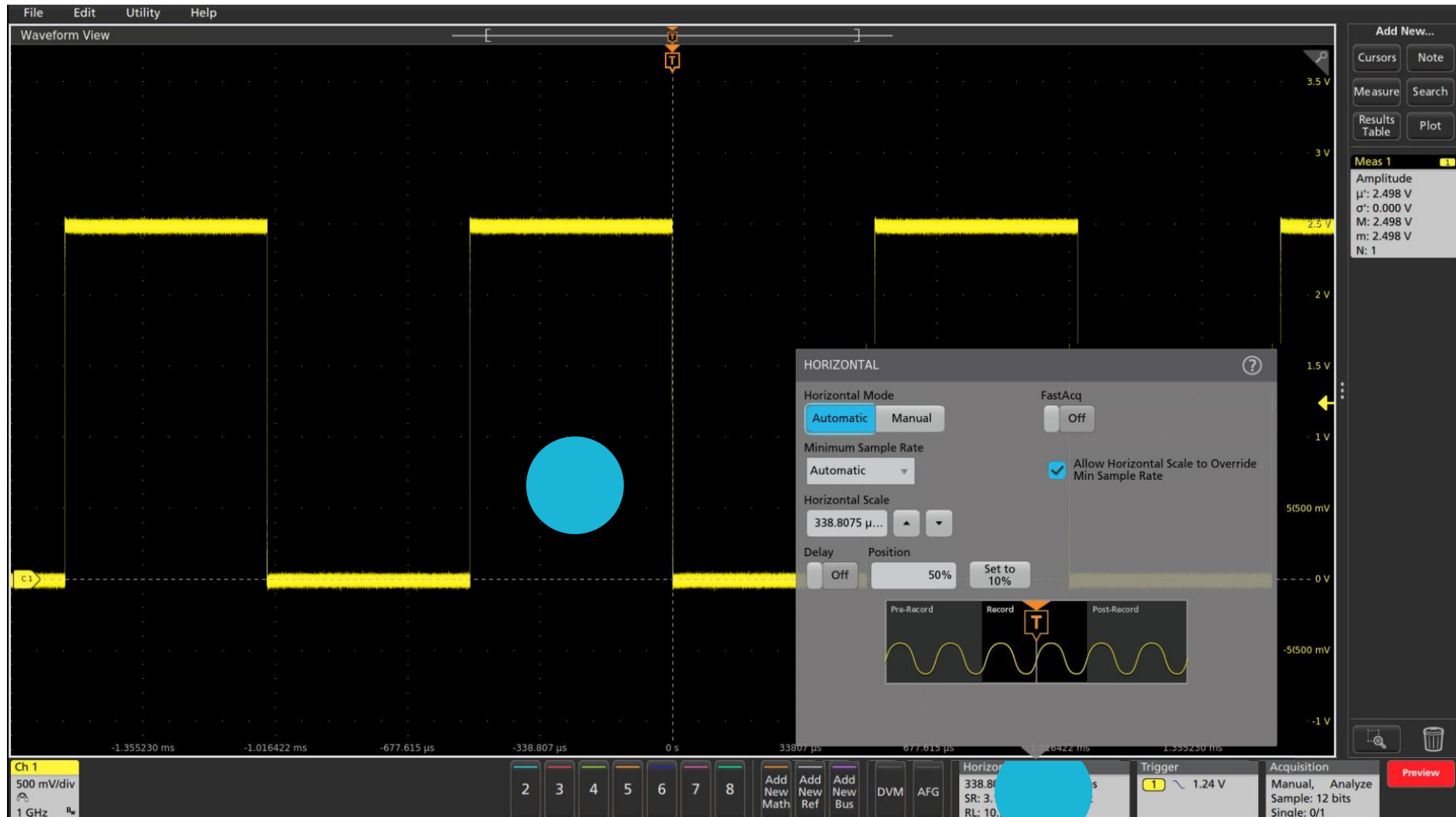
Immediate access to new Math, Reference, and Bus waveforms as well as integrated DVM and AFG

All critical horizontal, trigger and acquisition parameters



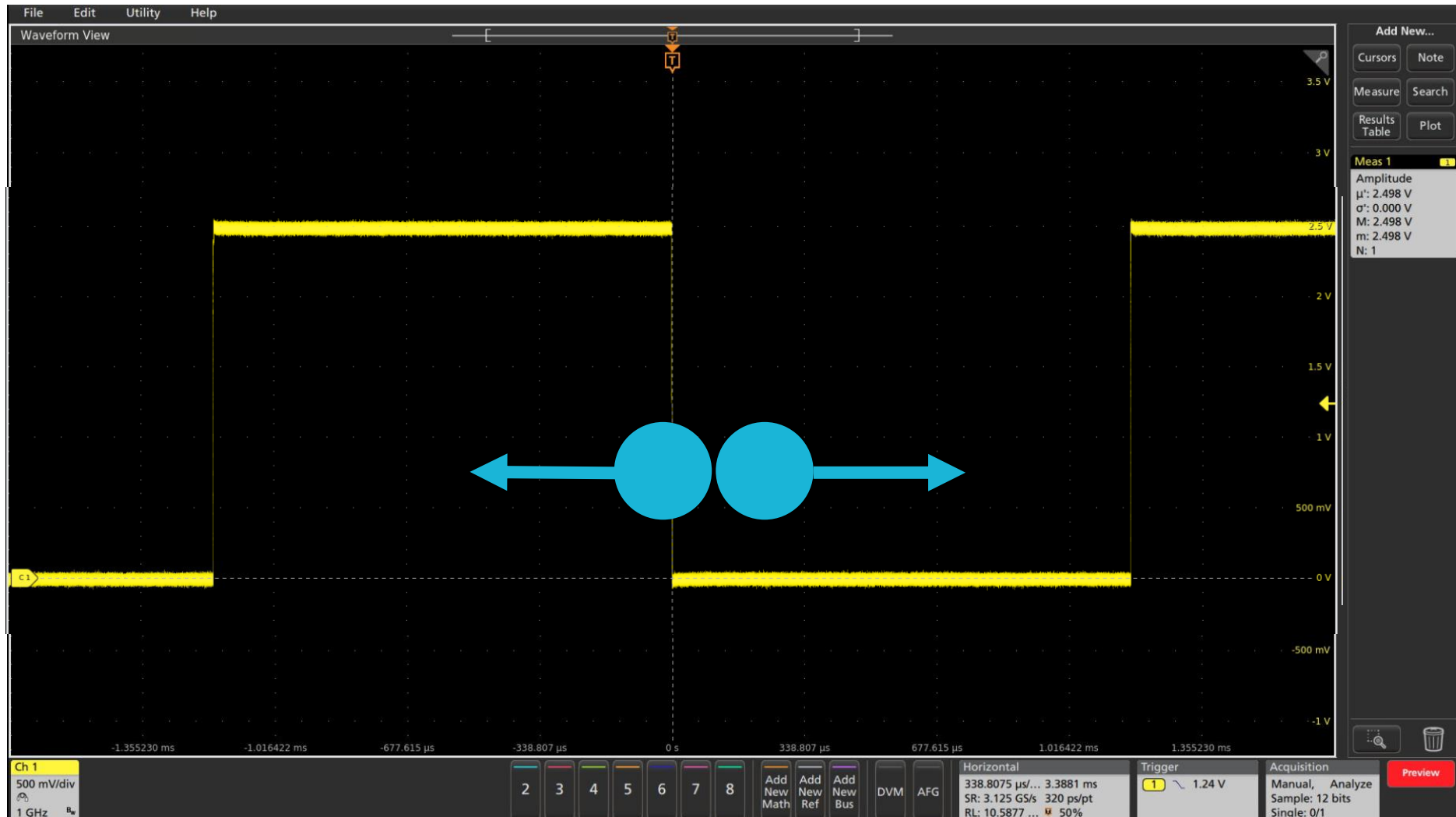
# New Direct Access User Interface

## FIRST USER INTERFACE DESIGNED FOR TOUCH



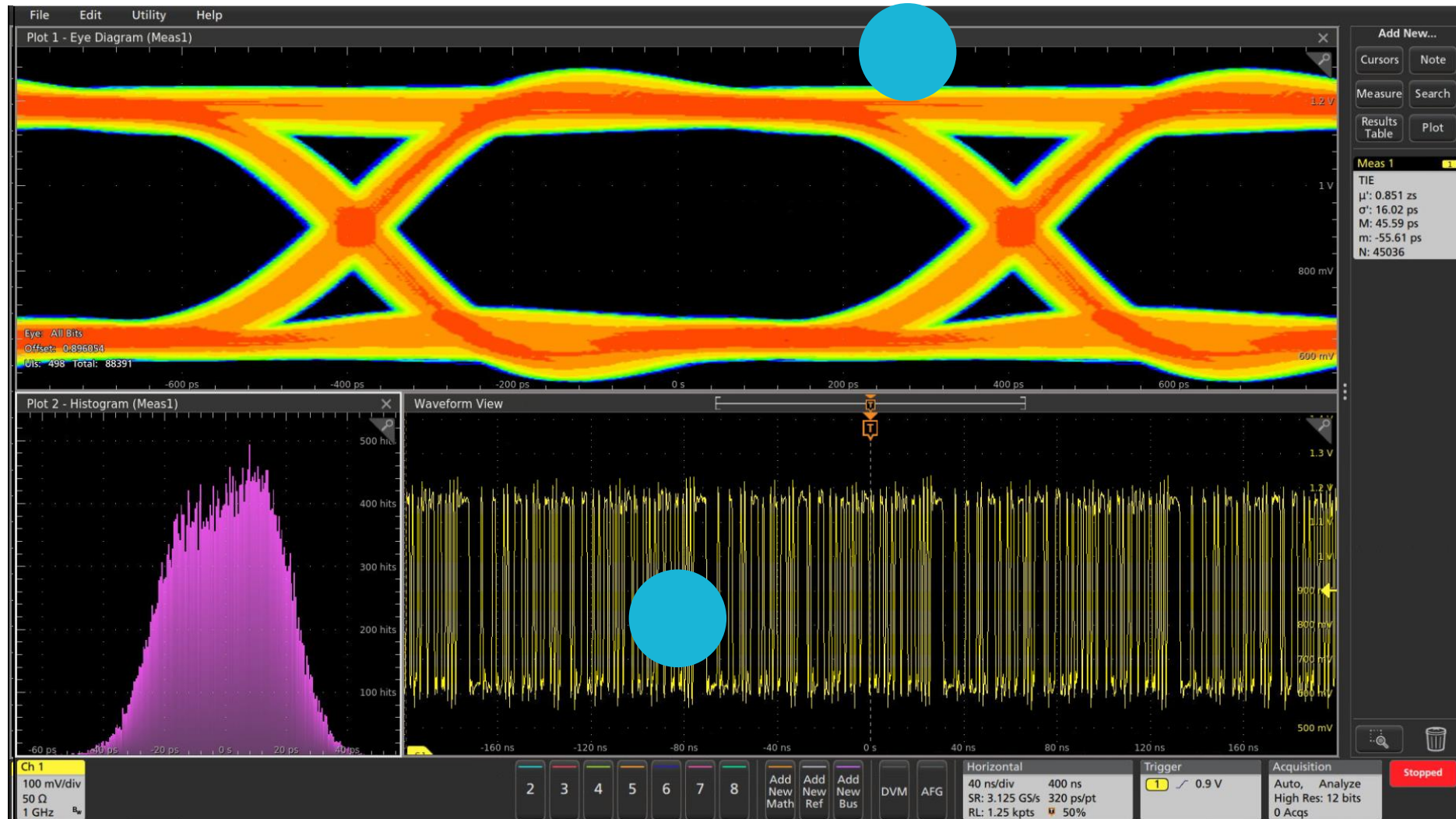
# New Direct Access User Interface

## FIRST USER INTERFACE DESIGNED FOR TOUCH



# New Direct Access User Interface

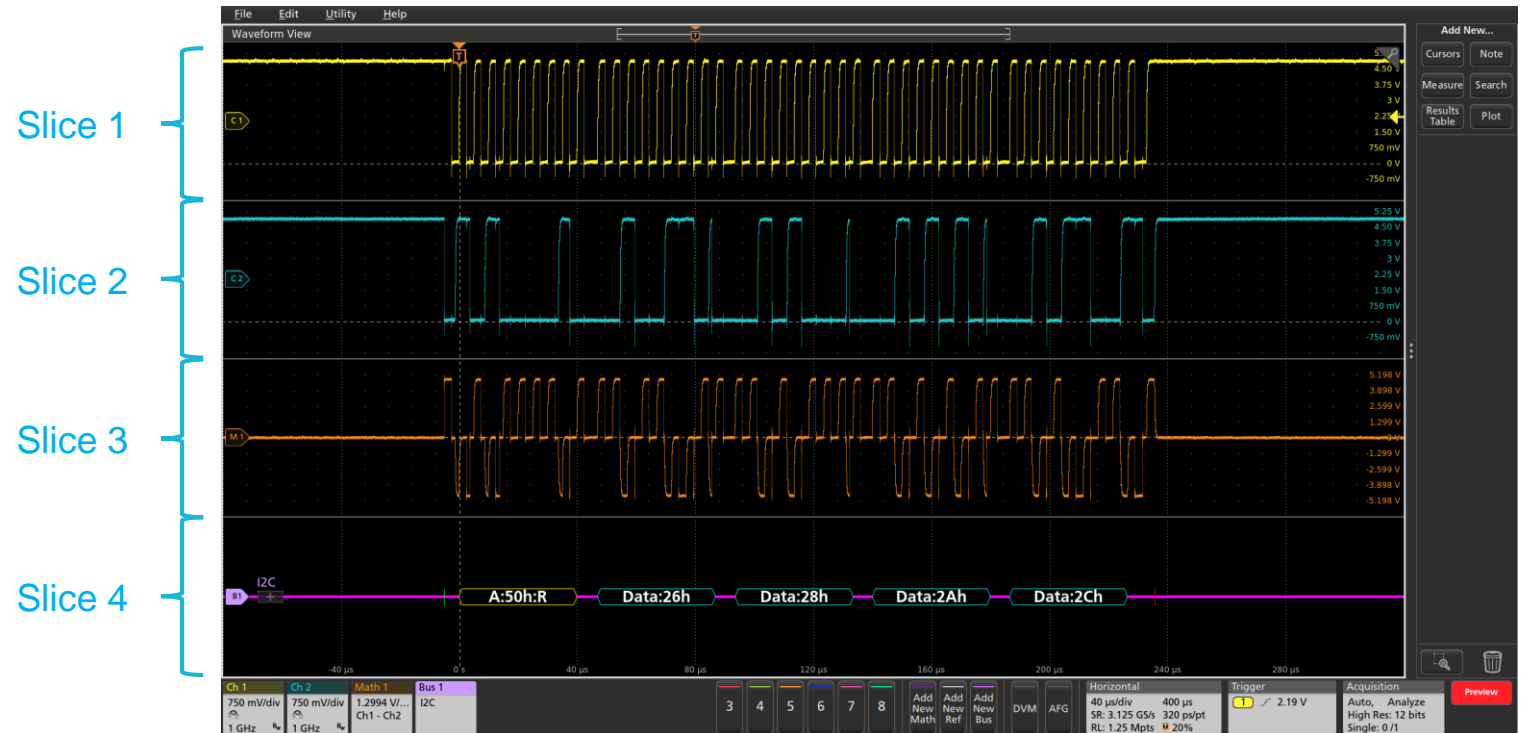
## ADJUSTABLE APPLICATION VIEWS



# Stacked / Overlay Display Mode

NEW STACKED/OVERLAY MODE PROVIDES THE BEST OF BOTH WORLDS!

- Stacked mode creates a 'slice' for each waveform
  - As waveforms are turned on, slices are automatically added
  - As waveforms are turned off, slices are automatically removed
  - Can reorder slices as desired
- Each slice uses the full range of the ADC
  - You can now have both visual separation as well as maximum resolution



- Stacked display mode is the default, but you can also specify overlay mode as your default



# Stacked / Overlay Display Mode

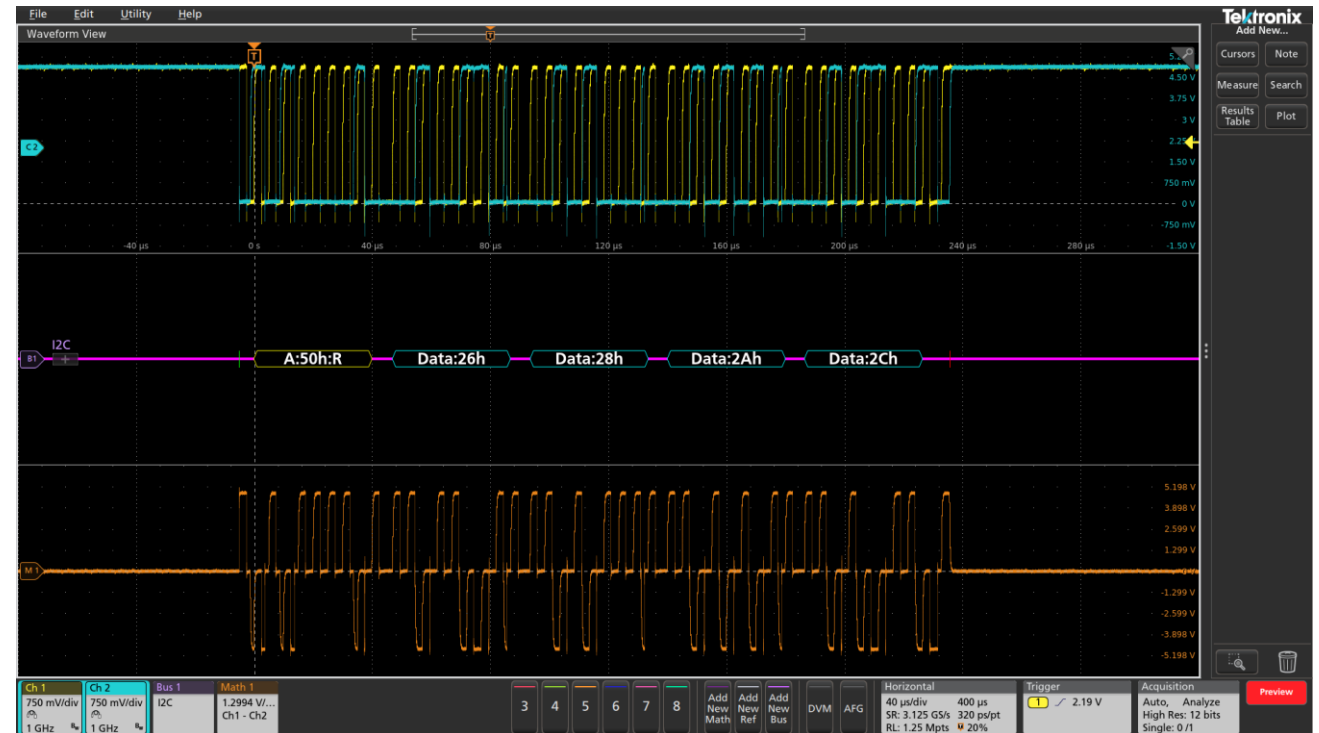
NEW STACKED/OVERLAY MODE PROVIDES THE BEST OF BOTH WORLDS!

- Stacked mode
  - Optimizes vertical resolution and easy viewing of many signals
  - Signals can be reordered
- Overlay mode
  - Optimizes comparison of signal amplitudes and timing
- Stacked/Overlay mode
  - Easy comparison of some of the signals, without compromising vertical resolution or ease of viewing multiple signals

analog signals overlaid for easy comparison

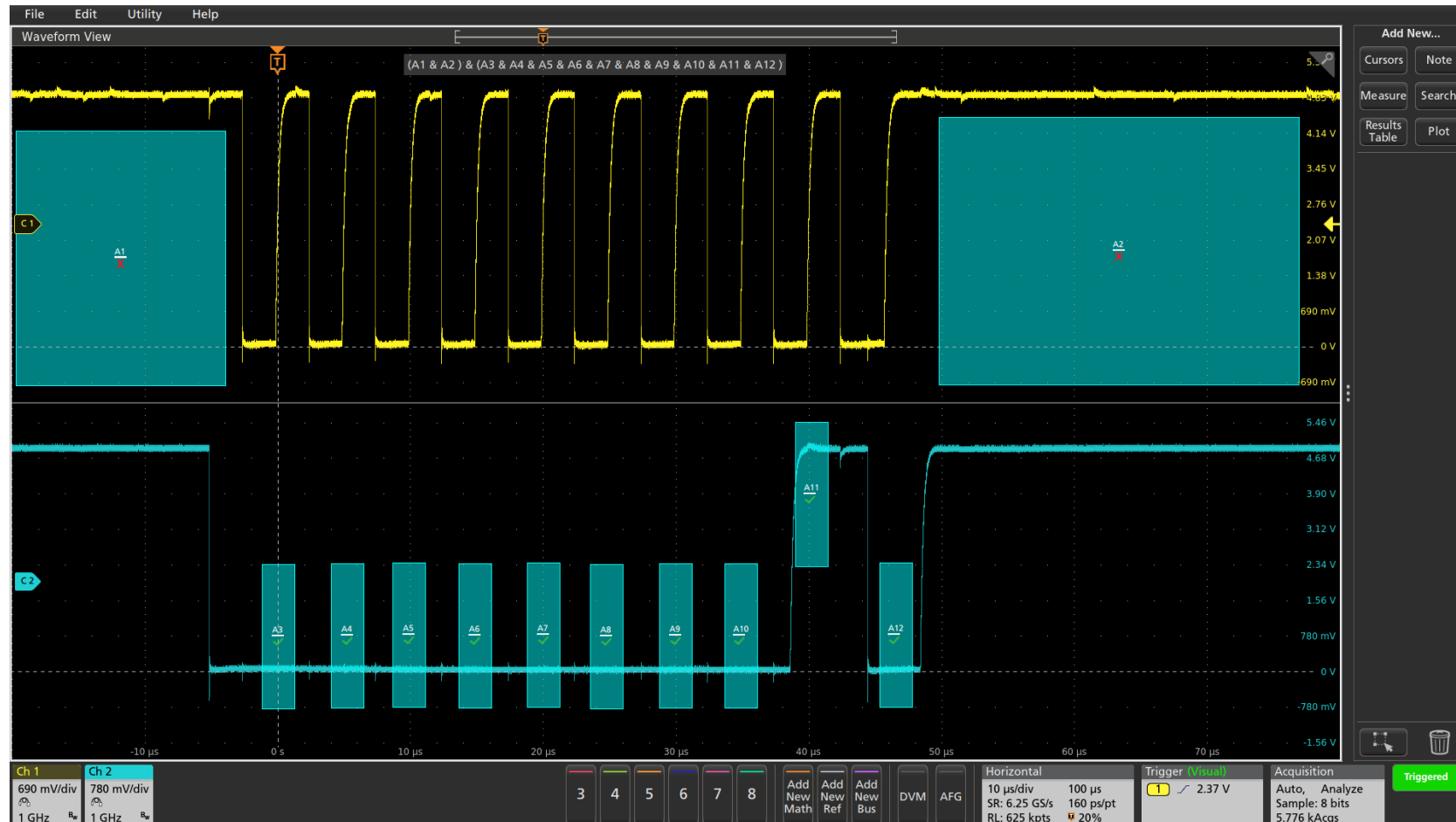
bus moved up for correlation with signals

math moved down



# Visual Trigger

- Visual Trigger makes the identification of the desired waveform events quick and easy by scanning through all waveform acquisitions and comparing them to on-screen areas (geometric shapes).
- An essentially-unlimited number of areas can be created using a variety of shapes including triangles, rectangles, hexagons, trapezoids, and user-specified shapes.
- Boolean combinatorial logic combines the areas to define the desired trigger behavior.

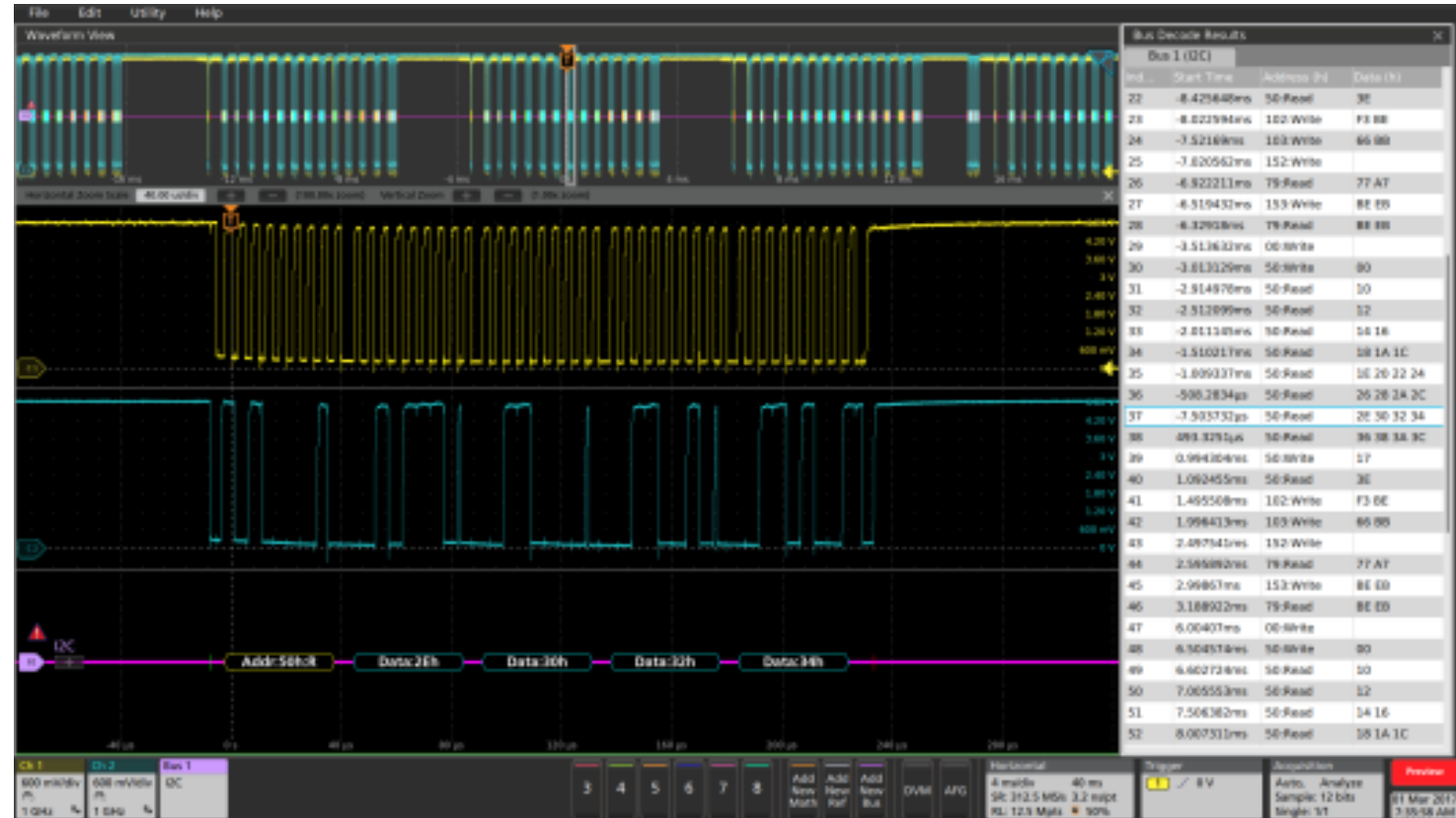


*Visual Trigger qualifies hardware trigger to capture complex events.  
This example shows capture of a specified digital data pattern during a burst of clock pulses.*

# Support for Embedded Serial Standards

## OPTIONAL SERIAL TRIGGER/DECODE PACKAGES

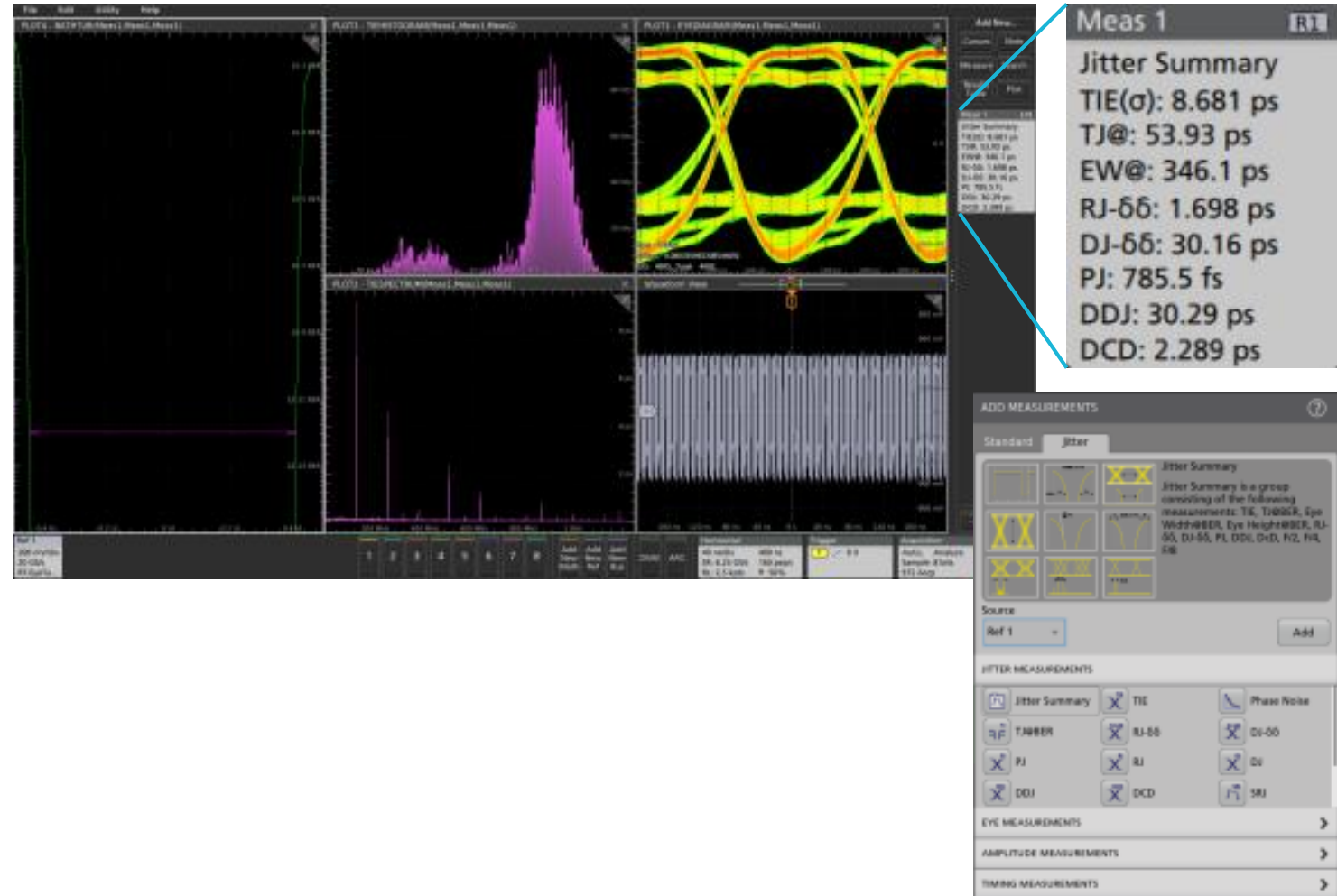
- Trigger on, and decode packet content of common serial standards
  - Saves significant time and frustration compared to manual process
- Decoded buses are time-aligned with other inputs
- Decoded packet content also available for viewing in a tabular view
  - I<sup>2</sup>C
  - SPI
  - CAN
  - CAN FD
  - LIN
  - FlexRay
  - SENT
  - RS-232
  - USB LS/FS/HS
  - Ethernet 10/100BASE-T
  - Audio I2S/LJ/RJ/TDM
  - ARINC 429
  - MIL-STD-1553
  - SPMI



# Jitter and Eye Analysis

## OPTIONAL SOFTWARE PACKAGE

- DPOJET functionality integrated into the scope application, providing faster and more intuitive operation
- Jitter measurements are accessed in the same simple manner as standard measurements
- Jitter Summary creates the following views with one button push:
  - Bathtub plot
  - TIE Histogram
  - TIE Spectrum
  - Eye Diagram
  - Most common jitter measurements
- Eye Diagram Mask Testing

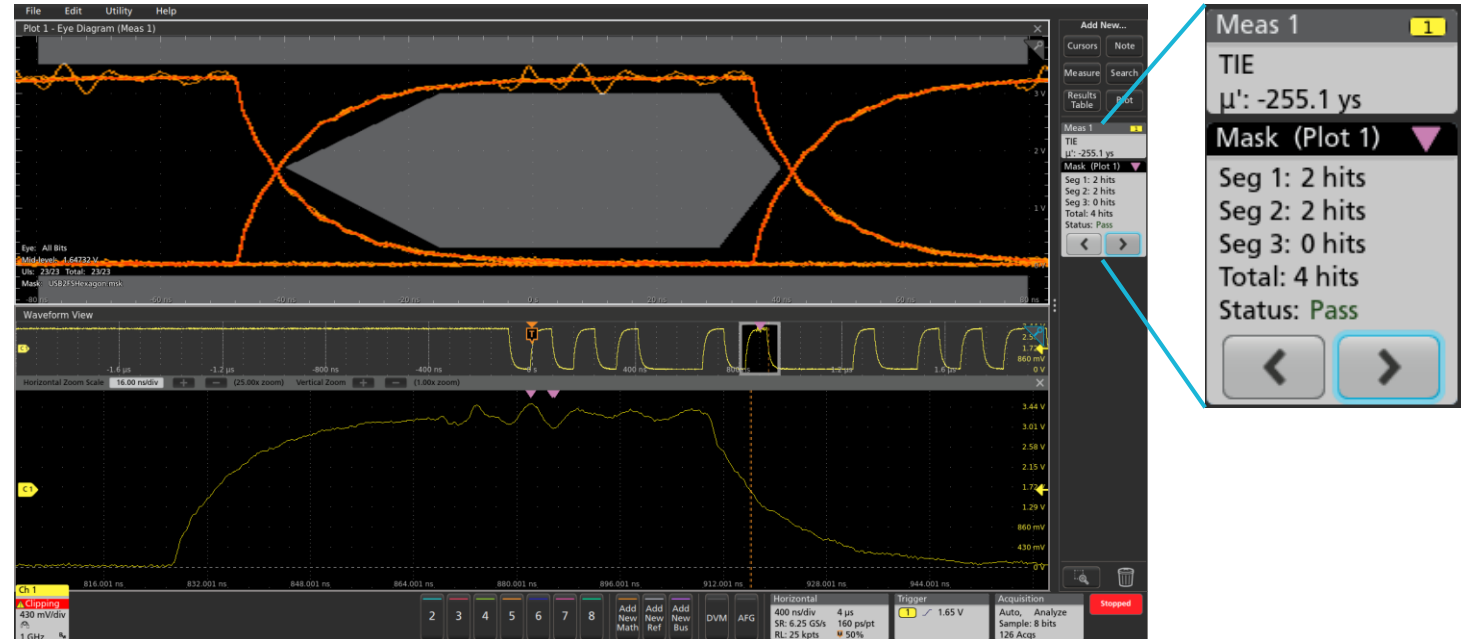




# Eye Diagram Mask Testing

## AUTOMATED PASS/FAIL TESTING FOR SERIAL SIGNALS

- Automated pass/fail mask testing on eye diagrams:
  - Included in 5-DJA jitter option
  - Verifies signal amplitudes and noise, timing jitter, and rise- and fall-times, with a single test
  - Masks specified by simple text file
  - Unlimited number of mask segments
  - User-specified pass/fail threshold and number of acquisitions to test
  - Manual navigation between violations
  - Eye diagram and mask hit data export for further analysis



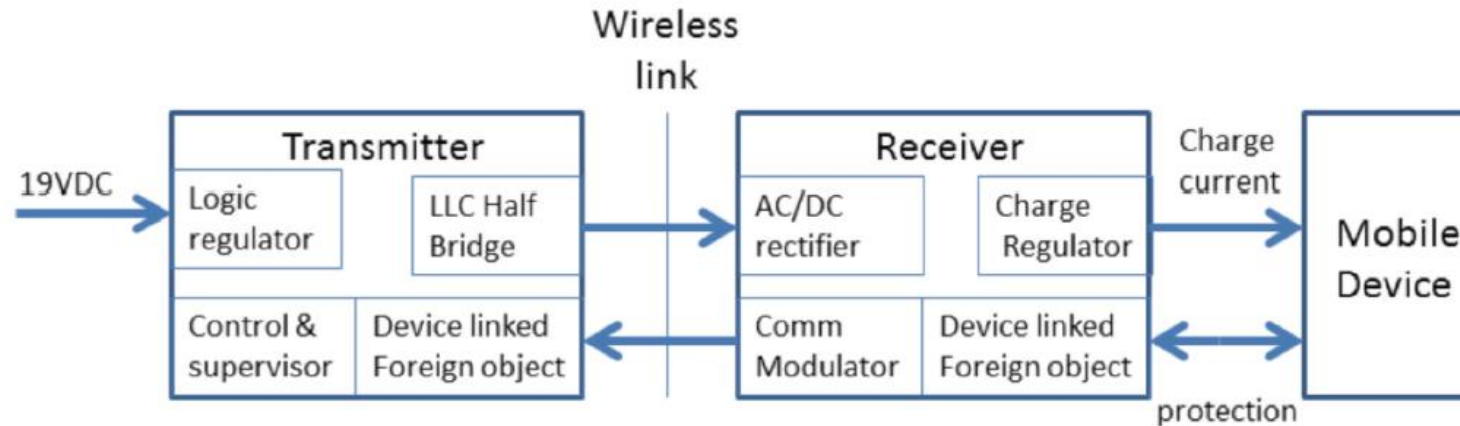
*Eye diagram mask test, with user-specified pass-fail threshold of 10 mask violations (hits). This example shows navigation between hits and correlation to time-domain waveform.*



# Qi Design Measurement with Tektronix Oscilloscope

---

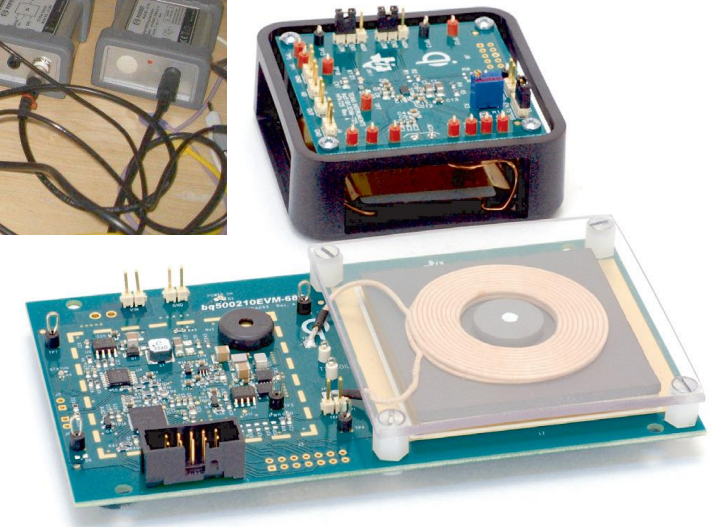
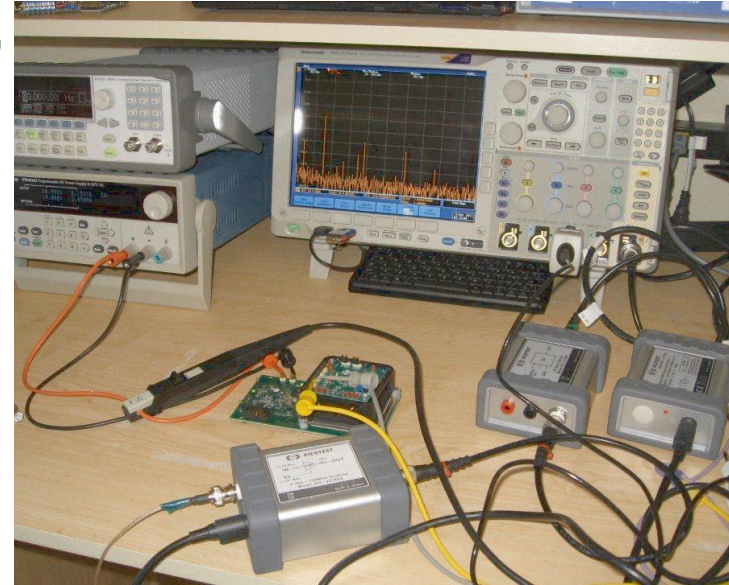
# WPC Qi - Magnetic Induction Power Transfer



- Operating Frequency is 110-205kHz
- One Base Station typically powers one Mobile Device
- In-band digital link is used for identification of compatible devices and control of power levels (operates through the same coils used for power transfer)

# Setting Up the Measurement with MDO4000B

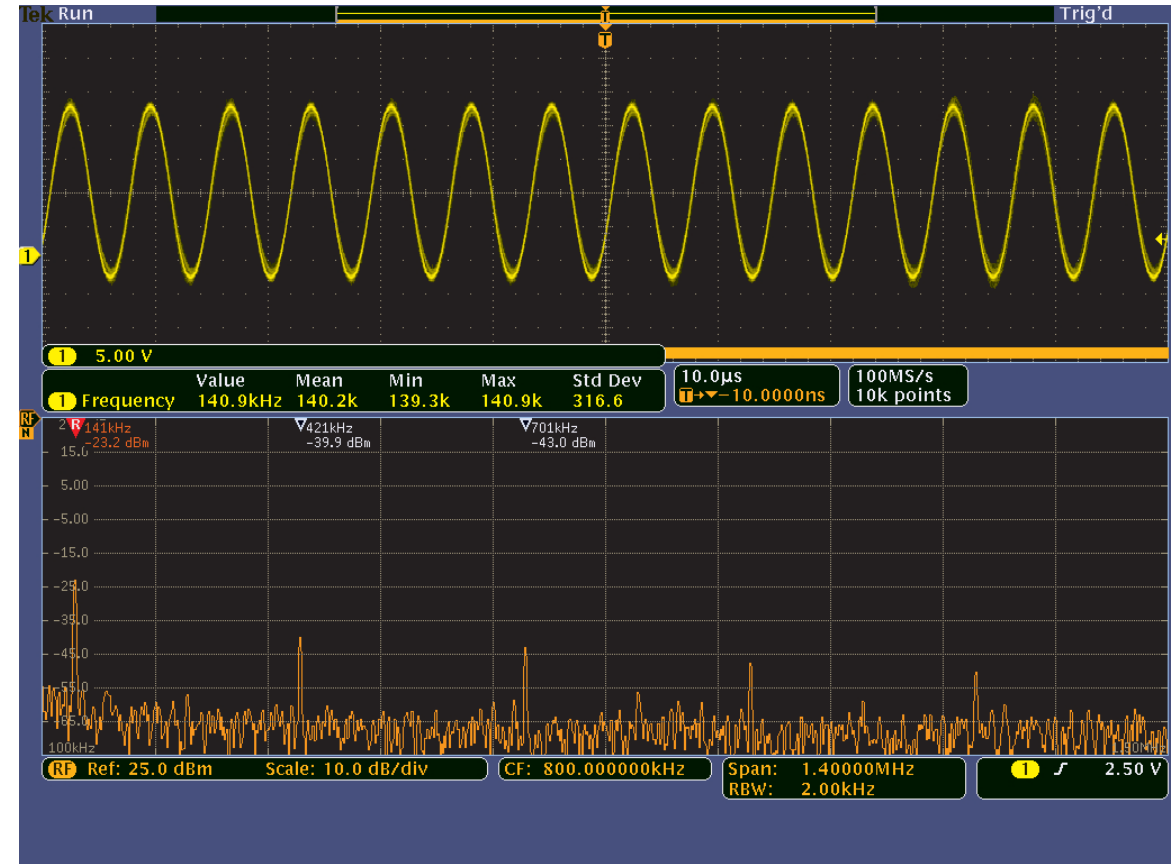
- Texas Instrument Wireless Power Set, including a Bq500210EVM-689 transmitter and Bq51013EVM-725 receiver.
- Test setup for measuring the charger including a Mixed Domain Oscilloscope, voltage and current probes, laboratory-grade power supply, and signal injectors.



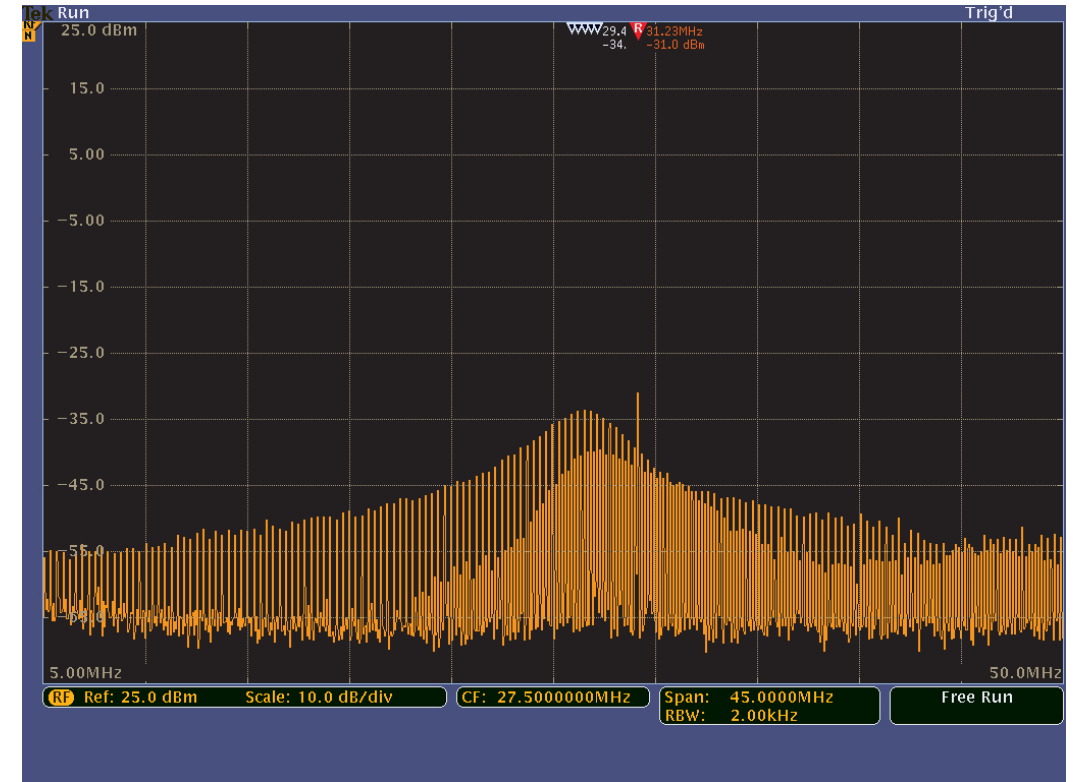
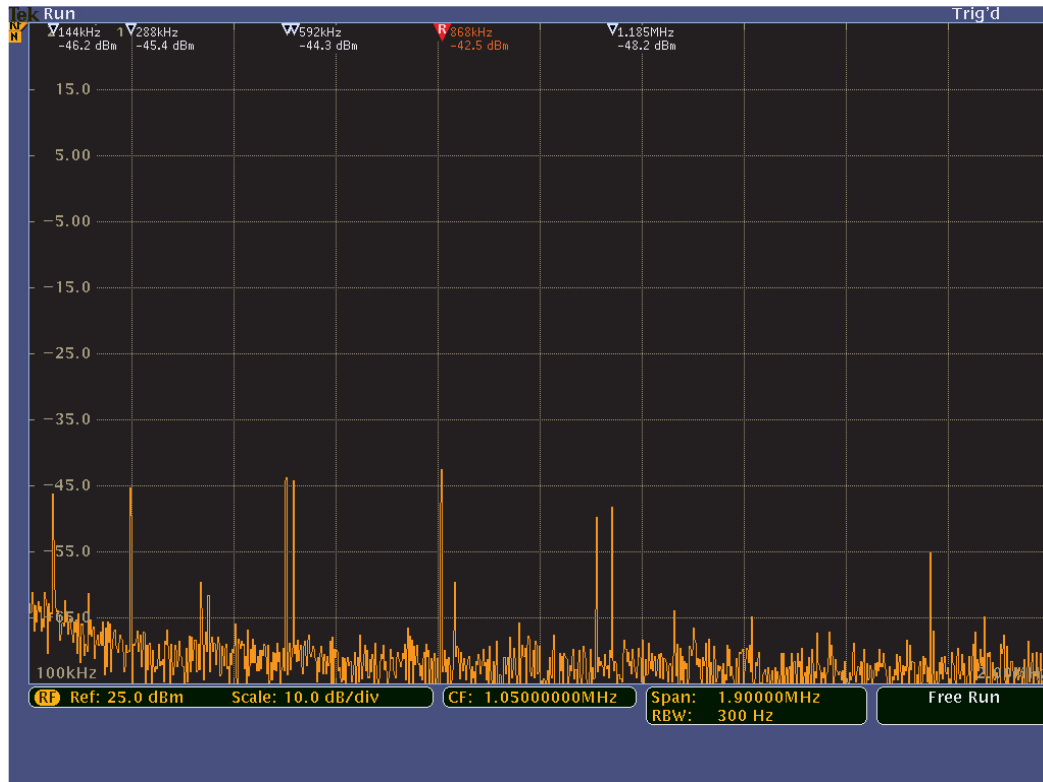


# Measurement

- Measured with a voltage probe connected to the resonant capacitor and also shows the resonant frequency.
- The spectrum analyzer channel displays the fundamental operating frequency of 141 kHz and is also rich with the odd harmonics associated with the 50% duty cycle switch voltage.



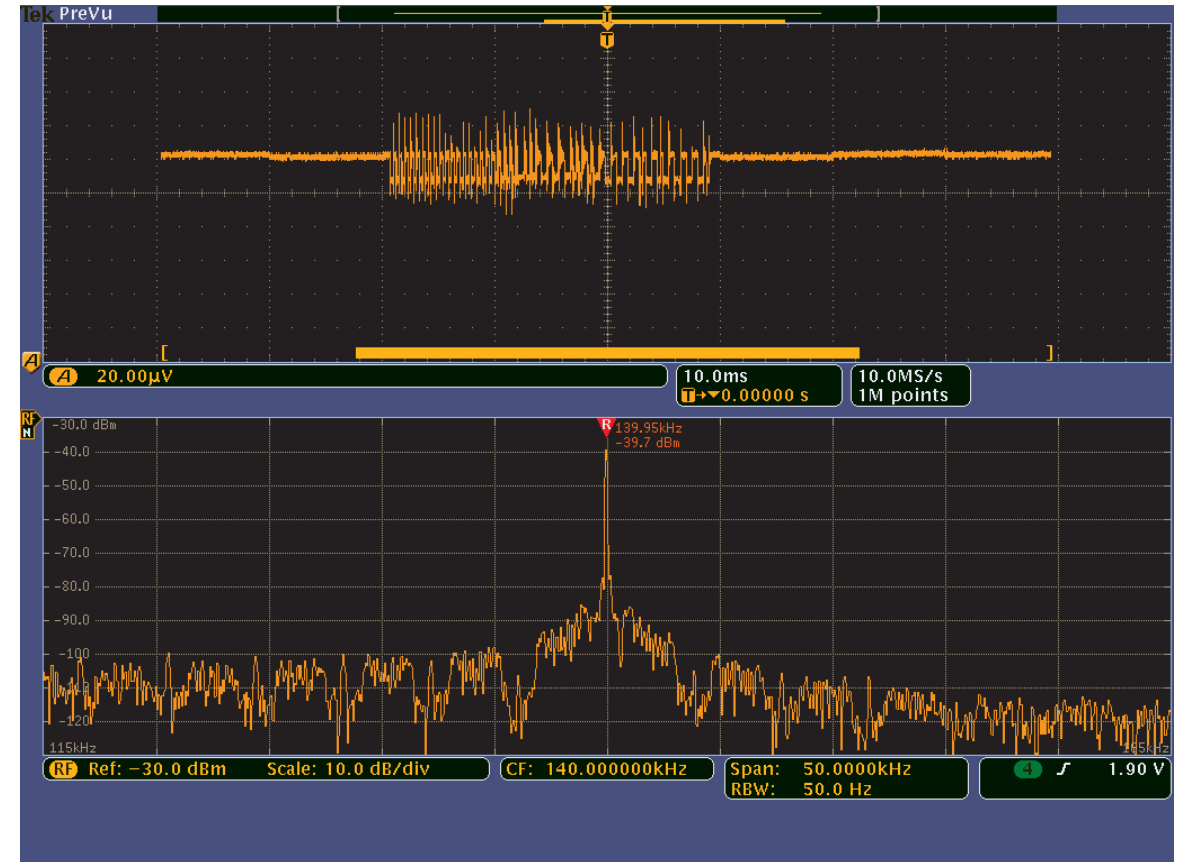
# Measurement



- The spectrum analyzer channel shows the radiated EMI in frequency domain

# Measurement

- Either method results in an amplitude modulation of the primary voltage. The spectrum-time capabilities of the spectrum analyzer channel are used to show the time-varying nature of the modulation behavior, specifically with the amplitude vs. time waveform.



# **Tektronix Innovation**

## **5 Series MSO**

**Thank you!**