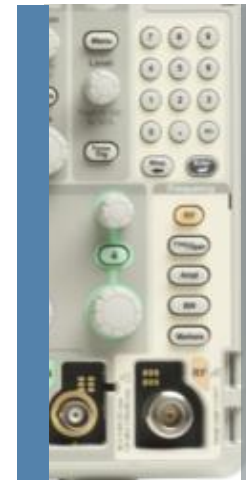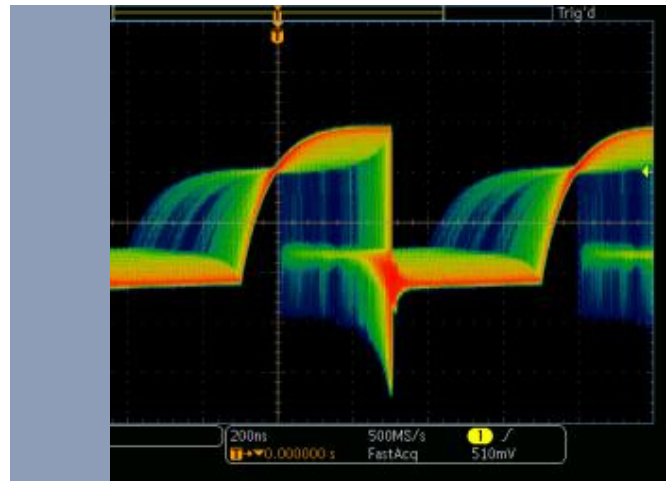# 6 Instruments, 1 Scope, Infinite Versatility
MDO3000 Mixed Domain Oscilloscope

1. Oscilloscope
2. Spectrum Analyzer
3. Arbitrary Function Generator
4. Logic Analyzer
5. Protocol Analyzer
6. DVM/Counter

**Tektronix**®

Customer Challenges & Needs

System-level debug of wireless-enabled designs

Mixed signal environments (low-voltage, power, RF, differential)

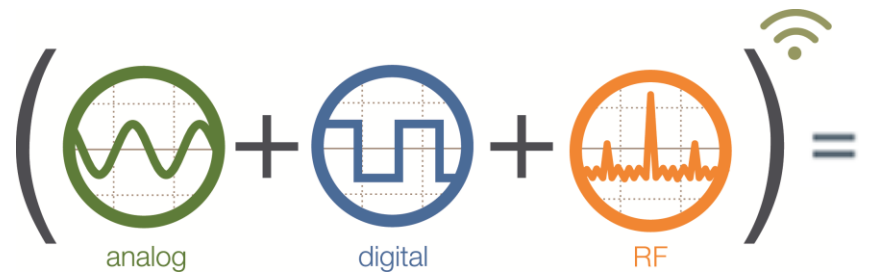Ability to have one instrument provide multiple testing functions

Spectrum analyzer #1 requested addition

Instrument upgradeability becoming an expectation

Tektronix®

MDO3000 Series
Mixed Domain Oscilloscopes

analog + digital + RF =

Tektronix®
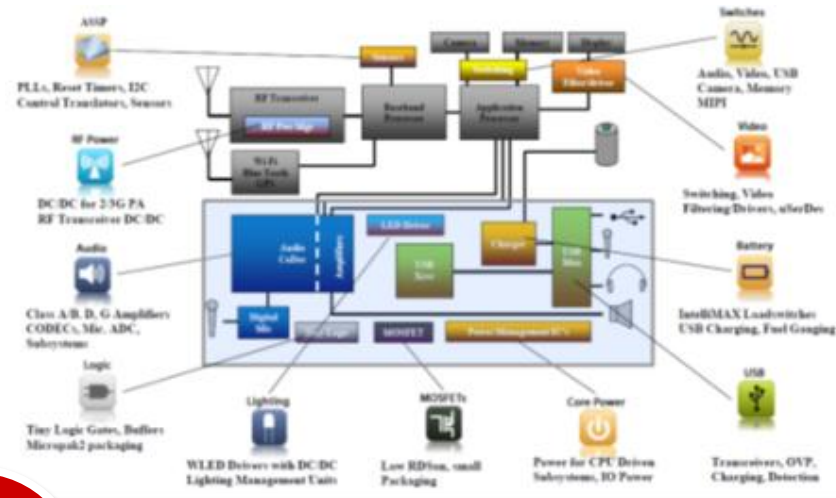
MDO3000 Series
Mixed Domain Oscilloscopes

1. Oscilloscope
2. Spectrum Analyzer
3. Arbitrary Function Generator
4. Logic Analyzer
5. Protocol Analyzer
6. DVM/Counter

The Ultimate 6-in-1 Integrated Oscilloscope

Completely customizable, providing what you need now – and later

Tektronix®

MDO3000 Series Mixed Domain Oscilloscopes

- 6-in-1 integrated oscilloscope
- Completely customizable & fully upgradeable
- Acquires in time domain or frequency domain

	MDO3104 MDO3102	MDO3054 MDO3052	MDO3034 MDO3032	MDO3024 MDO3022	MDO3014 MDO3012
Bandwidth	1 GHz	500 MHz	350 MHz	200 MHz	100 MHz
Analog Channels	2 or 4				
Analog Sample Rate	2.5 GS/s (3 or 4 ch) 5 GS/s (1 or 2 ch)	2.5 GS/s (All ch)			
Record Length	10 M Points *with Wave Inspector™ Navigation*				
Waveform Capture Rate	>280,000 wfms/s with FastAcq	>235,000 wfms/s with FastAcq			
Spectrum Analyzer	Standard Configuration: 9kHz to Analog Bandwidth **Option**: 9kHz to 3GHz				
Digital Channels	**Option**: 16 channels with P6316 16-ch digital probe 500 MS/s (2.5 ns resolution) digital Main, 8.25 GS/s (121.2 ps resolution) digital MagniVu™				
AFG	**Option**: 1 output with 13 predefined waveforms plus arbitrary				
Standard Analog Probes	TPP1000 – 1 GHz, 3.9pf, 10X, passive probe with 1 GHz models TPP0500B – 500 MHz, 3.9pf, 10X, passive probe with 350 and 500 MHz models TPP0250 – 250 MHz, 3.9pf, 10X, passive probe with 100 and 200 MHz models				

Tektronix®

MDO3000 Platform

NEW! Automatic dimming of display

9" WVGA

5.8 inches (147 mm) deep!

NEW!
Push encoders on Horizontal:
- Position (center when delay on, set to 10% when delay off)

NEW!
Push encoders on Vertical:
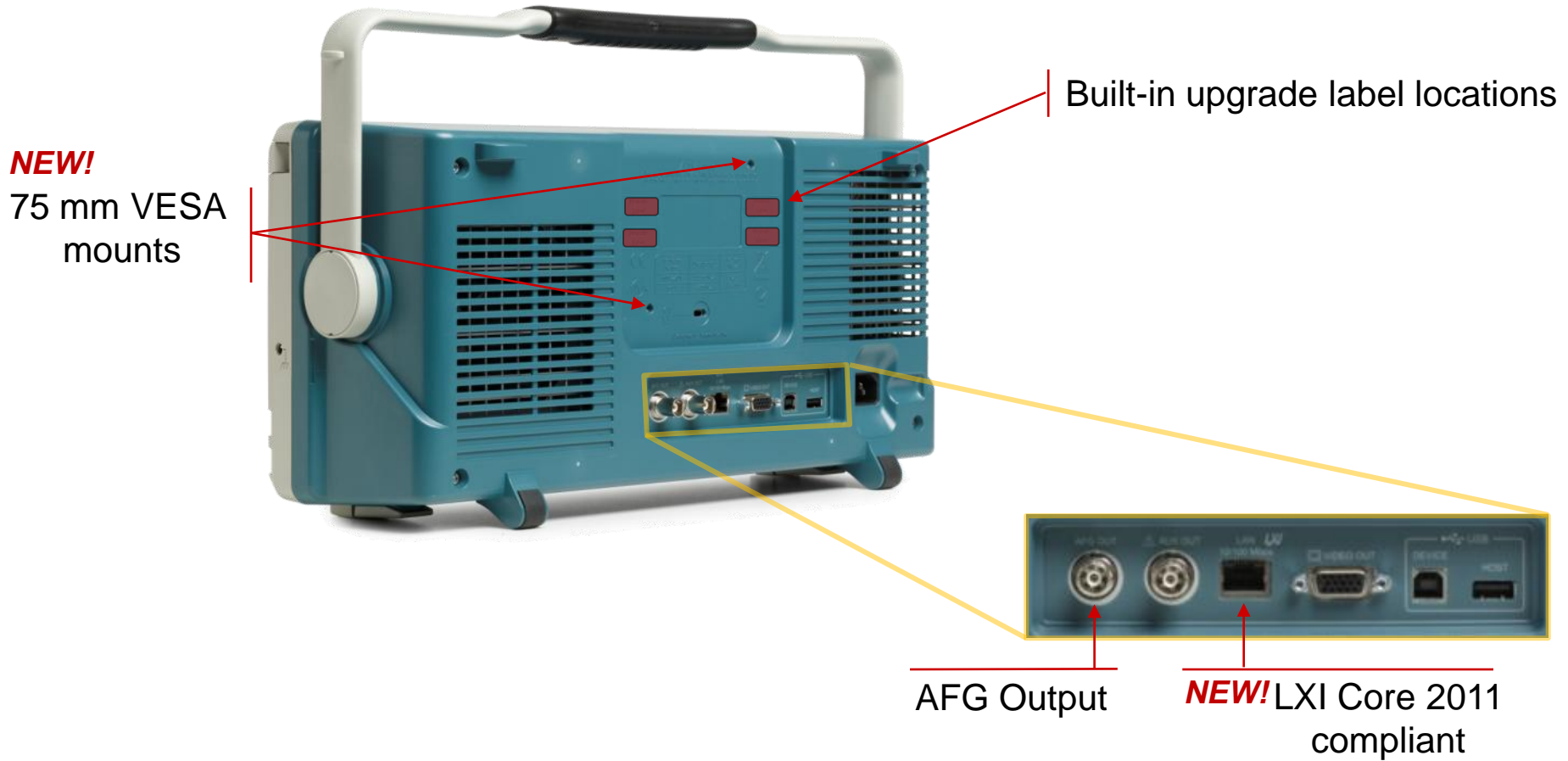- Position (center channel handle)
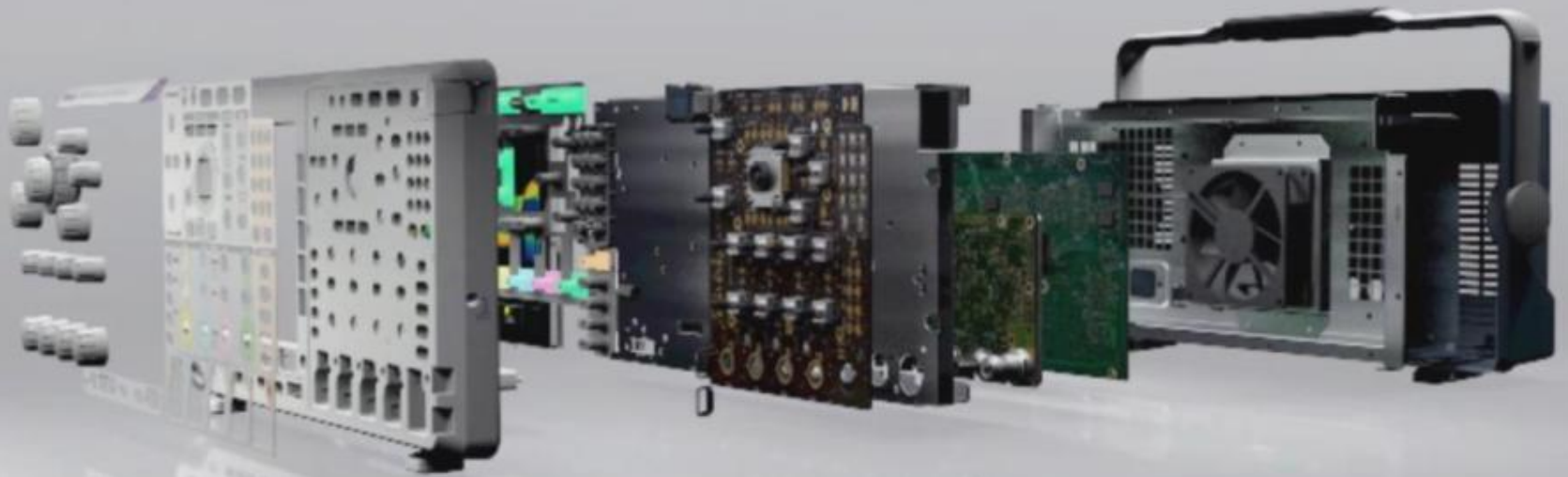- Scale (Fine/Coarse)

TekVPI inputs with low-C probing

NEW!
Dedicated RF input

Tektronix®

MDO3000 Platform

Built-in upgrade label locations

NEW!
75 mm VESA mounts

AFG Output

NEW! LXI Core 2011 compliant

Tektronix®

Six Instruments. One Scope.

Tektronix®

Tektronix®

# 1. Oscilloscope – Banner Specifications

	MDO3104 MDO3102	MDO3054 MDO3052	MDO3034 MDO3032	MDO3024 MDO3022	MDO3014 MDO3012
Oscilloscope Bandwidth	1 GHz	500 MHz	350 MHz	200 MHz	100 MHz
Analog Channels	2 or 4				
Analog Sample Rate	2.5 GS/s (3 or 4 ch) 5 GS/s (1 or 2 ch)	2.5 GS/s (All ch)			
Record Length	10 M Points *with Wave Inspector^{TM} Navigation*				
Waveform Capture Rate	> 280,000 wfm/s with FastAcq	> 235,000 wfm/s with FastAcq			
Analysis	Standard: Advanced Math, FFT, 30 Automated Measurements, Waveform Histograms **Optiona**l: Power, Limit/Mask Test				
Standard Analog Probes	TPP1000 – 1 GHz, 3.9pf, 10X, passive probe with 1 GHz models TPP0500B – 500 MHz, 3.9pf, 10X, passive probe with 350 and 500 MHz models TPP0250 – 250 MHz, 3.9pf, 10X, passive probe with 100 and 200 MHz models				

Tektronix®

Comprehensive Tools Speed _Every_ Stage of Debug

Discover
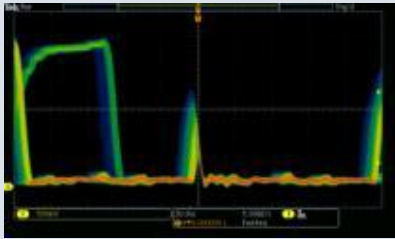
- **_New!_** FastAcq high speed waveform acquisition
  - >280,000 wfm/s
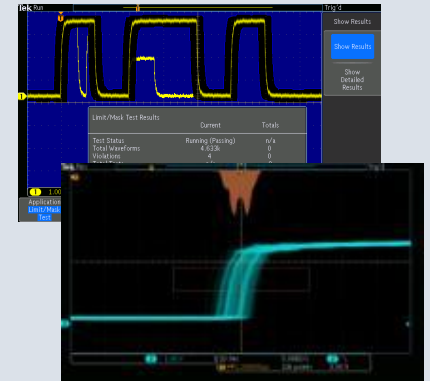- **_New!_** Color-graded, Inverted waveform palette digital phosphor display

Capture

- **_New!_** Industry best standard voltage probes
- 10 Mpoints record
- Complete set of triggers
- **_New!_** Act-on-event

Search

- Wave Inspector® Navigation and Search
 - **_New!_** Search Mark table shows a listing of each search event

Analyze

- 30 automated measurements
- Advanced waveform math and all video test tools standard
- **_New!_** Limit/Mask Testing
- Power analysis
- **_New!_** Waveform Histograms

Tektronix®

FastAcq

- **_New!_** FastAcq high speed waveform acquisition
    - \> 235,000 wfms/s on 100 – 500 MHz models
    - \> 280,000 wfms/s on 1 GHz models
    - Inverted waveform palette makes infrequent events instantly visible
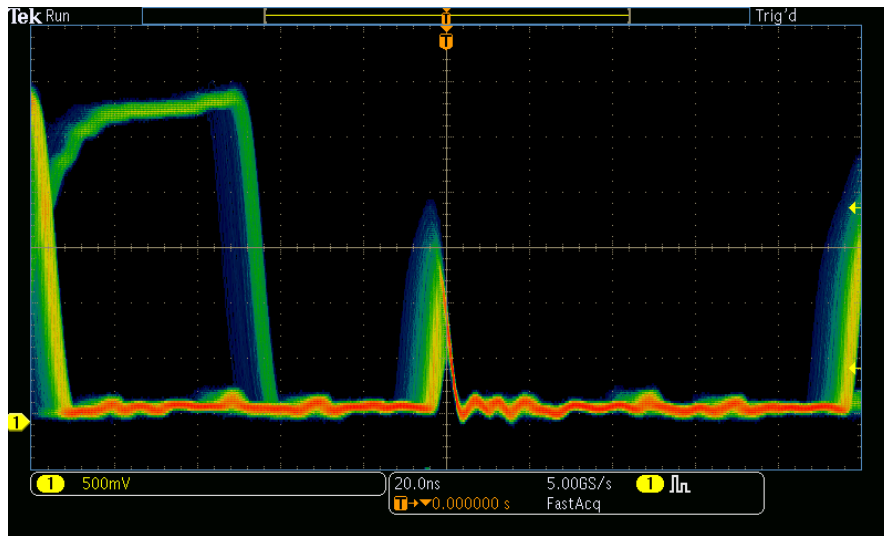
Temperature color grading
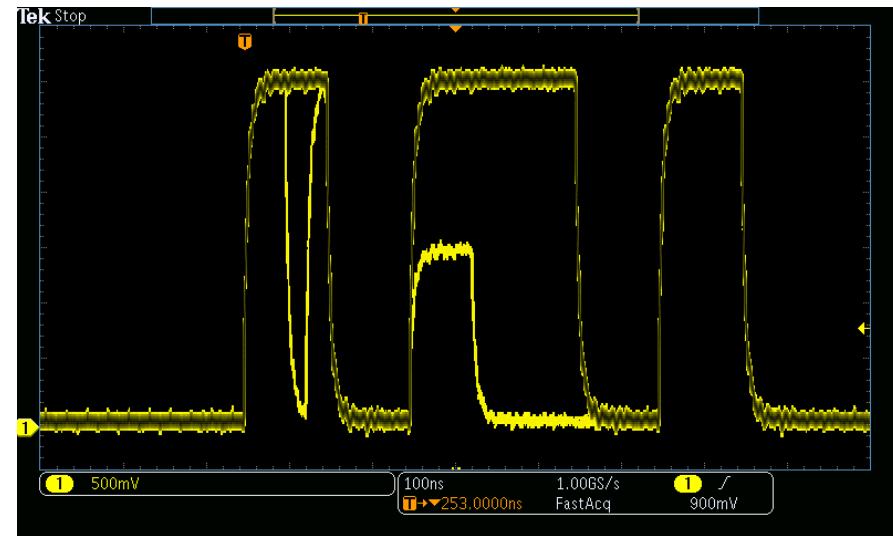
Inverted palette instantly shows anomalies

Find elusive glitches and transients in seconds

Tektronix®

Low Capacitance Passive Probes

- ***New!*** Industry best standard voltage probes included with every scope
  - 3.9 pF input capacitance reduces the impact to signals being measured

  - TPP0250: 250 MHz passive voltage probe
    - Standard on 100MHz, 200MHz models

  - TPP0500B: 500MHz passive voltage probe
    - Standard on 350MHz, 500MHz models

  - TPP1000: 1GHz passive voltage probe
    - Standard on 1GHz models

Active probe performance with passive probe ease-of-use

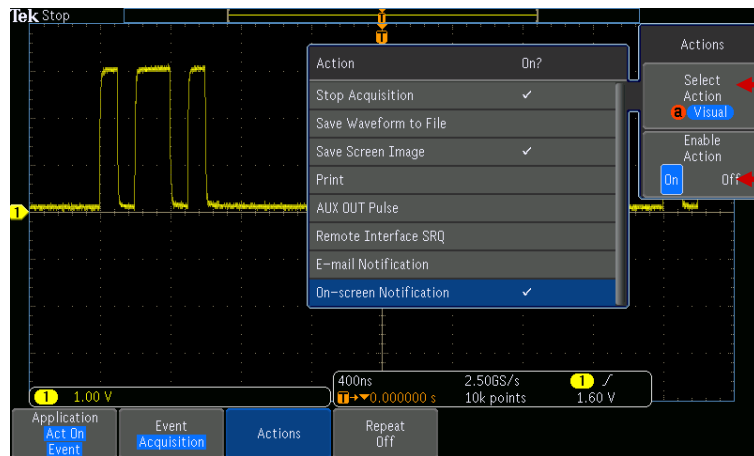**Tektronix®**

Act-on-Event: also called "Save on Trigger"
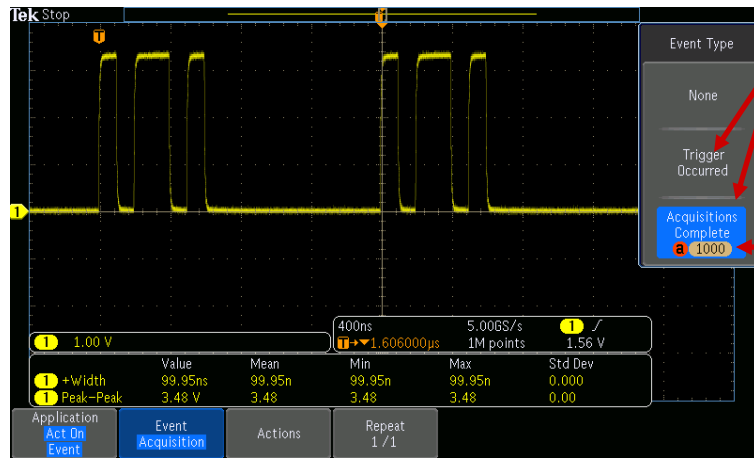
Select a single trigger or a number of acquisitions

Select the number of acquisitions from 1 to 1 Million

1. Select an action

2. Turn each action on/off

- ***New!*** Take actions when:
  - A <u>trigger occurs</u> or
  - A user-defined <u>number of acquisitions</u> have occurred

- Actions can be enabled/disabled independently
  - Stop Acquisition
  - Save Waveform to File
  - Save Screen Image
  - Print
  - AUX OUT Pulse
  - Remote Interface SRQ
  - E-mail notification
 - On-screen Notification

Tailor your tests to speed your debug tasks

**Tektronix**®

Wave Inspector Navigation & Search

- Dedicated set of front panel controls quickly finds events of interest in long records

- Quickly find events using automated search
  1. Define your search criteria
     - Common trigger combinations
     - Parallel data
     - Serial bus content
  2. Wave Inspector marks every instance
  3. Use the arrow buttons to jump from event to event

- **New!** Search Mark table shows a listing of each event, time stamped for easy timing measurements
  - Export .csv for reporting
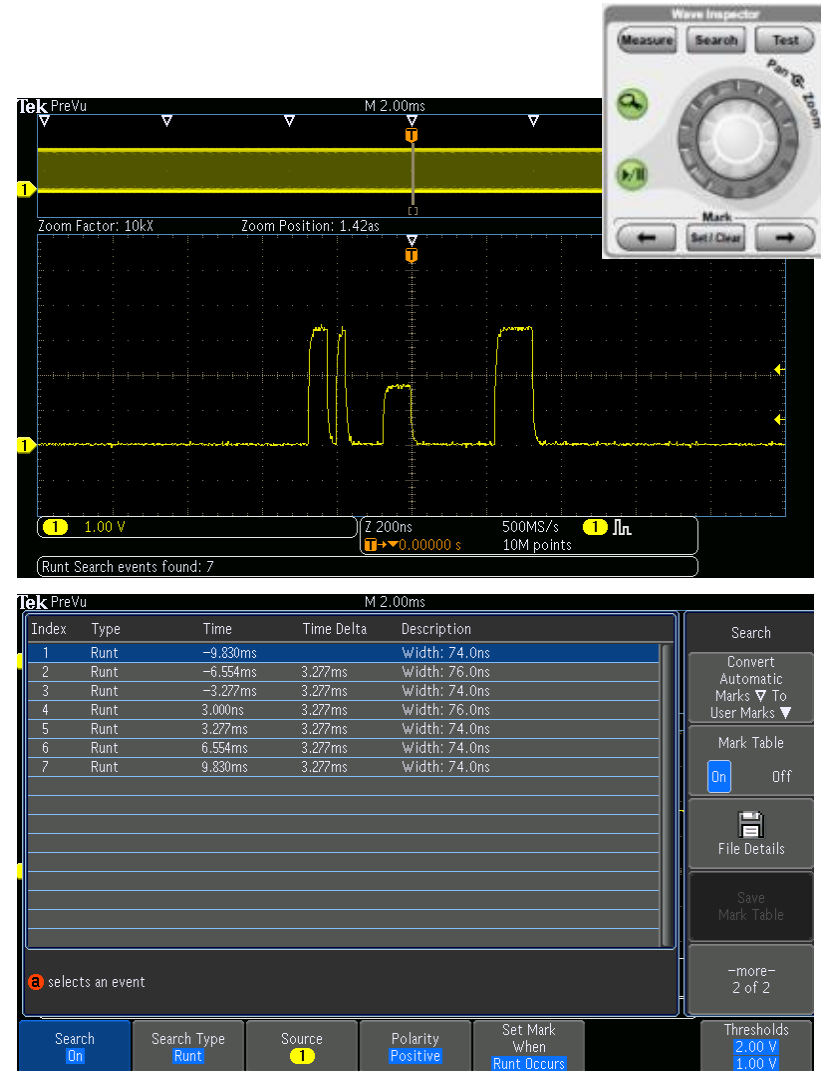
Find events of interest in long records in seconds

Tektronix

Limit/Mask Testing and Advanced Math

- **_New!_** Limit tests compare a tested signal to known good or "golden" signals with user-defined vertical and horizontal
  - Tailor your tests by defining test duration in number of waveforms or time
  - Results report number of violations, waveforms tested, and elapsed time

- **_New!_** Custom mask testing compares a tested signal to a mask
  - Load custom masks from files

- Advanced waveform math **_standard_**
 - User-defined equations using algebraic functions and variables
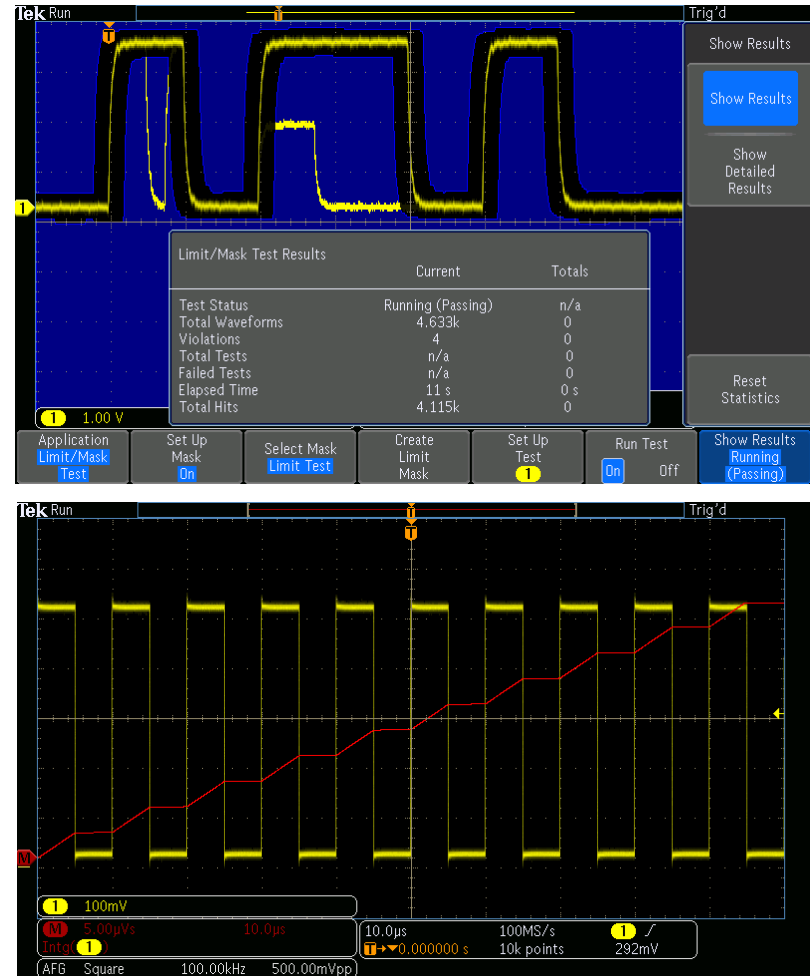
Perform go/no-go testing in seconds and produce complex math waveforms

16

Tektronix®

Power Analysis and Video Test

- **Perform quick, repeatable and accurate analysis of**
  - Power quality
  - Switching loss
  - Harmonics
  - Safe operating area (SOA)
  - Modulation
  - Ripple
  - Slew rate (di/dt, dv/dt)

- **All video test tools are *standard* on MDO3000**
  - NTSC, PAL, SECAM triggering
  - HDTV and custom line rate triggering
  - Video autoset and graticules
  - ***New!*** Video picture display

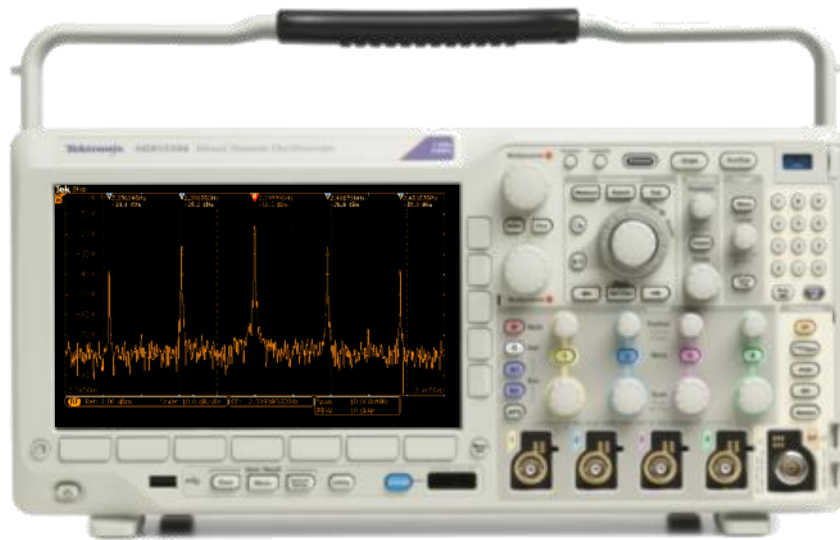*Quick, repeatable power measurements and industry best video test tools*

17

Tektronix®
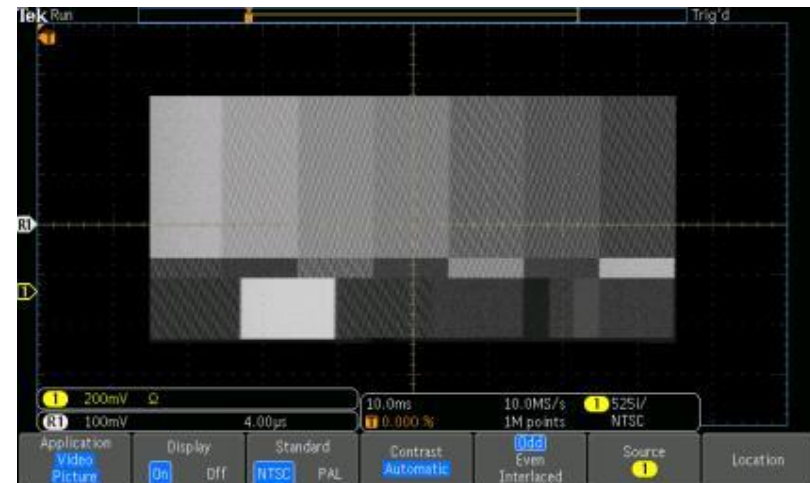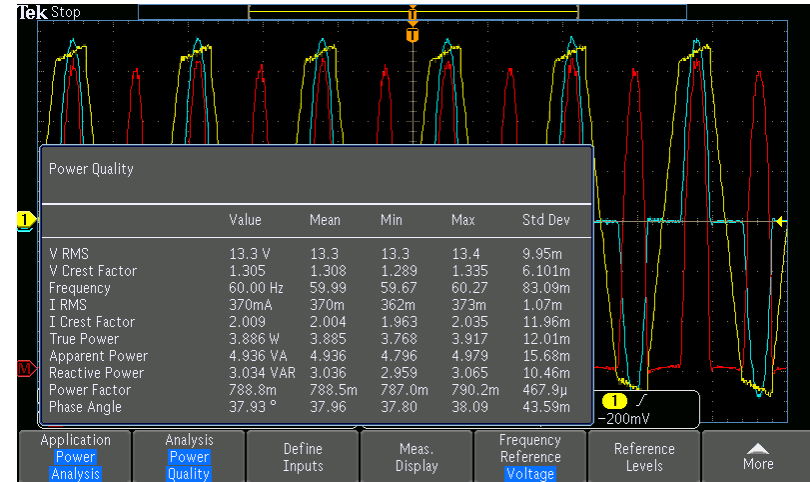
Spectrum Analyzer
up to 3 GHz

Tektronix®

2. Spectrum Analyzer – Banner Specifications

	MDO3104 MDO3102	MDO3054 MDO3052	MDO3034 MDO3032	MDO3024 MDO3022	MDO3014 MDO3012
Standard Capture Bandwidth	1 GHz	500 MHz	350 MHz	200 MHz	100 MHz
Optional Capture Bandwidth	3 GHz				
Standard Spectrum Analyzer Frequency Range	9 kHz – 1 GHz	9 kHz – 500 MHz	9 kHz – 350 MHz	9 kHz – 200 MHz	9 kHz – 100 MHz
Optional Spectrum Analyzer Frequency Range	9 kHz – 3 GHz				
DANL	-138 dBm/Hz 5MHz – 2 GHz; -142 dBm/Hz 5MHz – 2 GHz typical				
Phase Noise	-97 dBc/Hz at 100kHz offset; -101 dBc/Hz at 100kHz offset typical – 1 GHz CW				

Built-in spectrum analyzer in every model

Tektronix

Intuitive User Interface

10-digit keypad for data entry

RF Menu select traces

Set Frequency & Span

Set Ref Level & Vertical Scale

Set RBW & Window

Adjust markers
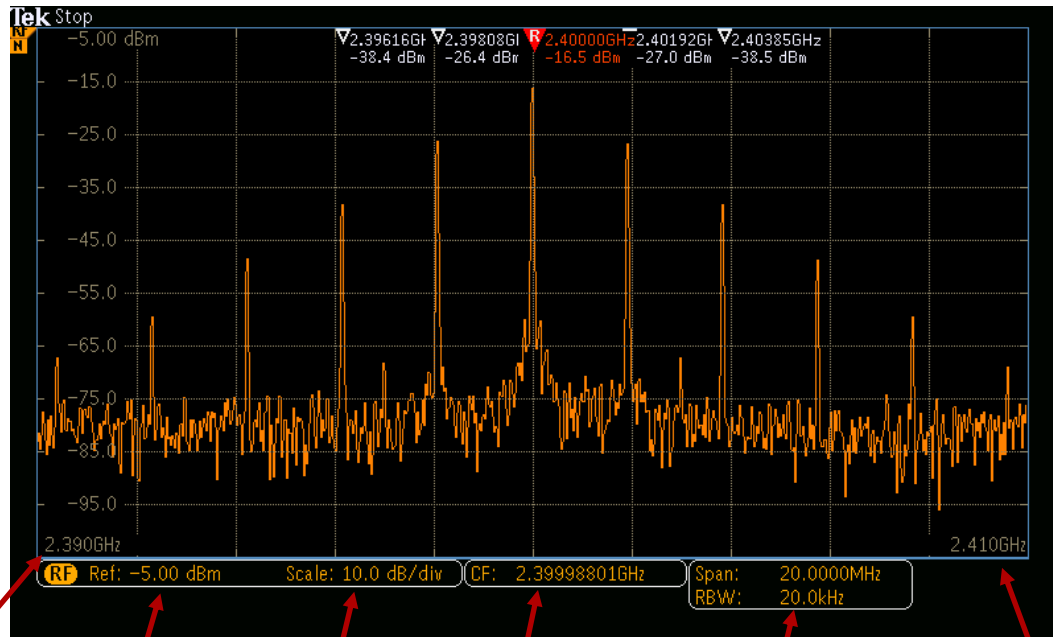
Start Frequency

Reference Level

Vertical Scale

Center Frequency

Span & Resolution Bandwidth

Stop Frequency
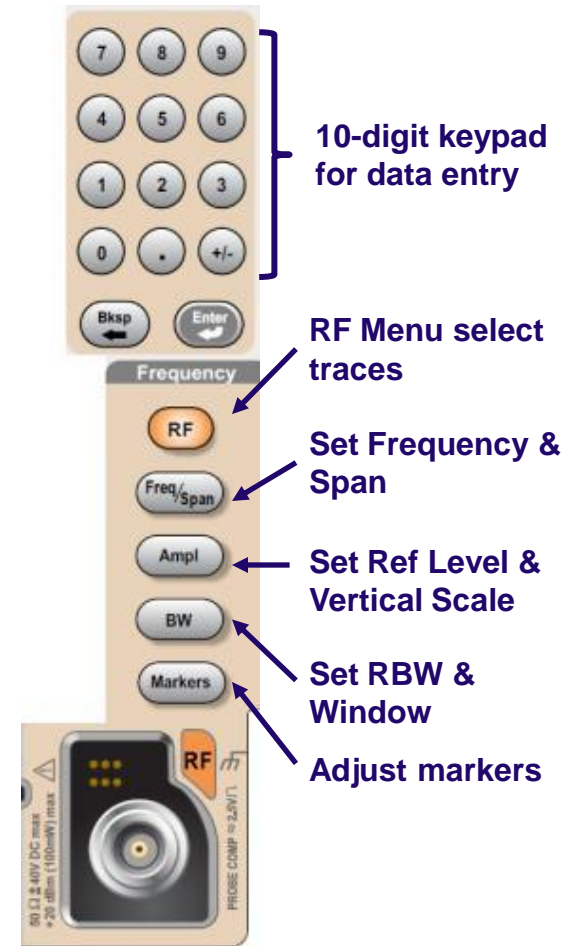
Operates like a traditional spectrum analyzer

Tektronix®

Performance Superior to Scope FFT

- **Wide capture bandwidth**
  - Up to 3 GHz capture bandwidth allows you to see your entire signal at once

- **Automated markers**
  - Up to 11 markers automatically mark each user defined peak greatly simplifying the common task of peak identification

- **Spectrogram display**
  - Graphically see slowly changing RF phenomena at a glance

- **Automated measurements**
  - Make quick work of common RF measurements
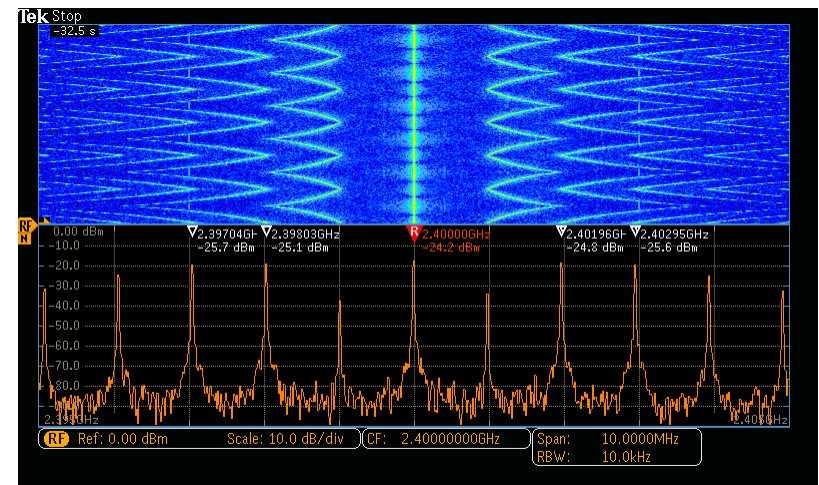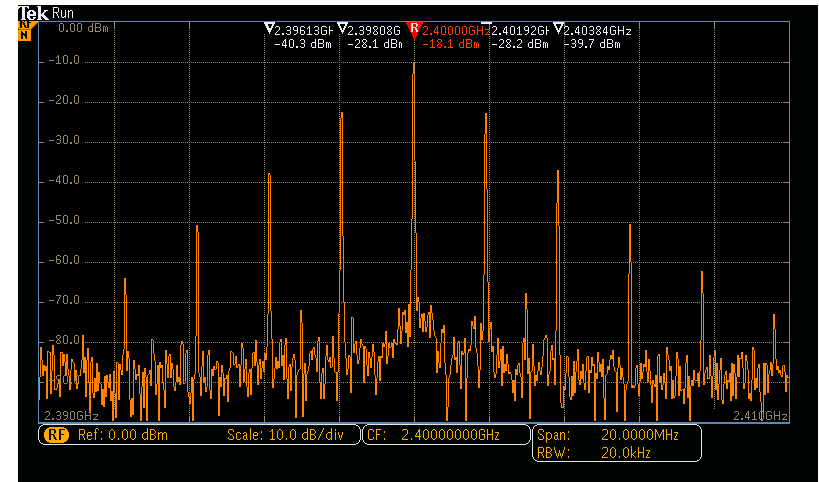
Performance you can't find in any other scope or spectrum analyzer

Tektronix®

Arbitrary/Function Generator
up to 50 MHz

Tektronix®

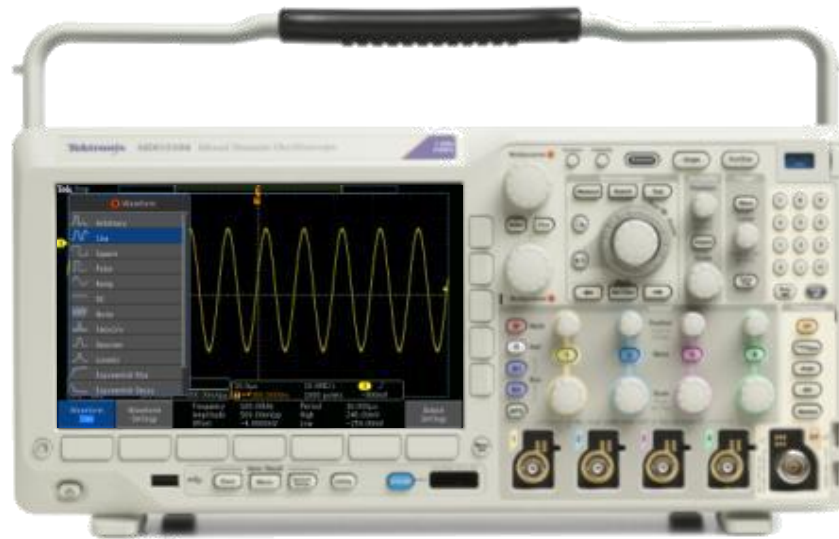|	MDO3104 MDO3102	MDO3054 MDO3052	MDO3034 MDO3032	MDO3024 MDO3022	MDO3014 MDO3012
Oscilloscope Bandwidth	1 GHz	500 MHz	350 MHz	200 MHz	100 MHz
AFG Standard Waveforms	Sine, Square/Pulse, Ramp/Triangle, DC Level, Gaussian, Lorentz, Exponential Rise/Fall, Sin(x)/x, Haversine, Cardiac, Random Noise				
AFG Maximum Frequency	50 MHz (Sine), 25 MHz (Square/Pulse), 5 MHz (Gaussian, Lorentz, Exponential Rise/Fall, Haversine), 2 MHz (Sin(x)/x), 500 kHz (Ramp/Triangle)				
Amplitude Range	10mV – 2.5V* max Into 50Ω 20mV – 5V* max into Hi-Z				
Arbitrary Record Length	128k points				
Arbitrary Sample Rate	250 MS/s				

*Note: Varies by signal type*

Tektronix®

Fastest Integrated AFG

- Optional, integrated arbitrary function generator offering signal generation up to 50 MHz
  - Industry's fastest integrated AFG
  - Simulate sensor signals or other signals to represent missing blocks of a design

- AFG is available all the time – when the scope is in time domain or frequency domain

- Add noise to any signal type to simulate the presence of noise in a circuit
  - Noise amount adjustable from 0% to 100% of signal amplitude

Waveform	Maximum Frequency
Sine	50 MHz
Square, Pulse	25 MHz
Gaussian, Lorentz, Haversine, Exponential Rise/Decay	5 MHz
Sin(x)/x	2 MHz
Ramp (Triangle), Cardiac	500 kHz
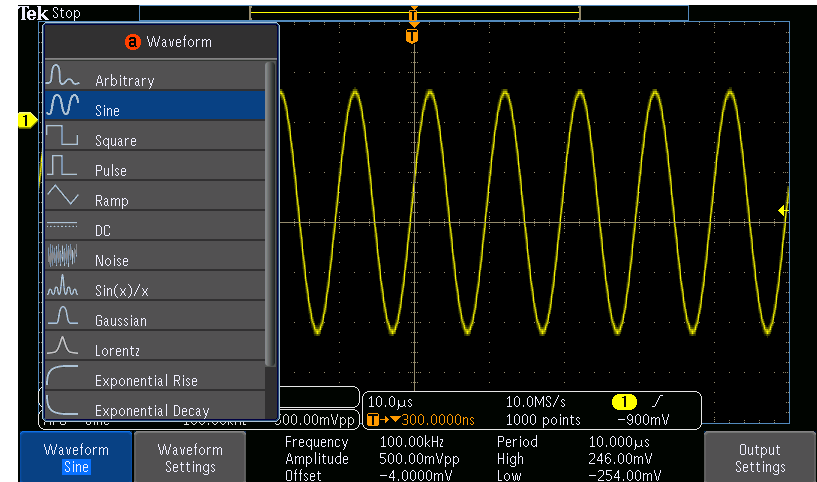
Simulate missing signals to speed design

**Tektronix**®

Fastest and Deepest Arbitrary Generation

- No longer need multiple instruments

- Simplify replication of signals by using a single instrument

- High performance AFG enables simplicity
  - 128 kpoints edit memory – 8X longer than competitive products
  - 250 MS/s output rate – 2X faster than competitive products

- Use the built-in waveform editor or Tektronix ArbExpress® PC-based waveform creation & editing software to make waveform creation a snap
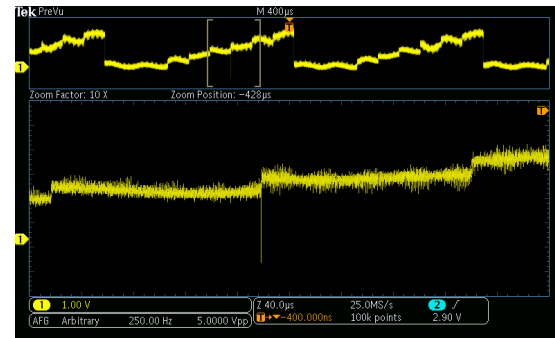
1 Load acquired waveform into arbitrary edit memory
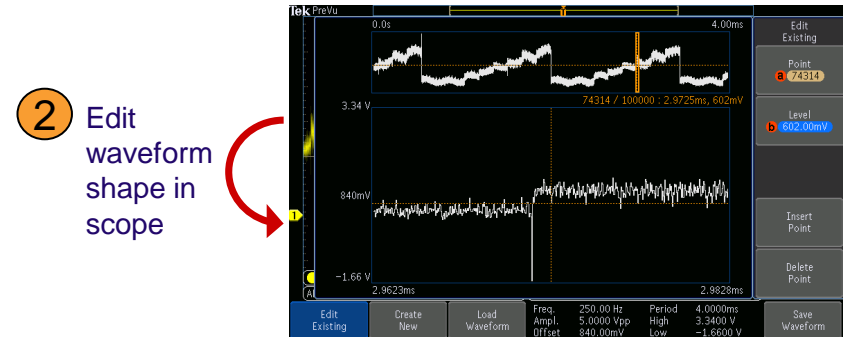
2 Edit waveform shape in scope

3 Replicate waveform out of AFG

Generate or Replicate complex waveforms easily

Tektronix

Logic Analyzer
16 channels
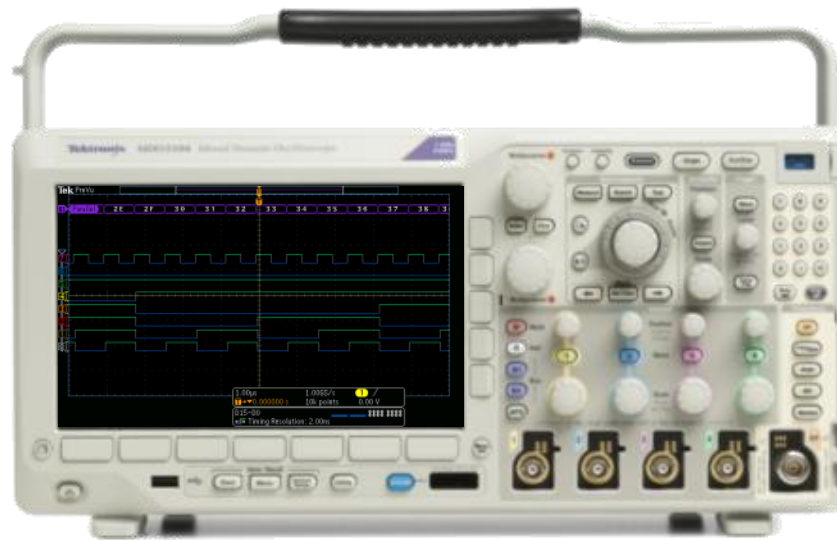
Tektronix®

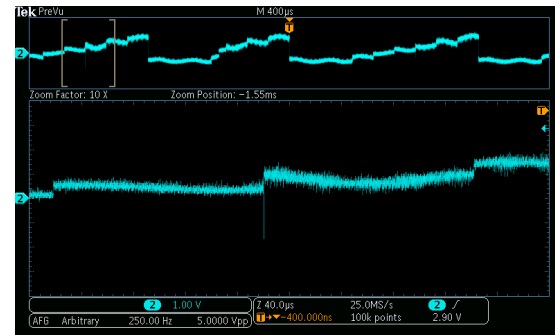|	MDO3104 MDO3102	MDO3054 MDO3052	MDO3034 MDO3032	MDO3024 MDO3022	MDO3014 MDO3012
Oscilloscope Bandwidth	1 GHz	500 MHz	350 MHz	200 MHz	100 MHz
Digital Channels	16 channels with P6316 16-ch digital probe				
Digital Sample Rate	Main: 500 MS/s (2 ns resolution) MagniVu: 8.25 GS/s (121.2 ps resolution)				
Digital Record Length	Main: 10 M Points MagniVu: 10 k Points centered on the trigger				
Minimum Detectable Pulse	2 ns				
Minimum Signal Swing	500 mVp-p				
Input Resistance	101 kΩ to ground				
Input Capacitance	8 pF				

Tektronix®

Intuitive Digital Display

- Logical highs are identified in **Green** and lows in **Blue**

- Optional 16 digital channels

  – 500 MS/s with 10 M points record length

  – 8.25 GS/s (121.2 ps resolution) MagniVu high speed sampling
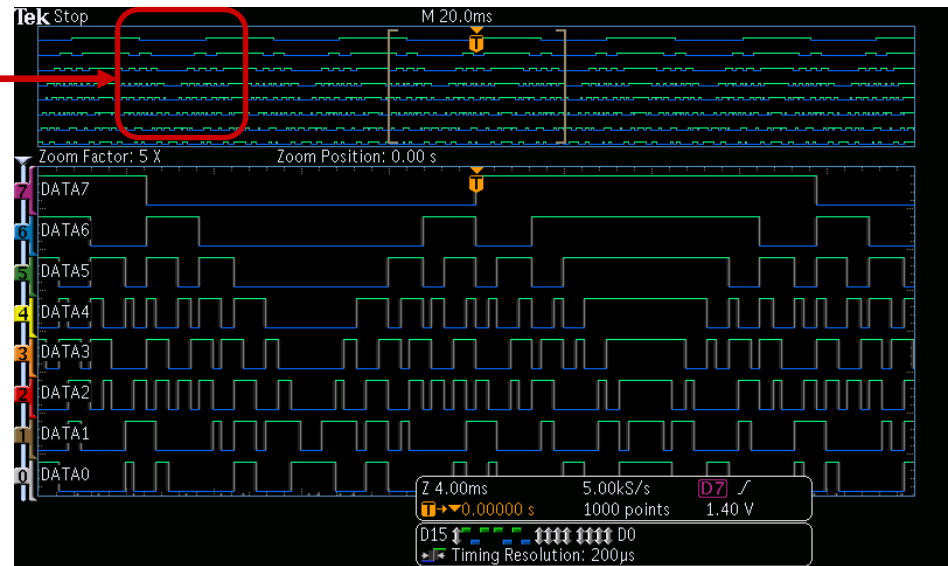
New! Monitor shows activity on digital channels at a glance

Color coding makes setup and operation a snap

Tektronix®

Parallel Bus Trigger, Decode & Search

- **Trigger on parallel bus data**
  - Clocked bus trigger will only evaluate the trigger condition when a clock is valid

- **View decoded data in hex or binary**
  - Clocked decode will only show valid data decode, eliminating unimportant transition states from the decode

- **Search & mark on a specific data value with Wave Inspector**

- **See decoded & search results data in an Event Table**
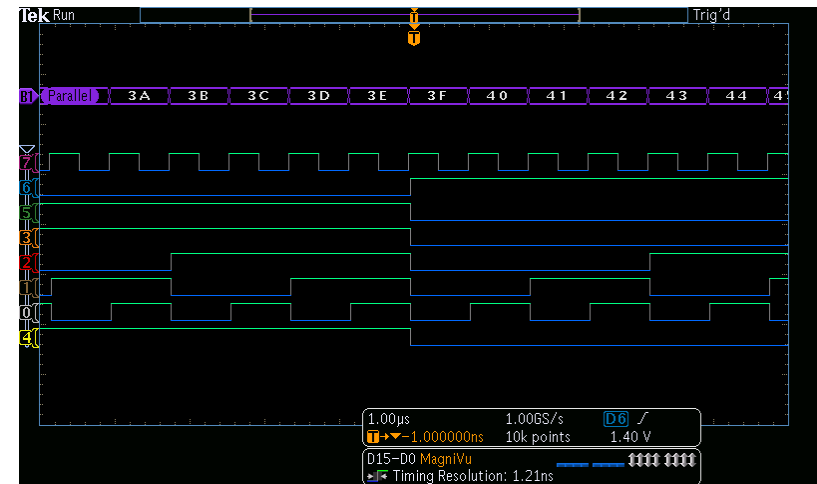
Determine bus values quickly and eliminate errors

Tektronix®

Protocol Analyzer

Tektronix®
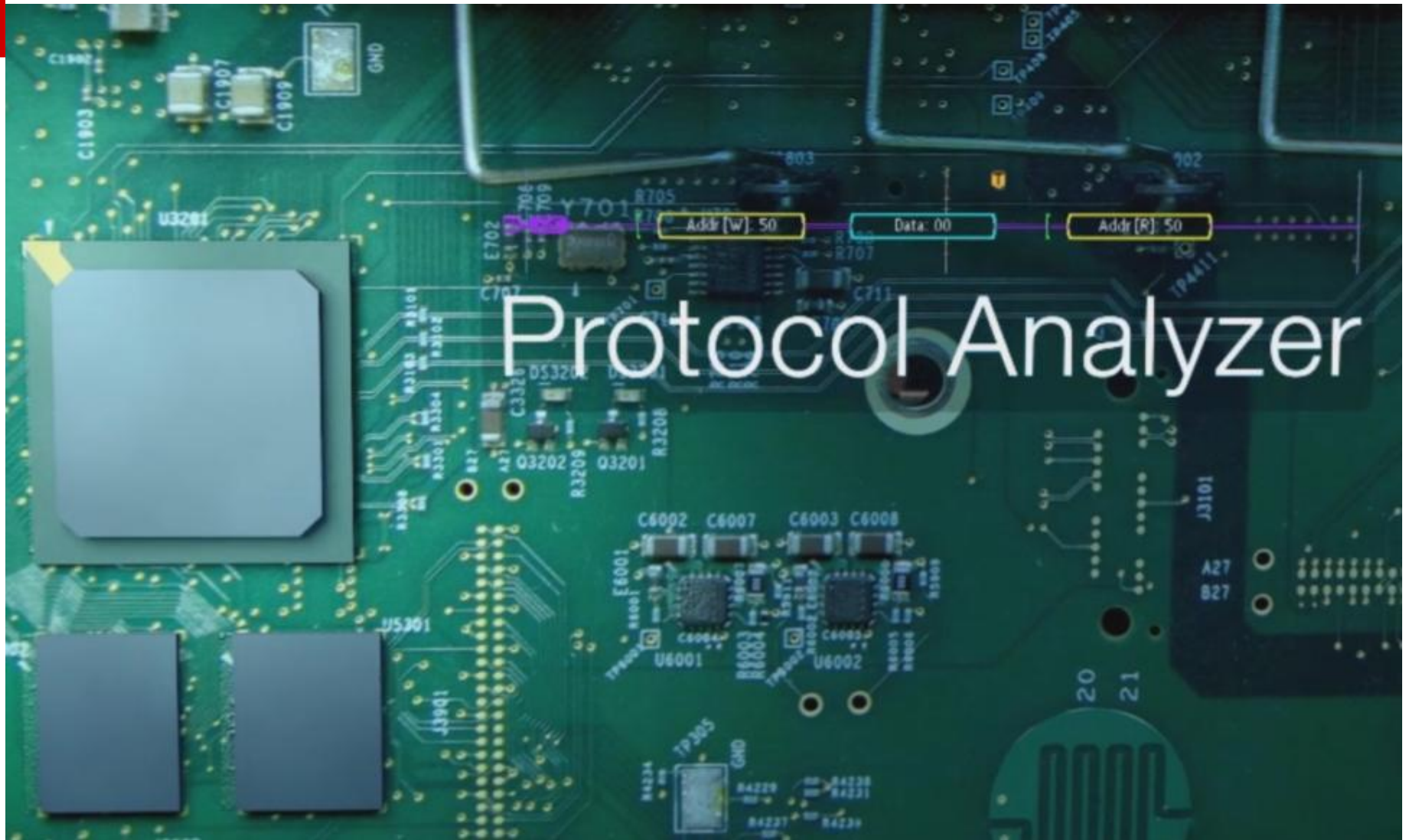
Protocol Analyzer – Banner Specifications

	MDO3104 MDO3102	MDO3054 MDO3052	MDO3034 MDO3032	MDO3024 MDO3022	MDO3014 MDO3012
Oscilloscope Bandwidth	1 GHz	500 MHz	350 MHz	200 MHz	100 MHz
Serial Bus Analysis	**Optiona**l: I^2C, SPI, RS-232/422/485/UART, USB, CAN, LIN, FlexRay, MIL-STD-1553, I^2S/LJ/RJ/TDM				
Bus Decode Radices	Binary, Hexadecimal, Decimal, ASCII				
Number of Buses	Supports two buses simultaneously				

Tektronix®

Serial Trigger, Decode & Search

- Trigger on packet content

- Automatically decode packet content

- Automated search on specific packet content to locate events of interest in seconds
  - Same criteria as trigger
  - *New* search mark table

- Serial analysis standards available
  - I^{2}C, SPI
  - RS-232/422/485/UART
  - CAN, LIN
  - FlexRay
- *New!* – USB 2.0
  - MIL-STD-1553
  - I^{2}S, LJ, RJ, TDM

Ensure you capture and can find all events of interest quickly

Tektronix®

Digital Voltmeter

Tektronix

DVM/Counter – Banner Specifications
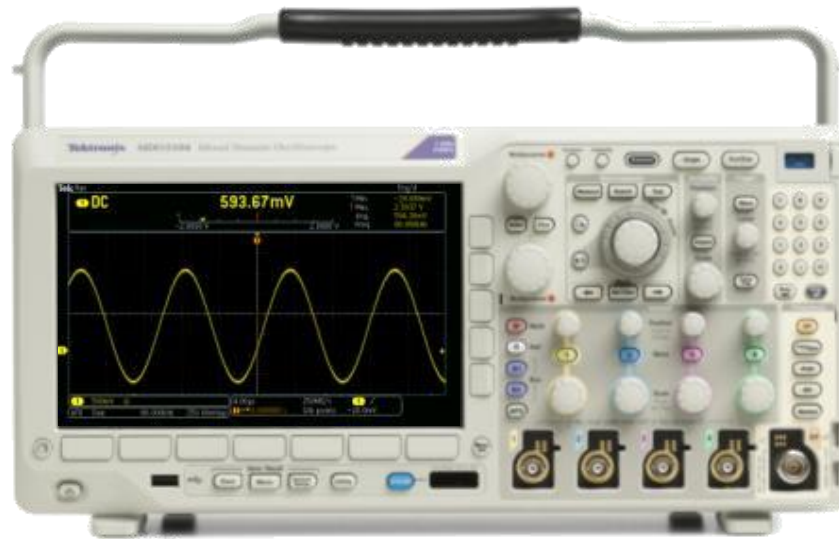
	MDO3104 MDO3102	MDO3054 MDO3052	MDO3034 MDO3032	MDO3024 MDO3022	MDO3014 MDO3012
Oscilloscope Bandwidth	1 GHz	500 MHz	350 MHz	200 MHz	100 MHz
Voltage Measurements	4-digit AC RMS, DC, AC+DC RMS 20 Hz to 10 kHz frequency range (typical)				
Frequency Measurement	5-digit Frequency count 150 MHz maximum input frequency				
Frequency Accuracy	10 ppm				

The DVM/Counter feature will be provided for free for any user who registers their product on www.tektronix.com/mdo3register.

Tektronix

Measurement Types

- Monitor signals while the scope is running or stopped
  - Uses any of the analog scope inputs
  - Free-running & not tied to scope acquisition state

- 4-digit AC RMS, DC, AC+DC RMS voltage measurements

- 5-digit Frequency measurements

- Autoranging of vertical amplification

- Graphical representation of measurement results
  - Minimum
  - Maximum
  - Current Value
  - Five second rolling range of values
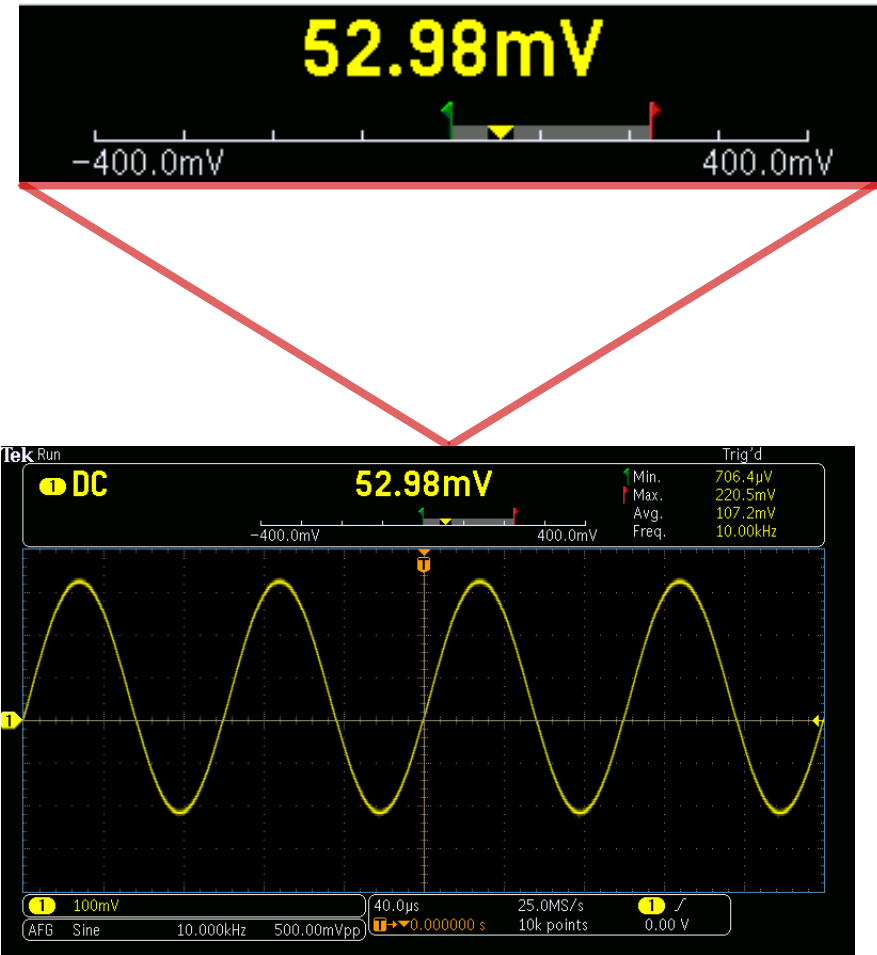
Monitor critical signals at a glance

Tektronix®

MDO3000 Configuration Steps

Tektronix®

Step 1: Select oscilloscope # of channels & bandwidth

Model	Description
MDO3104	(4) 1GHz analog channels, (1) 1GHz RF channel
MDO3102	(2) 1GHz analog channels, (1) 1GHz RF channel
MDO3054	(4) 500MHz analog channels, (1) 500MHz RF channel
MDO3052	(2) 500MHz analog channels, (1) 500MHz RF channel
MDO3034	(4) 350MHz analog channels, (1) 350MHz RF channel
MDO3032	(2) 350MHz analog channels, (1) 350MHz RF channel
MDO3024	(4) 200MHz analog channels, (1) 200MHz RF channel
MDO3022	(2) 200MHz analog channels, (1) 200MHz RF channel
MDO3014	(4) 100MHz analog channels, (1) 100MHz RF channel
MDO3012	(2) 100MHz analog channels, (1) 100MHz RF channel

Tektronix®

Step 2: Configure MDO3000 by adding instrument options

Option	Description
MDO3AFG	(1) Arbitrary function generator
MDO3MSO	(16) Digital channels; includes P6316 digital probe and accessories
MDO3SA	Increase spectrum analyzer input frequency to 9 kHz - 3 GHz
MDO3SEC	Add password protected security to enable or disable all communication ports and firmware upgrades to any MDO3000 Series oscilloscope

Above options are available on each MSO3000 model &
are configured in the factory when ordered with a scope.

Tektronix®

Step 3: Select application modules & accessories

Product	Description
MDO3AERO	MIL-STD-1553 serial bus triggering and analysis module for the MDO3000
MDO3AUDIO	Audio serial triggering and analysis module for the MDO3000
MDO3AUTO	Automotive serial triggering and analysis module for the MDO3000 (CAN, LIN)
MDO3COMP	Computer serial triggering and analysis module for the MDO3000 (RS-232/422/485/UART bus support)
MDO3EMBD	Embedded serial triggering and analysis module for the MDO3000 (I^2C, SPI)
MDO3FLEX	FlexRay serial triggering and analysis module for the MDO3000
MDO3USB	USB2.0 (LS, FS) serial bus triggering and analysis and (HS – 1GHz models only) analysis module for the MDO3000
MDO3LMT	Limit/mask test for MDO3000
MDO3PWR	Power measurement package for the MDO3000

Product	Description
ACD3000	Soft case – includes protective front panel cover
HCTEK4321	Hard transit case
RMD3000	Rack mount kit
TPA-BNC	TekVPI to TekProbe BNC adapter
TPA-N-PRE	9 kHz – 6 GHz Preamp for spectrum analyzer input
TPA-N-VPI	N-to-TekVPI adapter

| Product	Description
TEK-USB-488	GPIB-to-USB adapter
067-1686-00	Power measurement deskew and calibration fixture
TEK-DPG	Pulser accessory for deskew fixture
119-4146-00	Near field probe set, 100 kHz – 1 GHz
119-6609-00	Flexible monopole antenna

Tektronix

Step 4: Select additional probes

Product	Description
Passive Voltage	
TPP1000	1 GHz, 10x, 300Vrms, 4pF *One per channel included with 1 GHz models*
TPP0500B	500 MHz, 10x, 300Vrms, 4pF *One per channel included with 350 MHz and 500 MHz models*
TPP0250	250 MHz, 10x, 300Vrms, 4pF *One per channel included with 100 MHz and 200 MHz models*
TPP0502	500 MHz, 2x, 300Vrms, 12.7pF
Active Voltage	
TAP1500	1.5 GHz, 10x, 8V, 1pF
TAP2500	2.5 GHz, 10x, 4V, 0.8pF
High Voltage	
TPP0850	800 MHz, 50x, 2.5kV
P5100A	500 MHz, 100x, 2.5kV

Product	Description
High Voltage Differential	
TMDP0200	200 MHz, 25x/250x, ±75V/±750V diff
THDP0200	200 MHz, 50x/500x, ±150V/±1,500V diff
THDP0100	100 MHz, 100x/1000x, ±600V/±6,000V diff
High Speed Differential	
TDP0500	500 MHz differential active FET, ±42V
TDP1000	1 GHz, differential active FET, ±42V
Micro Volt Probes	
ADA400A	100x, 10x, 1x, 0.1x high gain differential amplifier
AC/DC Current	
TCP0020	50 MHz, 20A
TCP0030A	DC to 120 MHz, 30A
TCP0150	DC to 20 MHz, 150A

Tektronix®
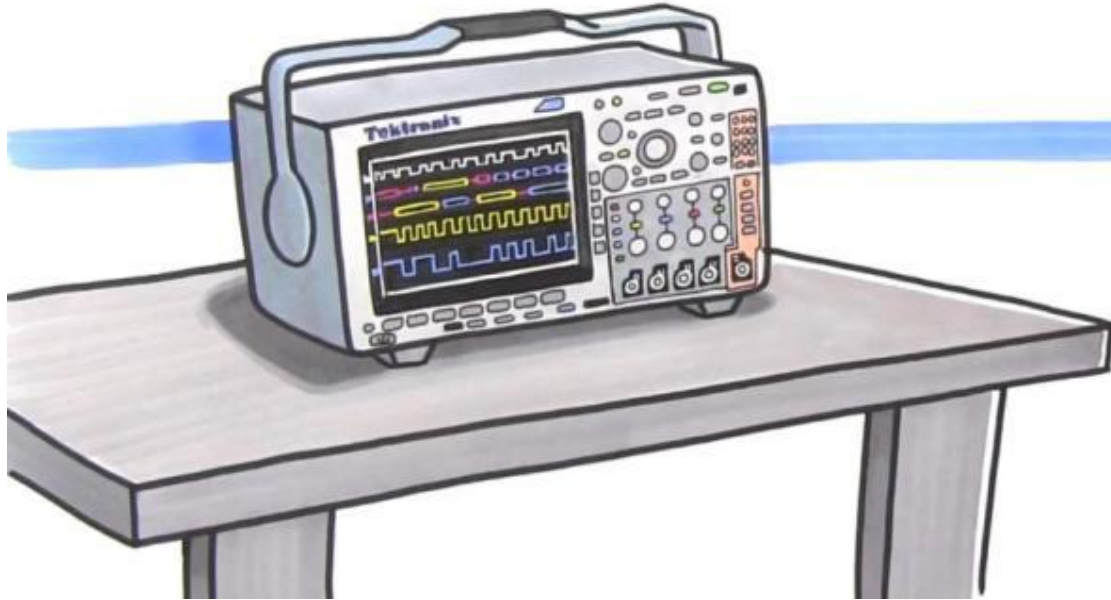
A Fully Upgradeable Platform that Grows with You as Your Measurement Needs Change

Bandwidth Upgrades
100MHz, 200MHz, 350MHz, 500MHz, 1GHz
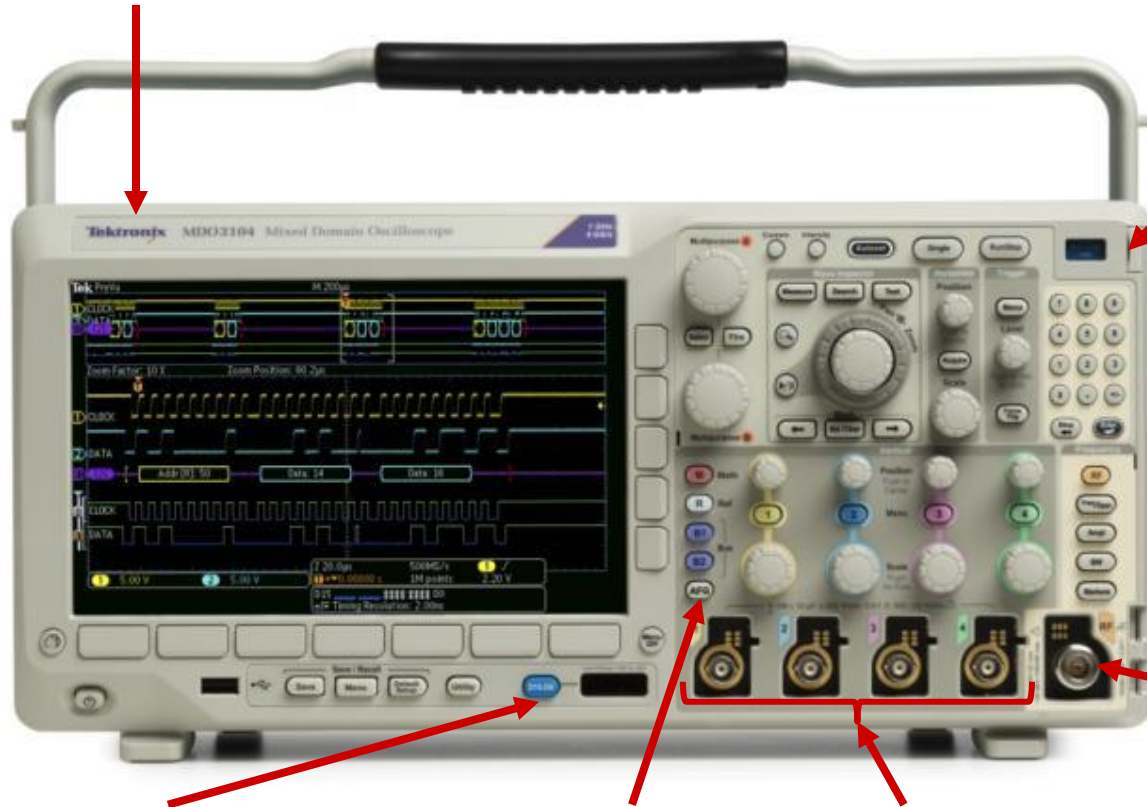
Analysis Upgrades

MDO3xxx: Serial bus trigger and analysis application modules

MDO3PWR: Power Measurements

MDO3LMT: Limit/Mask test

Spectrum Analyzer Frequency Range Option/Upgrade
MDO3SA: Increase spectrum analyzer input range to 9kHz – 3GHz

MSO Option/Upgrade
MDO3MSO:
16 digital channels

AFG Option/Upgrade
MDO3AFG: Arbitrary Function Generator

Digital Voltmeter
Free with product registration

Tektronix®

MDO3000 Series Post-Purchase Upgrades

- Increase MDO3000 performance & add functionality

- Increase performance*
  - Bandwidth upgrades – increase analog bandwidth and spectrum analyzer input frequency
  - Increase spectrum analyzer input frequency to 3 GHz

- Add functionality*
  - One-time permanent upgrades
    - AFG
    - MSO
    - Enhanced security

  - Application modules
    - Serial bus analysis
    - Power measurements
    - Limit/mask test

*Single-use one time functionality upgrade

Traditional application modules

Tektronix®

Tektronix Mixed Domain Oscilloscope Families

The *ONLY!* oscilloscopes with integrated spectrum analyzers

MDO3000

– 4 & 2 channel models
– Integrated AFG
– Integrated DVM
– Higher waveform capture rate
– 75Ω / Video support
– Upgradeability
– Smaller form factor

MDO4000B

– Bigger display
– Longer record length
– Need 3 or 4 buses
– Better RF performance
– Higher RF frequency coverage (6 GHz)
– Simultaneous time & frequency domains
– Vector signal analysis

Tektronix®

Additional Resources

- www.tektronix.com/mdo3000
  - Virtual Demo
  - Product Videos
  - Application Videos
  - Application Notes
  - Datasheet

- Onsite Seminars
  - We customize for you!

- YouTube channel
  - Tektronix Support with > 60 videos
    - http://www.youtube.com/channel/UCAzy_-kKC2PJHLc1CekiwTg

MDO3000 Mixed Domain Oscilloscope

Tektronix®

Thank You!

Contact Tektronix for More Information

Tektronix®