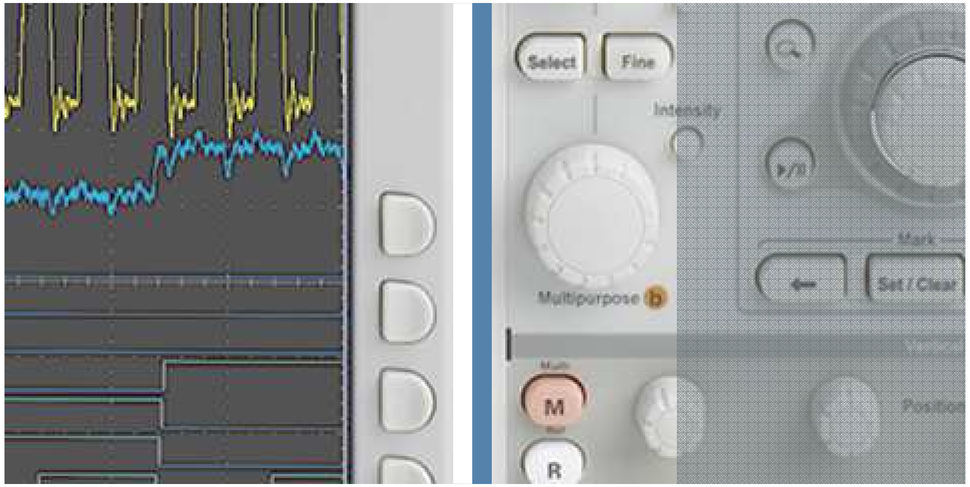
Critical Considerations for Probing



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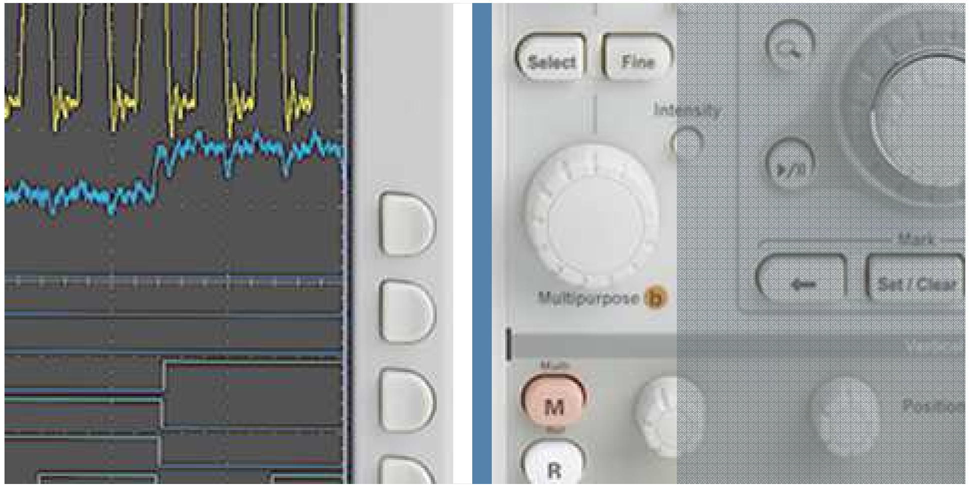
Agenda

- Types of Probes
- Probe Selection Criteria
- How Probes Affect Your Measurement
- Choosing a Probe

Types of Probes



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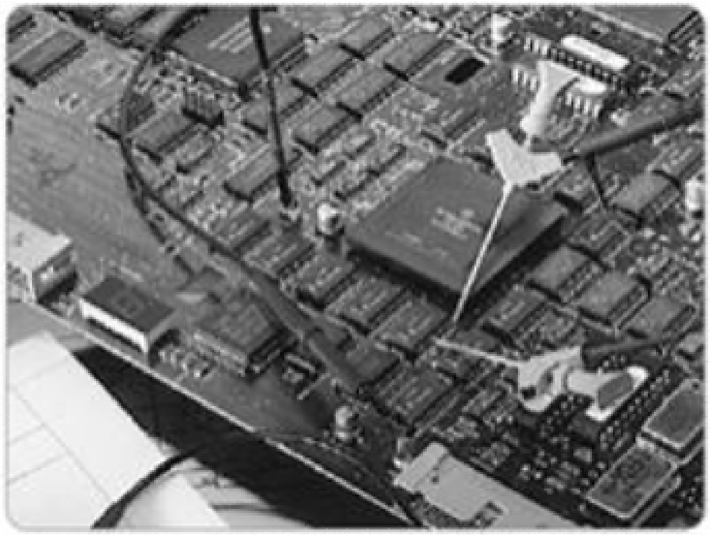
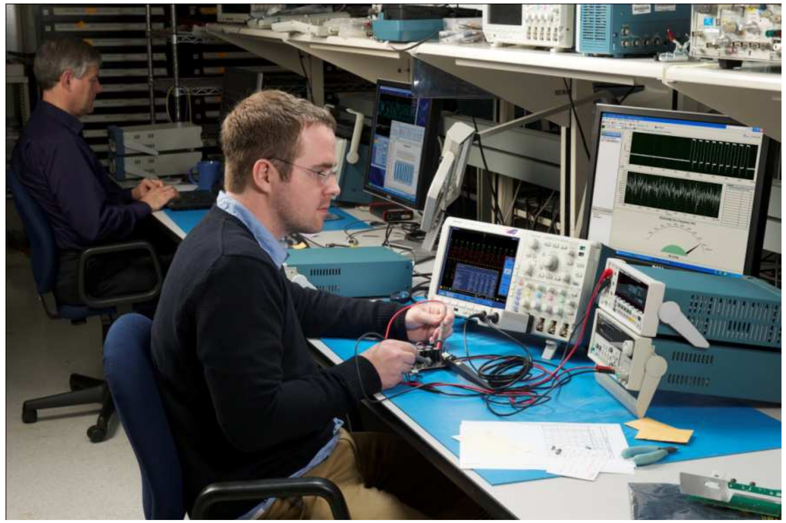
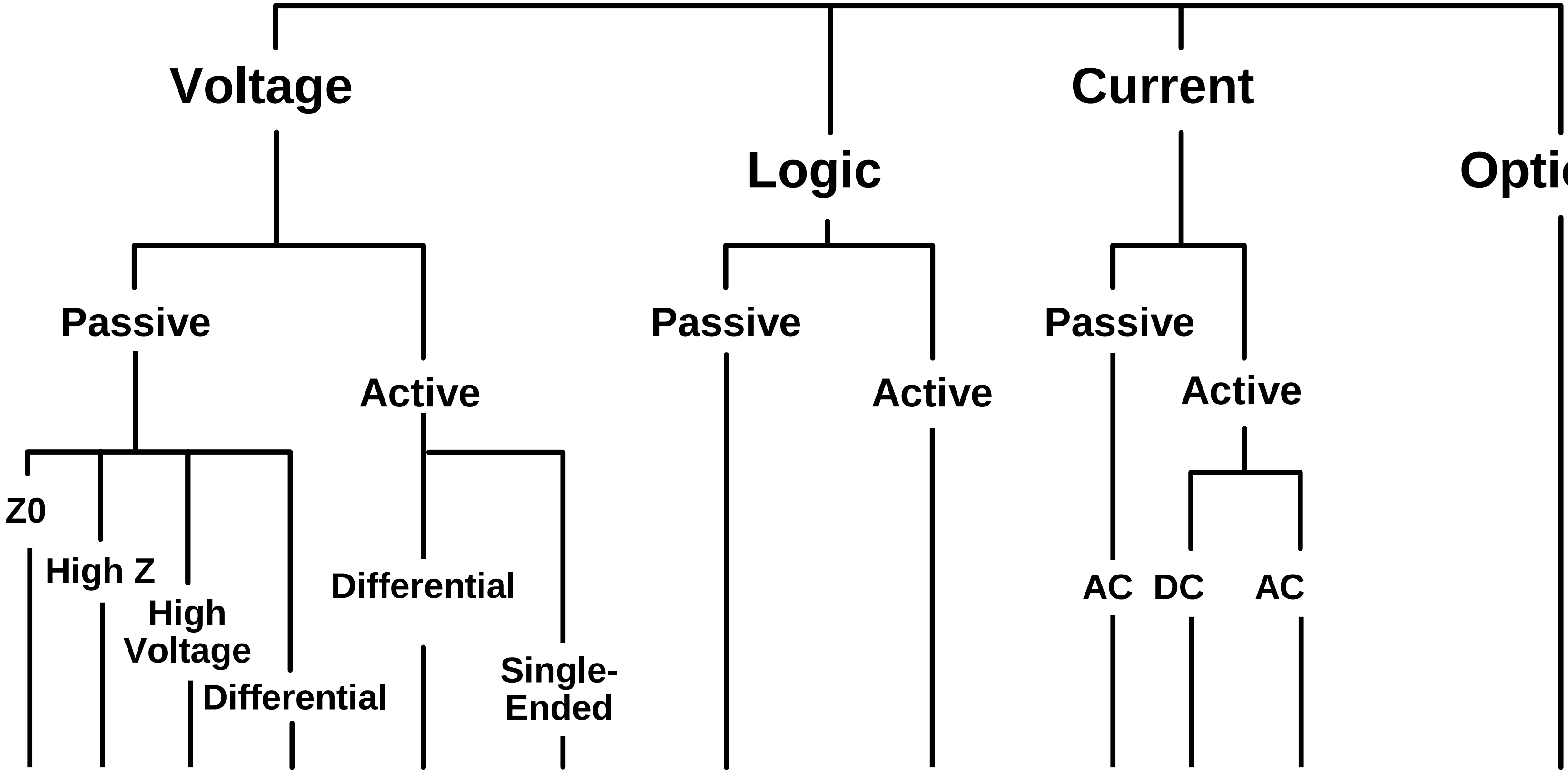
Probes: Critical Elements of the Measurement System

- The oscilloscope probe makes the physical and electrical connection between the circuit and the oscilloscope.
- The correct probe is critical to measurement quality.
- A poor choice will result in incorrect or misleading measurements.
- There are three defining characteristics for choosing the right probe:
  - Physical attachment (Connectivity)
  - Minimum impact on circuit operation (Signal Loading)
  - Quality signal transmission to the oscilloscope (Measured Response)



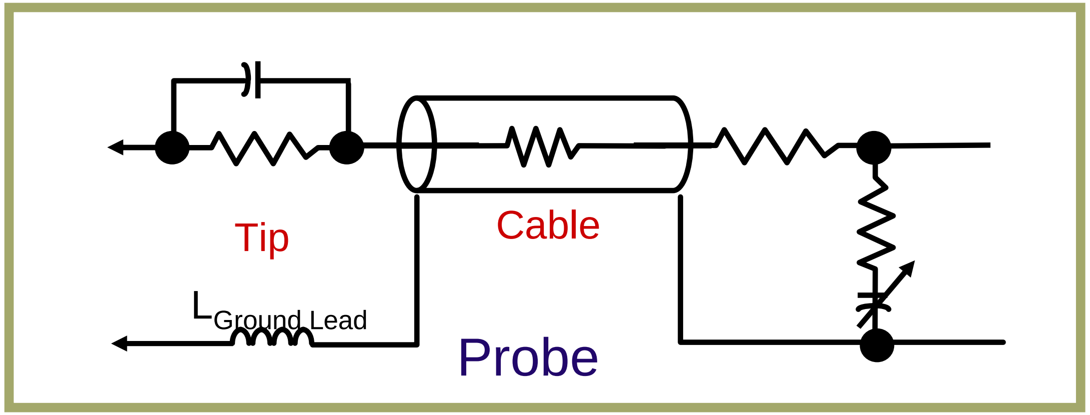


Basic Probe Types



Passive Voltage Probes

- Most basic probe with no active components
- Available in 1X, 2X, 10X, 100X and switchable
- Advantages
  - Inexpensive
  - Mechanically Rugged
  - Wide Dynamic Range
  - High Input R
- Disadvantages
  - High Input C
  - Inductance of long ground lead

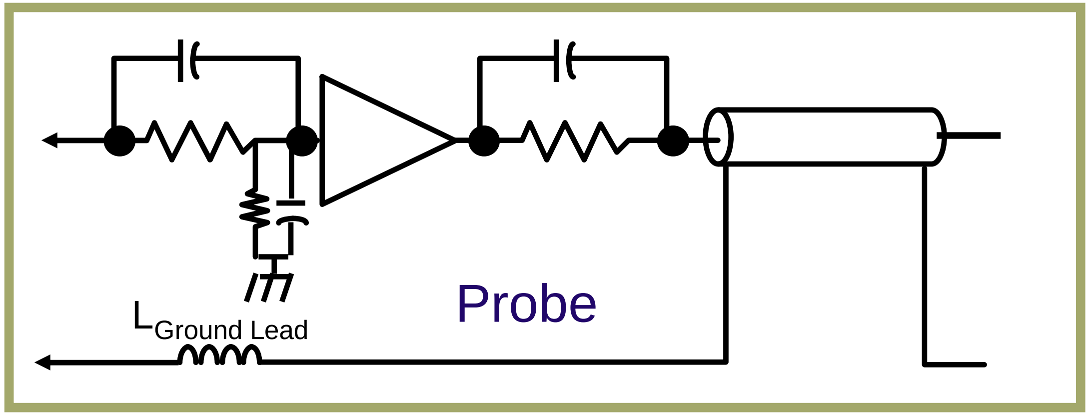


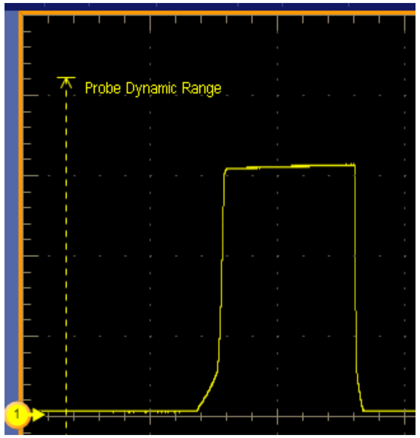
Tektronix P2220 Probe
1/10X, 200 MHz

Active Voltage Probe

- Uses active components
- Advantages
  - Low Input C
  - Wide Bandwidth
  - High Input R
  - Better Signal Fidelity
- Disadvantages
  - Higher Cost
  - Limited Dynamic Range
  - Mechanically Less Rugged

Tektronix TAP1500
Active Voltage Probe
10X, 1.5 GHz





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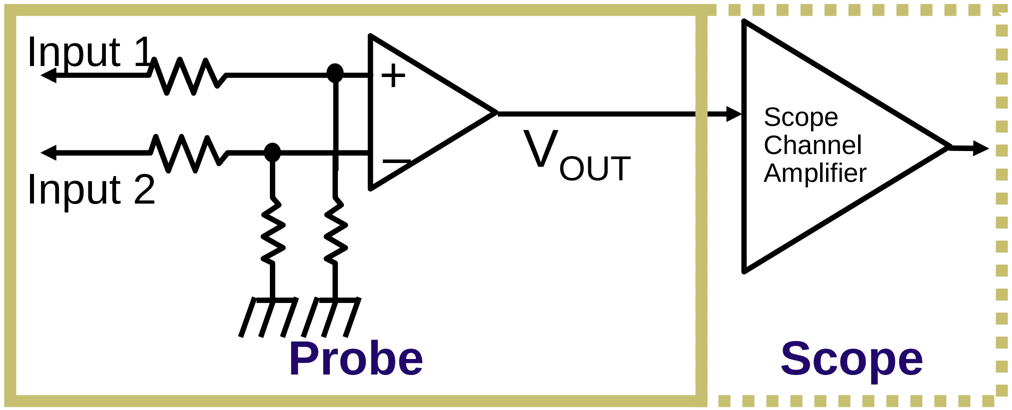
Differential Active Voltage Probes

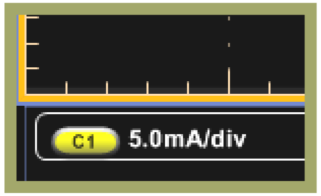
- Differential Probes measure signals that are referenced to each other instead of earth ground.
- Advantages
  - Wide bandwidth
  - Large Common Mode Rejection Ratio (CMRR)
  - Minimal skew between inputs
  - Small input capacitance



Tektronix TDP0500 and TDP1000 Differential Probe
500 MHz or 1 GHz, 42V

Current Probes

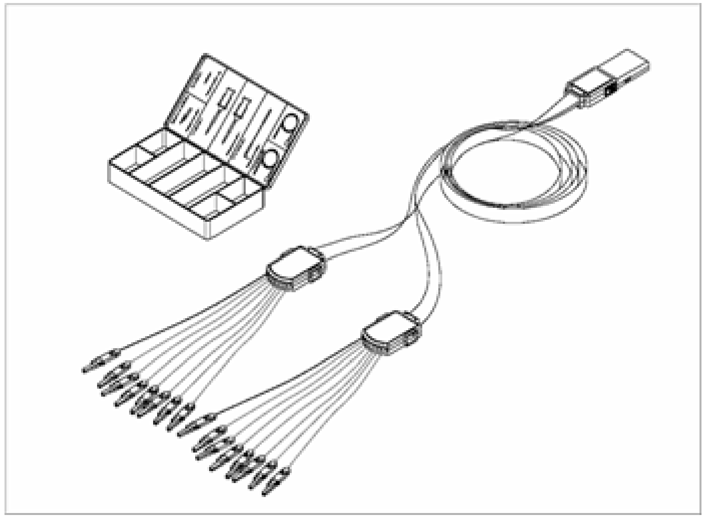
- Measures the electromagnetic flux field around a conductor to determine the current flow
- Two Major Types:
  - AC current probes (passive)
  - AD/DC current probes (active)
- Features to Consider:
  - Automatic scaling and units
  - Split-core vs. fixed-core connection to the device



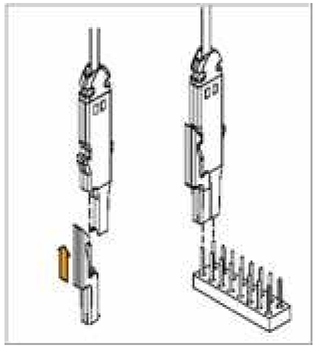
Tektronix TCP0150
AC/DC Current Probe
150 A, DC to 20 MHz

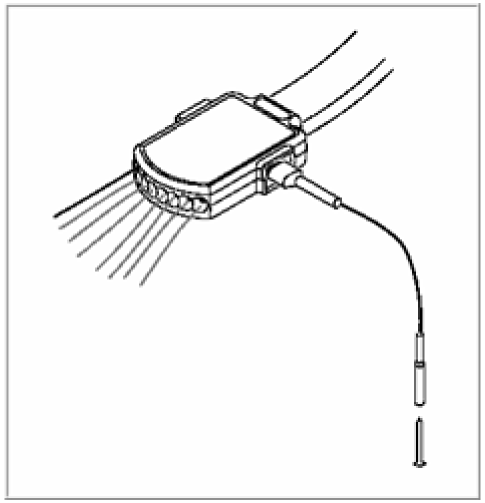
Logic Probes

- The MSO4000B Series Oscilloscope offers 16 digital channels
- Recommend the P6616 digital probe:
  - 16 Channels, 2 Groups of (8) channels
  - First coax in each group is colored blue for easy identification
  - Standard automotive spade connection for the common ground
  - 3 pF loading



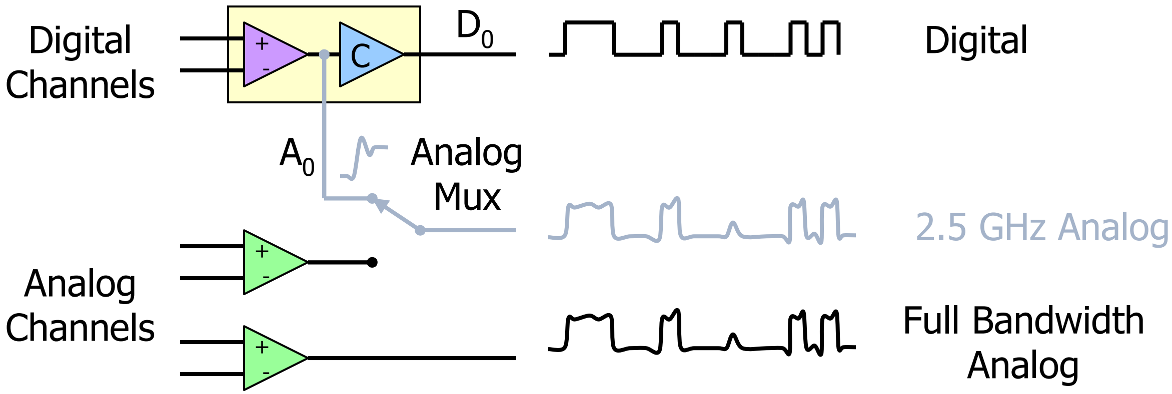
Tektronix P6616



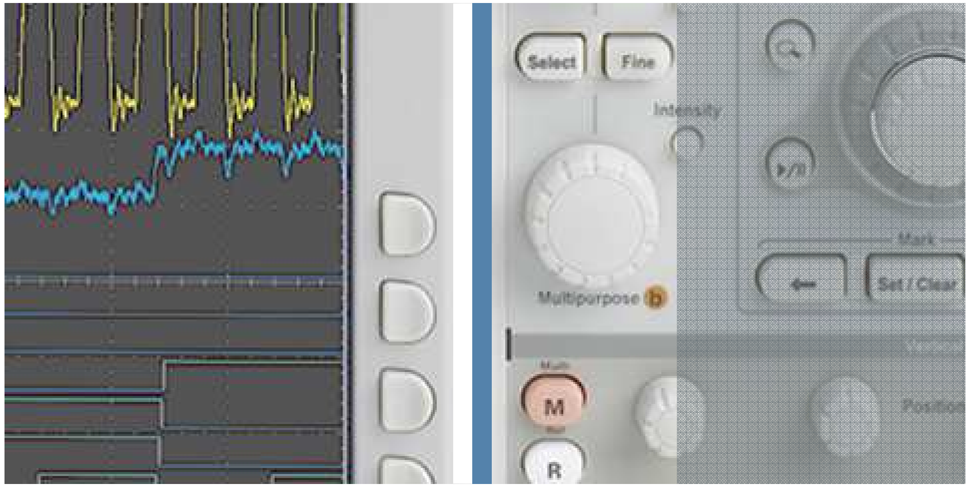


iCapture™ - One Connection for Analog and Digital

- **iCapture™ (Analog Mux)**
  - Acquire digital channels with digital time resolution (80ps)
  - Simultaneously route any (4) digital channels to analog channels
    - Validate signal connection
    - Check signal integrity
    - Validate logic threshold
    - Improve timing resolution



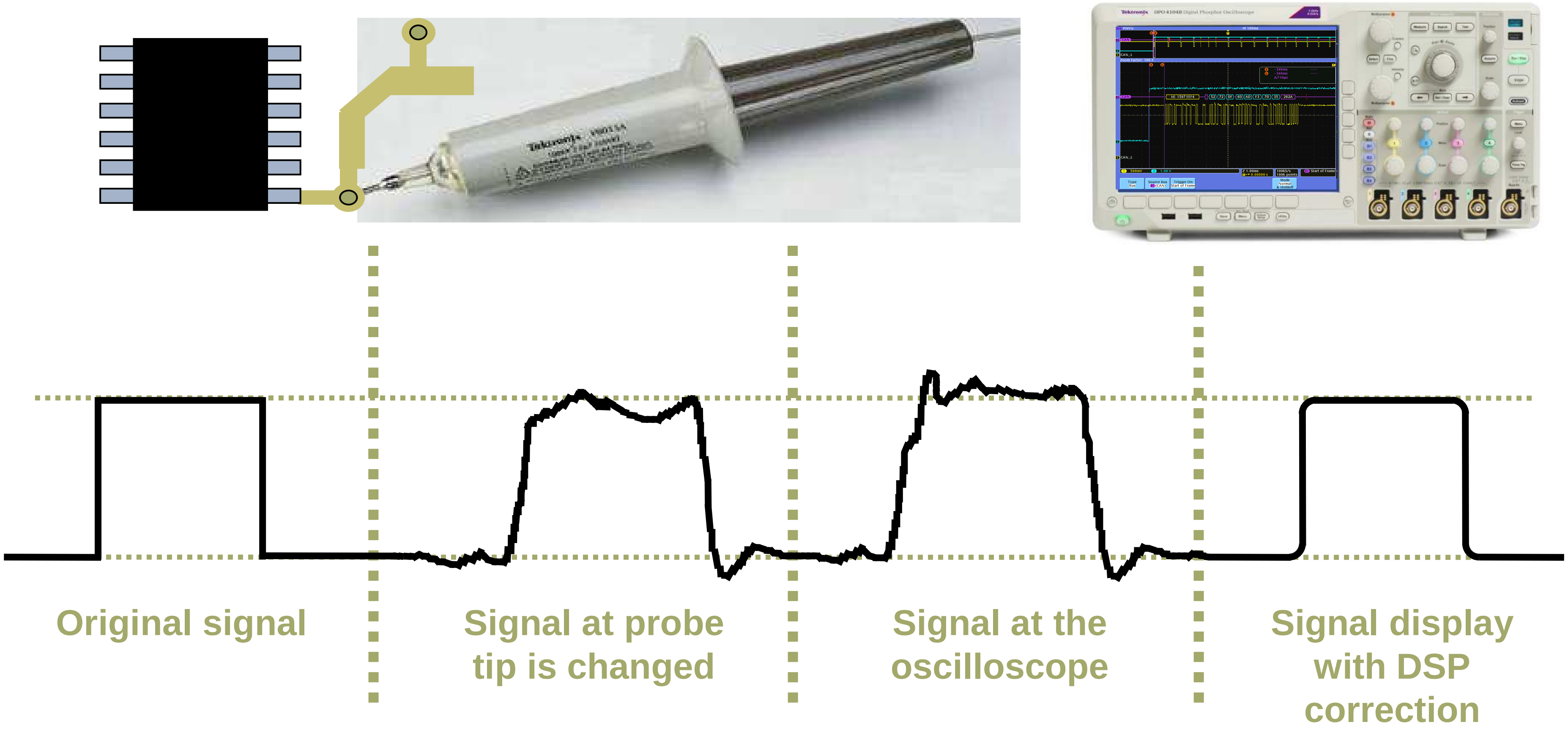
Probe Selection Criteria



What is Your Probe Selection Process?

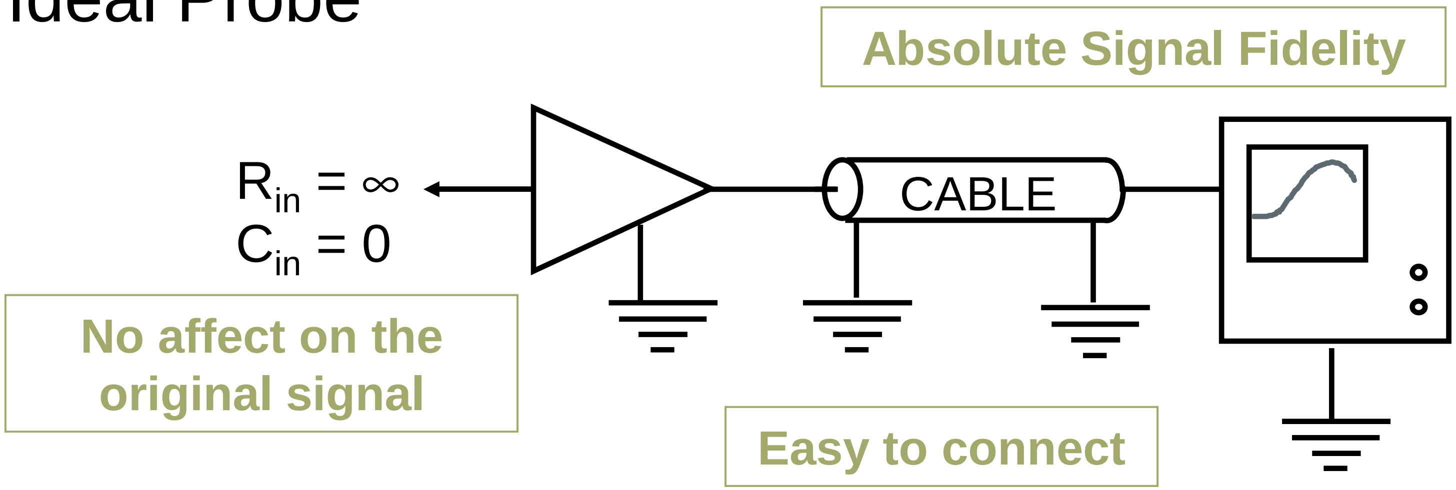
- The first one you spot in a drawer
- Distract a co-worker and take theirs

What is Your Probe Selection Process?



Deliver a Signal to the Scope with Good Fidelity

The Ideal Probe

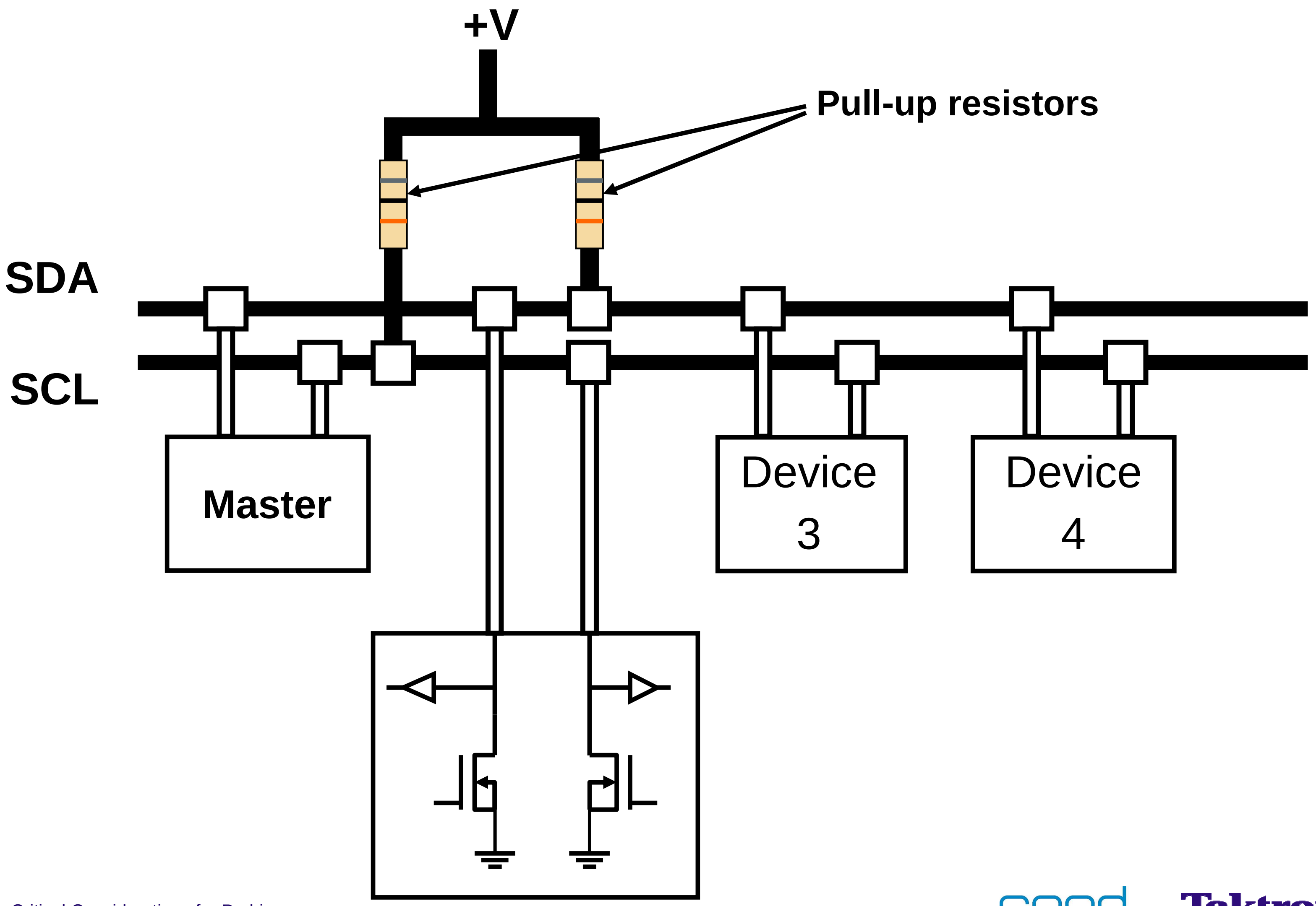


- **No affect on the original signal – *No signal source loading!***
  - Zero Input Capacitance
  - Infinite Input Resistance
- **Absolute Signal Fidelity**
  - Unlimited bandwidth “zero to infinity”
  - Unlimited rise time “instant – 0 s”
  - Zero attenuation “one-to-one”
  - Linear phase across all frequencies
- **A convenient and easy way to connect to the device-under-test**
  - Mechanically well suited to application

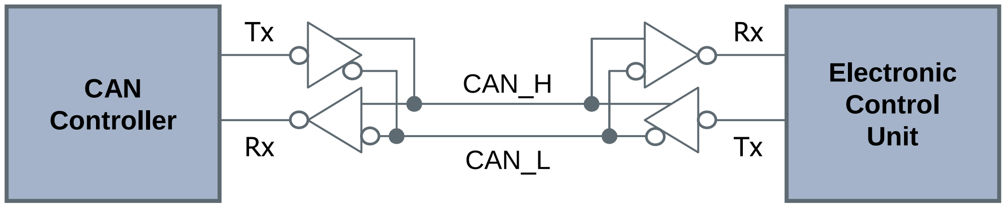
The Measurement System (Scope ***and*** Probe)

- No easy formula to calculate Measurement System specifications
- Tektronix provides specifications for scope & probe combinations
- For best results, use the probes recommended for your scope

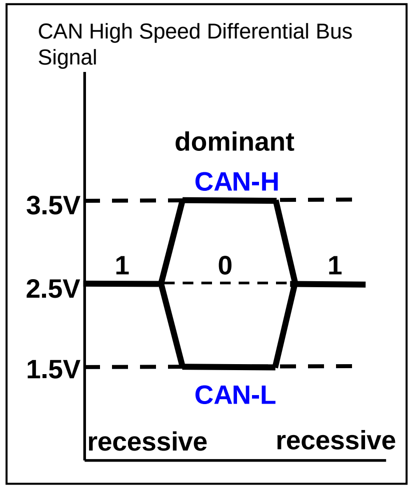
I²C (Physical Part)

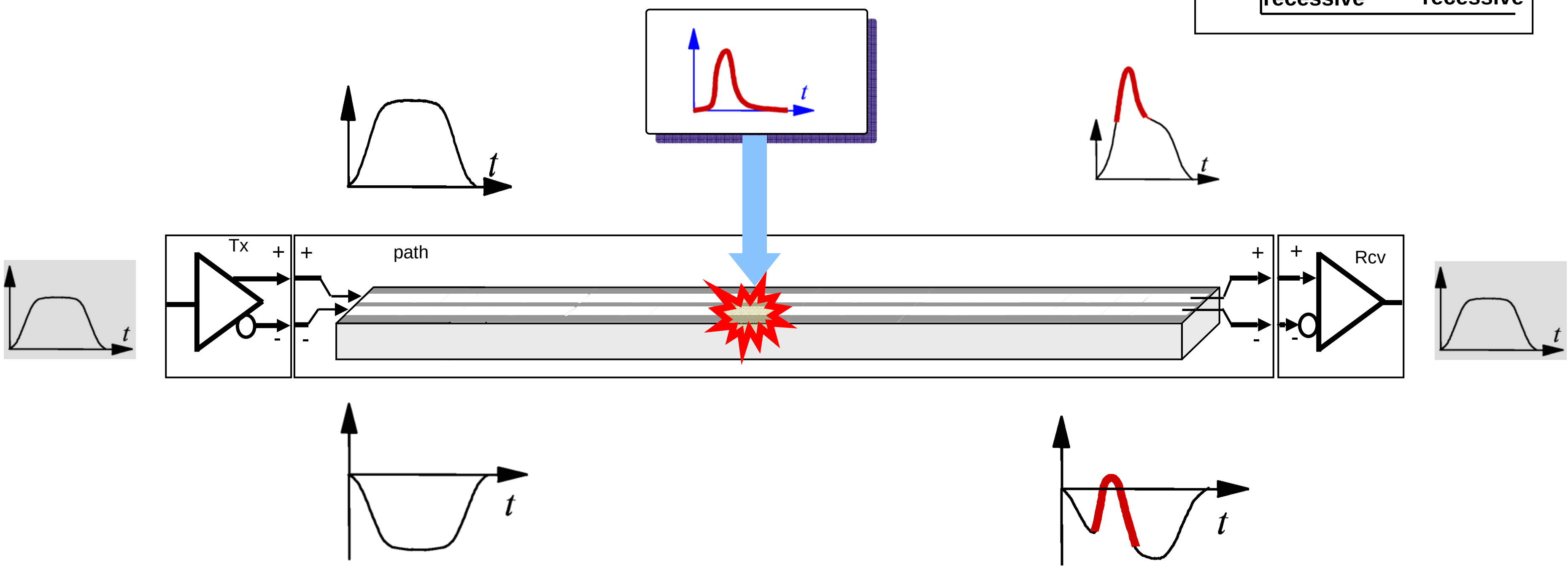


CAN is a differential BUS



CAN Physical Layer

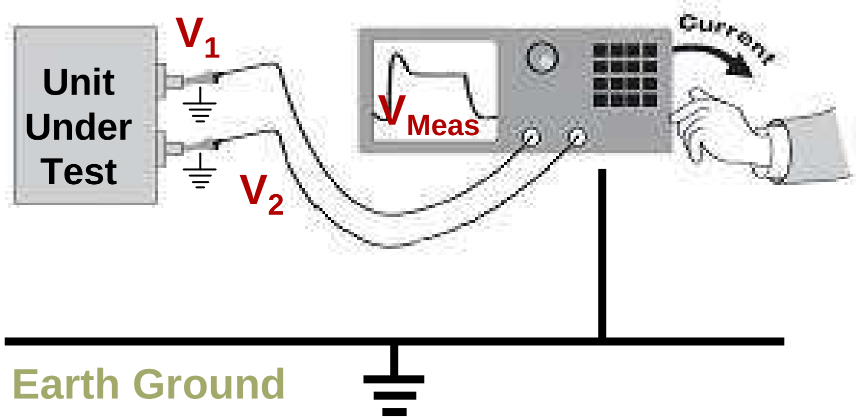




Differential & Floating Measurements

- A differential measurement is the difference in voltage levels between two input signals.
- For a floating measurement, neither input is at ground potential.

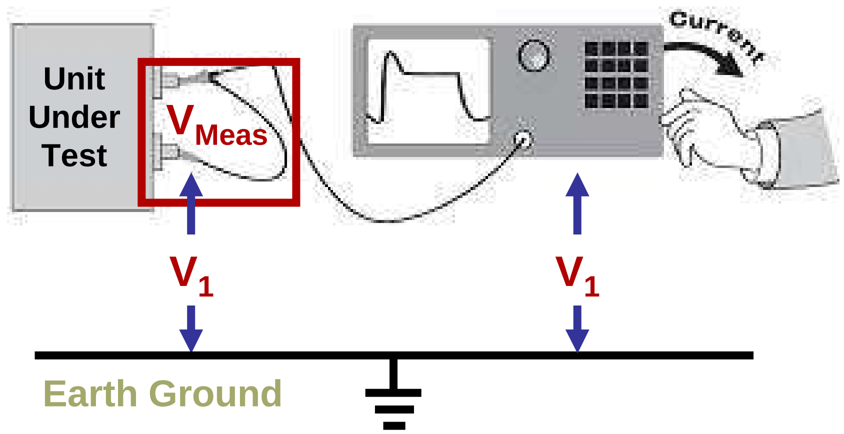
Differential Measurement



V_1 = Single-ended Measurement
V_2 = Single-ended Measurement

$V_{MEAS} = V_1 + \text{Inverse}(V_2)$

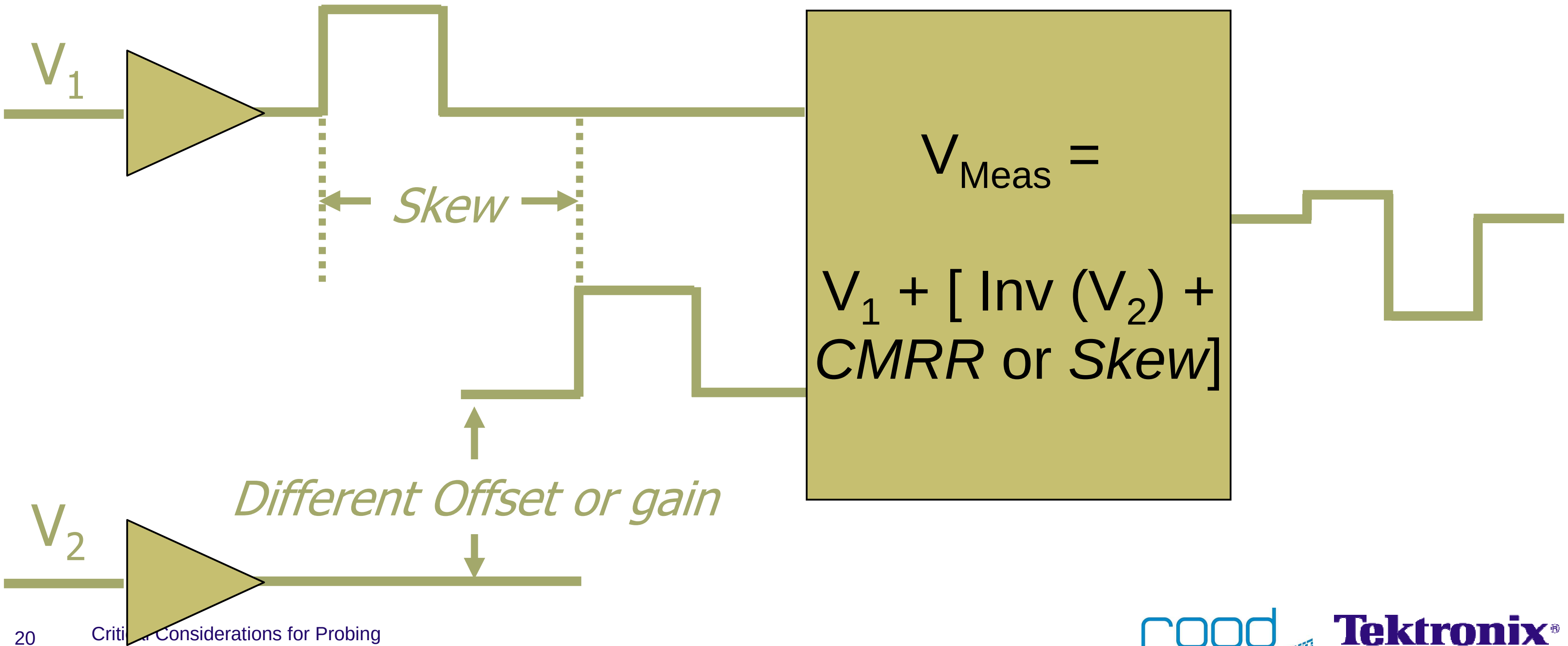
Floating Measurement



V_{Meas} = Measured Voltage between 2 probed points
V_1 = Offset Voltage above true ground

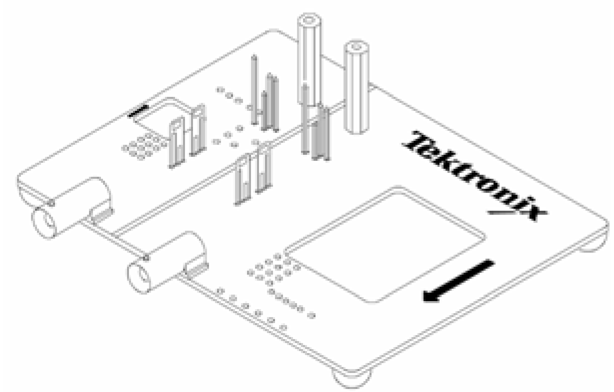
Differential Measurements with Single-ended Probes

- Poor CMRR
  - Inaccurate measurement (combination of offset and gain)
  - Noisier measurement
- Skew
  - Amplitude and timing errors

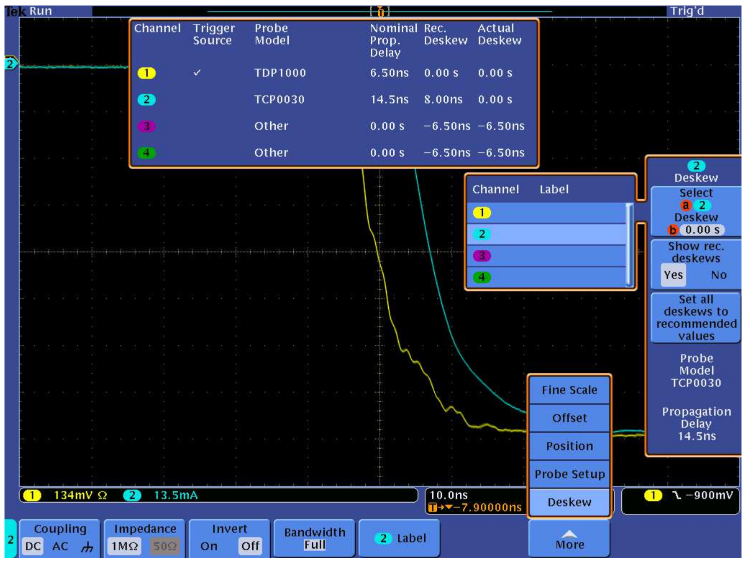


Deskew is a Source of Error

- Deskew is important when measuring:
  - Pseudo-differential (CH1 + (Inv (CH2))
  - Timing/Propagation Delay
- Include Probe adapters in deskew adjustment
- If possible, use the same probe family



Deskew Fixture



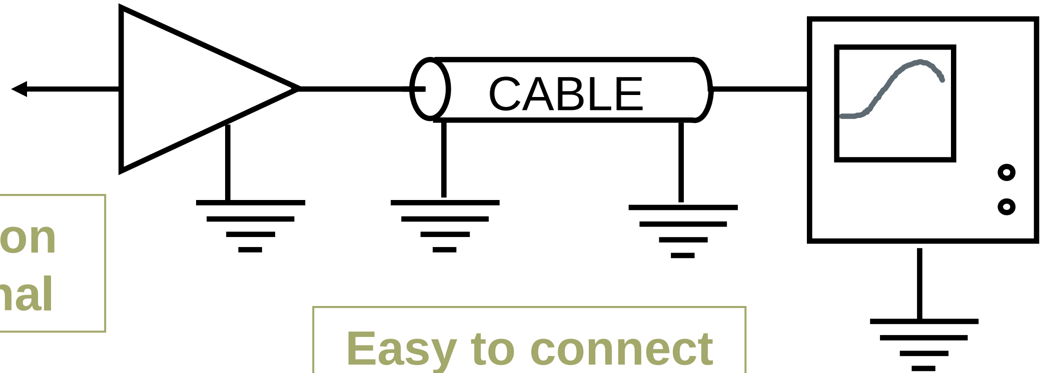
Result of "Floating" Measurements with Ground Connection

How Probes Affect Your Measurement

Probes Will Affect Your Measurement

- Signal Source Loading
  - Measurement system's impedance is critical
    - Input Resistance
    - Input Capacitance
    - Inductance
- Signal Fidelity
  - Measurement system parameters also crucial
    - Bandwidth
    - Rise Time

Good Signal Fidelity

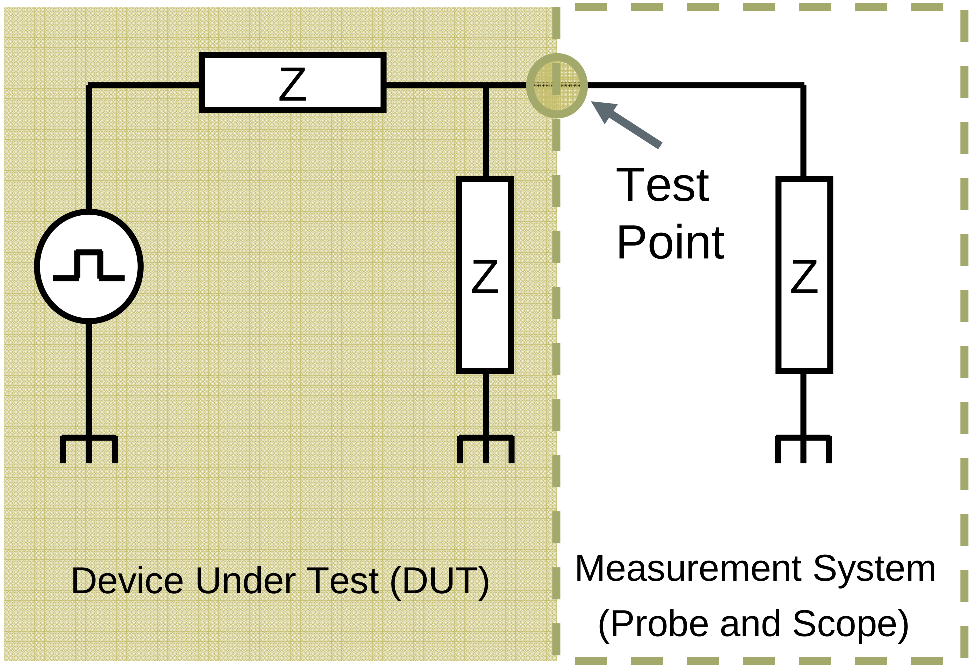


Minimize affect on the original signal

Easy to connect

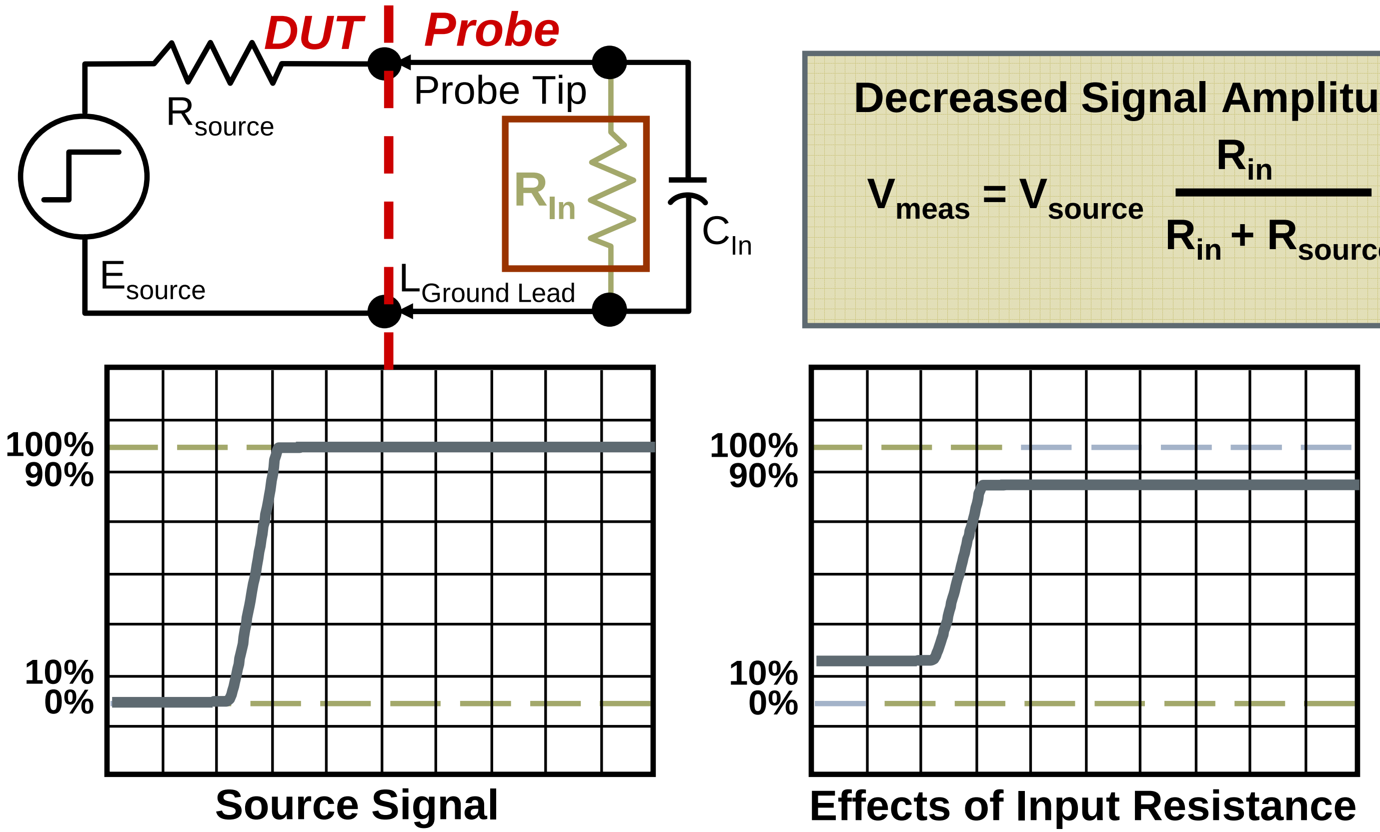
Signal Source Loading

- When the probe is connected to the DUT, the probe will draw some current.
- The impedance values of the probe and scope will affect the measured signal.
- The Measurement System impedance **(Z)** consists of:
  - Resistive Elements (Resistance, R)
  - Reactive Elements (Capacitance, C and Inductance, L) which vary over frequency
- Good probe design uses R, L, and C elements to influence signal fidelity, attenuation, and source loading over specified frequency ranges.



Source Loading – Input Resistance

- R_{in} acts like a voltage divider
- Higher input resistance – less loading
- Lower source resistance – less loading

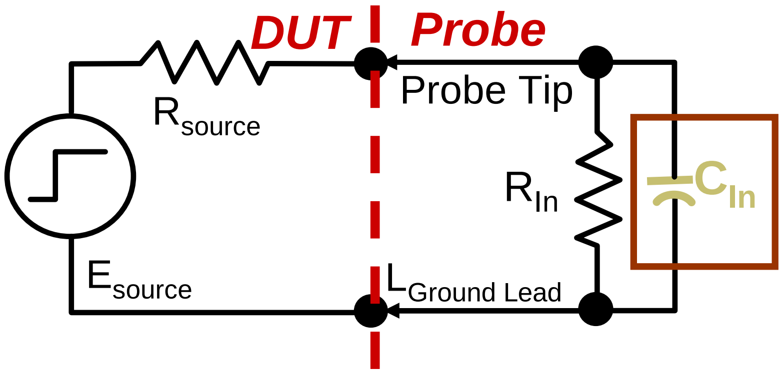


Decreased Signal Amplitude

$$V_{meas} = V_{source} \frac{R_{in}}{R_{in} + R_{source}}$$

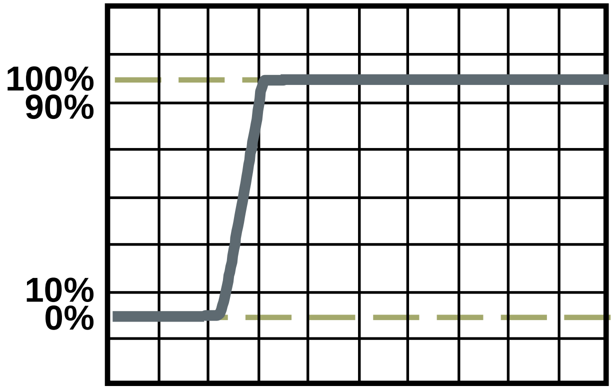
Source Loading – Input Capacitance

- Smaller input capacitance - higher probe impedance, less loading
- As signal frequency increases, capacitance increases and loading increases

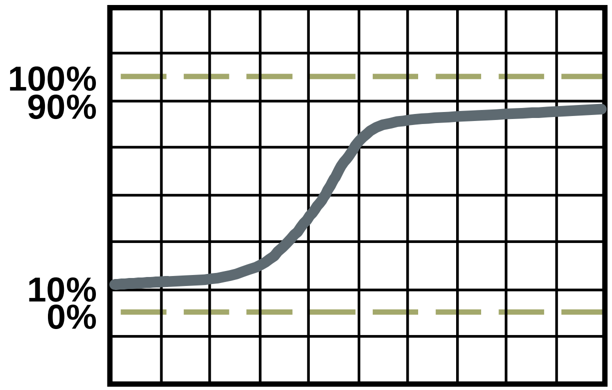


•Decreased Amplitude
•Phase Change
•Slower Rise Time

$$t_r \simeq 2.2(R_{source} \times C_{in})$$



Source Signal



Effects of Input Capacitance

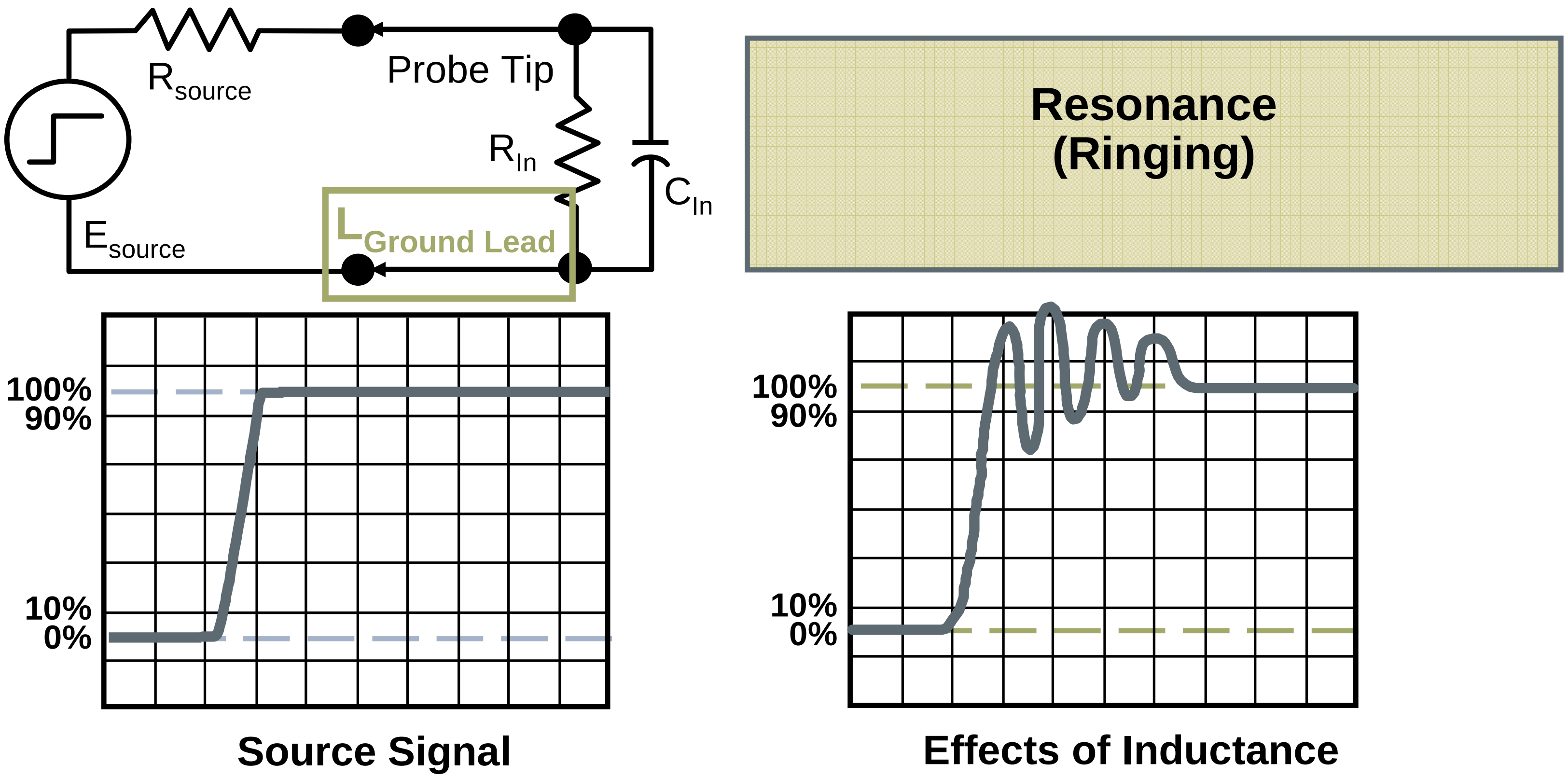
<u>Example:</u>
C_{in} = 100 pF
t_r ~ 220 nsec

C_{in} = 10pF
t_r ~ 22 nsec

If R_{source} = 1 kΩ

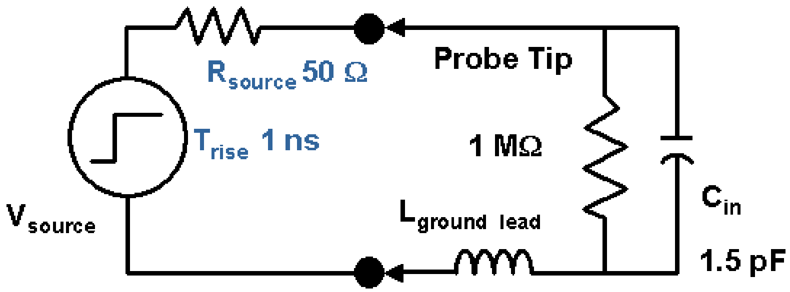
Source Loading - Inductance

- The longer the ground lead, the higher the probe inductance.
- Keep ground leads as short as possible to avoid ringing!



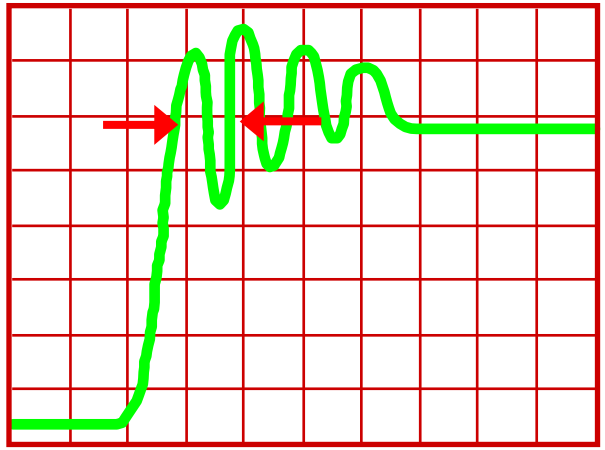
Resonance:
How Does Added Inductance Affect the Measurement?

T_{rise} of 1 ns ~ 350 MHz BW Equivalent



0.05 - 0.1 μH
(combined typical)

For a 10X Active Probe with C_{in} = 1.5 pF and a 6"Ground Lead



Ring Frequency Using a 1.5 pF Input Capacitance 10X High Z Active Probe and 6" Ground Lead.

$$\text{Ring Frequency} = \frac{1}{2\pi\sqrt{LC}} = \boxed{350\text{ MHz}}\ \boxed{\text{to}}\ \boxed{500\text{ MHz}}$$

Calculating Resonant Frequency

$$\textbf{Resonant Frequency} = \frac{1}{2\pi\sqrt{LC}}$$

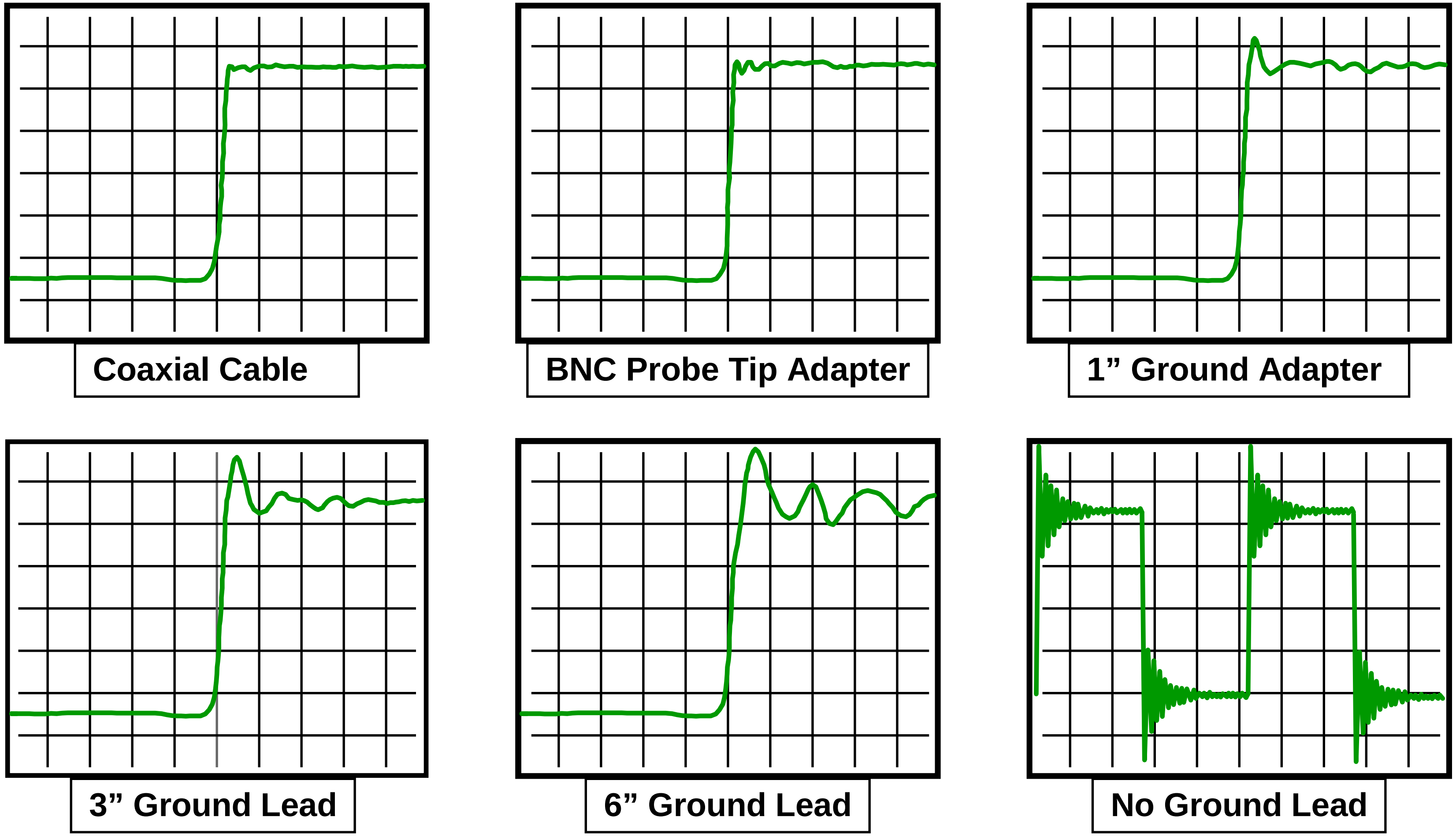
In practice, the resonant frequency should be >5 times the signal's BW equivalent based on rise and /or fall times. This gives a guideline to the maximum inductance (or maximum allowable probe-connection loop.)

<u>Rules of Thumb</u>:

L ≈ 20 nH/inch for typical lead lengths around 0" - 3" (probe tip and ground lead)

C ≈ Probe rated C plus 1 to 2 pF/inch of added lead length (probe tip)

Probing Tips and Tricks:
Ground Lead Length Effects



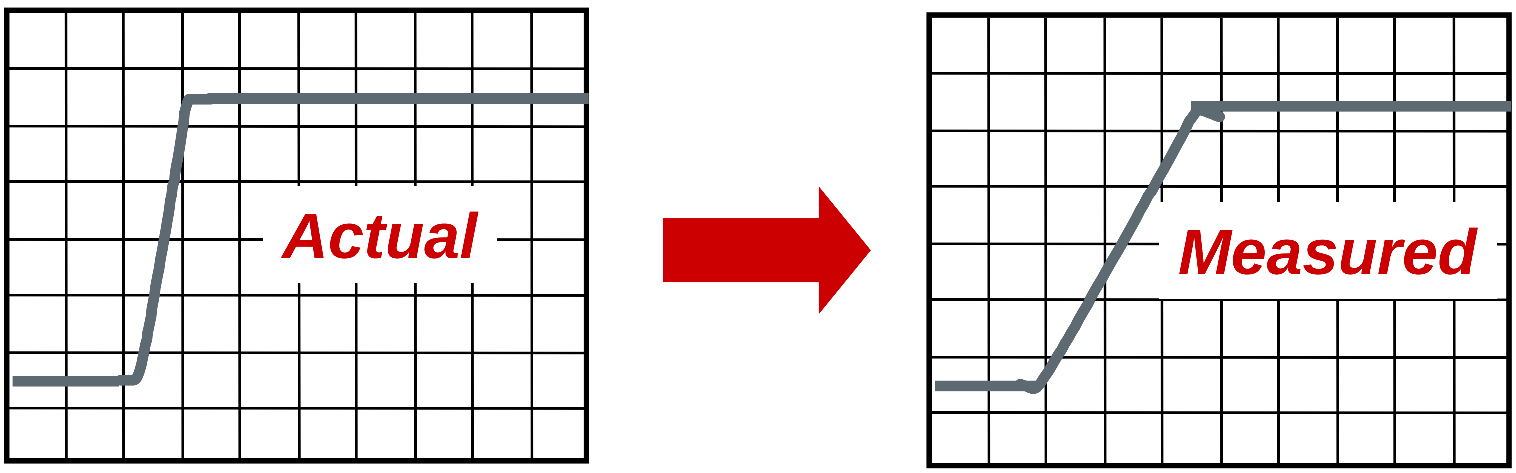
Signal Fidelity – Rise Time

- Insufficient rise time also affects the signal
- To accurately characterize your signal, follow the ***1/5th Rule***

$$T_{r,\ system} < \frac{T_{r,signal}}{5}$$

- Measured rise time depends on the signal ***and*** scope rise times

$$T_{r,Measured} = \sqrt{(T_{r,signal})^2 + (T_{r,\ system})^2}$$



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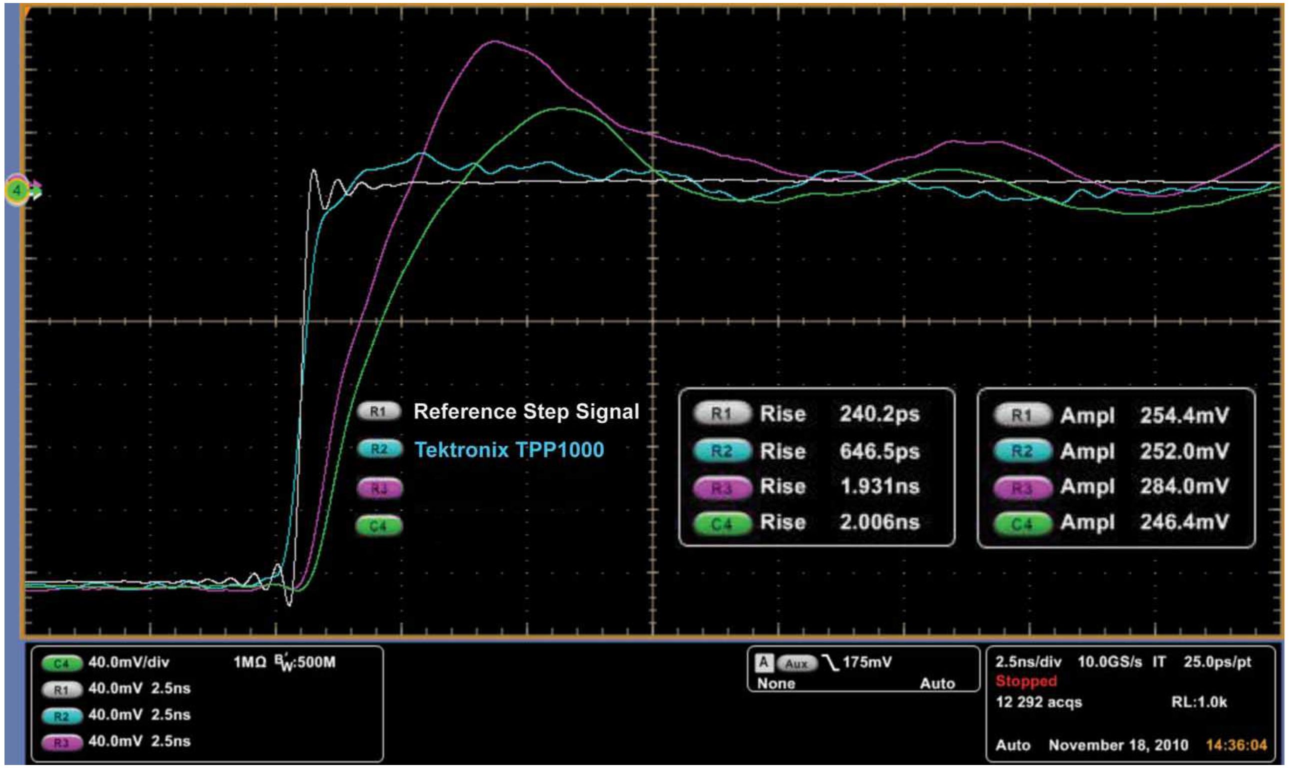
Low-Capacitance Passive Voltage Probing

- Comparison of different probes and compensation capabilities



- very different results
- Source of error

Probing Tips and Tricks:
Probe Adapters will Affect the Measurement

- Ease of connectivity and signal fidelity are a trade-off.
- Accessories may impact rise time and cause aberrations.

Source Through 50 Ohm Terminator + 1 MOhm CH 1

TDP1000 Square Pin

P6139A w/ 1" Z Lead

P6139A w/ 1" Z Lead (Incorrect LF Comp)

P6139A w/ Short Spring Ground

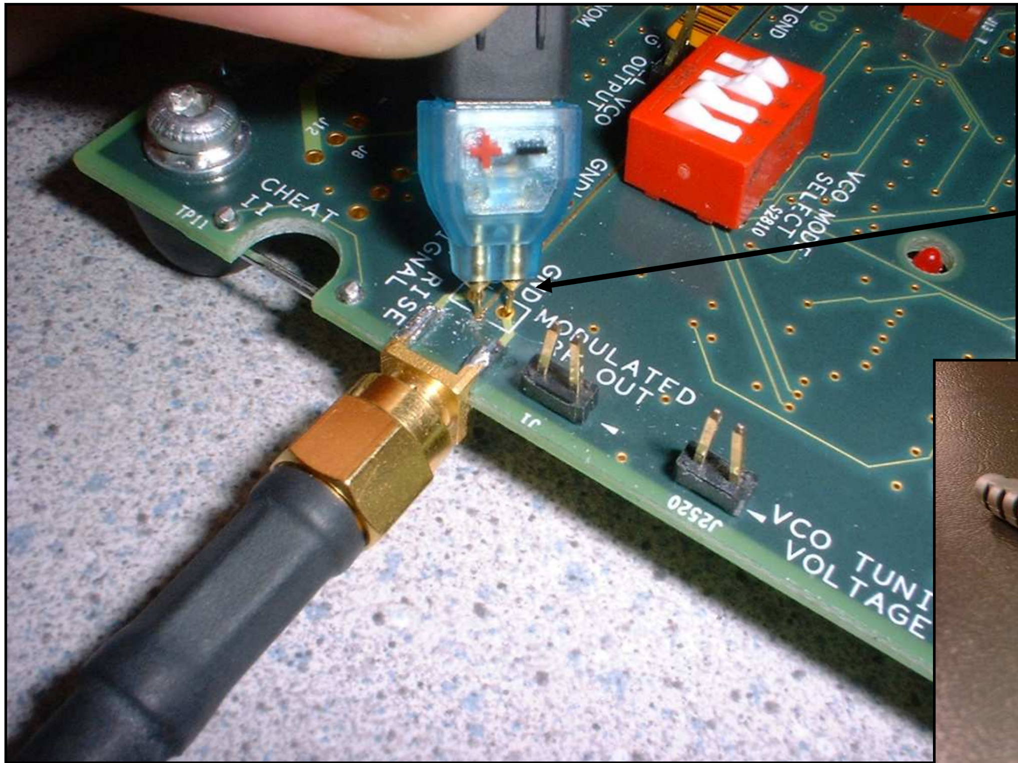
Probe Accessories - The Connection to the DUT

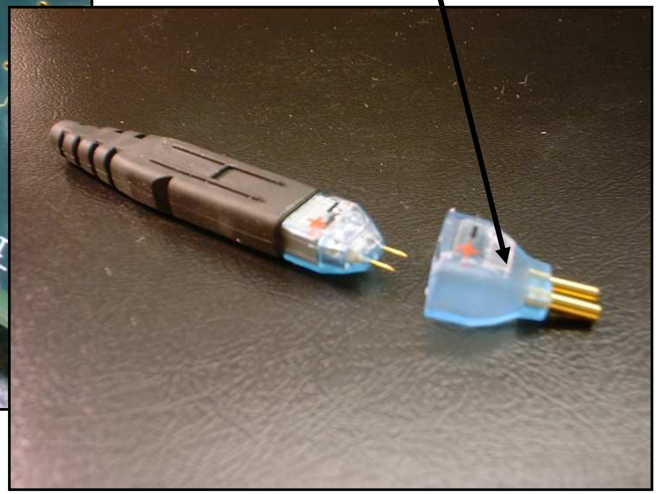
- Connects the Probe to the DUT
- Adjustment tools
- Marker bands
- 9-digit part numbers are found on the web or in the User Manual
- Probe Tip Adapters
- Ground Leads (Short and Long)
- Attachment Klips
- Square Pin Adapters
- Solder Down Adapters

Example Probe Loading

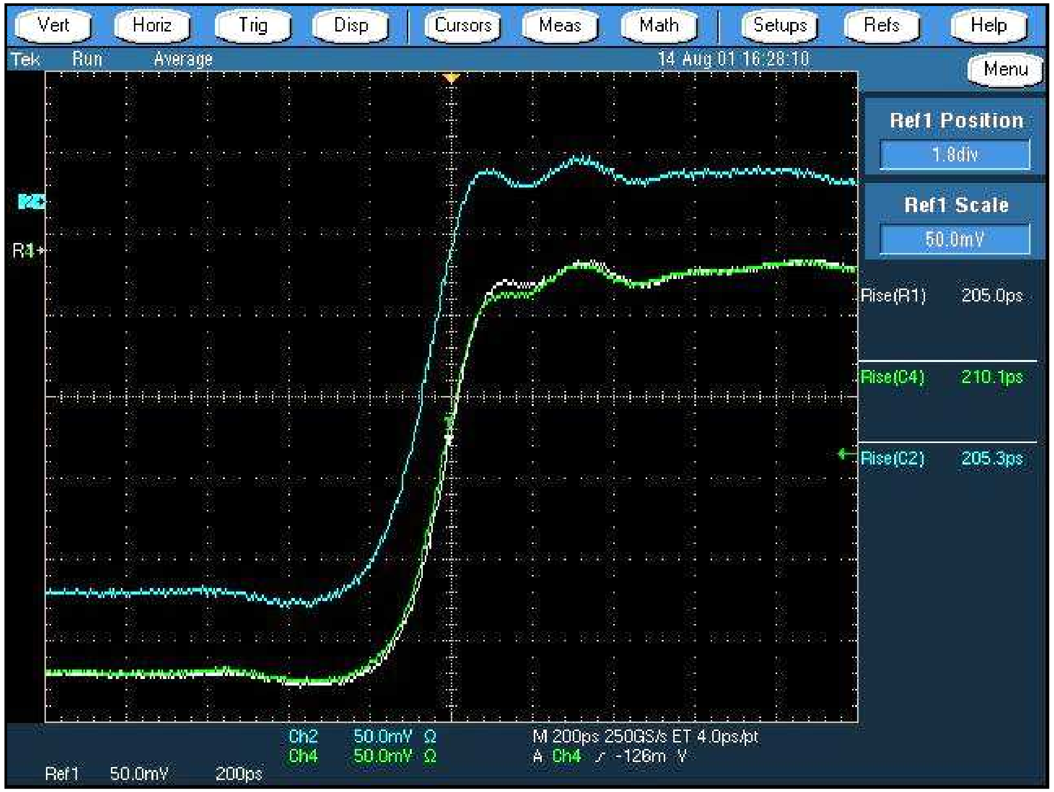
Active Differential Probe

Showing Various Adapter (e.g Square Pin Adapter)





Reference Signal vs. Probe Output

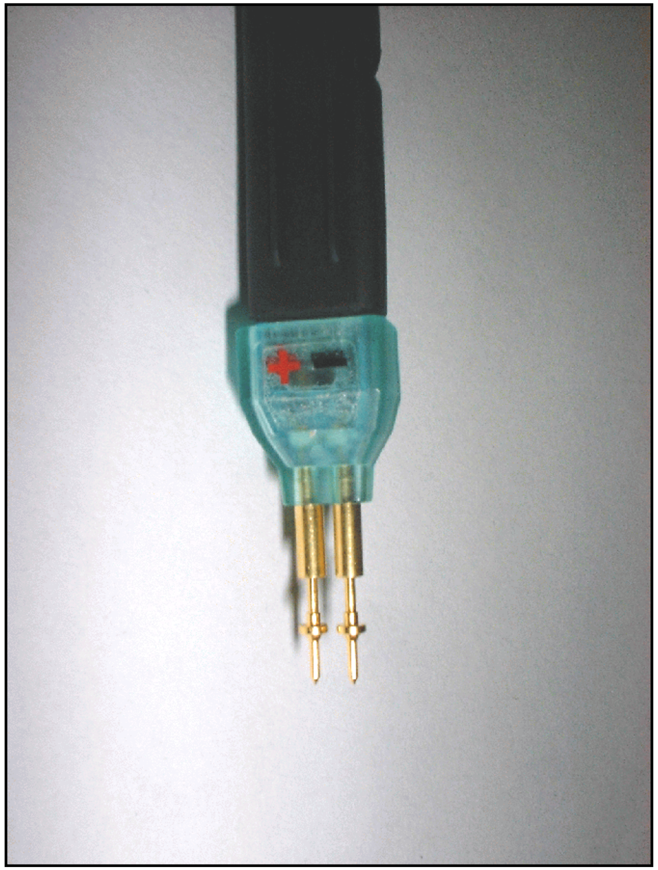


Green = probe loading (SMA output)

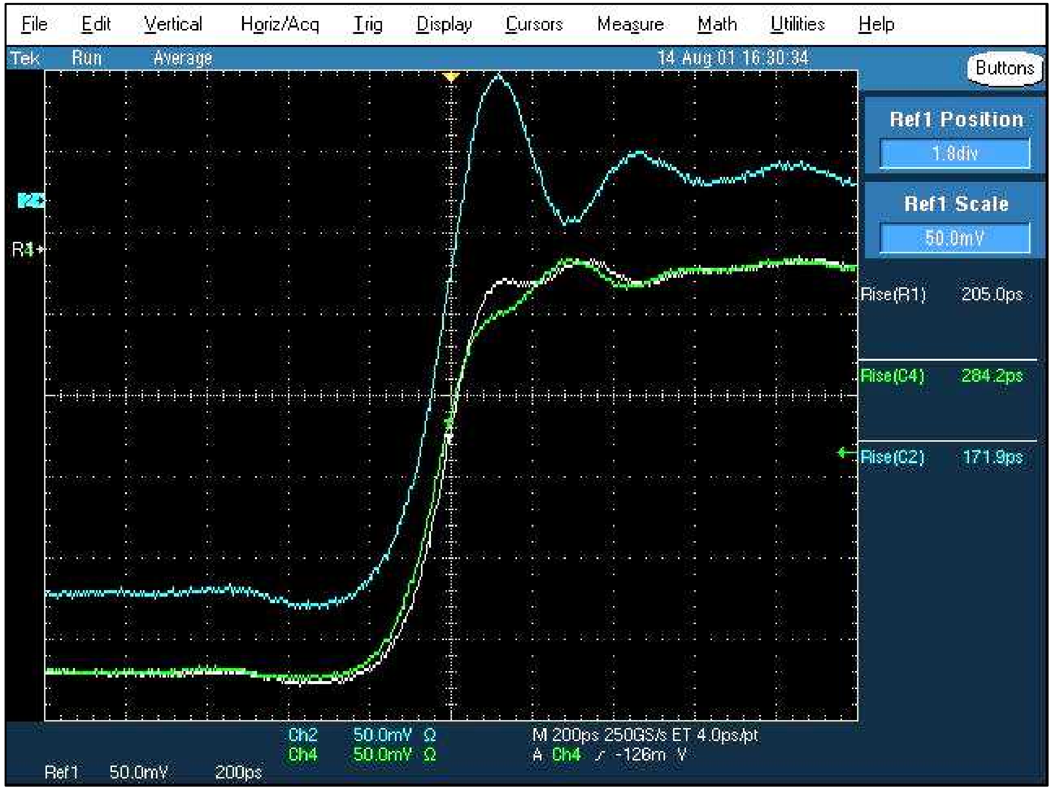
Blue = Probe output

White = stored Reference Signal

Effect of Square Pin Adapter



Reference Signal vs. Probe + Square Pin Adapter + Pins



Green = **probe loading (SMA output)**

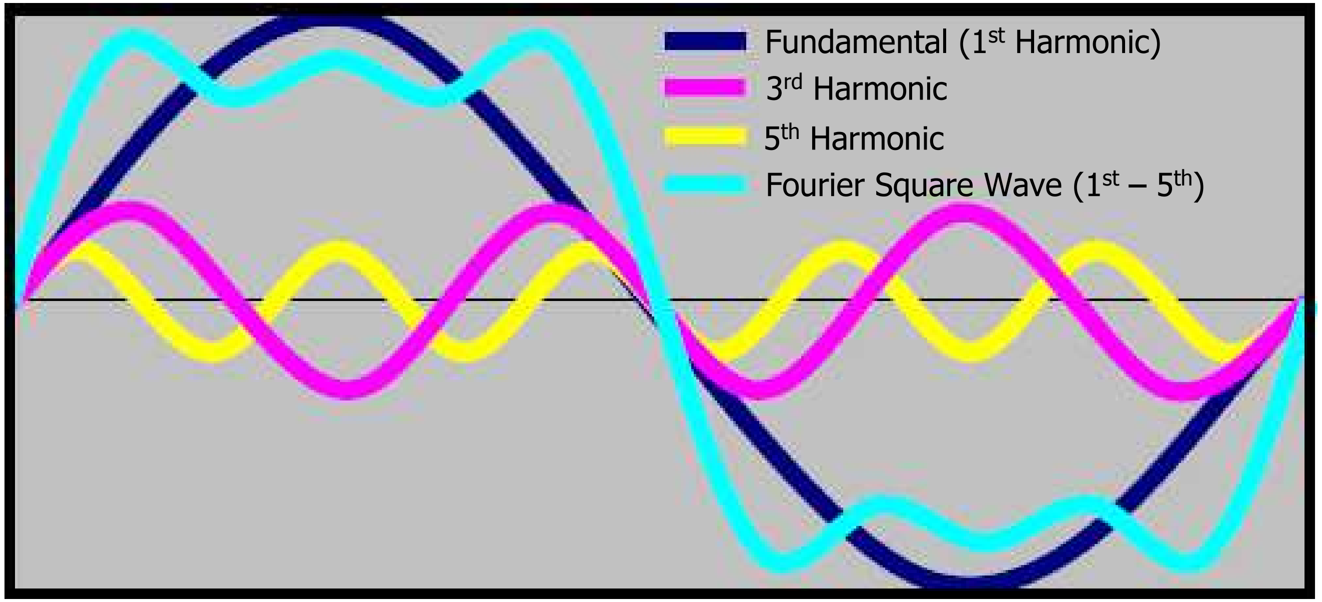
Blue = **Probe output**

White = **stored Reference Signal**

Signal Fidelity – Bandwidth Limitation

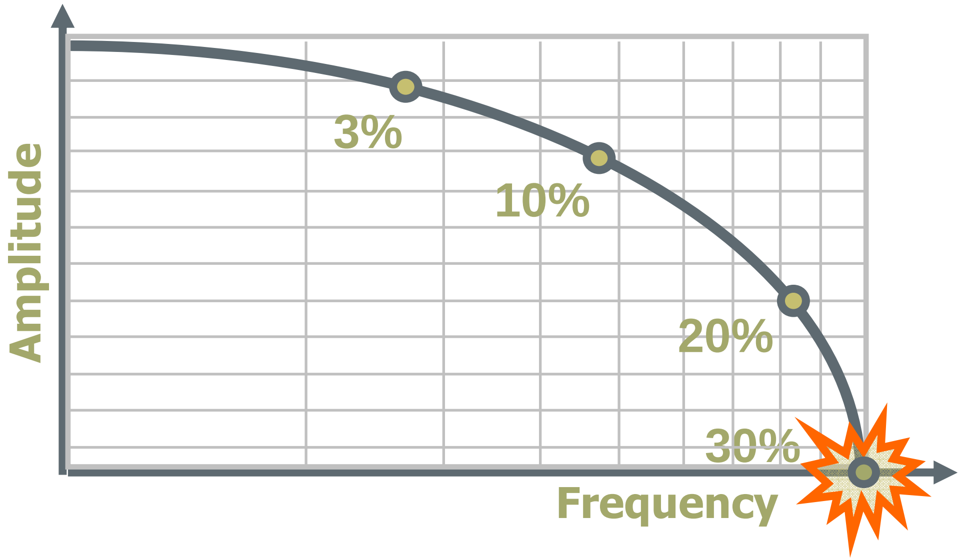
- Complex signals contain many spectral components that cumulatively form a signal over time.
  - Spectral components are sine waves at varying frequencies and varying amplitudes which are added together to collectively form one signal.
- To accurately characterize your signal, follow the ***5 Times Rule***

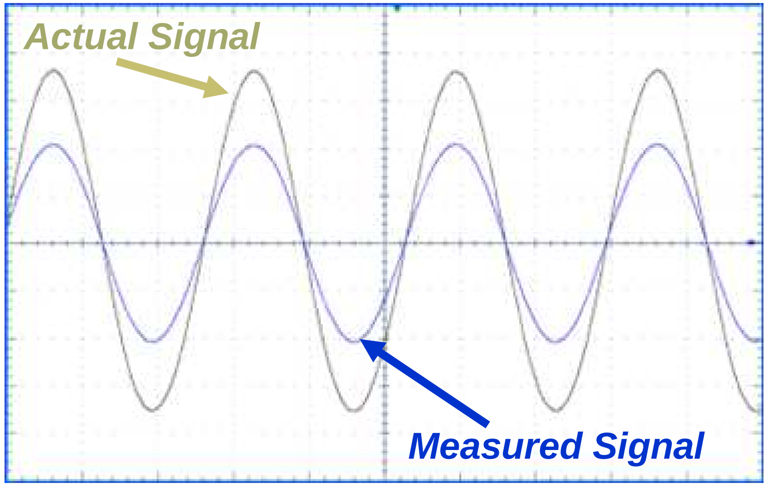
  BW of system > 5 x Fundamental Frequency



Signal Fidelity – Bandwidth Limitation

- 30% Amplitude error is true for a repetitive sine wave.

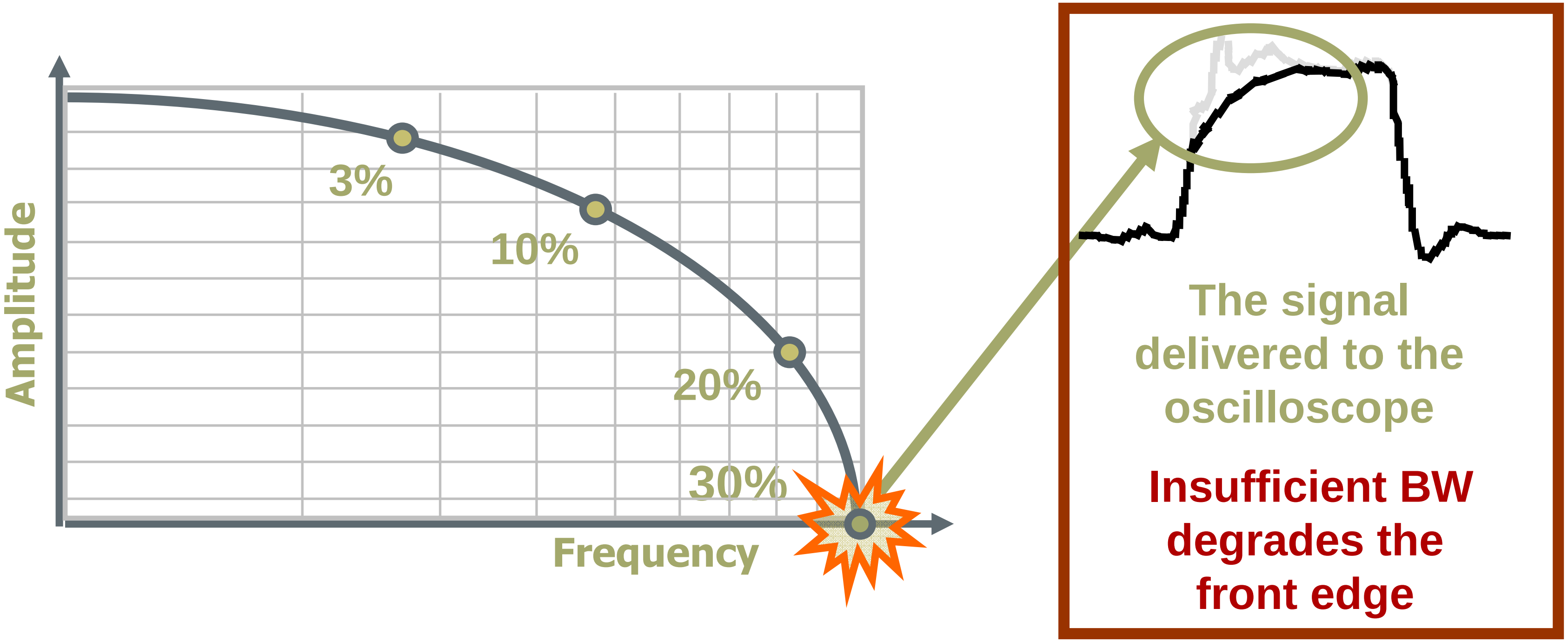




What if you aren't measuring a repetitive sine wave?

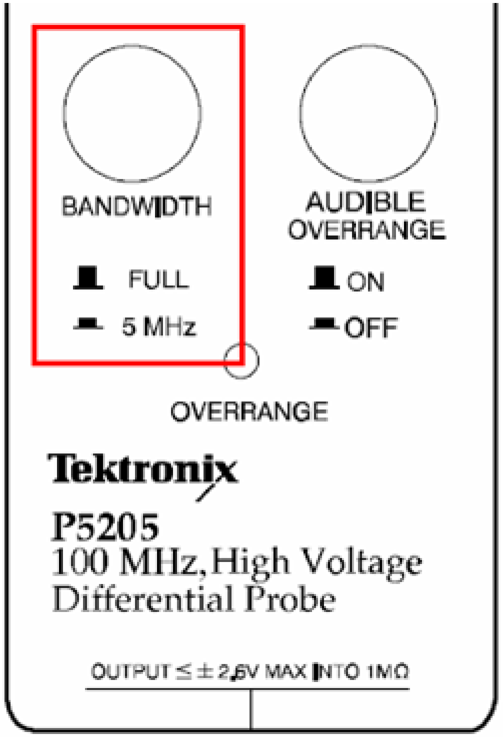
Signal Fidelity – Bandwidth Limitation

- Insufficient bandwidth affects the signal
  - Why is the front edge affected? The front edge contains the high frequency content.
  - If the measurement system doesn't have enough bandwidth, it won't capture the high frequency portion of the signal.



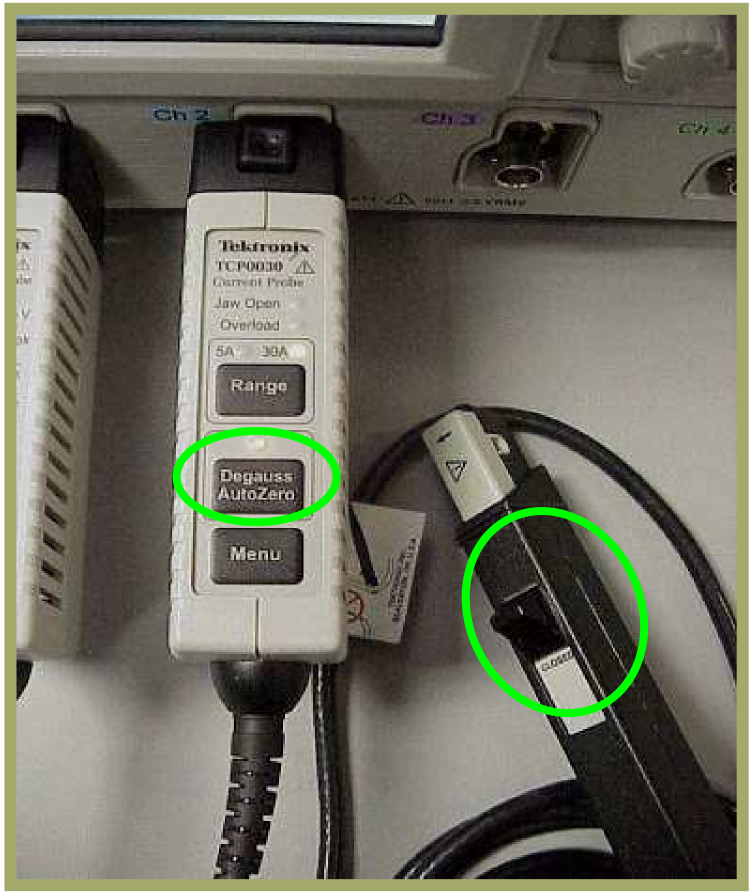
Voltage Probes: Bandwidth Limiting Filters

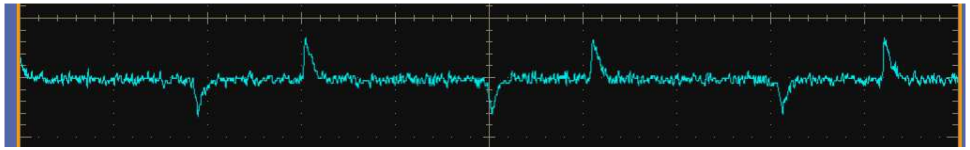
- Some voltage probes provide bandwidth limiting filters to remove unwanted high-frequency signal content.



Current Probe Degauss

- Removes residual magnetic flux from probe’s magnetic components
- High impact of measurement result (blue current waveform before and after “degaussing”)
- Capability of measuring DC (Hall-Element) and AC Signal Components simultaneously





Choosing a Probe

Choosing The Right Probe

- Carefully Consider Your Application:
  - Type of signal – voltage, current, single-ended, differential…
  - Signal frequency content (bandwidth issue)
  - Signal rise time
  - Source impedance (R and C)
  - Signal amplitudes (maximum and minimum)
  - Test point geometries
- *Choose a probe specified for your scope!*

TekVPI® – Tektronix Versatile Probe Interface

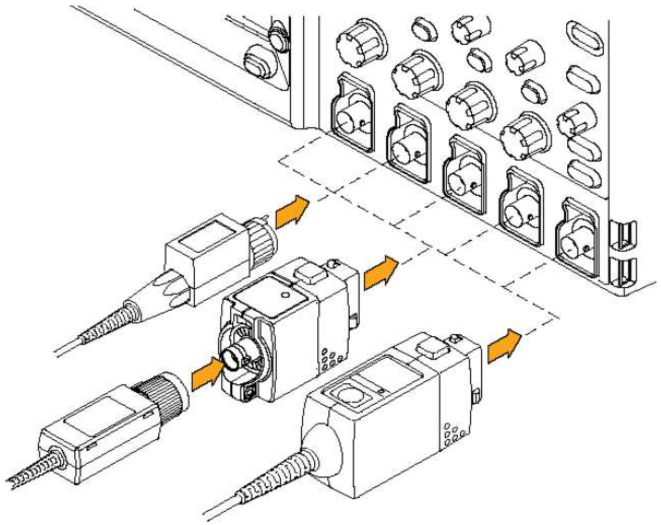
- Smart communication between oscilloscope and probe
  - Automatic units displayed
  - Nominal deskew of signal paths
  - Probe menu on oscilloscope interacts directly with probe
- Provides more power to probes
  - Enables greater flexibility in probe combinations
  - Enables direct connection to current probes (including ac/dc), differential probes, and single-ended active probes without external amplifiers

TekVPI Highlights

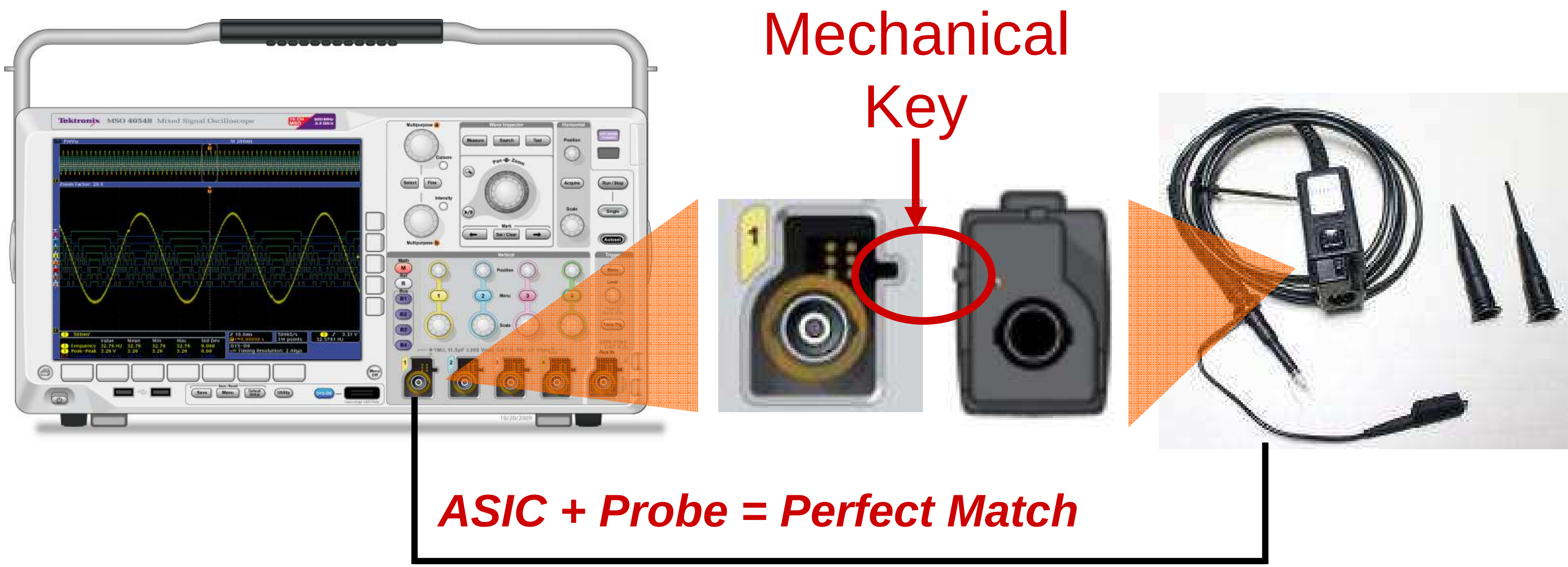
- Comp box controls provides easy and convenient access to controls and indicators plus:
  - Enhanced gain compensation increases accuracy
  - Stored propagation delay speeds critical deskew procedures
  - Auto degauss and probe offset autozero insures repeatable measurements
- Advanced Remote Control is ideal for manufacturing test applications

TekVPI to TekConnect Adapter

TekProbe to TekVPI Adapter



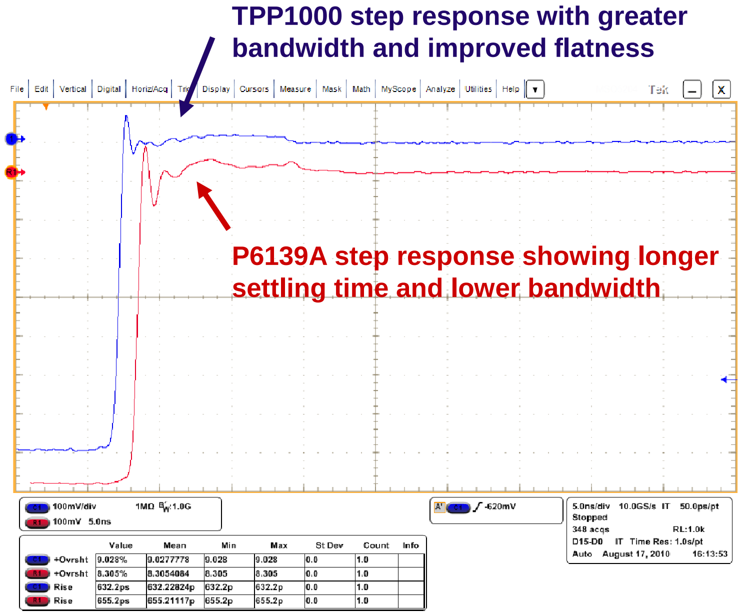
Breakthrough in Passive Probing



- Custom ASIC inside the oscilloscope is matched to the probes
- Probe notifies oscilloscope what type of probe it is via TekVPI
  – Sets input in oscilloscope to special path (not 1MΩ or 50 Ω)
- Scope can optimize signal input path to remove differences in hardware
  – AC compensation across frequency band
- Mechanical keying so TPP0500 and TPP1000 cannot be plugged into an oscilloscope without the matched ASIC

Low-Capacitance Passive Voltage Probing

- Industry leading 3.9pF capacitive loading
- TPP0500: 500 MHz passive voltage probe
  - Standard with 350 MHz and 500 MHz models
- TPP1000: 1 GHz passive voltage probe
  - Standard with 1 GHz and 2 GHz models
- Multiple ground connections included
  - Six inch ground lead
  - Short spring clip ground leads
- AC calibration routine optimizes frequency response
- <u>Application usage</u>
  - Digital system debug



Half the loading with twice the bandwidth

Low-Capacitance Passive Voltage Probing

- automated Procedure
- frequency response adjustment
- High accuracy results

Voltage Probes Specifications

Probe Specifications

I. Voltage Probes

Passive Probes

Type	Cable Length	Attenuation	Bandwidth at -3 dB	System Input Resistance	Typical Input C	Max Voltage	Compensation Range	Read Out	ID/Gnd Ref.	Tip/Head Style
1X Passive Probe										
P6101B	2 m	1	15 MHz	1 MΩ	100 pF	300 V_{RMS} CAT I	NA			5 mm (Min.)
10X Passive Probes										
P3010	2 m	10	100 MHz	10 MΩ	13 pF	420 V_{RMS} CAT I	10 to 15 pF	X		5 mm (Min.)
P5050	1.3 m	10	500 MHz	10 MΩ	11.1 pF	300 V_{RMS} CAT II	16 to 22 pF	X		3.5 mm (Comp.)
P6109B	2 m	10	100 MHz	10 MΩ	13 pF	420 V CAT I	15 to 35 pF	X		5 mm
P6015A	3.0 m	1000	75 MHz	100 MΩ	3.0 pF	20,000 V	7 to 49 pF			HVP

Differential Probes

Type	Cable Length	Attenuation	Bandwidth at -3 dB	Differential Input Resistance	Differential Input C	Max Nondestruct Voltage RMS	Differential Input Voltage	Common Mode Input Voltage	Typical CMRR	Interface Style
ADA400A		X 100	1 MHz	1 MΩ	55 pF	N/A	±10 V	0.01V	>80 dB at 10 kHz	TEKPROBE
		X 10					±10 V	1 V		
		X 1					±40 V	10 V		
		X 0.1					±40 V	80 V		
P5200[*7]	1.8 m	50	25 MHz	4 MΩ	7 pF	N/A	1300 V_{RMS}	1000 V_{RMS} CAT II	>50 dB at 1 MHz	BNC[*7]
		500								
P5205	1.8 m	50	100 MHz	4 MΩ	7 pF	N/A	1300 V_{RMS}	1000 V_{RMS} CAT II	>50 dB at 1 MHz	TEKPROBE
		500								
P5210	1.8 m	100	50 MHz	8 MΩ	7 pF	N/A	4400 V_{RMS}	2200 V_{RMS} CAT II	>50 dB at 1 MHz	TEKPROBE
		1000								
P6246	1.2 m	1	400 MHz	200 kΩ	<1 pF	±25 V	±850 mV	±7 V	>60 dB at 1 MHz	TEKPROBE
		10					±8.5 V			
P6247	1.2 m	1	1 GHz	200 kΩ	<1 pF	±25 V	±850 mV	±7 V	>60 dB at 1 MHz	TEKPROBE
		10					±8.5 V			
TDP0500	1.2 m	5	500 MHz	1 MΩ	<1 pF	±100V	±4.2 V	±35 V	>60 dB at 1 MHz	TekVPI™
		50					±42 V			DPO7000

Differential Probe Capabilities

- Selectable attenuation factors
- Excellent CMRR capabilities
- Low noise floor
- Reduced probe loading effects
- Selectable bandwidth limiting filters
- DC Reject / AC coupling to eliminate the DC offset in the measured signal
- Remote access and control
- Versatile DUT connectivity accessories.
- Small Probe head
- Status Indicator

TDP Probes

Differential & Floating Measurements

Characteristic	TMDP0200	THDP0200	THDP0100
Attenuation	25X/250X	50X/500X	100X/1000X
Differential Voltage	250X: +/- 750 V 25X: +/- 75V	500X: +/- 1500 V 50X: +/- 150 V	1000X: +/- 6000 V 100X: +/- 600 V
Common Mode Voltage	+/- 750 V	+/- 1500 V	+/- 6000 V
Max Input Voltage-to-Earth	550 V CAT I 300 V CAT III	1000 V CAT II 600 V CAT III	2300 V CAT I 1000 V CAT III
Bandwidth	200 MHz	200 MHz	100 MHz
Rise Time	< 1.8 ns	< 1.8 ns	< 3.5 ns
Slew Rate	< 275 V/ns @ 1/250 gain	< 650 V/ns @ 1/500 gain	< 2500 V/ns @ 1/1000 gain
Input Impedance at the Probe Tip	5 MΩ || < 2 pF	10 MΩ || < 2 pF	40 MΩ || < 2.5 pF
Common Mode Rejection Ratio	DC: > - 80 dB 1 MHz: > - 60 dB 3.2 MHz: > - 30 dB 50 MHz: > - 26 dB	DC: > - 80 dB 1 MHz: > - 60 dB 3.2 MHz: > - 30 dB 50 MHz: > - 26 dB	DC: > - 80 dB 1 MHz: > - 60 dB 3.2 MHz: > - 30 dB 50 MHz: > - 26 dB
Cable Length	1.5 m	1.5 m	1.5 m

TCP0030 AC/DC Current Probe

- Accurate and simplified current measurements by TCP0030 AC/DC current probe
  - Wide Dynamic Range
    - Measures 1mA to 30A
  - DC to 120 MHz Bandwidth
    - Captures high frequency harmonic components
  - TekVPI Probe Architecture
    - Connects directly to the DPO7000 Series oscilloscopes
    - User setups controlled via the Probe Compensation box buttons and LED indicators or via the easily accessible Scope Probe Menu
    - Remote programmable probe control via GPIB, USB or Ethernet

TCP0030 AC/DC Current Probe

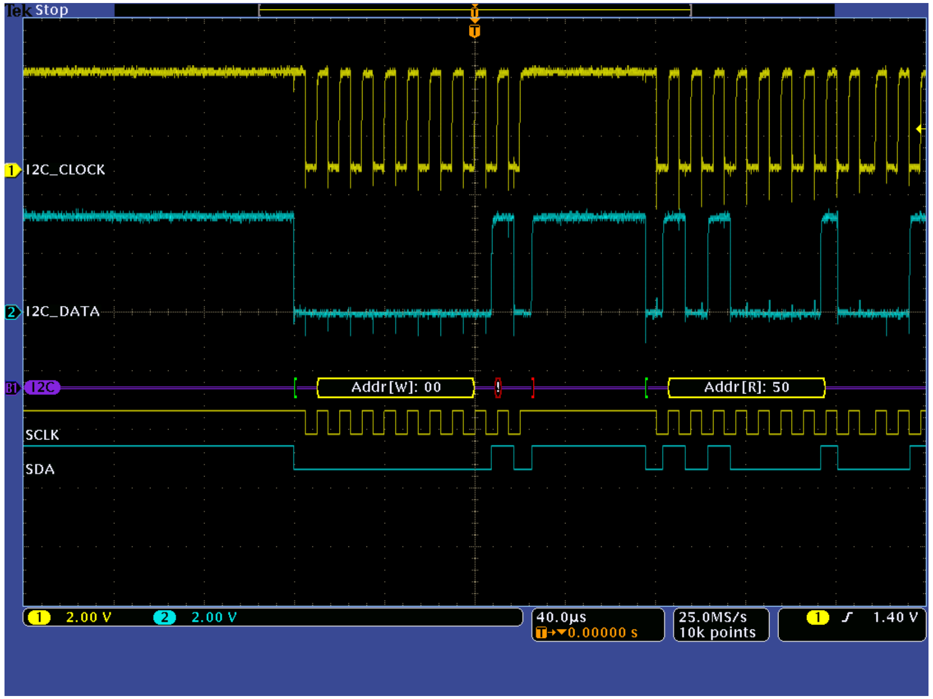
Current Probes Specification

II. Current Probes

	Bandwidth Hz to MHz	Peak Pulse	Max AC$_{P-P}$	Derate Below	Derate Above	Max DC	Amp-S Product	Current/Div Display Range	Rise Time	Insertion Impedance at 1 MHz	Max Barewire Voltage	Max Conductor Diameter	Cable Length
TCP300 and TCP400 Series Products For TEKPROBE, TekConnect and Standard 50 Ω / 1 MΩ BNC Oscilloscope Systems													
TCP312 w/TCPA300	DC to 100	50 A	60 A	N/A	50 kHz	5 A – 1 A/V 30 A – 10 A/V	50 A-μS[*6]– 1 A/V 500 A-μS[*6]– 10 A/V	1 A/V 10 A/V	≤3.5 ns	0.08 Ω	Insulated Wire Only	3.8 mm (0.15 in.)	1.5 m
TCP312 using CT4	0.5 to 20	20 kA[*3]	2 kA[*4]	50 Hz	1.2 kHz	20A	0.5 A-S	20 A/V 10 kA/V	<17.5 ns	2.5 mΩ	3 kV	38 mm (1.5 in.)	1.5 m
TCP305 w/TCPA300	DC to 50	50 A	100 A	N/A	2 kHz	25A - 5 A/V 50 A - 10 A/V	500 A-μS[*6]– 5 A/V NA – 10A/V	5A/V 10A/V	≤7 ns	0.035 Ω	Insulated Wire Only	3.8 mm (0.15 in.)	1.5 m
Direct Connect Current Probes													
TCP0030 (TekVPI™)	DC to 120	50 A	84 A	N/A	5 kHz	5 A 30 A	50 A-μS – 1 A/V 500 A-μS – 10 A/V	1 A/V[*5] 10 A/V[*5]	≤ 14.5 ns	0.08 Ω	Insulated Wire Only	3.8 mm (0.15 in.)	2 m
TCP0030 w/CT4	0.5 to 20	20 kA[*3]	2 kA[*4]	50 Hz	1.2 kHz	30 A	0.5 A-S		≤ 24.5 ns	30 mΩ	3 kV	38 mm (1.5 in.)	2 m
TCP0150	DC to 20	150 A	424 A	N/A	2 kHz	25 A 5 A/V 150 A 50 A/V	3,000A[*5] μS - 5 A/V 15,000 A[*5] μS - 50 A/V	5 A/V 50 A/V	≤ 17.5 ns	0.03 Ω	600 V$_{RMS}$ CAT I & II 300 V$_{RMS}$ CAT III	21 mm × 25 mm (0.83 × 1.0 in.)	2 m
TCP202 (TekProbe®)	DC to 50	50 A	40 A	N/A	20 kHz	15 A	500 A-μS		≤7.0 ns	0.07 Ω	300 V CAT I	0.15 in.	2.2 m

How do I probe serial digital buses?

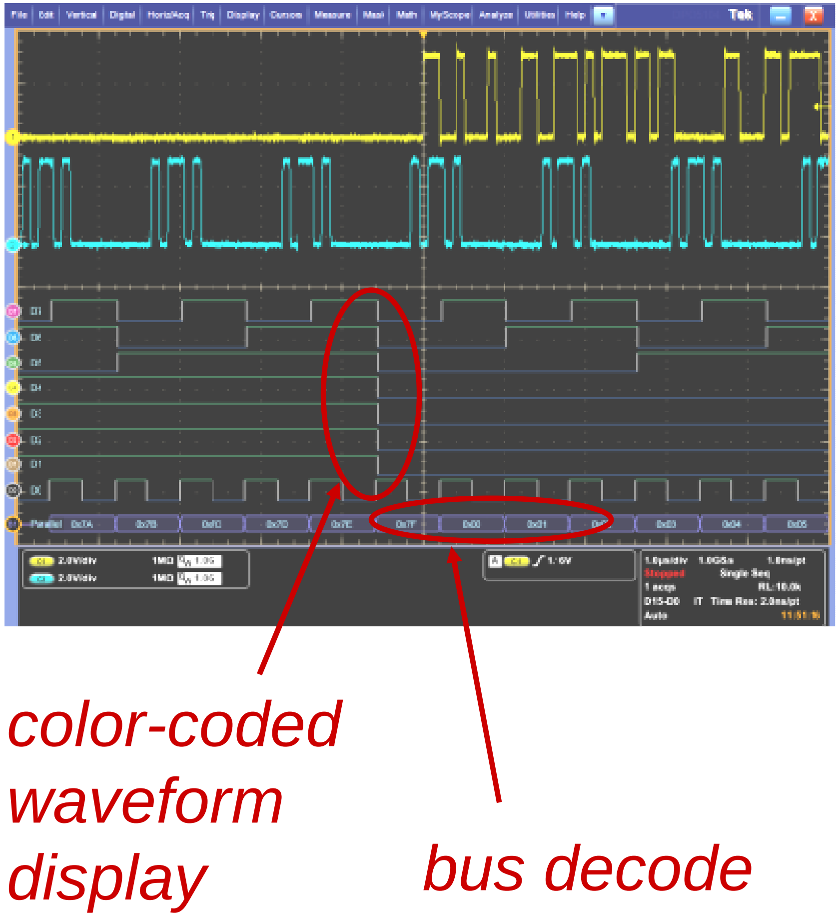
- Digital buses are <u>not</u> digital
- Digital signals do <u>not</u> necessarily have only two discrete levels
- Digital probes are <u>not</u> digital
- Everything you know about analog probing still applies
  - Minimize DC and AC loading
  - Voltage measurements are always differential
  - Minimize lead inductance



Bus and Waveforms display of I²C signal

- The real signal must be delivered to the oscilloscope's hardware or software comparator, where it can be compared to the digital threshold value(s)

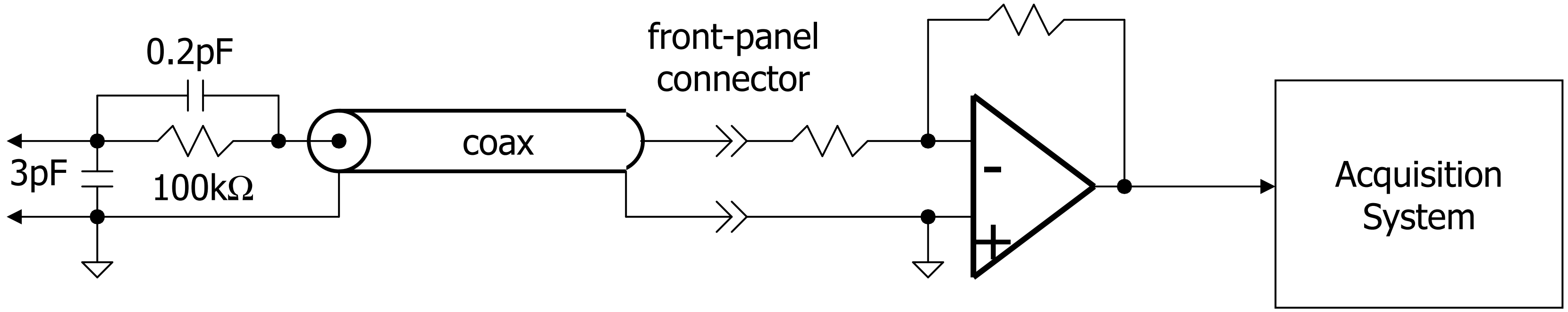
Digital Bus Analysis with Logic Probes



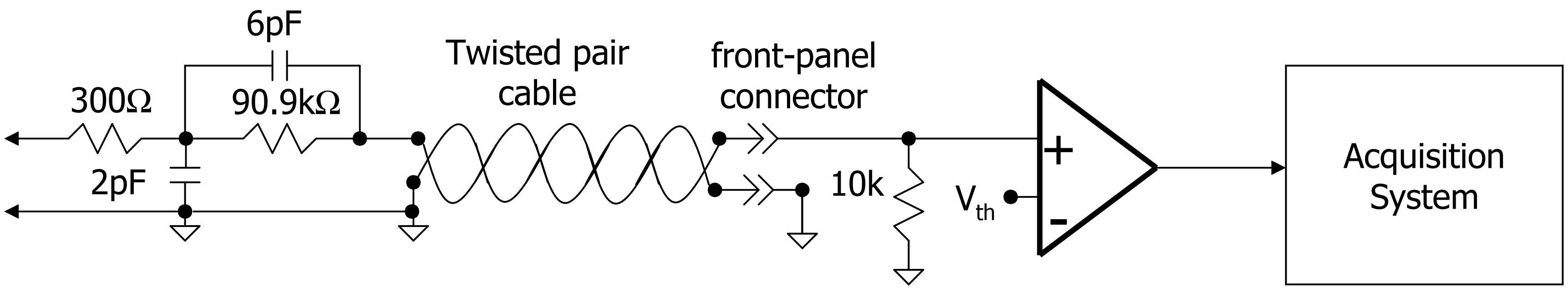
Specification	DPO4000B / MSO5000
Maximum Sample Rate	500MS/s 16.5GS/s with MagniVu
Maximum Input Toggle Rate	500 MHz
DC Input Voltage Range	± 42 Vpeak
Maximum Input Voltage Swing	30 Vp-p ≤200MHz 10 Vp-p >200 MHz
Input Impedance	100 kOhm
Input Capacitance	3 pF
Threshold Range	± 40 V
Minimum Input Swing	400 mVp-p
Minimum Detectable Pulse	1 ns

What do the probing and acquisition architectures look like

Passive probe A **Digital input circuit (logic analyzer ASIC)** **acquisition circuit**



Passive probe B **Digital input circuit (discrete design)** **acquisition circuit**

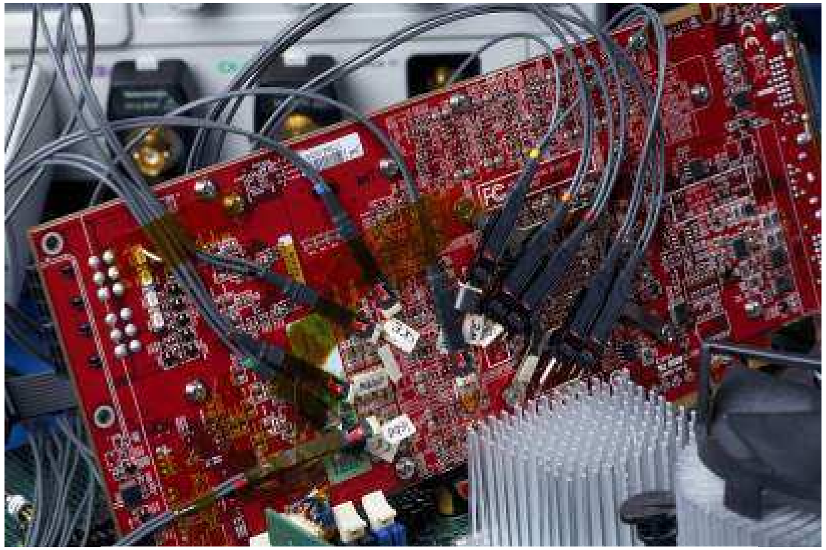


Logic Probe Specifications for iCapture™

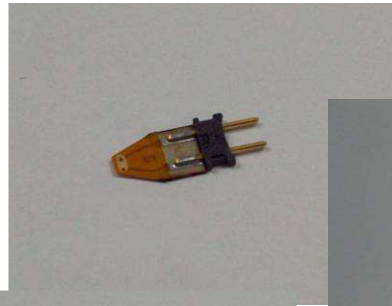
	P6780 Differential Probe	P6750 D-Max Probe P6717A General Purpose Probe
Analog Bandwidth	2.5 GHz	1 GHz
Input Impedance Input Voltage Range	40 kΩ ± 2.0% (differential-mode), 0.5pF -2V to +4,5V	20 kΩ ± 1.0%, 3 pF - 1,5V to +4V

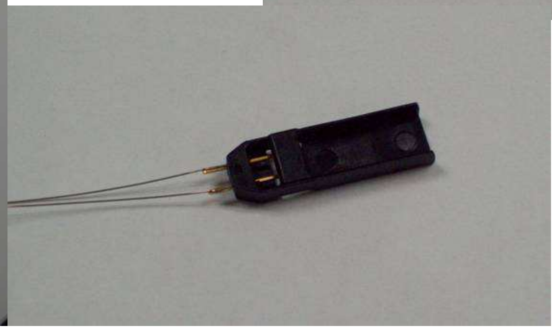
P6780 Probe Access to Tightly Spaced Test Points

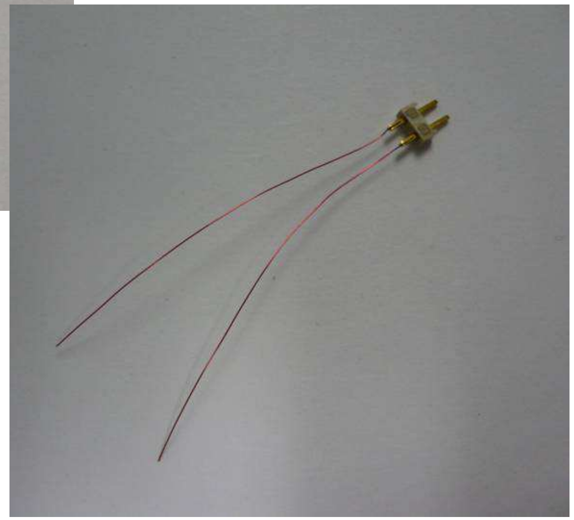
- Industry's only differential active probes for MSOs
  - Excellent signal fidelity
- Industry's best versatility in access points
  - Device Leads
  - Solder-in
  - VIA's and Traces
  - BGA packages
  - Square Pins
- Reduces fixturing costs and development time

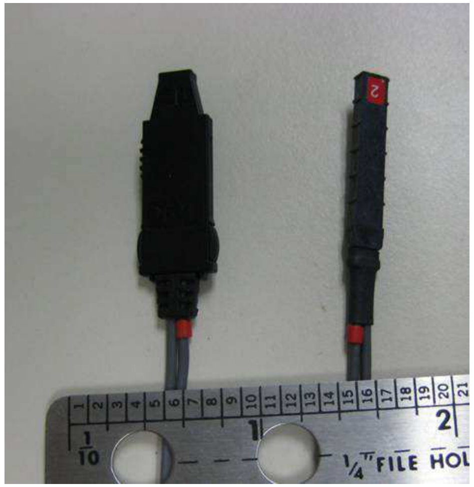


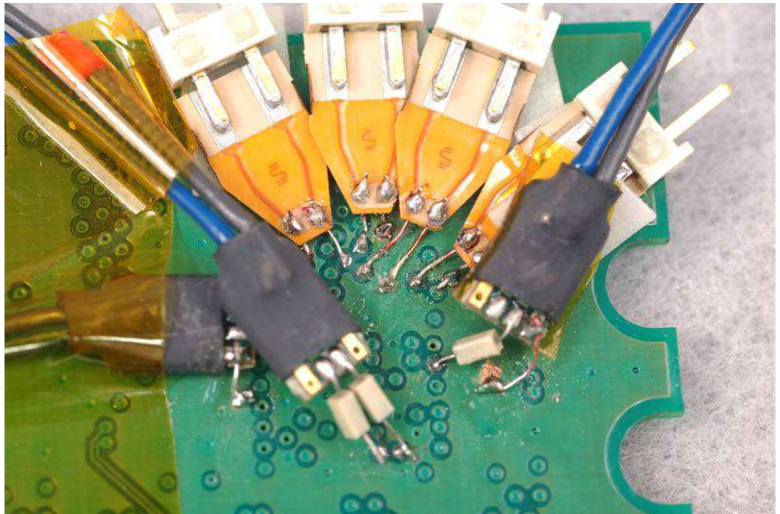
P6780 Probe and Accessories



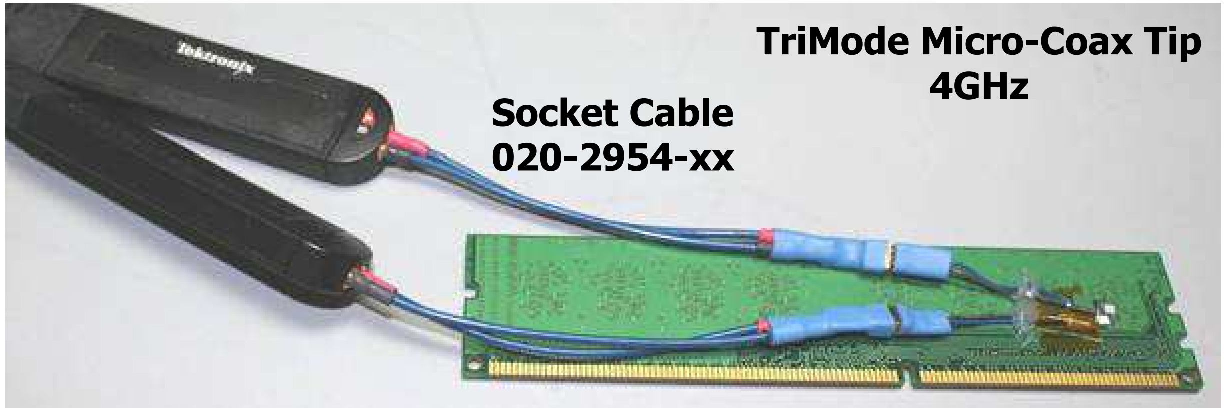




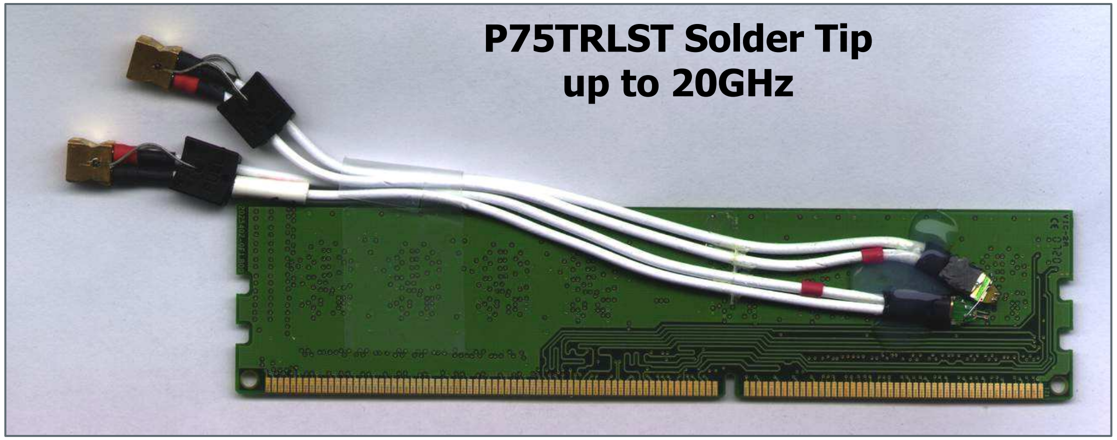




High Bandwidth Solder-In Probing Solutions

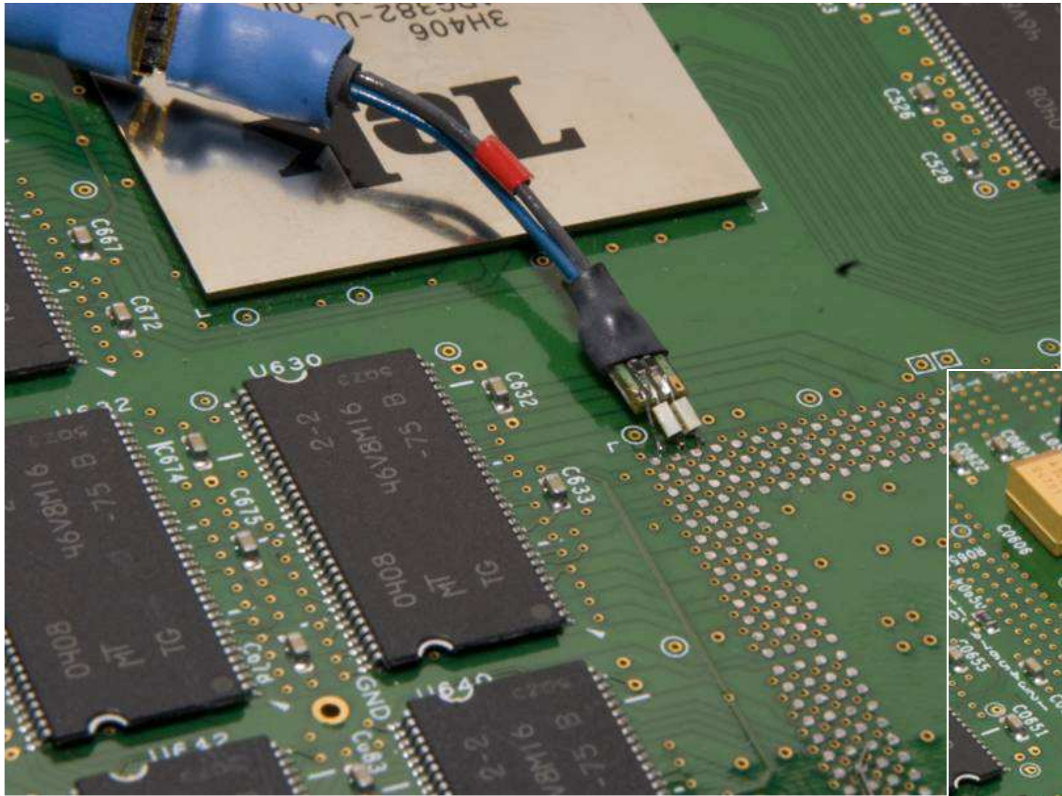


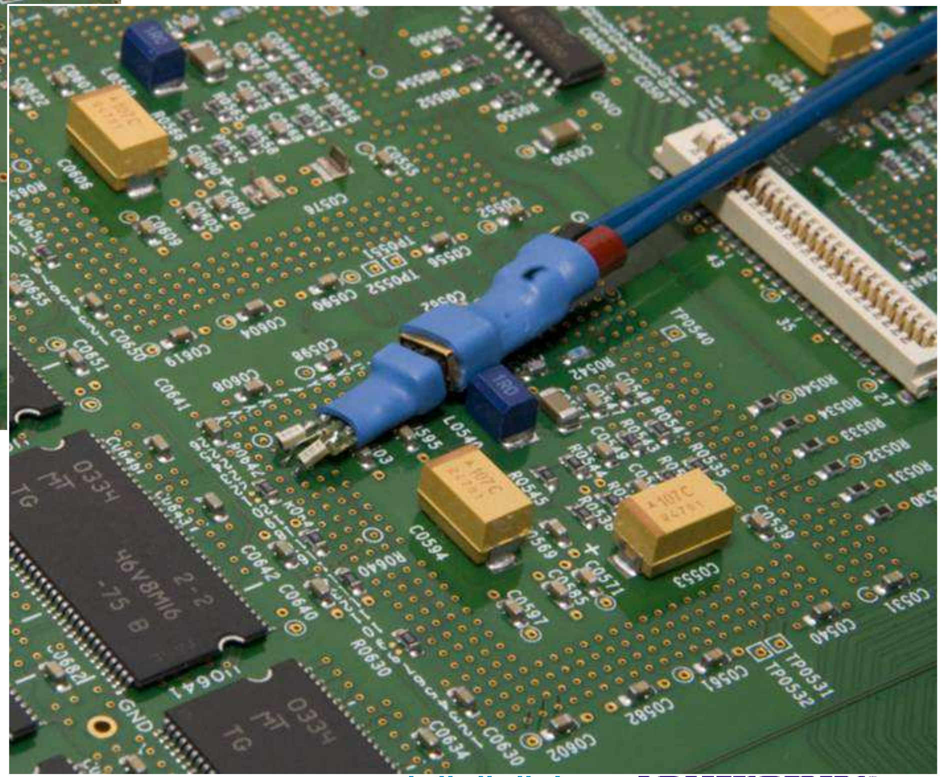
P7500 Series
Tri-Mode Probes



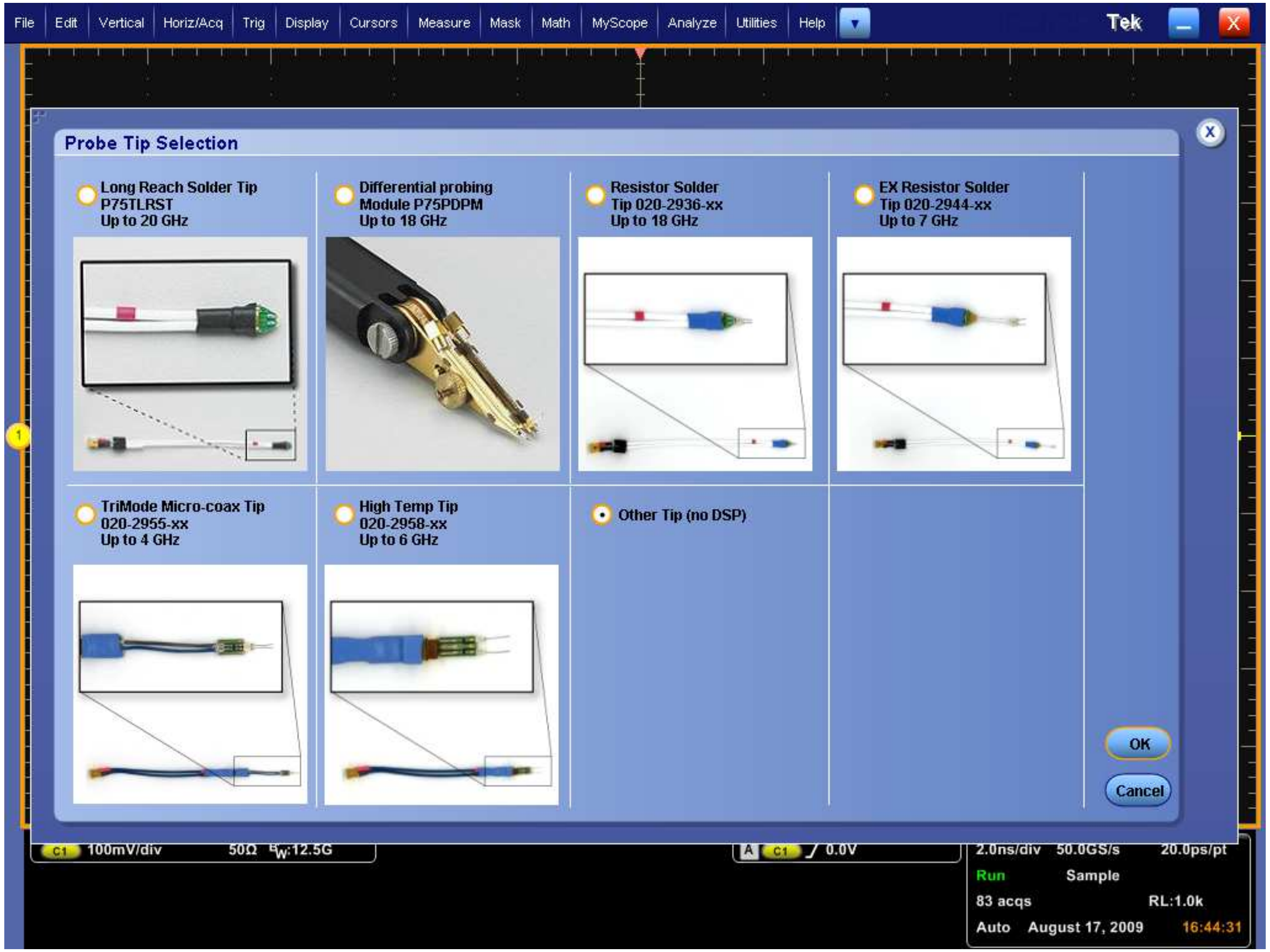
Accessories - Flexible Solutions

New tips solder to small vias



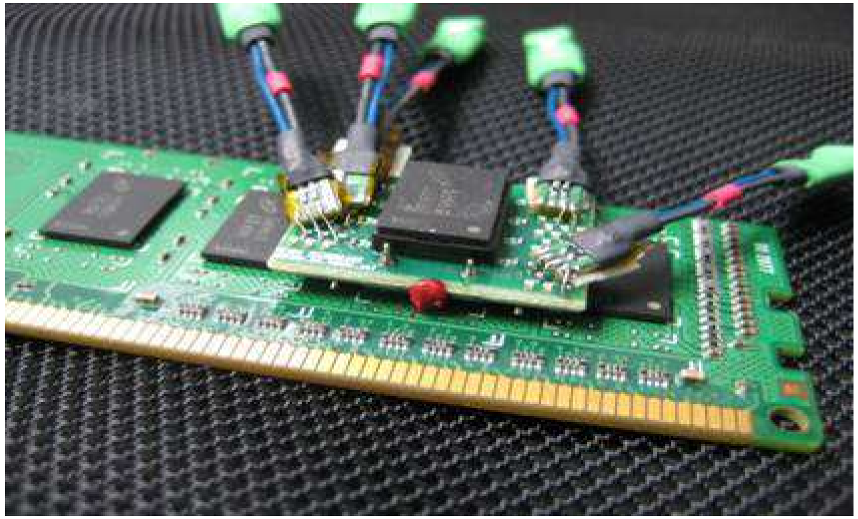


Selection on Oscilloscope Screen for the used Adapter



- Selection of different probe tips
- Clean signals, high fidelity with the best probes available
- Optimize performance for the signal-path scope/probe/tip

BGA Chip Interposer for Oscilloscopes

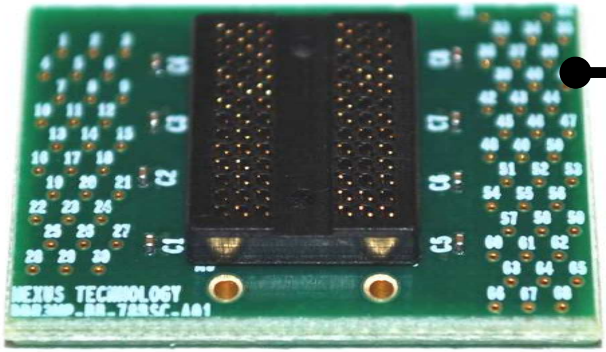


- Unique Socket Design allows for multiple chip exchanges
  - Solder-in version is also available
- Recommended probes: P7500 Series
  - New TriMode™ solder tips matched to Interposer (order #020-3022-00)
  - Interposer has embedded 100Ω resistors near BGA balls
    - in place of probe tip resistors
    - Designed as a Probe-Interposer System

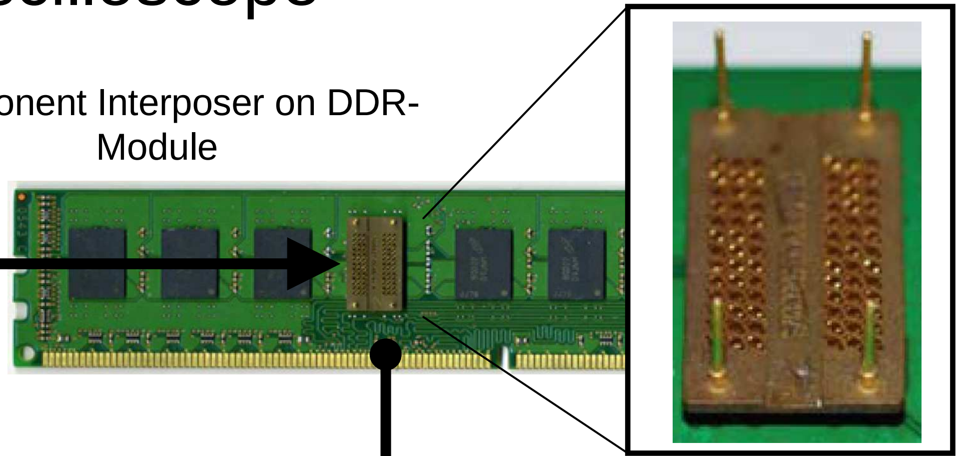
BGA Chip Interposer for Oscilloscope

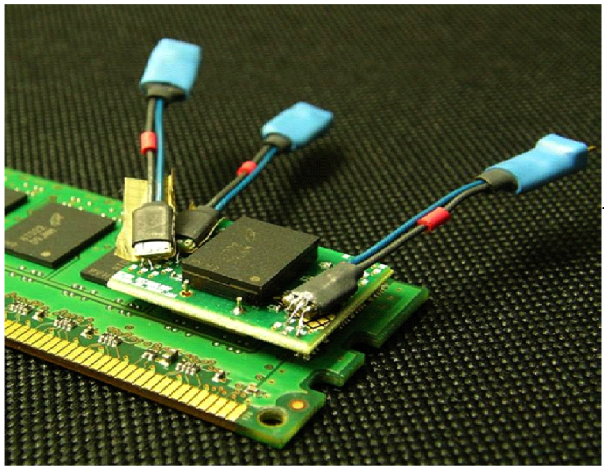
BGA Chip Interposer

(with and without Chip-Socket)

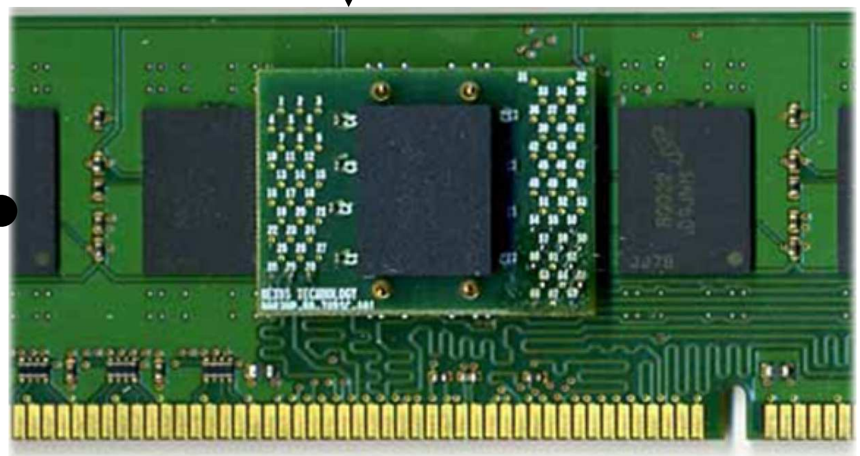


Component Interposer on DDR-Module





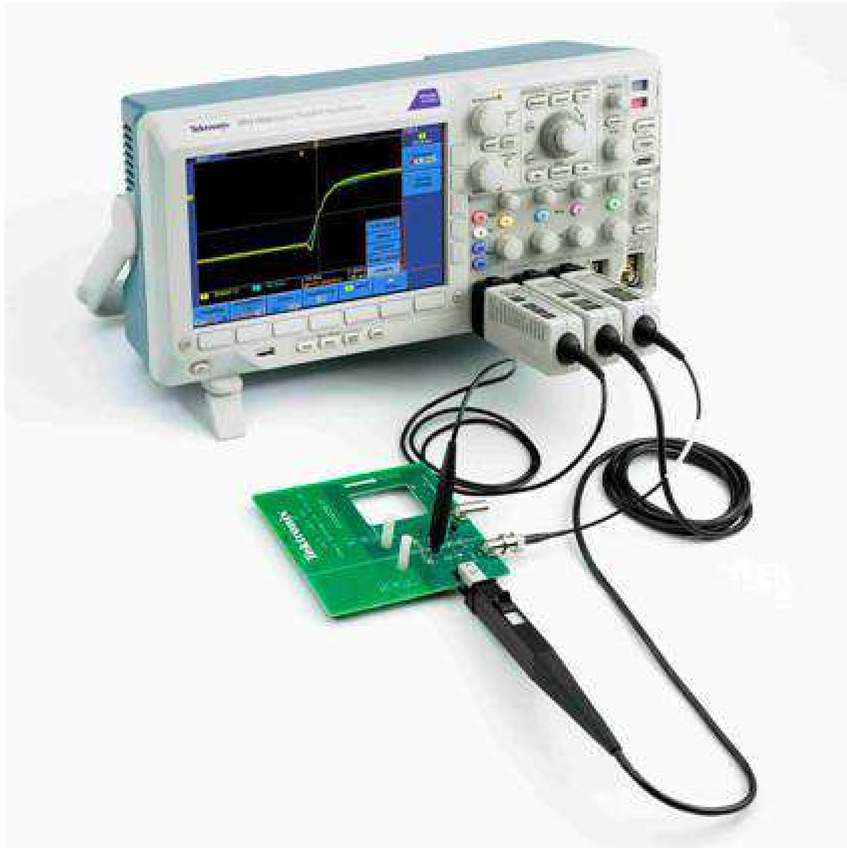
Interposer with Probe Tip for DQ, DQS and CLK



Component Interposer with Chip Interposer on DDR-Module

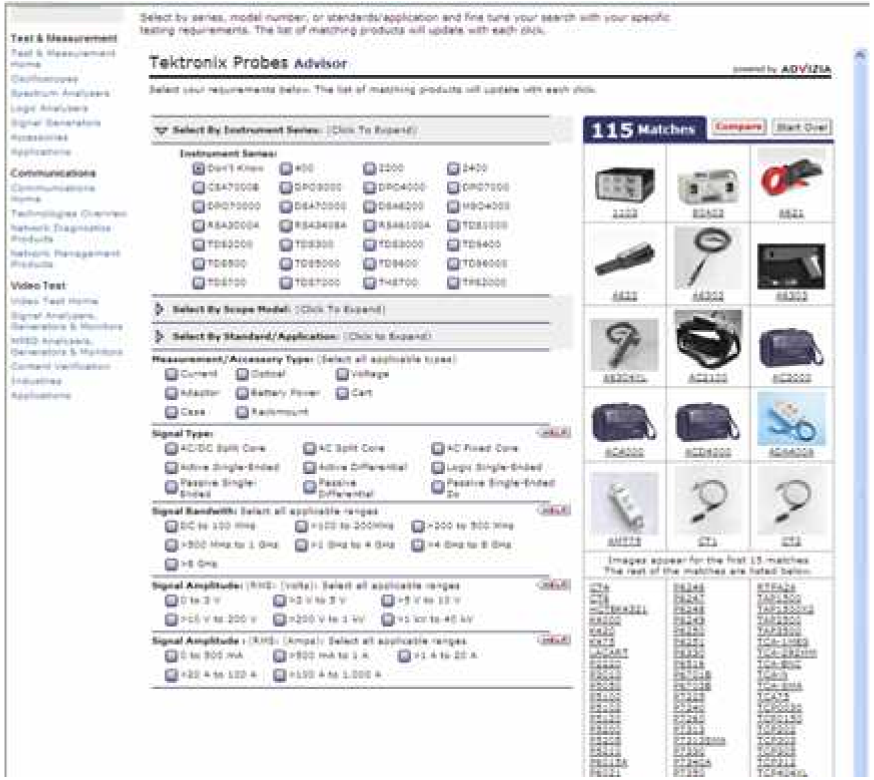
Summary

- Probes are a critical element of your measurement system
- To maximize measurement accuracy, carefully choose your probe;
  - Type of signal
  - Bandwidth
  - Rise time
  - Impedance
- Tektronix offers a wide range of probes and accessories to meet your needs



Tektronix Probe Selector

- Visit: www.tektronix.com/probes



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