Innovative approaches to improve accuracy in dynamic switching characterization

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Bodo's Wide Bandgap Event 2024

Making WBG Designs Happen

GaN

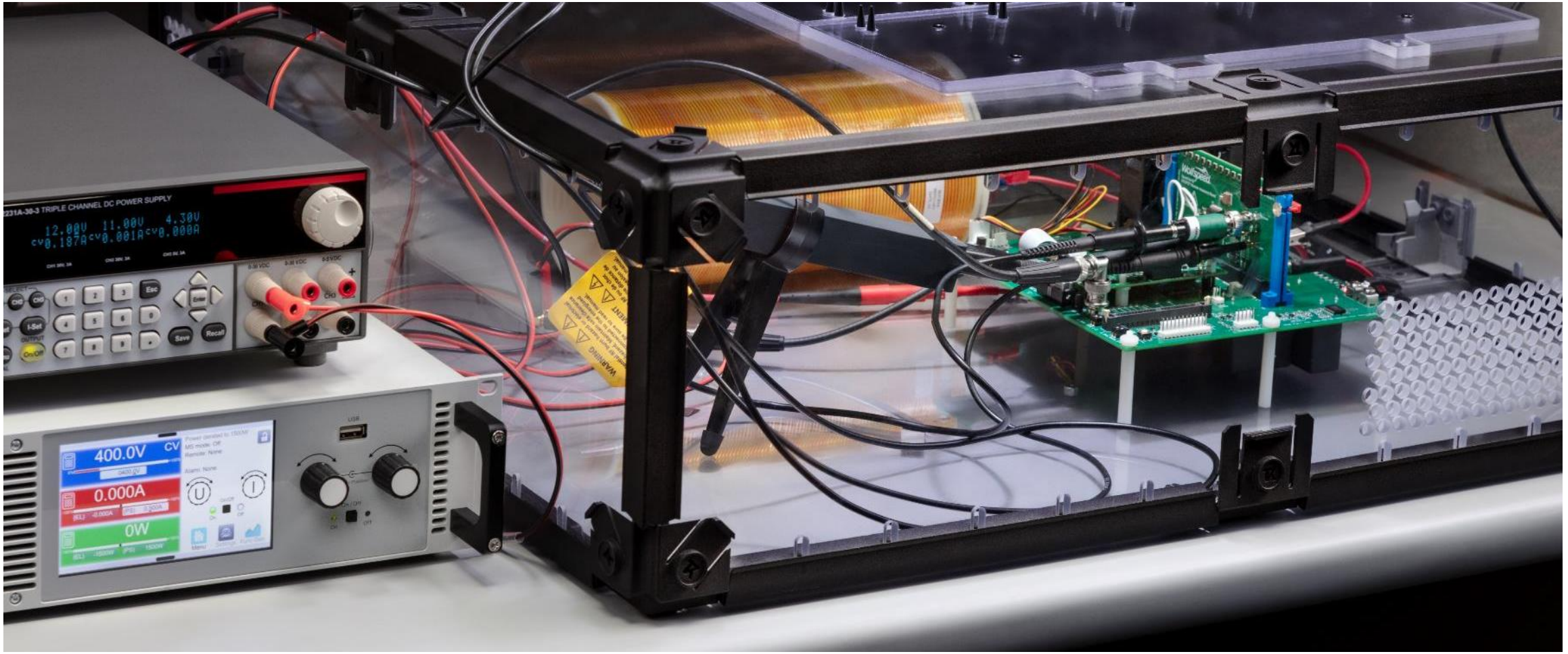
Agenda

BODO WBG 2024 – T&M

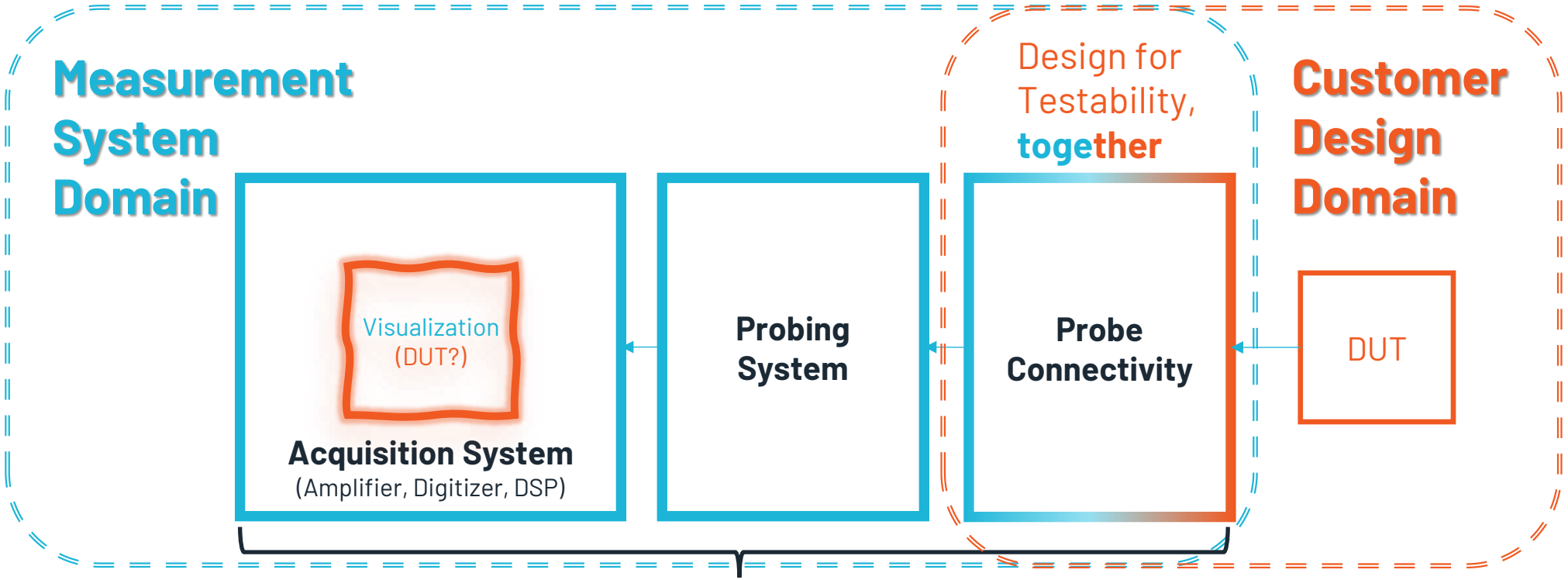
- Introduction
- **Controversial Specs** in Dynamic Switching Characterization
- **New** Measurements **Approaches** and **Solutions**

Tektronix, Keithley, EA Elektro-Automatik

A CONTINUOUS JOURNEY TOWARDS SAFETY AND PRECISION



Measurement systems are not Ideal things



Understand the signal **conditioning** of your measurement system
Understand the **computation/processing capabilities** with proper characterization

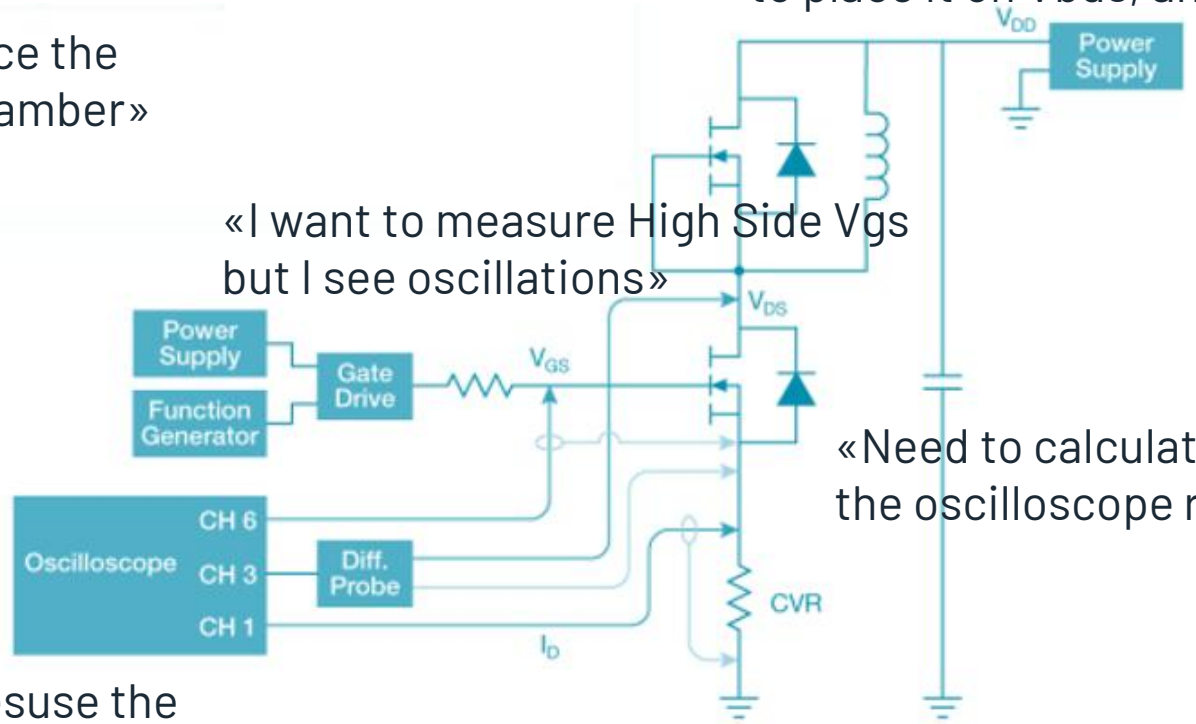
Double Pulse Test Use Case

«We use CVR for current measurements but need to place it on Vbus, and do it safely»

«Probe tips melt if I place the setup in the thermal chamber»

«I want to measure High Side Vgs but I see oscillations»

«Other?»



«Need to calculate **Rds ON** precisely but the oscilloscope resolution is not enough»

«We want to resuse the equipment we already have in the lab»

«My shunt is quite big,
has significant stray impedance when switching fast high Currents, but I would not know how else to connect»

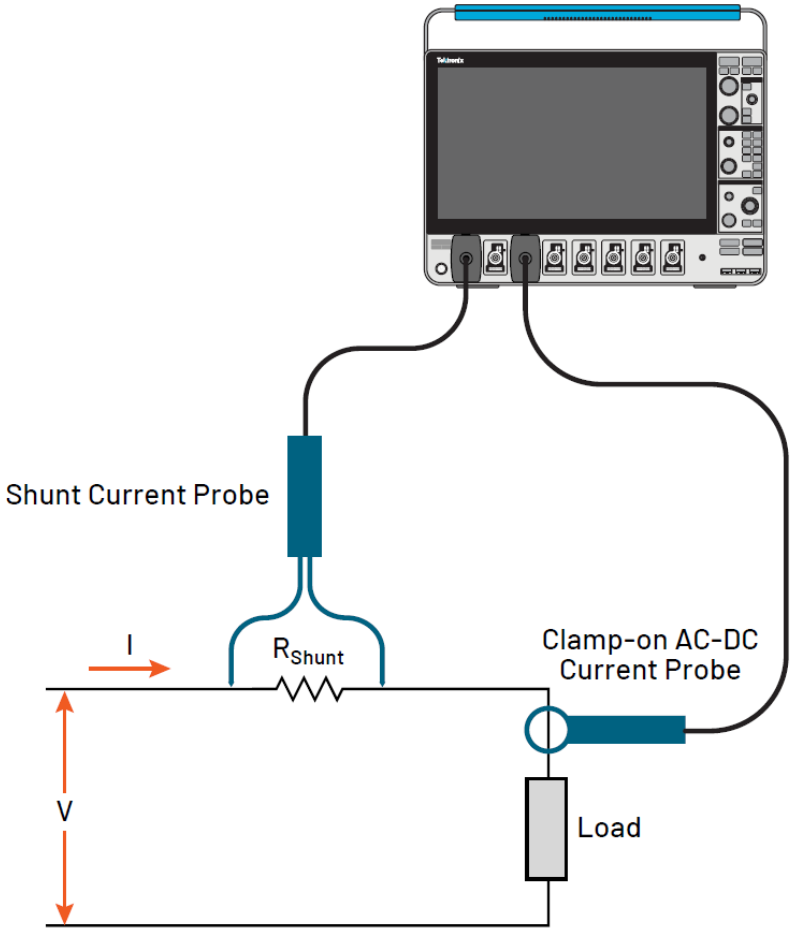
Dynamic Rds ON

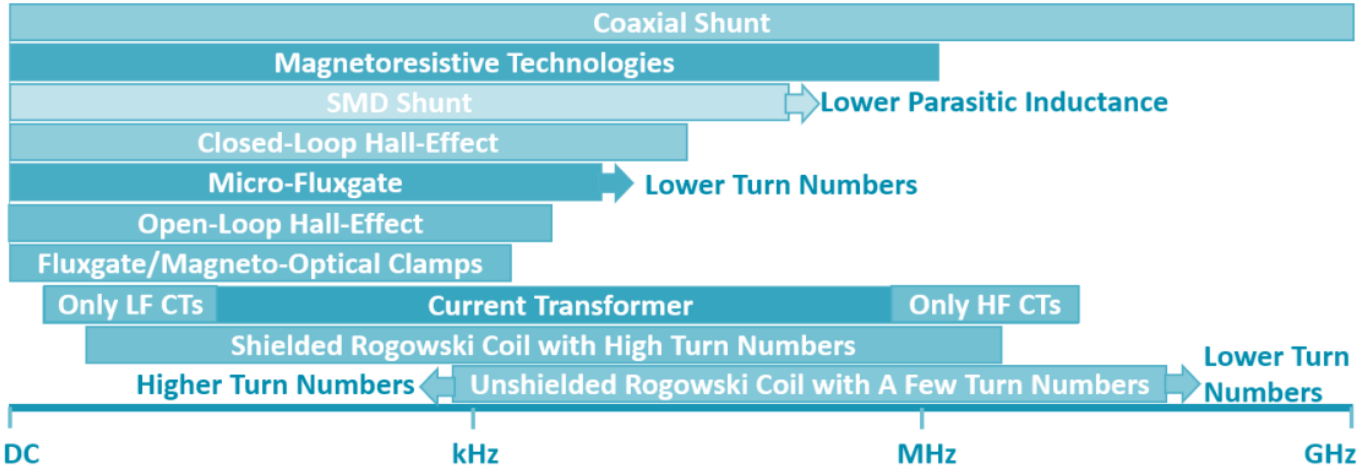
- Avoid overdesign for higher than effective Rds
- Consider ChargeTrapping Effect (in HV)
- Correlate accurately with Vgs, Temperature
- $\frac{Vds}{Id}$ when device is in saturation

- Measure Vds accurately
- Measure Id accuratey

Probing Id

BW, SAFETY, MAGNETIC SATURATION





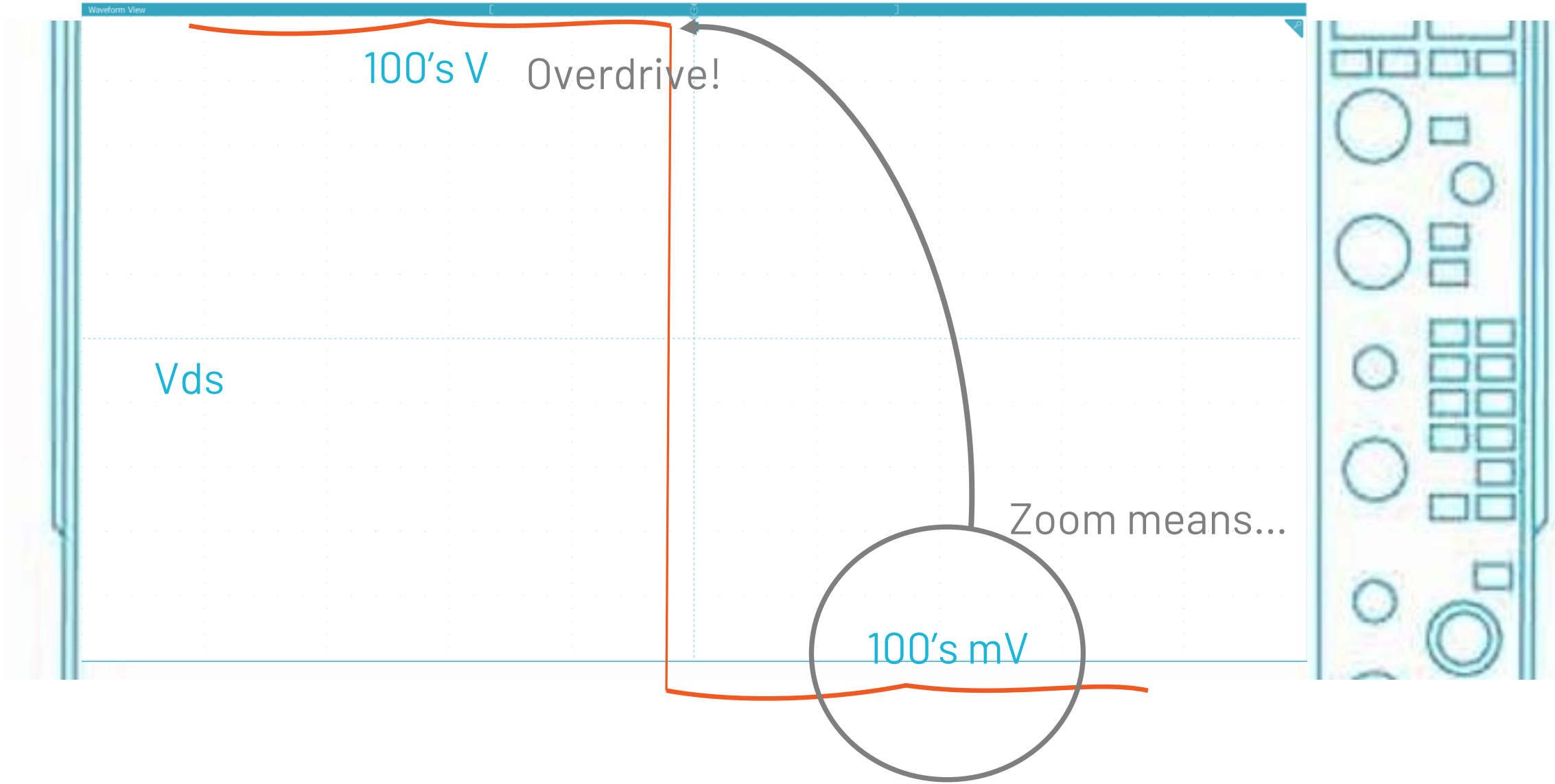
Parsa Sirat, A.; Parkhideh, B. Current Sensor Integration Issues with Wide-Bandgap Power Converters. *Sensors* **2023**, *23*, 6481. https://doi.org/10.3390/s23146481

Tektronix RF Isolated Current Shunt Probe

COMPLETING AN IDEAL SETUP FOR ACCURATE DOUBLE PULSE TEST

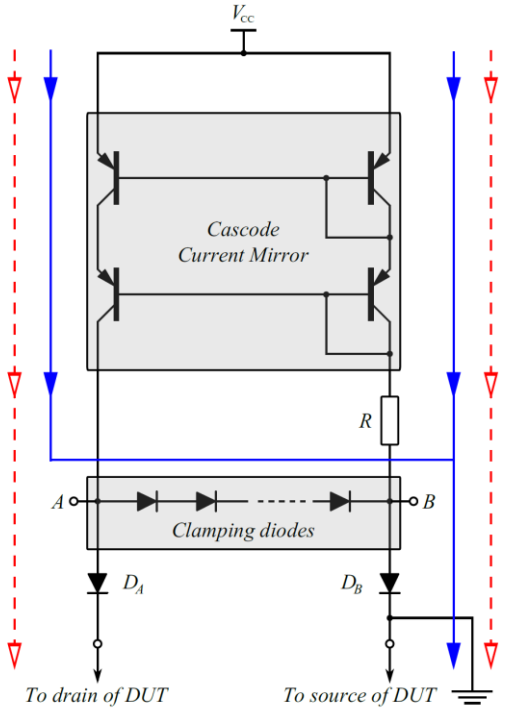
Probing Vds

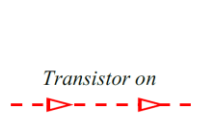
GIVE ME MORE BITS: OSCILLOSCOPE RESOLUTION IMPOSES TO CLAMP

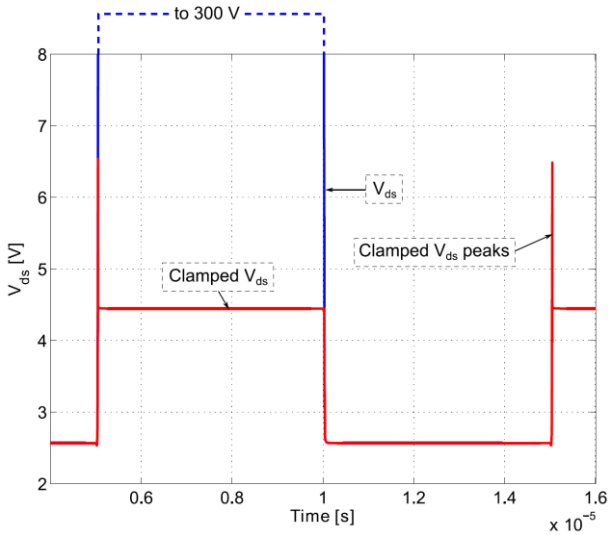


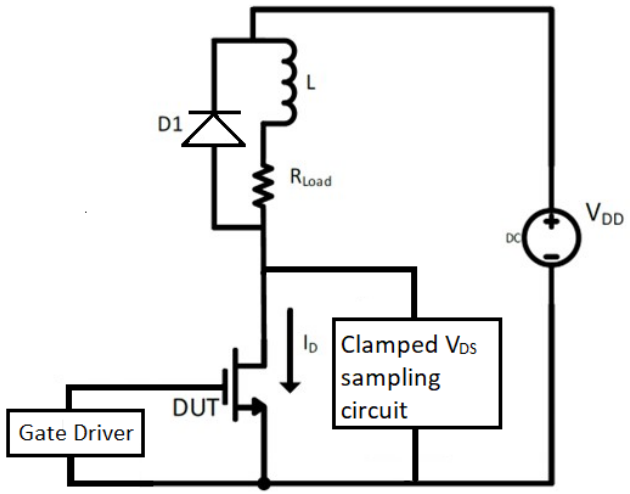
Invasive Clamping solution in High Power

PER DEVICE CLAMPING REQUIREMENTS?









REF IEEE paper: *A Fast Voltage Clamp Circuit for the Accurate Measurement of the Dynamic On-Resistance of Power Transistors*

What if we avoided clamping?

RDS ON CALCULATED BY SOFTWARE WITH DOUBLE PROBING AND FRONT END KNOW-HOW

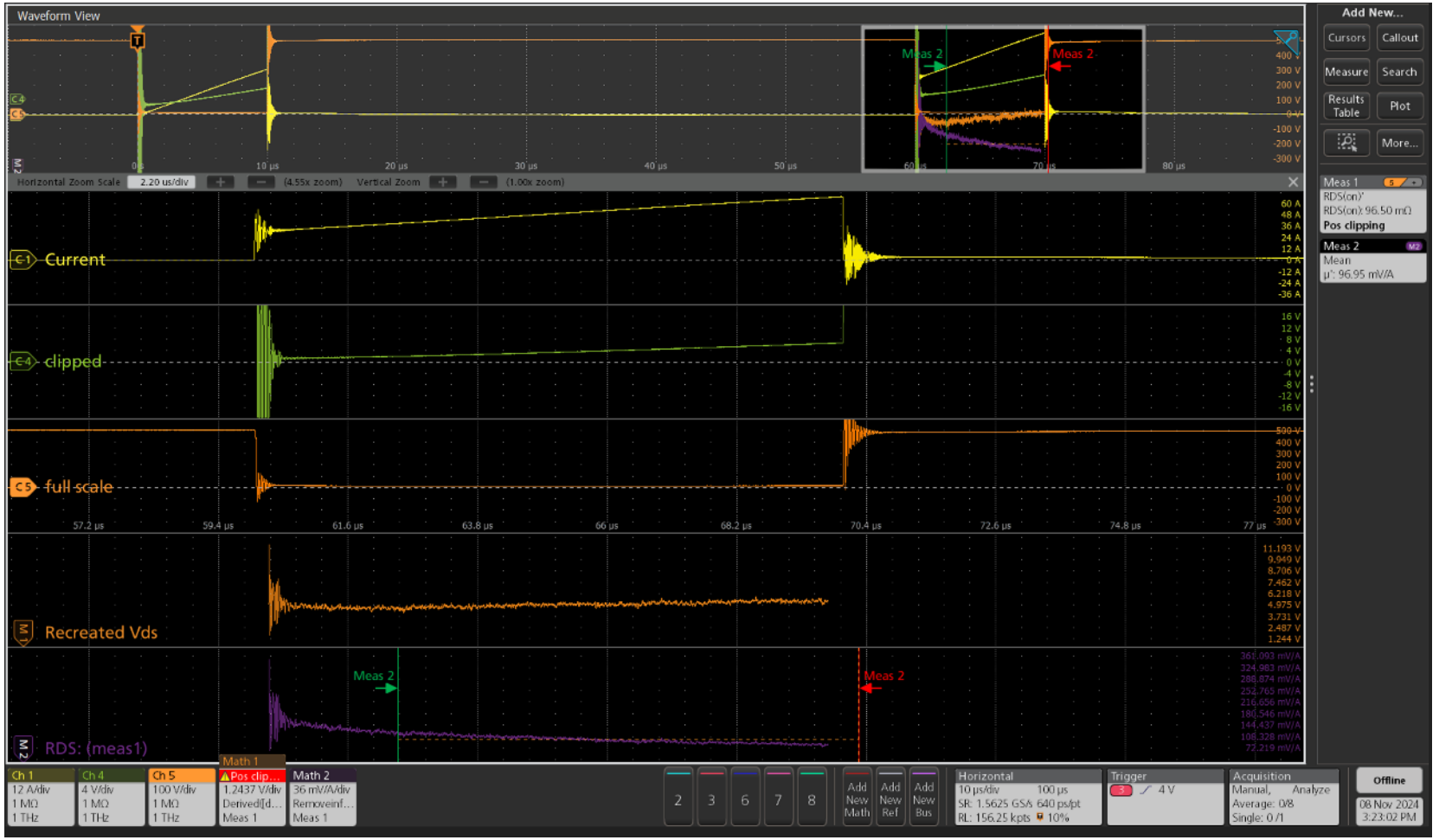
Acquire Vds in full scale and zoomed scale together

Acquire in high ENOB mode

Average mode to reduce noise at lower scales

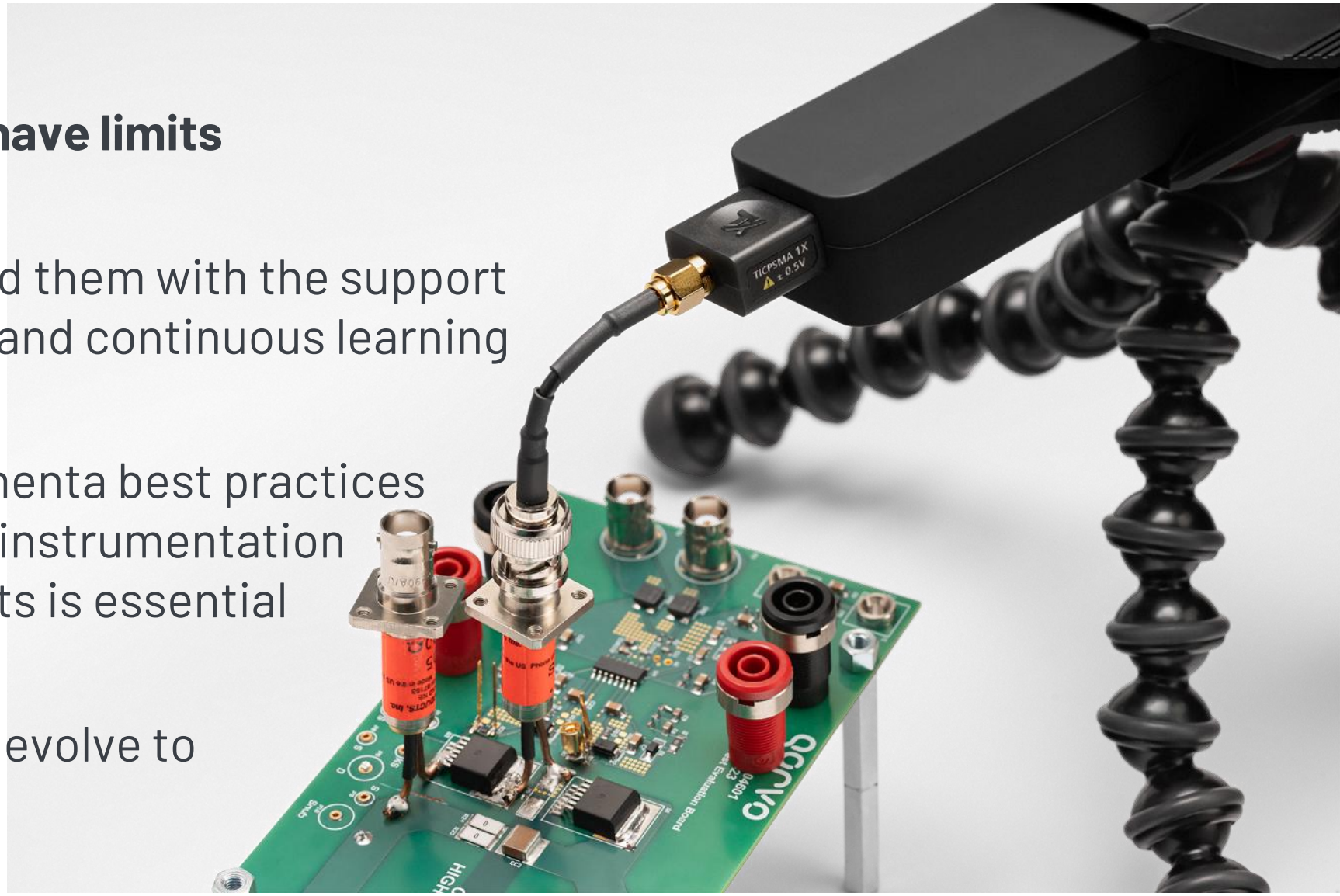
Merge waveforms to get derived Vds

Compute Rds(ON)



That’s A Wrap

- All Test Methodologies **have limits**
- T&M suppliers go beyond them with the support of customers expertize and continuous learning
- Education on measurementa best practices as well as awareness of instrumentation impact on measurements is essential
- Hardware and Software evolve to make it **real**



Back-up Stuff

TICP Series IsoVu™ Isolated Current Probes

INDUSTRY FIRST RF ISOLATED CURRENT PROBES

Bandwidth	250 MHz, 500 MHz, 1 GHz
DC Gain Accuracy	± 1.5%
Isolation	RF Isolation scheme
Common Mode Rejection Ratio (CMRR)	140 dB at DC Up to 90 dB at 1 MHz
Common Mode Voltage	1800 V; For use in a Pollution degree 1 environment 1300 V; Pollution degree 2 1000 V CAT II; 600V CAT III
RMS Input Referred Noise	4.7 nV/RT Hz (<150 uV at 1 GHz)
Current Measurements	AC + DC
Compatible Oscilloscopes	4 Series MSO, 5 Series MSO, 6 Series MSO, 4 Series B MSO, 5 Series B MSO, 6 Series B MSO, 5 Series MSO LP

Current measurement ranges today

INVERSE RELATION BETWEEN CURRENT AND FREQUENCY