#### **Tektronix**<sup>®</sup>

### Latest Advancements in Semiconductor Parameter Analyzers











• USB3 and USB2 ports (keyboards, mouse, storage...)



- Up to 9 Source Measure Units
- Up to 4 dual-channel Pulse and Measure units
- Capacitance Voltage Unit
- GNDU

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#### Test Case Example PHASE CHANGE MEMORY TEST BENCH



**Pulse Generation:** 

- Arbitrary Waveform Generator
- Variable Attenuator
- Amplifier

Pulse Measurement:

- Oscilloscope
- Voltage and current probes

## **Test Challenges and Solutions** HOW THE PARAMETER ANALYZER CAN HELP

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Test Need	Value Proposition
Configure multiple instrument and related parameters	All instruments visually configurable in one page
Multiple Instruments Synchronization and Trigger	Fully handled by Clarius software
Retrieve measurements data in both graphical and tabular formats	Fully handled by Clarius software
Extract device parameters report from measurements	Fully handled by Clarius software (customizable with Formulator)

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### IV Characterization and SMUs

#### **IV Characterization and Parameters extraction** CONFIGURE THE TESTS



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#### **IV Characterization and Parameters extraction** CONFIGURE TESTS



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#### **IV Characterization and Parameters extraction** ANALYZE THE RESULTS



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#### **Source Meter Units** THE NEW 4201-SMU AND 4211-SMU

SMU Current Specifications with 4200-PA Preamplifier<sup>4</sup>

		Current Max. Range <sup>1</sup> Voltage		Measure		Source	
				Resolution <sup>3</sup>	Accuracy ±(% rdg + amps)	Resolution <sup>3</sup>	Accuracy ±(% rdg + amps)
		1 A	21 V	1 µA	0.100% + 200 µA	50 µA	0.100% + 350 µA
4210-SMU High Power SMU and 4211-SMU High Power SMU <sup>2</sup>		100 mA	210 V	100 nA	0.045% + 3 µA	5 µA	0.050% + 15 μA
	4200-SMU Medium Power SMU and 4201-SMU Medium Power SMU <sup>2</sup>	100 mA	21 V	100 nA	0.045% + 3 µA	5 µA	0.050% + 15 µA
		10 mA	210 V	10 nA	0.037% + 300 nA	500 nA	0.042% + 1.5 µA
		1 mA	210 V	1 nA	0.035% + 30 nA	50 nA	0.040% + 150 nA
		100 µA	210 V	100 pA	0.033% + 3 nA	5 nA	0.038% + 15 nA
		10 µA	210 V	10 pA	0.050% + 600 pA	500 pA	0.060% + 1.5 nA
		1 µA	210 V	1 pA	0.050% + 100 pA	50 pA	0.060% + 200 pA
		100 nA	210 V	100 fA	0.050% + 30 pA	5 pA	0.060% + 30 pA
42XX-SMU with optional 4200-PA Preamp		10 nA	210 V	10 fA	0.050% + 1 pA	500 fA	0.060% + 3 pA
		1 nA	210 V	1 fA	0.050% + 100 fA	50 fA	0.060% + 300 fA
		100 pA	210 V	300 aA	0.100% + 30 fA	15 fA	0.100% + 80 fA
		10 pA	210 V	100 aA	0.500% + 15 fA	5 fA	0.500% + 50 fA
		1 pA	210 V	10 aA	1.000% + 10 fA	1.5 fA	1.000% + 40 fA
Voltage Compl	liance: Bipolar lin	nits set with a	single value b	etween full scale a	nd 10% of selected volt	age range.	

SMU Capacitance Specifications	Between SMU Terminals	4201-SMU and 4211-SMU Specs	Source of System Capacitance
Maximum Load Capacitance	Force HI and Force LO	100mA-1A ranges: 100 μF 100nA-10mA ranges: 10 μF 1nA-10nA preamp ranges: 10 μF 1pA-100pA preamp ranges: 1 μF	DUT, coax cables, chuck
Maximum Guard Capacitance	Force HI and Guard	5nF	Triax Cables and Connections
Maximum Shield Capacitance	Guard and Force LO	10nF	Triax Cables and Connections









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### **CV Measurements**



### **CVU Measurement Overview**



Measures AC impedance  $(Z_{DUT})$  of the DUT by sourcing an AC voltage across the device and measuring the resulting AC current and phase.

The time-domain AC values are processed into the frequency-domain to produce the phasor form of the impedance.

The capacitive impedance (and conductance) are calculated based on the measured AC impedance and the phase.

The capacitance is calculated from the impedance and the test frequency:

$$C_{DUT} = \frac{I_{DUT}}{2\pi f V_{ac}}$$

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### **CVU Measurement Overview**

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#### CVU Open Compensation C-V MEASUREMENTS ON A MOSFET



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### 4215-CVU vs 4210-CVU

Feature	4215-CVU	4210-CVU
Discreet Frequencies	10,000	37
Frequency Sweeps	Linear, log, list	Linear
AC Drive Voltage	10 mV to 1V rms	10 mV to 100 mV rms
New filter settings	yes	yes
Can be used with all Library tests?	yes	yes
Can be used with new CVU user library?	yes	yes, except log sweep
Y, admittance	yes	yes



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## The Clarius Software

### **Clarius+ Software Suite**

4200A-SCS SOFTWARE APPLICATIONS INCLUDED WITH SYSTEM



Learning Center contains manuals, white papers, applications notes, release notes, videos and other related literature



KCon – Keithley Configuration Utility



Clarius – Keithley Interactive Test Environment



**KXCI – Keithley External Control** Interface



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KULT – Keithley User Library Tool



**KPulse** – Keithley Pulse



### **Clarius+ Software Suite**

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#### C Default - Clarius PC – 0 × Ξ. ba $\bigcirc$ 0 ⇒ 1110 X C ••• Stop Analyze Toole Projects My Settings Learning Center Select Configure P Î X $(\mathbf{b})$ Test Settings Terminal Settings Help $\bigcirc$ vtlin#1 Key Parameters All Parameters Delete Copy Rename vtlin#1 Default $\checkmark$ 4 Site Measure Settings Drain SMU2 . A 💮 Subsite ~ Speed Normal • Operation Mode Voltage Bias • $\checkmark$ 🔺 🕂 4terminal-n-fet Report Timestamps Bias 1 V vds-id Compliance 0.1 Test Mode ~ vds-id\_1 Measure Current Report Voltage Gate SMU3 . -Mode Sweeping vtlin Operation Mode Voltage Linear Sweep v Sweep Delay 0 S - subvt Start 0 Hold Time 0 vgs-id V $\downarrow$ Stop 5 Bulk GNDU . - ig-vg Step 0.05 Operation Mode Ground Unit • Exit Condition Formulator cv-nmosfet Compliance 0.1 pulse-vds-id Measure Current 🗸 Report Voltage waveform-meas Source SMU1 • **A** Custom Test Operation Mode Voltage Bias . 🔺 🚎 5terminal-generic Bias 0 V A 🗸 Custom Test\_2 Compliance 0.1 $\checkmark$ Custom Test\_1 Measure Current Report Voltage $\square$ 🗧 3terminal-npn-bjt Messages 2023/09/13 - 11:08:57: Clarius Hardware Server started. NUM

### **Clarius+ Software Suite**



### **Clarius+ Software Suite**

# THANK YOU

#### **Contact Information**

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### **Question time**

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