System 82-4200
System 82-WIN

Simultaneous C-V Systems

Keithley supplies C-V products for virtually every stage of semiconductor research, development, and production processes. Our line of hardware and software products offers solutions for a broad array of measurements, including quasistatic and high frequency C-V. These can be measured either simultaneously or sequentially with Keithley C-V systems.

Keithley C-V software provides comprehensive analysis of measured and calculated parameters to help semiconductor fabs shorten their time-to-market and maintain device yields. Our solutions are used around the globe for applications that include:

- Developing and integrating new semiconductor processes
- Research and development of new materials and device structures, such as thin oxides, high-κ, and low-κ dielectrics
- Post-metalization process characterization
- Device reliability
- Analyzing failure mechanisms

- **Ultra-thin gate oxide characterization down to 30Å**
- **Oxide charge characterization, such as mobile ion, interface trap charges**
- **MIS device characterization, including threshold voltage, oxide thickness, etc.**
- **Carrier lifetime and generation velocity**
- **Accurate doping profile with C-V**
- **Industry's only simultaneous C-V and quasistatic C-V with feedback charge technique**
- **Easy-to-use test development software**
- **C-V/I-V combination systems may employ either Keithley's Model 4200-SCS Semiconductor Characterization System as the controller or the Metrics-ICS software**

Simplified Approach to C-V Measurements

Keithley's C-V instruments that either use Metrics-ICS software or are controlled by the Model 4200-SCS Semiconductor Characterization System, simplify characterizing devices accurately. For example, the System 82-WIN provides simultaneous C-V testing—quasistatic and high frequency C-V measurements can be performed in a single voltage sweep. This simultaneous technique, which is unique to Keithley, improves C-V measurement accuracy. This technique eliminates the need for multiple measurements, theoretical curves, and doping profile assumptions.

OPTIONAL SYSTEM ENHANCEMENTS

I-V CAPABILITY	
236	Source-Measure Unit
237	High Voltage Source-Measure Unit
238	High Current Source-Measure Unit
2400	SourceMeter
2410	High Voltage SourceMeter
2420	High Current SourceMeter
2430	Pulse SourceMeter

SWITCHING	
707A	Switching Matrix – up to 8×72
708A	Switching Matrix – up to 8×12
7174A	8×12 Low Current Matrix Card
7072A	8×12 Semiconductor Matrix Card

ACCESSORIES AVAILABLE

RANGE EXTENDERS	
5904	Range Extender for 20nF range on 590

RACK MOUNT KITS	
1019A-2	Dual Fixed Rack Mount Kit (for 230-1 and 595)
2288	Fixed Rack Mount Kit (for 590)

MISCELLANEOUS	
5905, 5906, 5907, 5909, and 5955	Calibration and Verification Sources

IEEE-488 INTERFACE	
KPC-488.2AT	Interface Card
KPCI-488.2	Interface Card

SOFTWARE	
Metrics-ICS	Windows-based Interactive Characterization Software including drivers for C-V and I-V instruments (included with Model 82-WIN)
Metrics-ICS-CV	C-V Analysis Libraries for Metrics-ICS (included with Model 82-WIN)
Metrics-ICS-SW	Switch Drivers for Metrics-ICS

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A GREATER MEASURE OF CONFIDENCE

System 82-4200
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Ordering Information

System 82-4200

Simultaneous C-V for use with Model 4200 Systems. Includes Model 595 Quasistatic C-V Meter, Model 590 100k/1M C-V Analyzer, Model 230-1 Programmable Voltage Source, Model 5909 Calibration Source, Model 5951 Remote Input Coupler, and all necessary cables. No software included. Use with Model 4200 with software revision 4.3.2 or later.

System 82-WIN

Factory-integrated, rack mounted, and assembled Simultaneous C-V System for Windows. Includes Model 230-1 Programmable Voltage Source, Model 595 Quasistatic C-V Meter, Model 590 100k/1M C-V Analyzer, Model 5951 Remote Input Coupler, Model 5909 Calibration Sources, Metrics-ICS software, Metrics-ICS-CV analysis libraries, computer and monitor (contact factory for complete configuration).

Model 82-WIN

Similar hardware to System 82-WIN, but without computer, monitor or rack-mounting hardware. Requires customer-supplied Windows-based computer. Customer provides system integration.

System 83

Factory integrated, rack mounted, and assembled Simultaneous C-V System including computer and monitor plus prober and hot chuck (contact factory for complete configuration).

System 86-WIN

Factory integrated, rack mounted, and assembled Simultaneous C-V System plus I-V and switching capability, including computer and monitor (contact factory for complete configuration).

Extended warranty, service, and calibration contracts are available.

Accessories Supplied

See system descriptions in Ordering Information.

Simultaneous C-V Systems

Simultaneous C-V testing with a fully integrated system including I-V measurements offers a variety of additional benefits. The simultaneous method eliminates errors due to changes in device characteristics between the first and second sweeps, which are caused by voltage stress. It also eliminates curve alignment errors due to a variety of factors. This solution minimizes hardware and software integration problems, while the automated test sequences this approach allows also help increase productivity.

Keithley's System 82-4200 and System 82-WIN include parameter extraction algorithms for C-V and C-t measurement. Table 1 lists some of the parameters calculated by these libraries. Device parameters such as interface trapped charge density, mobile charge density, doping profile, generation lifetime, threshold voltage, etc. are available and displayed immediately after measurement.

From Individual Instruments to Fully Integrated Systems

Keithley supplies a comprehensive range of instruments, software, and integrated systems that allow MOS semiconductor fabs to choose the best fit for their application, whether it's basic technology research, device development, or process characterization. Table 1 offers an overview of Keithley's C-V product features and measurement capabilities.

Table 1. Keithley C-V Product Capabilities

		82-4200 or 82-WIN Systems[1,2]	590 C-V Analyzer w/Metrics-ICS or 4200-SCS
Oxide Charge Characterization	Interface Trap Density, Band Bending	•	
	Mobile Ion Tests:		
	BTS Method	•	•
	STVS Method	•	
	Effective Oxide Charge Density, Q_{EFF}	•	•
MIS Device Parameters	Oxide Thickness	•	•
	Series Resistance	•	•
	Flatband C and V	•	•
	Threshold Voltage	•	•
	Bulk Doping	•	•
	Metal-Semiconductor Work Function	•	•
	Debye Length	•	•
	Bulk Potential	•	•
	Average Doping	•	•
Doping Profiles	Interface Trap Correction	•	
	Junction Doping	•	
	Pulsed High-Frequency C-V	•	•
Lifetime C-t	Capacitance vs. Time	•	•
	Zerbst Plot	•	•
	Minority Carrier Lifetime	•	•
	Surface Generation Velocity	•	•
Miscellaneous	Quasistatic C-V and Q/t vs. V	•	
	High Frequency C-V and G or R vs. V	•	•
	Simultaneous C-V	•	
	Automatic Test Sequences with Switch Control	•	
	Thermal Chuck Control	•	

1. Model 82-WIN is an instrument cluster, plus Metrics-ICS software for a Windows-based PC. The PC and system integration are supplied by the user. However, the embedded computer in the Keithley 4200-SCS can be used as the controller.
2. System 82-WIN is a factory integrated C-V characterization system customized to user specifications, supplied with a Pentium computer and Windows operating system.

System 82-4200
System 82-WIN

Simultaneous C-V Systems

HIGH FREQUENCY CAPACITANCE[1]

100 kHz:

RANGE	RESOLUTION	ACCURACY (1 Year, 18°–28°C) ±(%rdg + pF)	TEMPERATURE COEFFICIENT (0°–18°C & 28°C–40°C) ±(%rdg)/°C	NOISE P-P
2 pF	0.1 fF	1.0 + 0.01	0.03	10 fF
20 pF	1 fF	0.7 + 0.01	0.03	20 fF
200 pF	10 fF	0.7 + 0.05	0.03	180 fF
2 nF	100 fF	0.9 + 0.5	0.08	1800 fF
20 nF [2]	1 pF	1.4 + 10	0.3	18 pF

1 MHz:

RANGE	RESOLUTION	TEMPERATURE ACCURACY (1 Year, 18°–28°C) ±(%rdg + pF)	COEFFICIENT (0°–18°C & 28°C–40°C) ±(%rdg)/°C	NOISE P-P
20 pF	1 pF	0.9 + 0.02	0.03	20 fF
200 pF	10 fF	0.9 + 0.05	0.03	200 fF
2 nF	100 fF	1.4 + 0.5	0.14	400 fF

SHUNT CAPACITANCE LOADING EFFECT: 0.1% of reading additional error per 100pF load with equal shunt load on input and output.

TEST VOLTAGE: 15mV rms ± 10%.

TEST FREQUENCY TOLERANCE: ±0.1%.

QUASISTATIC CAPACITANCE[3]

100 kHz:

RANGE	RESOLUTION	ACCURACY (1 Year, 18°–28°C) ±(%rdg + pF)	NOISE P-P (Typical)
200 pF	10 fF	1.0 + 0.1	(0.12% rdg + 0.13 pF) × (100 mV/STEP V) + 0.01 pF
2 nF	100 fF	0.8 + 0.2	(0.09% rdg + 0.13 pF) × (100 mV/STEP V) + 0.1 pF
20 nF	1 fF	0.6 + 2.0	(0.09% rdg + 0.13 pF) × (100 mV/STEP V) + 0.1 pF

TEMPERATURE COEFFICIENT (0°–18° & 28°–40°C): ±(0.02% rdg + 0.1pF)/°C.

NOTES:

1. Specifications are based on parallel RC model and Quality Factor ≥20. Assumes proper cable correction and open circuit suppression.
2. Requires 5904 range extending adapter.
3. Quasistatic capacitance accuracy is exclusive of noise, for STEP V ≥ 0.05V and DELAY TIME ≤ 1 second. For other parameters, derate by (5mV/STEP V) × (DELAY TIME/1 second) in pF at 23°C. Double the derating for every 10°C rise in ambient temperature above 23°C. Typical allowable non-equilibrium current plus leakage current: <20pA on 200pF range; <200pA on 2nF range during capacitance measurements.

VOLTAGE MEASUREMENT

ACCURACY (1 Year, 18°–28°C): ±(0.05% rdg + 50mV).

RESOLUTION: 10mV.

TEMPERATURE COEFFICIENT (0°–18° & 28°–40°C): ±(0.005% + 1mV)/°C

VOLTAGE SOURCE

VOLTAGE	P-P NOISE[1] (0.1 Hz to 10 Hz)	RESOLUTION
≤ 20 V	150 µV	10 mV
> 20 V to 120 V	250 µV	100 mV

[1] Typically 3mV up to 75MHz.

MAXIMUM SWEEP SPAN, |VSTART – VSTOP|: 40V.

MAXIMUM OUTPUT CURRENT: ±2mA (–0%, +20%).

SWEEP STEP VOLTAGE SELECTIONS: 10mV, 20mV, 50mV, 100mV.

DC OUTPUT RESISTANCE: <10Ω.

GENERAL

READING RATES: 4½ readings per second to one reading every 400 seconds.

DATA BUFFER: 450 points maximum.

GRAPHICAL OUTPUTS: Computer display or Windows supported printers and plotters.

DIGITAL I/O: Consists of one output, four inputs, +5V (series limited with 33Ω), and COMMON referenced to IEEE-488 COMMON. Output will drive one TTL load. Inputs represent one TTL load.

OPERATING ENVIRONMENT 0° to 40°C, 70% non-condensing RH up to 35°C.

STORAGE ENVIRONMENT: –25°C to +65°C.

WARM-UP: 2 hour to rated accuracy.

SYSTEM CONFIGURATION: Models 230-1, 590, 595, and 5951 connected as shown in manual.

SYSTEM 82-4200 AND SYSTEM 82-WIN COMPONENTS:

- 230-1 Programmable Voltage Source
- 595 Quasistatic C-V Meter
- 590 100k/1M C-V Analyzer
- 5909 Calibration Sources for 200pf, 2nF ranges (see Options for additional ranges)
- 5951 Remote Input Coupler—Includes Models:
  - 4801 Low noise BNC Cable, 1.2m (4ft), (5 supplied)
  - 7007-1 Shielded IEEE-488 Cable, 1m (3.3 ft), (2 supplied)
  - 7007-2 Shielded IEEE-488 Cable, 2m (6.6 ft), (1 supplied)
  - 7051-2 RG-58C BNC to BNC Cable, 0.6m (2 ft), (3 supplied)

ADDITIONAL HARDWARE FOR SYSTEM 82-4200:

- 4200-SCS/F Semiconductor Characterization System with 2 each MPSMU and 12″ Flat Panel Display, or
- 4200-SCS/C Semiconductor Characterization System with 2 each MPSMU and Composite Front Bezel

ADDITIONAL SOFTWARE FOR SYSTEM 82-WIN:

Metrics ICS, version 3.5.2 (includes instrument drivers)

Metrics-ICS-CV Analysis Libraries

82-WIN System Configuration

82-WIN MINIMUM COMPUTER CONFIGURATION: 233MHz Pentium, 32MB RAM for Windows 95/98, 64MB RAM for Windows NT 4.0 or 2000, 6GB hard drive, Windows 95, 98, NT 4.0 with Service Pack 6, or 2000, Centronics parallel port.

82-WIN RECOMMENDED COMPUTER CONFIGURATION: 350MHz PentiumII, 64MB RAM for Windows 95/98, 128MB RAM for Windows NT 4.0 or 2000, 6GB hard drive, Windows 95, 98, NT 4.0 with Service Pack 6, or 2000, Centronics parallel port.

Compatible with IEEE-488 cards:
National Instruments PCI-GPIB, PCMCIA
Keithley KPC-488.2, KPC-488.2AT, KPCI-488

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