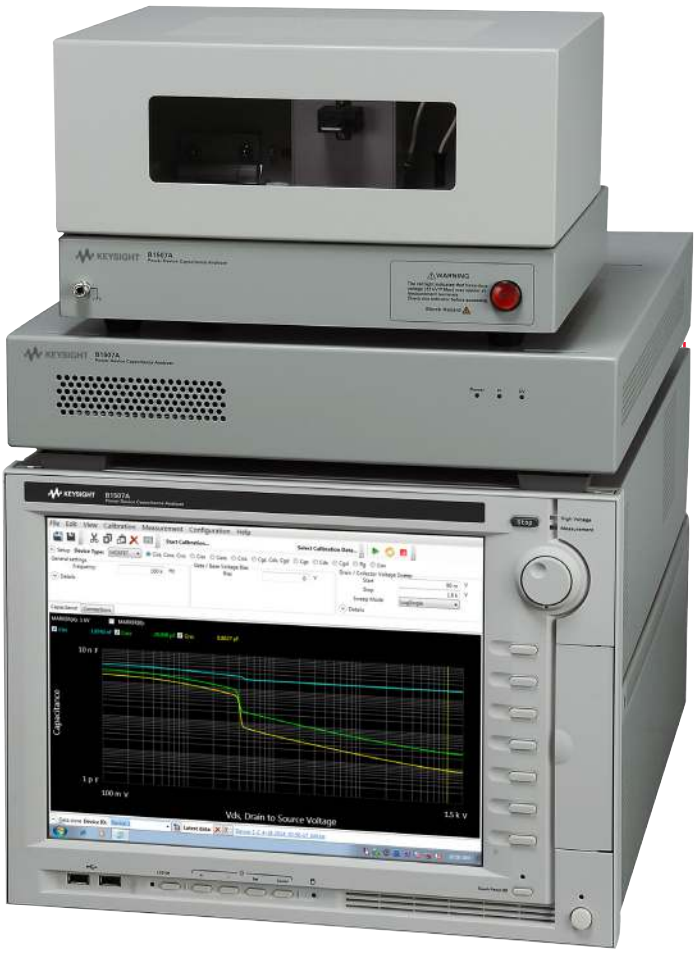
Keysight B1507A
Power Device Capacitance Analyzer

Data Sheet



Automatically evaluate all power device capacitance parameters (including Ciss, Coss, Crss, and Rg) under a wide range of operating voltages to improve power device and power electronics circuit design performance

KEYSIGHT TECHNOLOGIES

Introduction

With the increasing use of power devices fabricated from emerging new materials such as SiC and GaN, switching power supplies are operating at increasingly higher frequencies. This makes accurate device capacitance characterization more important than ever before. The B1507A Power Device Capacitance Analyzer meets this need, providing a complete solution for the evaluation of power device capacitance (such as input, output, and reverse transfer capacitances). The B1507A can help power device development engineers maximize product value and performance by revealing detailed device characteristics. It can also help power electronic circuit designers maximize their products' value by helping them to select the optimal power devices for their applications. The B1507A's intuitive GUI allows you to automatically measure all capacitances under a wide range of operating voltages. In addition, it makes it easy to switch back and forth between leakage tests (to verify the device is not damaged) and capacitance measurements without having to do any recabling.

The B1507A can help identify substandard devices under actual circuit operating voltage biases (up to 3 kV). This is an ideal complement to conventional IV test equipment (such as curve tracers) that do not have either capacitance or leakage testing capabilities.

Moreover, the B1507A's furnished software presents the user with an intuitive user interface that makes it easy to characterize devices without going through any formal training. Integrated switching circuitry within the test fixture supports fully-automated testing, with the ability to automatically make the correct connections for all types of capacitance measurements. This includes the insertion of DC blocking capacitors and AC blocking resistors as well as making the connections necessary for correct gate and drain/collector leakage measurements.

Finally, a unique plug-in style device test fixture socket adapter helps to eliminate cable connection and other human-related errors. Taken together, the B1507A's capabilities revolutionize power device development and power electronics circuit design by both helping to maximize end product value and accelerating product development cycles.

- Measure transistor input, output and reverse transfer capacitances (Ciss, Coss, Crss, Cies, Coes, Cres) at high bias voltages
- Measure independent terminal capacitances (Cgs, Cgd, Cds, Cge, Cgc, Cce)
- Measure capacitances for normally-on devices such as SiC JFET or GaN FET
- Measure internal gate resistance (Rg)
- Measure capacitance continuously as the gate voltage varies from negative to positive
- Easy to switch back and forth between leakage tests and capacitance measurements
- Wide operation voltage bias up to +/-3 kV
- Easy to use and fully automated measurement

Specification conditions

The measurement and output accuracy are specified under the conditions listed below. Note: The capacitance measurement accuracy is specified at the output terminals of the MFCMU. The SMU measurement and output accuracy are specified at the output terminals inside the test fixture.

1. Temperature: 23 °C ± 5 °C
2. Humidity: 20% to 70%, No condensation
3. Self-calibration after a 40 minute warm-up is required.
4. Ambient temperature change less than ±1 °C after self-calibration execution. (Note: This does not apply to the MFCMU).
5. Measurement made within one hour after self-calibration execution. (Note: This does not apply to the MFCMU).
6. Calibration period: 1 year
7. SMU integration time setting: 10 PLC (1 nA to 100 mA range, Averaging of high-speed ADC: 128 samples per 1 PLC
8. SMU filter: ON for MPSMU

Operating conditions

The B1507A's data sheet specifications are only guaranteed under the conditions listed below.

Temperature: +5°C to +40°C
Humidity: 20% to 70%, No condensation

Key Specifications of B1507A

Key Specification				
Capacitance measurement	Max bias	Gate		±100 V
		Collector/Drain		±3000 V
	Frequency range			1 kHz to 1 MHz
	Capacitance range			100 fF to 1µF
Collector / Drain channel	Max output	Voltage		±3000 V
		Current	DC	±8 mA
	Source	Min. resolution	Voltage	200 µV
			Current	100 fA
	Measurement	Min. resolution	Voltage	200 µV
			Current	100 fA
Gate channel	Max output	Voltage		±100 V
		Current	DC	±100 mA
	Source	Min. resolution	Voltage	25 µV
			Current	50 fA
	Measurement	Min. resolution	Voltage	0.5 µV
			Current	10 fA

Measurement parameters

Characteristics	**Category**	**Parameters**
Capacitance characteristics	Device Capacitance	Ciss, Coss, Coss_eff, Crss, Cgs, Cgd, Cds, Cies, Coes, Cres, Cge, Cgc, Cce,
	Gate Resistance	Rg
Static characteristics	Gate leakage current	Igss, Iges
	Output leakage current	Idss, Ices
	Breakdown voltage	BVds, BVces
	Threshold voltage	V(th),Vge(th)

Capacitance measurement specifications

B1507A capacitance measurement is achieved using the combination of an MFCMU module in the B1507A mainframe and the built-in device capacitance selector in the B1507A test fixture.

DC bias characteristics

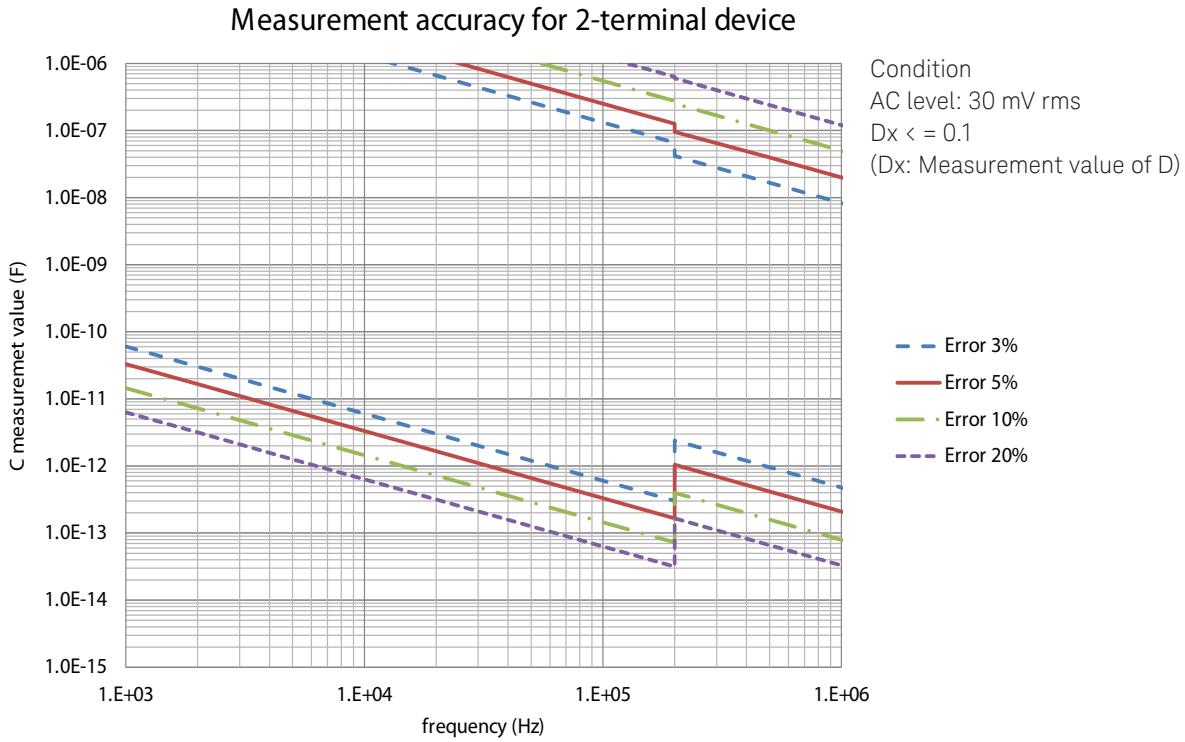
100 kΩ at SMU bias output resistance
Voltage drop compensation function is available.

Bypass capacitance in the capacitance selector

	Capacitance	Withstand voltage
Drain to Source Terminal	1 µF	±3000V
Gate to Source Terminal	1 µF	±100V

Measurement accuracy for 2-terminal device (Supplemental characteristics)

Accuracy of this supplemental characteristics is defined at the output terminals inside the test fixture.



Output terminals for 2-terminal device

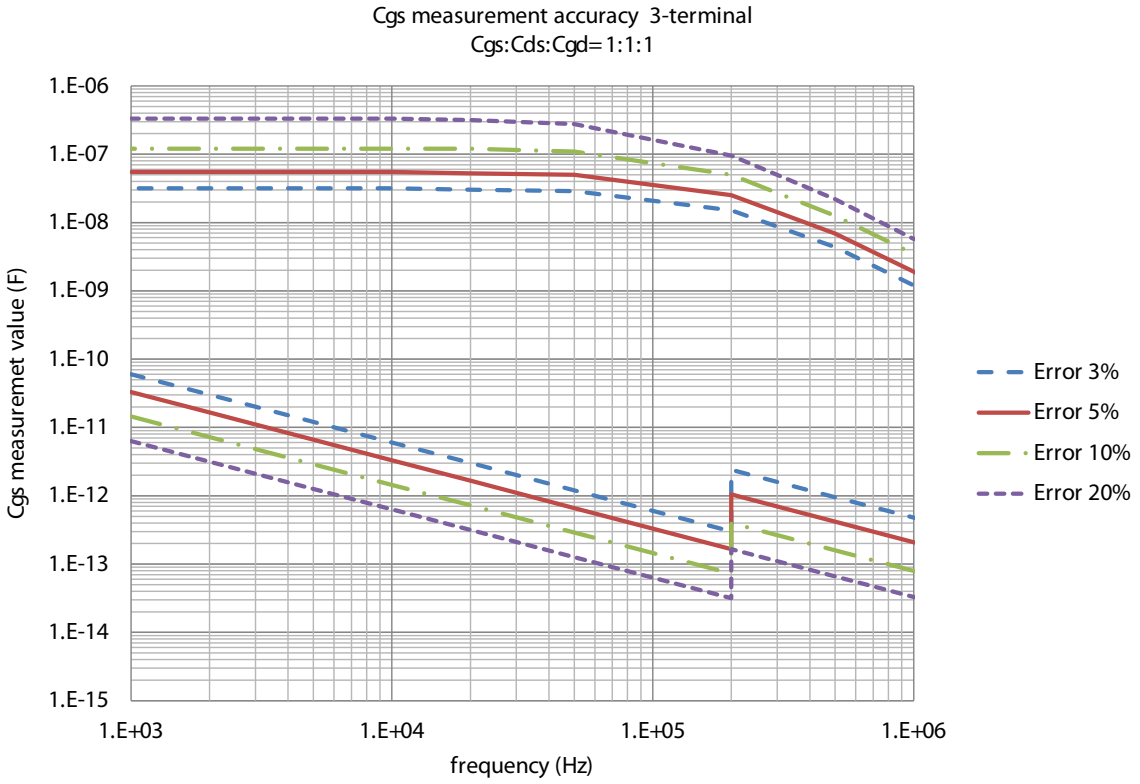
Collector/Drain	High	High	
Emitter/Source		Low	High
Base/Gate	Low		Low

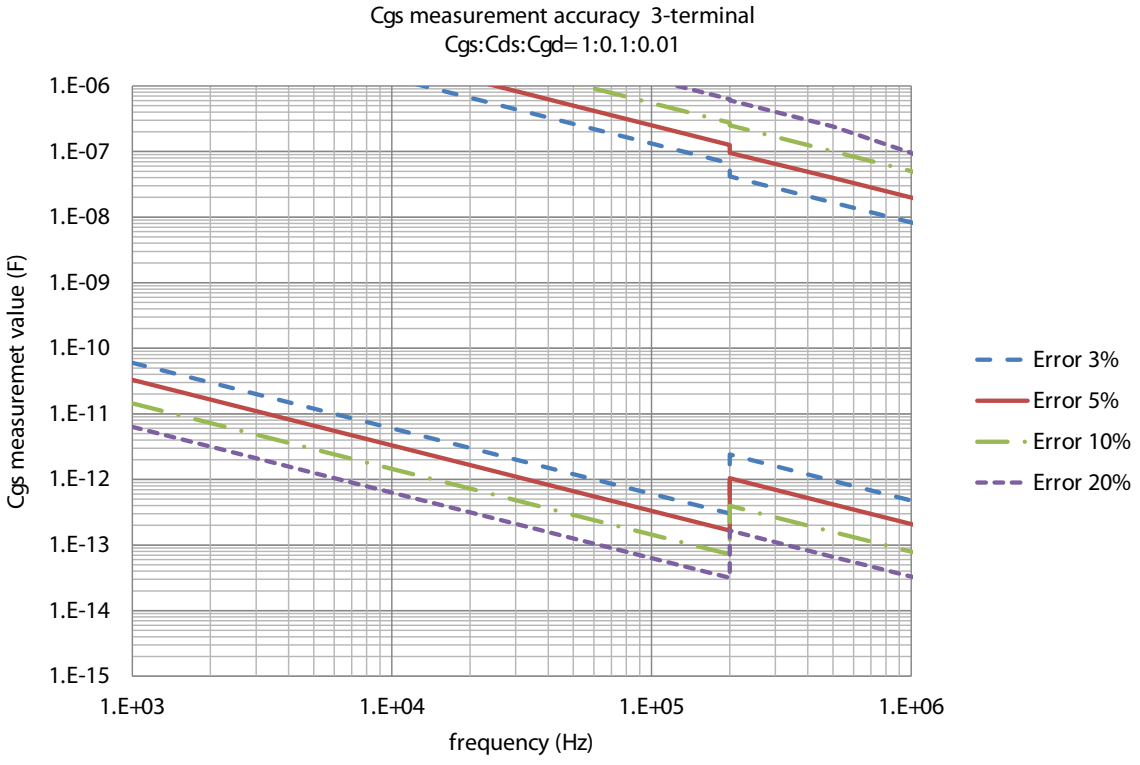
Measurement accuracy for 3-terminal device (Supplemental characteristics)

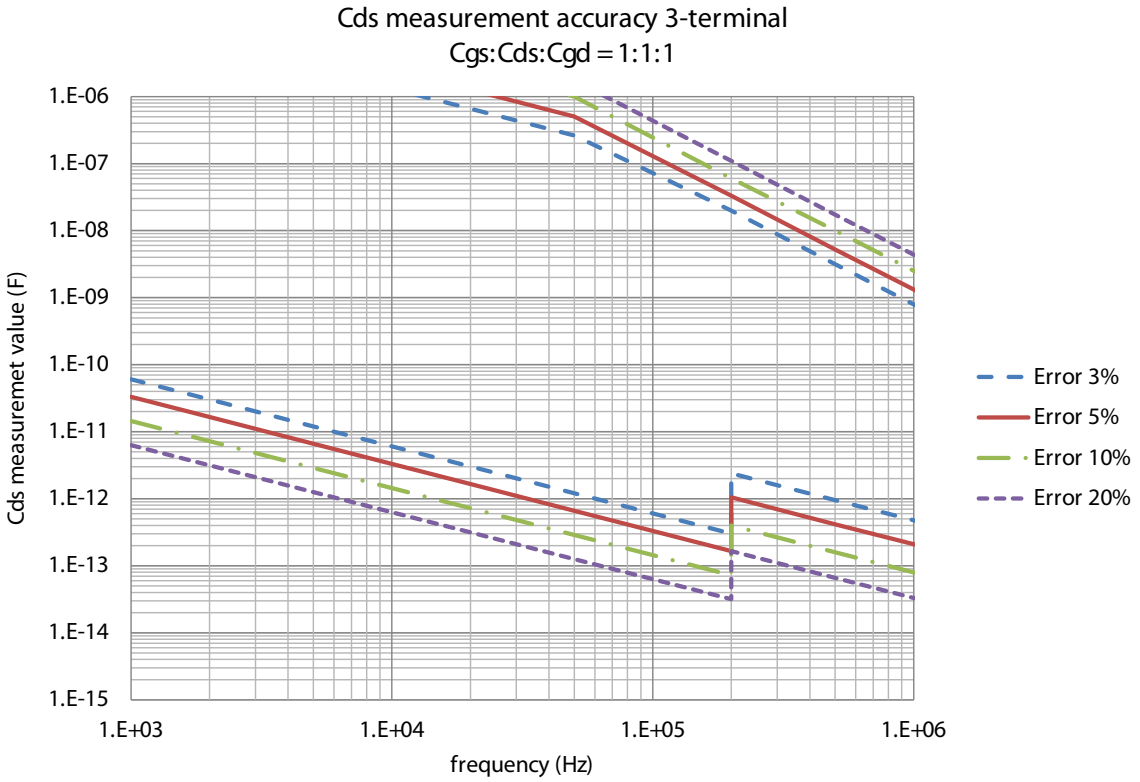
Accuracy of the following supplemental characteristics is defined at the output terminals inside the test fixture.

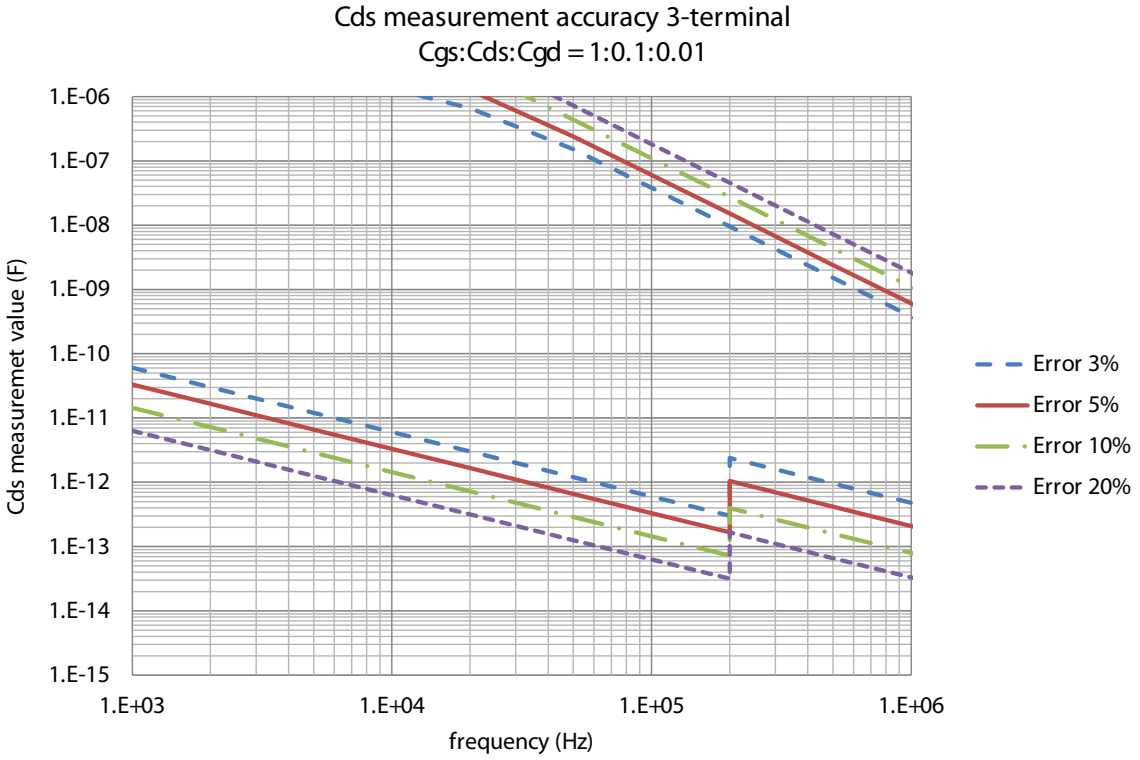
Condition

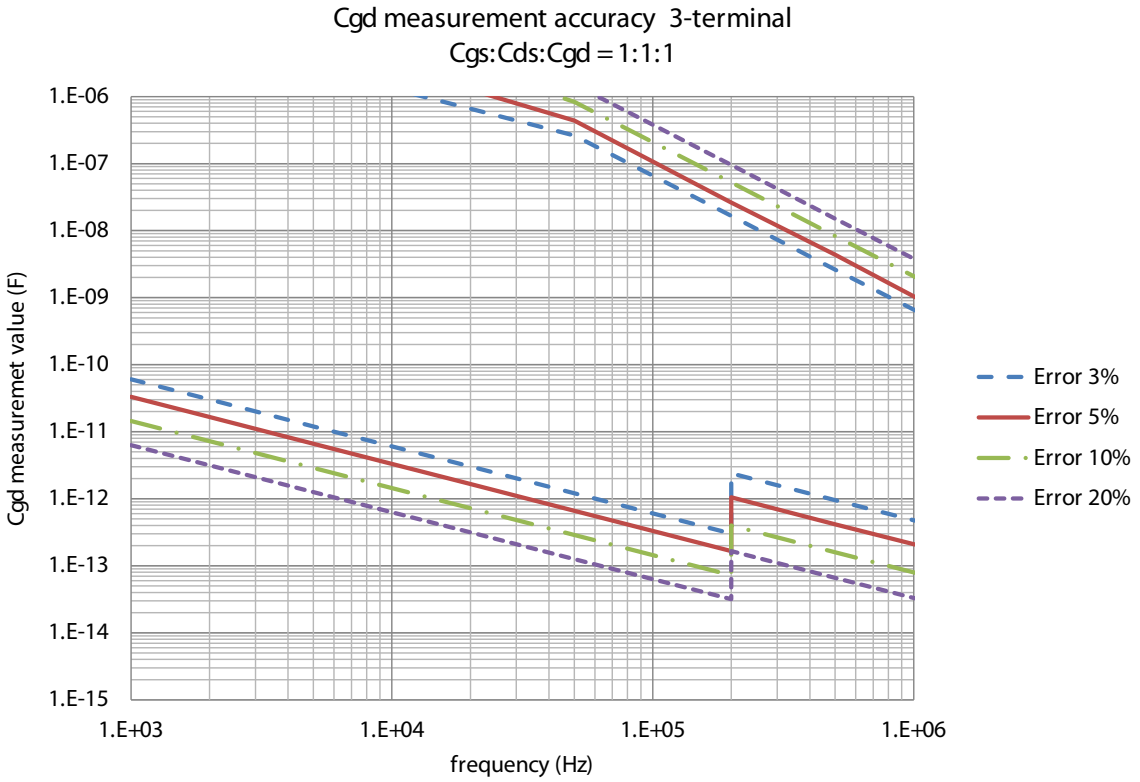
AC level: 30 mV rms, Dx < = 0.1 (Dx: Measurement value of D)

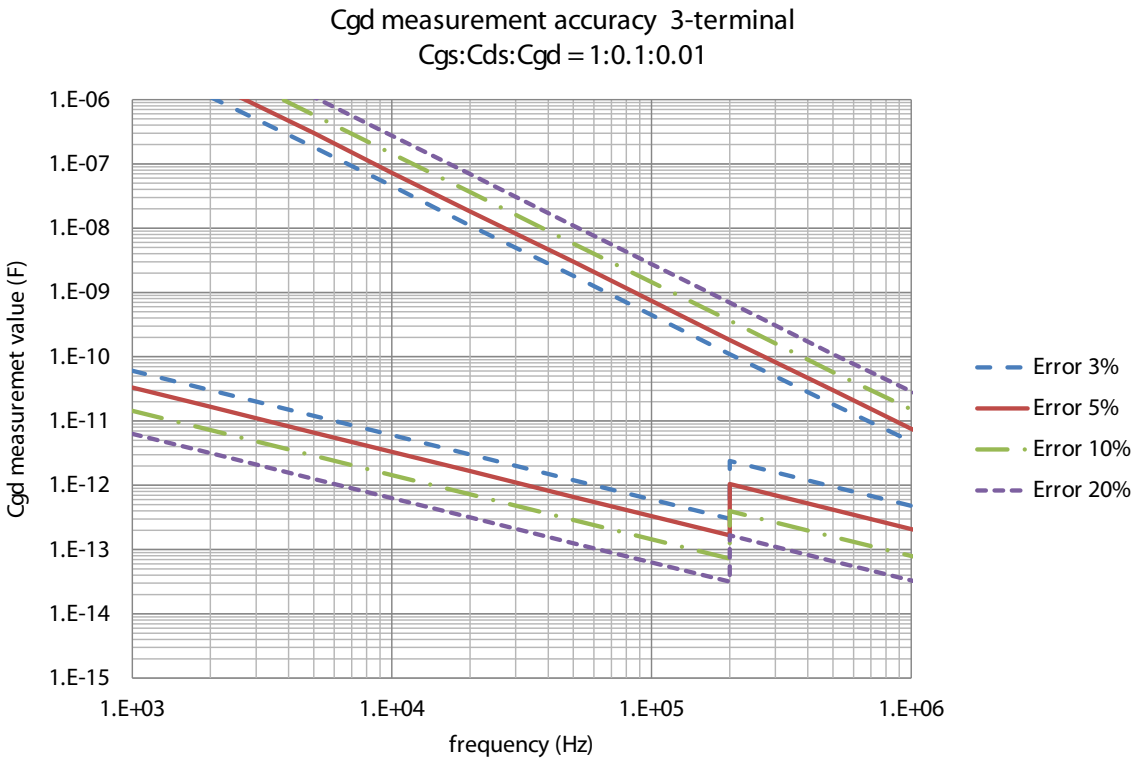


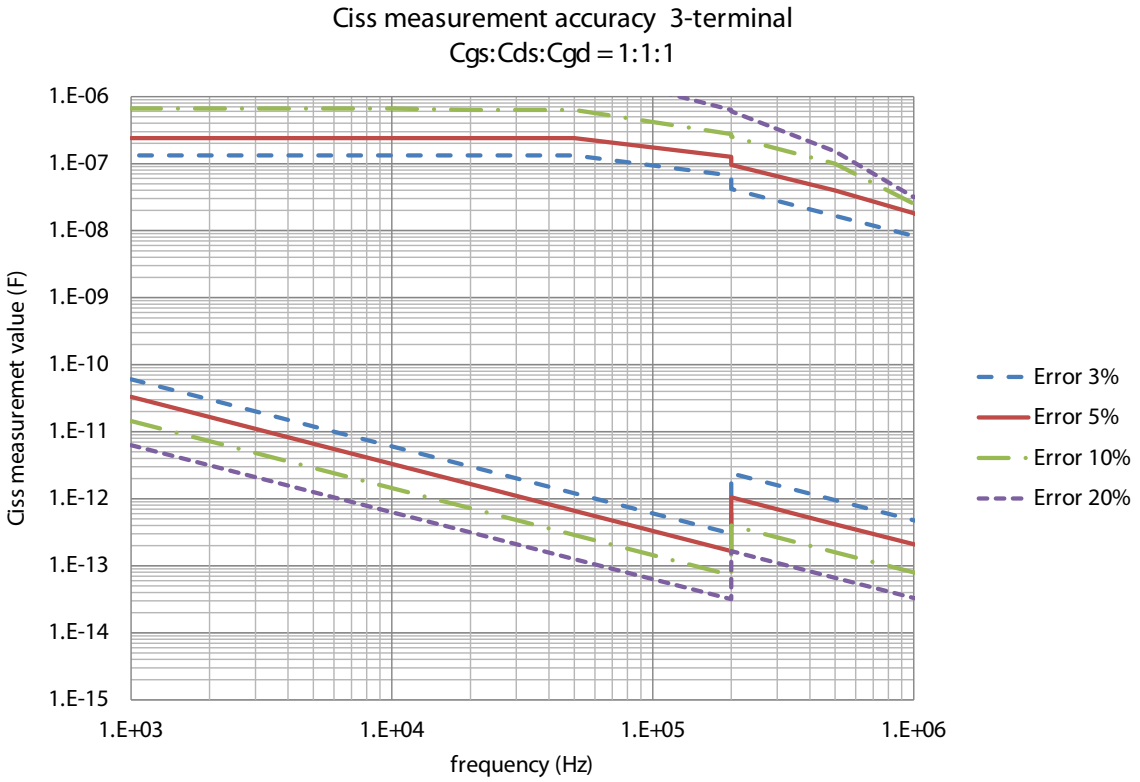


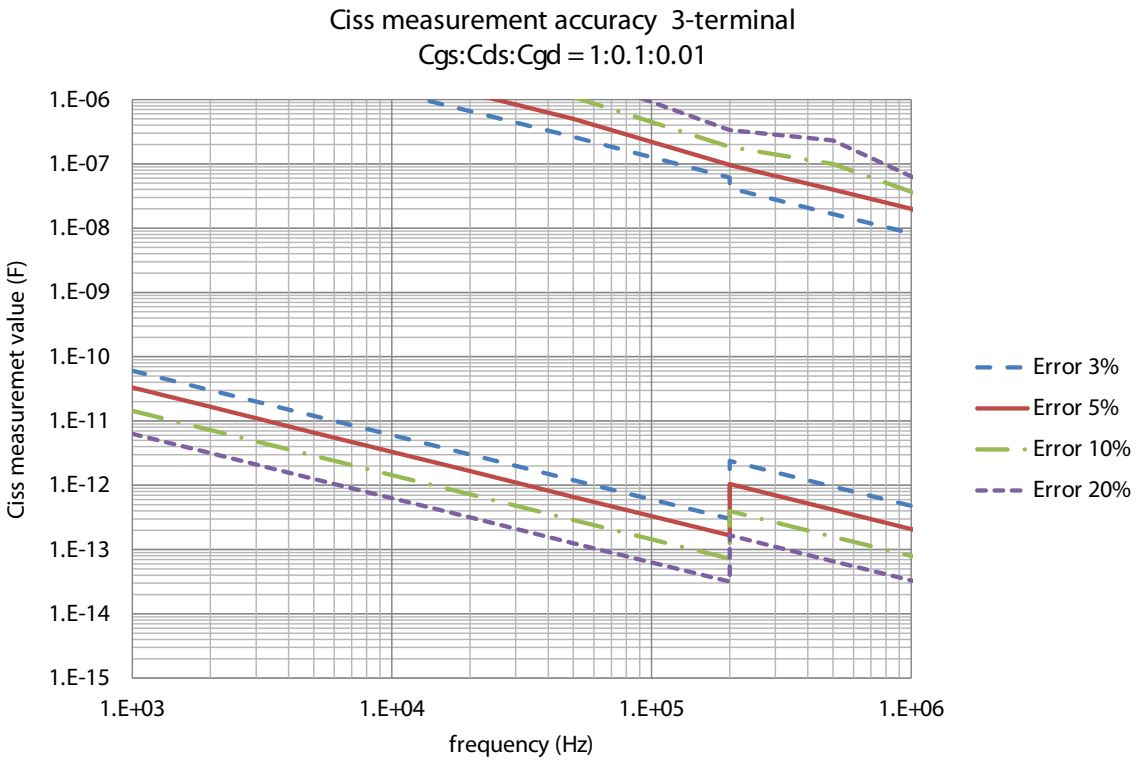

Cds measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:1:1
Cds measuremet value (F)
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
1.E-14
1.E-15
1.E+03
1.E+04
1.E+05
1.E+06
frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%

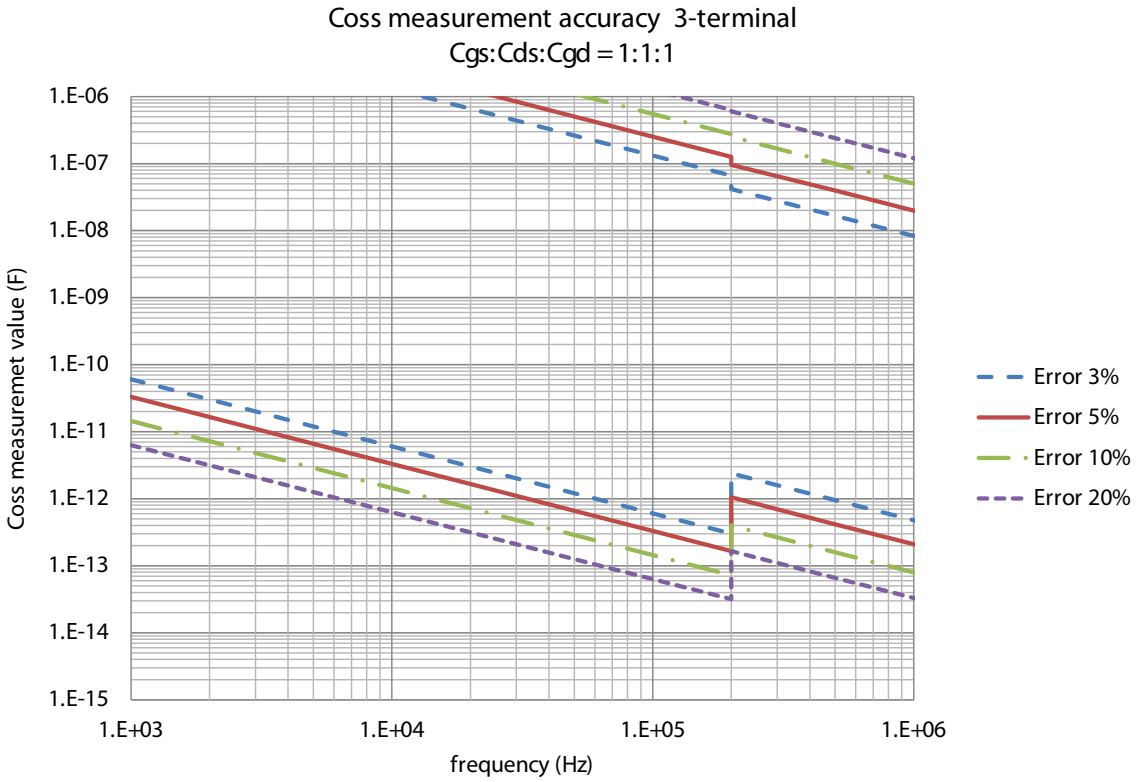

Cds measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:0.1:0.01
Cds measuremet value (F)
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
1.E-14
1.E-15
1.E+03
1.E+04
1.E+05
1.E+06
frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%

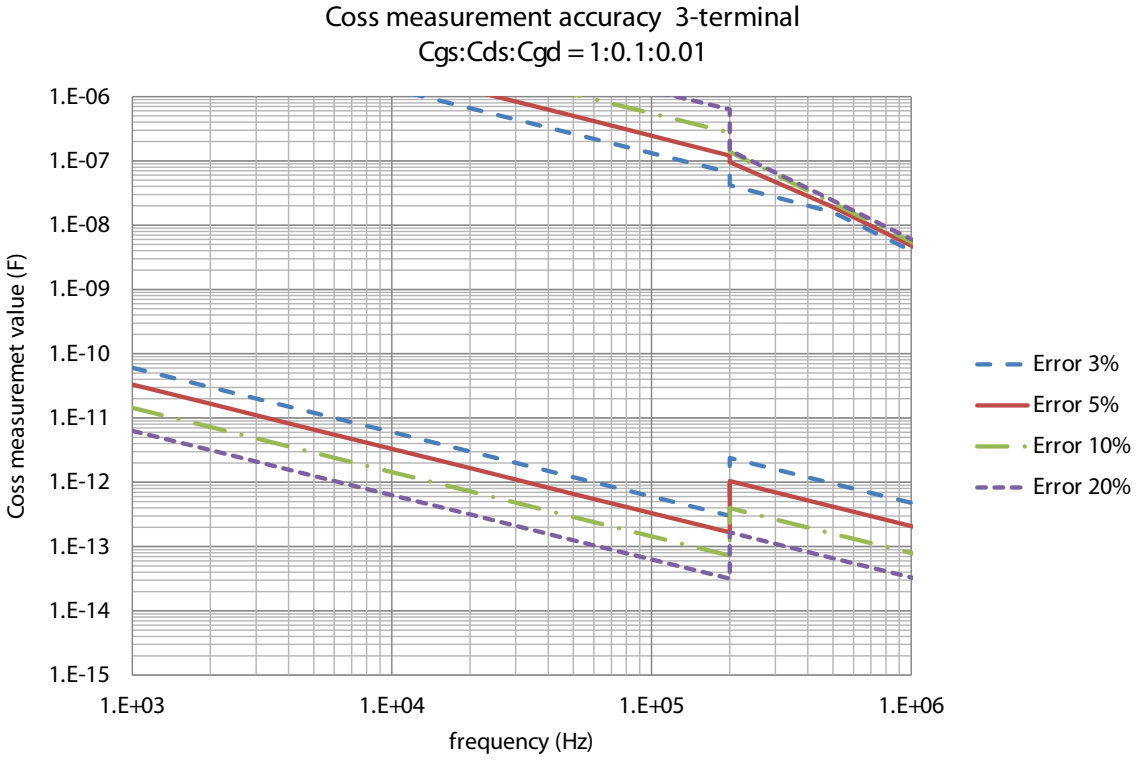

Cgd measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:1:1
Cgd measuremet value (F)
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
1.E-14
1.E-15
1.E+03
1.E+04
1.E+05
1.E+06
frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%


Cgd measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:0.1:0.01
Cgd measuremet value (F)
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
1.E-14
1.E-15
1.E+03
1.E+04
1.E+05
1.E+06
frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%


Ciss measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:1:1
Ciss measuremet value (F)
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
1.E-14
1.E-15
1.E+03
1.E+04
1.E+05
1.E+06
frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%


Ciss measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:0.1:0.01
Ciss measuremet value (F)
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
1.E-14
1.E-15
1.E+03
1.E+04
1.E+05
1.E+06
frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%


Coss measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:1:1
Coss measuremet value (F)
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
1.E-14
1.E-15
1.E+03
1.E+04
1.E+05
1.E+06
frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%


Coss measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:0.1:0.01
Coss measuremet value (F)
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
1.E-14
1.E-15
1.E+03
1.E+04
1.E+05
1.E+06
frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%

Output terminals for 3-terminal device

Parameter Name	Coss	Cds	Crss	Cgs	Ciss /Rg
Collector/Drain	High	High	High	AC Guard	Low
Emitter/Source	Low	AC Guard	Low	High	High
Base/Gate	Low	Low	AC Guard	Low	Low

Definition of 3-terminal device capacitances

Symbol	Description
Cgs	Capacitace between Base/Gate terminal and Emitter/Source terminal
Cds	Capacitace between Collector/Drain terminal and Emitter/Source terminal
Cgd	Capacitace between Base/Gate terminal and Collector/Drain terminal
Crss	Capacitace between Base/Gate terminal and Collector/Drain terminal
Ciss	Capacitace between Base/Gate terminal and Emitter/Source terminal and capacitance between Base/Gate terminal and Collector/Drain terminal
Coss	Capacitace between Collector/Drain terminal and Emitter/Source terminal and capacitance between Base/Gate terminal and Collector/Drain terminal

Current/Voltage measurement specifications

Current/Voltage measurement is achieved using the MPSMU module connected to Gate/Base terminal. The HVSMU module is connected to Drain/Collector terminal. The GNDU is connected to Source/Emitter terminal.

MPSMU Gate Output Specifications

Voltage range, resolution, and accuracy (high resolution ADC)

Voltage range	Force resolution	Measure resolution	Force accuracy [1] ±(% + mV)	Measure accuracy [1] ±(% + mV)	Maximum current
±0.5 V	25 µV	0.5 µV	±(0.018 + 0.5)	±(0.01 + 0.5)	100 mA
±2 V	100 µV	2 µV	±(0.018 + 0.5)	±(0.01 + 0.5)	100 mA
±5 V	250 µV	5 µV	±(0.018 + 1)	±(0.009 + 1)	100 mA
±20 V	1 mV	20 µV	±(0.018 + 3)	±(0.009 + 1)	100 mA
±40 V	2 mV	40 µV	±(0.018 + 6)	±(0.01 + 1)	[2]
±100 V	5 mV	100 µV	±(0.018 + 15)	±(0.012 + 2.5)	[2]

1. ± (% of reading value + offset value in mV)
2. 100 mA (Vo ≤ 20 V), 50 mA (20 V < Vo ≤ 40 V), 20 mA (40 V < Vo ≤ 100 V), Vo is the output voltage in Volts.

Current range, resolution, and accuracy (high resolution ADC)

Current range	Force resolution	Measure resolution	Force accuracy [1] ±(% + A + A)	Measure accuracy [1] ±(% + A + A)	Maximum voltage
±1 nA [3]	50 fA	10 fA	±(0.1 + 5E-11 + Vo x 5E-13)	±(0.1 + 5E-11 + Vo x 5E-13)	100 V
±10 nA [3]	500 fA	10 fA	±(0.1 + 5E-11 + Vo x 5E-13)	±(0.1 + 5E-11 + Vo x 5E-13)	100 V
±100 nA [3]	5 pA	100 fA	±(0.05 + 5E-11 + Vo x 5E-13)	±(0.05 + 5E-11 + Vo x 5E-13)	100 V
±1 µA [3]	50 pA	1 pA	±(0.05 + 1E-9 + Vo x 4E-11)	±(0.05 + 1E-9 + Vo x 4E-11)	100 V
±10 µA	500 pA	10 pA	±(0.05 + 3E-9 + Vo x 4E-11)	±(0.04 + 2E-9 + Vo x 4E-11)	100 V
±100 µA	5 nA	100 pA	±(0.035 + 15E-9 + Vo x 1E-10)	±(0.03 + 3E-9 + Vo x 1E-10)	100 V
±1 mA	50 nA	1 nA	±(0.04 + 15E-8 + Vo x 1E-9)	±(0.03 + 6E-8 + Vo x 1E-9)	100 V
±10 mA	500 nA	10 nA	±(0.04 + 15E-7 + Vo x 1E-8)	±(0.03 + 2E-7 + Vo x 1E-8)	100 V
±100 mA	5 µA	100 nA	±(0.045 + 15E-6 + Vo x 1E-7)	±(0.04 + 6E-6 + Vo x 1E-7)	[2]

1. ± (% of reading value + fixed offset in A + proportional offset in A), Vo is the output voltage in V.)
2. 100 V (Io ≤ 20 mA), 40 V (20 mA < Io ≤ 50 mA), 20 V (50 mA < Io ≤ 100 mA), Io is the output current in Amps.
3. Supplemental characteristics

Voltage range, resolution, and accuracy (high speed ADC)

Voltage range	Force resolution	Measure resolution	Force accuracy [1] ±(% + mV)	Measure accuracy [1] ±(% + mV)	Maximum current
±0.5 V	25 µV	25 µV	±(0.018 + 0.5)	±(0.01 + 0.5)	100 mA
±2 V	100 µV	100 µV	±(0.018 + 0.5)	±(0.01 + 0.7)	100 mA
±5 V	250 µV	250 µV	±(0.018 + 1)	±(0.01 + 2)	100 mA
±20 V	1 mV	1 mV	±(0.018 + 3)	±(0.01 + 4)	100 mA
±40 V	2 mV	2 mV	±(0.018 + 6)	±(0.015 + 8)	[2]
±100 V	5 mV	5 mV	±(0.018 + 15)	±(0.02 + 20)	[2]

1. ±(% of reading value + offset value in mV). Averaging is 128 samples in 1 PLC.
2. 100 mA (Vo ≤ 20 V), 50 mA (20 V < Vo ≤ 40 V), 20 mA (40 V < Vo ≤ 100 V), Vo is the output voltage in Volts.

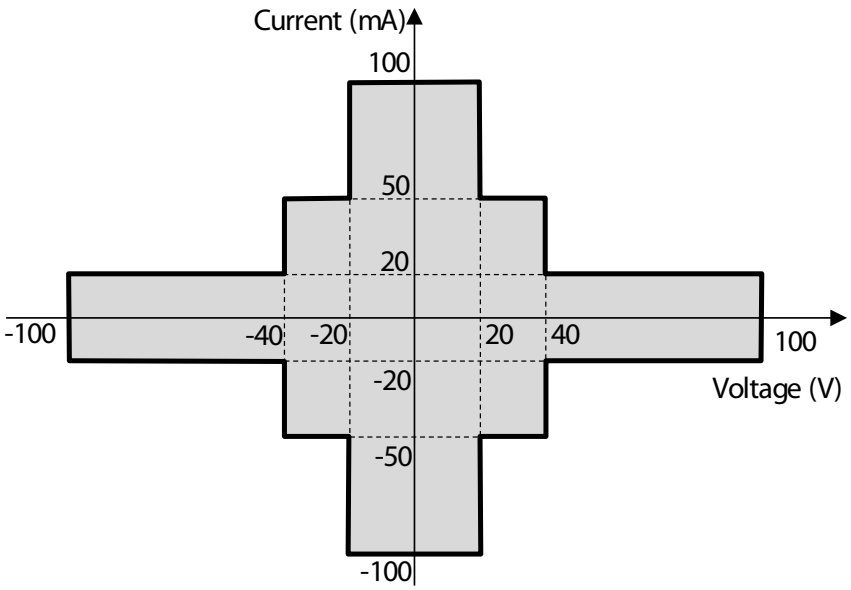
Current range, resolution, and accuracy (high speed ADC)					
Current range	**Force resolution**	**Measure resolution**	**Force accuracy [1] ±(% + A + A)**	**Measure accuracy [1] ±(% + A + A)**	**Maximum voltage**
±1 nA [3]	50 fA	50 fA	±(0.1 + 5E-11 + Vo x 5E-13)	±(0.25 + 5E-11 + Vo x 5E-13)	100 V
±10 nA [3]	500 fA	500 fA	±(0.1 + 5E-11 + Vo x 5E-13)	±(0.25 + 5E-11 + Vo x 5E-13)	100 V
±100 nA [3]	5 pA	5 pA	±(0.05 + 5E-11 + Vo x 5E-13)	±(0.1 + 5E-11 + Vo x 5E-13)	100 V
±1 µA [3]	50 pA	50 pA	±(0.05 + 1E-9 + Vo x 4E-11)	±(0.1 + 1E-9 + Vo x 4E-11)	100 V
±10 µA	500 pA	500 pA	±(0.05 + 3E-9 + Vo x 4E-11)	±(0.05 + 2E-9 + Vo x 4E-11)	100 V
±100 µA	5 nA	5 nA	±(0.035 + 15E-9 + Vo x 1E-10)	±(0.05 + 2E-8 + Vo x 1E-10)	100 V
±1 mA	50 nA	50 nA	±(0.04 + 15E-8 + Vo x 1E-9)	±(0.04 + 2E-7 + Vo x 1E-9)	100 V
±10 mA	500 nA	500 nA	±(0.04 + 15E-7 + Vo x 1E-8)	±(0.04 + 2E-6 + Vo x 1E-8)	100 V
±100 mA	5 µA	5 µA	±(0.045 + 15E-6 + Vo x 1E-7)	±(0.1 + 2E-5 + Vo x 1E-7)	[2]

1. ±(%of reading value + fixed offset in A + proportional offset in A), Vo is the output voltage in V.)
2. 100 V (Io ≤ 20 mA), 40 V (20 mA < Io ≤ 50 mA), 20 V (50 mA < Io ≤ 100 mA), Io is the output current in Amps.
3. Supplemental characteristics

Power consumption	
Voltage source mode:	
Voltage range	Power
0.5 V	20 x Ic (W)
2 V	20 x Ic (W)
5 V	20 x Ic (W)
20 V	20 x Ic (W)
40 V	40 x Ic (W)
100 V	100 x Ic (W)
Where Ic is the current compliance setting.	

Current source mode:	
Voltage compliance	Power
Vc ≤ 20	20 x Io (W)
20 < Vc ≤ 40	40 x Io (W)
40 < Vc ≤ 100	100 x Io (W)
Where Vc is the voltage compliance setting and Io is output current.	

MPSMU measurement and output range



HVSMU Drain Output Specifications

Voltage range, resolution, and accuracy					
Voltage range	**Force resolution**	**Measure resolution**	**Force accuracy [1] ±(% + mV)**	**Measure accuracy [1] ±(% + mV)**	**Maximum current**
±200 V	200 µV	200 µV	±(0.03 + 40)	±(0.03 + 40)	8 mA
±500 V	500 µV	500 µV	±(0.03 + 100)	±(0.03 + 100)	8 mA
±1500 V	1.5 mV	1.5 mV	±(0.03 + 300)	±(0.03 + 300)	8 mA
±3000 V	3 mV	3 mV	±(0.03 + 600)	±(0.03 + 600)	4 mA

1. ±(% of reading value + offset voltage V)

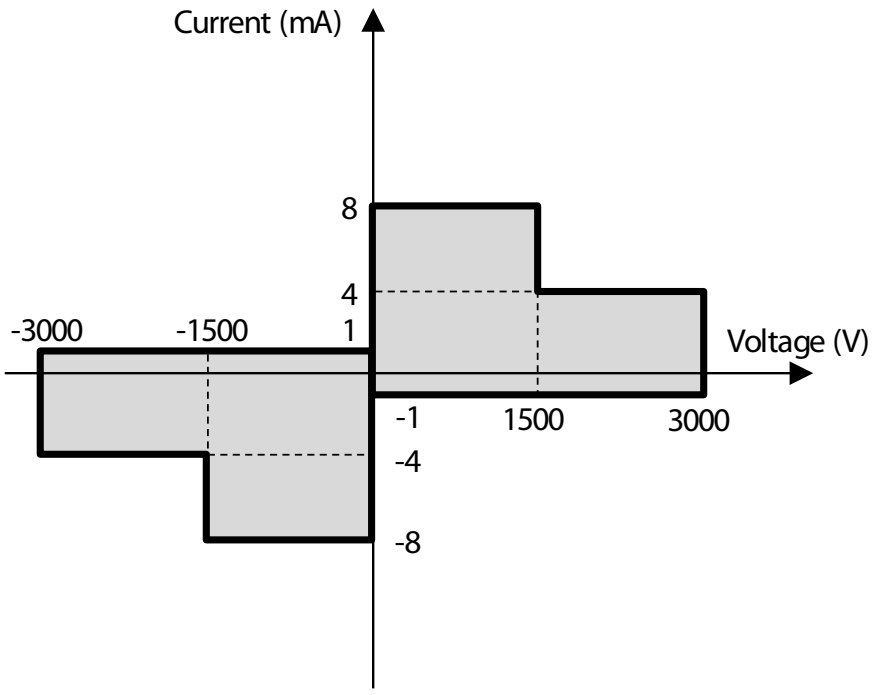
Current range, resolution, and accuracy						
Current range	**Force resolution**	**Measure resolution**	**Force accuracy [1] ±(% + A + A)**	**Measure accuracy [1] ±(% + A + A)**	**Maximum voltage**	**Minimum set current [2]**
±10 nA [3]	100 fA	100 fA	±(0.1 + 1E-9 + Vo x 8E-12)	±(0.1 + 1E-10 + Vo x 1E-13)	3000 V	1pA
±100 nA [3]	100 fA	100 fA	±(0.05 + 1E-9 + Vo x 8E-12)	±(0.05 + 1E-10 + Vo x 1E-13)	3000 V	100 pA
±1 µA [3]	1 pA	1 pA	±(0.05 + 1E-9 + Vo x 8E-12)	±(0.05 + 1E-10 + Vo x 1E-13)	3000 V	100 pA
±10 µA	10 pA	10 pA	±(0.04 + 2E-9 + Vo x 1E-11)	±(0.04 + 2E-9 + Vo x 1E-11)	3000 V	10 nA
±100 µA	100 pA	100 pA	±(0.03 + 3E-9 + Vo x 1E-11)	±(0.03 + 3E-9 + Vo x 1E-11)	3000 V	10 nA
±1 mA	1 nA	1 nA	±(0.03 + 6E-8 + Vo x 1E-10)	±(0.03 + 6E-8 + Vo x 1E-10)	3000 V	100 nA
±10 mA	10 nA	10 nA	±(0.03 + 2E-7 + Vo x 1E-9)	±(0.03 + 2E-7 + Vo x 1E-9)	1500 V	1 µA

1. ±(%of reading value + fixed offset in A + proportional offset in A), Vo is the output voltage in V.)
2. Output current needs to be set at a value greater than the current shown in the table.
3. Supplemental characteristics

Power consumption	
Voltage source mode:	
Current compliance	Power
Ic ≤ 4m	3000 x Ic (W)
4m < Ic ≤ 8m	1500 x Ic (W)
Where Ic is the current compliance setting.	

Current source mode:	
Voltage compliance	Power
Vc ≤ 1500	1500 x Io (W)
1500 < Vc ≤ 3000	3000 x Io (W)
Where Vc is the voltage compliance setting and Io is output current.	

HVSMU measurement and output range



SMU source measurement mode

For MPSMU:
VFIM, IFVM
For HVSMU:
VFIM, VFVM, IFVM, IFIM

Voltage/current compliance (limiting)

The SMU can limit output voltage or current to prevent damaging the device under test.

Voltage:
0 V to ±100 V (MPSMU)
0 V to ±3000 V (HVSMU)
Current:
±10 pA to ±100 mA (MPSMU)
±10 pA to ±8 mA [1] (HVSMU)
Compliance accuracy:
Same as the current or voltage set accuracy.

[1] **Maximum compliance is ±8 mA for the voltages greater than 1500V**

Power compliance

For MPSMU:
Power: 0.001 W to 2 W
Resolution: 0.001 W
For HVSMU:
No power compliance

SMU pulse measurement

Pulse width, period, and delay:
For MPSMU:
Pulse width: 500 µs to 2 s
Pulse width resolution: 100 µs
Pulse period: 5 ms to 5 s
Period ≥ delay + width + 2 ms (when delay + width ≤ 100 ms)
Period ≥ delay + width + 10 ms (when delay + width > 100 ms)
Pulse period resolution: 100 µs
Pulse delay: 0 s

For HVSMU:
Pulse width: 500 µs to 2 s
Pulse width resolution: 6 µs
Pulse period: 5 ms to 5 s
Period ≥ delay + width + 2 ms (when delay + width ≤ 100 ms)
Period ≥ delay + width + 10 ms (when delay + width > 100 ms)
Pulse period resolution: 100 µs
Pulse delay: 0 to (Period – width)
Pulse output limitation:
When the pulse voltage is more than 1500 volts, the pulse peak and base values must be the same polarity.
Pulse measurement delay:
6 µs to (Period – pulse measurement time – 2 m) s,
6 µs resolution

Supplemental Characteristics

Current compliance setting accuracy (for opposite polarity):

For MPSMU:
For 1 pA to 10 nA ranges:
V/I setting accuracy ±12% of range
For 100 nA to 100 mA ranges:
V/I setting accuracy ±2.5% of range

For HVSMU:
For 10 nA to 10 nA ranges:
V/I setting accuracy ±12% of range
For 100 nA to 10 mA ranges:
V/I setting accuracy ±2.5% of range

SMU pulse setting accuracy (fixed measurement range):

For MPSMU:
Width: ±0.5% ± 50 µs
Period: ±0.5% ± 100 µs

For HVSMU:
Width: ±0.1% ± 6 µs
Period: ±0.5% ± 100 µs

Minimum pulse measurement time:

16 µs (MPSMU)
6 µs (HVSMU)

MFCMU (multi frequency capacitance measurement unit) module specifications

Measurement functions

Measurement parameters:
Cp-G, Cp-D, Cp-Q, Cp-Rp, Cs-Rs, Cs-D, Cs-Q, Lp-G, Lp-D, Lp-Q, Lp-Rp, Ls-Rs, Ls-D, Ls-Q, R-X, G-B, Z-θ, Y-θ

Ranging:
Auto and fixed

Measurement terminal:
Four-terminal pair configuration, four BNC (female) connectors

Test signal

Frequency:
Range: 1 kHz to 5 MHz
Resolution: 1 mHz (minimum)
Accuracy: ±0.008%

Output signal level:
Range: 10 mV_{rms} to 250 mV_{rms}
Resolution: 1 mV_{rms}
Accuracy:
±(10.0% + 1 mV_{rms}) at the measurement port of the MFCMU
±(15.0% + 1 mV_{rms})

Output impedance: 50 Ω, typical

Signal level monitor:
Range: 10 mVrms to 250 mV_{rms}
Accuracy:
±(10.0% of reading + 1 mV_{rms}) at the measurement port of the MFCMU
±(15.0% + 1 mV_{rms})

DC bias function

DC bias:
Range: 0 to ±25 V
Resolution: 1 mV
Accuracy: ±(0.5% + 5.0 mV)
at the measurement port

Maximum DC bias current (Supplemental characteristics):

Impedance measurement range	Maximum DC bias current
50 Ω	10 mA
100 Ω	10 mA
300 Ω	10 mA
1 kΩ	1 mA
3 kΩ	1 mA
10 kΩ	100 µA
30 kΩ	100 µA
100 kΩ	10 µA
300 kΩ	10 µA

Output impedance: 50 Ω, typical

Sweep characteristics

Available sweep parameters:
Oscillator level, DC bias voltage, frequency
Sweep type: linear, log
Sweep mode: single, double
Sweep direction: up, down
Number of measurement points:
Maximum 1001 points

Measurement accuracy

The following parameters are used to express the impedance measurement accuracy at the measurement port of the MFCMU.

Z_X: Impedance measurement value (Ω)
D_X: Measurement value of D
$E = E_P' + (Z_S'/|Z_X| + Y_O'|Z_X|) \times 100$ (%)
$E_P' = E_{PL} + E_{POSC} + E_P$ (%)
$Y_O' = Y_{OL} + Y_{OSC} + Y_O$ (S)
$Z_S' = Z_{SL} + Z_{OSC} + Z_S$ (Ω)
|Z| accuracy
±E (%)
θ accuracy
±E/100 (rad)
C accuracy
at $D_X \leq 0.1$
±E (%)

at $D_X > 0.1$
$\pm E \times \sqrt{(1+D_X^2)}$ (%)
D accuracy
at $D_X \leq 0.1$
±E/100

at $D_X > 0.1$
$\pm E \times (1 + D_X)/100$
G accuracy
at $D_X \leq 0.1$
$\pm E / D_X$ (%)

at $D_X > 0.1$
$\pm E \times \sqrt{(1+D_X^2)}/D_X$ (%)

Note: measurement accuracy is specified under the following conditions:
Temperature: 23 °C ±5 °C
Integration time: 1 PLC

Parameters E_{POSC} Z_{OSC}		
Oscillator level	**E_{POSC} (%)**	**Z_{OSC} (mΩ)**
125 mV < V_{OSC} ≤ 250 mV	0.03 x (250/ V_{OSC} – 1)	5 x (250/V_{OSC} – 1)
64 mV < V_{OSC} ≤ 125 mV	0.03 x (125/ V_{OSC} – 1)	5 x (125/V_{OSC} – 1)
32 mV < V_{OSC} ≤ 64 mV	0.03 x (64/ V_{OSC} – 1)	5 x (64/V_{OSC} – 1)
V_{OSC} ≤ 32 mV	0.03 x (32/ V_{OSC} – 1)	5 x (64/V_{OSC} – 1)
V_{OSC} is oscillator level in mV.		

Parameters E_{PL} Y_{OL} Z_{SL}			
Cable length	**E_{PL} (%)**	**Y_{OL} (nS)**	**Z_{SL} (mΩ)**
1.5 m	0.02 + 3 x f/100	750 x f/100	5.0
3 m	0.02 + 5 x f/100	1500 x f/100	5.0
f is frequency in MHz. If measurement cable is extended, open compensation, short compensation, and load compensation must be performed.			

Parameters Y_{OSC} Y_0 E_P Z_S				
Frequency	**Y_{OSC} (nS)**	**Y_0 (nS)**	**E_P (%)**	**Z_S (mΩ)**
1 kHz ≤ f ≤ 200 kHz	1 x (125/ V_{OSC} – 0.5)	1.5	0.095	5.0
200 kHz < f ≤ 1 MHz	2 x (125/ V_{OSC} – 0.5)	3.0	0.095	5.0
1 MHz < f ≤ 2 MHz	2 x (125/ V_{OSC} – 0.5)	3.0	0.28	5.0
2 MHz < f	20 x (125/ V_{OSC} – 0.5)	30.0	0.28	5.0
f is frequency in Hz. V_{OSC} is oscillator level in mV.				

Example of calculated C/G measurement accuracy				
Frequency	**Measured capacitance**	**C accuracy[1]**	**Measured conductance**	**G accuracy[1]**
5 MHz	1 pF	± 0.61%	≤ 3 µS	± 192 nS
	10 pF	± 0.32%	≤ 31 µS	± 990 nS
	100 pF	± 0.29%	≤ 314 µS	± 9 µS
	1 nF	± 0.32%	≤ 3 mS	± 99 µS
1 MHz	1 pF	± 0.26%	≤ 628 nS	± 16 nS
	10 pF	± 0.11%	≤ 6 µS	± 71 nS
	100 pF	± 0.10%	≤ 63 µS	± 624 nS
	1 nF	± 0.10%	≤ 628 µS	± 7 µS
100 kHz	10 pF	± 0.18%	≤ 628 nS	± 11 nS
	100 pF	± 0.11%	≤ 6 µS	± 66 nS
	1 nF	± 0.10%	≤ 63 µS	± 619 nS
	10 nF	± 0.10%	≤ 628 µS	± 7 µS
10 kHz	100 pF	± 0.18%	≤ 628 nS	± 11 nS
	1 nF	± 0.11%	≤ 6 µS	± 66 nS
	10 nF	± 0.10%	≤ 63 µS	± 619 nS
	100 nF	± 0.10%	≤ 628 µS	± 7 µS
1 kHz	100 pF	± 0.92%	≤ 63 nS	± 6 nS
	1 nF	± 0.18%	≤ 628 nS	± 11 nS
	10 nF	± 0.11%	≤ 6 µS	± 66 nS
	100 nF	± 0.10%	≤ 63 µS	± 619 nS

1. The capacitance and conductance measurement accuracy is specified under the following conditions:
DX ≤ 0.1
Integration time: 1 PLC
Test signal level: 30 mVrms
At four-terminal pair port of MFCMU

Test fixture information

Terminal information

Terminals: 4ϕ banana

Gate/Base
Drain/Collector
Source/Emitter
AC/DC guard

TO socket adapter
Gate/Base
Drain/Collector
Source/Emitter

Other Terminals/Indicators

Power indicator: 1ea.
High voltage indicator: 1ea.
Measurement mode indicator:
IV mode: 1ea.
CV mode: 1ea.
Interlock terminal: 1ea.
Earth terminal: 1ea.
Wrist strap terminal: 1ea.

Selector information

This information is provided for users not utilizing the furnished test fixture but who wish to connect the selector outputs to other DUT interfaces such as a wafer prober.

Functionality

Selector capability

The selector allows the user to make connections to perform various capacitance and DC measurements such as leakage, breakdown and threshold voltage measurement.

Output terminals:
SHV terminals: 4 ea.
Gate/Base
Drain/Collector
Source/Emitter
AC/DC guard

Interlock terminal: 1ea
Indicators
Power indicator: 1ea.
Measurement mode indicator:
IV mode: 1ea.
CV mode: 1ea.

Software interfaces

The B1507A is equipped with a software suite for power device characterization (herafter referred to as the B1507A software suite). It supports various types of measurements and provides easy-to-use and simple operation. The B1507A software GUI can be accessed via its front panel 15-inch touch screen, softkeys and rotary knob, as well as through an optional USB keyboard and mouse. Measurement setups and data can be stored on the B1507A's HDD, and they can be exported to external storage. The B1507A also supports Keysight Technologies, Inc. EasyEXPERT software, a well-proven software interface for the B1500A, B1505A and B1506A.

Operating software

Windows 7 embedded

B1507A software suite

Key features:

- Dedicate software for;
  - Two and three-terminal device capacitance measurement
  - I/V characteristics measurement
  - Device power loss calculation
- Ready-to-use measurement templates for typical power device characteristics measurements
- Ability to automatically accumulate measurement data on the HDD in exportable formats

Software palette:

The Software Palette provides a complete list of the B1507A's measurement software and also allows this software to be launched. The Software Palette is displayed in full-screen mode after powering up the B1507A. The Software Palette can be minimized to access the Windows desktop.

IV measurement software:

I/V Measurement Software provides:

- Voltage/current sweep/spot measurements
- DC/pulse outputs
- Linear/log sweep with both single (one-way) and double (round-trip) capability for the primary sweep source (similar to the collector supply of a conventional curve tracer)
- Linear/list sweep capability for the secondary sweep source (corresponding to the step generator of a conventional curve tracer)
- The ability to assign the primary sweep source or the secondary sweep source to either the collector/drain terminal or to the base/gate terminal.
- Intuitive and interactive sweep/spot measurement operation using rotary knob.
- Pre-defined templates for typical MOSFET, IGBT and Diode I/V measurements.

Oscilloscope View:

I/V Measurement Software supports the pulse mode Oscilloscope View function for HVSMU. Oscilloscope View provides:

- Both voltage and current waveform monitoring for the measurement channels of all supported modules

Capacitance measurement software:

Capacitance measurement software provides:

- Automated measurement circuit configuration for three-terminal device capacitance measurement (e.g. Ciss, Coss and Crss), with no need to manually modify any device connections
  - With DC bias (sweep) control up to 3kV for Collector/Drain terminal
  - With DC bias (sweep) control up to 100V for Base/Collector terminal

- Automated correction for every measurement path
- Stable measurements even if the low-side load capacitance changes due to a bias change (load adaptive gain-phase compensation)
- Cancellation of the residual inductance measurement error on the AC guard path of three-terminal device capacitance measurements
- Pre-defined templates for typical capacitance measurements of both enhancement and depletion type MOSFETs, IGBTs and Diodes

Power loss calculation software:

Power loss calculation software provides:

- Calculation of switching device power loss for:
  - Hard switching mode
  - Soft switching mode
- Inputs to characterize the following parameters:
  - Gate charge
  - Gate switching charge
  - Equivalent output capacitance (energy related)
  - Equivalent output capacitance (time related)
  - Input parameter assistance using related measurement data including:
  - -- Display of source measurement data
- Switching condition parameter input
  - Support of parameter sweep for one parameter
- Power loss calculation results of:
  - Switching power loss (inductive load)
  - Coss switching power loss (energy related)

Keysight EasyEXPERT software

Key features:

- Ready-to-use application test library
- Multiple measurement modes (application test, classic test, tracer test, oscilloscope view and quick test)
- Multiple measurement functions (spot, sweep, time sampling, C-V, C-f, C-t, etc.)
- Data display, analysis and arithmetic functions
- Workspace and data management
- External instrument control
- Multiple programming methods (EasyEXPERT remote control and FLEX GPIB control)
- Multiple interface (USB, LAN, GPIB and digital I/O)
-

Key features:

EasyEXPERT comes with various application tests conveniently organized by device type, application, and technology.

Operation mode:

- Application test mode
- Classic test mode
- Tracer test mode
- Quick test mode

Measurement mode:

- IV measurement
  - Spot
  - Staircase sweep
  - Pulsed spot
  - Pulsed sweep
  - Staircase sweep with pulsed bias
  - Sampling
  - Multi-channel sweep
  - Multi-channel pulsed sweep
  - List sweep
  - Linear search1
  - Binary search1
- C measurement
  - Spot C
  - CV (DC bias) sweep
  - Pulsed spot C
  - Pulsed sweep CV
  - C-t sampling
  - C-f sweep
  - CV (AC level) sweep
  - Quasi-Static CV (QSCV)

1. Supported only by FLEX commands.

Automatic analysis function

On a graphics plot, the markers and lines can be automatically located using the auto analysis setup. Parameters can be auto matically determined using automatic analysis, user function, and read out functions.

Analysis functions

Up to 20 user-defined analysis functions can be defined using arithmetic expressions. Measured data, pre-defined variables, and read out functions can be used in the computation. The results can be displayed on the LCD.

Read out functions

The read out functions are built-in functions for reading various values related to the marker, cursor, or line.

Arithmetic functions

User functions

Up to 20 user-defined functions can be defined using arithmetic expressions.

Measured data and pre-defined variables can be used in the computation. The results can be displayed on the LCD.

Arithmetic operators

+, -, *, /, ^, abs (absolute value), at (arc tangent), avg (averaging), cond (conditional evaluation), delta, diff (differential), exp (exponent), integ (integration), lgt (logarithm, base 10), log (logarithm, base e), mavg (moving average), max, min, sqrt, trigonometric function, inverse trigonometric function, and so on.

Physical constants

Keyboard constants are stored in memory as follows:
q: Electron charge, 1.602177E-19 C
k: Boltzmann's constant, 1.380658E-23ε (e): Dielectric constant of vacuum, 8.854188E-12

Engineering units

The following unit symbols are also available on the keyboard:
a (10^{-18}), f (10^{-15}), p (10^{-12}), n (10^{-9}), u or μ (10^{-6}), m (10^{-3}), k (10^{3}), M (10^{6}), G (10^{9}), T (10^{12}) , P (10^{15})

Data display, analysis and arithmetic functions

Data Display

X-Y graph plot

X-axis and up to eight Y-axes, linear and log scale, real time graph plotting. X-Y graph plot can be printed or stored as image data to clip board or mass stor age device. (File type: bmp, gif, png, emf)

Scale:
Auto scale and zoom

Marker:
Marker to min/max, interpolation, direct marker, and marker skip

Cursor:
Direct cursor

Line:
Two lines, normal mode, grad mode, tangent mode, and regres sion mode

Overlay graph comparison:

Graphical plots can be overlaid.

List display

Measurement data and calculated user function data are listed in conjunction with sweep step number or time domain sampling step number. Up to 20 data sets can be displayed.

Data variable display

Up to 20 user-defined parameters can be displayed on the graphics screen.

Common specification for software interfaces

Sweep measurement

Number of steps: 1 to 10001 (SMU), 1 to 1001 (CMU)
Sweep mode: Linear or logarithmic (log)
Sweep direction: Single or double sweep
Hold time:
0 to 655.35 s, 10 ms resolution
Delay time:
0 to 65.535 s, 100 μs resolution
0 to 655.35 s, 100 μs resolution
(CV (AC level) sweep, C-f sweep)
Step delay time:
0 to 1 s, 100 μs resolution
Step output trigger delay time:
0 to (delay time) s, 100 μs resolution
Step measurement trigger delay time:
0 to 65.535 s, 100 μs resolution

Sampling (time domain) measurement [1]

Displays the time sampled voltage/current data (by SMU) versus time.
Sampling channels: Up to 10
Sampling mode: Linear, logarithmic (log)
Sampling points:
For linear sampling:
1 to 100,001/(number of channels)
For log sampling:
1 to 1+ (number of data for 11 decades)
Sampling interval range:
100 μs to 2ms, 10μs resolution
2 ms to 65.535 s, 1 ms resolution
For < 2ms, the interval is ≥ 100 μs +20 μs x (num. of channels – 1)
Hold time, initial wait time:
-90 ms to -100 μs, 100 μs resolu tion
0 to 655.35 s, 10 ms resolution
Measurement time resolution: 100 μs

1. Supported only by EasyEXPERT and FLEX commands.

Other measurement characteristics

Measurement control
Single, repeat, append, and stop

SMU setting capabilities

Limited auto ranging, voltage/current compliance, power compliance, automatic sweep abort functions, self-test, and self-calibration

Standby mode [1]
SMUs in "Standby" remain programmed to their specified output value even as other units are reset for the next measurement.

Bias hold function [1]
This function allows you to keep a source active between measurements. The source module will apply the specified bias between measurements when running classic tests inside an application test, in quick test mode, or during a repeated measurement. The function ceases as soon as these conditions end or when a measurement that does not use this function is started.

Current offset cancel [1]
This function subtracts the offset current from the current measurement raw data, and returns the result as the measurement data. This function is used to compensate the error factor (offset current) caused by the measurement path such as the measurement cables, manipulators, or probe card.

Time stamp [1]
The B1507A supports a time stamp function utilizing an internal quartz clock.
Resolution: 100 μs

1. Supported only by EasyEXPERT and FLEX commands.

General specifications

Altitude

Operating: 0 m to 2,000 m (6,561 ft)
Storage: 0 m to 4,600 m (15,092 ft)

Power requirement

ac Voltage: 90 V to 264 V
Line Frequency: 47 Hz to 63 Hz

Maximum volt-amps (VA)

B1507A mainframe: 900 VA
B1507A selector: 70 VA

Acoustic Noise Emission

Lpa < 55dB

Lwa:55dB (Operating mode)

About measurement accuracy

RF electromagnetic field and SMU measurement accuracy: SMU voltage and current measurement accuracy can be affected by RF electromagnetic field strengths greater than 3 V/m in the frequency range of 80 MHz to 1 GHz. The extent of this effect depends upon how the instrument is positioned and shielded.

Induced RF field noise and SMU measurement accuracy:
SMU voltage and current measurement accuracy can be affected by induced RF field noise strengths greater than 3 Vrms in the frequency range of 150 kHz to 80 MHz. The extent of this effect depends upon how the instrument is positioned and shielded.

Regulatory compliance

EMC:
- IEC 61326-1 / EN 61326-1
- Canada: ICES/NMB-001
- AS/NZS CISPR 11

Safety:
- IEC61010-1 / EN 61010-1
- CAN/CSA-C22.2 No. 61010-1

Certification

CE, cCSAus, C-Tick, KC

Dimensions

B1507A mainframe:
420 mm W x 330 mm H x 575 mm D
B1507A selector:
420 mm W x 75 mm H x 575 mm D
B1507A test fixture:
340 mm W x 200 mm H x 345 mm D

Weight

B1507A mainframe: 29.5 kg
B1507A selector: 9.4 kg
B1507A test fixture: 4.9 kg

Furnished accessories

Measurement cables and adapter
System cable between mainframe and selector, 1 ea.
System cable between selector and test fixture, 1 ea.
CMU cable, 1 ea
Digital I/O cable, 1 ea.
3-pin Inline Package Socket Module, 1 ea
200 mm normal cable, 4 ea.
Banana pin adapter, 4 ea.
Mini alligator clip, 4 ea.

Keyboard, 1 ea.
Mouse, 1 ea.
Stylus pen, 1 ea.
Power cable, 2 ea.
Manual & Software CD-ROM, 1 ea.

1. In case of some supplemental characteristics, humidity range is defined as 20% to 50% RH

Ordering Information

Model number	Option		Description
B1507A			Power Device Capacitance Analyzer
	Power Line Frequency		
		050	50 Hz Line Frequency
		060	60 Hz Line Frequency
	Documentation		
		ABA	English User's Guide
		ABJ	Japanese User's Guide
	Calibration		
		UK6	Commercial calibration certificate with test data
		A6J	ANSI Z540-1-1994 Calibration
	Drive option		
		DR1	Replace A Built-in DVD-R Drive With A Read-only DVD Drive
B1507AU			Upgrade Kit for B1507A
	Accessories		
		F10	3-pin Inline Package Socket Module

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