Advanced Test Equipment Corp.
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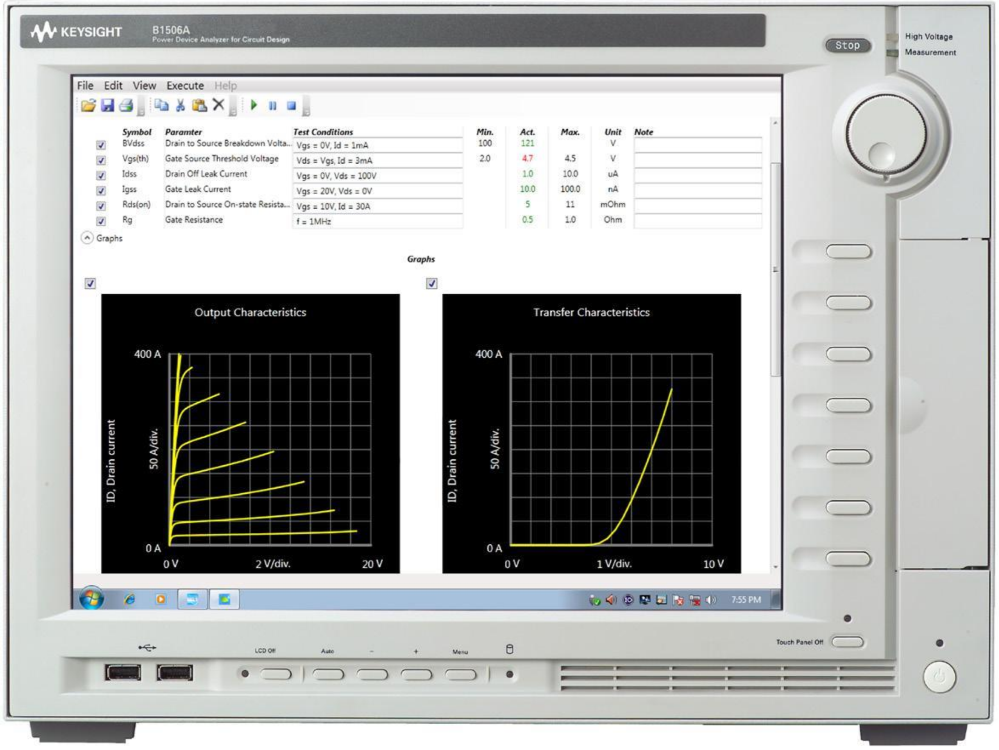
B1506A

Power device analyzer for circuit design



	Symbol	Paramter	Test Conditions	Min.	Act.	Max.	Unit	Note
☑	BVdss	Drain to Source Breakdown Volta...	Vgs = 0V, Id = 1mA	100	121		V	
☑	Vgs(th)	Gate Source Threshold Voltage	Vds = Vgs, Id = 3mA	2.0	4.7	4.5	V	
☑	Idss	Drain Off Leak Current	Vgs = 0V, Vds = 100V		1.0	10.0	uA	
☑	Igss	Gate Leak Current	Vgs = 20V, Vds = 0V		10.0	100.0	nA	
☑	Rds(on)	Drain to Source On-state Resista...	Vgs = 10V, Id = 30A		5	11	mOhm	
☑	Rg	Gate Resistance	f = 1MHz		0.5	1.0	Ohm	

Introduction

Evaluate all device parameters under various operating conditions to improve power electronics circuit design performance.

- Measures all IV parameters (Ron, BV, Leakage, Vth, Vsat, etc.)
- Measure transistor input, output, and reverse transfer capacitances (Ciss, Coss, Crss, Cies, Coes, Cres, Rg) at high bias voltages
- Qg curve measurement for Nch MOSFETs and IGBTs
- Power loss (conduction, driving, and switching) evaluation
- Menu-driven user interface specially designed for circuit designers (Easy Test Navigator - ETN)
- Quick and automatic device datasheet generation
- Datasheet characterization mode supports quick and easy evaluations of data sheet parameters
- Wide operation I/V (1500A, 3kV), Thermal test (−50 to +250 °C)
- Oscilloscope View provides visual verification of pulsed measurement waveforms
- Covers typical semiconductor devices and electronic components used in high-power circuits

Product Overview

The B1506A Power Device Analyzer for Circuit Design is a complete solution that can help power electronic circuit designers maximize the value of their power electronics products by enabling them to select the correct power semiconductor devices and components for their applications. It can evaluate all relevant device parameters under a wide range of operating conditions, including IV parameters such as breakdown voltage and on-resistance, as well as three terminal FET capacitances, gate charge, and power loss.

The B1506A has a wide range of capabilities that help it identify substandard semiconductor devices and components under actual circuit operating conditions, including a wide voltage and current range (3 kV and 1500 A), a wide temperature measurement range (-50 to +250 °C), fast pulsing capability, and sub-nA level current measurement capability. Its unique software interface, Easy Test Navigator, presents the user with a familiar device data sheet format, making it easy to characterize semiconductor devices and components without formal training. Integrated switching circuitry within the test fixture supports fully automated testing, which can automatically change between high voltage and high current testing and between IV and CV measurements. In addition, a unique plug-in style device test fixture socket adapter eliminates cable connection and other human-related errors.

The B1506A also supports the complete automation of thermal characterization. This can be accomplished through the integrated Thermostream control. Since the DUT is close to the B1506A’s measurement resources, the large parasitics caused by cable extensions leading to a temperature chamber do not exist. For this reason, oscillation-free ultra-high currents of up to 1500 A can be accurately evaluated at low and high temperatures.

The B1506A’s capabilities revolutionize power electronics circuit design by both helping to maximize end product value and accelerating product development cycles.

Specification Conditions

The measurement and output accuracy are specified under the conditions listed below.

Note: The SMU measurement and output accuracies are specified at the output terminals in the test fixture, except for capacitance measurement, which is specified at the output terminals of the MFCMU.

1. Temperature: 23 ±5 °C
2. Humidity: 20 to 70%, No condensation
3. Self-calibration after a 40-minute warm-up is required.
4. Ambient temperature changes 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 1 A range, voltage range), 200 μs (20 A range), Averaging of high-speed ADC: 128 samples per 1 PLC
8. SMU filter: ON (for MPSMU)
9. The accuracy of the drain output current measurement specification is not guaranteed until 20 seconds after a voltage change.

Operating Conditions

The B1506A has to be used under the conditions listed below.
Temperature: +5 to +40 °C
Humidity: 20 to 70%, No condensation

When used with Thermostream and the air temperature is more than +20 °C
Temperature: +20 to +30 °C
Humidity: 20% to 70%, No condensation

When used with Thermostream and the air temperature is less than +20 °C
Temperature: +20 to +30 °C
Humidity: 20 to 50%, No condensation

When used with a Thermal plate
Temperature: +5 to +30 °C
Humidity: 20 to 70%, No condensation

Key Specifications of B1506A

				B1506A-H20/H21	B1506A-H50/H51	B1506A-H70/H71
Collector / Drain channel	Maximum output	Voltage		±3000 V	±3000 V	±3000 V
		Current	Pulsed	±20 A	±500 A	±1500 A
			DC	±1 A	±100 mA	
	Minimum Resolution (Source)		Voltage	200 nV	25 µV	
			Current	100 fA	100 fA	
	Minimum Resolution (Measurement)		Voltage	200 nV	500 nV	
			Current	10 fA	10 fA	
Gate channel	Maximum output	Voltage		±100 V		
		Current	Pulsed	±1 A		
			DC	±100 mA		
	Minimum Resolution (Source)		Voltage	200 nV		
			Current	500 fA		
	Minimum Resolution (Measurement)		Voltage	200 nV		
			Current	10 fA		
Capacitance measurement (H21 / H51 / H71 only)	Max bias	Gate		±100 V		
		Collector / Drain		±3000 V		
	Frequency range			1 kHz to 1 MHz		
	Capacitance range			100 fF to 1µF		

Measurement parameters

Characteristics	Category	Parameters
Static characteristics	Threshold voltage	Vgs(th),Vge(th)
	Transfer Characteristics [1]	Id-Vgs, Ic-Vge, gfs
	On resistance	Rds-on. Vce(sat)
	Gate leakage current	Igss, Iges
	Output leakage current	Idss, Ices
	Output Characteristics	Id-Vds, Ic-Vce
	Breakdown voltage	BVds, BVces
Gate charge characteristics [4]	Gate Charge	Qg, Qg(th), Qgs, Qgd for Nch MOSFETs and IGBTs
Capacitance characteristics [4]	Gate Resistance	Rg
	Device Capacitance	Ciss, Coss, Crss, Cgs, Cgd, Cies, Coes, Cres
Power loss [4]		Driving loss/Switching loss [2] Conduction loss at specified duty cycle [3]

1. The UHCU in the B1506A-H5x/H7x has an output resistance, similar to the traditional curve tracers. Therefore, the applied voltage to the Drain/Collector varies while the output current is changing due to the voltage drop at the output resistance.
   - The Easy Test Navigator software can provide the similar measurement results as the traditional curve tracers.
   - The EasyEXPERT group+ software can provide more accurate results beyond the traditional curve tracers by compensating the voltage drop at the output resistance.
2. Driving loss and switching loss are calculated by measuring Qg characteristics, Vth, and Rg at the specified frequency.
3. Conduction loss is calculated from measured Rds-on and peak current.
4. B1506A-H21/H51/H71 only

Supported power devices and electronic components

MOSFETs, IGBTs, Diodes, Inductors, Capacitors, Shunt R, Resistors, Connectors, Cable, Relays, Photo couplers, Solid state relays.

Operation range

IV functionality	Operation range
Collector/drain voltage	±3000 V
Collector/drain current	±1500 A (B1506A-H70/H71)
	±500 A (B1506A-H50/H51)
	±20 A (B1506A-H20/H21)
Gate	±30 V/±1 A (pulse): MCSMU
	±100 V/±100 mA: MPSMU

CV functionality [1]	Operation range
Gate DC bias voltage	±100 V
Collector/drain DC bias voltage	±3000 V
Frequency	1 kHz to 1 MHz
Capacitance	100 fF to 1 μF

Gate charge functionality [1]	Operation range
Qg, Qgd, Qd	1 nC to 100 μC
VDD	0 to +3000 V
ID	0 to 1500 A
Gate drive	-30 to 30 V

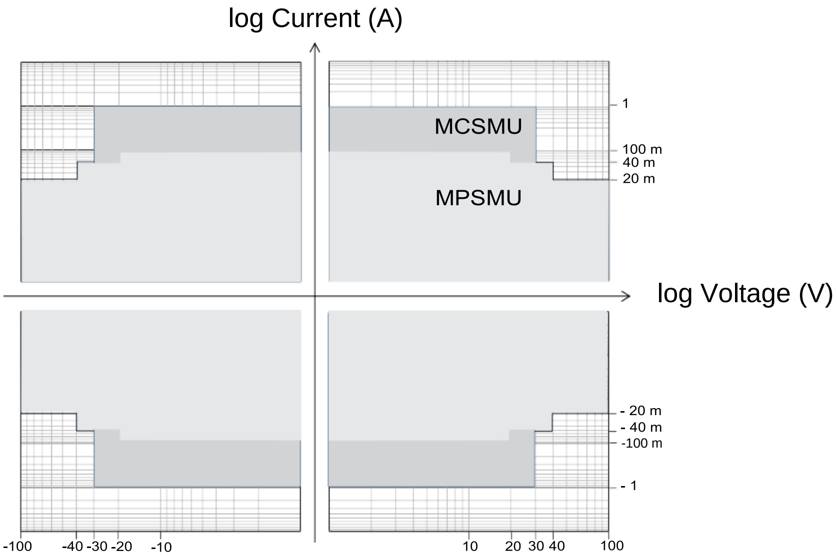
[1] B1506A-H21/H51/H71 only

Current / Voltage Measurement Specifications

Gate/base step generator specification

Gate/Base step generator IV Operating range is defined as the combination of MCSMU and MPSMU modules. The following graph shows the entire IV operating range of the gate/base step generator for B1506A.

Refer to the section for each module later in this document for detailed specifications of each module.



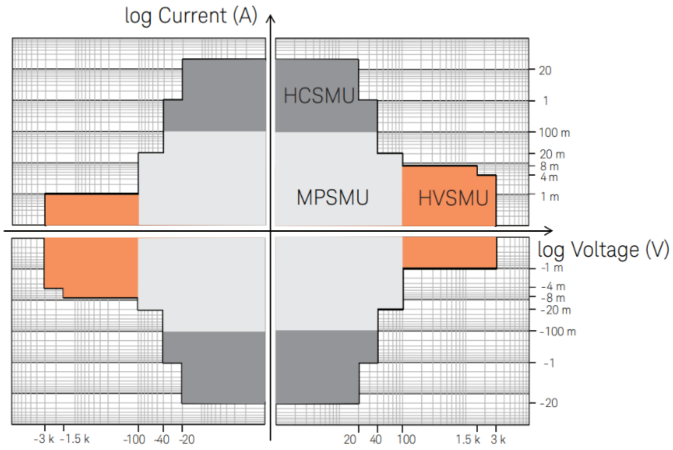
Gate / Base step generator measurement and output range

Drain/collector supply specification

B1506A-H20/H21

The drain / Collector Supply IV Operating range for B1506A-H21 is defined as the combination of HCSMU, MPSMU, and HVSMU modules. The following graph shows the entire IV operating range of drain/collector supply for B1506A-H20/H21.

Refer to the section for each module later in this document for detailed specifications of each module.

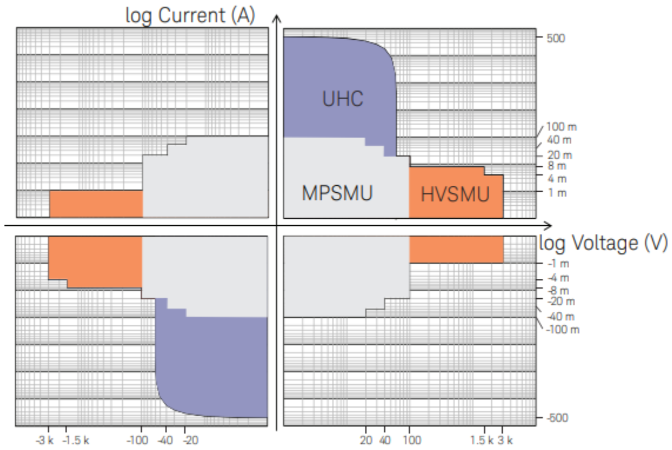


IV operating range for B1506A-H20/H21

B1506A-H50/H51

The drain/Collector Supply IV Operating range for B1506A-H51 is defined as the combination of UHCU, MPSMU, and HVSMU modules. The following graph shows the entire IV operating range of drain/collector supply for B1506A-H50/H51.

Refer to the section for each module later in this document for detailed specifications of each module

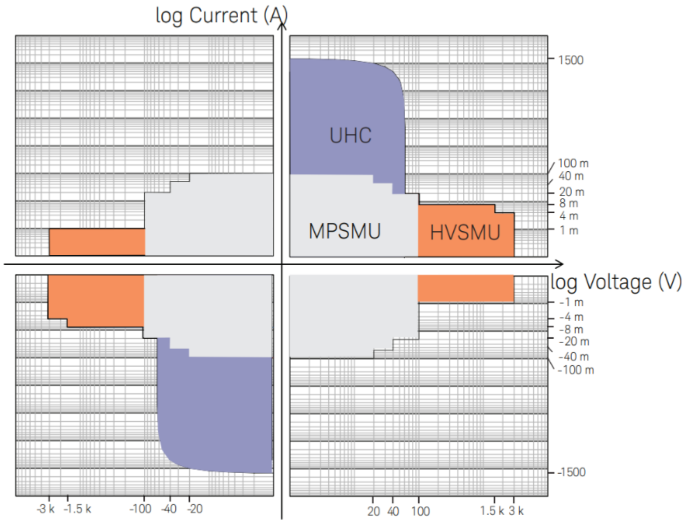


IV operating range for B1506A-H50/H51

B1506A-H70/H71

The drain / Collector Supply IV Operating range for B1506A-H71 is defined as the combination of UHCU, MPSMU, and HVSMU modules. The following graph shows the entire IV operating range of drain/collector supply for B1506A-H70/H71.

Refer to the section for each module later in this document for detailed specifications of each module.



IV operating range for B1506A-H70/H71

Capacitance Measurement Specifications

Capacitance measurement of B1506A-H21/H51/H71 is provided with the combination of the MFCMU module in the B1506A mainframe and the built-in device capacitance selector in the B1506A test fixture.

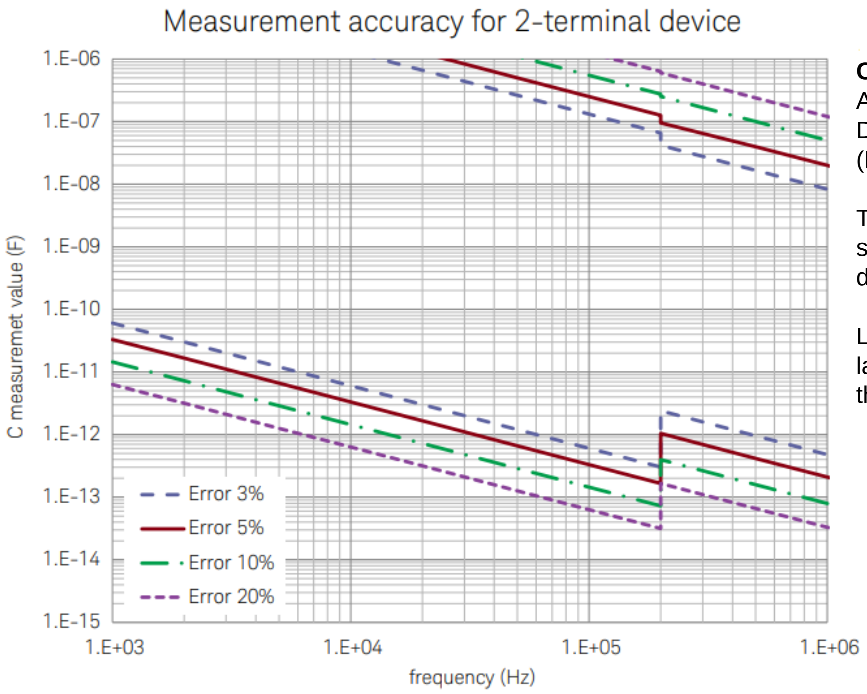
DC bias characteristics

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	±3000 V
Gate to Source Terminal	1 μF	±100V

Measurement accuracy for a 2-terminal device (Supplemental characteristics)



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

The noise level depends on setting parameters and the device under test.

Long integration times and/or large signal levels can reduce the noise level.

Measurement accuracy for a 2-terminal device

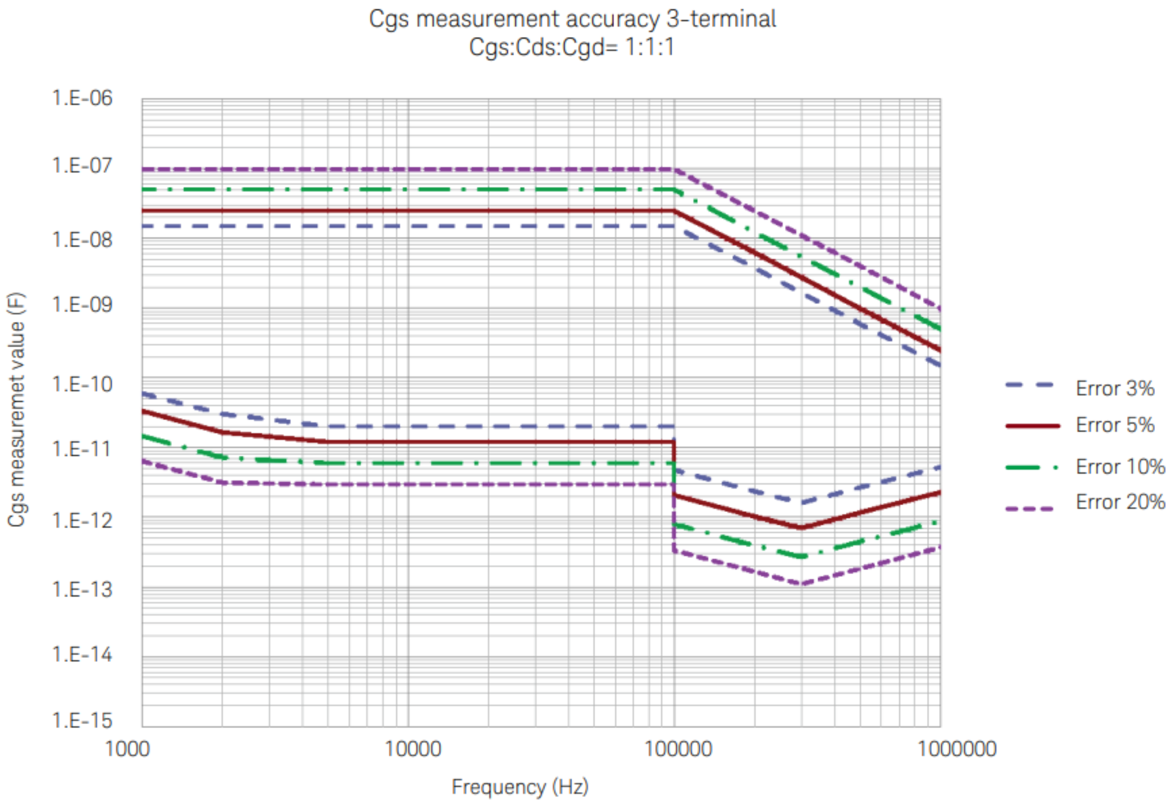
Output terminals for 2-terminal device

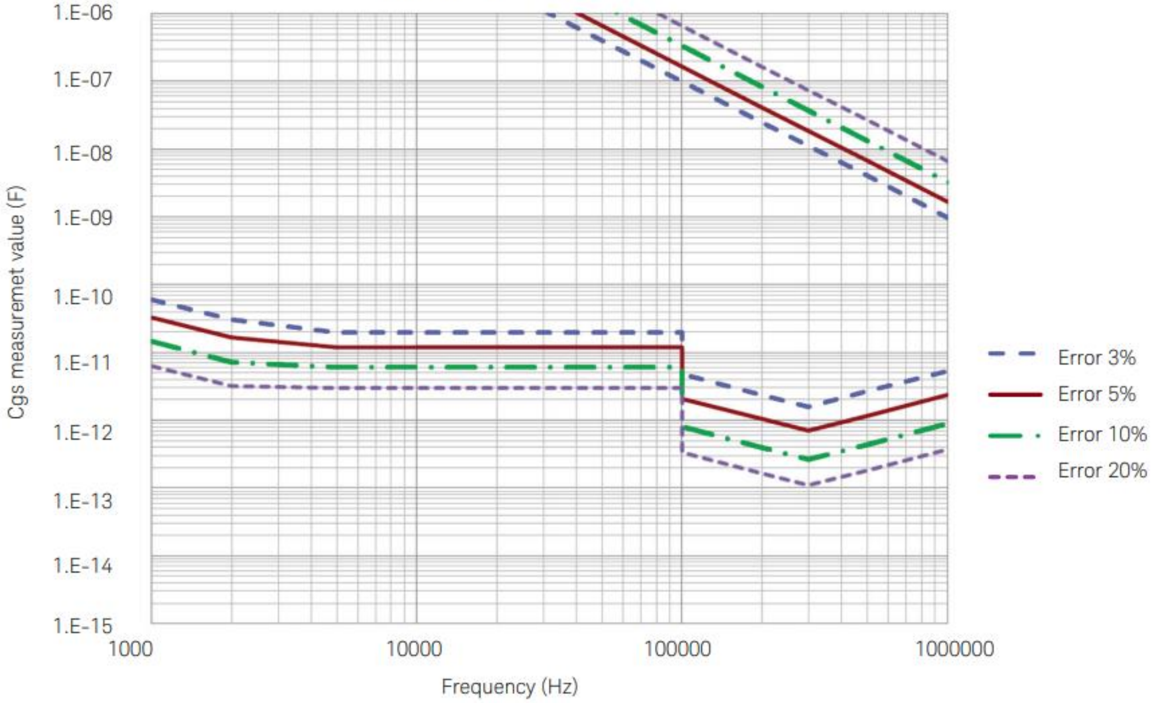
Collector/drain	Force	Open	Open	Open
	Sense	High	High	Open
Emitter/source	Force	Open	Open	Open
	Sense	Low	Open	Low
Base/gate	High	Open	Low	High
	Low	Open	Open	Open

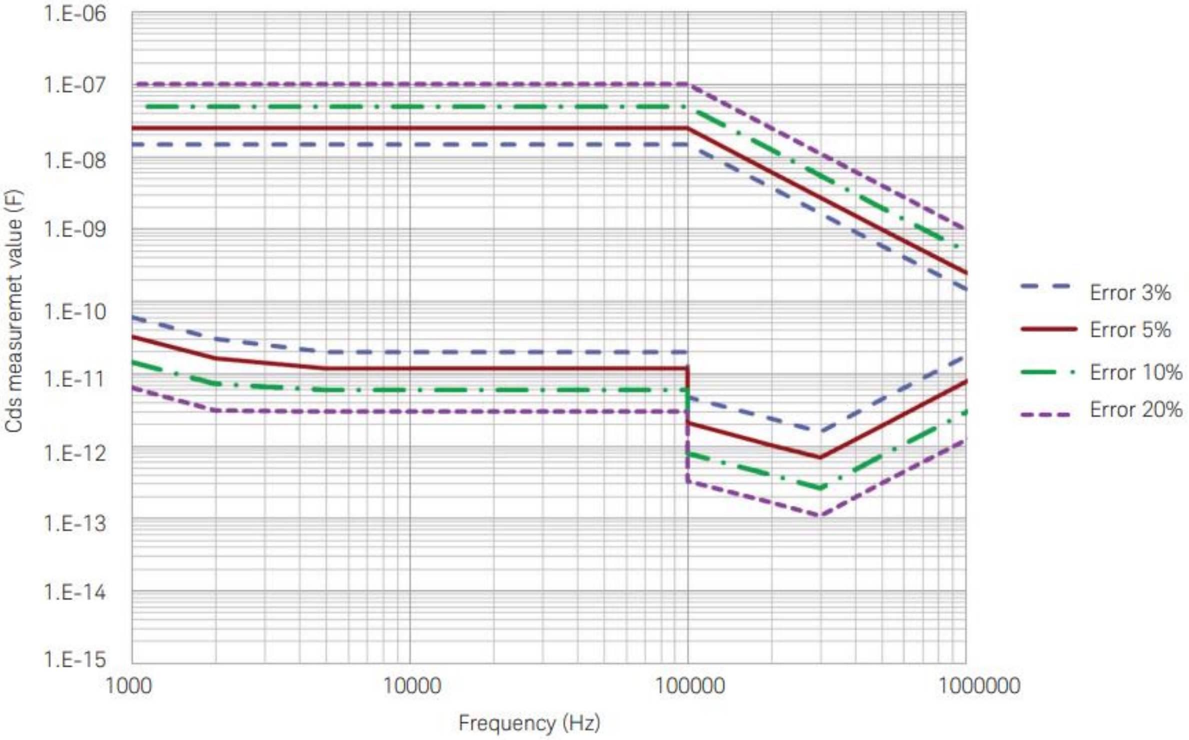
Measurement accuracy for a 3-terminal device (Supplemental characteristics)

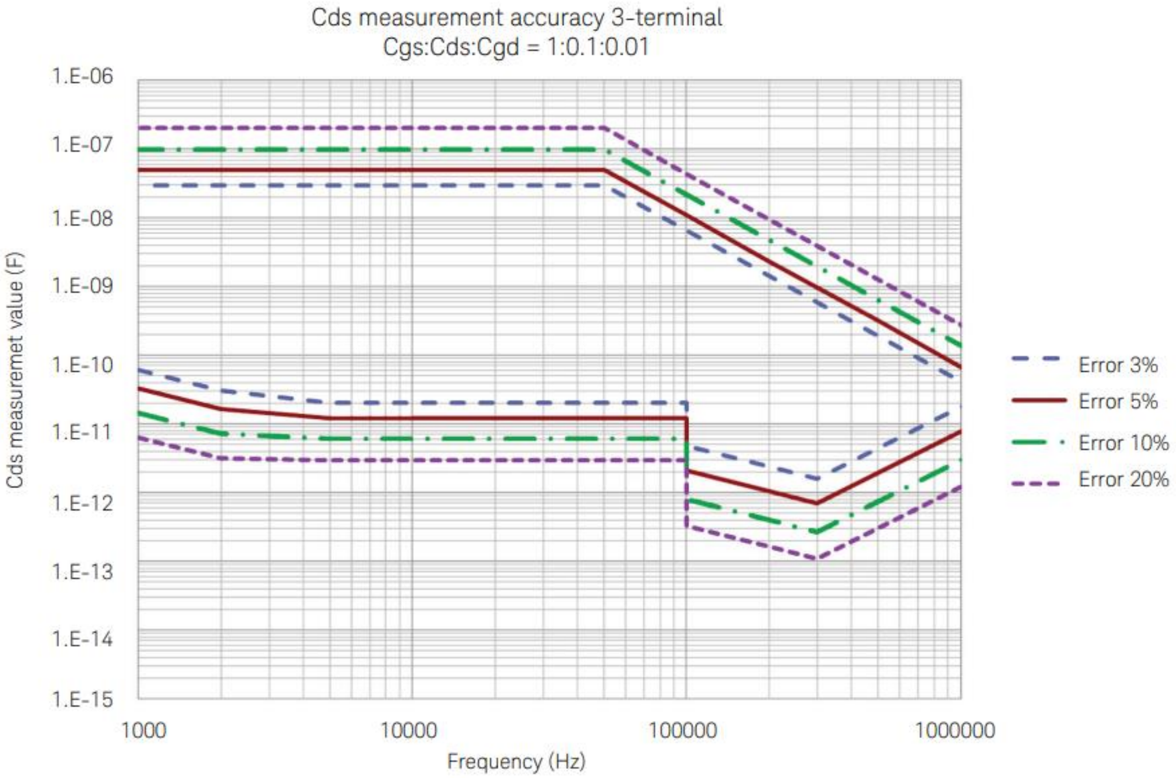
Condition

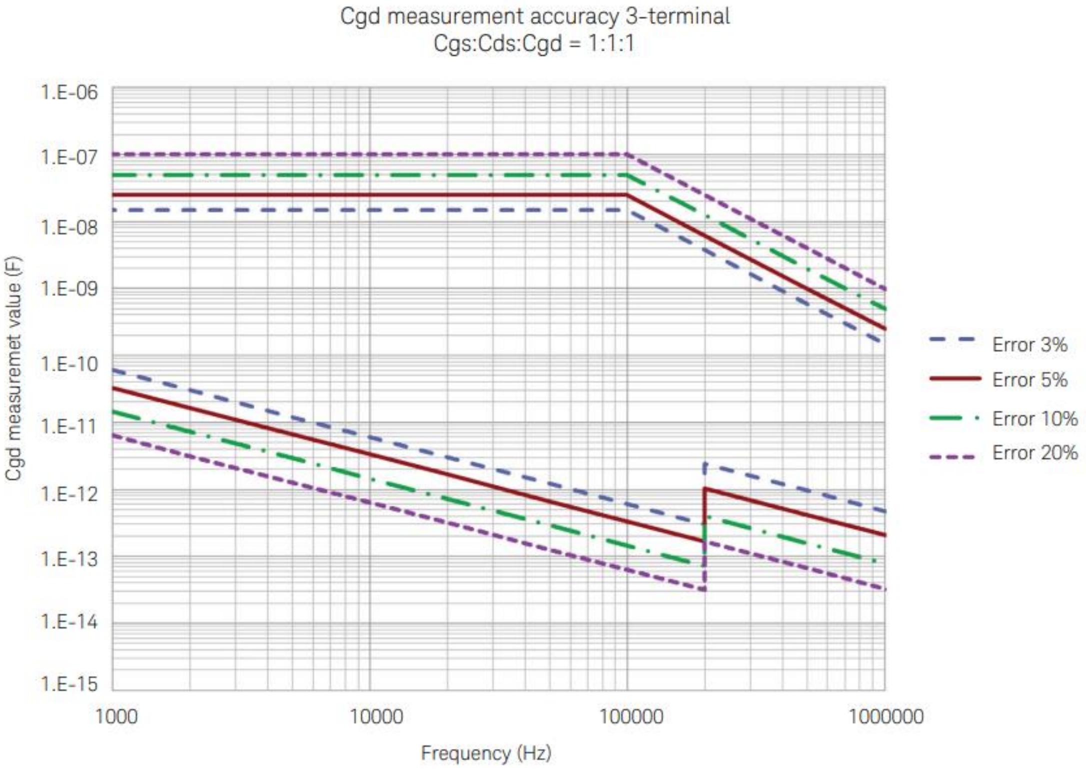
AC level: 30 mV rms, Dx < = 0.1 (Dx: Measurement value of D)

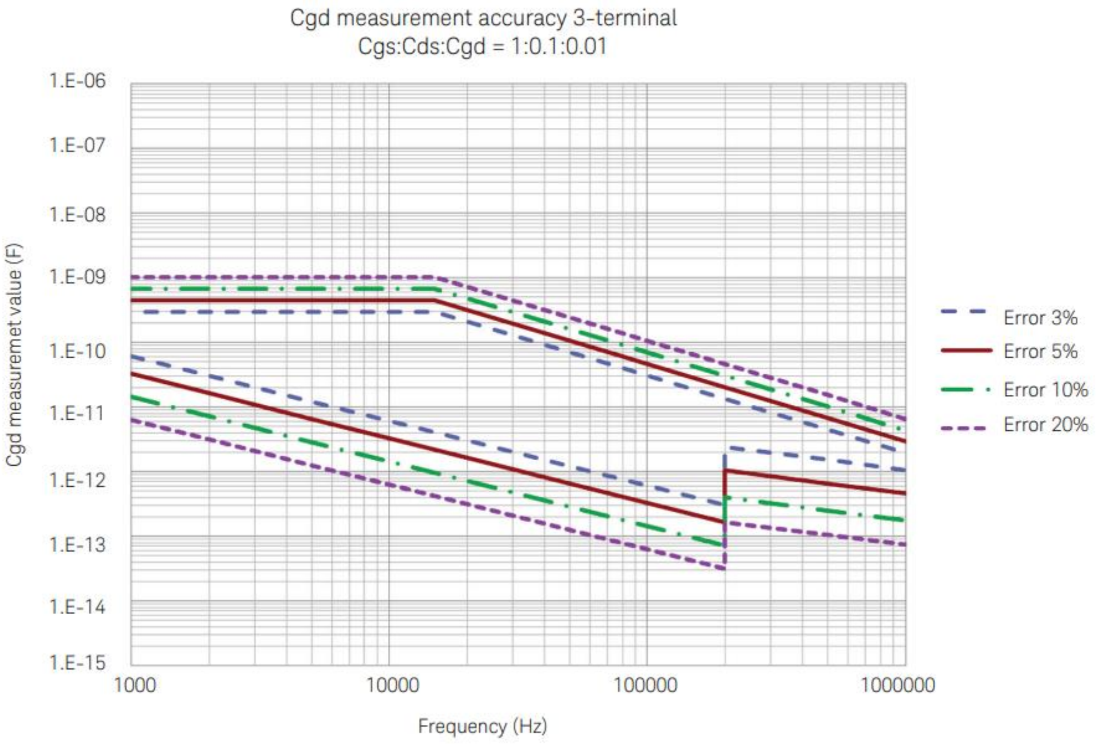


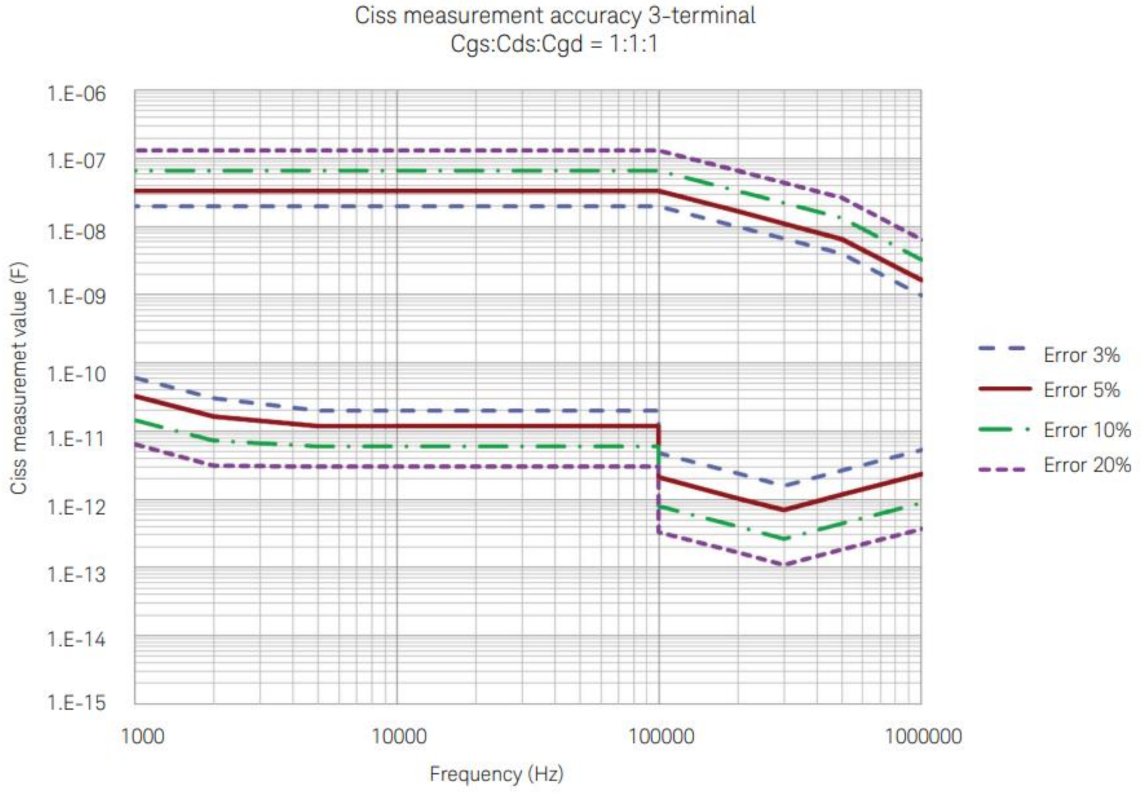

Cgs measurement accuracy 3-terminal
Cgs:Cds:Cgd= 1:0.1:0.01

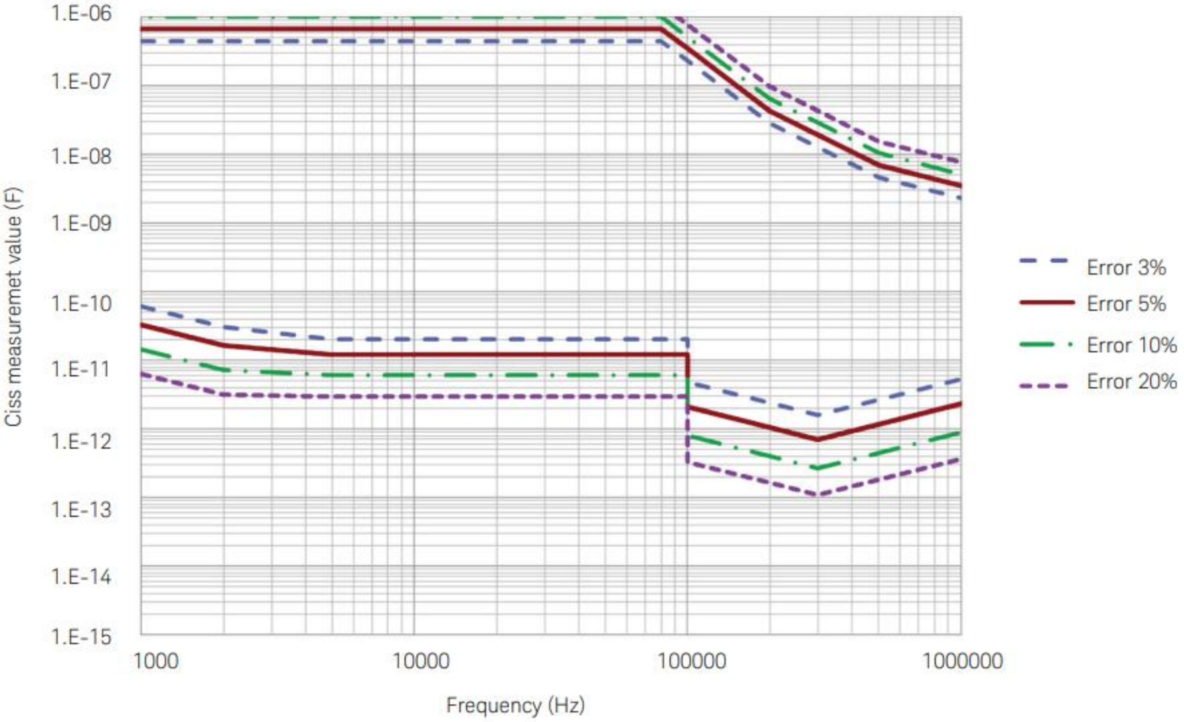

Cds measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:1:1


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
1000
10000
100000
1000000
Frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%

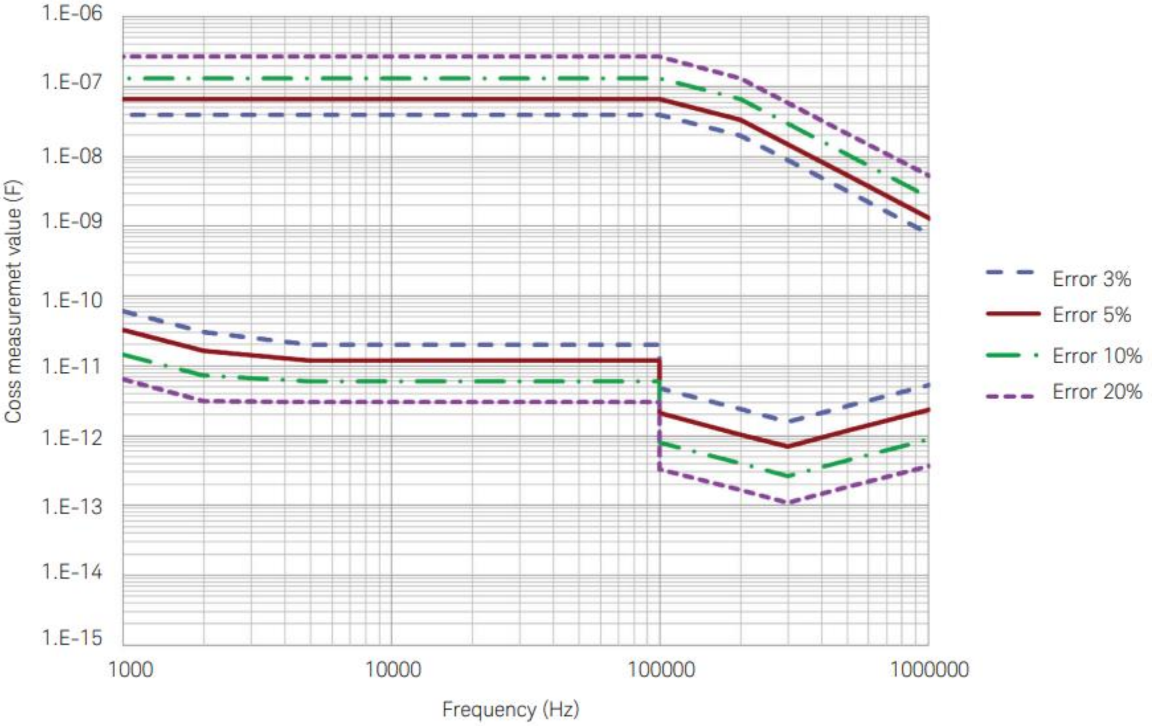

Cgd measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:1:1
Cgd measuremet value (F)
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
1.E-14
1.E-15
1000
10000
100000
1000000
Frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%


Cgd measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:0.1:0.01
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
Cgd measuremet value (F)
1000
10000
100000
1000000
Frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%

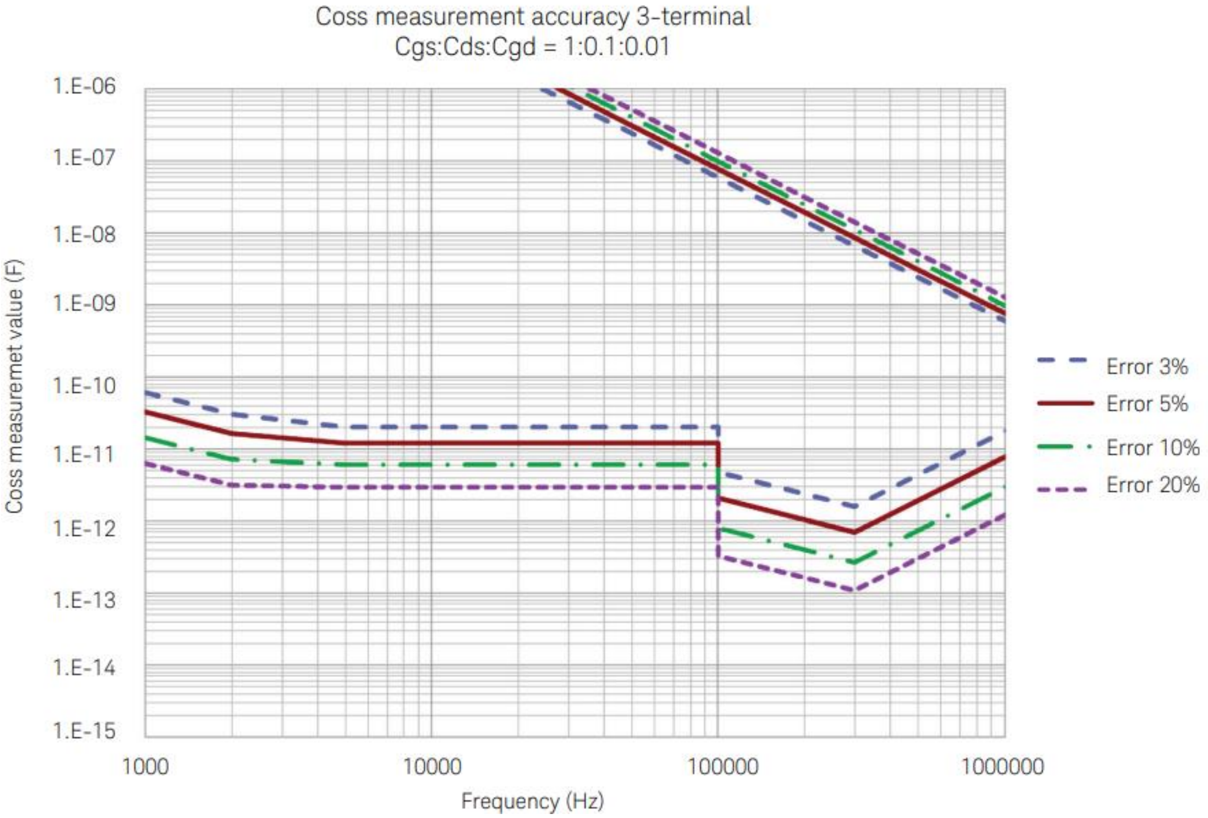

Ciss measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:1:1
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
1.E-14
1.E-15
Ciss measuremet value (F)
1000
10000
100000
1000000
Frequency (Hz)
Error 3%
Error 5%
Error 10%
Error 20%



Ciss measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:0.1:0.01



Coss measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:1:1


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
1000
10000
100000
1000000
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	Force	Open	Open	Open	Open	Open
	Sense	High	High	High	ACG	Low
Emitter/source	Force	Open	Open	Open	Open	Open
	Sense	Low	Low	ACG	Low	Low
Base/gate	High	Low	ACG	Low	High	High
	Low	Open	Open	Open	Open	Open

Definition of 3-terminal device capacitances

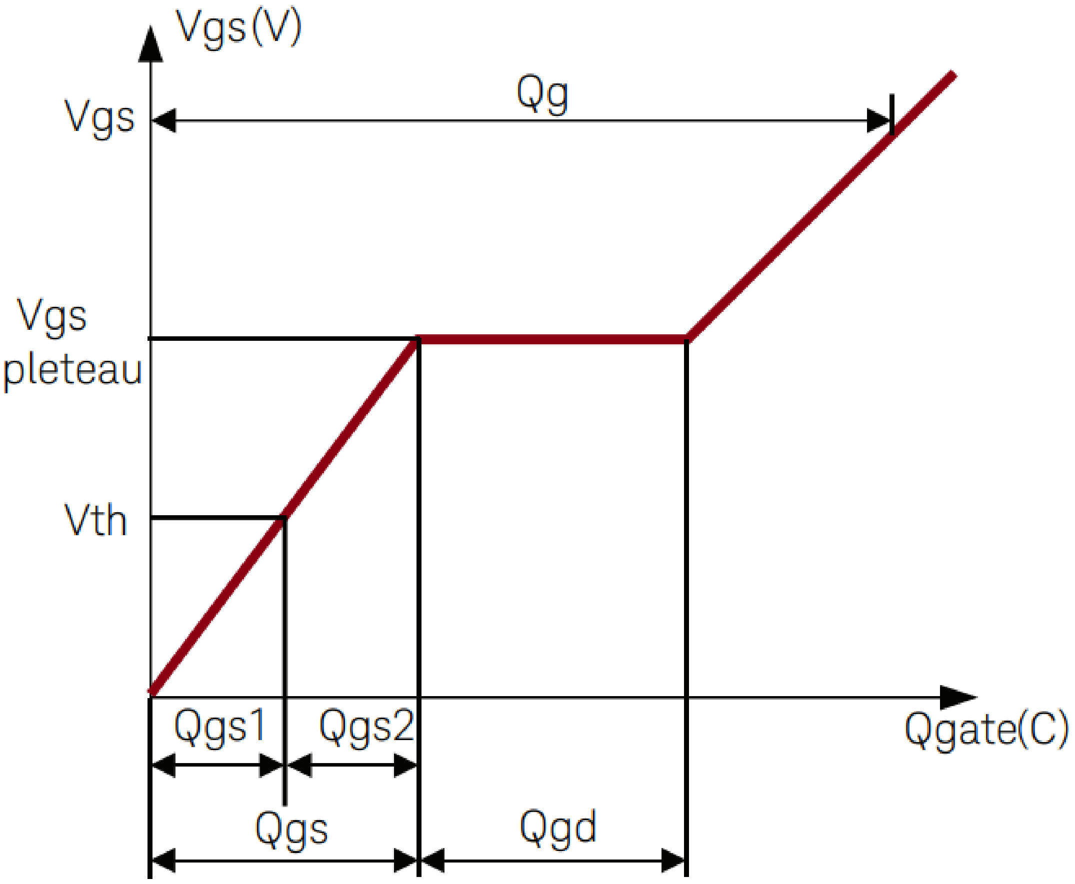
Symbol	Description
Cgs	Capacitance between Base/Gate terminal and Emitter/Source terminal
Cds	Capacitance between Collector/Drain terminal and Emitter/Source terminal
Cgd	Capacitance between Base/Gate terminal and Collector/Drain terminal
Crss	Capacitance between Base/Gate terminal and Collector/Drain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

Gate Charge Measurement Specifications

B1506A-H21/H51/H71 can perform gate charge characteristics for Nch MOSFETs and IGBTs by using a gate charge socket adapter included in B1506A as an accessory. Both resistors and transistors are supported as drain/collector current control devices.

Temperature dependency measurement using Thermostream or Thermal plate is not supported.

- Qg: Gate charge
- Qgs: Gate-source charge
- Qgs1: Gate charge at threshold
- Qgs2: Gate charge from threshold to onset of plateau
- Qgd: Gate-drain charge



Measurement parameters

	B1506A-H21	B1506A-H51	B1506A-H71
Measurement parameter	**Measurable range**		
Qg	1 nC to 100 µC		
Minresolution	10 pC		
Vds (Vce) @ high voltage	0 V to +3000 V		
Resolution	3 mV / 6 µs		
Vds (Vce) @ high current	Not supported	−60 V to 60 V	
Resolution		100 µV/2 µs	
Vgs (Vge)	−30V to +30V		
V/T resolution	40 uV/2 us		
Id (Ic)	0 to 20 A	0 to 500 A	0 to 1500 A
I/T resolution	2 mA/2 µs		
Ig	10 nA to 1 A		
I/T resolution	10 pA/2 µs		

Setting parameters

	B1506A-H21	B1506A-H51	B1506A-H71
Setting parameter	**Setting range**		
Vds (Vce) @ high voltage	0 V to +3000 V		
Resolution	3 mV/6 us		
Vds(Vce) @ high current	−20 to 20 V	−60 to 60 V	
Resolution	20 µV/2 µs	100 µV/2 µs	
Id max	20 A	450 A	1100 A
Gate drive Vgs(Vge)	−30V to +30V		
Resolution	40 µV		
Gate control current Ig	1 µA to 1 A		
Resolution	0.1 µA		
Current regulatory control voltage	−30 to +30 V		
Resolution	40 µV		
On-time	50 to 950 µs		50 to 450 µs
Resolution	2 µs		
Target device	Nch MOSFET and IGBT TO packaged device		
	Nch MOSFET and IGBT module device		

UHC (Ultra High Current) Specification

Voltage range, resolution, and accuracy

Voltage range	Setting resolution	Measure resolution	Setting accuracy [1,2,3] ± (% + mV)	Measure accuracy [1,3] ± (% + mV)
± 60 V	200 µV	100 µV	± (0.2 + 10)	± (0.2 + 10)

1.± (% of reading value + fixed offset in mV)
2. Setting accuracy is defined at open load.
3.Accuracy is defined 1ms pulse width at 500A range and 500 µs pulse width at 1500A range.

Current range, resolution, and accuracy [1]

Current range	Setting resolution	Measure resolution	Setting accuracy [2,3] ± (% + A + A)	Measure accuracy [2,3] ± (% + A +A)
± 500 A	1 mA	500 µA	± (0.6 + 0.3 + 0.01*Vo)	± (0.6 + 0.3 + 0.01*Vo)
±1500 A	4 mA	2 mA	± (0.8 + 0.9 + 0.02*Vo)	± (0.8 + 0.9 + 0.02*Vo)

1. Maximum voltage compliance in current pulse mode is 63 V. Over 400 A at 500 A range and over 1200 A at 1500 A range are supplemental characteristics.
2. Accuracy is defined with 1ms pulse width at the 500 A range and with 500 µs pulse width at the 1500 A range.
3. ± (% of reading value + fixed offset in A + proportional offset in A), Vo is the Output Voltage.

UHCU Pulse width and resolution

Current range	Voltage pulse width	Current pulse width	Resolution	Pulse period [1]
500 A	10 µsec – 1 msec	10 µsec – 1 msec	2 µsec	Duty ≤ 0.4%
1500 A	10 µsec – 500 µsec	10 µsec – 500 µsec	2 µsec	Duty ≤ 0.1%

1. At the continuous maximum current output, the output current may be reduced due to insufficient charging time.

Output peak power

Current range	Peak power
±500 A	7.5 kW
±1500 A	22.5 kW

Other functionality

Filter

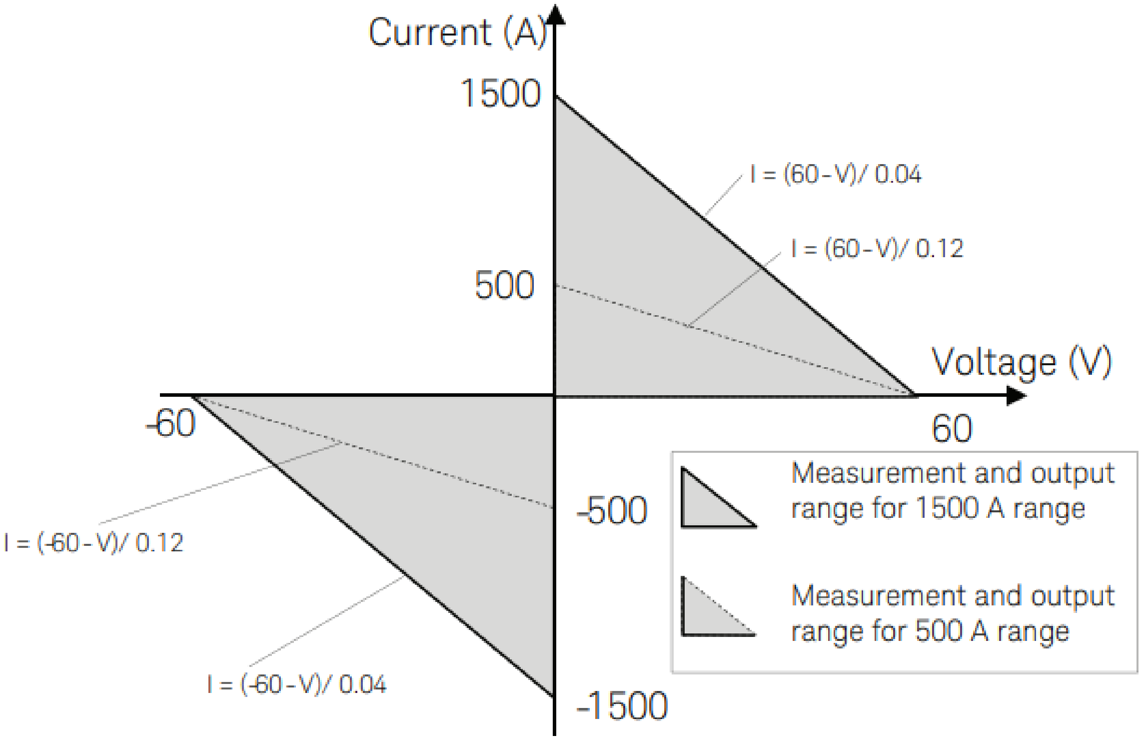
- A filter can be used for UHC output in the current mode at the 500 A range.

Supplemental characteristics

UHCU output resistance

Output range	Nominal value
500 A	120 mΩ
1500 A	40 mΩ

UHC measurement and output range



The UHCU output is only available in pulsed mode.

In the equations in the above diagram, 'I' stands for current, and 'V' is for voltage.

The maximum current is defined when the output terminals are shorted.

Also, the maximum current is limited by the residual resistance of the test leads and by the DUT impedance.

HCSMU Drain Output Specifications

Voltage range, resolution, and accuracy

Voltage range	Force resolution	Measure resolution	Force accuracy [1] ± (% + mV + mV)	Measure accuracy [1] ± (% + mV + mV)	Maximum current
±0.2 V	200 nV	200 nV	± (0.06 + 0.6 + Io x 0.05)	± (0.06 + 0.6 + Io x 0.05)	20 A
±2 V	2 µV	µV	± (0.06 + 0.6 + Io x 0.5)	± (0.06 + 0.6 + Io x 0.5)	20 A
±20 V	20 µV	20 µV	± (0.06 + 3 + Io x 5)	± (0.06 + 3 + Io x 5)	20 A
±40 V	40 µV	40 µV	± (0.06 + 3 + Io x 10)	± (0.06 + 3 + Io x 10)	1 A

1. ± (% of reading value + fixed offset in mV + proportional offset in mV). Note: Io is the output current in A.

Current range, resolution, and accuracy

Current range	Force resolution	Measure resolution	Force accuracy [1] ± (% + A + A)	Measure accuracy [1] ± (% + A + A)	Maximum voltage
±10 µA	10 pA	10 pA	± (0.06 + 1E-8 + Vo x 3E-9)	± (0.06 + 1E-8 + Vo x 3E-9)	40 V
±100 µA	100 pA	100 pA	± (0.06 + 2E-8 + Vo x 3E-9)	± (0.06 + 2E-8 + Vo x 3E-9)	40 V
±1 mA	1 nA	1 nA	± (0.06 + 2E-7 + Vo x 1E-8)	± (0.06 + 2E-7 + Vo x 1E-8)	40 V
±10 mA	10 nA	10 nA	± (0.06 + 2E-6 + Vo x 1E-7)	± (0.06 + 2E-6 + Vo x 1E-7)	40 V
±100 mA	100 nA	100 nA	± (0.06 + 2E-5 + Vo x 1E-6)	± (0.06 + 2E-5 + Vo x 1E-6)	40 V
±1 A	1 µA	1 µA	± (0.4 + 2E-4 + Vo x 1E-5)	± (0.4 + 2E-4 + Vo x 1E-5)	40 V
±20 A [2]	20 µA	20 µA	± (0.4 + 2E-3 + Vo x 1E-4)	± (0.4 + 2E-3 + Vo x 1E-4)	20 V

1. ± (% of reading value + fixed offset in A + proportional offset in A), Vo is the output voltage in V.
2. Pulse mode only. The maximum value of the base current during pulsing is ±100 mA.

Power consumption

Voltage source mode

Voltage range	Power
0.2 V	40 x Ic (W)
2 V	40 x Ic (W)
40 V	40 x Ic (W)

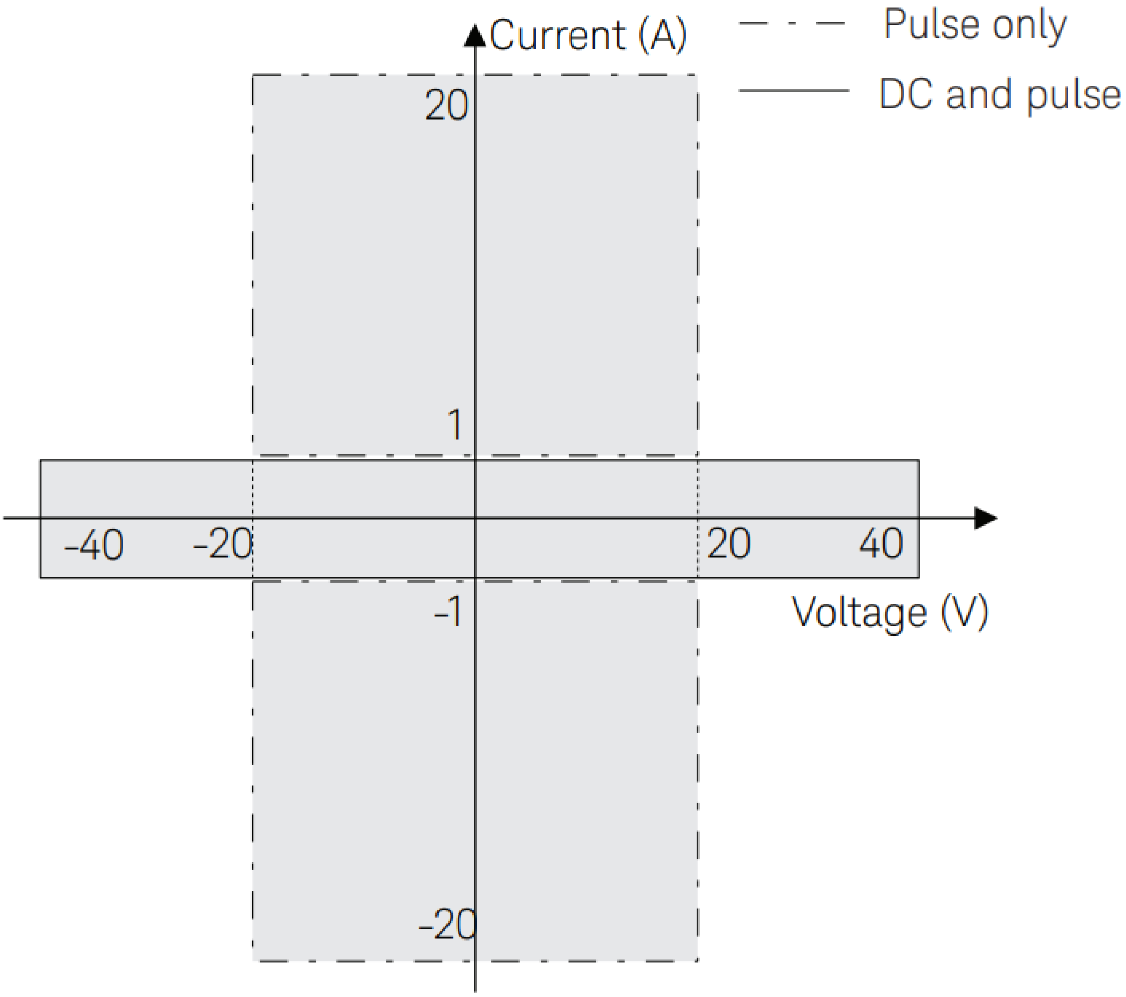
Where Ic is the current compliance setting. For pulse current, Ic = (duty) x Ipulse

Current source mode

Voltage compliance	Power
Vc ≤ 0.2	40 x Io (W)
0.2 < Vc ≤ 2	40 x Io (W)
2 < Vc ≤ 40	40 x Io (W)

Where Vc is the voltage compliance setting, and Io is the output current. For pulse current, Io = (duty) x Ipulse

HCSMU 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 in mV)

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 3E-11) [4]	±(0.1 + 1E-9 + Vo x 3E-11) [4]	3000 V	1pA
±100 nA [3]	100 fA	100 fA	±(0.05 + 1E-9 + Vo x 3E-11) [4]	±(0.05 + 1E-9 + Vo x 3E-11) [4]	3000 V	100 pA
±1 µA [3]	1 pA	1 pA	±(0.05 + 1E-9 + Vo x 3E-11) [4]	±(0.05 + 1E-9 + Vo x 3E-11) [4]	3000 V	100 pA
±10 µA [3]	10 pA	10 pA	±(0.04 + 2E-9 + Vo x 3E-11) [4]	±(0.04 + 2E-9 + Vo x 3E-11) [4]	3000 V	10 nA
±100 µA	100 pA	100 pA	±(0.03 + 3E-9 + Vo x 3E-9)	±(0.03 + 3E-9 + Vo x 3E-9)	3000 V	10 nA
±1 mA	1 nA	1 nA	±(0.03 + 6E-8 + Vo x 3E-9)	±(0.03 + 6E-8 + Vo x 3E-9)	3000 V	100 nA
±10 mA	10 nA	10 nA	±(0.03 + 2E-7 + Vo x 3E-9)	±(0.03 + 2E-7 + Vo x 3E-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 more than the current shown in the table.
3. Supplemental characteristics
4. If only the sense line is connected to the DUT and the force line is left open, then the third term of the accuracy equation is Vo x 2E-12.

Power consumption

Voltage source mode

Current compliance	Power
Ic ≤ 4 m	3000 x Ic (W)
4 m < Ic ≤ 8 m	1500 x Ic (W)

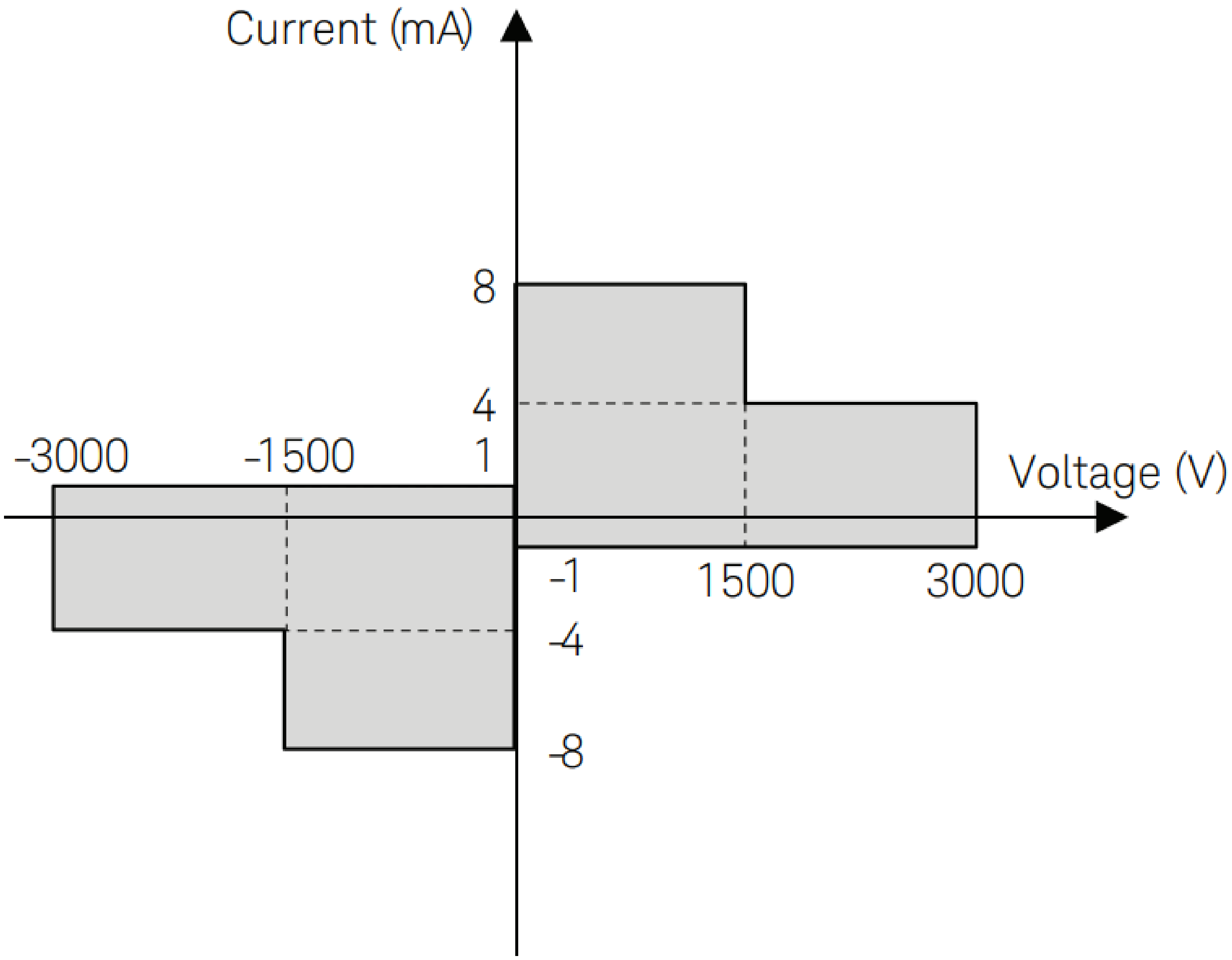
Where Ic is the current compliance setting.

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 the output current.

HVSMU measurement and output range



MPSMU Drain Output / 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 V.

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
±10 nA [3]	500 fA	10 fA	±(0.1 + 1E-9 + Vo x 3E-11)	±(0.1 + 1E-9 + Vo x 3E-11)	100 V
±100 nA [3]	5 pA	100 fA	±(0.05 + 1E-9 + Vo x 3E-11)	±(0.05 + 1E-9 + Vo x 3E-11)	100 V
±1 µA [3]	50 pA	1 pA	±(0.05 + 1E-9 + Vo x 3E-11)	±(0.05 + 1E-9 + Vo x 3E-11)	100 V
±10 µA	500 pA	10 pA	±(0.05 + 3E-9 + Vo x 3E-11) [4] ±(0.05 + 3E-9 + Vo x 3E-9) [5]	±(0.04 + 2E-9 + Vo x 3E-11) [4] ±(0.04 + 2E-9 + Vo x 3E-9) [5]	100 V
±100 µA	5 nA	100 pA	±(0.035 + 15E-9 + Vo x 1E-10) [4] ±(0.035 + 15E-9 + Vo x 3E-9) [5]	±(0.03 + 3E-9 + Vo x 1E-10) [4] ±(0.03 + 3E-9 + Vo x 3E-9) [5]	100 V
±1 mA	50 nA	1 nA	±(0.04 + 15E-8 + Vo x 1E-9) [4] ±(0.04 + 15E-8 + Vo x 3E-9) [5]	±(0.03 + 6E-8 + Vo x 1E-9) [4] ±(0.03 + 6E-8 + Vo x 3E-9) [5]	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 A.
3. Supplemental characteristics
4. For Gate Output
5. For Drain Output

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 V.

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
±10 nA [3]	500 fA	500 fA	±(0.1 + 1E-9 + Vo x 3E-11)	±(0.25 + 1E-9 + Vo x 3E-11)	100 V
±100 nA [3]	5 pA	5 pA	±(0.05 + 1E-9 + Vo x 3E-11)	±(0.1 + 1E-9 + Vo x 3E-11)	100 V
±1 µA [3]	50 pA	50 pA	±(0.05 + 1E-9 + Vo x 3E-11)	±(0.1 + 1E-9 + Vo x 3E-11)	100 V
±10 µA	500 pA	500 pA	±(0.05 + 3E-9 + Vo x 3E-11) [4] ±(0.05 + 3E-9 + Vo x 3E-9) [5]	±(0.05 + 2E-9 + Vo x 3E-11) [4] ±(0.05 + 2E-9 + Vo x 3E-9) [5]	100 V
±100 µA	5 nA	5 nA	±(0.035 + 15E-9 + Vo x 1E-10) [4] ±(0.035 + 15E-9 + Vo x 3E-9) [5]	±(0.05 + 2E-8 + Vo x 1E-10) [4] ±(0.05 + 2E-8 + Vo x 3E-9) [5]	100 V
±1 mA	50 nA	50 nA	±(0.04 + 15E-8 + Vo x 1E-9) [4] ±(0.04 + 15E-8 + Vo x 3E-9) [5]	±(0.04 + 2E-7 + Vo x 1E-9) [4] ±(0.04 + 2E-7 + Vo x 3E-9) [5]	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 A.
3. Supplemental characteristics
4. For Gate Output
5. For Drain Output

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)

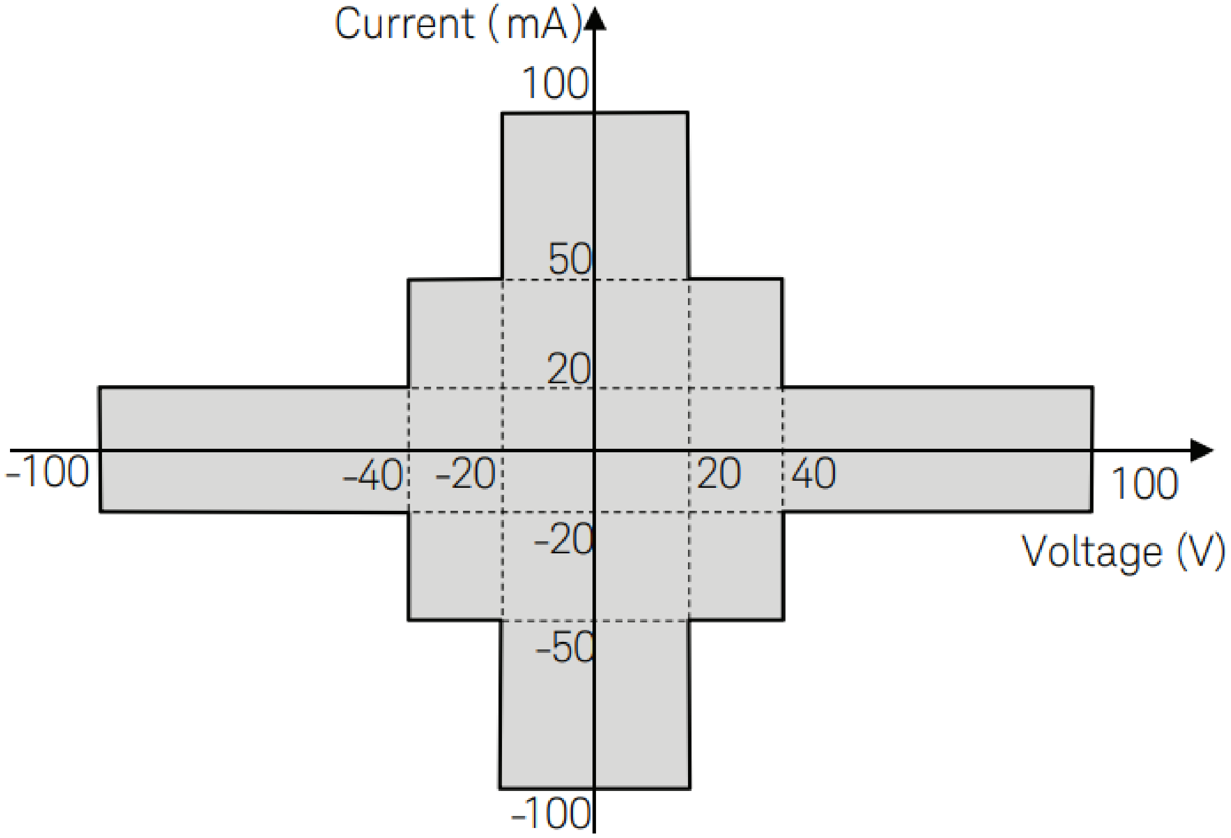
Where Ic is the current compliance setting.

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 the output current.

MPSMU measurement and output range



MCSMU Gate Output/AUX Output Specifications

Voltage range, resolution, and accuracy

Voltage range	Force resolution	Measure resolution	Force accuracy [1] ± (% + mV)	Measure accuracy [1] ± (% + mV)	Maximum current
±0.2 V	200 nV	200 nV	±(0.06 + 0.14)	±(0.06 + 0.14)	1 A
±2 V	2 µV	2 µV	±(0.06 + 0.6)	±(0.06 + 0.6)	1 A
±20 V	20 µV	20 µV	±(0.06 + 3)	±(0.06 + 3)	1 A
±40 V [2]	40 µV	40 µV	±(0.06 + 3)	±(0.06 + 3)	1 A

1. ±(% of reading value + fixed offset in mV).
2. Maximum output voltage is 30 V

Current range, resolution, and accuracy

Current range	Force resolution	Measure resolution	Force accuracy [1] ± (% + A + A)	Measure accuracy [1] ± (% + A + A)	Maximum voltage
±10 µA	10 pA	10 pA	±(0.06 + 1E-8 + Vo x 1E-10)	±(0.06 + 1E-8 + Vo x 1E-10)	30 V
±100 µA	100 pA	100 pA	±(0.06 + 2E-8 + Vo x 1E-9)	±(0.06 + 2E-8 + Vo x 1E-9)	30 V
±1 mA	1 nA	1 nA	±(0.06 + 2E-7 + Vo x 1E-8)	±(0.06 + 2E-7 + Vo x 1E-8)	30 V
±10 mA	10 nA	10 nA	±(0.06 + 2E-6 + Vo x 1E-7)	±(0.06 + 2E-6 + Vo x 1E-7)	30 V
±100 mA	100 nA	100 nA	±(0.06 + 2E-5 + Vo x 1E-6)	±(0.06 + 2E-5 + Vo x 1E-6)	30 V
±1 A [2]	1 µA	1 µA	±(0.4 + 2E-4 + Vo x 1E-5)	±(0.4 + 2E-4 + Vo x 1E-5)	30 V

1. ±(% of reading value + fixed offset in A + proportional offset in A), Vo is the output voltage in V.
2. Pulse mode only. The maximum value of the base current during pulsing is ±50 mA.

Power consumption

Voltage source mode

Voltage range	Power
0.2 V	40 x Ic (W)
2 V	40 x Ic (W)
40 V	40 x Ic (W)

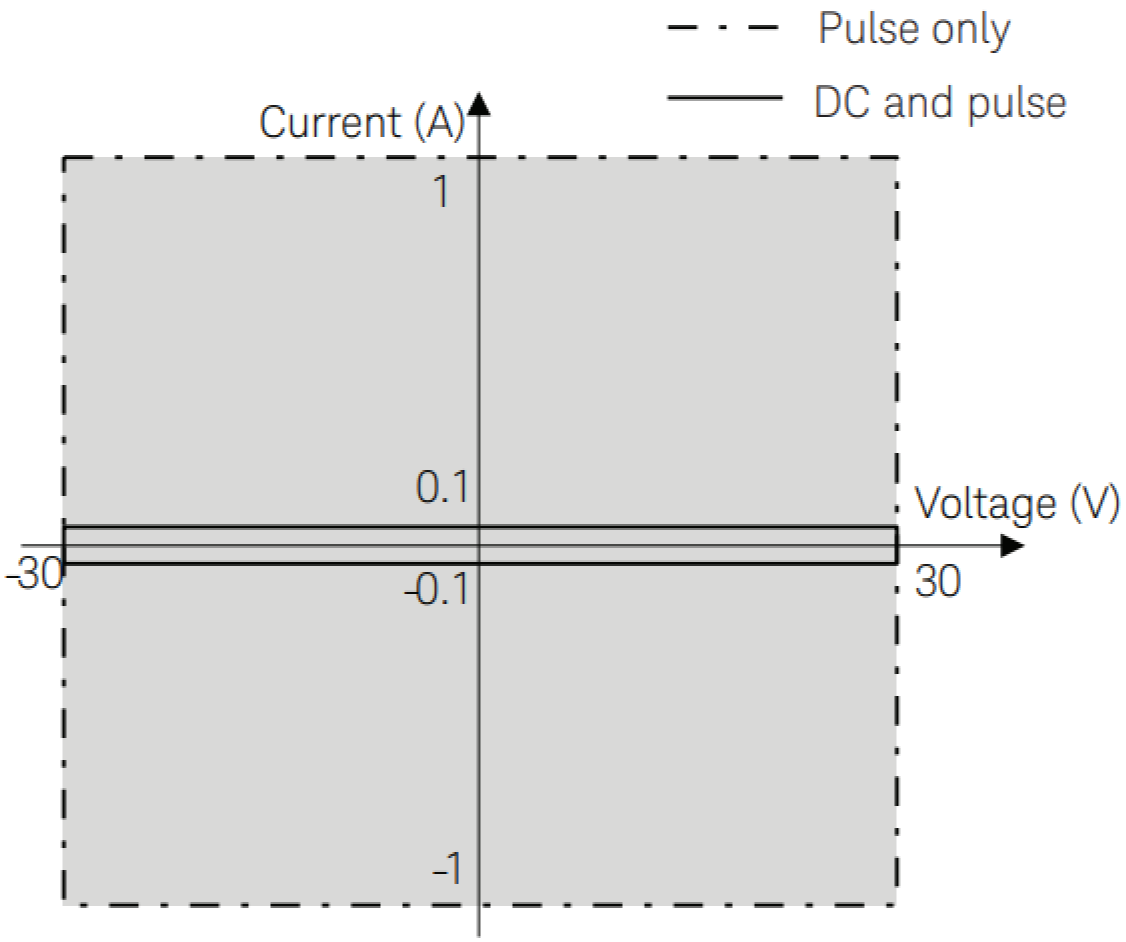
Where Ic is the current compliance setting.

Current source mode

Voltage compliance	Power
Vc ≤ 0.2	40 x Io (W)
0.2 < Vc ≤ 2	40 x Io (W)
2 < Vc ≤ 40	40 x Io (W)

Where Vc is the voltage compliance setting, and Io is the output current.

MCSMU measurement and output range



SMU Other Specifications

Specifications	
SMU source measurement mode	For MPSMU: • VFIM, IFVM For HCSMU, MCSMU and 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 ±40 V (HCSMU) • 0 V to ±30 V (MCSMU) • 0 V to ±3000 V (HVSMU) Current: • ±10 pA to ±100 mA (MPSMU) • ±10 nA to ±20 A (HCSMU) • ±10 nA to ±1 A (MCSMU) • ±10 pA to ±8 mA (HVSMU) Compliance accuracy: • Same as the current or voltage set accuracy.
Power compliance	For MPSMU: • Power: 0.001 W to 2 W • Resolution: 0.001 W For HCSMU: • Power: 0.001 W to 40 W (DC) • Resolution: 0.001 W For MCSMU: • Power: 0.001 W to 3 W (DC) • 0.001 W to 30 W (Pulse) • 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 HCSMU: • Pulse width: ◦ 50 µs to 1 ms (20 A range) ◦ 50 µs to 2 s (10 µA to 1 A range) • Pulse width resolution: 2 µs

- Pulse period: 5 ms to 5 s
- Pulse period resolution: 100 µs
- Pulse duty:
    - For 20 A range: ≤ 1%
    - For 10 µA to 1 A range:
        - Period ≥ delay + width + 2 ms (when delay + width ≤ 100 ms)
        - Period ≥ delay + width + 10 ms (when delay + width > 100 ms)
- Pulse delay: 0 to (Period – width)

For MCSMU:

- Pulse width:
    - 10 µs to 100 ms (1 A range)
    - 10 µs to 2 s (10 µA to 100 mA range)
- Pulse width resolution: 2 µs
- Pulse period: 5 ms to 5 s
- Pulse period resolution: 100 µs
- Pulse duty:
    - For 1 A range: ≤ 5%
    - For 10 µA to 100 mA range:
        - Period ≥ delay + width + 2 ms (when delay + width ≤ 100 ms)
        - Period ≥ delay + width + 10 ms (when delay + width > 100 ms)
- Pulse delay: 0 to (Period – width)

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 V, the peak and base of the pulse should be the same polarities.
- Pulse measurement delay:
    - 6 µs to (Period – pulse measurement time – 2 m) s
    - 6 µs resolution

Supplemental Characteristics

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 HCSMU and MCSMU: • For 10 μA to 1 A ranges: V/I setting accuracy ±2.5% of range • For 20 A range (HCSMU): V/I setting accuracy ±0.6% of range For HVSMU: • For 10 nA range: 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 HCSMU and MCSMU: • Width: ±0.1% ± 2 μs • Period: ±0.1% ± 100 μs For HVSMU: • Width: ±0.1% ± 6 μs • Period: ±0.5% ± 100 μs
Minimum pulse measurement time	16 μs (MPSMU) 2 μs (HCSMU and MCSMU) 6 μs (HVSMU))

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

MFCMU (multi-frequency capacitance measurement unit) module specifications

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 $\mathrm{mV_{rms}}$ to 250 $\mathrm{mV_{rms}}$
- Resolution: 1 $\mathrm{mV_{rms}}$
- Accuracy:
  - ±(10.0% + 1 $\mathrm{mV_{rms}}$) at the measurement port of the MFCMU
  - ±(15.0% + 1 $\mathrm{mV_{rms}}$)

Output impedance:

- 50 Ω, typical

Signal level monitor:

- Range: 10 $\mathrm{mV_{rms}}$ to 250 $\mathrm{mV_{rms}}$
- Accuracy:
  - ±(10.0% of reading + 1 $\mathrm{mV_{rms}}$) at the measurement port of the MFCMU
  - ±(15.0% + 1 $\mathrm{mV_{rms}}$)

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
$E = E_P' + (Z_S'/|Z_X| + Y_O'|Z_X|) \times 100$ (%)
$E_P' = E_{POSC} + E_P$ (%)
$Y_O' = Y_{OSC} + Y_O$ (S)
$Z_S' = Z_{OSC} + Z_S$ (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 ±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 Y_{OSC}, Y_O, E_P, Z_S

Frequency	Y_{OSC} (nS)	Y_O (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 the 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:
D_X ≤ 0.1
Integration time: 1 PLC
Test signal level: 30 mV_{rms}
At the four-terminal pair port of MFCMU

Test Fixture Specification

There are 3 types of test fixtures available for B1506A, depending on the selected option.

Functionality

Fixture capability

- Current expander capability (H51/H71)

Selector capability

- This allows the user to switch the output between the HVSMU, MPSMU, and UHCU or HCSMU.

Thermocouple input: 2 ea

- Two K-type thermocouple inputs
- Temperature range: -50 °C to 300 °C.

Thermocouple reading accuracy

Temperature range	Accuracy
0°C ≤ T < 100° C	+/-2°C
T ≥ 100° C	+/-5°C
T < 0° C	+/-5°C

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.

Software interfaces

The B1506A is equipped with Easy Test Navigator, a software suite for power device characterization (hereafter referred to as Easy Test Navigator). It supports various types of measurements and provides easy-to-use and simple operation. The Easy Test Navigator 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 B1506A's SSD, and they can be exported to external storage. The B1506A also supports Keysight Technologies, Inc. EasyEXPERT group+ software, a well-proven software interface for the B1500A and B1505A.

B1506A Easy Test Navigator

Key features:

- Dedicate software for:
  - Datasheet characterization
  - I/V characteristics measurement
  - Three-terminal device capacitance measurement
  - Gate charge measurement
  - Thermal monitor/control
  - Device power loss calculation
- Ready-to-use measurement templates for typical power device characteristics measurements
- Ability to automatically accumulate measurement data on the SSD in exportable formats

Easy Test Navigator palette:

The Easy Test Navigator Palette provides a complete list of the B1506A’s measurement software and also allows this software to be launched. The Easy Test Navigator Palette is displayed in full-screen mode after powering up the B1506A. The Easy Test Navigator Palette can be minimized to access the Windows desktop.

Datasheet characterization software:

The datasheet characterization software provides the following:

- A simple operating environment that can measure a range of device parameters and characteristics using a familiar datasheet-like format.
  - The ability to input measurement conditions in a datasheet-like format.
  - The ability to specify graphical limits on sweep measurements.
  - Display measured parameters and characteristics in a datasheet-like format.
  - The ability to compare measurement results with expected values.
- The minimal software learning curve for device characterization using the predefined measurement templates.
- The ability to effectively generate new datasheet specifications for operating conditions not covered on the manufacturer’s datasheet.

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 a rotary knob.
- Predefined templates for typical MOSFET, IGBT, and Diode I/V measurements.

Oscilloscope view:

I/V Measurement Software supports the pulse mode Oscilloscope View function for the HCSMU, MCSMU, HVSMU, and UHCU modules.

Oscilloscope View provides 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 3 kV for Collector/Drain terminal
    - With DC bias (sweep) control up to 100 V for the 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.
- Predefined templates for typical capacitance measurements of both enhancement and depletion type MOSFETs, IGBTs, and Diodes.

Gate charge measurement software:

Gate charge measurement Software provides:

- Support for both constant current load mode and resistive load mode correction of parasitic capacitance and residual resistance in the gate path.
- Monitoring of gate and drain/ collector voltage/ and current waveforms during the device turn-on period phase.
- JESD24-2 compliant Qg curve, line fitting, and parameter extraction.

Thermal monitor/control software:

Thermal monitor/control software provides:

- Thermometer indication
- Thermal profile with measurement triggers
- Optional control of Thermal Plate

Power loss calculation software:

Power loss calculation software provides:

- Calculation of power loss at a switching device for:
    - Hard switching mode
    - Soft switching mode
- Device characteristics parameter input for:
    - Gate resistance
    - On resistance
    - Gate charge
    - Gate switching charge
    - Equivalent output capacitance energy-related
    - Equivalent output capacitance time related
    - Parameter input assist from related measurement data with the following:
      - Display of source measurement data
- Switching condition parameter input
    - Support of parameter sweep for one parameter
- Power loss calculation results of:
    - Total power loss
    - Conductive power loss
    - Driving power loss
    - Switching power loss (inductive load, resistive load)
    - Graph representation of loss components for optional parameter sweep

Keysight EasyEXPERT group+ software

Key features:

- Ready-to-use application test library
- Multiple measurement modes (application test, classic test, tracer test, oscilloscope view, 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 interfaces (USB, LAN, GPIB, and digital I/O)

Operation mode:

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

Measurement mode:

- V measurement
  - Spot
  - Staircase sweep
  - Pulsed spot
  - Pulsed sweep
  - Staircase sweeps with pulsed bias
  - Sampling
  - Multi-channel sweep
  - Multi-channel pulsed sweep
  - List sweep
  - Linear search [1]
  - Binary search [1]
- 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)

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[1] Supported only by FLEX commands.

Common specifications 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 2 ms, 10 µs 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 resolution 0 to 655.35 s, 10 ms resolution • Measurement time resolution: 100 µs

[1] Supported only by EasyEXPERT group+ 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	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 for the error factor (offset current) caused by the measurement path, such as the measurement cables, manipulators, or probe card.
Time stamp [1]	The B1506A supports a time stamp function utilizing an internal quartz clock. • Resolution: 100 µs

1. Supported only by EasyEXPERT group+ and FLEX commands.

Data display, analysis, and arithmetic functions

Data display **X-Y graph plot**	X-axis and up to eight Y-axes, linear and log scale, and real-time graph plotting. X-Y graph plots can be printed or stored as image data on a clipboard or mass storage 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 regression mode • Overlay graph comparison: Graphical plots can be overlaid.
List display	Measurement data and calculated user function data are listed in conjunction with the 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.

Automatic analysis function

On a graphics plot, the markers and lines can be automatically located using the auto analysis setup. Parameters can be automatically 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, predefined 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 predefined 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-23 ε (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})

Recommended GPIB I/F

		Interface	B1506A
Keysight	82350B/C	PCI	✓ [1]
	82357A	USB	✓ [2]
	82357A	USB	✓ [2]
National Instrument	GPIB-USB-HS	USB	✓ [2]

1. An 82350B/C card is highly recommended because of its stability and speed.
2. USB GPIB interfaces might cause serial poll errors intermittently due to intrinsic communication scheme differences. It is reported that using an even GPIB address sometimes significantly decreases the chance of the error. The NI GPIB-USB-HS is recommended for stability, and the Keysight 82357B is recommended for speed.

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)	B1506A mainframe: 900 VA B1506A test fixture: 130 VA (H21), 470 VA (H51/H71)
Acoustic noise emission	Lpa: < 55 dB Lwa: 55 dB (Operating mode) Lwa: 73 dB (Worst Case 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, RCM, KC
Dimensions	• B1506A mainframe: 420 mm W x 330 mm H x 575 mm D • B1506A test fixture: 420 mm W x 360 mm H x 575 mm D • B1506A-T01 Thermal Test Enclosure: Outer dimension: 370 mm W x 340 mm H x 315 mm D Inner dimension: 280 mm W x 130 mm H x 180 mm D
Weight	• B1506A mainframe H21: 34.5 kg H51/H71: 35 kg • B1506A test fixture H21: 22 kg H51/H71: 33.5 kg

Furnished accessories	• Measurement cables and adapter • System cable, 1 ea. • CMU cable, 1 ea • Digital I/O cable, 1 ea. • Blank Silicon Plate, 1 ea. • 3-pin Inline Package Socket Module, 1 ea • Curve Tracer Test Adapter Socket Module, 1ea • Thermocouple (high temperature resistant, 75 cm), 2 ea. • 200 mm high current cable, 2 ea. • 300 mm high current cable, 2 ea. • 200 mm normal cable, 8 ea. • 300 mm normal cable, 6 ea. • Banana pin adapter, 18 ea. • Mini alligator clip, 14 ea. • Large clip, 4 ea. • For B1506A-H21/51/71 only Universal Socket Module, 1 ea. Gate Charge Socket Adapter, 1 ea. • Keyboard, 1 ea. • Mouse, 1 ea. • Stylus pen, 1 ea. • Power cable, 2 ea.

Ordering Information

Ordering information

Model number	Option	Description
B1506A		Power device analyzer for circuit design [1]
	H20	Option H20 - 20 A/3 kV/Thermal Fixture Package
	H21	Option H21 - 20 A/3 kV/C-V/Gate Charge/Thermal Fixture Package
	H50	Option H50 - 500 A/3 kV/Thermal Fixture Package
	H51	Option H51 - 500 A/3 kV/C-V/Gate Charge/Thermal Fixture Package
	H70	Option H70 - 1500 A/3 kV/Thermal Fixture Package
	H71	Option H71 - 1500 A/3 kV/C-V/Gate Charge/Thermal Fixture Package
	Thermal test option	
	T01	Thermal Test Enclosure (Thermostream Compatible)
	Documentation	
	0B0	Download the Product Manual from the Keysight website
	Calibration documentation	
	UK6	Commercial calibration certificate with test data
	A6J	ANSI Z540-1-1994 Calibration
	Drive option	
B1506AU		Upgrade kit for B1506A
	Mainframe upgrade	
	B1500AU-PC3	Mainframe upgrade (available for S/N MY53440101 or later)
	Current upgrade	
	005	20 A to 500 A Current Upgrade Option
	015	500 A to 1500 A Current Upgrade Option
	105	20A to 500A Current Upgrade for B1506A-H20
	115	500A to 1500A Current Upgrade for B1506A-H50
	CV and Qg upgrade [2]	
	021	Add CV and Qg to B1506A-H20
	051	Add CV and Qg to B1506A-H50
	071	Add CV and Qg to B1506A-H70
	Accessory	
	T01	Thermal Test Enclosure (Thermostream Compatible)
	F02	Blank Silicon Plate
	F10	3-pin Inline Package Socket Module
	F11	Universal Socket Module [3]
	F13	Curve Tracer Test Adapter Socket Module
	F14	Gate Charge Socket Adapter

Note: Both Thermostream and Thermal plate (HP289 with GP-IB control) are sold and supported by inTEST corporation.

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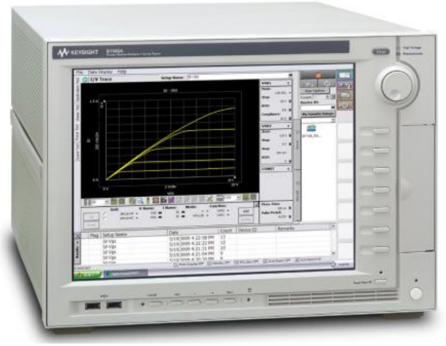
1. Mainframe with serial number MY64320101 or later is not equipped with DVD drive.
2. Universal Socket Module (B1506AU Opt F11) and Gate Charge Socket Adapter (B1506AU Opt F14) are not furnished. Order these options if necessary.
3. B1506AU Opt F11 Universal Socket Module contains a universal socket module, test wire for the thermal test (2m), ultra-high current test wire for the thermal test (2m), lag connector x20, lag connector for ultra-high current test wire x6, and screws.

If you need more measurement capabilities, the best choice is Keysight precision SMU products

	Keysight B2900 Precision Instrument Family	www.keysight.com/find/smu
	Keysight B1500A Semiconductor Device Analyzer	www.keysight.com/find/B1500A
	Keysight B1505A Power Device Analyzer/Curve Tracer (1500 A/10 kV)	www.keysight.com/find/B1505A

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