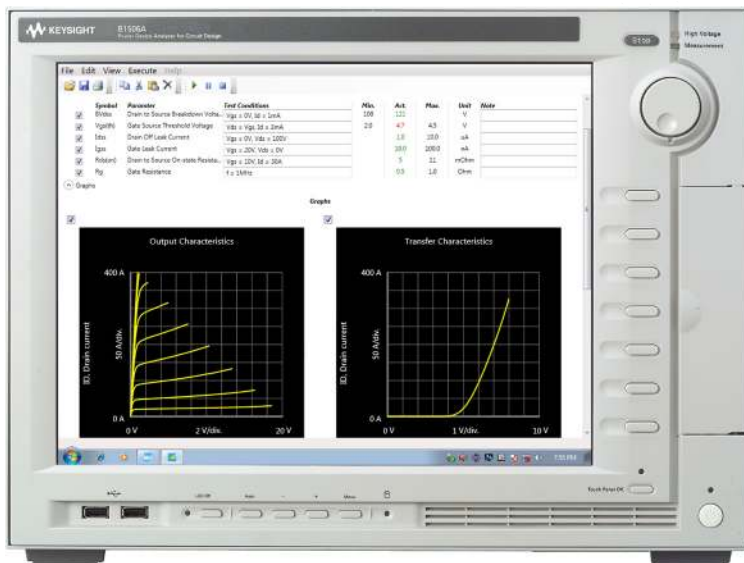


B1506A Power Device Analyzer for Circuit Design



Introduction

Evaluate all device parameters under a wide range of 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
- Data sheet 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

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 that makes it easy to characterize semiconductor devices and components without going through any formal training. Integrated switching circuitry within the test fixture supports fully automated testing, with the ability to automatically change between both high voltage and high current testing as well as 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 in close proximity 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 both low and high temperature.

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 accuracy are specified at the output terminals in the test fixture except for capacitance measurement that 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 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 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 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
			DC	±1 A	±100 mA
	Minimum Resolution (Source)	Voltage	200 nV		25 μ V
		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 1 μ F	

Measurement Parameters

Characteristics	Category	Parameters
Static characteristics	Threshold voltage	V _{gs(th)} , V _{ge(th)}
	Transfer Characteristics	I _d -V _{gs} , I _c -V _{ge} , g _{fs}
	On resistance	R _{ds-on} , V _{ce(sat)}
	Gate leakage current	I _{gss} , I _{ges}
	Output leakage current	I _{dss} , I _{ces}
	Output Characteristics	I _d -V _{ds} , I _c -V _{ce}
	Breakdown voltage	BV _{ds} , BV _{ces}
Gate charge characteristics ³	Gate Charge	Q _g , Q _{g(th)} , Q _{gs} , Q _{gd} for Nch MOSFETs and IGBTs
Capacitance characteristics ³	Gate Resistance	R _g
	Device Capacitance	C _{iss} , C _{oss} , C _{rss} , C _{gs} , C _{gd} , C _{ies} , C _{oes} , C _{res}
Power loss ³		Driving loss/Switching loss ¹
		Conduction loss at specified duty cycle ²

1. Driving loss and switching loss are calculated by measured Q_g characteristics, V_{th} and R_g at specified frequency.

2. Conduction loss are calculated from measured R_{ds-on} and peak current.

3. B1506A-H21/H51/H71 only

Supported Power Devices and Electronics 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 functionality¹	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 functionality¹	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

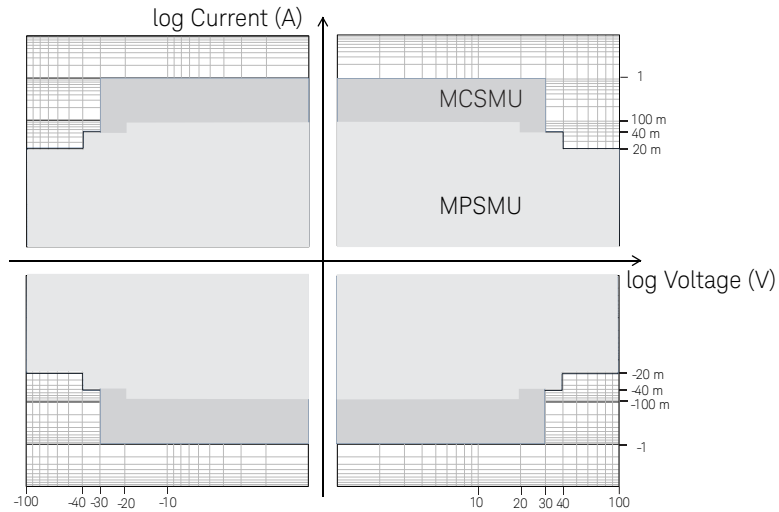
1. B1506A-H21/H51/H71 only

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 entire IV operating range of gate/base step generator for B1506A.

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



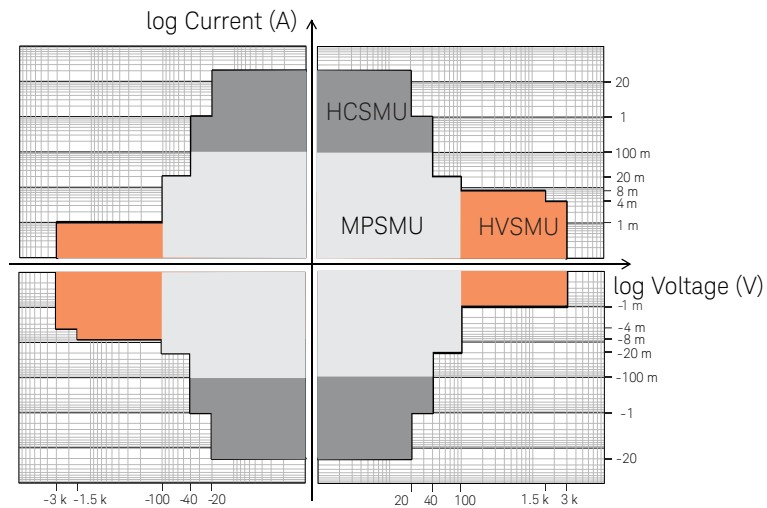
Gate/Base step generator measurement and output range

Drain/collector supply specification

B1506A-H20/H21

Drain/Collector Supply IV Operating range for B1506A-H21 is defined as the combination of HCSMU, MPSMU and HVSMU modules. The following graph shows 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 specification of each module.



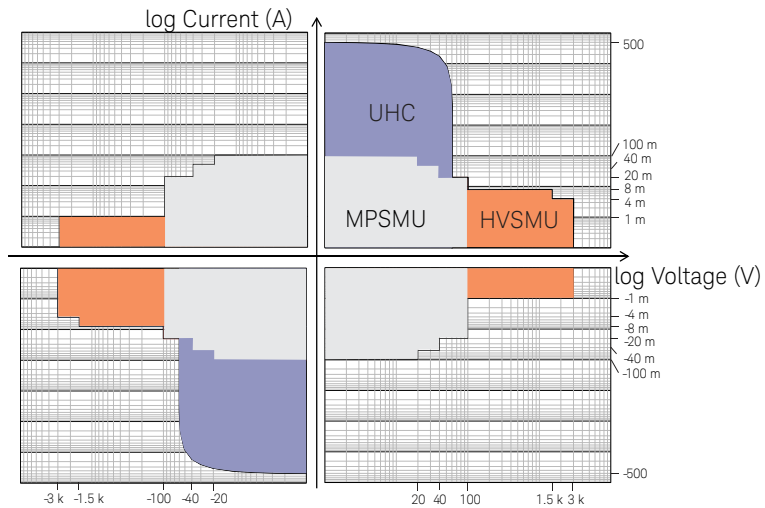
IV operating range for B1506A-H20/H21

Drain/collector supply specification (continued)

B1506A-H50/H51

Drain/Collector Supply IV Operating range for B1506A-H51 is defined as the combination of UHCU, MPSMU and HVSMU modules. The following graph shows 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 specification of each module.

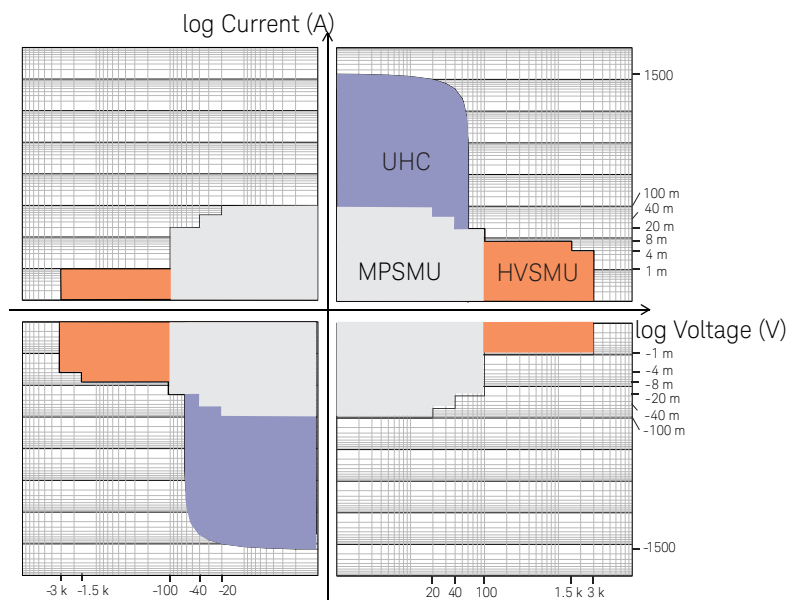


IV operating range for B1506A-H50/H51

B1506A-H70/H71

Drain/Collector Supply IV Operating range for B1506A-H71 is defined as the combination of UHCU, MPSMU and HVSMU modules. The following graph shows 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 specification 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 MFCMU module in the B1506A mainframe and built-in device capacitance selector in the B1506A test fixture.

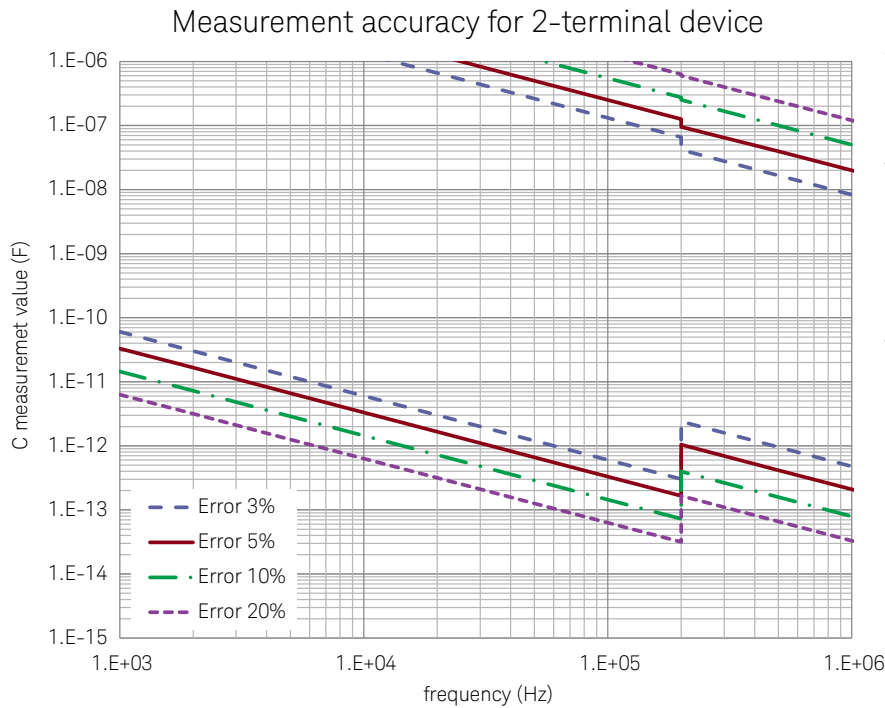
DC bias characteristics

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

Measurement accuracy for 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.

Output terminals for 2-terminal device

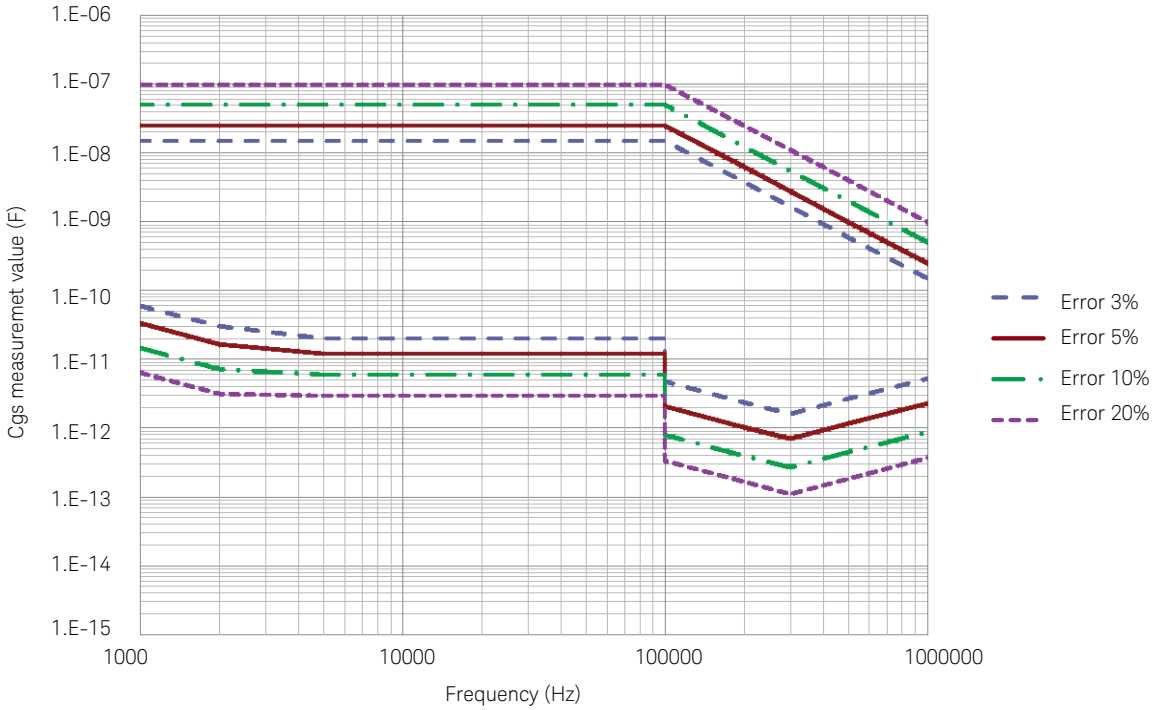
Collector/drain	Force	Open	Open	Open
	Sense	High	High	Open
Emitter/source	Force	Open	Open	Open
	Sense	Low	Open	Low
Base/gate	High	Open	Low	High
	Low	Open	Open	Open

Measurement accuracy for 3-terminal device (Supplemental characteristics)

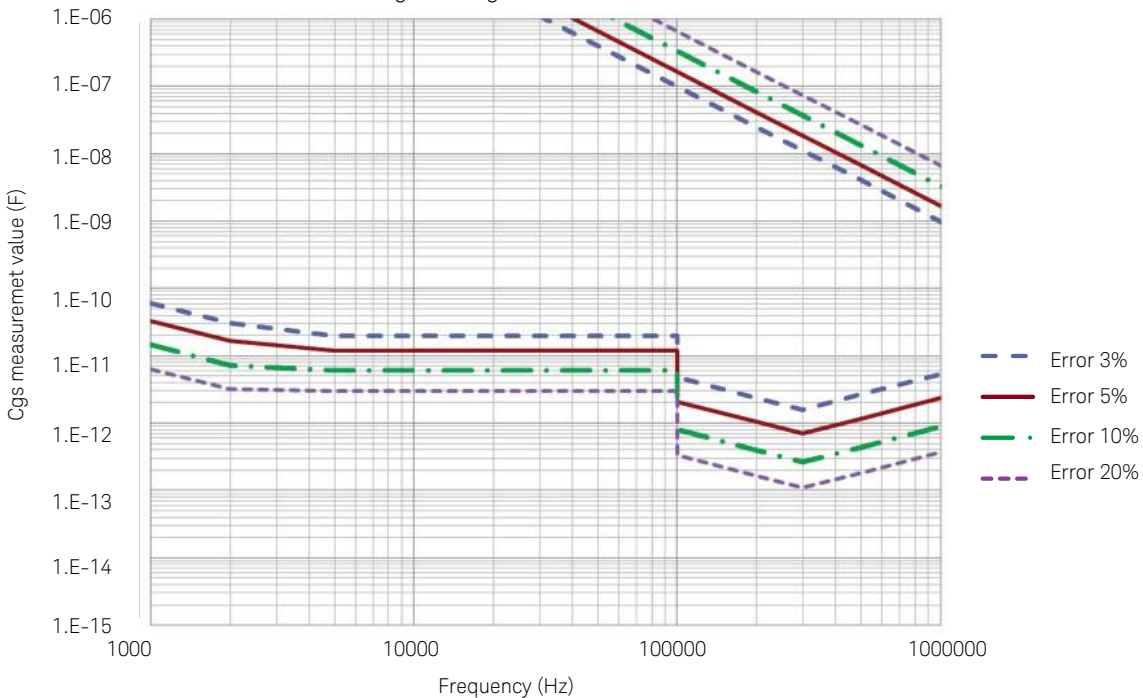
Condition

AC level: 30 mV rms, $D_x < 0.1$ (D_x : Measurement value of D)

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

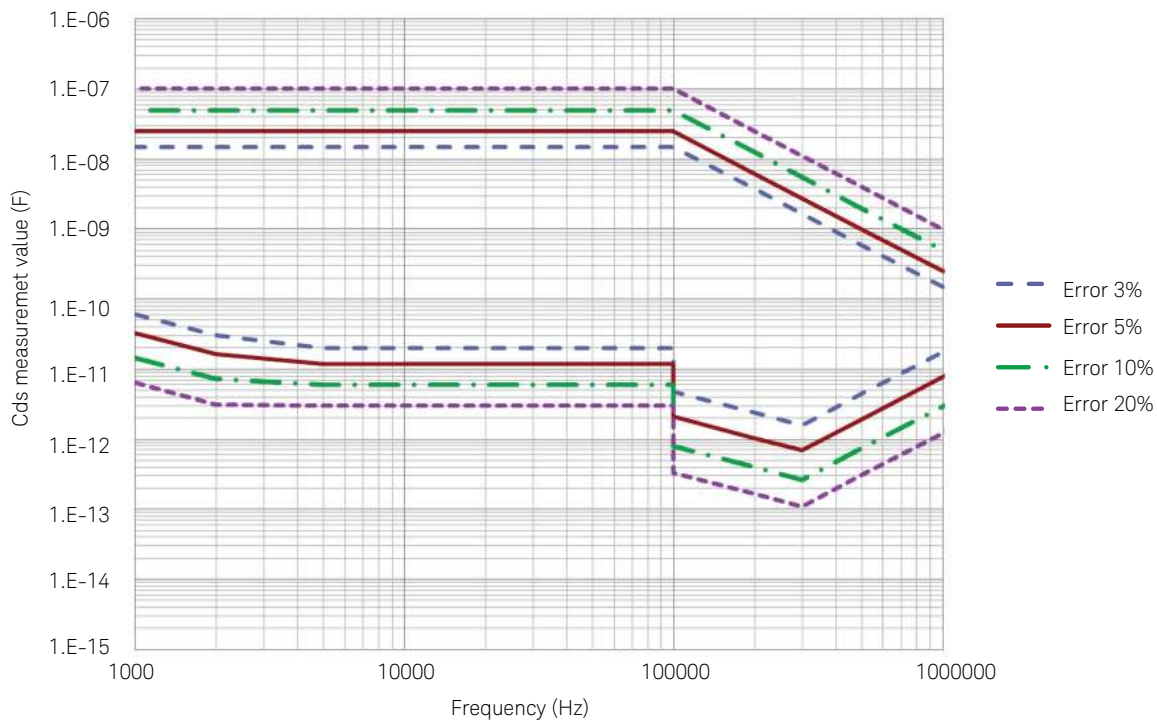


Cgs measurement accuracy 3-terminal
Cgs:Cds:Cgd= 1:0.1:0.01

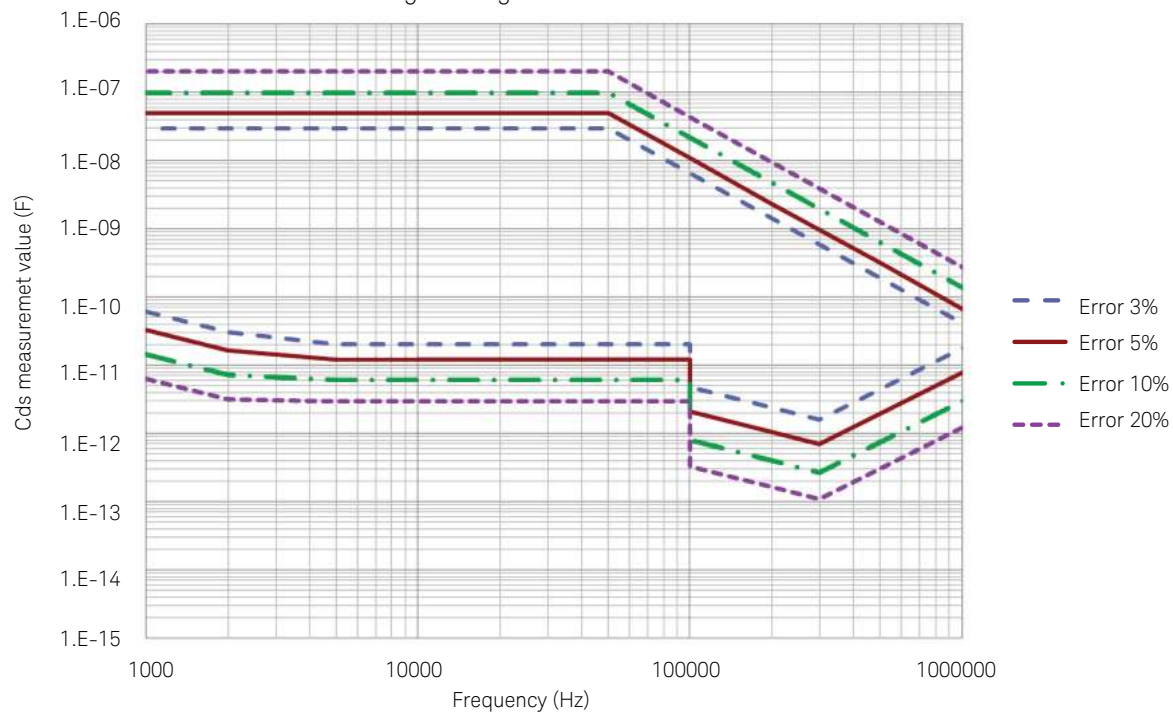


Measurement accuracy for 3-terminal device (Supplemental characteristics) (continued)

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

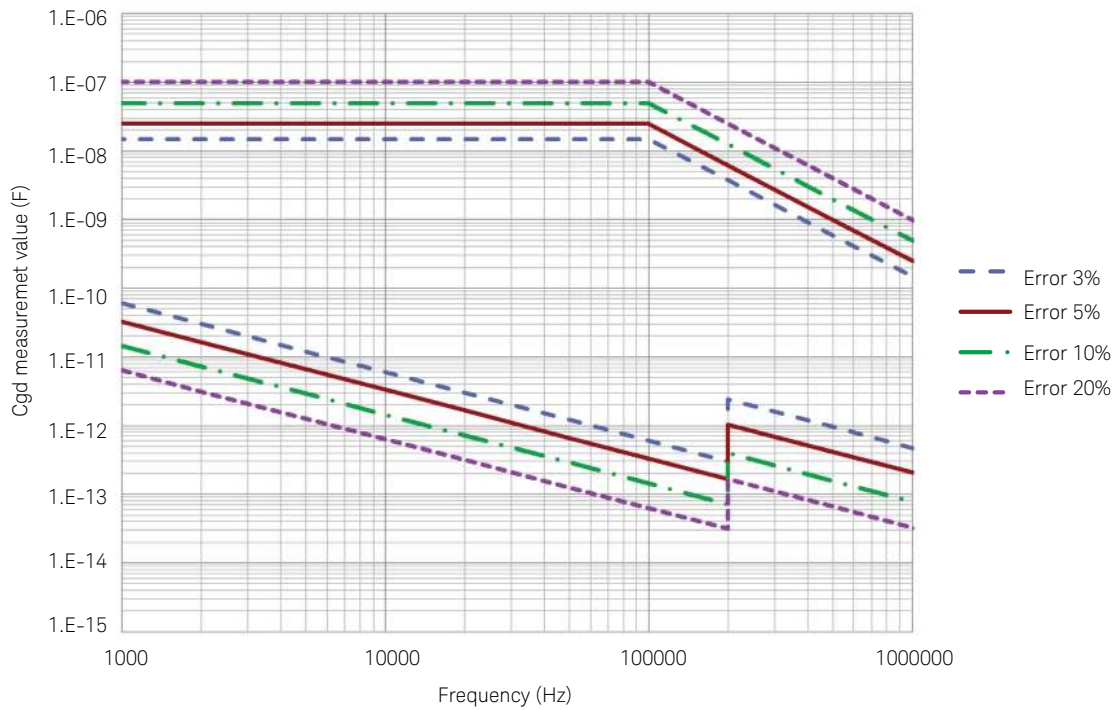


Cds measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:0.1:0.01

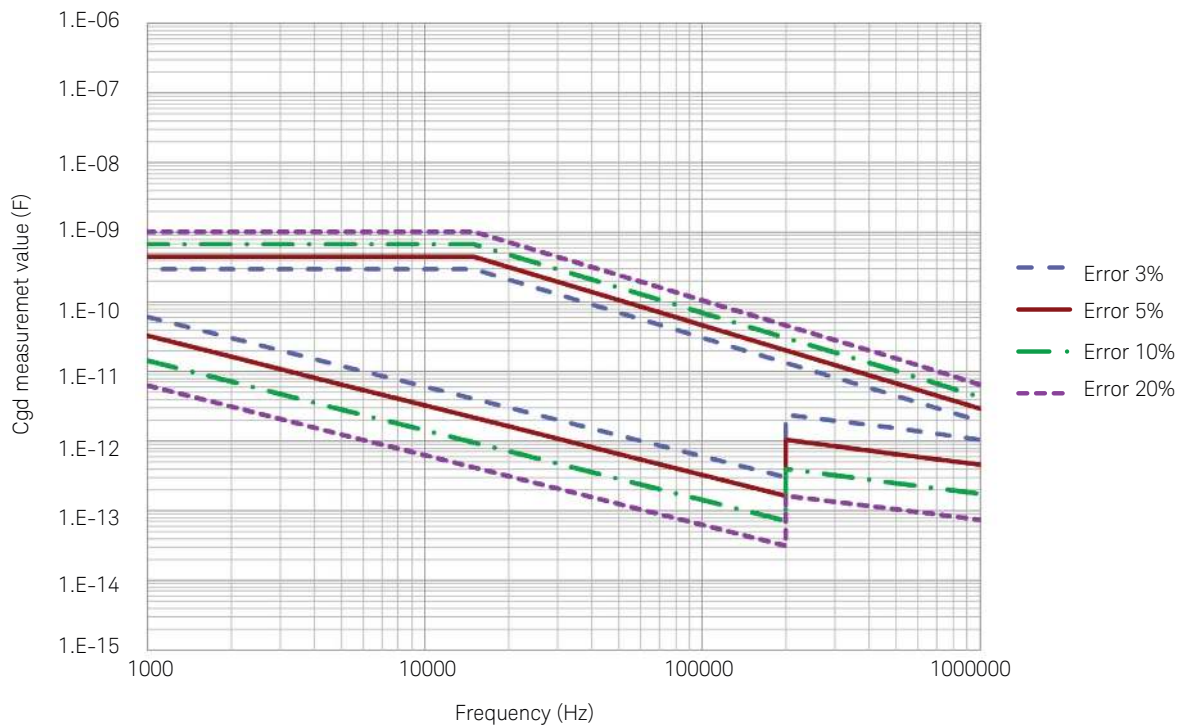


Measurement accuracy for 3-terminal device (Supplemental characteristics) (continued)

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

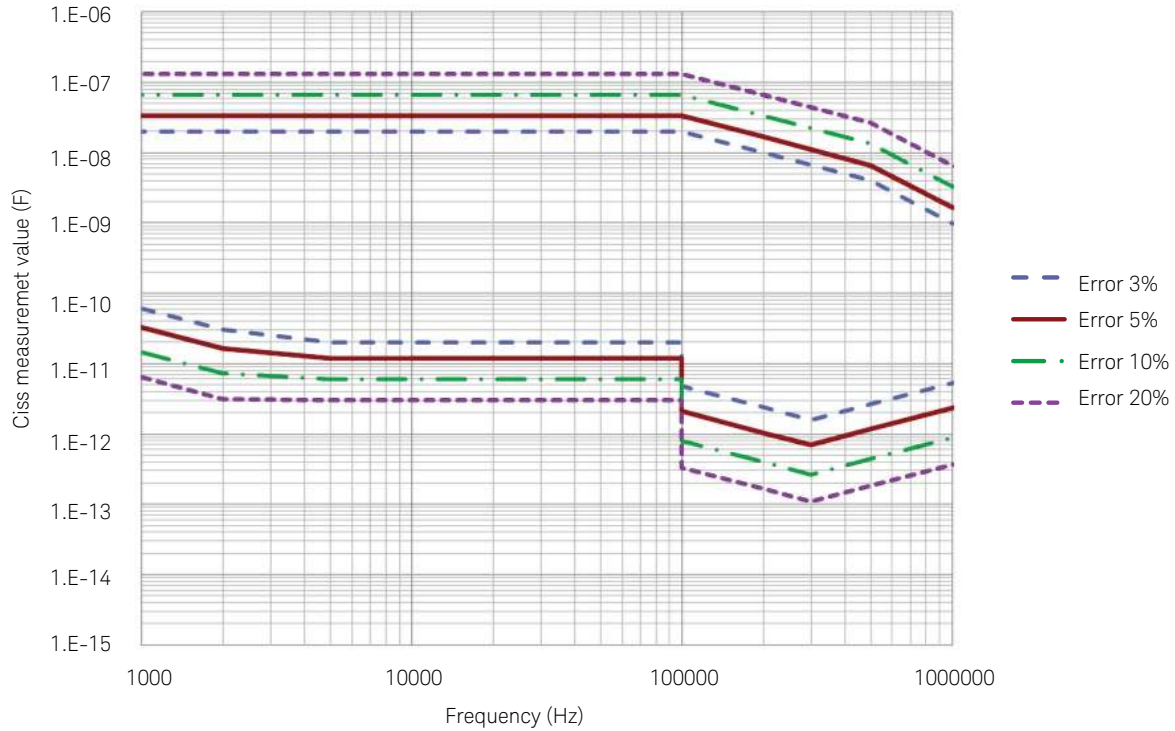


Cgd measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:0.1:0.01

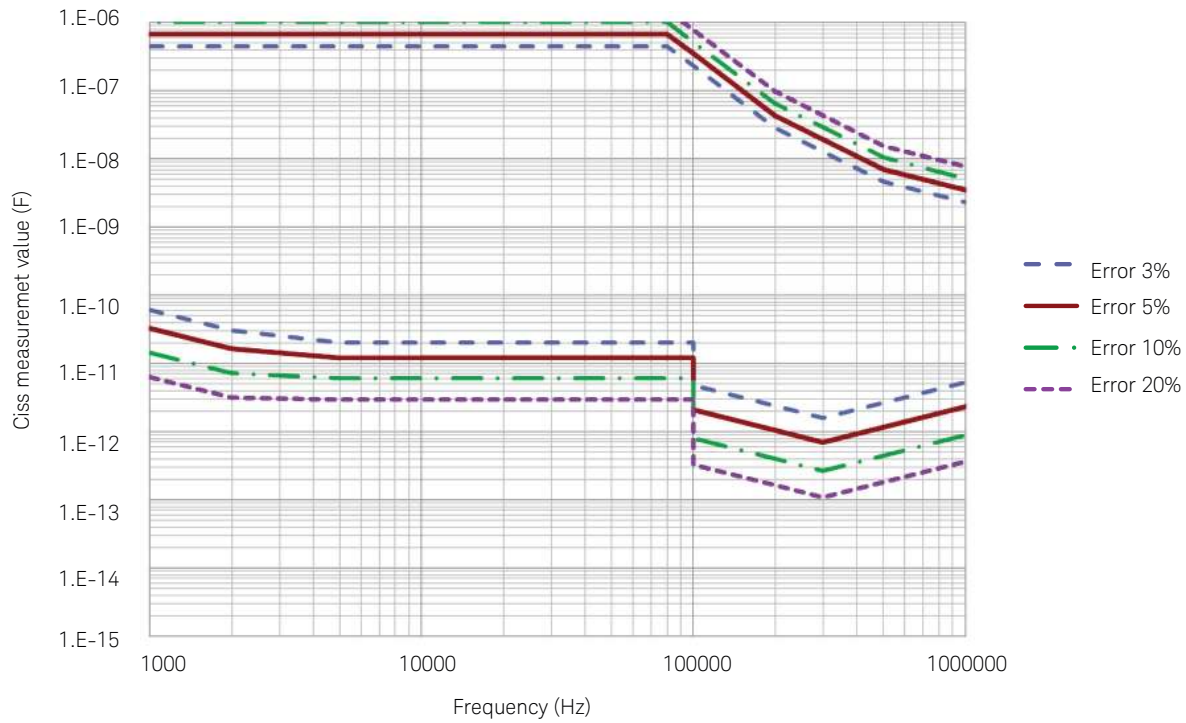


Measurement accuracy for 3-terminal device (Supplemental characteristics) (continued)

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

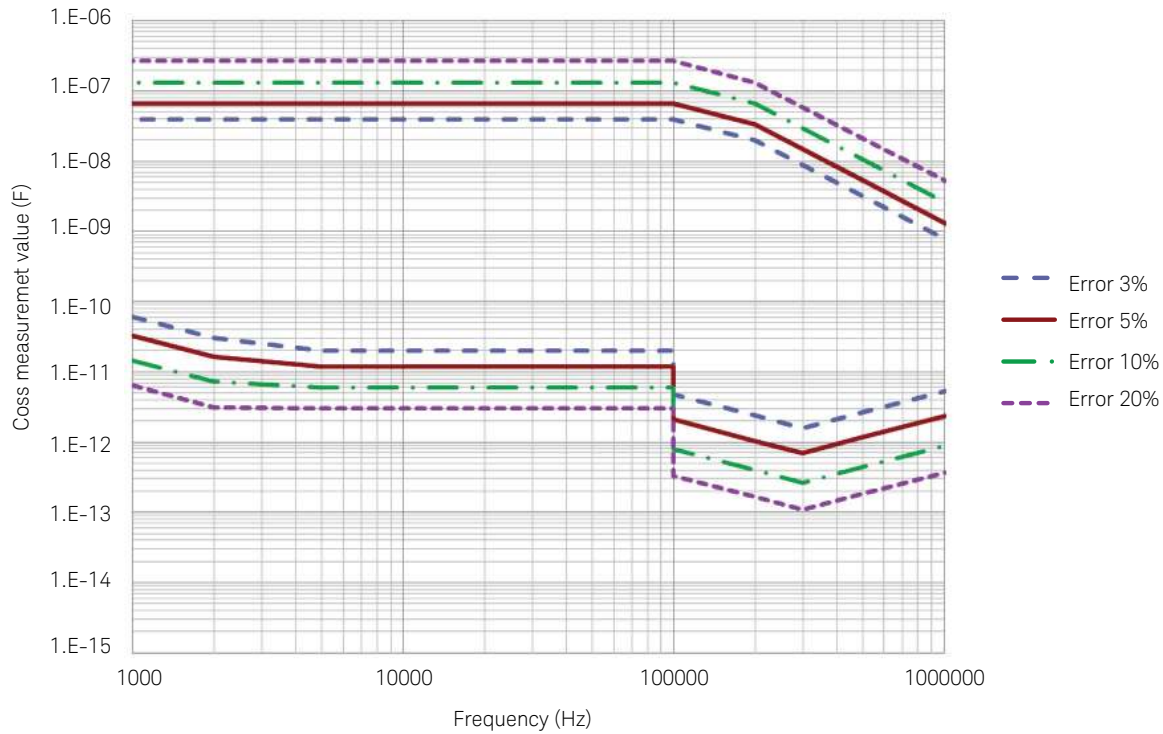


Ciss measurement accuracy 3-terminal
Cgs:Cds:Cgd = 1:0.1:0.01

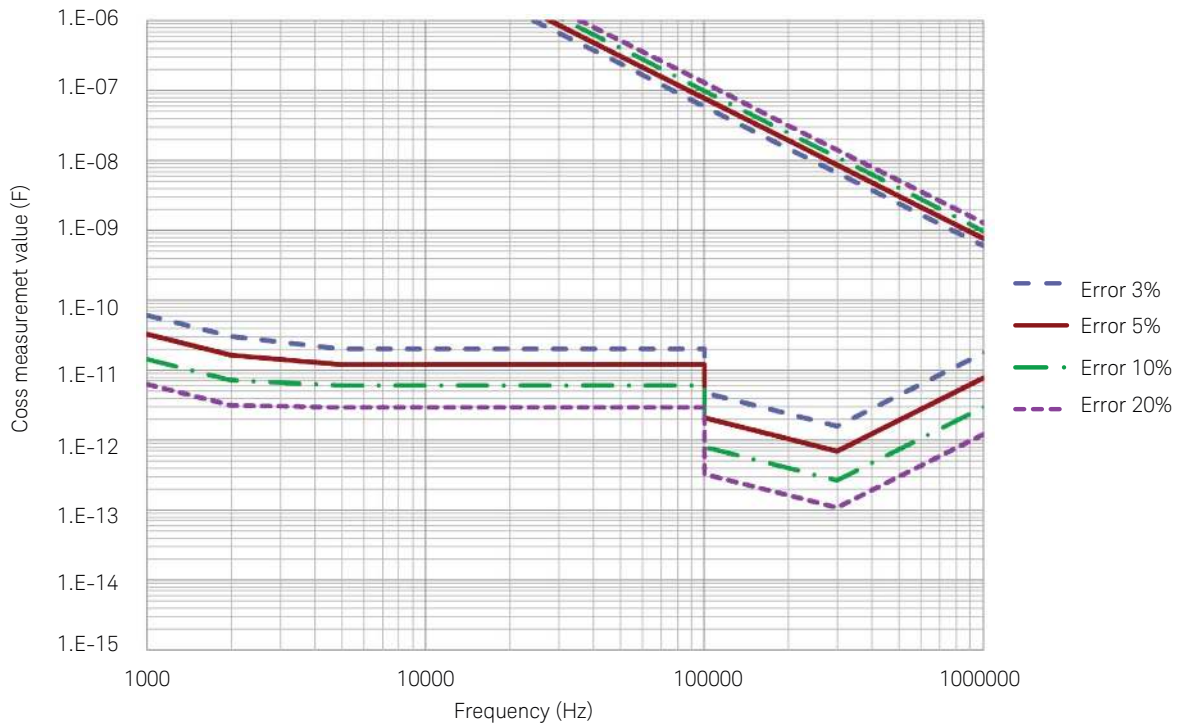


Measurement accuracy for 3-terminal device (Supplemental characteristics) (continued)

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



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



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

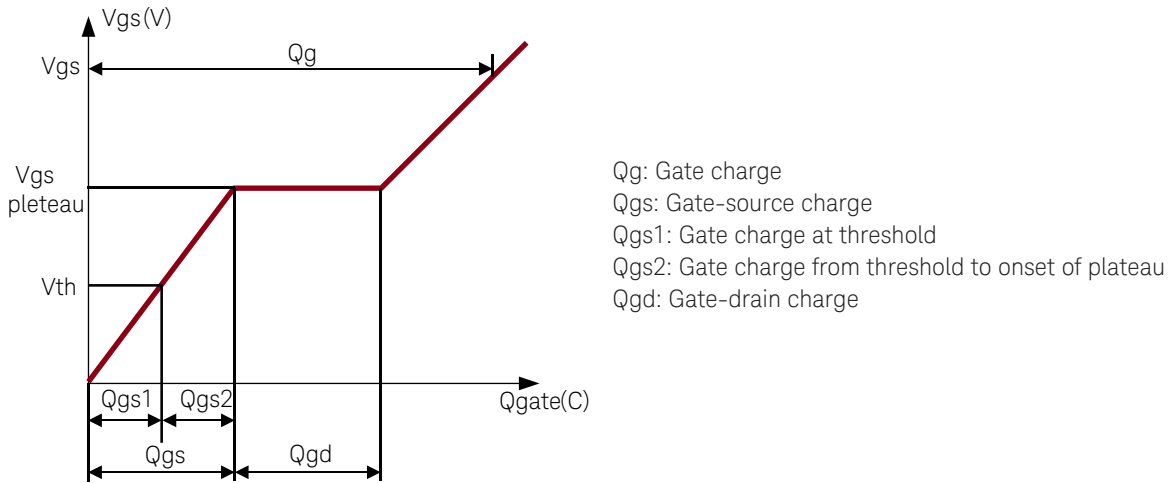
Definition of 3-terminal device capacitances

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 Emitter/Source terminal

Gate Charge Measurement Specifications

B1506A-H21/H51/H71 can perform gate charge characteristics for Nch MOSFETs and IGBTs by using gate charge socket adapter, that is included in B1506A as an accessory. Both resistor and transistor are supported as drain/collector current control device.

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



Measurement parameters

Measurement parameter	B1506A-H21	B1506A-H51	B1506A-H71
Q_g		Measurable range	
Min resolution		1 nC to 100 μ C	
V_{ds} (V_{ce}) @ high voltage		0 V to +3000 V	
Resolution		3 mV / 6 μ s	
V_{ds} (V_{ce}) @ high current	Not support	-60 V to 60 V	
Resolution		100 μ V/2 μ s	
V_{gs} (V_{ge})		-30V to +30V	
V/T resolution		40 μ V/2 μ s	
I_d (I_c)	0 to 20 A	0 to 500 A	0 to 1500 A
I/T resolution		2 mA/2 μ s	
I_g		10 nA to 1 A	
I/T resolution		10 pA/2 μ s	

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 μ s	
Vds(Vce) @ high current	-20 to 20 V		-60 to 60 V
Resolution	20 μ V/2 μ s		100 μ V/2 μ s
Id max	20 A	450 A	1100 A
Gate drive Vgs(Vge)		-30 to +30 V	
Resolution		40 μ V	
Gate control current Ig		1 μ A to 1 A	
Resolution		0.1 μ A	
Current regulator control voltage		-30 to +30 V	
Resolution		40 μ V	
On time	50 to 950 μ s		50 to 450 μ s
Resolution		2 μ s	
Target device	Nch MOSFET and IGBT TO packaged device		
	Nch MOSFET and IGBT module device		

UHC (Ultra High Current) Specifications

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)

- ±(% of reading value + fixed offset in mV)
- Setting accuracy is defined at open load.
- 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)

- 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.
- Accuracy is defined with 1ms pulse width at 500 A range and with 500 μs pulse width at 1500 A range.
- ±(% of reading value + fixed offset in A + proportional offset in A), Vo is the Output Voltage.

UHC 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%

- At 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

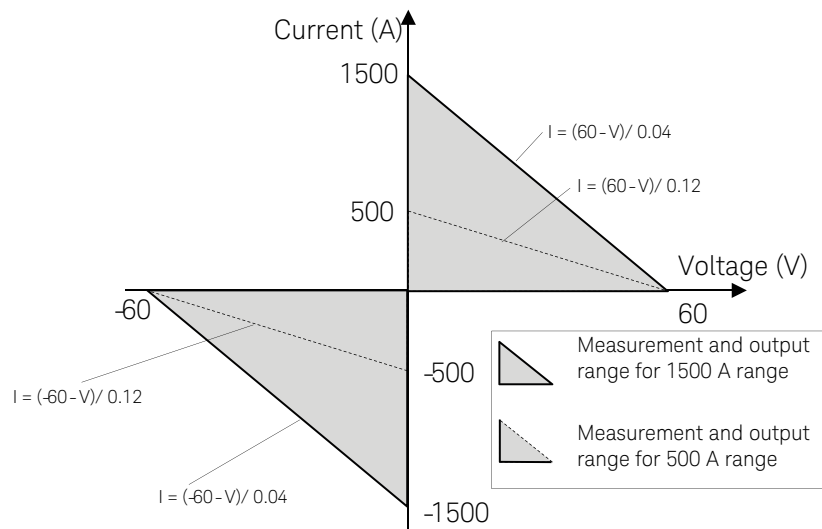
Filter

Filter can be used for UHC output in current mode at 500 A range.

Supplemental characteristics

UHC output resistance	
Output range	Nominal value
500 A	120 mΩ
1500 A	40 mΩ

UHC measurement and output range



The UHC output is only available in pulsed mode.

In the equations in the above diagram, 'I' stands for current, 'V' 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 + I _o × 0.05)	±(0.06 + 0.6 + I _o × 0.05)	20 A
±2 V	2 μV	2 μV	±(0.06 + 0.6 + I _o × 0.5)	±(0.06 + 0.6 + I _o × 0.5)	20 A
±20 V	20 μV	20 μV	±(0.06 + 3 + I _o × 5)	±(0.06 + 3 + I _o × 5)	20 A
±40 V	40 μV	40 μV	±(0.06 + 3 + I _o × 10)	±(0.06 + 3 + I _o × 10)	1 A

1. ±(% of reading value + fixed offset in mV + proportional offset in mV). Note: I_o 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 + V _o × 3E-9)	±(0.06 + 1E-8 + V _o × 3E-9)	40 V
±100 μA	100 pA	100 pA	±(0.06 + 2E-8 + V _o × 3E-9)	±(0.06 + 2E-8 + V _o × 3E-9)	40 V
±1 mA	1 nA	1 nA	±(0.06 + 2E-7 + V _o × 1E-8)	±(0.06 + 2E-7 + V _o × 1E-8)	40 V
±10 mA	10 nA	10 nA	±(0.06 + 2E-6 + V _o × 1E-7)	±(0.06 + 2E-6 + V _o × 1E-7)	40 V
±100 mA	100 nA	100 nA	±(0.06 + 2E-5 + V _o × 1E-6)	±(0.06 + 2E-5 + V _o × 1E-6)	40 V
±1 A	1 μA	1 μA	±(0.4 + 2E-4 + V _o × 1E-5)	±(0.4 + 2E-4 + V _o × 1E-5)	40 V
±20 A ²	20 μA	20 μA	±(0.4 + 2E-3 + V _o × 1E-4)	±(0.4 + 2E-3 + V _o × 1E-4)	20 V

1. ±(% of reading value + fixed offset in A + proportional offset in A), V_o 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 × I _c (W)
2 V	40 × I _c (W)
40 V	40 × I _c (W)

Where I_c is the current compliance setting.

For pulse current, I_c = (duty) × I_{pulse}

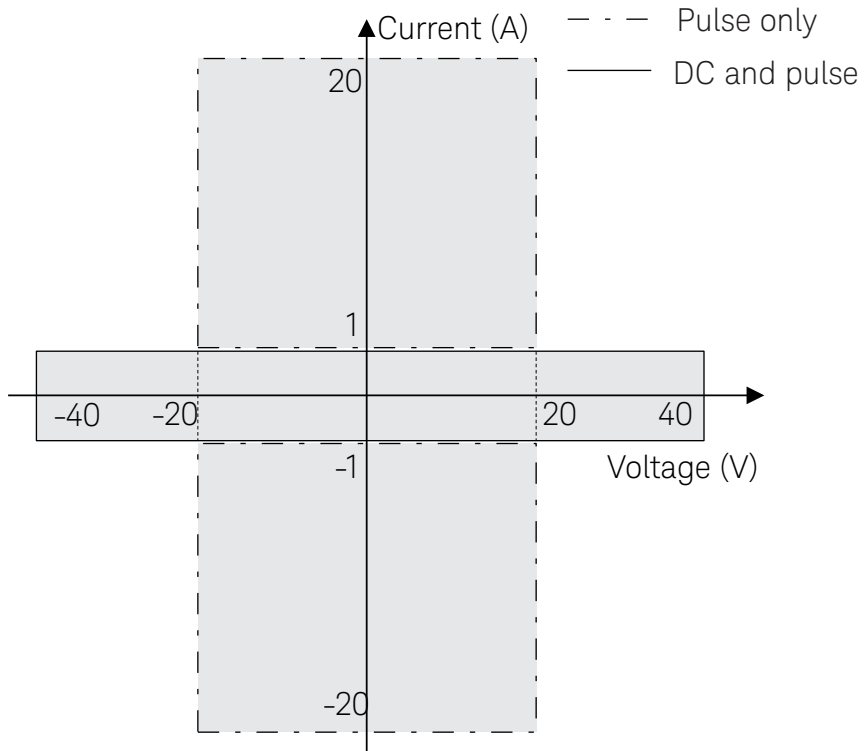
Current source mode:

Voltage compliance	Power
V _c ≤ 0.2	40 × I _o (W)
0.2 < V _c ≤ 2	40 × I _o (W)
2 < V _c ≤ 40	40 × I _o (W)

Where V_c is the voltage compliance setting and I_o is output current. For pulse

current, I_o = (duty) × I_{pulse}

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 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 + V _o x 3E-11) ⁴	±(0.1 + 1E-9 + V _o x 3E-11) ⁴	3000 V	1 pA
±100 nA ³	100 fA	100 fA	±(0.05 + 1E-9 + V _o x 3E-11) ⁴	±(0.05 + 1E-9 + V _o x 3E-11) ⁴	3000 V	100 pA
±1 μA ³	1 pA	1 pA	±(0.05 + 1E-9 + V _o x 3E-11) ⁴	±(0.05 + 1E-9 + V _o x 3E-11) ⁴	3000 V	100 pA
±10 μA ³	10 pA	10 pA	±(0.04 + 2E-9 + V _o x 3E-11) ⁴	±(0.04 + 2E-9 + V _o x 3E-11) ⁴	3000 V	10 nA
±100 μA	100 pA	100 pA	±(0.03 + 3E-9 + V _o x 3E-9)	±(0.03 + 3E-9 + V _o x 3E-9)	3000 V	10 nA
±1 mA	1 nA	1 nA	±(0.03 + 6E-8 + V _o x 3E-9)	±(0.03 + 6E-8 + V _o x 3E-9)	3000 V	100 nA
±10 mA	10 nA	10 nA	±(0.03 + 2E-7 + V _o x 3E-9)	±(0.03 + 2E-7 + V _o x 3E-9)	1500 V	1 μA

1. ±(% of reading value + fixed offset in A + proportional offset in A), V_o is the output voltage in V.

2. Output current needs to be set more than 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 V_o x 2E-12.

Power consumption

Voltage source mode:

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

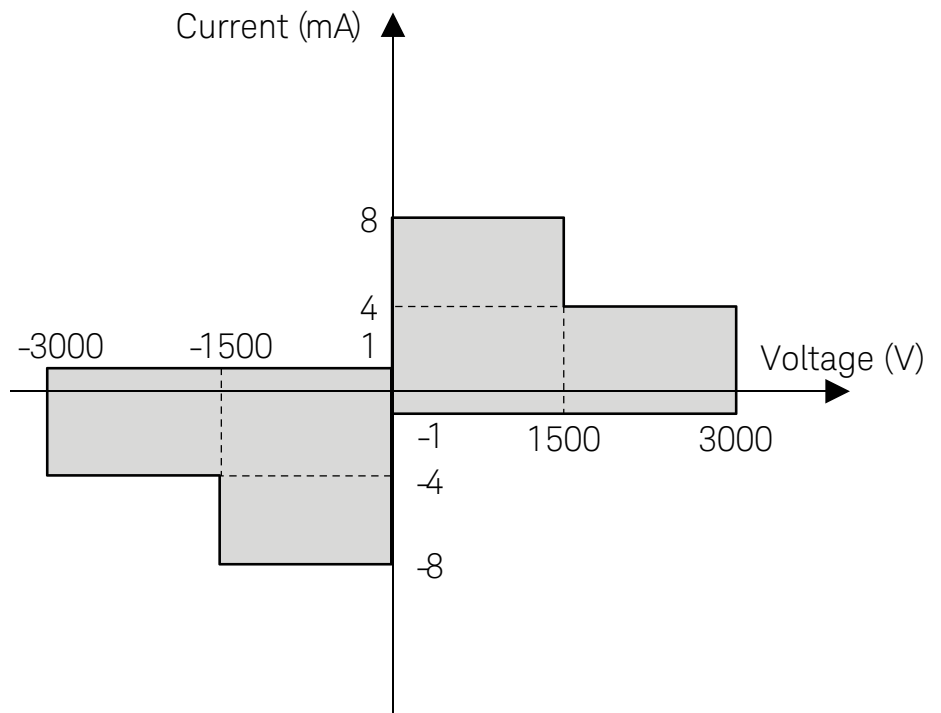
Where I_c is the current compliance setting.

Current source mode:

Voltage compliance	Power
V _c ≤ 1500	1500 x I _o (W)
1500 < V _c ≤ 3000	3000 x I _o (W)

Where V_c is the voltage compliance setting and I_o is 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 ($V_o \leq 20$ V), 50 mA (20 V < $V_o \leq 40$ V), 20 mA (40 V < $V_o \leq 100$ V), V_o 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
±10 nA ³	500 fA	10 fA	±(0.1 + 1E-9 + $V_o \times 3E-11$)	±(0.1 + 1E-9 + $V_o \times 3E-11$)	100 V
±100 nA ³	5 pA	100 fA	±(0.05 + 1E-9 + $V_o \times 3E-11$)	±(0.05 + 1E-9 + $V_o \times 3E-11$)	100 V
±1 µA ³	50 pA	1 pA	±(0.05 + 1E-9 + $V_o \times 3E-11$)	±(0.05 + 1E-9 + $V_o \times 3E-11$)	100 V
±10 µA	500 pA	10 pA	±(0.05 + 3E-9 + $V_o \times 3E-11$) ⁴ ±(0.05 + 3E-9 + $V_o \times 3E-9$) ⁵	±(0.04 + 2E-9 + $V_o \times 3E-11$) ⁴ ±(0.04 + 2E-9 + $V_o \times 3E-9$) ⁵	100 V
±100 µA	5 nA	100 pA	±(0.035 + 15E-9 + $V_o \times 1E-10$) ⁴ ±(0.035 + 15E-9 + $V_o \times 3E-9$) ⁵	±(0.03 + 3E-9 + $V_o \times 1E-10$) ⁴ ±(0.03 + 3E-9 + $V_o \times 3E-9$) ⁵	100 V
±1 mA	50 nA	1 nA	±(0.04 + 15E-8 + $V_o \times 1E-9$) ⁴ ±(0.04 + 15E-8 + $V_o \times 3E-9$) ⁵	±(0.03 + 6E-8 + $V_o \times 1E-9$) ⁴ ±(0.03 + 6E-8 + $V_o \times 3E-9$) ⁵	100 V
±10 mA	500 nA	10 nA	±(0.04 + 15E-7 + $V_o \times 1E-8$)	±(0.03 + 2E-7 + $V_o \times 1E-8$)	100 V
±100 mA	5 µA	100 nA	±(0.045 + 15E-6 + $V_o \times 1E-7$)	±(0.04 + 6E-6 + $V_o \times 1E-7$)	²

1. ± (% of reading value + fixed offset in A + proportional offset in A), V_o is the output voltage in V.)

2. 100 V ($I_o \leq 20$ mA), 40 V (20 mA < $I_o \leq 50$ mA), 20 V (50 mA < $I_o \leq 100$ mA), I_o is the output current in Amps.

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 ($V_o \leq 20$ V), 50 mA (20 V < $V_o \leq 40$ V), 20 mA (40 V < $V_o \leq 100$ V), V_o is the output voltage in Volts.

MPSMU Drain Output /Gate Output Specifications

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 + V _o x 3E-11)	±(0.25 + 1E-9 + V _o x 3E-11)	100 V
±100 nA ³	5 pA	5 pA	±(0.05 + 1E-9 + V _o x 3E-11)	±(0.1 + 1E-9 + V _o x 3E-11)	100 V
±1 μA ³	50 pA	50 pA	±(0.05 + 1E-9 + V _o x 3E-11)	±(0.1 + 1E-9 + V _o x 3E-11)	100 V
±10 μA	500 pA	500 pA	±(0.05 + 3E-9 + V _o x 3E-11) ⁴ ±(0.05 + 3E-9 + V _o x 3E-9) ⁵	±(0.05 + 2E-9 + V _o x 3E-11) ⁴ ±(0.05 + 2E-9 + V _o x 3E-9) ⁵	100 V
±100 μA	5 nA	5 nA	±(0.035 + 15E-9 + V _o x 1E-10) ⁴ ±(0.035 + 15E-9 + V _o x 3E-9) ⁵	±(0.05 + 2E-8 + V _o x 1E-10) ⁴ ±(0.05 + 2E-8 + V _o x 3E-9) ⁵	100 V
±1 mA	50 nA	50 nA	±(0.04 + 15E-8 + V _o x 1E-9) ⁴ ±(0.04 + 15E-8 + V _o x 3E-9) ⁵	±(0.04 + 2E-7 + V _o x 1E-9) ⁴ ±(0.04 + 2E-7 + V _o x 3E-9) ⁵	100 V
±10 mA	500 nA	500 nA	±(0.04 + 15E-7 + V _o x 1E-8)	±(0.04 + 2E-6 + V _o x 1E-8)	100 V
±100 mA	5 μA	5 μA	±(0.045 + 15E-6 + V _o x 1E-7)	±(0.1 + 2E-5 + V _o x 1E-7)	²

- ±(% of reading value + fixed offset in A + proportional offset in A), V_o is the output voltage in V.
- 100 V (I_o ≤ 20 mA), 40 V (20 mA < I_o ≤ 50 mA), 20 V (50 mA < I_o ≤ 100 mA), I_o is the output current in Amps.
- Supplemental characteristics
- For Gate Output
- For Drain Output

Power consumption

Voltage source mode:

Voltage range	Power
0.5 V	20 x I _c (W)
2 V	20 x I _c (W)
5 V	20 x I _c (W)
20 V	20 x I _c (W)
40 V	40 x I _c (W)
100 V	100 x I _c (W)

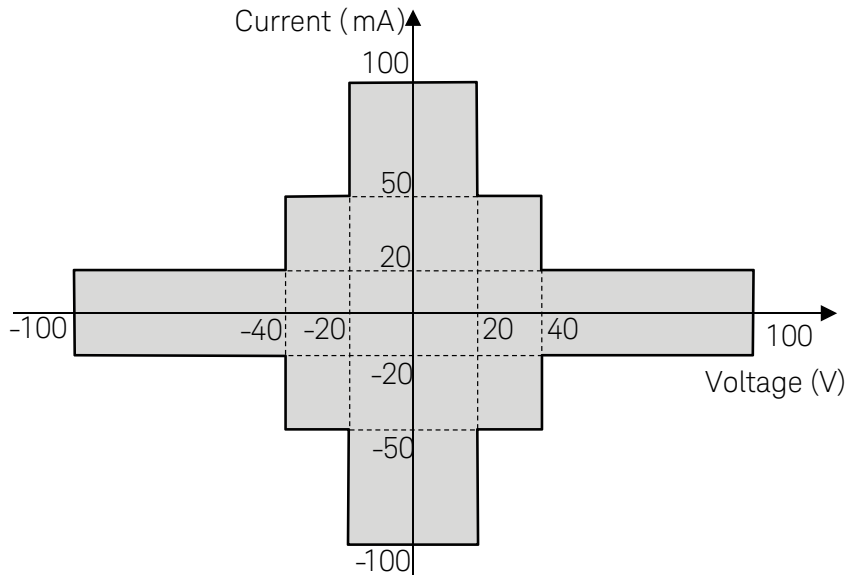
Where I_c is the current compliance setting.

Current source mode:

Voltage compliance	Power
V _c ≤ 20	20 x I _o (W)
20 < V _c ≤ 40	40 x I _o (W)
40 < V _c ≤ 100	100 x I _o (W)

Where V_c is the voltage compliance setting and I_o is 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 + V _o x 1E-10)	±(0.06 + 1E-8 + V _o x 1E-10)	30 V
±100 μA	100 pA	100 pA	±(0.06 + 2E-8 + V _o x 1E-9)	±(0.06 + 2E-8 + V _o x 1E-9)	30 V
±1 mA	1 nA	1 nA	±(0.06 + 2E-7 + V _o x 1E-8)	±(0.06 + 2E-7 + V _o x 1E-8)	30 V
±10 mA	10 nA	10 nA	±(0.06 + 2E-6 + V _o x 1E-7)	±(0.06 + 2E-6 + V _o x 1E-7)	30 V
±100 mA	100 nA	100 nA	±(0.06 + 2E-5 + V _o x 1E-6)	±(0.06 + 2E-5 + V _o x 1E-6)	30 V
±1 A ²	1 μA	1 μA	±(0.4 + 2E-4 + V _o x 1E-5)	±(0.4 + 2E-4 + V _o x 1E-5)	30 V

1. ±(% of reading value + fixed offset in A + proportional offset in A), V_o 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 I _c (W)
2 V	40 x I _c (W)
40 V	40 x I _c (W)

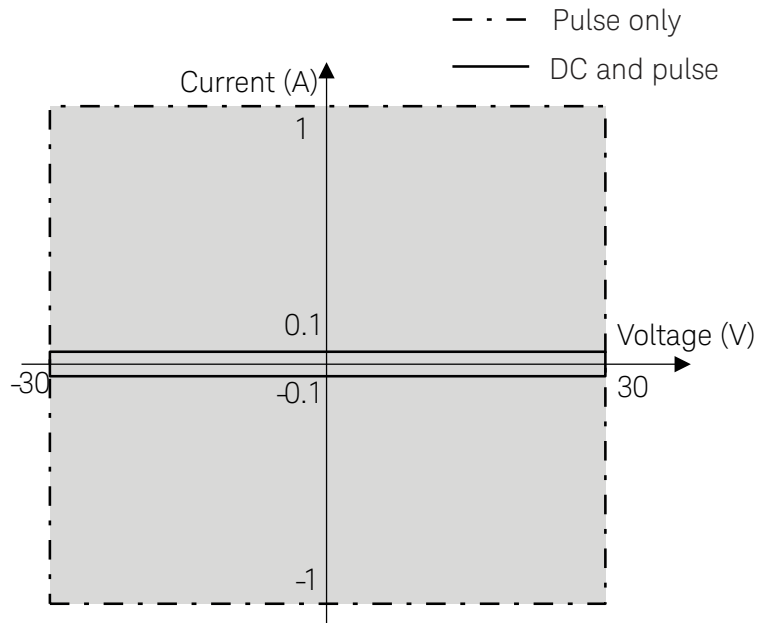
Where I_c is the current compliance setting.

Current source mode:

Voltage compliance	Power
V _c ≤ 0.2	40 x I _o (W)
0.2 < V _c ≤ 2	40 x I _o (W)
2 < V _c ≤ 40	40 x I _o (W)

Where V_c is the voltage compliance setting and I_o is output current.

MCSMU measurement and output range



SMU Other Specifications

SMU source measurement mode

For MPSMU:

VFIM, IFVM

For HCSPMU, MCSPMU and HVSPMU:

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 (HCSPMU)

0 V to ± 30 V (MCSPMU)

0 V to ± 3000 V (HVSPMU)

Current:

± 10 pA to ± 100 mA (MPSMU)

± 10 nA to ± 20 A (HCSPMU)

± 10 nA to ± 1 A (MCSPMU)

± 10 pA to ± 8 mA (HVSPMU)

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 HCSPMU:

Power: 0.001 W to 40 W (DC)

0.001 W to 400 W (Pulse)

Resolution: 0.001 W

For MCSPMU:

Power: 0.001 W to 3 W (DC)

0.001 W to 30 W (Pulse)

Resolution: 0.001 W

For HVSPMU:

No power compliance

SMU pulse measurement

Pulse width, period, and delay:

For MPSMU:

Pulse width: 500 μ s to 2 s

Pulse width resolution: 100 μ s

Pulse period: 5 ms to 5 s

Period \geq delay + width + 2 ms (when delay + width \leq 100 ms)

Period \geq delay + width + 10 ms (when delay + width $>$ 100 ms)

Pulse period resolution: 100 μ s

Pulse delay: 0 s

For HCSPMU:

Pulse width:

50 μ s to 1 ms (20 A range)

50 μ s to 2 s (10 μ A to 1 A range)

Pulse width resolution: 2 μ s

Pulse period: 5 ms to 5 s

Pulse period resolution: 100 μ s

Pulse duty:

For 20 A range: \leq 1%

For 10 μ A to 1 A range

Period \geq delay + width + 2 ms (when delay + width \leq 100 ms)

Period \geq delay + width + 10 ms (when delay + width $>$ 100 ms)

Pulse delay: 0 to (Period-width)

For MCSPMU:

Pulse width:

10 μ s to 100 ms (1 A range)

10 μ s to 2 s (10 μ A to 100 mA range)

Pulse width resolution: 2 μ s

Pulse period: 5 ms to 5 s

Pulse period resolution: 100 μ s

Pulse duty:

For 1 A range: \leq 5%

For 10 μ A to 100 mA range

Period \geq delay + width + 2 ms (when delay + width \leq 100 ms)

Period \geq delay + width + 10 ms (when delay + width $>$ 100 ms)

Pulse delay: 0 to (Period-width)

For HVSPMU:

Pulse width: 500 μ s to 2 s

Pulse width resolution: 6 μ s

Pulse period: 5 ms to 5 s

Period \geq delay + width + 2 ms

(when delay + width \leq 100 ms)

Period \geq delay + width + 10 ms

(when delay + width $>$ 100 ms)

Pulse period resolution: 100 μ s

Pulse delay: 0 to (Period - width)

Pulse output limitation:

When the pulse voltage is more than 1500 volts, the peak and base of pulse should be same polarities.

Pulse measurement delay:

6 μ s to (Period - pulse

measurement time - 2 m) s,

6 μ s resolution

Supplemental Characteristics

Current compliance setting accuracy (for opposite polarity):

For MPSMU:

For 1 pA to 10 nA ranges:

V/I setting accuracy $\pm 12\%$ of range

For 100 nA to 100 mA ranges:

V/I setting accuracy $\pm 2.5\%$ of range

For HCSMU and MCSMU:

For 10 μ A to 1 A ranges:

V/I setting accuracy $\pm 2.5\%$ of range

For 20 A range (HCSMU):

V/I setting accuracy $\pm 0.6\%$ of range

For HVSMU:

For 10 nA to 10 mA ranges:

V/I setting accuracy $\pm 12\%$ of range

For 100 nA to 10 mA ranges:

V/I setting accuracy $\pm 2.5\%$ of range

SMU pulse setting accuracy (fixed measurement range):

For MPSMU:

Width: $\pm 0.5\% \pm 50 \mu$ s

Period: $\pm 0.5\% \pm 100 \mu$ s

For HCSMU and MCSMU:

Width: $\pm 0.1\% \pm 2 \mu$ s

Period: $\pm 0.1\% \pm 100 \mu$ s

For HVSMU:

Width: $\pm 0.1\% \pm 6 \mu$ s

Period: $\pm 0.5\% \pm 100 \mu$ s

Minimum pulse measurement time:

16 μ s (MPSMU)

2 μ s (HCSMU and MCSMU)

6 μ s (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: $\pm 0.008\%$

Output signal level:

Range: 10 mV_{rms} to 250 mV_{rms}
Resolution: 1 mV_{rms}

Accuracy:

$\pm(10.0\% + 1 \text{ mV}_{\text{rms}})$ at the measurement port of the MFCMU
 $\pm(15.0\% + 1 \text{ mV}_{\text{rms}})$

Output impedance: 50 Ω , typical

Signal level monitor:

Range: 10 mV_{rms} to 250 mV_{rms}

Accuracy:

$\pm(10.0\%$ of reading $+ 1 \text{ mV}_{\text{rms}})$ at the measurement port of the MFCMU
 $\pm(15.0\% + 1 \text{ mV}_{\text{rms}})$

DC bias function

DC bias:

Range: 0 to $\pm 25 \text{ V}$
Resolution: 1 mV
Accuracy: $\pm(0.5\% + 5.0 \text{ mV})$ 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 k Ω	1 mA
3 k Ω	1 mA
10 k Ω	100 μA
30 k Ω	100 μA
100 k Ω	10 μA
300 k Ω	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

$E = E_p' + (Z_s' / |Z_x| + Y_o' |Z_x|) \times 100 (\%)$

$E_p' = E_{\text{POSC}} + E_p (\%)$

$Y_o' = Y_{\text{OSC}} + Y_o (\text{S})$

$Z_s' = Z_{\text{OSC}} + Z_s (\Omega)$

|Z| accuracy

$\pm E (\%)$

θ accuracy

$\pm E / 100 (\text{rad})$

C accuracy

at $D_x \leq 0.1$

$\pm E (\%)$

at $D_x > 0.1$

$\pm E \times \sqrt{(1 + D_x^2)} (\%)$

D accuracy

at $D_x \leq 0.1$

$\pm E / 100$

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: $23 \pm 5 \text{ }^\circ\text{C}$

Integration time: 1 PLC

MFCMU (multi frequency capacitance measurement unit) module specifications (continued)

Parameters E_{POSC} Z_{OSC}		
Oscillator level	E_{POSC} (%)	Z_{OSC} (m Ω)
$125 \text{ mV} < V_{OSC} \leq 250 \text{ mV}$	$0.03 \times (250/V_{OSC} - 1)$	$5 \times (250/V_{OSC} - 1)$
$64 \text{ mV} < V_{OSC} \leq 125 \text{ mV}$	$0.03 \times (125/V_{OSC} - 1)$	$5 \times (125/V_{OSC} - 1)$
$32 \text{ mV} < V_{OSC} \leq 64 \text{ mV}$	$0.03 \times (64/V_{OSC} - 1)$	$5 \times (64/V_{OSC} - 1)$
$V_{OSC} \leq 32 \text{ mV}$	$0.03 \times (32/V_{OSC} - 1)$	$5 \times (64/V_{OSC} - 1)$

V_{OSC} is oscillator level in mV.

Parameters Y_{OSC} Y_0 E_p Z_s				
Frequency	Y_{OSC} (nS)	Y_0 (nS)	E_p (%)	Z_s (m Ω)
$1 \text{ kHz} \leq f \leq 200 \text{ kHz}$	$1 \times (125/V_{OSC} - 0.5)$	1.5	0.095	5.0
$200 \text{ kHz} < f \leq 1 \text{ MHz}$	$2 \times (125/V_{OSC} - 0.5)$	3.0	0.095	5.0
$1 \text{ MHz} < f \leq 2 \text{ MHz}$	$2 \times (125/V_{OSC} - 0.5)$	3.0	0.28	5.0
$2 \text{ MHz} < f$	$20 \times (125/V_{OSC} - 0.5)$	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	$\pm 0.61\%$	$\leq 3 \mu\text{S}$	$\pm 192 \text{ nS}$
	10 pF	$\pm 0.32\%$	$\leq 31 \mu\text{S}$	$\pm 990 \text{ nS}$
	100 pF	$\pm 0.29\%$	$\leq 314 \mu\text{S}$	$\pm 9 \mu\text{S}$
	1 nF	$\pm 0.32\%$	$\leq 3 \text{ mS}$	$\pm 99 \mu\text{S}$
1 MHz	1 pF	$\pm 0.26\%$	$\leq 628 \text{ nS}$	$\pm 16 \text{ nS}$
	10 pF	$\pm 0.11\%$	$\leq 6 \mu\text{S}$	$\pm 71 \text{ nS}$
	100 pF	$\pm 0.10\%$	$\leq 63 \mu\text{S}$	$\pm 624 \text{ nS}$
	1 nF	$\pm 0.10\%$	$\leq 628 \mu\text{S}$	$\pm 7 \mu\text{S}$
100 kHz	10 pF	$\pm 0.18\%$	$\leq 628 \text{ nS}$	$\pm 11 \text{ nS}$
	100 pF	$\pm 0.11\%$	$\leq 6 \mu\text{S}$	$\pm 66 \text{ nS}$
	1 nF	$\pm 0.10\%$	$\leq 63 \mu\text{S}$	$\pm 619 \text{ nS}$
	10 nF	$\pm 0.10\%$	$\leq 628 \mu\text{S}$	$\pm 7 \mu\text{S}$
10 kHz	100 pF	$\pm 0.18\%$	$\leq 628 \text{ nS}$	$\pm 11 \text{ nS}$
	1 nF	$\pm 0.11\%$	$\leq 6 \mu\text{S}$	$\pm 66 \text{ nS}$
	10 nF	$\pm 0.10\%$	$\leq 63 \mu\text{S}$	$\pm 619 \text{ nS}$
	100 nF	$\pm 0.10\%$	$\leq 628 \mu\text{S}$	$\pm 7 \mu\text{S}$
1 kHz	100 pF	$\pm 0.92\%$	$\leq 63 \text{ nS}$	$\pm 6 \text{ nS}$
	1 nF	$\pm 0.18\%$	$\leq 628 \text{ nS}$	$\pm 11 \text{ nS}$
	10 nF	$\pm 0.11\%$	$\leq 6 \mu\text{S}$	$\pm 66 \text{ nS}$
	100 nF	$\pm 0.10\%$	$\leq 63 \mu\text{S}$	$\pm 619 \text{ nS}$

1. The capacitance and conductance measurement accuracy is specified under the following conditions:
 $D_X \leq 0.1$
 Integration time: 1 PLC
 Test signal level: $30 \text{ mV}_{\text{rms}}$
 At 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, MPSPMU and UHCU or HCSMU.

Thermocouple input: 2ea

Two K-type thermocouple inputs

Temperature range: -50 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 with 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 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:

- 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
- Minimal software learning curve for device characterization using the pre-defined 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 rotary knob.
- Pre-defined templates for typical MOSFET, IGBT and Diode I/V measurements.

Software Interfaces (continued)

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 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

Gate charge measurement software:

Gate charge measurement Software provides:

- Support for both constant current load mode and resistive load mode
- Correction of for parasitic capacitance and residual resistance for in the gate path
- Monitoring of gate and drain/collector voltage/ and current waveforms during the device turn-on periodphase
- 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;
 - 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 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 over 40 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:

- V 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.

Software Interfaces (continued)

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 μ s resolution

0 to 655.35 s, 100 μ s resolution

(CV (AC level) sweep, C-f sweep)

Step delay time:

0 to 1 s, 100 μ s resolution

Step output trigger delay time:

0 to (delay time) s, 100 μ s resolution

Step measurement trigger delay time:

0 to 65.535 s, 100 μ s resolution

Sampling (time domain) measurement¹

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 μ s to 2ms, 10 μ s resolution

2 ms to 65.535 s, 1 ms resolution

For < 2ms, the interval is $\geq 100 \mu$ s

+20 μ s x (num. of channels – 1)

Hold time, initial wait time:

-90 ms to -100 μ s, 100 μ s resolution

0 to 655.35 s, 10 ms resolution

Measurement time resolution: 100 μ s

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 mode¹

SMUs in “Standby” remain programmed to their specified output value even as other units are reset for the next measurement.

Bias hold function¹

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 the error factor (offset current) caused by the measurement path such as the measurement cables, manipulators, or probe card.

Time stamp¹

The B1506A supports a time stamp function utilizing an internal quartz clock.

Resolution: 100 μ s

1. Supported only by EasyEXPERT 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, real time graph plotting. X-Y graph plot can be printed or stored as image data to clip board 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 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.

Software Interfaces (continued)

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, 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-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	$\sqrt{1}$
	82357A	USB	$\sqrt{2}$
	82357A	USB	$\sqrt{2}$
National Instrument	GPIB-USB-HS	USB	$\sqrt{2}$

1. An 82350B/C card is highly recommended because of stability and speed.
2. USB GPIB interfaces might cause serial poll error intermittently due to the 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.

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

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: 130VA (H21), 470 VA (H51/H71),

Acoustic Noise Emission

Lpa < 55dB
Lwa:55dB (Operating mode)
Lwa:73dB (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.
Manual & Software CD-ROM, 1 ea.
Disk set for Keysight
4155B/4155C/4156B/4156C
firmware update, 1 set

Ordering Information

Model number	Option	Description
B1506A		Power Device Analyzer for Circuit Design
	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
	ABA	English User's Guide
	ABJ	Japanese User's Guide
	Calibration Documentation	
	UK6	Commercial calibration certification with test data
	A6J	ANSI Z540-1-1994 Calibration
	Drive Option	
	DR1	Replace a build-in DVD-R with a read-only DVD drive
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	
	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
	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.

* B1506AU Opt F11 Universal Socket Module contains a universal socket module, test wire for thermal test (2m), ultra-high current test wire for thermal test (2m), lag connector x 20, lag connector for ultra-high current test wire x 6, and screws.

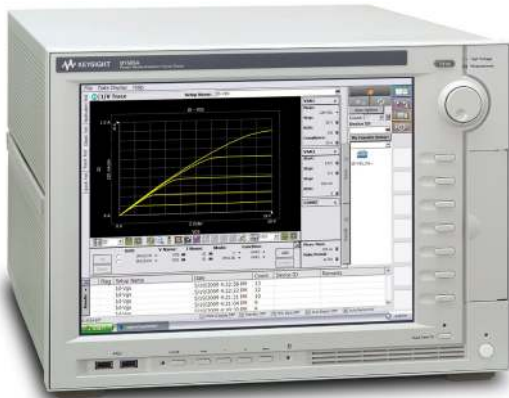
If you need more measurement capabilities, the best choice is Keysight precision SMU products.



Keysight B2900 Precision Instrument Family
www.keysight.com/find/b2900a



Keysight B1500A Semiconductor Device Analyzer
www.keysight.com/find/B1500A



Keysight B1505A Power Device Analyzer/Curve Tracer (1500 A/10 kV)
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