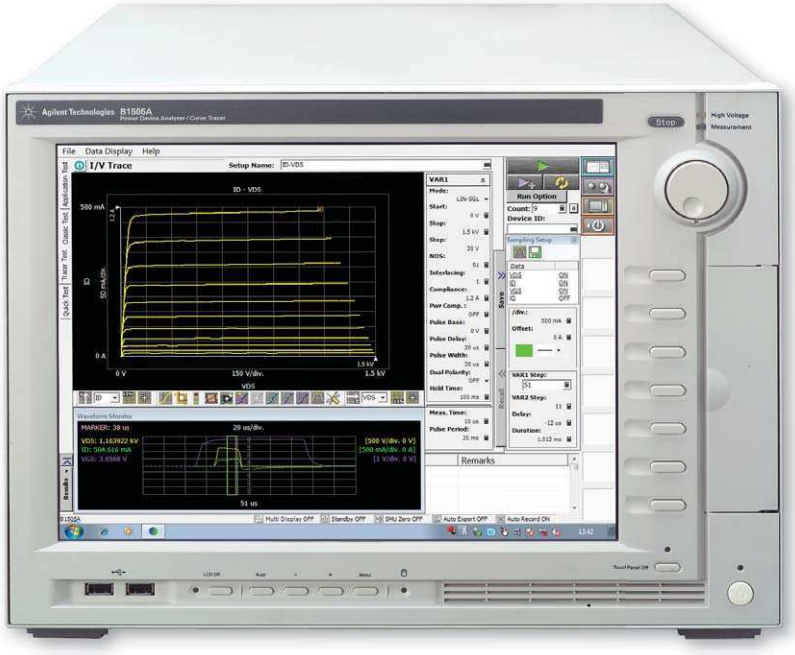
Agilent B1505A
Power Device Analyzer/Curve Tracer

Data Sheet



Introduction

The B1505A Power Device Analyzer/Curve Tracer is a single-box solution with next-generation curve tracer functionality that can accurately evaluate and characterize power devices at up to 10 kV and 1500 amps. The B1505A is capable of handling all types of power device evaluation, with features that include a wide voltage and current range, fast pulsing capability (10 µs), µΩ level on-resistance measurement resolution and sub-pA level current measurement capability. In addition, an oscilloscope view permits visual verification of both current and voltage pulsed waveforms.

Two independent analog-to-digital (A/D) converters on each channel support a 2 µs sampling rate for accurate monitoring of the critical timings that can affect device behavior.

It can also perform capacitance measurements at high voltage biases (up to 3000 V). The B1505A with EasyEXPERT software includes a curve tracer mode that combines familiar curve tracer functionality with the convenience of a PC-based instrument; this makes it easy for traditional curve-tracer users to become productive quickly. Module selector and Quick Test feature enable fully automated measurement on multiple parameters without the need to recable. The net result is improved ease of use, better data analysis and simplified data management for the measurement of power devices and power circuitry.

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Basic features

- Performs wide range of IV measurements
  - Up to 10 kV / 1500 A
  - Large peak power : 22.5 kW
  - Medium current measurement with high voltage bias (e.g. 500 mA at 1200 V, Peak power : 900 W)
  - μΩ resistance measurement
  - sub-pA leakage measurement
- Performs high bias voltage CV measurements
- Pulsed measurement (≥10 μs)
- Two independent A/D converters (22 bit equivalent) on each channel enable the simultaneous high-speed (2 μs) sampling of current and voltage
- Temperature measurement
- Easy to use EasyEXPERT test environment
- Curve tracer test mode with knob sweep capability
- Oscilloscope view
- Modular configuration with ten module slots for supported modules
- Multiple SMU types available: HPSMU, MPSMU, HCSMU, MCSMU and HVSMU
- Support for high power devices with up to 6 pins
- Fast high voltage/high current switch for GaN current collapse effect characterization
- Multi-frequency capacitance measurement unit (MFCMU) (1 kHz to 5 MHz) available
- Standard accessories for package test and wafer test: test fixture, module selector and high voltage bias-tee
- 4.2-amp ground unit included standard with the mainframe
- GPIB port for instrument control
- Self-test, self-calibration, diagnostics

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 SMU connector terminals, using the Zero Check terminal as a reference.

1. Temperature: 23 °C ± 5 °C
2. Humidity: 20% to 70%
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: 1 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 HPSMU and MPSMU)
9. SMU measurement terminal connection: Kelvin connection (for HPSMU, MPSMU, HCSMU and MCSMU), non-Kelvin (for HVSMU)

Note: This document lists specifications and supplemental characteristics for the B1505A and its associated modules. The specifications are the standards against which the B1505A and its associated modules are tested. When the B1505A or any of its associated modules are shipped from the factory, they meet the specifications. The "supplemental" characteristics described in the following specifications are not guaranteed, but provide useful information about the functions and performance of the instrument.

Note: Module upgrades to existing B1505A systems must be carried out at an Agilent Technologies service centre. In order to ensure system specifications the new modules need to be installed and the complete unit calibrated. Contact your nearest Agilent Technologies office to arrange the installation and calibration of new B1505A modules.

B1505A Specifications

Supported plug-In modules

The B1505A supports ten slots for plug-in modules.

Part number	Description	Slots occupied	Range of operation	Measure resolution
B1510A	High Power Source Monitor Unit (HPSMU)	2	-200 V to 200 V, -1 A to 1 A	2 µV, 10 fA
B1511A	Medium Power Source Monitor Unit (MPSMU)	1	-100 V to 100 V, -100 mA to 100 mA	0.5 µV, 10 fA
B1512A	High Current Source Monitor Unit (HCSMU)	2	-40 V to 40 V, -1 A to 1 A -20 V to 20 V, -20 A to 20 A (Pulse only)	200 nV, 10 pA
B1513B	High Voltage Source Monitor Unit (HVSMU)	2	-3000 V to 3000 V, -4 mA to 4 mA -1500 V to 1500 V, -8 mA to 8 mA	200 µV, 10 fA
B1514A	Medium Current Source Monitor Unit (MCSMU)	1	-30 V to 30 V, -100 mA to 100 mA -30 V to 30 V, -1 A to 1 A (Pulse only)	200 nV, 10pA
B1520A[1]	Multi Frequency Capacitance Measurement Unit (MFCMU)	1	1 kHz to 5 MHz	0.035 fFrms[2]

1. N1300A-100 SMU CMU Unify Unit (SCUU) is not supported for the B1505A.

2. Valid when connecting a 10 pF capacitor to the measurement terminals under the following measurement conditions: a frequency of 1 MHz, a signal level of 250 mV AC, and a measurement time of 1 PLC. The display resolution is 0.000001 fF at 1 fF order by 6 digits display.

Maximum module configuration

The total power consumption of all modules cannot exceed 84 W. Under this rule, the B1505A can contain any combination of the following SMUs:

- Up to 4 dual-slot HPSMUs[1]
- Up to 10 single-slot MPSMUs
- Up to 2 dual-slot HCSMUs[1]
- Up to 6 single-slot MCSMUs
- 1 dual-slot HVSMU

1. The total number of installed HPSMU and HCSMU modules cannot exceed 4.

In addition, up to 1 single-slot MFCMU can be installed per B1505A mainframe for any of the above listed SMU configurations.

The installation order of the modules is: HPSMU, MPSMU, MFCMU, MCSMU, HCSMU and HVSMU starting from the bottom of the B1505A mainframe.

Maximum voltage between Common and Ground

≤ ± 42 V

Ground unit (GNDU) specifications

The GNDU is furnished with the B1505A mainframe.

Output voltage: 0 V ± 100 µV
Maximum sink current: ± 4.2 A
Output terminal/connection:
Triaxial connector, Kelvin (remote sensing)

GNDU supplemental characteristics

Load capacitance: 1 µF
Cable resistance:
For $I_S \leq 1.6$ A: Force line R < 1 Ω
For 1.6 A < $I_S \leq 2.0$ A: Force line R < 0.7 Ω
For 2.0 A < $I_S \leq 4.2$ A: Force line R < 0.35 Ω
For all cases: Sense line R ≤ 10 Ω

Where I_S is the current being sunk by the GNDU.

HPSMU Module 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
±2 V	100 µV	2 µV	±(0.018 + 0.4)	±(0.01 + 0.14)	1 A
±20 V	1 mV	20 µV	±(0.018 + 3)	±(0.01 + 0.14)	1 A
±40 V	2 mV	40 µV	±(0.018 + 6)	±(0.01 + 1)	500 mA
±100 V	5 mV	100 µV	±(0.018 + 15)	±(0.012 + 2.5)	125 mA
±200 V	10 mV	200 µV	±(0.018 + 30)	±(0.014 + 2.8)	50 mA

1. *± (% of reading value + offset value in mV)*

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

Current range	Force resolution	Measure resolution	Force accuracy[1] ±(% + A + A)	Measure accuracy[1] ±(% + A + A)	Maximum voltage
±1 nA	50 fA	10 fA	±(0.1 + 3E-13 + Vo x 1E-15)	±(0.1 + 3E-13 + Vo x 1E-15)	200 V
±10 nA	500 fA	10 fA	±(0.1 + 3E-12 + Vo x 1E-14)	±(0.1 + 25E-13 + Vo x 1E-14)	200 V
±100 nA	5 pA	100 fA	±(0.05 + 3E-11 + Vo x 1E-13)	±(0.05 + 25E-12 + Vo x 1E-13)	200 V
±1 µA	50 pA	1 pA	±(0.05 + 3E-10 + Vo x 1E-12)	±(0.05 + 1E-10 + Vo x 1E-12)	200 V
±10 µA	500 pA	10 pA	±(0.05 + 3E-9 + Vo x 1E-11)	±(0.04 + 2E-9 + Vo x 1E-11)	200 V
±100 µA	5 nA	100 pA	±(0.035 + 15E-9 + Vo x 1E-10)	±(0.03 + 3E-9 + Vo x 1E-10)	200 V
±1 mA	50 nA	1 nA	±(0.04 + 15E-8 + Vo x 1E-9)	±(0.03 + 6E-8 + Vo x 1E-9)	200 V
±10 mA	500 nA	10 nA	±(0.04 + 15E-7 + Vo x 1E-8)	±(0.03 + 2E-7 + Vo x 1E-8)	200 V
±100 mA	5 µA	100 nA	±(0.045 + 15E-6 + Vo x 1E-7)	±(0.04 + 6E-6 + Vo x 1E-7)	200 V[2]
±1 A	50 µA	1 µA	±(0.4 + 3E-4 + Vo x 1E-6)	±(0.4 + 15E-5 + Vo x 1E-6)	200 V[2]

1. *± (% of reading value + fixed offset in A + proportional offset in A), Vo is the output voltage in V.)*
2. *200 V (Io ≤ 50 mA), 100 V (50 mA < Io ≤ 125 mA), 40 V (125 mA < Io ≤ 500 mA), 20 V (500 mA < Io ≤ 1 A), Io is the output current in Amps.*

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

Voltage range	Force resolution	Measure resolution	Force accuracy[1] ±(% + mV)	Measure accuracy[1] ±(% + mV)	Maximum current
±2 V	100 µV	100 µV	±(0.018 + 0.4)	±(0.01 + 0.7)	1 A
±20 V	1 mV	1 mV	±(0.018 + 3)	±(0.01 + 4)	1 A
±40 V	2 mV	2 mV	±(0.018 + 6)	±(0.015 + 8)	500 mA
±100 V	5 mV	5 mV	±(0.018 + 15)	±(0.02 + 20)	125 mA
±200 V	10 mV	10 mV	±(0.018 + 30)	±(0.035 + 40)	50 mA

1. *±(% of reading value + offset value in mV). Averaging is 128 samples in 1 PLC.*

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

Current range	Force resolution	Measure resolution	Force accuracy[1] ±(% + A + A)	Measure accuracy[1] ±(% + A + A)	Maximum voltage
±1 nA	50 fA	50 fA	±(0.1 + 3E-13 + Vo x 1E-15)	±(0.25 + 3E-13 + Vo x 1E-15)	200 V
±10 nA	500 fA	500 fA	±(0.1 + 3E-12 + Vo x 1E-14)	±(0.25 + 2E-12 + Vo x 1E-14)	200 V
±100 nA	5 pA	5 pA	±(0.05 + 3E-11 + Vo x 1E-13)	±(0.1 + 2E-11 + Vo x 1E-13)	200 V
±1 µA	50 pA	50 pA	±(0.05 + 3E-10 + Vo x 1E-12)	±(0.1 + 2E-10 + Vo x 1E-12)	200 V
±10 µA	500 pA	500 pA	±(0.05 + 3E-9 + Vo x 1E-11)	±(0.05 + 2E-9 + Vo x 1E-11)	200 V
±100 µA	5 nA	5 nA	±(0.035 + 15E-9 + Vo x 1E-10)	±(0.05 + 2E-8 + Vo x 1E-10)	200 V
±1 mA	50 nA	50 nA	±(0.04 + 15E-8 + Vo x 1E-9)	±(0.04 + 2E-7 + Vo x 1E-9)	200 V
±10 mA	500 nA	500 nA	±(0.04 + 15E-7 + Vo x 1E-8)	±(0.04 + 2E-6 + Vo x 1E-8)	200 V
±100 mA	5 µA	5 µA	±(0.045 + 15E-6 + Vo x 1E-7)	±(0.1 + 2E-5 + Vo x 1E-7)	200 V[2]
±1 A	50 µA	50 µA	±(0.4 + 3E-4 + Vo x 1E-6)	±(0.5 + 3E-4 + Vo x 1E-6)	200 V[2]

1. *±(%of reading value + fixed offset in A + proportional offset in A), Vo is the output voltage in V.)*
2. *200 V (Io ≤ 50 mA), 100 V (50 mA < Io ≤ 125 mA), 40 V (125 mA < Io ≤ 500 mA), 20 V (500 mA < Io ≤ 1 A), Io is the output current in Amps.*

Power consumption

Voltage source mode:

Voltage range	Power
2 V	20 x Ic (W)
20 V	20 x Ic (W)
40 V	40 x Ic (W)
100 V	100 x Ic (W)
200 V	200 x Ic (W)

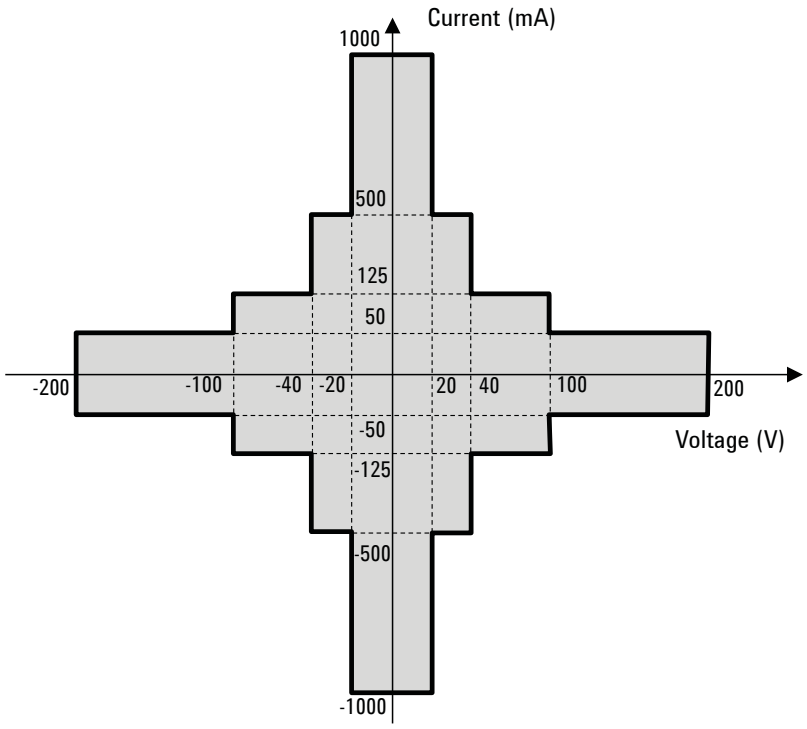
Where Ic is the current compliance setting.

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)
100 < Vc ≤ 200	200 x Io (W)

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

HPSMU measurement and output range



MPSMU Module 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 + 0.15)	±(0.01 + 0.12)	100 mA
±2 V	100 µV	2 µV	±(0.018 + 0.4)	±(0.01 + 0.14)	100 mA
±5 V	250 µV	5 µV	±(0.018 + 0.75)	±(0.009 + 0.25)	100 mA
±20 V	1 mV	20 µV	±(0.018 + 3)	±(0.01 + 0.9)	100 mA
±40 V	2 mV	40 µV	±(0.018 + 6)	±(0.01 + 1)	[2]
±100 V	5 mV	100 µV	±(0.018 + 15)	±(0.012 + 2.5)	[2]

1. ± (% of reading value + offset value in mV)

2. 100 mA (Vo ≤ 20 V), 50 mA (20 V < Vo ≤ 40 V), 20 mA (40 V < Vo ≤ 100 V), Vo is the output voltage in Volts.

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

Current range	Force resolution	Measure resolution	Force accuracy[1] ±(% + A + A)	Measure accuracy[1] ±(% + A + A)	Maximum voltage
±1 nA	50 fA	10 fA	±(0.1 + 3E-13 + Vo x 1E-15)	±(0.1 + 2E-13 + Vo x 1E-15)	100 V
±10 nA	500 fA	10 fA	±(0.1 + 3E-12 + Vo x 1E-14)	±(0.1 + 1E-12 + Vo x 1E-14)	100 V
±100 nA	5 pA	100 fA	±(0.05 + 3E-11 + Vo x 1E-13)	±(0.05 + 2E-11 + Vo x 1E-13)	100 V
±1 µA	50 pA	1 pA	±(0.05 + 3E-10 + Vo x 1E-12)	±(0.05 + 1E-10 + Vo x 1E-12)	100 V
±10 µA	500 pA	10 pA	±(0.05 + 3E-9 + Vo x 1E-11)	±(0.04 + 2E-9 + Vo x 1E-11)	100 V
±100 µA	5 nA	100 pA	±(0.035 + 15E-9 + Vo x 1E-10)	±(0.03 + 3E-9 + Vo x 1E-10)	100 V
±1 mA	50 nA	1 nA	±(0.04 + 15E-8 + Vo x 1E-9)	±(0.03 + 6E-8 + Vo x 1E-9)	100 V
±10 mA	500 nA	10 nA	±(0.04 + 15E-7 + Vo x 1E-8)	±(0.03 + 2E-7 + Vo x 1E-8)	100 V
±100 mA	5 µA	100 nA	±(0.045 + 15E-6 + Vo x 1E-7)	±(0.04 + 6E-6 + Vo x 1E-7)	[2]

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

2. 100 V (Io ≤ 20 mA), 40 V (20 mA < Io ≤ 50 mA), 20 V (50 mA < Io ≤ 100 mA), Io is the output current in Amps.

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 + 0.15)	±(0.01 + 0.25)	100 mA
±2 V	100 µV	100 µV	±(0.018 + 0.4)	±(0.01 + 0.7)	100 mA
±5 V	250 µV	250 µV	±(0.018 + 0.75)	±(0.01 + 2)	100 mA
±20 V	1 mV	1 mV	±(0.018 + 3)	±(0.01 + 4)	100 mA
±40 V	2 mV	2 mV	±(0.018 + 6)	±(0.015 + 8)	[2]
±100 V	5 mV	5 mV	±(0.018 + 15)	±(0.02 + 20)	[2]

1. ±(% of reading value + offset value in mV). Averaging is 128 samples in 1 PLC.

2. 100 mA (Vo ≤ 20 V), 50 mA (20 V < Vo ≤ 40 V), 20 mA (40 V < Vo ≤ 100 V), Vo is the output voltage in Volts.

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

Current range	Force resolution	Measure resolution	Force accuracy[1] ±(% + A + A)	Measure accuracy[1] ±(% + A + A)	Maximum voltage
±1 nA	50 fA	50 fA	±(0.1 + 3E-13 + Vo x 1E-15)	±(0.25 + 3E-13 + Vo x 1E-15)	100 V
±10 nA	500 fA	500 fA	±(0.1 + 3E-12 + Vo x 1E-14)	±(0.25 + 2E-12 + Vo x 1E-14)	100 V
±100 nA	5 pA	5 pA	±(0.05 + 3E-11 + Vo x 1E-13)	±(0.1 + 2E-11 + Vo x 1E-13)	100 V
±1 µA	50 pA	50 pA	±(0.05 + 3E-10 + Vo x 1E-12)	±(0.1 + 2E-10 + Vo x 1E-12)	100 V
±10 µA	500 pA	500 pA	±(0.05 + 3E-9 + Vo x 1E-11)	±(0.05 + 2E-9 + Vo x 1E-11)	100 V
±100 µA	5 nA	5 nA	±(0.035 + 15E-9 + Vo x 1E-10)	±(0.05 + 2E-8 + Vo x 1E-10)	100 V
±1 mA	50 nA	50 nA	±(0.04 + 15E-8 + Vo x 1E-9)	±(0.04 + 2E-7 + Vo x 1E-9)	100 V
±10 mA	500 nA	500 nA	±(0.04 + 15E-7 + Vo x 1E-8)	±(0.04 + 2E-6 + Vo x 1E-8)	100 V
±100 mA	5 µA	5 µA	±(0.045 + 15E-6 + Vo x 1E-7)	±(0.1 + 2E-5 + Vo x 1E-7)	[2]

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

2. 100 V (Io ≤ 20 mA), 40 V (20 mA < Io ≤ 50 mA), 20 V (50 mA < Io ≤ 100 mA), Io is the output current in Amps.

Power consumption

Voltage source mode:

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

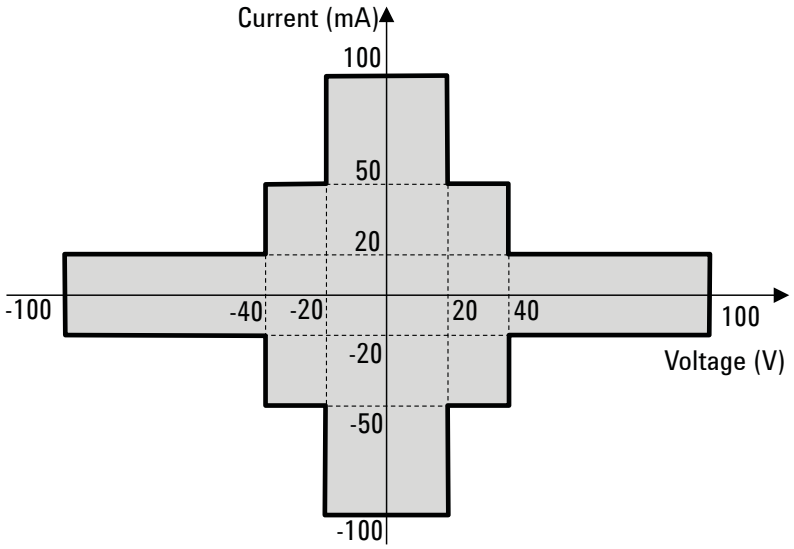
Where Ic is the current compliance setting.

Current source mode:

Voltage compliance	Power
Vc ≤ 20	20 x Io (W)
20 < Vc ≤ 40	40 x Io (W)
40 < Vc ≤ 100	100 x Io (W)

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

MPSMU measurement and output range



HCSMU Module 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 + 0.14 + Io x 0.05)	±(0.06 + 0.14 + Io x 0.05)	20 A
±2 V	2 µV	2 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 + 2E-9 + Vo x 1E-10)	±(0.06 + 2E-9 + Vo x 1E-10)	40 V
±100 µA	100 pA	100 pA	±(0.06 + 2E-8 + Vo x 1E-9)	±(0.06 + 2E-8 + Vo x 1E-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.

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:

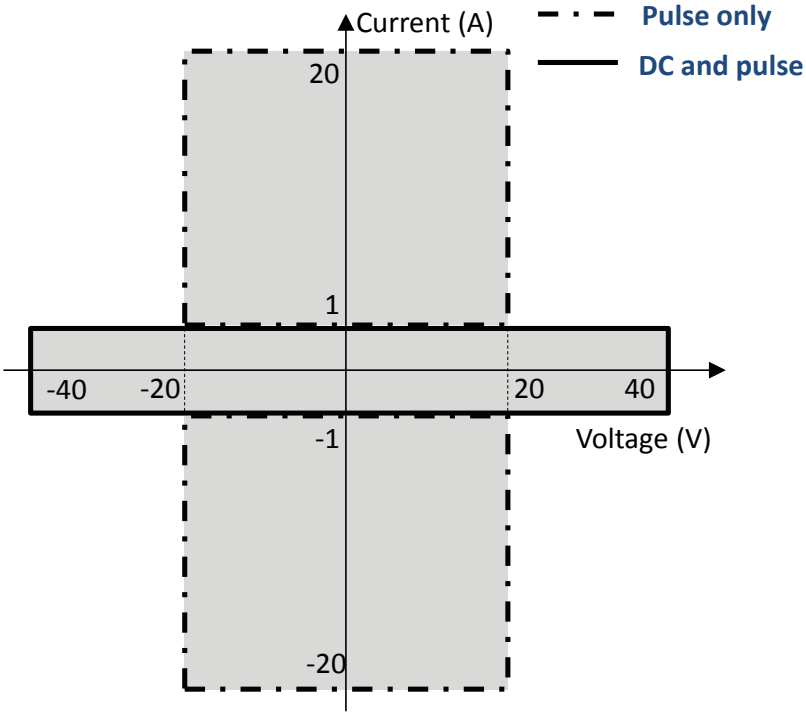
Voltage compliance	Power
Vc ≤ 0.2	40 x Io (W)
0.2 < Vc ≤ 2	40 x Io (W)
2 < Vc ≤ 40	40 x Io (W)

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

Current range expansion

If two HCSMUs are combined using the Dual HCSMU combination adapter or the Dual HCSMU Kelvin combination adapter, then the maximum current ranges are 40A (Pulsed) and 2A (DC).

HCSMU measurement and output range



HVSMU Module 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]
±1 nA	10 fA	10 fA	±(0.1 + 6E-13 + Vo x 1E-15)	±(0.1 + 6E-13 + Vo x 1E-15)	3000 V	1pA
±10 nA	100 fA	100 fA	±(0.1 + 25E-13 + Vo x 1E-15)	±(0.1 + 25E-13 + Vo x 1E-15)	3000 V	1pA
±100 nA	100 fA	100 fA	±(0.05 + 25E-12 + Vo x 1E-13)	±(0.05 + 25E-12 + Vo x 1E-13)	3000 V	100 pA
±1 µA	1 pA	1 pA	±(0.05 + 1E-10 + Vo x 1E-13)	±(0.05 + 1E-10 + Vo x 1E-13)	3000 V	100 pA
±10 µA	10 pA	10 pA	±(0.04 + 2E-9 + Vo x 1E-11)	±(0.04 + 2E-9 + Vo x 1E-11)	3000 V	10 nA
±100 µA	100 pA	100 pA	±(0.03 + 3E-9 + Vo x 1E-11)	±(0.03 + 3E-9 + Vo x 1E-11)	3000 V	10 nA
±1 mA	1 nA	1 nA	±(0.03 + 6E-8 + Vo x 1E-10)	±(0.03 + 6E-8 + Vo x 1E-10)	3000 V	100 nA
±10 mA	10 nA	10 nA	±(0.03 + 2E-7 + Vo x 1E-9)	±(0.03 + 2E-7 + Vo x 1E-9)	1500 V	1 µA

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

2. Output current needs to be set more than current shown in the table.

Power consumption

Voltage source mode:

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

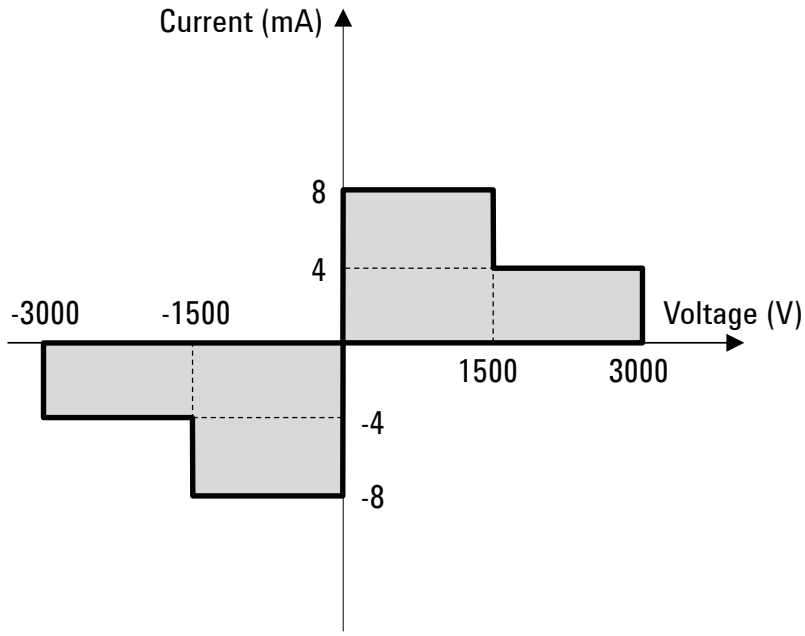
Where Ic is the current compliance setting.

Current source mode:

Voltage compliance	Power
Vc ≤ 1500	1500 x Io (W)
1500 < Vc ≤ 3000	3000 x Io (W)

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

HCSMU measurement and output range



MCSMU Module Specifications

Voltage range, resolution, and accuracy

Voltage range	Force resolution	Measure resolution	Force accuracy[1] ±(% + mV)	Measure accuracy[1] (% + mV + mV)	Maximum current
±0.2 V	200 nV	200 nV	±(0.06 + 0.14)	±(0.06 + 0.14 + Io x 0.05)	1 A
±2 V	2 µV	2 µV	±(0.06 + 0.6)	±(0.06 + 0.6 + Io x 0.5)	1 A
±20 V	20 µV	20 µV	±(0.06 + 3)	±(0.06 + 3 + Io x 5)	1 A
±40 V[2]	40 µV	40 µV	±(0.06 + 3)	±(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.

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 + 2E-9 + Vo x 1E-10)	±(0.06 + 2E-9 + 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.

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)

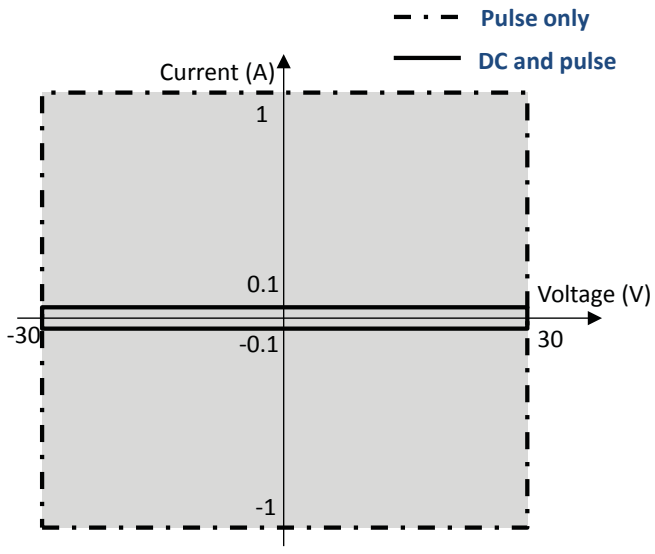
Where Ic is the current compliance setting.

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 output current.

MCSMU measurement and output range



SMU source measurement mode
For HPSMU and MPSMU:
VFIM, IFVM
For HCSMU, MCSMU and HVSMU:
VFIM, VFVM, IFVM, IFIM
Output terminal/connection:
For HPSMU and MPSMU:
Dual triaxial connector,
Kelvin (remote sensing)
For HCSMU:
Triaxial connector (for sense) and coaxial connector (for force)
Kelvin (remote sensing)
For MCSMU:
Dual triaxial connector, Kelvin (remote sensing)
For HVSMU:
High voltage triaxial connector, non-Kelvin
Voltage/current compliance (limiting)
The SMU can limit output voltage or current to prevent damaging the device under test.

Voltage:
0 V to ±200 V (HPSMU)
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:
±1 pA to ±1 A (HPSMU)
±1pA to ±100 mA (MPSMU)
±10 nA to ±20 A (HCSMU)
±10 nA to ±1 A (MCSMU)
±1 pA to ±8 mA (HVSMU)
Compliance accuracy:
Same as the current or voltage set accuracy.
Power compliance

For HPSMU:
Power: 0.001 to 20 W
Resolution: 0.001 W
For MPSMU:
Power: 0.001 to 2 W
Resolution: 0.001 W
For HCSMU:
Power: 0.001 to 40 W (DC)
0.001 to 400 W (Pulse)
Resolution: 0.001 W
For MCSMU:
Power: 0.001 to 3 W (DC)
0.001 to 30 W (Pulse)
Resolution: 0.001 W"
For HVSMU:
No power compliance

SMU pulse measurement
Pulse width, period, and delay:

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

Supplemental Characteristics

Current compliance setting accuracy (for opposite polarity):

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

SMU pulse setting accuracy (fixed measurement range):

For HPSMU and 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% ± 2 µs
- Period: ±0.5% ± 100 µs

Minimum pulse measurement time:
- 16 µs (HPSMU and MPSMU)
- 2 µs (HCSMU and MCSMU)
- 6 µs (HVSMU)

Voltage source output resistance:
(Force line, non-Kelvin connection)
- 0.2 Ω (HPSMU)
- 0.3Ω (MPSMU)
- 3 Ω (HVSMU, at 10 mA range)

Voltage measurement input resistance:
- ≥ 10^{13} Ω (HPSMU, MPSMU)
- ≥ 10^{9} Ω (HCSMU, MCSMU, ≤ 1 A), 80 kΩ (HCSMU, 20 A)
- ≥ 10^{12} Ω (HVSMU)

Current source output resistance:
- ≥ 10^{13} Ω (HPSMU, MPSMU)
- ≥ 10^{9} Ω (HCSMU, MCSMU, ≤ 1 A), 80 kΩ (HCSMU, 20 A)
- ≥ 10^{12} Ω (HVSMU, at 10 nA range)

Maximum allowable cable resistance:
(Kelvin connection)

For HPSMU and MPSMU:
- Sense: 10 Ω
- Force: 10 Ω (≤ 100 mA), 1.5 Ω (>100 mA)

For HCSMU:
- Sense: 10 Ω
- Force: 0.6 Ω (with Low Force)

For MCSMU
- Sense: 10 Ω
- Force : 1 Ω (with Low Force)

Maximum allowable inductance:

For HCSMU and MCSMU:
- Force 3 µH (with Low Force (shield))

Maximum load capacitance:

For HPSMU and MPSMU:
- 1 pA to 10 nA ranges: 1000 pF
- 100 nA to 10 mA ranges: 10 nF
- 100 mA and 1 A ranges: 100 µF

For HCSMU:
- 10 µA to 10 mA ranges: 12 nF
- 100 mA to 20 A ranges: 100 µF

For MCSMU:
- 10µA to 10 mA range : 12 nF
- 100 mA to 1 A range : 100 µF

For HVSMU:
- 1 nA to 1 µA ranges: 1000 pF
- 10 µA to 10 mA ranges: 10 nF

Maximum guard capacitance:
- 900 pF (HPSMU and MPSMU)
- 1500 pF (HVSMU)

Maximum shield capacitance:
- 5000 pF (HPSMU, MPSMU and HVSMU)

Noise characteristics:

For HPSMU, MPSMU and HVSMU
- Voltage source: 0.01% of V range (rms.)
- Current source: 0.1% of I range (rms.)

For HCSMU
- Voltage/Current source: 100 mV (0 to peak) max

For MCSMU
- Voltage / Current source: 200 mV (0 to peak) max

Overshoot:

For HPSMU and MPSMU
- Voltage source: 0.03% of V range
- Current source: 1% of I range

For HCSMU and MCSMU (filter ON)
- Voltage/Current source: 10% of range

For HVSMU
- Voltage source: 1V (resistive load)
- Current source: 1% of I range

Range switching transient noise:

For HPSMU and MPSMU (filter ON):
- Voltage ranging: 250 mV
- Current ranging: 70 mV

For HCSMU and MCSMU:
- 10 µA to 1 A ranges:
  - Voltage ranging: 250 mV
  - Current ranging: 70 mV
- 20 A ranges:
  - Voltage ranging: 5 V max

For HVSMU:
- Voltage ranging: 300 mV
- Current ranging: 300 mV

Maximum guard offset voltage:
- ±1 mV (HPSMU)
- ±3 mV (MPSMU)
- ±5 mV (HVSMU)

Maximum slew rate:
- 0.2 V/µs (HPSMU and MPSMU)
- 1 V/µs (HCSMU and MCSMU)
- 0.4 V/µs (HVSMU)

Output settling time

For HVSMU:
- Output settling time: 500 µs
- To reach 0.01% of settling value.
- Conditions:
  - 100 V step, 8 mA compliance, 1000 pF load capacitance

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
Cable length:
1.5 m or 3 m, automatic identification of accessories

Test signal

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

Output signal level:
Range: 10 mV_{rms} to 250 mV_{rms}
Resolution: 1 mV_{rms}
Accuracy:
±(10.0% + 1 mV_{rms}) at the measurement port of the MFCMU
±(15.0% + 1 mV_{rms}) at the measurement port of MFCMU cable (1.5 m or 3.0 m)
Output impedance: 50 Ω, typical
Signal level monitor:
Range: 10 mVrms to 250 mV_{rms}
Accuracy:
±(10.0% of reading + 1 mV_{rms}) at the measurement port of the MFCMU
±(15.0% + 1 mV_{rms}) at the measurement port of MFCMU cable (1.5 m or 3.0 m)

DC bias function

DC bias:
Range: 0 to ±25 V
Resolution: 1 mV
Accuracy: ±(0.5% + 5.0 mV) at the measurement port or the MFCMU or the MFCMU cable (1.5 m/3 m)

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
DC bias monitor:
Range: 0 to ±25 V
Accuracy (open load):
±(0.2% of reading + 10.0 mV)
at the measurement port or the MFCMU cable (1.5 m/3 m)

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 or the MFCMU cable (1.5 m or 3 m).

Z_X: Impedance measurement value (Ω)

D_X: Measurement value of D

$E = E_P' + (Z_S'/|Z_X| + Y_O'|Z_X|) \times 100$ (%)

$E_P' = E_{PL} + E_{POSC} + E_P$ (%)

$Y_O' = Y_{OL} + Y_{OSC} + Y_O$ (S)

$Z_S' = Z_{SL} + Z_{OSC} + Z_S$ (Ω)

|Z| accuracy
±E (%)

θ accuracy
±E/100 (rad)

C accuracy
at $D_X \leq 0.1$
±E (%)

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

D accuracy
at $D_X \leq 0.1$
±E/100

at $D_X > 0.1$
$\pm E \times (1 + D_X)/100$

G accuracy
at $D_X \leq 0.1$
$\pm E/D_X$ (%)

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

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

Parameters E_{POSC} Z_{OSC}

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

V_{osc} is oscillator level in mV.

Parameters E_{PL} Y_{OL} Z_{SL}

Cable length	E_{PL} (%)	Y_{OL} (nS)	Z_{SL} (mΩ)
1.5 m	0.02 + 3 x f/100	750 x f/100	5.0
3 m	0.02 + 5 x f/100	1500 x f/100	5.0

f is frequency in MHz. If measurement cable is extended, open compensation, short compensation, and load compensation must be performed.

Parameters Y_{OSC} Y_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 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 four-terminal pair port of MFCMU

UHC (Ultra High Current) Expander / Fixture (N1265A) Specifications

Specifications

Functions:
Fixture capability
Current expander capability
Expands the B1505A's current capability up to 1500 A. Current expansion is made using the Ultra High Current Unit (UHCU), which is comprised of an external module and either two MCSMUs, two HCSMUs or one MCSMU and one HCSMU.

Selector capability
This allows the user to switch the output between the UHCU and other modules connected to the selector input ports. The modules supported on the high-voltage input port are the HVSMU and HVMCU; the modules supported on the SMU input port are the HPSMU and MPSMU.

Channels:

Channel	Number	Input	Output
SMU	6 (When using non-Kelvin connections) 3 (When using Kelvin connections)	Triaxial[1]	Banana
UHV	1	UHV coaxial (High), SHV (Low)	UHV coaxial (High), SHV (Low)
Bias Tee	1	SHV x 2(High, Low)	SHV x 2 (High, Low)
Gate control	1	Triaxial x 2 (Force, Sense)	Banana x 2 (High, Low)
Selector	1[2]	HV Triaxial x 1 Triaxial x 2 (Force, Sense)	Banana x 6 (High Force/Sense, Low Force/Sense, Guard, Chassis)

1. Either the HCSMU or the Dual HCSMU can be connected to the SMU 3 port.
2. The UHCU or any module connected to one of the other two selector input terminals can be connected to the output terminal.

Maximum output for selector channel:

HVSMU Output : ±3000 V/4 mA, ±1500 V/8 mA
HVMCU Output : ±2200 V/1.1 A, ±1500 V/2.5 A
HPSMU Output: ±200 V/1 A
MPSMU Output: ±100 V/100 mA
UHCU Output: ±60 V/1500 A or 500 A
Refer to each module specification.

Gate control channel:

Non-Kelvin connection
Maximum Voltage : ±40 V
Maximum Current : ±1 A Pulse, 100m A DC.
Output Resistance: 0 Ω/10 Ω/100 Ω/1000 Ω (nominal value)

UHCU:

Output peak power	
Current range	**Peak power**
± 500 A	7.5 kW
± 1500 A	22.5 kW

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 500 A range and with 500 µs pulse width at 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 continuous maximum current output, the output current may be reduced due to insufficient charging time.

Other functionality

Fiilter

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

Thermocouple input: 2ea

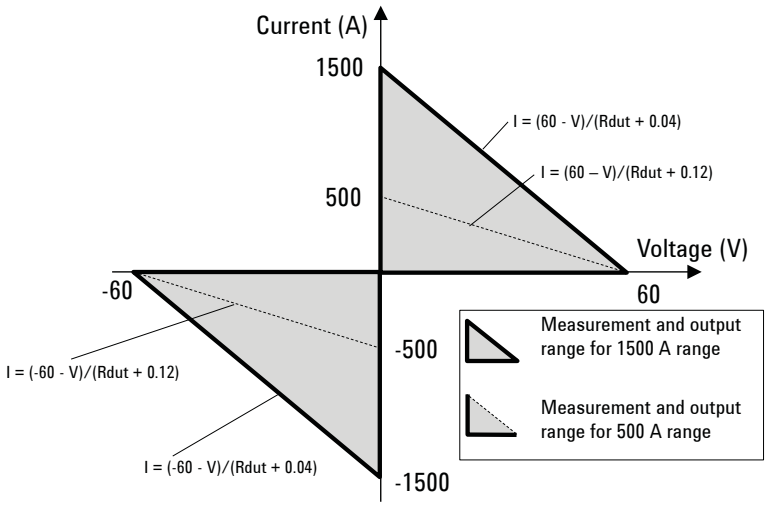
2 K-type thermocouple inputs
Temperature range: -50 degree C to 300 degree C.

Other Terminals/Indicators

Digital I/O input: 1ea.
Digital I/O output: 1 ea.
Power indicator: 1ea.
High voltage indicator: 1ea.
Selector indicator: 1ea.
Interlock terminal: 1ea.
Earth terminal: 1ea.
Wrist strap terminal: 1ea.

Supplemental characteristics

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, 'V' for Voltage and 'Rdut' stands for the impedance of the device under test.

UHCU Output resistance	
Output range	**Nominal value**
500 A	120 mΩ
1500 A	40 mΩ

Leakage

Selector channel

HVSMU is applied at High Sense terminal: less than 1n A
HPSMU/MPSMU is applied at High Force terminal: less than 10 nA

UHVU channel

Less than 1nA

SMU channel

Less than 1nA

Thermocouple reading accuracy	
Temperature range	**Accuracy**
0°C <= T < 100° C	+/-2°C
T>= 100° C	+/-5°C
T< 0° C	+/-5°C

HVSMU Current Expander (N1266A) Specifications

Specifications

Functions:
Current expander capability
Expands HVSMU current up to 2.5 A. Current expansion is made using the High Voltage Medium Current Unit (HVMCU), which is comprised of a module in the N1266A and two MCSMUs.

Selector capability
This allows the connections between the output terminal to be switched between the HVMCU and the HVSMU. The HVSMU output can be routed either directly or through a 100 kΩ resistor.

Output Terminals:
High (HV Triaxial)
Low (BNC)

Maximum output:
HVSMU : ±3000 V/4 mA, ±1500 V/8 mA
HVMCU : Refer to HVMCU specification

HVMCU

Output Peak Power

Voltage range	Peak power
± 2200 V	600 W
± 1500 V	900 W

Voltage range, resolution, and accuracy

Voltage range	Setting resolution	Measure resolution	Setting accuracy[1, 2, 3] ±(% + V)	Measure accuracy[1, 2] ±(% + V)
± 2200 V	3 mV	3 mV	±(5 + 20)	±(0.8 + 1.8)
± 1500 V	1.5 mV	3 mV	±(5 + 20)	±(0.8 + 1.8)

1. ±(% of reading value + fixed offset in V)
2. Accuracy is defined with 100 µs pulse at 1.1 A range and 2.5 A range, 1 ms pulse at 100 mA range.
3. Setting accuracy is defined at open load.

Current range, resolution, and accuracy[1]

Current range	Measure resolution	Measure accuracy[1] ±(% + A + A)
± 2.5 A	4 µA	±(0.9 + 4E-3 + Vo x 3E-7)
± 1.1 A	4 µA	±(0.9 + 4E-3 + Vo x 3E-7)
± 110 mA	200 nA	±(0.9 + 2E-4 + Vo x 3E-7)

1. Supplemental characteristics over 1.1 A.

HVMCU Pulse width and resolution		
Output range	**Pulse width**	**Resolution**
1500 V / 2.5 A	10 µsec – 100 µsec	2 µsec
2200 V / 1.1 A	10 µsec – 100 µsec	2 µsec
2200 V / 110 mA	10 µsec – 1 msec	2 µsec

Other Terminals / Indicators

Digital I/O Input: 1ea.
Digital I/O output: 1ea.
Power indicator: 1ea
Selector indicator: 1ea

Supplemental characteristics

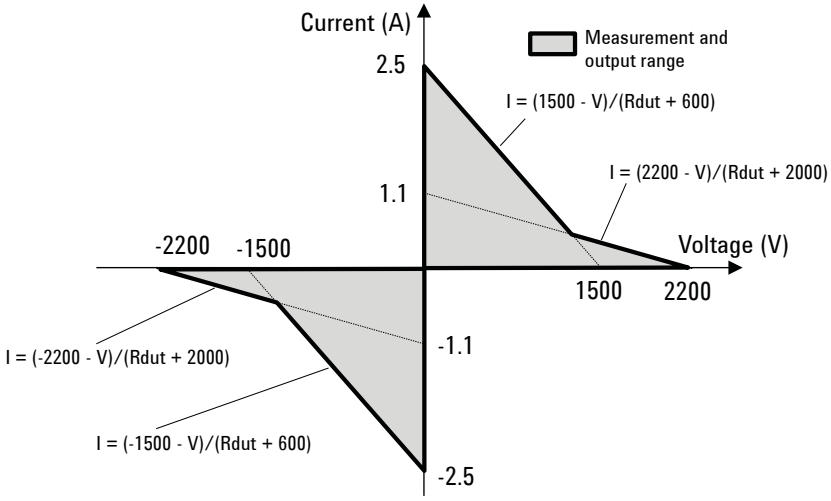
HVMCU Charged Capacitance: 0.22 µF

Output resistance	
Output range	**Nominal value**
1500 V / 2.5 A	600 Ω
2200 V / 1.1 A	2000 Ω
2200 V / 110 mA	20000 Ω

Leakage

Selector output
HVSMU: less than 80 pA

HVMCU Measurement and output range



The HVMCU's output is only available in pulsed mode.

In the equations in the above diagram, 'I' stands for current, 'V' for Voltage and 'Rdut' stands for the impedance of the device under test.

UHV (Ultra High Voltage) Expander (N1268A) Specifications

Specifications

Voltage range, resolution, and accuracy[1]				
Voltage range	**Force resolution**	**Measure resolution**	**Setting accuracy[2, 3] ±(% + V)**	**Measure accuracy[2] ±(% + V)**
± 10 kV	10 mV	10 mV	±(1.2 + 42)	±(1.2 + 42)

1. N1268A is controlled and makes measurement with two MCSMUs or a combination of a HCSMU and a MCSMU.
2. ±(% of reading value + fixed offset in V)
3. Setting accuracy is defined at open load.

Current range, resolution, and accuracy[1]		
Current range	**Measure resolution**	**Measure accuracy[2] ±(% + A + A)**
± 10 µA	10 pA	±(0.06 + 2E-9 + 1E-9)
± 100 µA	100 pA	±(0.06 + 2E-8 + 1E-9)
± 1 mA	1 nA	±(0.06 + 2E-7 + 1E-9)
± 10 mA	10 nA	±(0.06 + 2E-6 + 1E-9)
± 100 mA[3]	100 nA	±(0.06 + 20E-6 + 1E-9)

1. N1268A is controlled and makes measurement with two MCSMUs or a combination of a HCSMU and a MCSMU.
2. ±(% of reading value + fixed offset in A + fixed offset in A)
3. Pulsed mode only (Maximum pulse width is 1 ms). The maximum current is 20 mA.

UHV Pulse width and resolution		
Output range	**Pulse width**	**Resolution**
100 mA	100 µs to 1 ms	2 µs
≤ 10 mA	100 µs to 2 s	2 µs

Output Terminals

High : UHV coaxial
Low : SHV

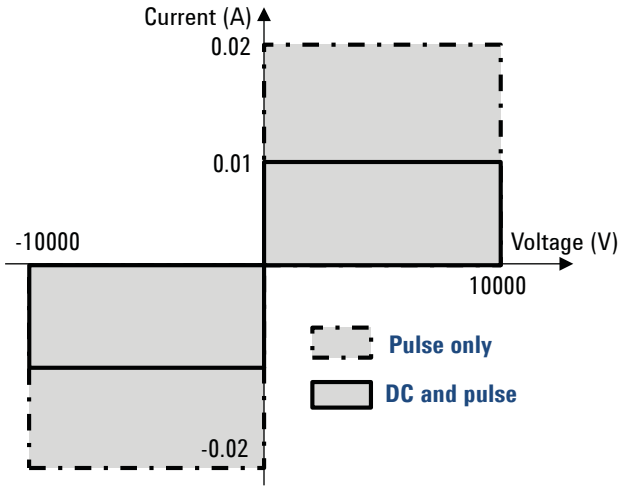
Other Terminals / Indicators

Digital I/O Input: 1ea.
Power indicator: 1ea
High Voltage indicator: 1ea
Interlock terminal Input: 1ea
Interlock terminal Output: 1ea
Earth terminal: 1ea

Supplemental characteristics

UHVU Output resistance	
Output range	**Nominal value**
High	10000 Ω
Low	1000 Ω

UHV measurement and output range



Other AC characteristics	
Slew rate	100 V/µs (with 1m cable)
Overshoot	±1% of setting voltage
Ripple	3 Vp-p
Maximum load capacitance	5 nF
Maximum load inductance	5 µH

Accessories

N1258A module selector

Specifications

Input terminals:
- HPSMU force port[1], 1 ea., (Triaxial)
- HPSMU sense port[1], 1 ea., (Triaxial)
- HCSMU force port, 1 ea. (BNC)
- HCSMU sense port, 1 ea. (Triaxial)
- HVSMU port[2], 1 ea. (HV triaxial)
- GNDU port, 1 ea. (Triaxial)
- Digital I/O port, 1 ea. (D-sub 25 pin)
- AC power line connector, 1 ea.

1. Either HPSMU or MPSMU can be connected to HPSMU port.
2. Either HVSMU or HVMCU can be connected to HVSMU port.

Output terminal:
- High force (HV triaxial)
- High sense (HV triaxial)
- Low force (BNC)
- Low sense (BNC)
- External relay control output (D-sub 25 pin)

Protection:
- HPSMU, GNDU, HCSMU Low Force

Power indicator:
- LED turns yellow when AC power is applied and turns green the module selector is ready to use.

Status indicator:
- Green LED lights to indicate the present connection path of module selector; Open, HCSMU, HPSMU, or HVSMU.

Maximum voltage/current:
- For HPSMU port:
  - ±200 V/1 A
- For HCSMU port:
  - ±40 V/2 A, ±20 V/30 A (Pulse width 1 ms, duty 1%)
- For HVSMU port:
  - ±3000 V/4 mA, ±1500 V/2.5 A, ±2200 V/1.1 A

Supplemental characteristics

Leakage current:
- For HPSMU:
  - 10 pA at 200 V
- For HCSMU:
  - 100 pA at 10 V (High Force to Low Force, High Sense to Low Sense)
- For HVSMU:
  - 10 pA at 1500 V (humidity range: 20% to 70% RH)
  - 20 pA at 3000 V (humidity range: 20% to 50% RH)

N1259A test fixture

Specifications

Input terminals:
- HPSMU port[1], 2 ea.
  - Force, sense (Triaxial)
- HCSMU port, 2 ea.
  - Force (BNC), sense (Triaxial)
- HVSMU port[2], 1 ea. (HV triaxial)
- GNDU port, 1 ea. (Triaxial)
- AUX port, 2 ea. (BNC)
- Interlock port, 1 ea.

1. Either HPSMU or MPSMU can be connected to HPSMU port.
2. Either HVSMU or HVMCU can be connected to HVSMU port.

Protection:
- HPSMU, GNDU, HCSMU Low Force terminal

High voltage indicator:
- LED turns red when a SMU output voltage is over 42 V.

Maximum voltage/current:
- For HPSMU port:
  - Force: ±200 V/1 A
  - Sense: ±200 V
- For HCSMU port:
  - High Force: ±40 V/2 A, ±20 V/40 A (Pulse width 1 ms, duty 1%)
  - Low Force: ±40 V/2 A, ±20 V/40 A (Pulse width 1 ms, duty 1%)
  - High Sense: ±40 V
  - Low Sense: ±40 V
- For HVSMU port:
  - Force: ±3000 V/4 mA, ±1500 V/2.5 A, ±2200 V/1.1 A

Note: The total power consumption of all modules cannot exceed 50 W when using test fixture under the condition that operating temperature is more than 35 °C.

Supplemental characteristics

Leakage current:
- For HPSMU (Force, Sense) port:
  - 10 pA at 200 V (Force, Sense)
- For HCSMU (High Force, High sense) port: 100 pA at 10 V
- For HVSMU (Force) port:
  - 10 pA at 1500 V (humidity range: 20% to 70% RH)
  - 20 pA at 3000 V (humidity range: 20% to 50% RH)

N1259A-010 inline package socket module (3 pin)

Specifications

Number of terminal:
- Sockets, 6 ea. (Ø4 mm jack (banana))

DUT interface:
- Inline package socket (3-pin)

Maximum voltage for terminals:
- 3000 Vdc

N1259A-011 universal socket module

Specifications

Number of terminal:
- Sockets, 8 ea. (Ø4 mm jack (banana))

Maximum voltage for terminals:
- 3000 Vdc

N1259A-013 Curve Tracer test adapter socket module

Specifications

Number of terminals:
- Sockets, 6 ea.
- (Ø4 mm jack (banana))

Test adapter interface:*
- Sockets, 6 ea.
- (Ø4 mm jack (banana))

Maximum voltage at terminals:
- 3000V Vdc

*A test adapter for Tektronix curve tracers (370B/371B) can be connected to this interface.

N1259A-020 high voltage bias-tee

Specifications

Input terminals:
- DC bias input, 1 ea.
  - (Ø4 mm jack (banana))
- MFCMU port, 1 ea.
  - Hcur, Hpot, Lcur, Lpot, (BNC)
  - Guard input, 1ea (Ø4 mm banana jack)

Output terminal:
- MFCMU port
  - High (SHV)
  - Low (SHV)

External DC bias voltage: ±3000 V
Frequency:
- 10 kHz to 1 MHz (150 Ω at 10 kHz)

Series capacitance: 110 nF ±5%
Input resistance: 100 kΩ ±1%

N1259A-021 1 MΩ resistor box

Specifications

Input/output terminals:
- Ø4 mm jack (banana), 1 ea.

Resistance: 1 MΩ ±5%
Maximum voltage: ±3000 V
Power rating: 9 W

Supplemental characteristics

Leakage current: 10 pA at 100 V

N1259A-022 100 kΩ resistor box

Specifications

Input/output terminals:
- Ø4 mm jack (banana), 1 ea.

Resistance: 100 kΩ ±5%
Maximum voltage: ±3000 V
Power rating: 6.4 W

Supplemental characteristics

Leakage current: 10 pA at 100 V

N1259A-030 1 kΩ resistor box for gate

Specifications

Input/output terminals:
- Ø4 mm jack (banana), 1 ea.

Resistance: 1 kΩ ±10%
Maximum voltage: ±200 V
Maximum power: 1 W

Supplemental characteristics

Leakage current: 10 pA at 100 V

N1259A-035 Universal resistor box

Specifications

Input/output terminals:
- Ø4 mm banana jack, 1 ea.

Resistance: Installed by a user
Maximum voltage for terminals:
- ±3000 V

N1259A-300 module selector for test fixture

Specifications

Input terminals:
- HPSMU port[1], 1 ea.
  - Force, sense (Triaxial)
- HCSMU port, 1 ea.
  - Force (BNC), sense (Triaxial)
- HVSMU port[2], 1 ea. (HV triaxial)
- GNDU port, 1 ea. (Triaxial)
- Digital I/O port, 1 ea. (D-sub 25 pin)
- AC power line connector, 1 ea.

1. Either HPSMU or MPSMU can be connected to HPSMU port.
2. Either HVSMU or HVMCU can be connected to HVSMU port.

Output terminal:
- High force and guard
- High sense and guard
- Low force
- Low sense
- (Ø4 mm jack (banana))

Protection:
- HPSMU, GNDU, HCSMU Low Force

Power indicator:
- LED turns yellow when AC power is applied and turns green the module selector is ready to use.

Status indicator:
- Green LED lights to indicate the present connection path of module selector; Open, HCSMU, HPSMU, or HVSMU.

Maximum voltage/current:
- For HPSMU port:
  - ±200 V/1 A
- For HCSMU port:
  - ±40 V/2 A, ±20 V/30 A
  - (Pulse width 1 ms, duty 1%)
- For HVSMU:
  - ±3000 V/4 mA,
  - ±1500 V/2.5 A, ±2200 V/1.1 A

Supplemental characteristics
Leakage current:
For HPSMU:
10 pA at 200 V
For HCSMU:
100 pA at 10 V (High Force to Low Force, High Sense to Low Sense)
For HVSMU:
10 pA at 1500 V (humidity range: 20% to 70% RH)
30 pA at 3000 V (humidity range: 20% to 50% RH)

N1260A high voltage bias-tee

Specifications
Input terminals:
HVSMU port, 1 ea. (HV triaxial)
MFCMU port, 1 ea.
(4 BNC, Hp, Hc, Lp, Hc)
Output terminal:
H-AC Guard (SHV connector)
L-AC Guard (SHV connector)
External DC bias voltage: ±3000 V
Frequency:
10 kHz to 1 MHz (150 Ω at 10 kHz)
Series capacitance: 110 nF ±5%
Input resistance: 100 kΩ ±1%

N1261A protection adapter

N1261A-001 protection adapter for HPSMU (triaxial output)

Specifications
Input terminals:
Force (Triaxial)
Sense (Triaxial)
Output terminals:
Force (Triaxial)
Sense (Triaxial)
1. Either the HPSMU or the MPSMU can be connected to HPSMU port.

Supplemental characteristics
Leakage current: 10 pA at 200 V

N1261A-002 protection adapter for GNDU (BNC output)

Specifications
Input terminals:
Force/Sense (Triaxial)
Output terminals:
Force (BNC)
Sense (BNC)

N1261A-003 protection adapter for HPSMU (HV triaxial output)

Specifications
Input terminals[1]:
Force (Triaxial)
Sense (Triaxial)
Output terminals:
Force (HV triaxial)
Sense (HV triaxial)
1. Either the HPSMU or the MPSMU can be connected to HPSMU port.

Supplemental characteristics
Leakage current: 10 pA at 200 V

N1261A-004 protection adapter for GNDU (SHV output)

Specifications
Input terminals:
Force/Sense (Triaxial)
Output terminals:
Force (SHV)
Sense (SHV)

N1262A Resistor Box

N1262A-001 1 MΩ resistor box

Specifications
Input terminals:
HVSMU port, 1 ea. (HV triaxial)
Output terminals:
SHV connector, 1 ea.
Resistance: 1 MΩ ±5%
Maximum voltage: ±3000 V
Maximum power: 9 W

Supplemental characteristics
Leakage current:
10 pA at 100 V

N1262A-002 100 kΩ resistor box

Specifications
Input terminals:
HVSMU port, 1 ea. (HV triaxial)
Output terminals:
SHV connector, 1 ea.
Resistance: 100 kΩ ±5%
Maximum voltage: ±3000 V
Maximum power: 6.4 W

Supplemental characteristics
Leakage current: 10 pA at 100 V

N1262A-010 1 kΩ resistor box for gate (triaxial output)

Specifications
Input terminals:
Triaxial connector, 1 ea.
Output terminals:
Triaxial connector, 1 ea.
Resistance: 1 kΩ ±10%
Maximum voltage: ±200 V
Maximum power: 1 W

Supplemental characteristics
Leakage current: 10 pA at 100 V

N1262A-011 1 kΩ resistor box for gate (SHV output)

Specifications
Input terminals:
HV triaxial connector, 1 ea.
Output terminals:
SHV connector, 1 ea.
Resistance: 1 kΩ ±10%
Maximum voltage: ±3000 V
Maximum power: 1 W

Supplemental characteristics
Leakage current: 10 pA at 100 V

N1262A-020 Universal resistor box, Triaxial

Specifications
Input terminals:
  Triaxial connector, 1 ea.
Output terminals:
  Triaxial connector, 1 ea.
Resistance: Installed by user
Maximum voltage for terminals: ±200 V

N1262A-021 Universal resistor box, HV Triaxial to SHV

Specifications
Input terminals:
  HVSMU port, 1 ea. (HV triaxial)
Output terminals:
  SHV connector, 1 ea.
Resistance: Installed by user
Maximum voltage for terminals:
±3000 V

N1262A-023 Universal resistor box for Ultra High Voltage

Specifications
Input terminals:
  UHV coaxial connector, 1 ea.
Output terminals:
  UHV coaxial connector, 1 ea.
Resistance: Installed by user
Maximum voltage for terminals:
±10 kV

N1262A-036 50 Ohm Termination Adapter

Specifications
Input terminal (BNC)
Output terminal (BNC)
Maximum power: 1 W

Accessories for N1265A

N1254A-524 500 A Ultra High Current Prober System Cable

Specifications
Input terminals: 8 ea. (Ø4 mm jack (banana))
  Selector Output
    High Force
    High Sense
    Low Force
    Low Sense
    Guard
  Gate output
    High Force
    Low Force
  Chassis
Output terminals
    High Force (Ø4 mm jack (banana))
    Low Force (Ø4 mm jack (banana))
    High Sense (HV triaxial)
    Low Sense (BNC)
    Gate (BNC)
Maximum voltage / current
  For High Force
    ±3000 V/39 A (DC), 500 A (Pulse)
  For Low Force
    ±200 V/39 A (DC), 500 A (Pulse)
  For High Sense
    ±3000 V/1 A
  For Low Sense, Gate
    ±200 V/1 A

N1265A-010 500 A Ultra High Current 3-pin Inline Package Socket Module

Specifications
Number of terminal:
Sockets, 6 ea. (Ø4 mm jack (banana))
DUT interface:
Inline package socket (3-pin)
Maximum voltage for terminals:
3000 Vdc
Maximum current for terminals:
  For Collector/Drain Force and Emitter/Source Force
    39 A (DC), 500 A (Pulse)
  For others
    1A (DC), 20 A (Pulse)

N1265A-011 Universal Socket Module

Specifications
Number of terminal:
  Sockets, 6 ea. (Ø4 mm jack (banana))
Maximum voltage for terminals:
  3000 Vdc
Universal blank area :
  90 mm (W) x 81 mm (D)

N1265A-013 Curve Tracer Test Adapter Socket Module

Specifications
Number of terminals: Sockets, 6 ea. (Ø4 mm jack (banana))
Test adapter interface:*
  Sockets, 6 ea. (Ø4 mm jack (banana))
Maximum voltage at terminals:
 3000V Vdc
Maximum current for terminals:
  For Collector/Drain Force and Emitter/Source Force
    39 A (DC), 500 A (Pulse)
  For others
    1A (DC), 20 A (Pulse)
*A test adapter for Tektronix curve tracers (370B/371B) can be connected to this interface.

N1265A-035 Universal R-Box for N1265A

Specifications
Input: 4 ea. (Ø4 mm plug (banana))
  High (Force, Sense)
  Low (Force, Sense)
Output terminals: 2 ea. (Ø4 mm jack (banana))
  High, Low
Resistance: Installed by a user
Maximum voltage for terminals: ±200 V

N1265A-040 10 kV Ultra High Voltage Gate Protection Adapter

Specifications
Input: 4 ea. (Ø4 mm plug (banana))
  High (Force, Sense)
  Low (Force, Sense)
Output terminals: 2 ea. (Ø4 mm jack (banana))
  High, Low
Maximum voltage: ±200 V
Maximum surge voltage: ±10 kV

N1265A-041 Thermocouple, Type K, 2 ea

Feature
N1265A-041 can be connected to Thermocouple terminal inside the N1265A and enables B1505A to read out temperature at the top of the thermocouple.

Specifications
Connector: Type K plug
Length: 3000 mm
Temperature range: -50 °C to +180 °C

N1265A-045 Container for Protection Adapter and Bias Tee

Feature
N1265A-045 can accommodate protection adapters and bias tee which are used with N1265A to make the measurement environment clean and safe

Specifications
Dimension: 420 mm W x 193 mm H x 565 mm D
Weight: 15 kg
Maximum superimposed load: 50 kg

N1267A High Voltage Source Monitor Unit / High Current Source Monitor Unit Fast Switch

Feature
To change connection between HVSMU and HCSMU for Gallium Nitride current collapse measurement. Switch is controlled by a MCSMU. Note: The N1267A is only supported by the B1513B; the B1513A is not supported.
Note: N1267A doesn't support 40A or two HCSMU configuration. Note: N1267A doesn't support N1265A.

Specifications
Input terminals:
  HVSMU port, 1ea (HV triaxial)
  HCSMU port, 1ea (Force: BNC, Sense: Triaxial)
  MCSMU port, 1ea (Force/Sense: Triaxial)
  GND port, 1ea (Triaxial)
Output terminals:
  High (HV triaxial)
  Low (BNC)
Maximum current: 20A
Maximum voltage: ±3000 V

N1269A Ultra High Voltage Connection Adapter

Feature
To make the connection simple and to protect measurement resources from unexpected surge when connecting UHVU to wafer prober.

Specifications
Input terminals:
  Gate MCSMU Force, 1ea (Triaxial)
  Gate MCSMU Sense, 1ea (Triaxial)
  Chuck MCSMU Force, 1ea (Triaxial)
  Chuck MCSMU Sense, 1ea (Triaxial)
  UHV Low, 1ea (HV triaxial)
Output terminals: 3ea (SHV)
  Gate, Chuck, Source
Maximum voltage: ±200 V
Maximum surge voltage: ±10 kV

Agilent EasyEXPERT Software

Functions

Operation mode:
  Application test mode, Classic test mode, Tracer test mode (Curve tracer mode), Oscilloscope view, Quick test mode

Key features:
- Categorized and predefined application library
- Device definition
- Measurement parameter settings
- Save/Recall My Favorite Setups
- Define/customize application library
- Execute measurement (Single/Repeat/Append)
- Oscilloscope view
- Quick test execution
- Direct control
- Save/Recall measurement data and settings
- Test result data management
- Import/Export device definition, measurement settings, my favorite setup, measurement data, and application library
- Graph plot display/analysis/printing
- Workspace management
- Self-test, self calibration, diagnostics

Application library

Category:
Sample test definitions for the following applications. They are subject to change without notice.
  High Power Device, Utility

Measurement mode details

The Agilent B1505A supports the following measurement modes:

- IV spot
- IV staircase sweep
- IV pulsed spot
- IV pulsed sweep
- IV staircase sweep with pulsed bias
- IV Sampling
- IV High speed sampling
- Multi channel sweep*
- Multi channel pulse spot
- Multi channel pulse sweep
- CV sweep
- C-t sampling
- C-f sweep
- CV (DC bias) staircase sweep
- List sweep
- Linear search**
- Binary search**

** EasyEXPERT supports VAR1 and VAR1'.*

***They are supported by FLEX command only.*

Each SMU can sweep using VAR1 (primary sweep), VAR2 (secondary sweep), or VAR1' (synchronous sweep).

VAR1

Primary sweep controls the staircase (dc or pulsed) voltage or current sweep.

Maximum number of steps: N1=1001

VAR2

Subordinate linear staircase or linear pulsed sweep. After primary sweep is completed, the VAR2 unit output is incremented.

Maximum number of steps: N_2=1001
(condition: $1 \leq N_1 \times N_2 \leq 128128$)

VAR1

Staircase or pulse sweep synchronized with the VAR1 sweep. Sweep is made with a user specified ratio and offset value. VAR1' output is calculated as VAR1' = a x VAR1 + b, where "a" is the user specified ratio and "b" is the user specified offset value.

CONST

A source unit can be set as a constant voltage or current source depending on the unit.

Sweep measurement time settings:

Hold time:
0 to 655.35 s, 10 ms resolution
Delay time:
0 to 65.5350 s, 100 µs resolution
(Staircase sweep, multi channel sweep)
0 to 655.350 s, 100 µs resolution
(CV(DC bias) staircase sweep, AC level sweep, frequency 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

Staircase sweep measurement mode:

Forces swept voltage or current, and measures DC voltage or current. One channel can sweep current or voltage while up to ten channels can measure current or voltage. A second channel can be synchronized with the primary sweep channel as an additional voltage or current sweep source.

Number of steps: 1 to 1001
Sweep type: linear or logarithmic
Sweep direction:
Single or double sweep

Pulsed sweep measurement mode:

Forces pulsed swept voltage or current, and measures DC voltage or current. A second channel can be programmed to output a staircase sweep voltage or current synchronized with the pulsed sweep output.

Staircase sweep with pulsed bias measurement mode:

Forces swept voltage or current, and measures DC voltage or current. A second channel can be programmed to output a pulsed bias voltage or current. A third channel can be synchronized with the primary sweep channel as an additional voltage or current sweep source.

Sampling (time domain) measurement mode

Displays the time sampled voltage/current data (by SMU) versus time.

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 mode: linear, log
Sampling interval range:
100 µs to 2 ms, 10 µs resolution
2 ms to 65.535 s, 1 ms resolution
For < 2 ms, 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

Oscilloscope View (I/V):
Displays the time sampled current or voltage data for the HCSMU, MCSMU, HVSMU, UHCU, HVMCU and UHVU modules versus time. The window over which the measurement is being performed is also displayed, permitting verification of measurement timing over the output waveform.

Sampling interval :
- 2 µs (HCSMU/MCSMU/UHCU/ HVMCU/UHVU)
- 6 µs (HVSMU)

Sampling points:
- 2000 Sa (HCSMU/MCSMU/UHCU/ HVMCU/UHVU)
- 4000 Sa (HVSMU)

Marker function :
- Read-out for each data channel
- Resolution : 2µs

Data saving :
- Numeric: Text/CSV/XMLSS
- Image: EMF/BMP/JPG/PNG

Search measurement mode:
Forces and measures voltage or current by using linear search method or binary search method.

Bias hold function
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 stamp
The B1505A supports a time stamp function utilizing an internal quartz clock.
- Resolution: 100 µs

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

Arithmetic and analysis 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, 1.602177 E-19 C

k: Boltzman's Constant, 1.380658 E-23

ε (e): Dielectric Constant of Vacuum, 8.854188 E-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})

Analysis capabilities

Overlay graph comparison
A graphics plot can be stored and overlaid.

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

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.

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

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.

Graph plot
Display mode
  Data display window can be printed.
  Only X-Y graph can be printed.
Graph plot file
  Graph plot can be stored as image data to clip board or mass storage device.
  File type: bmp, gif, png, emf

Output
Display modes
  X-Y graph, list display, and parameter display
  X-Y graph display
  X-axis and up to eight Y-axis
Linear and log scale

Real time graph plotting

List display

Measurement data and calculated user function data are listed in conjunction with VAR1 step number or time domain sampling step number. Up to 20 data sets can be displayed.

Other functions

Import/export files.
File type:
  Agilent EasyEXPERT format, XML-SS format, CSV format
Data storage
  Hard disk drive, DVD-ROM/CD-R/CD-RW drive
Interfaces
  GPIB, Interlock, USB (USB 2.0, front 2, rear 2), LAN (100BASE-TX/10BASE-T), trigger in/out, digital I/O
Trigger I/O
  Only available using GPIB FLEX commands.

  Trigger in/out synchronization pulses before and after setting and measuring dc voltage and current. Arbitrary trigger events can be masked or activated independently.

Supported external instruments

EasyEXPERT Standard edition:

- Supported by application tests: 4284A/E4980A, 81110A, 3458A

EasyEXPERT Plus edition:
- All external instruments supported by EasyEXPERT Standard edition

Furnished software

- Prober control execution files
- Desktop EasyEXPERT software with license-to-use for Standard edition
- 4155/56 setup file converter tool

  (Supported operating systems: Microsoft® Windows® XP Professional (Service Pack 3 or later), Windows Vista Business (Service Pack 2 or later (32bit only)), and Windows 7 Professional (Service Pack 1 or later (32bit and 64bit)); Supported language: English (US))

General specifications

Temperature range
Operating: +5 °C to +40 °C
Storage: -20 °C to +60 °C

Humidity range[1]
Operating: 20% to 70% RH, non-condensing
Storage: 10% to 90% RH, non-condensing
Storage: 20% to 80% RH, non-condensing (N1268A)

Altitude
Operating: 0 m to 2,000 m (6,561 ft)
Storage: 0 m to 4,600 m (15,092 ft)
0 m to 2,000 m (6,561 ft) (N1268A)

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

Maximum volt-amps (VA)
B1505A: 900 VA
N1258A: 65VA
N1259A-300: 35VA
N1265A: 400 VA
N1266A: 60 VA
N1268A: 350 VA

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

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

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

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

Certification
CE, cCSAus, C-Tick

Dimensions
B1505A:
- 420 mm W x 330 mm H x 575 mm D

N1258A module selector:
- 330 mm W x 120 mm H x 410 mm D

N1259A test fixture:
- 420 mm W x 272 mm H x 410 mm D

N1260A High voltage bias-tee:
- 164 mm W x 53 mm H x 125 mm D

N1261A-001 HPSMU protection adapter (Triaxial output):
- 80 mm W x 40 mm H x 110 mm D

N1261A-002 GNDU protection adapter (BNC output):
- 80 mm W x 40 mm H x 110 mm D

N1261A-003 HPSMU protection adapter (HV triaxial output):
- 90 mm W x 40 mm H x 140 mm D

N1261A-004 GNDU protection adapter (SHV output):
- 80 mm W x 40 mm H x 125 mm D

N1262A resister box:
- 50 mm W x 40 mm H x 125 mm D

N1265A UHC expander / fixture:
- 420 mm W x 285mm H x 575 mm D

N1266A HVSMU current expander:
- 420 mm W x 75 mm H x 575 mm D

N1267A HVSMU / HCSMU fast switch: TBD

N1268A UHV expander: 420 mm W x 222 mm H x 482 mm D

Weight
B1505A (empty): 20 kg
B1511A: 1.1 kg
B1510A: 2.0 kg
B1512A: 2.1 kg
B1513B: 2.0 kg
B1514A: 1.3 kg
B1520A: 1.3 kg
N1258A: 5.0 kg
N1259A: 12.0 kg
N1260A: 0.6 kg
N1261A: 0.3 kg
N1262A: 0.3 kg
N1265A: 30 kg
N1266A: 10 kg
N1267A: TBD
N1268A: 18 kg

Furnished accessories
Measurement cables and adapter
- Triaxial cable for HPSMU, MPSMU and MCSMU, 2 ea.
- HCSMU cable, 1 ea.
- HCSMU Kelvin adapter, 1 ea.
- HVSMU cable, 1 ea.

Interlock cable, 1 ea.
Ground unit cable, 1 ea.
Keyboard, 1 ea.
Mouse, 1 ea.
Stylus pen, 1 ea.
Power cable, 1 ea.
Manual CD-ROM, 1 ea.
Desktop EasyEXPERT CD-ROM, 1 ea.
License-to-use for Desktop EasyEXPERT
- Standard edition, 1 license

Software CD-ROM
- (including utility tools)

Disk set for Agilent
- 4155B/4155C/4156B/4156C firmware update, 1 set

SMU number label for the B1505A
- installed with SMU, 1 sheet

N1258A : Digital I/O cable, 1 ea.
N1259A-300 : Digital I/O cable, 1 ea.
N1265A : Digital I/O cable, 1 ea.
N1266A : Digital I/O cable, 1 ea.
N1268A : Digital I/O cable, 1 ea., Interlock cable, 1 ea.

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

Order Information

Mainframe and modules	
B1505A	Power Device Analyzer/Curve Tracer mainframe
	Configure the following modules: High power SMU (HPSMU) Medium power SMU (MPSMU) High current SMU (HCSMU) Medium current SMU (MCSMU) High voltage SMU (HVSMU) Multi frequency CMU (MFCMU)
B1505A-015	1.5 m cable
B1505A-030	3.0 m cable
B1505A-050	50 Hz line frequency
B1505A-060	60 Hz line frequency
B1505A-A6J	ANSI Z540 compliant calibration
B1505A-UK6	Commercial calibration certificate with test data
B1505A-ABA	English documentation
B1505A-ABJ	Japanese documentation
B1500A-1CM	Rackmount kit
B1505A expanders/fixtures	
N1259A	Test fixture
N1259A-010	Inline package socket module (3 pin)
N1259A-011	Universal socket module
N1259A-012	Blank PTFE board
N1259A-013	Curve Tracer test adaptor socket module
N1259A-020	High voltage bias-tee
N1259A-021	1 MΩ Resistor box
N1259A-022	100 kΩ Resistor box
N1259A-030	1 kΩ Resistor box for gate
N1259A-035	Universal R-Box
N1259A-300	Module selector
N1265A	UHC expander / fixture
N1265A-002	Blank Silicon Plate
N1265A-010	500 A Ultra High Current 3-pin Inline Package Socket Module
N1265A-011	Universal Socket Module
N1265A-013	Curve Tracer Test Adapter Socket Module
N1265A-015	1500 A Current Option
N1265A-035	Universal R-Box for N1265A
N1265A-040	10 kV Ultra High Voltage Gate Protection Adapter
N1265A-041	Thermocouple, Type K, 2 ea
N1265A-045	Container for Protection Adapter and Bias Tee
N1266A	High Voltage Source Monitor Unit Current Expander
N1267A	High Voltage Source Monitor Unit / High Current Source Monitor Unit Fast Switch
N1268A	Ultra High Voltage Expander
B1505A accessories	
16444A-001	Keyboard
16444A-002	Mouse
16444A-003	Stylus pen
N1253A-100	Digital I/O cable
N1253A-200	Digital I/O BNC box
N1254A-100	Ground unit Kelvin adapter
N1254A-101	Triaxial(m)-BNC(f)
N1254A-102	Triaxial(m)-BNC(m)
N1254A-103	Triaxial(m)-BNC(f)
N1254A-104	Triaxial(f)-BNC(m)
N1254A-105	Triaxial(f)-BNC(m)
N1254A-106	Triaxial(m)-BNC(f)
N1254A-107	Triaxial(m)-BNC(f)
N1254A-500	HV Jack Connector (Solder Type)
N1254A-501	HV Jack /Jack Adapter
N1254A-502	HV plug Connector(Solder Type)
N1254A-503	BNC Coax Cable Assy 1.5m(Open End)
N1254A-504	HVTriax Jack Coax Cable Assy 1.5m(Open End)
N1254A-505	HVTriax Plug Triax Cable Assy 1.5m (Open End)
N1254A-506	HVTriax Plug Coax Cable Assy 1.5m(Open End)
N1254A-507	HVTriax Plug Coax Cable Assy 1.5m
N1254A-508	Test Lead cable Black
N1254A-509	Test Lead cable Red
N1254A-510	Dolphin clip 2 ea. (red and black)
N1254A-511	Cable lag adapter 2 ea. (red and black)
N1254A-512	SHV Cable Assy 250mm
N1254A-513	SHV to Banana
N1254A-514	BNC-Plug? Plug
N1254A-515	BNC-Jack ?Plug-Jack
N1254A-516	BNC-Jack-Jack-Jack
N1254A-517	Adapter, Trixial Jack to Triaxial Plug
N1254A-518	SHV Cable 1.5 m
N1254A-520	10 kV Ultra High Voltage Open End Cable, 1 m.
N1254A-521	10 kV Ultra High Voltage Jack to Jack Adapter
N1254A-522	1500 A Ultra High Current Banana to Banana Cable, 2 ea.
N1254A-523	1500 A Ultra High Current Banana to Open End Cable, 1 m, 2 ea
N1254A-524	500 A Ultra High Current Prober System Cable
N1258A	Module selector
N1260A	High voltage bias-tee
N1261A	Protection adapter
N1262A	Resistor box
N1262A-020	Universal R-Box, Triaxial
N1262A-021	Universal R-Box, HV Triaxial to SHV
N1262A-023	Universal R-Box for Ultra High Voltage
N1262A-036	50 Ohm Termination Adapter
SMU cables/accessories	
16493S-001	HCSMU cable (1.5 m)
16493S-002	HCSMU cable (3 m)

Order Information

16493S-010	HCSMU Kelvin adapter
16493S-011	HCSMU non-Kelvin adapter
16493S-020	Dual HCSMU Kelvin combination adapter
16493S-021	Dual HCSMU combination adapter
16493T-001	High voltage triaxial cable (1.5 m)
16493T-002	High voltage triaxial cable (3 m)
16493U-001	High current BNC cable (1.5 m)
16493U-002	High current BNC cable (3 m)
16494A-001	Triaxial cable (1.5 m)
16494A-002	Triaxial cable (3 m)
16493K-001	Kelvin triaxial cable (1.5 m)
16493K-002	Kelvin triaxial cable (3 m)
16493V-001	10 kV Ultra High Voltage Cable, 1.5 m
16493V-002	10 kV Ultra High Voltage Cable, 3 m
N1269A	Ultra High Voltage Connection Adapter
CMU accessories	
N1300A-001	CMU cable (1.5 m)
N1300A-002	CMU cable (3 m)
Other accessories	
16493G-001	Digital I/O cable (1.5 m)
16493G-002	Digital I/O cable (3 m)
16493J-001	Interlock cable (1.5 m)
16493J-002	Interlock cable (3 m)
16493L-001	GNDU cable (1.5 m)
16493L-002	GNDU cable (3 m)

Retrofit and upgrade kits	
B1505AU	Upgrade kit for B1505A
B1505AU-001	Conversion kit from B1500A to B1505A
B1505AU-010	High power source monitor unit (B1510A)
B1505AU-011	Medium power source monitor unit (B1511A)
B1505AU-012	High current source monitor unit (B1512A)
B1505AU-013	High voltage source monitor unit (B1513B)
B1505AU-014	Medium current source monitor unit (B1514A)
B1505AU-020	Multi frequency capacitance measurement unit (B1520A)
B1505AU-SWS	EasyEXPERT Extension support and subscription
N1259AU	Upgrade kit for N1259A
N1265AU	Upgrade kit for N1265A
Package solution	
B1505AP	Pre-configured Power Device Analyzer/Curve Tracer (B1505A w/ modules/fixture)
B1505AP-H20	3 kV / 20 A / Fixture Pack
B1505AP-H21	3 kV / 20 A / C-V / Fixture Pack
B1505AP-H50	3 kV / 500 A / Fixture Pack
B1505AP-H51	3 kV / 500 A / C-V / Fixture Pack
B1505AP-H70	3 kV / 1500 A / Fixture Pack
B1505AP-H71	3 kV / 1500 A / C-V / Fixture Pack
B1505AP-U50	10 kV / 500 A / Fixture Pack
B1505AP-U70	10 kV / 1500 A / Fixture Pack

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Agilent B2900A Series Precision Source/Measure Unit

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