The Keysight Technologies, Inc. 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 A. 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 fully automated capacitance measurements (such as Ciss, Coss and Crss) at high voltage biases (up to 3 kV). Moreover, it can evaluate gate charge (which is an important parameter for high frequency switching converter efficiency) at up to 3 kV as well. The B1505A with EasyEXPERT group+ 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, device capacitance selector and Quick Test feature enable fully automated measurement on multiple parameters without the need to recable. Keysight EasyEXPERT group+ GUI based characterization software is available either on the B1505A’s embedded Windows 7 platform with 15-inch touch screen or on your PC to accelerate the characterization tasks. It supports efficient and repeatable device characterization in the entire characterization process from measurement setup and execution to analysis and data management either interactive manual operation or automation across a wafer in conjunction with a semiautomatic wafer prober. EasyEXPERT group+ makes it easy to perform complex device characterization immediately with hundreds of ready-to-use measurements (application tests) furnished, and allows you the option of storing test condition and measurement data automatically after each measurement in a unique built-in database (workspace), ensuring that valuable information is not lost and that measurements can be repeated at a later date. The net result is improved ease of use, better data analysis and simplified data management for the measurement of power devices and power circuitry.
Basic features

- Precision measurement across a wide range of operating conditions
  - All-in-one solution for power device characterization up to 1500 A/10 kV
  - Medium current measurement with high voltage bias (e.g. 500 mA at 1200 V)
  - μΩ resistance measurement capability
  - Accurate sub-picoamp level current measurement at high voltage bias
  - Fully automated thermal test from -50 to +250 °C

Extensive device evaluation capabilities

- Fully automated Capacitance (Ciss, Coss, Crss, etc.) measurement at up to 3000 V of DC bias
- High power pulsed measurements down to 10 μs
- Gate charge measurement covering Nch MOSFETs and IGBTs both in package and on wafer
- High voltage/high current fast switch option to characterize GaN current collapse effect
- Up to 5 high voltage (3 kV) source/measure unit channels for reliability applications
- Perform both hot and cold temperature dependency testing in an interlock equipped test fixture

Improved measurement efficiency

- Switch between high-voltage and high-current measurements without the need to recable
- Automated reconfiguration of test circuitry for transistor capacitance measurement (Ciss, Coss, Crss, Cgs, Cgd, Cds, etc.) for both packaged and on-wafer devices
- Standard test fixtures with interlock for safe packaged power device testing
- Supported and secure on-wafer high-power testing over 200 A and up to 10 kV
- Oscilloscope view allows verification of applied voltage and current waveforms
- MS Windows-based EasyEXPERT group+ software facilitates data management and simplifies data analysis

Upgradable and scalable hardware architecture

- A wide selection of measurement modules
- Support for high power devices with up to 6 pins
- GPIB, USB, LAN interfaces and VGA video output port
- 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 ± 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 MCMU), 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 a Keysight Technologies, Inc. service centre. In order to ensure system specifications the new modules need to be installed and the complete unit calibrated. Contact your nearest Keysight 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.

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
<th>Slots occupied</th>
<th>Range of operation</th>
<th>Measure resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1510A</td>
<td>High Power Source Monitor Unit (HPSMU)</td>
<td>2</td>
<td>-200 V to 200 V, -1 A to 1 A</td>
<td>2 µV, 10 fA</td>
</tr>
<tr>
<td>B1511B</td>
<td>Medium Power Source Monitor Unit (MPMU)</td>
<td>1</td>
<td>-100 V to 100 V, -100 mA to 100 mA</td>
<td>0.5 µV, 10 fA</td>
</tr>
<tr>
<td>B1512A</td>
<td>High Current Source Monitor Unit (HCSMU)</td>
<td>2</td>
<td>-40 V to 40 V, -1 A to 1 A</td>
<td>200 nV, 10 pA</td>
</tr>
<tr>
<td>B1513C</td>
<td>High Voltage Source Monitor Unit (HVSMU)</td>
<td>2</td>
<td>-3000 V to 3000 V, -4 mA to 4 mA</td>
<td>200 µV, 10 fA</td>
</tr>
<tr>
<td>B1514A</td>
<td>Medium Current Source Monitor Unit (MCSMU)</td>
<td>1</td>
<td>-30 V to 30 V, -100 mA to 100 mA</td>
<td>200 nV, 10 pA</td>
</tr>
<tr>
<td>B1520A</td>
<td>Multi Frequency Capacitance Measurement Unit (MFCMU)</td>
<td>1</td>
<td>1 kHz to 5 MHz</td>
<td></td>
</tr>
</tbody>
</table>

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

**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
- Up to 10 single-slot MPMUs
- Up to 2 dual-slot HCSMUs
- Up to 6 single-slot MCSMUs
- Up to 5 dual-slot HVSMU

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, MPMU, 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

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

**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 \( R \leq 10 \) Ω  
Where \( I_s \) is the current being sunk by the GNDU.

**Peripherals and interface**

**Data storage**  
Hard disk drive, DVD-R drive

**Interfaces**  
GPIB, interlock, USB (USB 2.0, front 2, rear 2), LAN (1000BASE-T/100BASE-TX/10BASE-T), trigger in/out, digital I/O, VGA video output

**Remote control capabilities**

- FLEX commands (GPIB)  
- EasyEXPERT group+ remote control function (LAN)

**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.

**Furnished software**

- EasyEXPERT group+
- VXI plug & play driver for the B1500A
- MDM file converter

This tool can convert the EasyEXPERT group+ file (XTR/ZTR) to Keysight IC-CAP MDM file format.

The EasyEXPERT file of the following measurements performed in the classic mode is only supported:

- IV Sweep  
- Multi channel IV Sweep  
- CV Sweep

- 4155/56 setup file converter tool

This tool can convert 4155 and 4156 measurement setup files (file extensions MES or DAT) into equivalent EXPERT group+ classic test mode setup files

**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) Supported .NET Framework Microsoft .NET Framework 3.5 SP1
# HPSMU Module Specifications

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

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy $^1$</th>
<th>Measure accuracy $^1$</th>
<th>Maximum current</th>
</tr>
</thead>
<tbody>
<tr>
<td>±2 V</td>
<td>100 µV</td>
<td>2 µV</td>
<td>±(0.018 + 0.4)</td>
<td>±(0.01 + 0.14)</td>
<td>1 A</td>
</tr>
<tr>
<td>±20 V</td>
<td>1 mV</td>
<td>20 µV</td>
<td>±(0.018 + 3)</td>
<td>±(0.009 + 0.9)</td>
<td>1 A</td>
</tr>
<tr>
<td>±40 V</td>
<td>2 mV</td>
<td>40 µV</td>
<td>±(0.018 + 6)</td>
<td>±(0.01 + 1)</td>
<td>500 mA</td>
</tr>
<tr>
<td>±100 V</td>
<td>5 mV</td>
<td>100 µV</td>
<td>±(0.018 + 15)</td>
<td>±(0.012 + 2.5)</td>
<td>125 mA</td>
</tr>
<tr>
<td>±200 V</td>
<td>10 mV</td>
<td>200 µV</td>
<td>±(0.018 + 30)</td>
<td>±(0.014 + 2.8)</td>
<td>50 mA</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Current range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy $^1$</th>
<th>Measure accuracy $^1$</th>
<th>Maximum voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>±1 nA</td>
<td>50 fA</td>
<td>10 fA</td>
<td>±(0.1 + 3E-13 + Vo x 1E-15)</td>
<td>±(0.1 + 2E-13 + Vo x 1E-15)</td>
<td>200 V</td>
</tr>
<tr>
<td>±10 nA</td>
<td>500 fA</td>
<td>10 fA</td>
<td>±(0.1 + 3E-12 + Vo x 1E-14)</td>
<td>±(0.1 + 1E-12 + Vo x 1E-14)</td>
<td>200 V</td>
</tr>
<tr>
<td>±100 nA</td>
<td>5 pA</td>
<td>100 fA</td>
<td>±(0.05 + 3E-11 + Vo x 1E-13)</td>
<td>±(0.05 + 2E-11 + Vo x 1E-13)</td>
<td>200 V</td>
</tr>
<tr>
<td>±1 µA</td>
<td>50 pA</td>
<td>1 pA</td>
<td>±(0.05 + 3E-10 + Vo x 1E-12)</td>
<td>±(0.05 + 1E-10 + Vo x 1E-12)</td>
<td>200 V</td>
</tr>
<tr>
<td>±10 µA</td>
<td>500 pA</td>
<td>10 pA</td>
<td>±(0.05 + 3E-9 + Vo x 1E-11)</td>
<td>±(0.04 + 2E-9 + Vo x 1E-11)</td>
<td>200 V</td>
</tr>
<tr>
<td>±100 µA</td>
<td>5 nA</td>
<td>100 pA</td>
<td>±(0.035 + 15E-9 + Vo x 1E-10)</td>
<td>±(0.03 + 2E-9 + Vo x 1E-10)</td>
<td>200 V</td>
</tr>
<tr>
<td>±1 mA</td>
<td>50 nA</td>
<td>1 nA</td>
<td>±(0.04 + 15E-8 + Vo x 1E-9)</td>
<td>±(0.03 + 6E-8 + Vo x 1E-9)</td>
<td>200 V</td>
</tr>
<tr>
<td>±10 mA</td>
<td>500 nA</td>
<td>10 nA</td>
<td>±(0.04 + 15E-7 + Vo x 1E-8)</td>
<td>±(0.04 + 2E-7 + Vo x 1E-8)</td>
<td>200 V</td>
</tr>
<tr>
<td>±100 mA</td>
<td>5 µA</td>
<td>100 nA</td>
<td>±(0.045 + 15E-6 + Vo x 1E-7)</td>
<td>±(0.04 + 6E-6 + Vo x 1E-7)</td>
<td>200 V $^2$</td>
</tr>
<tr>
<td>±1 A</td>
<td>50 µA</td>
<td>1 µA</td>
<td>±(0.4 + 3E-4 + Vo x 1E-6)</td>
<td>±(0.4 + 15E-5 + Vo x 1E-6)</td>
<td>200 V $^2$</td>
</tr>
</tbody>
</table>

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 A.

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

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy $^1$</th>
<th>Measure accuracy $^1$</th>
<th>Maximum current</th>
</tr>
</thead>
<tbody>
<tr>
<td>±2 V</td>
<td>100 µV</td>
<td>2 µV</td>
<td>±(0.018 + 0.4)</td>
<td>±(0.01 + 0.14)</td>
<td>1 A</td>
</tr>
<tr>
<td>±20 V</td>
<td>1 mV</td>
<td>20 µV</td>
<td>±(0.018 + 3)</td>
<td>±(0.009 + 0.9)</td>
<td>1 A</td>
</tr>
<tr>
<td>±40 V</td>
<td>2 mV</td>
<td>40 µV</td>
<td>±(0.018 + 6)</td>
<td>±(0.01 + 1)</td>
<td>500 mA</td>
</tr>
<tr>
<td>±100 V</td>
<td>5 mV</td>
<td>100 µV</td>
<td>±(0.018 + 15)</td>
<td>±(0.012 + 2.5)</td>
<td>125 mA</td>
</tr>
<tr>
<td>±200 V</td>
<td>10 mV</td>
<td>200 µV</td>
<td>±(0.018 + 30)</td>
<td>±(0.014 + 2.8)</td>
<td>50 mA</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Current range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy $^1$</th>
<th>Measure accuracy $^1$</th>
<th>Maximum voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>±1 nA</td>
<td>50 fA</td>
<td>50 fA</td>
<td>±(0.1 + 3E-13 + Vo x 1E-15)</td>
<td>±(0.25 + 3E-13 + Vo x 1E-15)</td>
<td>200 V</td>
</tr>
<tr>
<td>±10 nA</td>
<td>500 fA</td>
<td>500 fA</td>
<td>±(0.1 + 3E-12 + Vo x 1E-14)</td>
<td>±(0.25 + 2E-12 + Vo x 1E-14)</td>
<td>200 V</td>
</tr>
<tr>
<td>±100 nA</td>
<td>5 pA</td>
<td>5 pA</td>
<td>±(0.05 + 3E-11 + Vo x 1E-13)</td>
<td>±(0.1 + 2E-11 + Vo x 1E-13)</td>
<td>200 V</td>
</tr>
<tr>
<td>±1 µA</td>
<td>50 pA</td>
<td>50 pA</td>
<td>±(0.05 + 3E-10 + Vo x 1E-12)</td>
<td>±(0.1 + 2E-10 + Vo x 1E-12)</td>
<td>200 V</td>
</tr>
<tr>
<td>±10 µA</td>
<td>500 pA</td>
<td>500 pA</td>
<td>±(0.05 + 3E-9 + Vo x 1E-11)</td>
<td>±(0.05 + 2E-9 + Vo x 1E-11)</td>
<td>200 V</td>
</tr>
<tr>
<td>±100 µA</td>
<td>5 nA</td>
<td>5 nA</td>
<td>±(0.035 + 15E-9 + Vo x 1E-10)</td>
<td>±(0.05 + 2E-8 + Vo x 1E-10)</td>
<td>200 V</td>
</tr>
<tr>
<td>±1 mA</td>
<td>50 nA</td>
<td>50 nA</td>
<td>±(0.04 + 15E-8 + Vo x 1E-9)</td>
<td>±(0.04 + 2E-7 + Vo x 1E-9)</td>
<td>200 V</td>
</tr>
<tr>
<td>±10 mA</td>
<td>500 nA</td>
<td>500 nA</td>
<td>±(0.04 + 15E-7 + Vo x 1E-8)</td>
<td>±(0.04 + 2E-6 + Vo x 1E-8)</td>
<td>200 V</td>
</tr>
<tr>
<td>±100 mA</td>
<td>5 µA</td>
<td>5 µA</td>
<td>±(0.045 + 15E-6 + Vo x 1E-7)</td>
<td>±(0.1 + 2E-5 + Vo x 1E-7)</td>
<td>200 V $^2$</td>
</tr>
<tr>
<td>±1 A</td>
<td>50 µA</td>
<td>50 µA</td>
<td>±(0.4 + 3E-4 + Vo x 1E-6)</td>
<td>±(0.5 + 3E-4 + Vo x 1E-6)</td>
<td>200 V $^2$</td>
</tr>
</tbody>
</table>

1. ±(% of reading value + offset value 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 A.
Voltage source mode:

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 V</td>
<td>20 x Ic (W)</td>
</tr>
<tr>
<td>20 V</td>
<td>20 x Ic (W)</td>
</tr>
<tr>
<td>40 V</td>
<td>40 x Ic (W)</td>
</tr>
<tr>
<td>100 V</td>
<td>100 x Ic (W)</td>
</tr>
<tr>
<td>200 V</td>
<td>200 x Ic (W)</td>
</tr>
</tbody>
</table>

Where Ic is the current compliance setting.

Current source mode:

<table>
<thead>
<tr>
<th>Voltage compliance</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vc ≤ 20</td>
<td>20 x Io (W)</td>
</tr>
<tr>
<td>20 &lt; Vc ≤ 40</td>
<td>40 x Io (W)</td>
</tr>
<tr>
<td>40 &lt; Vc ≤ 100</td>
<td>100 x Io (W)</td>
</tr>
<tr>
<td>100 &lt; Vc ≤ 200</td>
<td>200 x Io (W)</td>
</tr>
</tbody>
</table>

Where Vc is the voltage compliance setting and Io is output current.
# MPSMU Module Specifications

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

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy $^1$</th>
<th>Measure accuracy $^1$</th>
<th>Maximum current</th>
</tr>
</thead>
<tbody>
<tr>
<td>±0.5 V</td>
<td>25 μV</td>
<td>0.5 μV</td>
<td>±(0.018 + 0.15)</td>
<td>±(0.01 + 0.12)</td>
<td>100 mA</td>
</tr>
<tr>
<td>±2 V</td>
<td>100 μV</td>
<td>2 μV</td>
<td>±(0.018 + 0.4)</td>
<td>±(0.01 + 0.14)</td>
<td>100 mA</td>
</tr>
<tr>
<td>±5 V</td>
<td>250 μV</td>
<td>5 μV</td>
<td>±(0.018 + 0.75)</td>
<td>±(0.009 + 0.25)</td>
<td>100 mA</td>
</tr>
<tr>
<td>±20 V</td>
<td>1 mV</td>
<td>20 μV</td>
<td>±(0.018 + 3)</td>
<td>±(0.009 + 0.9)</td>
<td>100 mA</td>
</tr>
<tr>
<td>±40 V</td>
<td>2 mV</td>
<td>40 μV</td>
<td>±(0.018 + 6)</td>
<td>±(0.01 + 1)</td>
<td>2</td>
</tr>
<tr>
<td>±100 V</td>
<td>5 mV</td>
<td>100 μV</td>
<td>±(0.018 + 15)</td>
<td>±(0.012 + 2.5)</td>
<td>2</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Current range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy $^1$</th>
<th>Measure accuracy $^1$</th>
<th>Maximum voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>±1 nA</td>
<td>50 fA</td>
<td>10 fA</td>
<td>±(0.1 + 3E-13 + Vo x 1E-15)</td>
<td>±(0.1 + 2E-13 + Vo x 1E-15)</td>
<td>100 V</td>
</tr>
<tr>
<td>±10 nA</td>
<td>500 fA</td>
<td>10 fA</td>
<td>±(0.1 + 3E-12 + Vo x 1E-14)</td>
<td>±(0.1 + 1E-12 + Vo x 1E-14)</td>
<td>100 V</td>
</tr>
<tr>
<td>±100 nA</td>
<td>5 pA</td>
<td>100 fA</td>
<td>±(0.05 + 3E-11 + Vo x 1E-13)</td>
<td>±(0.05 + 2E-11 + Vo x 1E-13)</td>
<td>100 V</td>
</tr>
<tr>
<td>±1 μA</td>
<td>50 pA</td>
<td>1 pA</td>
<td>±(0.05 + 3E-10 + Vo x 1E-12)</td>
<td>±(0.05 + 1E-10 + Vo x 1E-12)</td>
<td>100 V</td>
</tr>
<tr>
<td>±10 μA</td>
<td>500 pA</td>
<td>10 pA</td>
<td>±(0.05 + 3E-9 + Vo x 1E-11)</td>
<td>±(0.04 + 2E-9 + Vo x 1E-11)</td>
<td>100 V</td>
</tr>
<tr>
<td>±100 μA</td>
<td>5 nA</td>
<td>100 pA</td>
<td>±(0.035 + 15E-9 + Vo x 1E-10)</td>
<td>±(0.03 + 2E-9 + Vo x 1E-10)</td>
<td>100 V</td>
</tr>
<tr>
<td>±1 mA</td>
<td>50 nA</td>
<td>1 nA</td>
<td>±(0.04 + 15E-8 + Vo x 1E-9)</td>
<td>±(0.03 + 6E-8 + Vo x 1E-9)</td>
<td>100 V</td>
</tr>
<tr>
<td>±10 mA</td>
<td>500 nA</td>
<td>10 nA</td>
<td>±(0.04 + 15E-7 + Vo x 1E-8)</td>
<td>±(0.03 + 2E-7 + Vo x 1E-8)</td>
<td>100 V</td>
</tr>
<tr>
<td>±100 mA</td>
<td>5 μA</td>
<td>100 nA</td>
<td>±(0.045 + 15E-6 + Vo x 1E-7)</td>
<td>±(0.04 + 6E-6 + Vo x 1E-7)</td>
<td>2</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy $^1$</th>
<th>Measure accuracy $^1$</th>
<th>Maximum current</th>
</tr>
</thead>
<tbody>
<tr>
<td>±0.5 V</td>
<td>25 μV</td>
<td>25 μV</td>
<td>±(0.018 + 0.15)</td>
<td>±(0.01 + 0.25)</td>
<td>100 mA</td>
</tr>
<tr>
<td>±2 V</td>
<td>100 μV</td>
<td>100 μV</td>
<td>±(0.018 + 0.4)</td>
<td>±(0.01 + 0.7)</td>
<td>100 mA</td>
</tr>
<tr>
<td>±5 V</td>
<td>250 μV</td>
<td>250 μV</td>
<td>±(0.018 + 0.75)</td>
<td>±(0.01 + 2)</td>
<td>100 mA</td>
</tr>
<tr>
<td>±20 V</td>
<td>1 mV</td>
<td>1 mV</td>
<td>±(0.018 + 3)</td>
<td>±(0.01 + 4)</td>
<td>100 mA</td>
</tr>
<tr>
<td>±40 V</td>
<td>2 mV</td>
<td>2 mV</td>
<td>±(0.018 + 6)</td>
<td>±(0.015 + 8)</td>
<td>2</td>
</tr>
<tr>
<td>±100 V</td>
<td>5 mV</td>
<td>5 mV</td>
<td>±(0.018 + 15)</td>
<td>±(0.02 + 20)</td>
<td>2</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Current range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy $^1$</th>
<th>Measure accuracy $^1$</th>
<th>Maximum voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>±1 nA</td>
<td>50 fA</td>
<td>50 fA</td>
<td>±(0.1 + 3E-13 + Vo x 1E-15)</td>
<td>±(0.25 + 3E-13 + Vo x 1E-15)</td>
<td>100 V</td>
</tr>
<tr>
<td>±10 nA</td>
<td>500 fA</td>
<td>500 fA</td>
<td>±(0.1 + 3E-12 + Vo x 1E-14)</td>
<td>±(0.25 + 2E-12 + Vo x 1E-14)</td>
<td>100 V</td>
</tr>
<tr>
<td>±100 nA</td>
<td>5 pA</td>
<td>5 pA</td>
<td>±(0.05 + 3E-11 + Vo x 1E-13)</td>
<td>±(0.1 + 2E-11 + Vo x 1E-13)</td>
<td>100 V</td>
</tr>
<tr>
<td>±1 μA</td>
<td>50 pA</td>
<td>50 pA</td>
<td>±(0.05 + 3E-10 + Vo x 1E-12)</td>
<td>±(0.1 + 2E-10 + Vo x 1E-12)</td>
<td>100 V</td>
</tr>
<tr>
<td>±10 μA</td>
<td>500 pA</td>
<td>500 pA</td>
<td>±(0.05 + 3E-9 + Vo x 1E-11)</td>
<td>±(0.05 + 2E-9 + Vo x 1E-11)</td>
<td>100 V</td>
</tr>
<tr>
<td>±100 μA</td>
<td>5 nA</td>
<td>5 nA</td>
<td>±(0.035 + 15E-9 + Vo x 1E-10)</td>
<td>±(0.05 + 2E-8 + Vo x 1E-10)</td>
<td>100 V</td>
</tr>
<tr>
<td>±1 mA</td>
<td>50 nA</td>
<td>50 nA</td>
<td>±(0.04 + 15E-8 + Vo x 1E-9)</td>
<td>±(0.04 + 2E-7 + Vo x 1E-9)</td>
<td>100 V</td>
</tr>
<tr>
<td>±10 mA</td>
<td>500 nA</td>
<td>500 nA</td>
<td>±(0.04 + 15E-7 + Vo x 1E-8)</td>
<td>±(0.04 + 2E-6 + Vo x 1E-8)</td>
<td>100 V</td>
</tr>
<tr>
<td>±100 mA</td>
<td>5 μA</td>
<td>5 μA</td>
<td>±(0.045 + 15E-6 + Vo x 1E-7)</td>
<td>±(0.1 + 2E-5 + Vo x 1E-7)</td>
<td>2</td>
</tr>
</tbody>
</table>

1. ±(% of reading value + fixed offset in A + proportional offset in A), Vo is the output voltage in V.  
2. 100 V (Io ≤ 20 mA), 40 V (20 mA < Io ≤ 50 mA), 20 V (50 mA < Io ≤ 100 mA), Io is the output current in A.
## Voltage source mode:

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 V</td>
<td>20 x Ic (W)</td>
</tr>
<tr>
<td>2 V</td>
<td>20 x Ic (W)</td>
</tr>
<tr>
<td>5 V</td>
<td>20 x Ic (W)</td>
</tr>
<tr>
<td>20 V</td>
<td>20 x Ic (W)</td>
</tr>
<tr>
<td>40 V</td>
<td>40 x Ic (W)</td>
</tr>
<tr>
<td>100 V</td>
<td>100 x Ic (W)</td>
</tr>
</tbody>
</table>

Where Ic is the current compliance setting.

## Current source mode:

<table>
<thead>
<tr>
<th>Voltage compliance</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vc ≤ 20</td>
<td>20 x Io (W)</td>
</tr>
<tr>
<td>20 &lt; Vc ≤ 40</td>
<td>40 x Io (W)</td>
</tr>
<tr>
<td>40 &lt; Vc ≤ 100</td>
<td>100 x Io (W)</td>
</tr>
</tbody>
</table>

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

### Voltage range, resolution, and accuracy

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Measure accuracy&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Maximum current</th>
</tr>
</thead>
<tbody>
<tr>
<td>±0.2 V</td>
<td>200 nV</td>
<td>200 nV</td>
<td>±(0.06 + 0.14 + Io x 0.05)</td>
<td>±(0.06 + 0.14 + Io x 0.05)</td>
<td>20 A</td>
</tr>
<tr>
<td>±2 V</td>
<td>2 µV</td>
<td>2 µV</td>
<td>±(0.06 + 0.6 + Io x 0.5)</td>
<td>±(0.06 + 0.6 + Io x 0.5)</td>
<td>20 A</td>
</tr>
<tr>
<td>±20 V</td>
<td>20 µV</td>
<td>20 µV</td>
<td>±(0.06 + 3 + Io x 5)</td>
<td>±(0.06 + 3 + Io x 5)</td>
<td>20 A</td>
</tr>
<tr>
<td>±40 V</td>
<td>40 µV</td>
<td>40 µV</td>
<td>±(0.06 + 3 + Io x 10)</td>
<td>±(0.06 + 3 + Io x 10)</td>
<td>1 A</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Current range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Measure accuracy&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Maximum voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 µA</td>
<td>10 pA</td>
<td>10 pA</td>
<td>±(0.06 + 2E-7 + Vo x 1E-10)</td>
<td>±(0.06 + 2E-7 + Vo x 1E-10)</td>
<td>40 V</td>
</tr>
<tr>
<td>±100 µA</td>
<td>100 pA</td>
<td>100 pA</td>
<td>±(0.06 + 2E-8 + Vo x 1E-9)</td>
<td>±(0.06 + 2E-8 + Vo x 1E-9)</td>
<td>40 V</td>
</tr>
<tr>
<td>±1 mA</td>
<td>1 nA</td>
<td>1 nA</td>
<td>±(0.06 + 2E-7 + Vo x 1E-9)</td>
<td>±(0.06 + 2E-7 + Vo x 1E-9)</td>
<td>40 V</td>
</tr>
<tr>
<td>±10 mA</td>
<td>10 nA</td>
<td>10 nA</td>
<td>±(0.06 + 2E-6 + Vo x 1E-7)</td>
<td>±(0.06 + 2E-6 + Vo x 1E-7)</td>
<td>40 V</td>
</tr>
<tr>
<td>±100 mA</td>
<td>100 nA</td>
<td>100 nA</td>
<td>±(0.06 + 2E-5 + Vo x 1E-6)</td>
<td>±(0.06 + 2E-5 + Vo x 1E-6)</td>
<td>40 V</td>
</tr>
<tr>
<td>±1 A</td>
<td>1 µA</td>
<td>1 µA</td>
<td>±(0.4 + 2E-4 + Vo x 1E-5)</td>
<td>±(0.4 + 2E-4 + Vo x 1E-5)</td>
<td>40 V</td>
</tr>
<tr>
<td>±20 A&lt;sup&gt;2&lt;/sup&gt;</td>
<td>20 µA</td>
<td>20 µA</td>
<td>±(0.4 + 2E-3 + Vo x 1E-4)</td>
<td>±(0.4 + 2E-3 + Vo x 1E-4)</td>
<td>20 V</td>
</tr>
</tbody>
</table>

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

### Power consumption

<table>
<thead>
<tr>
<th>Voltage source mode:</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage range</td>
<td>Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2 V</td>
<td>40 x Ic (W)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 V</td>
<td>40 x Ic (W)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 V</td>
<td>40 x Ic (W)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Current source mode:</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage compliance</td>
<td>Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vc ≤ 0.2</td>
<td>40 x Io (W)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2 &lt; Vc ≤ 2</td>
<td>40 x Io (W)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 &lt; Vc ≤ 40</td>
<td>40 x Io (W)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

### Current range expansion

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

Voltage range, resolution, and accuracy

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy(^1)</th>
<th>Measure accuracy(^1)</th>
<th>Maximum current</th>
</tr>
</thead>
<tbody>
<tr>
<td>±200 V</td>
<td>200 µV</td>
<td>200 µV</td>
<td>±(0.03 + 40)</td>
<td>±(0.03 + 40)</td>
<td>8 mA</td>
</tr>
<tr>
<td>±500 V</td>
<td>500 µV</td>
<td>500 µV</td>
<td>±(0.03 + 100)</td>
<td>±(0.03 + 100)</td>
<td>8 mA</td>
</tr>
<tr>
<td>±1500 V</td>
<td>1.5 mV</td>
<td>1.5 mV</td>
<td>±(0.03 + 300)</td>
<td>±(0.03 + 300)</td>
<td>8 mA</td>
</tr>
<tr>
<td>±3000 V</td>
<td>3 mV</td>
<td>3 mV</td>
<td>±(0.03 + 600)</td>
<td>±(0.03 + 600)</td>
<td>4 mA</td>
</tr>
</tbody>
</table>

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

Current range, resolution, and accuracy

<table>
<thead>
<tr>
<th>Current range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy(^1)</th>
<th>Measure accuracy(^1)</th>
<th>Maximum voltage</th>
<th>Minimum set current(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>±1 nA</td>
<td>10 fA</td>
<td>10 fA</td>
<td>±(0.05 + 6E-13 + Vo x 1E-13)</td>
<td>±(0.05 + 6E-13 + Vo x 1E-13)</td>
<td>3000 V</td>
<td>1 pA</td>
</tr>
<tr>
<td>±10 nA</td>
<td>100 fA</td>
<td>100 fA</td>
<td>±(0.05 + 25E-13 + Vo x 1E-13)</td>
<td>±(0.05 + 25E-13 + Vo x 1E-13)</td>
<td>3000 V</td>
<td>1 pA</td>
</tr>
<tr>
<td>±100 nA</td>
<td>100 fA</td>
<td>100 fA</td>
<td>±(0.05 + 25E-12 + Vo x 1E-13)</td>
<td>±(0.05 + 25E-12 + Vo x 1E-13)</td>
<td>3000 V</td>
<td>100 pA</td>
</tr>
<tr>
<td>±1 µA</td>
<td>1 pA</td>
<td>1 pA</td>
<td>±(0.05 + 1E-10 + Vo x 1E-13)</td>
<td>±(0.05 + 1E-10 + Vo x 1E-13)</td>
<td>3000 V</td>
<td>100 pA</td>
</tr>
<tr>
<td>±10 µA</td>
<td>10 pA</td>
<td>10 pA</td>
<td>±(0.04 + 2E-9 + Vo x 1E-11)</td>
<td>±(0.04 + 2E-9 + Vo x 1E-11)</td>
<td>3000 V</td>
<td>10 nA</td>
</tr>
<tr>
<td>±100 µA</td>
<td>100 pA</td>
<td>100 pA</td>
<td>±(0.03 + 3E-9 + Vo x 1E-11)</td>
<td>±(0.03 + 3E-9 + Vo x 1E-11)</td>
<td>3000 V</td>
<td>10 nA</td>
</tr>
<tr>
<td>±1 mA</td>
<td>1 nA</td>
<td>1 nA</td>
<td>±(0.03 + 6E-8 + Vo x 1E-10)</td>
<td>±(0.03 + 6E-8 + Vo x 1E-10)</td>
<td>3000 V</td>
<td>100 nA</td>
</tr>
<tr>
<td>±10 mA</td>
<td>10 nA</td>
<td>10 nA</td>
<td>±(0.03 + 2E-7 + Vo x 1E-9)</td>
<td>±(0.03 + 2E-7 + Vo x 1E-9)</td>
<td>1500 V</td>
<td>1 µA</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Current compliance</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ic ≤ 4 m</td>
<td>3000 x Ic + 12 (W)(^1)</td>
</tr>
<tr>
<td>4 m &lt; Ic ≤ 8 m</td>
<td>1500 x Ic + 12 (W)(^1)</td>
</tr>
</tbody>
</table>

Where Ic is the current compliance setting.

Current source mode:

<table>
<thead>
<tr>
<th>Voltage compliance</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vc ≤ 1500</td>
<td>1500 x Io (W) + 12 (^1)</td>
</tr>
<tr>
<td>1500 &lt; Vc ≤ 3000</td>
<td>3000 x Io (W) + 12 (^1)</td>
</tr>
</tbody>
</table>

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

1. The “+ 12” factor does not apply to the first installed HVSMU; it only applies to the second thru fifth installed HVSMUs.

HVSMU measurement and output range

HVSMU has 3 output range settings, which are “0 to +3 kV”, “-1500 V to +1500 V”, and “0 to -3 kV”. If more than one HVSMU is installed in the B1505A, all of the HVSMUs must use the same output range setting.
MCSMU Module Specifications

### Voltage range, resolution, and accuracy

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy (^1)</th>
<th>Measure accuracy (^1)</th>
<th>Maximum current</th>
</tr>
</thead>
<tbody>
<tr>
<td>±0.2 V</td>
<td>200 nV</td>
<td>200 nV</td>
<td>±(0.06 + 0.14)</td>
<td>±(0.06 + 0.14)</td>
<td>1 A</td>
</tr>
<tr>
<td>±2 V</td>
<td>2 μV</td>
<td>2 μV</td>
<td>±(0.06 + 0.6)</td>
<td>±(0.06 + 0.6)</td>
<td>1 A</td>
</tr>
<tr>
<td>±20 V</td>
<td>20 μV</td>
<td>20 μV</td>
<td>±(0.06 + 3)</td>
<td>±(0.06 + 3)</td>
<td>1 A</td>
</tr>
<tr>
<td>±40 V(^2)</td>
<td>40 μV</td>
<td>40 μV</td>
<td>±(0.06 + 3)</td>
<td>±(0.06 + 3)</td>
<td>1 A</td>
</tr>
</tbody>
</table>

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

2. Maximum output voltage is 30 V.

### Current range, resolution, and accuracy

<table>
<thead>
<tr>
<th>Current range</th>
<th>Force resolution</th>
<th>Measure resolution</th>
<th>Force accuracy (^1)</th>
<th>Measure accuracy (^1)</th>
<th>Maximum voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 μA</td>
<td>10 pA</td>
<td>10 pA</td>
<td>±(0.06 + 2E-9 + Vo x 1E-10)</td>
<td>±(0.06 + 2E-9 + Vo x 1E-10)</td>
<td>30 V</td>
</tr>
<tr>
<td>±100 μA</td>
<td>100 pA</td>
<td>100 pA</td>
<td>±(0.06 + 2E-8 + Vo x 1E-9)</td>
<td>±(0.06 + 2E-8 + Vo x 1E-9)</td>
<td>30 V</td>
</tr>
<tr>
<td>±1 mA</td>
<td>1 nA</td>
<td>1 nA</td>
<td>±(0.06 + 2E-7 + Vo x 1E-8)</td>
<td>±(0.06 + 2E-7 + Vo x 1E-8)</td>
<td>30 V</td>
</tr>
<tr>
<td>±10 mA</td>
<td>10 nA</td>
<td>10 nA</td>
<td>±(0.06 + 2E-6 + Vo x 1E-7)</td>
<td>±(0.06 + 2E-6 + Vo x 1E-7)</td>
<td>30 V</td>
</tr>
<tr>
<td>±100 mA</td>
<td>100 nA</td>
<td>100 nA</td>
<td>±(0.06 + 2E-5 + Vo x 1E-6)</td>
<td>±(0.06 + 2E-5 + Vo x 1E-6)</td>
<td>30 V</td>
</tr>
<tr>
<td>±1 A(^2)</td>
<td>1 μA</td>
<td>1 μA</td>
<td>±(0.4 + 2E-4 + Vo x 1E-5)</td>
<td>±(0.4 + 2E-4 + Vo x 1E-5)</td>
<td>30 V</td>
</tr>
</tbody>
</table>

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

2. Pulse mode only. The maximum value of the base current during pulsing is ±50 mA.

### Power consumption

**Voltage source mode:**

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 V</td>
<td>40 x Ic (W)</td>
</tr>
<tr>
<td>2 V</td>
<td>40 x Ic (W)</td>
</tr>
<tr>
<td>40 V</td>
<td>40 x Ic (W)</td>
</tr>
</tbody>
</table>

Where Ic is the current compliance setting.

**Current source mode:**

<table>
<thead>
<tr>
<th>Voltage compliance</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vc ≤ 0.2</td>
<td>40 x Io (W)</td>
</tr>
<tr>
<td>0.2 &lt; Vc ≤ 2</td>
<td>40 x Io (W)</td>
</tr>
<tr>
<td>2 &lt; Vc ≤ 40</td>
<td>40 x Io (W)</td>
</tr>
</tbody>
</table>

Where Vc is the voltage compliance setting and Io is output current.
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)
- ±1 pA 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 W to 20 W
- Resolution: 0.001 W
For MPSMU:
- Power: 0.001 W to 2 W
- Resolution: 0.001 W
For HCSMU:
- Power: 0.001 W to 40 W (DC)
- Resolution: 0.001 W
For MCSMU:
- Power: 0.001 W to 3 W (DC)
- 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: 100 µs
- Pulse period: 5 ms to 5 s
- Period ≥ delay + width + 2 ms (when delay + width ≤ 100 ms)
- Period ≥ delay + width + 10 ms (when delay + width > 100 ms)
- Pulse period resolution: 100 µs
- Pulse delay: 0 to (Period – width)

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 HVSMU:
- Pulse width: 500 µs to 2 s
- Pulse width resolution: 2 µs
- 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)

Supplemental Characteristics

Current compliance setting accuracy (for opposite polarity):

For HPSMU and MPSMU:
- For 1 pA to 10 nA ranges:
  - V/I setting accuracy ±12.5% 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 MCMU:
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 MCMU)
6 µs (HVSMU)

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

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

Current source output resistance:
≥ 10^13 Ω (HPSMU, MPSMU)
≥ 10^9 Ω (HCSMU, MCMU, ≤ 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 MCMU:
Sense: 10 Ω
Force: 1 Ω
(with Low Force)

Maximum allowable inductance:
For HPSMU and MPSMU:
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 HPSMU:
10 µA to 10 mA ranges: 12 nF
100 mA to 20 A ranges: 100 µF

For MCMU:
10 µA 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 (Filter ON for HPSMU and MPSMU)

Voltage source:
0.01% of V range (rms.)
Current source:
0.1% of I range (rms.)

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

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

Overshoot:
(Filter ON for all SMUs)
For HPSMU and MPSMU
Voltage source: 0.03% of V range
Current source: 1% of I range

For HCSMU and MCMU
(Filter ON)
Voltage/Current source:
10% of range

For HVSMU
Voltage source: 1 V (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 MCMU:
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 MCMU)
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:

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 mVrms to 250 mVrms
  - Resolution: 1 mVrms
  - Accuracy: ±(10.0% + 1 mVrms) at the measurement port of the MFCMU
    or ±(15.0% + 1 mVrms) at the measurement port of MFCMU cable (1.5 m or 3 m)

Output impedance: 50 Ω, typical

Signal level monitor:
- Range: 10 mVrms to 250 mVrms
  - Accuracy: ±(10.0% of reading + 1 mVrms) at the measurement port of the MFCMU
    or ±(15.0% + 1 mVrms) at the measurement port of MFCMU cable (1.5 m or 3 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):

<table>
<thead>
<tr>
<th>Impedance measurement range</th>
<th>Maximum DC bias current</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Ω</td>
<td>10 mA</td>
</tr>
<tr>
<td>100 Ω</td>
<td>10 mA</td>
</tr>
<tr>
<td>300 Ω</td>
<td>10 mA</td>
</tr>
<tr>
<td>1 kΩ</td>
<td>1 mA</td>
</tr>
<tr>
<td>3 kΩ</td>
<td>1 mA</td>
</tr>
<tr>
<td>10 kΩ</td>
<td>100 μA</td>
</tr>
<tr>
<td>30 kΩ</td>
<td>100 μA</td>
</tr>
<tr>
<td>100 kΩ</td>
<td>10 μA</td>
</tr>
<tr>
<td>300 kΩ</td>
<td>10 μA</td>
</tr>
</tbody>
</table>

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**: Impedance measurement value (Ω)

**D**:
- Measurement value of D
  - Impedance measurement range
  - Maximum DC bias current

**E**:
- ±E (%)
- ±E/100 (rad)

**C**:
- Accuracy
- ±E (%)
  - at D ≤ 0.1
  - ±E x √(1 + D²)/D (Ω)

**G**:
- Accuracy
- ±E x (1 + D)/100 (Ω)

**θ**:
- Accuracy
- ±E/100 (rad)

**Note:** Measurement accuracy is specified under the following conditions:
- Temperature: 23 ±5 °C
- Integration time: 1 PLC
<table>
<thead>
<tr>
<th>Parameters E_P, Y_O, Z_S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscillator level</td>
</tr>
<tr>
<td>1.5 m</td>
</tr>
<tr>
<td>3 m</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Parameters Y_O, Y_E, Z_S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>1 kHz ≤ f ≤ 200 kHz</td>
</tr>
<tr>
<td>200 kHz &lt; f ≤ 1 MHz</td>
</tr>
<tr>
<td>1 MHz &lt; f ≤ 2 MHz</td>
</tr>
<tr>
<td>2 MHz &lt; f</td>
</tr>
</tbody>
</table>

f is frequency in Hz. V_OSC is oscillator level in mV.

Example of calculated C/G measurement accuracy

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Measured capacitance</th>
<th>C accuracy 1</th>
<th>Measured conductance</th>
<th>G accuracy 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 MHz</td>
<td>1 pF</td>
<td>± 0.61%</td>
<td>≤ 3 µS</td>
<td>± 192 nS</td>
</tr>
<tr>
<td></td>
<td>10 pF</td>
<td>± 0.32%</td>
<td>≤ 31 µS</td>
<td>± 990 nS</td>
</tr>
<tr>
<td></td>
<td>100 pF</td>
<td>± 0.29%</td>
<td>≤ 314 µS</td>
<td>± 9 µS</td>
</tr>
<tr>
<td></td>
<td>1 nF</td>
<td>± 0.32%</td>
<td>≤ 3 mS</td>
<td>± 99 µS</td>
</tr>
<tr>
<td>1 MHz</td>
<td>1 pF</td>
<td>± 0.26%</td>
<td>≤ 628 nS</td>
<td>± 16 nS</td>
</tr>
<tr>
<td></td>
<td>10 pF</td>
<td>± 0.11%</td>
<td>≤ 6 µS</td>
<td>± 71 nS</td>
</tr>
<tr>
<td></td>
<td>100 pF</td>
<td>± 0.10%</td>
<td>≤ 63 µS</td>
<td>± 624 nS</td>
</tr>
<tr>
<td></td>
<td>1 nF</td>
<td>± 0.10%</td>
<td>≤ 628 µS</td>
<td>± 7 µS</td>
</tr>
<tr>
<td>100 kHz</td>
<td>10 pF</td>
<td>± 0.18%</td>
<td>≤ 628 nS</td>
<td>± 11 nS</td>
</tr>
<tr>
<td></td>
<td>100 pF</td>
<td>± 0.11%</td>
<td>≤ 6 µS</td>
<td>± 66 nS</td>
</tr>
<tr>
<td></td>
<td>1 nF</td>
<td>± 0.10%</td>
<td>≤ 63 µS</td>
<td>± 619 nS</td>
</tr>
<tr>
<td></td>
<td>10 nF</td>
<td>± 0.10%</td>
<td>≤ 628 µS</td>
<td>± 7 µS</td>
</tr>
<tr>
<td>10 kHz</td>
<td>100 pF</td>
<td>± 0.18%</td>
<td>≤ 628 nS</td>
<td>± 11 nS</td>
</tr>
<tr>
<td></td>
<td>1 nF</td>
<td>± 0.11%</td>
<td>≤ 6 µS</td>
<td>± 66 nS</td>
</tr>
<tr>
<td></td>
<td>10 nF</td>
<td>± 0.10%</td>
<td>≤ 63 µS</td>
<td>± 619 nS</td>
</tr>
<tr>
<td></td>
<td>100 nF</td>
<td>± 0.10%</td>
<td>≤ 628 µS</td>
<td>± 7 µS</td>
</tr>
<tr>
<td>1 kHz</td>
<td>100 pF</td>
<td>± 0.92%</td>
<td>≤ 63 nS</td>
<td>± 6 nS</td>
</tr>
<tr>
<td></td>
<td>1 nF</td>
<td>± 0.18%</td>
<td>≤ 628 nS</td>
<td>± 11 nS</td>
</tr>
<tr>
<td></td>
<td>10 nF</td>
<td>± 0.11%</td>
<td>≤ 6 µS</td>
<td>± 66 nS</td>
</tr>
<tr>
<td></td>
<td>100 nF</td>
<td>± 0.10%</td>
<td>≤ 63 µS</td>
<td>± 619 nS</td>
</tr>
</tbody>
</table>

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
Device Capacitance Selector (N1272A) specification

The N1272A simplifies 2 and 3 terminal device capacitance measurements by automatically creating the correct configuration of test resources (including adding any needed DC blocking capacitors and AC blocking resistors) for a specified capacitance measurement. To measure packaged device capacitance the N1273A Capacitance Test Fixture is also necessary. However, the N1272A can be used directly with a probe station to measure on-wafer device capacitances.

DC bias characteristics

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

Bypass capacitance in the capacitance selector

<table>
<thead>
<tr>
<th></th>
<th>Capacitance</th>
<th>Withstand voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain to source terminal</td>
<td>1 µF</td>
<td>±3000 V</td>
</tr>
<tr>
<td>Gate to source terminal</td>
<td>1 µF</td>
<td>±100 V</td>
</tr>
</tbody>
</table>

Measurement accuracy for 2-terminal device (Supplemental characteristics)

The accuracy of the supplemental characteristics is defined at the output terminals of the TO socket adapter in the N1273A Capacitance Test Fixture when the N1272A is connected to B1505A with the 1.5 m CMU cable and the N1273A system cable.

Output terminals for 2-terminal device

<table>
<thead>
<tr>
<th></th>
<th>Collector/drain</th>
<th>Emitter/source</th>
<th>Base/gate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector/drain</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Emitter/source</td>
<td>Low</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Base/gate</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Measurement accuracy for 3-terminal device (Supplemental characteristics)

Accuracy of this supplemental characteristics is defined at the output terminals at the TO socket adapter in the N1273A Capacitance Test Fixture when N1272A is connected to B1505A with CMU 1.5 m cable and to the N1273A with system cable.

Condition
AC level: 30 mV rms, Dx ≤ 0.1 (Dx: Measurement value of D)
DC path leakage (Supplemental characteristics)

HVSMU port input / Drain output
Offset: 100 pA
Leakage: Vo x 1E-13 (Vo: Output voltage)

HVSMU port input / Direct output
Offset: 100 pA
Leakage: Vo x 1E-13 (Vo: Output voltage)

MPSMU port input / Gate output
Offset: 50 pA
Leakage: Vo x 5E-13 (Vo: Output voltage)

Selector information

This information is provided for users not utilizing the N1273A capacitance test fixture but who wish to connect the selector outputs to other DUT interfaces such as a wafer prober.

Functionality
Selector capability

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

Output terminals:
HV Triaxial: 1 ea.
SHV terminals: 4 ea.
Gate/Base
Drain/Collector
Source/Emitter
AC/DC guard

Output terminals for 3-terminal device

<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Coss</th>
<th>Cds</th>
<th>Crss</th>
<th>Cgs</th>
<th>Ciss /Rg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector/drain</td>
<td>Force</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td></td>
<td>Sense</td>
<td>High</td>
<td>High</td>
<td>AC Guard</td>
<td>Low</td>
</tr>
<tr>
<td>Emitter/source</td>
<td>Force</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td></td>
<td>Sense</td>
<td>Low</td>
<td>Low</td>
<td>AC Guard</td>
<td>Low</td>
</tr>
<tr>
<td>Base/gate</td>
<td>High</td>
<td>Low</td>
<td>AC Guard</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
</tr>
</tbody>
</table>

Definition of 3-terminal device capacitances

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cgs</td>
<td>Capacitace between Base/Gate terminal and Emitter/Source terminal</td>
</tr>
<tr>
<td>Cds</td>
<td>Capacitace between Collector/Drain terminal and Emitter/Source terminal</td>
</tr>
<tr>
<td>Cgd</td>
<td>Capacitace between Base/Gate terminal and Collector/Drain terminal</td>
</tr>
<tr>
<td>Crss</td>
<td>Capacitace between Base/Gate terminal and Collector/Drain terminal</td>
</tr>
<tr>
<td>Ciss</td>
<td>Capacitace between Base/Gate terminal and Emitter/Source terminal and capacitance between Base/Gate terminal and Collector/Drain terminal</td>
</tr>
<tr>
<td>Coss</td>
<td>Capacitace between Collector/Drain terminal and Emitter/Source terminal and capacitance between Base/Gate terminal and Collector/Drain terminal</td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>Channel</th>
<th>Number</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU</td>
<td>6 (When using non-Kelvin connections)</td>
<td>Triaxial¹</td>
<td>Banana</td>
</tr>
<tr>
<td></td>
<td>3 (When using Kelvin connections)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UHV</td>
<td>1</td>
<td>UHV coaxial (High), SHV (Low)</td>
<td>UHV coaxial (High), SHV (Low)</td>
</tr>
<tr>
<td>Bias Tee</td>
<td>1</td>
<td>SHV x 2 (High, Low)</td>
<td>SHV x 2 (High, Low)</td>
</tr>
<tr>
<td>Gate control</td>
<td>1</td>
<td>Triaxial x 2 (Force, Sense)</td>
<td>Banana x 2 (High, Low)</td>
</tr>
<tr>
<td>Selector</td>
<td>1²</td>
<td>HV Triaxial x 1</td>
<td>Banana x 6 (High Force/Sense, Low Force/Sense, Guard, Chassis)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Triaxial x 2 (Force, Sense)</td>
<td></td>
</tr>
</tbody>
</table>

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, 100 mA DC.
Output Resistance: 0 Ω/10 Ω/100 Ω/1000 Ω (nominal value)
UHCU:

### Output peak power

<table>
<thead>
<tr>
<th>Current range</th>
<th>Peak power</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 500 A</td>
<td>7.5 kW</td>
</tr>
<tr>
<td>± 1500 A</td>
<td>22.5 kW</td>
</tr>
</tbody>
</table>

### Voltage range, resolution, and accuracy

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Setting resolution</th>
<th>Measure resolution</th>
<th>Setting accuracy</th>
<th>Measure accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 60 V</td>
<td>200 µV</td>
<td>100 µV</td>
<td>±(0.2 + 10)</td>
<td>±(0.2 + 10)</td>
</tr>
</tbody>
</table>

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

### Current range, resolution, and accuracy

<table>
<thead>
<tr>
<th>Current range</th>
<th>Setting resolution</th>
<th>Measure resolution</th>
<th>Setting accuracy</th>
<th>Measure accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 500 A</td>
<td>1 mA</td>
<td>500 µA</td>
<td>±(0.6 + 0.3 + 0.01*Vo)</td>
<td>±(0.6 + 0.3 + 0.01*Vo)</td>
</tr>
<tr>
<td>± 1500 A</td>
<td>4 mA</td>
<td>2 mA</td>
<td>±(0.8 + 0.9 + 0.02*Vo)</td>
<td>±(0.8 + 0.9 + 0.02*Vo)</td>
</tr>
</tbody>
</table>

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 1 ms 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

<table>
<thead>
<tr>
<th>Current range</th>
<th>Voltage pulse width</th>
<th>Current pulse width</th>
<th>Resolution</th>
<th>Pulse period</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 A</td>
<td>10 µs – 1 ms</td>
<td>10 µs – 1 ms</td>
<td>2 µs</td>
<td>Duty ≤ 0.4%</td>
</tr>
<tr>
<td>1500 A</td>
<td>10 µs – 500 µs</td>
<td>10 µs – 500 µs</td>
<td>2 µs</td>
<td>Duty ≤ 0.1%</td>
</tr>
</tbody>
</table>

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

Filter
- Filter can be used for UHC output in current mode at 500 A range.
Thermocouple input: 2 ea
- Two K-type thermocouple inputs
- Temperature range: -50 °C to 300 °C.

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

Supplemental characteristics

<table>
<thead>
<tr>
<th>UHCU Output resistance</th>
<th>Output range</th>
<th>Nominal value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>500 A</td>
<td>120 mΩ</td>
</tr>
<tr>
<td></td>
<td>1500 A</td>
<td>40 mΩ</td>
</tr>
</tbody>
</table>

Leakage
- Selector channel
  - HVSMU is applied at High Sense terminal: less than 1 nA
  - HPSMU/MPSMU is applied at High Force terminal: less than 10 nA
- UHVU channel
  - Less than 1 nA
- SMU channel
  - Less than 1 nA

Thermocouple reading accuracy

<table>
<thead>
<tr>
<th>Temperature range</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 °C ≤ T &lt; 100 °C</td>
<td>±2 °C</td>
</tr>
<tr>
<td>T ≥ 100 °C</td>
<td>±5 °C</td>
</tr>
<tr>
<td>T &lt; 0 °C</td>
<td>±5 °C</td>
</tr>
</tbody>
</table>

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, by contact resistance between the internal jumper cable and the DUT and by the DUT impedance.
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, HVSMU 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

<table>
<thead>
<tr>
<th>HVMCU</th>
<th>Output Peak Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage range</td>
<td>Peak power</td>
</tr>
<tr>
<td>± 2200 V</td>
<td>600 W</td>
</tr>
<tr>
<td>± 1500 V</td>
<td>900 W</td>
</tr>
</tbody>
</table>

| Voltage range, resolution, and accuracy
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage range</td>
<td>Setting resolution</td>
<td>Measure resolution</td>
<td>Setting accuracy&lt;sup&gt;1,2,3&lt;/sup&gt; ±(% + V)</td>
</tr>
<tr>
<td>± 2200 V</td>
<td>3 mV</td>
<td>3 mV</td>
<td>±(5 + 20)</td>
</tr>
<tr>
<td>± 1500 V</td>
<td>1.5 mV</td>
<td>3 mV</td>
<td>±(5 + 20)</td>
</tr>
</tbody>
</table>

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<sup>1,2</sup> |
| --- | --- | --- |
| Current range | Measure resolution | Measure accuracy<sup>1</sup> ±(% + 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.
2. Applicable condition: 20 averaging samples
Other Terminals / Indicators

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

Supplemental characteristics

HVMCU Charged Capacitance: 0.22 μF

HVMCU Pulse width and resolution

<table>
<thead>
<tr>
<th>Output range</th>
<th>Pulse width</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500 V / 2.5 A</td>
<td>10 μs – 100 μs</td>
<td>2 μs</td>
</tr>
<tr>
<td>2200 V / 1.1 A</td>
<td>10 μs – 100 μs</td>
<td>2 μs</td>
</tr>
<tr>
<td>2200 V / 110 mA</td>
<td>10 μs – 1 ms</td>
<td>2 μs</td>
</tr>
</tbody>
</table>

HVMCU Measurement and output range

The HVMC’s 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, by contact resistance between the internal jumper cable and the DUT and by the DUT impedance.

Leakage

Selector output

HVSMU: less than 80 pA
UHV (Ultra High Voltage) Expander (N1268A) Specifications

Specifications

| Voltage range, resolution, and accuracy¹ |  |  |
|-----------------------------------------|------------------|------------------|------------------|------------------|
| Voltage range                           | Force resolution | Measure resolution | Setting accuracy¹,² | Measure accuracy² |
| ± 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 accuracy¹ |  |  |
|------------------------------------------|------------------|------------------|------------------|------------------|
| Current range                            | Measure resolution | Measure accuracy² |
| ± 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 mA³                                | 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.

<table>
<thead>
<tr>
<th>UHV Pulse width and resolution</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Output range</td>
<td>Pulse width</td>
<td>Resolution</td>
</tr>
<tr>
<td>100 mA</td>
<td>100 µs to 1 ms</td>
<td>2 µs</td>
</tr>
<tr>
<td>≤ 10 mA</td>
<td>100 µs to 2 s</td>
<td>2 µs</td>
</tr>
</tbody>
</table>

Pulse Period
Min: 10 ms
Max: 5 s

Output Terminals
High : UHV coaxial
Low : SHV

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

Supplemental characteristics

<table>
<thead>
<tr>
<th>UHVU Output resistance</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Output range</td>
<td>Nominal value</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>10000 Ω</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1000 Ω</td>
<td></td>
</tr>
</tbody>
</table>

Other AC characteristics

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

UHV measurement and output range
Gate charge measurement specifications

The B1505A can perform gate charge characterization for Nch MOSFETs and IGBTs. Both packaged devices and on-wafer devices are supported. The following table shows the available solutions and their required accessories (which depend on device type and current level). Temperature dependent measurements using a Thermostream or the Thermal plate are not supported.

**Measurement parameter**

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

**Hardware configuration and measurement/setting parameters**

<table>
<thead>
<tr>
<th>Hardware configuration</th>
<th>Package solution</th>
<th>On-wafer solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>High voltage module</td>
<td>B1513B/C HVSMU</td>
<td></td>
</tr>
<tr>
<td>Max voltage range</td>
<td>3000 V</td>
<td></td>
</tr>
<tr>
<td>High current module</td>
<td>B1512A HCSMU</td>
<td>N1265A-500</td>
</tr>
<tr>
<td></td>
<td>N1265A-1500A</td>
<td></td>
</tr>
<tr>
<td>Max current range</td>
<td>20 A</td>
<td>500 A</td>
</tr>
<tr>
<td></td>
<td>1500 A</td>
<td>20 A</td>
</tr>
<tr>
<td></td>
<td>500 A</td>
<td>1500 A</td>
</tr>
<tr>
<td>Gate control module</td>
<td>B1514A MCSMU</td>
<td></td>
</tr>
<tr>
<td>Ireg control module</td>
<td>B1514A MCSMU</td>
<td></td>
</tr>
<tr>
<td>Fixture/selector</td>
<td>N1259A</td>
<td>N1265A</td>
</tr>
<tr>
<td></td>
<td>N1258A</td>
<td>N1265A</td>
</tr>
<tr>
<td>Adapter/selector</td>
<td>N1259AU-014</td>
<td>N1265AU-014</td>
</tr>
<tr>
<td></td>
<td>N1274A</td>
<td>N1275A</td>
</tr>
</tbody>
</table>

**Measurement parameter**

Qg: 1 nC to 100 µC  
Min resolution: 10 pC  
Vgs (vce) @ high voltage: 0 V to +3000 V  
Voltage/sampling resolution: 3 mV / 6 us  
Vds (vce) @ high current: Not Support  
Voltage/sampling resolution: -60 V to 60 V  
Not Support  
-60 V to 60 V  
-60 V to 60 V  
Id (ic) maximum rated current: 20 A  
350 A  
500 A  
20 A  
350 A  
500 A  
Current/sampling resolution: 2 mA / 2 µs  
Vgs (vge): -30 V to +30 V  
Voltage/sampling resolution: 40 µV / 2 µs  
Ig: 10 nA to 1 A  
Current/sampling resolution: 10 pA / 2 µs
### Hardware configuration and measurement/setting parameters (continued)

<table>
<thead>
<tr>
<th>Setting parameters</th>
<th>Package solution</th>
<th>On-wafer solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vds (vce) @ high voltage</td>
<td>0 V to +3000 V</td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>3 mV</td>
<td></td>
</tr>
<tr>
<td>Vds(vce) @ high current</td>
<td>-20 to 20 V¹</td>
<td>-60 to 60 V</td>
</tr>
<tr>
<td>Resolution</td>
<td>20 µV</td>
<td>100 µV</td>
</tr>
<tr>
<td>Id max</td>
<td>20 A¹</td>
<td>450 A¹</td>
</tr>
<tr>
<td>Gate drive vgs(vge)</td>
<td>-30 to +30 V</td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>40 µV</td>
<td></td>
</tr>
<tr>
<td>Gate control current ig</td>
<td>1 µA to 1 A</td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1 µA</td>
<td></td>
</tr>
<tr>
<td>Current regulator control voltage</td>
<td>-30 to +30 V</td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>40 µV</td>
<td></td>
</tr>
<tr>
<td>On time</td>
<td>50 - 950 µs</td>
<td>50 - 950 µs</td>
</tr>
<tr>
<td>Resolution</td>
<td>2 µs</td>
<td></td>
</tr>
</tbody>
</table>

1. The maximum current will be reduced by the series resistance of the current source, residual resistance in the measurement path, and the DUT impedance.
2. The gate charge measurement adapter also has a maximum current limit of 500 A.

### Target devices:

Nch MOSFETs and IGBTs in TO package, in modules and on-wafer

Note that Pch MOSFETs are not supported.
N1267A High Voltage Source Monitor Unit / High Current Source Monitor Unit Fast Switch

Features
The N1267A supports fast switching between the HVSMU and HCSMU to enable the measurement of the Gallium Nitride current collapse effect.

The N1267A switch requires one MCSMU in the B1505A mainframe for control. The gate of the DUT (Device Under Test) can be driven by either an MCSMU or an HCSMU.

Note #1: The N1267A can only be used with the B1513B or B1503C HVSMU; it cannot be used with the B1513A HVSMU.
Note #2: The N1267A does not support the two HCSMU 40 A configuration.
Note #3: The N1267A does not support the N1265A test fixture/current expander.

Specifications
Input terminals:
- HVSMU port, 1 ea (HV triaxial)
- HCSMU port, 1 ea (Force: BNC, Sense: Triaxial)
- MCSMU port, 1 ea (Force/Sense: Triaxial)
- GND port, 1 ea (Triaxial)

Output terminals: High (HV triaxial), Low (BNC)
- Maximum current: 20 A
- Maximum voltage: 3000 V

Measurement mode
GaN Current collapse (Dynamic I-V) measure mode
  1. I-V time domain measurement
  2. I-V trace measurement

Static characteristics mode
  1. Id-Vds, Vf-If measurement
  2. Id(off)-Vds, Vr-Ir measurement

Source and Measure Range
**GaN current collapse measure mode**

To make the GaN current collapse measurement, the HVSMU first applies high voltage stress to the DUT when the DUT is in the OFF-state. Next the HVSMU performs voltage measurement and the HCSMU performs I-V measurement to monitor the ON-state characteristics of the DUT. When making the ON-state measurement, the HVSMU is measuring voltage and both the HVSMU and HCSMU are used to measure the total current.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>+1 V - +3000 V</td>
<td>4 mA (V &gt; 1500 V), 8 mA (V ≤ 1500 V)</td>
</tr>
</tbody>
</table>

1 Setting value must be the ON state voltage plus 1 V or more.

**HCSMU source setting range for ON-state**

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 V - ±40 V</td>
<td>Maximum 20 A pulse (V ≤ 20V) / 1 A DC, Minimum 20 mA</td>
</tr>
</tbody>
</table>

2 Voltage actually applied to the device under test (DUT) is the setting value minus the voltage drop of the switch.

3 Sum of HCSMU output current and HVSMU output current flow into DUT.

Minimum voltage measurement resolution for OFF-state: 200 µV
Minimum current measurement resolution for ON-state: 100 nA
Minimum transition time (OFF to ON): 20 µs
Duration setting for OFF-state: 10 ms - 655.35 s
Sampling rate: 2 µs to 12 µs for current, 6 µs for voltage
Minimum ON state duration: 50 µs

**Static characteristics mode**

The following information applies to measurement of the DUT ON-state static characteristics. The N1267A ensures that the DUT is in the ON-state during these measurements. The HVSMU applies 0 V with 1 µA compliance and measures Vds or Vf. At the same time, the HCSMU is also performing an I-V measurement. The Id or If is determined by adding together the total current measured by both the HCSMU and the HVSMU.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 V - ±40 V</td>
<td>Maximum 20 A pulse (V ≤ 20V) / 1 A DC, Minimum 20 mA</td>
</tr>
</tbody>
</table>

4 Offset error for the Id-Vds, If-Vf measurement is typical 1 µA

Minimum voltage measurement resolution: 200 µV
Minimum current measurement resolution: 10 pA

The following information applies to measurement of the DUT OFF-state static characteristics. The N1267A ensures that the DUT is in the OFF-state during these measurements. The HCSMU applies 0 V. At the same time, the HVSMU performs I-V measurement and measures Vds or Vr. The Id(Off) or Ir is determined by adding together the total current measured by both the HCSMU and the HVSMU.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 V - +3000 V</td>
<td>Maximum 4 mA (V &gt; 1500 V), 8 mA (V ≤ 1500 V), Minimum 10 µA</td>
</tr>
</tbody>
</table>

5 Leak error for the Idss, Ir-Vr measurement is typical 2 nA.
N1258A module selector

Specifications
Input terminals:
- HPSMU force port, 1 ea., (Triaxial)
- HPSMU sense port, 1 ea., (Triaxial)
- HCSMU force port, 1 ea. (BNC)
- HCSMU sense port, 1 ea. (Triaxial)
- HVSMU port, 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 15 pin)

Protection:
- HPSMU, GNDU, HCSMU Low Force terminal

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)
  - 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, 2 ea.
  - Force, sense (Triaxial)
- HCSMU port, 2 ea.
  - Force (BNC), sense (Triaxial)
- HVSMU port, 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
  - 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 (Force, Sense)
  - 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:
3000 V Vdc
Maximum current for terminals:
- For Collector/Drain Force and Emitter/Source Force: 39 A (DC), 500 A (Pulse)
- For others: 1 A (DC), 20 A (Pulse)

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

N1259A-014 Gate Charge Socket Adapter

Purpose
To make gate charge measurements with the N1259A.

Required Hardware
- N1259A test fixture, 1 ea.
- N1259A-300 Module selector, 1 ea.
- B1512A HCSMU, 1 ea.
- B1513B/C HVSMU, 1 ea.
- B1514A MCSMU, 2 ea.

Specifications
Number of terminals: Sockets, 8 ea.
(Ø4 mm jack (banana))
Maximum voltage at terminals:
- For Gate DUT High: 30 V
- For Gate DUT Low: 10 V
- For selector force High: 3000 V
- For selector force Low: 10 V
- For selector sense High: 3000 V
- For selector sense Low: 10 V
- For SMU control High: 30 V
- For SMU control Low: 10 V
Maximum current for terminals:
- For Gate DUT High: 1 A
- For Gate DUT Low: 1 A
- For selector force: 500 A
- For selector sense: 20 mA
- For SMU control: 1 A

Furnished accessories
- Test lead (red), short, 2 ea.
- Test lead (black), short, 2 ea.
- Test lead (red), long, 4 ea.
- Test lead (black), long, 4 ea.

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:
- 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 port¹, 1 ea.
  - Force, sense (Triaxial)
- HCSMU port, 1 ea.
  - Force (BNC), sense (Triaxial)
- HVSMU port², 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.

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%

Supplemental characteristics
Leakage current: 10 pA at 200 V

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 (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: ±3000 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

N1265A–010 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 Force
    39 A (DC), 500 A (Pulse)
  For sense
    1 A (DC), 20 A (Pulse)

N1265A–011 Universal Socket Module

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

N1254A–524 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-014 Gate Charge Socket Adapter

Purpose
To make gate charge measurements with the N1265A.

Required Hardware
- N1265A UHC expander, 1 ea.
- B1513B/C HVSMU, 1 ea.
- B1514A MCSMU, 2 ea.

Specifications
Number of terminals: Sockets, 8 ea. (Ø 4 mm jack (banana))
Maximum voltage at terminals:
  - For Gate DUT High: 30 V
  - For Gate DUT Low: 10 V
  - For selector force High: 3000 V
  - For selector force Low: 10 V
  - For selector sense High: 3000 V
  - For selector sense Low: 10 V
  - For SMU control High: 30 V
  - For SMU control Low: 10 V
Maximum current for terminals:
  - For Gate DUT High: 1 A
  - For Gate DUT Low: 1 A
  - For selector force: 500 A
  - For selector sense: 20 mA
  - For SMU control: 1 A

Furnished accessories
- Ultra high current banana test lead, 2 ea.
- Test lead (red), short, 2 ea.
- Test lead (black), short, 2 ea.
- Test lead (red), long, 2 ea.
- Test lead (black), long, 2 ea.

N1265A-035 Universal R-Box for N1265A

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

N1265A-040 10 kV Ultra High Voltage Gate Protection Adapter

Specifications
Input: 4 ea. (Ø 4 mm plug (banana))
  - High (Force, Sense)
  - Low (Force, Sense)
Output terminals: 2 ea. (Ø 4 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

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

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

N1271A Thermal test enclosure

Operation Condition
Temperature: +5 °C to 30 °C
Humidity: 20% to 70% RH, Non-condensing
Accuracy specifications degrade by a factor of 3x versus measurements made without the thermal enclosure.
(Supplemental characteristics)
Common furnished accessories:
  - 200 mm high current cable, 2 ea.
  - 300 mm high current cable, 2 ea.
  - 200 mm normal cable, 6 ea.
  - 300 mm normal cable, 4 ea.
  - Banana pin adapter, 14 ea.
  - Mini alligator clip, 10 ea.
  - Large clip, 4 ea.

N1271A-001 Thermal plate compatible enclosure for N1259A/N1265A

Purpose
Supports placement of the inTEST Thermal Plate within the test fixtures (N1259A/N1265A) to enable temperature dependency measurements up to 250 °C.

The inTest thermal plate with GP-IB control option is necessary for automated thermal measurement.
N1271A-002 Thermostream compatible enclosure for N1265A (3 kV IV)

**Purpose**
To enable thermal testing by creating an interface between the N1265A and an inTEST Thermostream. The enclosure supports fully automated IV temperature measurements from -50 °C. to +220 °C.

**Specifications**
- Accuracy specifications degrade by a factor of 3x versus measurements made without the thermal enclosure.
- **Number of channels**
  - SMU: 6 (When using non-Kelvin connections), 3 (When using Kelvin connections)
  - Gate: 1
  - Selector output: 1

N1271A-005 Thermostream compatible enclosure for N1265A (3 kV IV, CV & 10kV)

**Purpose**
To enable thermal testing by creating an interface between the N1265A and an inTEST Thermostream. The enclosure supports fully automated IV and CV measurements up to 3 kV, and IV measurements up to 10 kV at temperature ranging from -50 °C. to +220 °C.

**Specifications**
- Accuracy specifications degrade by a factor of 3x versus measurements made without the thermal enclosure.
- **Number of channels**
  - SMU: 4 (When using non-Kelvin connections), 2 (When using Kelvin connections)
  - Gate: 1
  - Gate with protection resistor for UHV: 1
  - Selector output: 1
  - UHV: 1
  - Capacitance: 1

N1273A Capacitance Test Fixture

**Purpose**
To enable packaged device capacitance testing in conjunction with the N1272A Device Capacitance Selector.

**Specifications**
- Input terminals:
  - Collector/Drain (SHV) 3000 V 20 mA
  - Base/Gate (SHV) 100 V 100 mA
  - Emitter/Source (SHV) 100 V 120 mA
  - AC/DC Guard (SHV) 3000 V 100 mA
  - Interlock port, 1 ea.
  - Earth terminal
- High voltage indicator: LED turns red when a SMU output is over 42V.
- Maximum voltage for SHV port: 3 kV
- **Furnished accessories**
  - System cable between selector and test fixture (SHV x 4, Interlock, Earth), 1 ea.
  - 3-pin Inline Package Socket Module, 1 ea.
  - 200 mm normal cable, 4 ea.
  - Banana pin adapter, 4 ea.
  - Mini alligator clip, 4 ea.
  - M5 8 mm Torx pan head screw, 2 ea.

N1273A-011 Universal Socket Module

**Specifications**
- **Number of terminals**: Sockets, 6 ea. (O4 mm jack (banana))
- Maximum voltage for terminals: 3 kV
- **Furnished accessories**
  - Test wire for thermal test (2 m)
  - Lag connectors x 14
  - Screws

N1273A-013 Curve Tracer Test Adapter Socket Module

**Specifications**
- **Number of terminals**: Sockets, 6 ea. (O4 mm jack (banana))
- (Sense terminals of this adapter are open. Only force terminals are connected to output terminals of N1273A.)
- Maximum voltage for terminals: 3 kV 100 mA
- *A test adapter for Tektronix curve tracers (370B/371B) can be connected to this interface.*

N1274A On-Wafer Gate Charge measurement adapter/selector for 20 A/3 kV

**Purpose**
To enable gate charge measurements on-wafer using the HCSMU (20 A) and HVSMU (3 kV).

**Required Hardware**
The following modules and accessories are required in addition to the N1274A.
- N1258A Module selector
- B1512A HCSMU
- B1513B/B1513C HVSMU
- B1514A MCSMU x 2
- Current control MOSFET/IGBT

**Specifications**
- Input terminals (Connector) [Maximum voltage/current]:
  - Current control MCSMU Force (Triaxial) (±30 V/1 A)
  - Current control MCSMU Sense (Triaxial) (±30 V/1 A)
  - DUT Gate control MCSMU/HVSMU Force (Triaxial) (±30 V/1 A)
  - DUT Gate control MCSMU/HVSMU Sense (Triaxial) (±30 V/1 A)
Specifications

Input terminals (Connector) [Maximum voltage/current]:
- Current control MCSMU Force (Triaxial) [±30 V/1 A]
- Current control MCSMU Sense (Triaxial) [±30 V/1 A]
- High Force from N1254A Opt524 (banana) [±60 V/500 A]
- Low Sense from N1254A Opt524 (BNC) [±10 V/1 A]
- Output terminal (Connector) [Maximum voltage/current]:
  - High Force to DUT (banana) [±60 V/500 A]
  - Low Sense to DUT (banana) [±10 V/1 A]
  - Gate (BNC) [±40 V/20 A]

Furnished cables
- Ultra high current banana to banana cable (30 cm), 1 ea.
- BNC cable (30 cm), 1 ea.

Keysight EasyEXPERT group+ Software

Keysight EasyEXPERT group+ GUI based characterization software is available either on the B1505A’s embedded Windows 7 platform with 15-inch touch screen or on your PC to accelerate the characterization tasks. It supports efficient and repeatable device characterization in the entire characterization process from measurement setup and execution to analysis and data management either interactive manual operation or automation across a wafer in conjunction with a semiautomatic wafer prober. EasyEXPERT group+ makes it easy to perform complex device characterization immediately with the hundreds of ready-to-use measurements (application tests) furnished, and allows you the option of storing test condition and measurement data automatically after each measurement in a unique built-in database (workspace), ensuring that valuable information is not lost and that measurements can be repeated at a later date. Finally, EasyEXPERT has built-in analysis capabilities and a graphical programming environment that facilitate the development of complex testing algorithms.

Key features
- Multiple measurement modes for quick setup and measurement execution (application test, classic test, tracer test, quick test and oscilloscope view)
- Graphical display, automated analysis capabilities and data generation to Excel and image for analysis and reporting
- Built-in database (workspace) records test data automatically and simplifies the data management without numerous data files
- GUI-based self-test, self-calibration and diagnostics menu for hardware maintenance
- EasyEXPERT group+ remote control function supports the remote measurement execution of application tests that are created on GUI interactively, via the LAN interface
- Data back capability and various data protection feature for shared usage by multiple users
- Characterization environment is available either on mainframe (embedded Windows 7) or on user’s PC as a personal and portable analyzer environment. EasyEXPERT group+ can be installed on any PC as many as needed without additional charge.

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Application Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power MOSFET (Si, GaN)</td>
<td>Id-Vds, Rds-Id, Id-Vgs, Vth, Cgs, Cds, Cgd, Current collapse, Breakdown, QSCV, etc.</td>
</tr>
<tr>
<td>IGBT</td>
<td>Ic-Vce, Ic-Vge, Vth, Cge, Cce, Cgc, Breakdown, etc.</td>
</tr>
<tr>
<td>SiC</td>
<td>Id-Vds, Rds-Id, Id-Vgs, Vth, Cgs, Cds, Current collapse, Breakdown, QSCV, etc.</td>
</tr>
<tr>
<td>Power BJT</td>
<td>Ic-Vce, Vce(sat), Ic-Vcbo, Ic-VCEO, Ie-Vbeo, etc.</td>
</tr>
<tr>
<td>Power Diode</td>
<td>I-F, I-Vr, C-J-Vr, etc.</td>
</tr>
<tr>
<td>Capacitor</td>
<td>C-V, C-f, C-t, leak-V, Breakdown, TDDB, etc.</td>
</tr>
<tr>
<td>And more</td>
<td>And more</td>
</tr>
</tbody>
</table>

N1275A On-Wafer Gate Charge measurement adapter for N1265A

Purpose
To enable on-wafer gate charge measurements with the UHCU (500 A) and HVSMU (3 kV)

Note: Unlike the N1274A, switching between IV and Qg requires manual connection changes.

Required Hardware
The following modules and accessories are required in addition to the N1274A.
- N1265A Ultra High Current Expander
- N1254A-524 Prober System Cable
- B1513B/B1513C HVSMU
- B1514A MCSMU x 2
- Current control MOSFET/IGBT
Application library

EasyEXPERT group+ comes with over 40 application tests conveniently organized by device type, application, and technology. You can easily edit and customize the furnished application tests to fit your specific needs. Application tests are provided for the following categories; they are subject to change without notice.

Measurement modes and functions

Operation mode:
Application test mode
The application test mode provides application oriented point-and-click test setup and execution. An application test can be selected from the library by device type and desired measurement, and then executed after modifying the default input parameters as needed.

Classic test mode
The classic test mode provides function oriented test setup and execution with the same look, feel, and terminology of the 4155/4156 user interface. In addition, it improves the 4155/4156 user interface by taking full advantage of EasyEXPERT group+’s GUI features.

Tracer test mode
The tracer test mode offers intuitive and interactive sweep control using a rotary knob similar to a curve tracer. Just like an analog curve tracer, you can sweep in only one direction (useful for R&D device analysis) or in both directions (useful in failure analysis applications). Test setup created in tracer test mode can be seamlessly and instantaneously transferred to classic test mode for further detailed measurement and analysis.

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

Oscilloscope view
The oscilloscope view (available in tracer test mode) displays measured current or voltage data versus time. The pulsed measurement waveforms appear in a separate window for easy verification of the measurement timings. This function is useful for verifying waveform timings and debugging pulsed measurements. The following modules are supported in this view: HCSMU, MCSMU, HVSMU, UHCU, HVMCU, and UHVU. The oscilloscope view can display the pulsed waveform timings at any (user specified) sweep step of the sweep output.

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: 2 μs

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

Quick test mode
A GUI-based Quick Test mode enables you to perform test sequencing without programming. You can select, copy, rearrange and cut-and-paste any application tests with a few simple mouse clicks. Once you have selected and arranged your tests, simply click on the measurement button to begin running an automated test sequence.

Measurement modes:
The Keysight B1505A supports the following measurement modes:
- IV measurement
- Spot
- Staircase sweep
- Pulsed spot
- Pulsed sweep
- Staircase sweep with pulsed bias
- Sampling
- Multi-channel sweep
- Multi-channel pulsed sweep
- List sweep
- Linear search
- Binary search
- 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.

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

Recommended GPIB I/F

<table>
<thead>
<tr>
<th>Interface</th>
<th>B1505A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keysight</td>
<td></td>
</tr>
<tr>
<td>82350B PCI</td>
<td>✔</td>
</tr>
<tr>
<td>82357A USB</td>
<td>✔</td>
</tr>
<tr>
<td>82357B USB</td>
<td>✔</td>
</tr>
<tr>
<td>National Instrument</td>
<td>GPIB-USB-HS</td>
</tr>
</tbody>
</table>

1. An 82350B 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.
Delay time:
0 to 65.535 s, 100 μs resolution
0 to 655.35 s, 100 μs resolution
(CV (AC level) sweep, C-f sweep)
Step delay time:
0 to 1 s, 100 μs resolution
Step output trigger delay time:
0 to (delay time) s, 100 μs resolution
Step measurement trigger delay time:
0 to 65.535 s, 100 μs resolution

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

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 clipboard or mass storage device. (File type: bmp, gif, png, emf)
Scale:
Auto scale and zoom
Marker:
Marker to min/max, interpolation, direct marker, and marker skip
Cursor:
Direct cursor
Line:
Two lines, normal mode, grad mode, tangent mode, and regression mode.
Overlay graph comparison:
Graphical plots can be overlaid.

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

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

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

Analysis functions
Up to 20 user-defined analysis functions can be defined using arithmetic expressions. Measured data, 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.

1. In case of some supplemental characteristics, humidity range is defined as 20% to 50% RH
Physical constants
Keyboard constants are stored in memory as follows:

- **q**: Electron charge, $1.602177 \times 10^{-19}$ C
- **k**: Boltzmann’s constant, $1.380658 \times 10^{-23}$
- **ε (ε)**: Dielectric constant of vacuum, $8.854188 \times 10^{-12}$

Engineering units
The following unit symbols are also available on the keyboard:

- **a** ($10^{-18}$), **f** ($10^{-15}$), **p** ($10^{-12}$), **n** ($10^{-9}$), **μ or μ** ($10^{-6}$), **m** ($10^{-3}$), **k** ($10^3$), **M** ($10^6$), **G** ($10^9$), **T** ($10^{12}$), **P** ($10^{15}$)

Data management

Workspace (Built-in database)
EasyEXPERT group+ supports the built-in database called “workspace”. Workspaces are created on a HDD, and they enable to manage and access all the measurement related data without handling numerous files. Every workspace supports the following features:

- Access to measurement capabilities and data stored in the workspace.
- Save/Import/Export measurement settings and data (application library, measurement settings, my favorite setup, and measurement data)
- Recall the setup for measurement reproduction and data for analysis

Data auto record/ auto export
EasyEXPERT group+ has the ability to automatically store the measurement setup and data within a workspace. It can also export measurement data in real time, in a variety of formats such as Excel (xls).

Import/export files
File type:
Keysight EasyEXPERT format, XML-SS format, CSV format

Data Protection
EasyEXPERT group+ has various options to protect important data as follows.

- Password protection (workspace, test definition and my favorite)
- User level access control (engineer mode/operator mode)

Workspace back-up and portability
EasyEXPERT group+ has the ability to import/export a workspace for back-up and portability.

General specification

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

Humidity range
- 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: 65 VA
- N1259A-300: 35 VA
- N1265A: 400 VA
- N1266A: 60 VA
- N1268A: 350 VA
- N1272A: 70 VA

Acoustic Noise Emission
- $L_{pa} < 65$ dB
- $L_{wa}$: 66 dB (Operating mode)
- $L_{wa}$: 73 dB (Worst case mode)

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

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

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

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

Certification
CE, cCSAus, RCM

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 resistor 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:  
202 mm W x 56 mm H x 175 mm D

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

N1269A Ultra High Voltage Connection Adapter:  
134 mm W x 56 mm H x 150 mm D

N1271A-001 Thermal plate compatible enclosure for N1259A/N1265A:  
500 mm W 190 mm H 365 mm D

N1271A-002 Thermostream compatible enclosure for N1265A (3kV IV):  
330 mm W 340 mm H 430 mm D (Outer dimension)
284 mm W 150 mm H 195 mm D (Inner dimension)

N1271A-005 Thermostream compatible enclosure for N1265A (3kV IV, CV & 10kV):  
330 mm W 340 mm H 430 mm D (Outer dimension)
275 mm W 150 mm H 195 mm D (Inner dimension)

N1272A:  
420 mm W x 75 mm H x 575 mm D

N1273A:  
340 mm W x 200 mm H x 345 mm D

N1274A:  
330 mm W x 90 mm H x 410 mm D

N1275A:  
116 mm W x 78 mm H x 125 mm D

N1268A: 18 kg
N1269A: 0.4 kg
N1271A-001: 4.5 kg
N1271A-002: 10.5 kg
N1271A-005: 10.5 kg
N1272A: 9.4 kg
N1273A: 0.7 kg
N1274A: 3.2 kg
N1275A: 0.4 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.
Product CD-ROM, 1 ea.
Software entitlement document for EasyEXPERT group+
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 1.5 m, 1 ea.
Interlock cable, 1 ea.
N1272A : Digital I/O cable 1.5m, 1 ea
HVSMU cable 1.5 m, 1 ea.

Weight
B1505A (empty): 20 kg
B1511B: 1.1 kg
B1510A: 2.0 kg
B1512A: 2.1 kg
B1513C: 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: 0.8 kg
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-014 Gate Charge socket adapter
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-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-014 Gate Charge socket adapter
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
N1271A Thermal Test Enclosure
N1271A-001 Thermal plate compatible enclosure for N1259A/N1265A
N1271A-002 Thermostream compatible enclosure for N1265A (3kV IV)
N1271A-005 Thermostream compatible enclosure for N1265A (3kV, CV & 10kV)
N1272A Device Capacitance Selector
N1273A Capacitance Test Fixture
N1273A-011 Universal Socket Module
N1273A-013 Curve Tracer Test Adapter Socket Module
N1274A On-Wafer Gate Charge measurement adapter/selector for 20 A/3 kV
N1275A On-Wafer Gate Charge measurement adapter for N1265A

**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(f)
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 250 mm
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, Triaxial 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
## B1505A accessories (continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1254A-524</td>
<td>Ultra High Current Prober System Cable</td>
</tr>
<tr>
<td>N1254A-525</td>
<td>SHV Cable Assy 1.5m - SHV Plug To Open-end</td>
</tr>
<tr>
<td>N1254A-526</td>
<td>Ultra High Current Cable, 2m, No Connectors At Either End</td>
</tr>
<tr>
<td>N1254A-527</td>
<td>PTFE Standoff, Jack, 4 ea.</td>
</tr>
<tr>
<td>N1254A-528</td>
<td>PTFE Standoff With Banana Plug, 4 ea.</td>
</tr>
<tr>
<td>N1254A-556</td>
<td>Test Leads and Connection Kit for Capacitance Test, 30 cm, 4 ea.</td>
</tr>
<tr>
<td>N1254A-557</td>
<td>Test Leads And Connection Kit For Thermal Test with N1271A</td>
</tr>
<tr>
<td>N1254A-558</td>
<td>SHV Cable 3m</td>
</tr>
<tr>
<td>N1258A</td>
<td>Module selector</td>
</tr>
<tr>
<td>N1260A</td>
<td>High voltage bias-tee</td>
</tr>
<tr>
<td>N1261A</td>
<td>Protection adapter</td>
</tr>
<tr>
<td>N1262A</td>
<td>Resistor box</td>
</tr>
<tr>
<td>N1262A-020</td>
<td>Universal R-Box, Triaxial</td>
</tr>
<tr>
<td>N1262A-021</td>
<td>Universal R-Box, HV Triaxial to SHV</td>
</tr>
<tr>
<td>N1262A-023</td>
<td>Universal R-Box for Ultra High Voltage</td>
</tr>
<tr>
<td>N1262A-036</td>
<td>50 Ohm Termination Adapter</td>
</tr>
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</table>

## SMU cables/accessories

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>16493S-001</td>
<td>HCSMU cable (1.5 m)</td>
</tr>
<tr>
<td>16493S-002</td>
<td>HCSMU cable (3 m)</td>
</tr>
<tr>
<td>16493S-010</td>
<td>HCSMU Kelvin adapter</td>
</tr>
<tr>
<td>16493S-011</td>
<td>HCSMU non-Kelvin adapter</td>
</tr>
<tr>
<td>16493S-020</td>
<td>Dual HCSMU Kelvin combination adapter</td>
</tr>
<tr>
<td>16493S-021</td>
<td>Dual HCSMU combination adapter</td>
</tr>
<tr>
<td>16493T-001</td>
<td>High voltage triaxial cable (1.5 m)</td>
</tr>
<tr>
<td>16493T-002</td>
<td>High voltage triaxial cable (3 m)</td>
</tr>
<tr>
<td>16493U-001</td>
<td>High current BNC cable (1.5 m)</td>
</tr>
<tr>
<td>16493U-002</td>
<td>High current BNC cable (3 m)</td>
</tr>
<tr>
<td>16494A-001</td>
<td>Triaxial cable (1.5 m)</td>
</tr>
<tr>
<td>16494A-002</td>
<td>Triaxial cable (3 m)</td>
</tr>
<tr>
<td>16493K-001</td>
<td>Kelvin triaxial cable (1.5 m)</td>
</tr>
<tr>
<td>16493K-002</td>
<td>Kelvin triaxial cable (3 m)</td>
</tr>
<tr>
<td>16493V-001</td>
<td>10 kV Ultra High Voltage Cable, 1.5 m</td>
</tr>
<tr>
<td>16493V-002</td>
<td>10 kV Ultra High Voltage Cable, 3 m</td>
</tr>
<tr>
<td>N1269A</td>
<td>Ultra High Voltage Connection Adapter</td>
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</table>

## CMU accessories

<table>
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<tr>
<th>Code</th>
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<tbody>
<tr>
<td>N1300A-001</td>
<td>CMU cable (1.5 m)</td>
</tr>
<tr>
<td>N1300A-002</td>
<td>CMU cable (3 m)</td>
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## Other accessories

<table>
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<tr>
<th>Code</th>
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<tbody>
<tr>
<td>16493G-001</td>
<td>Digital I/O cable (1.5 m)</td>
</tr>
<tr>
<td>16493G-002</td>
<td>Digital I/O cable (3 m)</td>
</tr>
<tr>
<td>16493J-001</td>
<td>Interlock cable (1.5 m)</td>
</tr>
<tr>
<td>16493J-002</td>
<td>Interlock cable (3 m)</td>
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<tr>
<td>16493L-001</td>
<td>GNDU cable (1.5 m)</td>
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<tr>
<td>16493L-002</td>
<td>GNDU cable (3 m)</td>
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## Retrofit and upgrade kits

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>B1505AU</td>
<td>Upgrade kit for B1505A</td>
</tr>
<tr>
<td>B1505AU-001</td>
<td>Conversion kit from B1500A to B1505A</td>
</tr>
<tr>
<td>B1505AU-010</td>
<td>High power source monitor unit (B1510A)</td>
</tr>
<tr>
<td>B1505AU-11B</td>
<td>Medium power source monitor unit (B1511B)</td>
</tr>
<tr>
<td>B1505AU-012</td>
<td>High current source monitor unit (B1512A)</td>
</tr>
<tr>
<td>B1505AU-13C</td>
<td>High voltage source monitor unit (B1513C)</td>
</tr>
<tr>
<td>B1505AU-014</td>
<td>Medium current source monitor unit (B1514A)</td>
</tr>
<tr>
<td>B1505AU-020</td>
<td>Multi frequency capacitance measurement unit (B1520A)</td>
</tr>
<tr>
<td>B1505AU-SWS</td>
<td>EasyEXPERT group+ Extension support and subscription</td>
</tr>
<tr>
<td>N1259AU</td>
<td>Upgrade kit for N1259A</td>
</tr>
<tr>
<td>N1265AU</td>
<td>Upgrade kit for N1265A</td>
</tr>
</tbody>
</table>

## Package solution

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1505AP</td>
<td>Pre-configured Power Device Analyzer/Curve Tracer (B1505A w/ modules/fixture)</td>
</tr>
<tr>
<td>B1505AP-H20</td>
<td>3 kV / 20 A / Fixture Pack</td>
</tr>
<tr>
<td>B1505AP-H21</td>
<td>3 kV / 20 A / C-V / Fixture Pack</td>
</tr>
<tr>
<td>B1505AP-H50</td>
<td>3 kV / 500 A / Fixture Pack</td>
</tr>
<tr>
<td>B1505AP-H51</td>
<td>3 kV / 500 A / C-V / Fixture Pack</td>
</tr>
<tr>
<td>B1505AP-H70</td>
<td>3 kV / 1500 A / Fixture Pack</td>
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<tr>
<td>B1505AP-H71</td>
<td>3 kV / 1500 A / C-V / Fixture Pack</td>
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<tr>
<td>B1505AP-U50</td>
<td>10 kV / 500 A / Fixture Pack</td>
</tr>
<tr>
<td>B1505AP-U70</td>
<td>10 kV / 1500 A / Fixture Pack</td>
</tr>
</tbody>
</table>
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http://www.keysight.com/find/emt_product_registration
Register your products to get up-to-date product information and find warranty information.

Keysight Services
www.keysight.com/find/service
Keysight Services can help from acquisition to renewal across your instrument’s lifecycle. Our comprehensive service offerings—one-stop calibration, repair, asset management, technology refresh, consulting, training and more—helps you improve product quality and lower costs.

Keysight Assurance Plans
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