Agilent B1500A
Semiconductor Device Analyzer

Data Sheet

Introduction

The Agilent B1500A Semiconductor Device Analyzer is the only parameter analyzer with the versatility to provide a wide range of device characterization capabilities, uncompromised measurement reliability, and efficient and repeatable measurement. It supports all state-of-the-art measurements (IV, CV, and fast pulsed IV), giving it the ability to cover the electrical characterization and evaluation of devices, materials, semiconductors, active/passive components, or virtually any other type of electronic device. In addition, the B1500A's modular architecture with ten available slots allows you to add or upgrade measurement modules if your measurement needs change over time.

Agilent EasyEXPERT, resident GUI-based software running on the B1500A's embedded Windows 7 platform, supports efficient and repeatable device characterization ranging from interactive manual measurements all the way up to test automation across a wafer in conjunction with a semiautomatic wafer prober. With hundreds of ready-to-use measurements (application tests) furnished at no charge, EasyEXPERT makes it easy to perform complex device characterization immediately. The EasyEXPERT GUI can be accessed using the B1500A's 15-inch touch screen, as well as through an optional USB keyboard and mouse. EasyEXPERT also allows you the option of storing test condition and measurement data automatically after each measurement in unique workspaces, 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.

Basic Features

Measurement capabilities:

Current versus voltage (IV) measurement

- Accurate and precise measurement ranges of 0.1 fA - 1 A and 0.5 µV - 200 V
- Spot and sweep measurement
- Time sampling measurements (100 µs minimum sampling rate)
- Pulsed measurement with minimum pulse widths of 50 µs using the MCSMU or 500 µs using the HPSMU, MPSMU, or HRSMU
- The ASU (atto-sense and switch unit) can be used with the MPSMU, or HRSMU to provide 0.1 fA measurement resolution and SMU/AUX path switching
- Two analog-to-digital converter choices (high-resolution ADC or high-speed ADC) available for each SMU type (HPSMU, MPSMU and HRSMU)

Capacitance measurement

- Multi-frequency AC impedance measurement supports CV (capacitance versus voltage), C-t (capacitance versus time) and C-f (capacitance versus frequency) measurement
- Capacitance measurement frequency range of 1 kHz to 5 MHz
- Quasi-Static Capacitance-Voltage (QS-CV) measurement with leakage current compensation
- Automated switching between IV and CV measurements using either the optional SCUU (SMU CMU unify unit) and GSWU (guard switch unit) or a pair of ASUs

Pulsed IV/Fast IV/Transient IV measurement

- Provides high speed and high sensitivity measurement capability for ultra-fast IV (current-voltage), pulsed IV and transient IV measurements, including NBTI/PBTI and RTN (Random Telegraph Signal Noise) measurements
- Arbitrary waveform generation with 10 ns programmable resolution
- Simultaneous high-speed voltage/current measurement (200 MSa/s, 5 ns sampling rate)
- SMU technology supports pulsed IV measurement without load line effects

Pulse Generation

- Up to ±40 V voltage pulsing and arbitrary waveform generation for non-volatile memory evaluation
- Single channel two-level and three level pulsing capability

B1500A platform:

- 15-inch touch screen supports all capabilities of the intuitive GUI for convenient device characterization
- Configurable and upgradable measurement modules with 10 slots per mainframe
- GPIB, USB and LAN interfaces

EasyEXPERT software:

- GUI based operation on an embedded Windows 7 OS
- Furnished with over 300 ready-to-use application tests
- Graphical display, analysis and printing capabilities facilitate data analysis and report generation
- Individualized workspace environments and automated test data recording simplify data management
- Curve tracer like knob control of measurement parameters supports interactive real-time device characterization and automatic data recording feature
- Oscilloscope view (available for the MCSMU) supports pulsed voltage and current waveform viewing for quick and easy timing verification
- Quick test mode supports test sequencing without programming
- Classic test mode provides the familiar look, feel and terminology of the legacy Agilent 4155/56 parameter analyzer
- Efficient data back-up of individual workspace environments (includes device definitions, measurement settings, my favorite setups, measurement data and customized application libraries).
- GUI-based control of the Agilent B2200A, B2201A and E5250A switching matrices
- EasyEXPERT remote control function supports the remote execution of application tests via the LAN interface
- Self-test, self-calibration, diagnostics

Specification conditions

The measurement and output accuracy are specified at the rear panel connector terminals when referenced to the Zero Check terminal. The B1530A WGFMU measurement and output accuracy are specified at the output terminal of the RSU. Accuracy is specified under the following conditions:

1. Temperature: 23 °C ±5 °C
2. Humidity: 20 % to 60 %
3. After 40 minute warm-up followed by self-calibration
4. Ambient temperature change less than ±1 °C after self-calibration execution, not applicable for MFCMU and WGFMU
5. Measurement made within one hour after self-calibration execution, not applicable for MFCMU and WGFMU
6. Calibration period: 1 year
7. SMU integration time setting:
   1 PLC (1 nA to 1A range, voltage range)
   20 PLC (100 pA range)
   50 PLC (1 pA to 10 pA range)
   Averaging of high-speed ADC:
   128 samples per 1 PLC
8. SMU filter: ON (for HPSMU, MPSMU and HRSMU)
9. SMU measurement terminal connection: Kelvin connection
10. WGFMU load capacitance: 25 pF or less

Note: This document lists specifications and supplemental characteristics for the B1500A and its associated modules. The specifications are the standards against which the B1500A and its associated modules are tested. When the B1500A and any of its associated modules are shipped from the factory, they meet the specifications. The "supplemental" characteristics described in the following specifications are not warranted, but provide useful information about the functions and performance of the instrument.

Note: Agilent Technologies is responsible for removing, installing, and replacing the B1500A modules. Contact your nearest Agilent Technologies to install and calibrate the B1500A modules.

B1500A Specifications

Supported plug-in modules

The B1500A supports ten slots for plug-in modules.

Module Name	Slots occupied	Key Features
B1510A High power source/monitor unit (HPSMU)	2	- Range up to 200 V/1 A with 4-quadrant operation - Minimum measurement resolution 10 fA/2 µV - Spot, sweep and more measurement capabilities
B1511B Medium power source/monitor unit (MPSMU)	1	- Range up to 100 V/0.1 A with 4-quadrant operation - Minimum measurement resolution 10 fA/0.5 µV - Optional ASU (atto-sense and switch unit) for 100 aA resolution and IV/CV switching capability - Sampling (time domain) measure ment from 100 µs - Pulse measurement from 500 µs pulse width
B1517A High resolution source/monitor unit (HRSMU)	1	- Range up to 100 V/0.1 A with 4-quadrant operation - Minimum measurement resolution 1 fA/0.5 µV - Optional ASU (atto-sense and switch unit) for 100 aA resolution and IV/CV switching capability - Accurate Quasi-Static Capacitance Voltage (QS-CV) measurement with leakage current compensation
B1514A 50 µs Pulse medium current source/monitor unit (50 µs Pulse MCSMU)	1	- Range up to 30 V/1 A pulsed (0.1 A DC) with 4-quadrant operation - Pulse measurement from 50 µs pulse width with 2 µs resolution - Oscilloscope view (voltage/current waveform viewer) is supported - Minimum measurement resolution 10 pA/0.2 µV
B1520A Multi-frequency capacitance measurement unit (MFCMU)	1	- AC impedance measurement (C-V, C-f, C-t) - 1 kHz to 5 MHz frequency range with minimum 1 mHz frequency resolution - 25 V built-in DC bias and 100 V DC bias with SMU and SCUU (SMU CMU Unify Unit) - Easy and fast yet accurate IV and CV automated connection change by SCUU
B1525A High voltage semiconductor pulse generator unit (HV-SPGU)	1	- High voltage output up to ±40 V applicable for non-volatile memory testing - Two-level and three-level pulse capability by single channel - Flexible arbitrary waveform generation with 10 ns resolution (arbitrary linear waveform generation function) - Two channels per module
B1530A Waveform generator / fast measurement unit (WGFMU)	1	-Ultra-fast IV measurement capability for the pulsed IV and transient IV such as NBTI/PBTI, RTN, etc. -Waveform generation with 10 ns programmable resolution -Simultaneous high-speed IV measurement capability (200 MSa/s, 5 ns sampling rate) -10V peak-to-peak output -No load line effect accurate pulsed IV measurement by dynamic SMU technology

Maximum module configuration

The total power consumption of all SMU modules cannot exceed 84 W.
Under this rule, the B1500A can contain any combination of the following

SMUs:

- Up to 10 MPSMUs
- Up to 10 HRSMUs
- Up to 4 HPSMUs
- Up to 4 MCSMUs

Only one single-slot MFCMU can be installed per B1500A mainframe. Up to five single-slot HV-SPGUs can be installed per mainframe. Up to five single-slot WGFMUs can be installed per mainframe.

When one or more WGFMU modules are installed in the B1500A mainframe, the following table applies. Multiply the values given below by the number of installed modules of that type and add the products together. The sum of the products must be less than or equal to 59 for the configuration to be permissible.

MPSMU	2
HRSMU	2
HPSMU	14
MCSMU	5
MFCMU	7
HV-SPGU	12
WGFMU	10

Maximum voltage between common and ground

≤ ±42 V

Ground unit (GNDU) specification

The GNDU is furnished standard with the B1500A mainframe.

Output voltage: 0 V ±100 µV

Maximum sink current: ±4.2 A

Output terminal/connection:
Triaxial connector, Kelvin (remote sensing)

GNDU supplemental characteristics

Load capacitance: 1 µF

Cable resistance:

For $I_S \leq 1.6$ A: force line R < 1 Ω

For 1.6 A < $I_S \leq 2.0$ A: force line R < 0.7 Ω

For 2.0 A < $I_S \leq 4.2$ A: force line R < 0.35 Ω

For all cases: sense line R ≤ 10 Ω

Where I_S is the current being sunk by the GNDU.

MPSMU and HRSMU module specifications

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

Voltage range	Force resolution	Measure resolution	Force accuracy[1]	Measure accuracy[1]	Maximum current
±0.5 V	25 µV	0.5 µV	±(0.018 % + 150 µV)	±(0.01 % + 120 µV)	100 mA
±2 V	100 µV	2 µV	±(0.018 % + 400 µV)	±(0.01 % + 140 µV)	100 mA
±5 V	250 µV	5 µV	±(0.018 % + 750 µV)	±(0.009 % + 250 µV)	100 mA
±20 V	1 mV	20 µV	±(0.018 % + 3 mV)	±(0.009 % + 900 µV)	100 mA
±40 V	2 mV	40 µV	±(0.018 % + 6 mV)	±(0.01 % + 1 mV)	[2]
±100 V	5 mV	100 µV	±(0.018 % + 15 mV)	±(0.012 % + 2.5 mV)	[2]

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

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

SMU type		Current range	Force resolution	Measure resolution[1,2]	Force accuracy[3]	Measure accuracy[3]	Maximum voltage
MPSMU w/ ASU	HRSMU w/ ASU	±1 pA	1 fA	100 aA	±(0.9 %+15 fA)	±(0.9 %+12 fA)	100 V
	HRSMU	±10 pA	5 fA	400 aA (with ASU) 1 fA (HRSMU)	±(0.46 %+30 fA+10 aA x Vo)	±(0.46 %+15 fA+10 aA x Vo)	100 V
		±100 pA	5 fA	500 aA (with ASU) 2 fA (HRSMU)	±(0.3 %+100 fA+100 aA x Vo)	±(0.3 %+30 fA+100 aA x Vo)	100 V
MPSMU		±1 nA	50 fA	10 fA	±(0.1 %+300 fA+1 fA x Vo)	±(0.1 %+200 fA+1 fA x Vo)	100 V
		±10 nA	500 fA	10 fA	±(0.1 %+3 pA+10 fA x Vo)	±(0.1 %+1 pA+10 fA x Vo)	100 V
		±100 nA	5 pA	100 fA	±(0.05 %+30 pA+100 fA x Vo)	±(0.05 %+20 pA+100 fA x Vo)	100 V
		±1 µA	50 pA	1 pA	±(0.05 %+300 pA+1 pA x Vo)	±(0.05 %+100 pA+1 pA x Vo)	100 V
		±10 µA	500 pA	10 pA	±(0.05 %+3 nA+10 pA x Vo)	±(0.04 %+2 nA+10 pA x Vo)	100 V
		±100 µA	5 nA	100 pA	±(0.035 %+15 nA+100 pA x Vo)	±(0.03 %+3 nA+100 pA x Vo)	100 V
		±1 mA	50 nA	1 nA	±(0.04 %+150 nA+1 nA x Vo)	±(0.03 %+60 nA+1 nA x Vo)	100 V
		±10 mA	500 nA	10 nA	±(0.04 %+1.5 µA+10 nA x Vo)	±(0.03 %+200 nA+10 nA x Vo)	100 V
		±100 mA	5 µA	100 nA	±(0.045 %+15 µA+100 nA x Vo)	±(0.04 %+6 µA+100 nA x Vo)	[4]

1. Specified measurement resolution is limited by fundamental noise limits. Minimum displayed resolution is 1 aA at 1 pA range by 6 digits.
2. Measurements made in the lower ranges can be greatly impacted by vibrations and shocks. These specifications assume an environment free of these factors.
3. ± (% of read value + offset current (fixed part determined by the output/measurement range + proportional part that is multiplied by Vo))
4. 100 V (Io ≤ 20 mA), 40 V (20 mA < Io ≤ 50 mA), 20 V (50 mA < Io ≤ 100 mA), Io is the output current in Amps.

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

Voltage range	Force resolution	Measure resolution	Force accuracy[1]	Measure accuracy[1]	Maximum current
±0.5 V	25 µV	25 µV	±(0.018 % + 150 µV)	±(0.01 % + 250 µV)	100 mA
±2 V	100 µV	100 µV	±(0.018 % + 400 µV)	±(0.01 % + 700 µV)	100 mA
±5 V	250 µV	250 µV	±(0.018 % + 750 µV)	±(0.01 % + 2 mV)	100 mA
±20 V	1 mV	1 mV	±(0.018 % + 3 mV)	±(0.01 % + 4 mV)	100 mA
±40 V	2 mV	2 mV	±(0.018 % + 6 mV)	±(0.015 % + 8 mV)	[2]
±100 V	5 mV	5 mV	±(0.018 % + 15 mV)	±(0.02 % + 20 mV)	[2]

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

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

SMU type		Current range	Force resolution	Measure resolution[1,2]	Force accuracy[3]	Measure accuracy[3]	Maximum voltage
MPSMU w/ASU	HRSMU w/ASU	±1 pA	1 fA	100 aA	±(0.9 %+15 fA)	±(1.8 %+12 fA)	100 V
	HRSMU	±10 pA	5 fA	1 fA	±(0.46 %+30 fA+10 aA x Vo)	±(0.5 %+15 fA+10 aA x Vo)	100 V
		±100 pA	5 fA	5 fA	±(0.3 %+100 fA+100 aA x Vo)	±(0.5 %+40 fA+100 aA x Vo)	100 V
MPSMU		±1 nA	50 fA	50 fA	±(0.1 %+300 fA+1 fA x Vo)	±(0.25 %+300 fA+1 fA x Vo)	100 V
		±10 nA	500 fA	500 fA	±(0.1 %+3 pA+10 fA x Vo)	±(0.25 %+2 pA+10 fA x Vo)	100 V
		±100 nA	5 pA	5 pA	±(0.05 %+30 pA+100 fA x Vo)	±(0.1 %+20 pA+100 fA x Vo)	100 V
		±1 µA	50 pA	50 pA	±(0.05 %+300 pA+1 pA x Vo)	±(0.1 %+200 pA+1 pA x Vo)	100 V
		±10 µA	500 pA	500 pA	±(0.05 %+3 nA+10 pA x Vo)	±(0.05 %+2 nA+10 pA x Vo)	100 V
		±100 µA	5 nA	5 nA	±(0.035 %+15 nA+100 pA x Vo)	±(0.05 %+20 nA+100 pA x Vo)	100 V
		±1 mA	50 nA	50 nA	±(0.04 %+150 nA+1 nA x Vo)	±(0.04 %+200 nA+1 nA x Vo)	100 V
		±10 mA	500 nA	500 nA	±(0.04 %+1.5 µA+10 nA x Vo)	±(0.04 %+2 µA+10 nA x Vo)	100 V
		±100 mA	5 µA	5 µA	±(0.045 %+15 µA+100 nA x Vo)	±(0.1 %+20 µA+100 nA x Vo)	[4]

1. Specified measurement resolution is limited by fundamental noise limits. Minimum displayed resolution is 1 aA at 1 pA range by 6 digits.
2. Measurements made in the lower ranges can be greatly impacted by vibrations and shocks. These specifications assume an environment free of these factors.
3. ± (% of read value + offset current (fixed part determined by the output/measurement range + proportional part that is multiplied by Vo))
4. 100 V (Io ≤ 20 mA), 40 V (20 mA < Io ≤ 50 mA), 20 V (50 mA < Io ≤ 100 mA), Io is the output current in Amps.

Power consumption

Voltage source mode

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

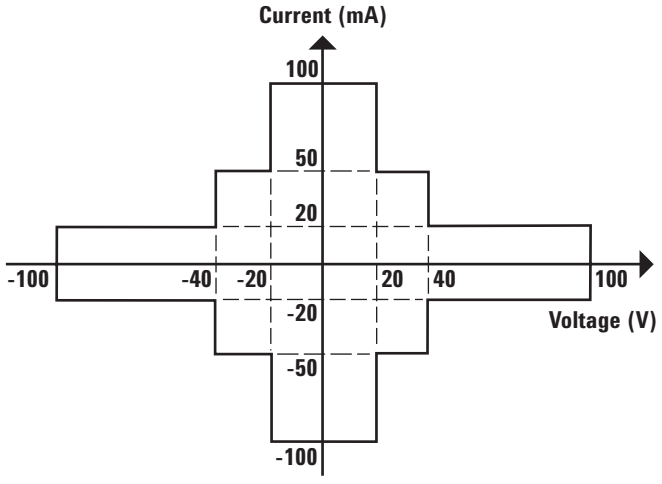
Where Ic is the current compliance setting.

Current source mode

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

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

MPSMU and HRSMU measurement and output range



HPSMU module specifications

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

Voltage range	Force resolution	Measure resolution	Force accuracy[1]	Measure accuracy[1]	Maximum current
±2 V	100 µV	2 µV	±(0.018 % + 400 µV)	±(0.01 % + 140 µV)	1 A
±20 V	1 mV	20 µV	±(0.018 % + 3 mV)	±(0.009 % + 900 µV)	1 A
±40 V	2 mV	40 µV	±(0.018 % + 6 mV)	±(0.01 % + 1 mV)	500 mA
±100 V	5 mV	100 µV	±(0.018 % + 15 mV)	±(0.012 % + 2.5 mV)	125 mA
±200 V	10 mV	200 µV	±(0.018 % + 30 mV)	±(0.014 % + 2.8 mV)	50 mA

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

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

Current range	Force resolution	Measure resolution[1]	Force accuracy[2]	Measure accuracy[2]	Maximum voltage
±1 nA	50 fA	10 fA	±(0.1 %+300 fA+1 fA x Vo)	±(0.1 %+200 fA+1 fA x Vo)	200 V
±10 nA	500 fA	10 fA	±(0.1 %+3 pA+10 fA x Vo)	±(0.1 %+1 pA+10 fA x Vo)	200 V
±100 nA	5 pA	100 fA	±(0.05 %+30 pA+100 fA x Vo)	±(0.05 %+20 pA+100 fA x Vo)	200 V
±1 µA	50 pA	1 pA	±(0.05 %+300 pA+1 pA x Vo)	±(0.05 %+100 pA+1 pA x Vo)	200 V
±10 µA	500 pA	10 pA	±(0.05 %+3 nA+10 pA x Vo)	±(0.04 %+2 nA+10 pA x Vo)	200 V
±100 µA	5 nA	100 pA	±(0.035 %+15 nA+100 pA x Vo)	±(0.03 %+3 nA+100 pA x Vo)	200 V
±1 mA	50 nA	1 nA	±(0.04 %+150 nA+1 nA x Vo)	±(0.03 %+60 nA+1 nA x Vo)	200 V
±10 mA	500 nA	10 nA	±(0.04 %+1.5 µA+10 nA x Vo)	±(0.03 %+200 nA+10 nA x Vo)	200 V
±100 mA	5 µA	100 nA	±(0.045 %+15 µA+100 nA x Vo)	±(0.04 %+6 µA+100 nA x Vo)	[3]
±1 A	50 µA	1 µA	±(0.4 %+300 µA+1 µA x Vo)	±(0.4 %+150 µA+1 µA x Vo)	[3]

1. Specified measurement resolution is limited by fundamental noise limits.
2. ± (% of read value + offset current (fixed part determined by the output/measurement range + proportional part that is multiplied by Vo))
3. 200 V (Io ≤ 50 mA), 100 V (50 mA < Io ≤ 125 mA), 40 V (125 mA < Io ≤ 500 mA), 20 V (500 mA < Io ≤ 1 A), Io is the output current in Amps.

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

Voltage range	Force resolution	Measure resolution	Force accuracy[1]	Measure accuracy[1]	Maximum current
±2 V	100 µV	100 µV	±(0.018 % + 400 µV)	±(0.01 % + 700 µV)	1 A
±20 V	1 mV	1 mV	±(0.018 % + 3 mV)	±(0.01 % + 4 mV)	1 A
±40 V	2 mV	2 mV	±(0.018 % + 6 mV)	±(0.015 % + 8 mV)	500 mA
±100 V	5 mV	5 mV	±(0.018 % + 15 mV)	±(0.02 % + 20 mV)	125 mA
±200 V	10 mV	10 mV	±(0.018 % + 30 mV)	±(0.035 % + 40 mV)	50 mA

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

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

Current range	Force resolution	Measure resolution[1]	Force accuracy[2]	Measure accuracy[2]	Maximum voltage
±1 nA	50 fA	50 fA	±(0.1 %+300 fA+1 fA x Vo)	±(0.25 %+300 fA+1 fA x Vo)	200 V
±10 nA	500 fA	500 fA	±(0.1 %+3 pA+10 fA x Vo)	±(0.25 %+2 pA+10 fA x Vo)	200 V
±100 nA	5 pA	5 pA	±(0.05 %+30 pA+100 fA x Vo)	±(0.1 %+20 pA+100 fA x Vo)	200 V
±1 µA	50 pA	50 pA	±(0.05 %+300 pA+1 pA x Vo)	±(0.1 %+200 pA+1 pA x Vo)	200 V
±10 µA	500 pA	500 pA	±(0.05 %+3 nA+10 pA x Vo)	±(0.05 %+2 nA+10 pA x Vo)	200 V
±100 µA	5 nA	5 nA	±(0.035 %+15 nA+100 pA x Vo)	±(0.05 %+20 nA+100 pA x Vo)	200 V
±1 mA	50 nA	50 nA	±(0.04 %+150 nA+1 nA x Vo)	±(0.04 %+200 nA+1 nA x Vo)	200 V
±10 mA	500 nA	500 nA	±(0.04 %+1.5 µA+10 nA x Vo)	±(0.04 %+2 µA+10 nA x Vo)	200 V
±100 mA	5 µA	5µ nA	±(0.045 %+15 µA+100 nA x Vo)	±(0.1 %+20 µA+100 nA x Vo)	[3]
±1 A	50 µA	50 µA	±(0.4 %+300 µA+1 µA x Vo)	±(0.5 %+300 µA+1 µA x Vo)	[3]

1. Specified measurement resolution is limited by fundamental noise limits.
2. ± (% of read value + offset current (fixed part determined by the output/measurement range + proportional part that is multiplied by Vo))
3. 200 V (Io ≤ 50 mA), 100 V (50 mA < Io ≤ 125 mA), 40 V (125 mA < Io ≤ 500 mA), 20 V (500 mA < Io ≤ 1 A), Io is the output current in Amps.

Power consumption

Voltage source mode

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

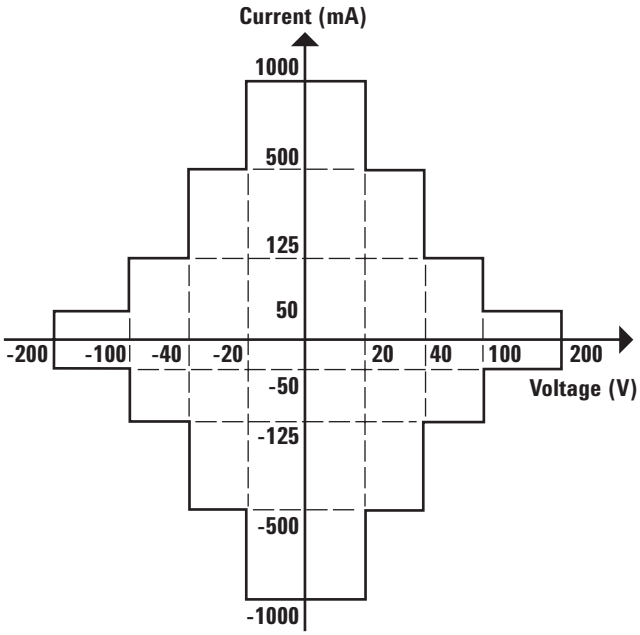
Where Ic is the current compliance setting.

Current source mode

Voltage compliance	Power
Vc ≤ 20	20 x Io (W)
20 < Vc ≤ 40	40 x Io (W)
40 < Vc ≤ 100	100 x Io (W)
100 < Vc ≤ 200	200 x Io (W)

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

HPSMU measurement and output range



MCSMU Module Specifications

Voltage range, resolution, and accuracy

Voltage range	Force resolution	Measure resolution	Force accuracy[1] ±(% + mV)	Measure accuracy[1] (% + mV + mV)	Maximum current
±0.2 V	200 nV	200 nV	±(0.06 + 0.14)	±(0.06 + 0.14 + Io x 0.05)	1 A
±2 V	2 µV	2 µV	±(0.06 + 0.6)	±(0.06 + 0.6 + Io x 0.5)	1 A
±20 V	20 µV	20 µV	±(0.06 + 3)	±(0.06 + 3 + Io x 5)	1 A
±40 V[2]	40 µV	40 µV	±(0.06 + 3)	±(0.06 + 3 + Io x 10)	1 A

1. ±(% of reading value + fixed offset in mV + proportional offset in mV). Note:Io is the output current in A.
2. Maximum output voltage is 30 V.

Current range, resolution, and accuracy

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

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

Power consumption

Voltage source mode:

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

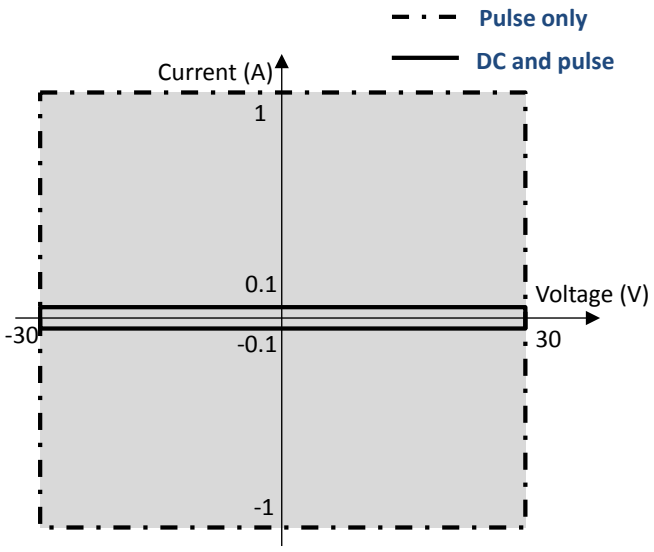
Where Ic is the current compliance setting.

Current source mode:

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

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

MCSMU measurement and output range



Output terminal/connection
Dual triaxial connector, Kelvin (remote sensing)

Voltage/current compliance (limiting)
The SMU can limit output voltage or current to prevent damaging the device under test.

Voltage:
0 V to ±100 V (MPSMU, HRSMU)
0 V to ±200 V (HPSMU)
0 V to ±30 V (MCSMU)

Current:
±10 fA to ±100 mA (HRSMU/MPSMU with ASU)
±100 fA to ±100 mA (HRSMU)
±1 pA to ±100 mA (MPSMU)
±1 pA to ±1 A (HPSMU)
±10 nA to ±1 A (MCSMU)

Compliance accuracy:
Same as the current or voltage set accuracy.

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 V_{rms} in the frequency range of 150 kHz to 80 MHz. The extent of this effect depends upon how the instrument is positioned and shielded.

Pulse measurement
Programmable pulse width, period and delay:

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

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

* Recommended pulse width ≥50 µs
Time to reach within 1% of the final value at resistive load >50 Ω , 10 V step voltage, 1 A compliance (supplemental characteristics)

Supplemental Characteristics

Current compliance setting accuracy (for opposite polarity):
For HPSMU, MPSMU, and HRSMU:
For 1 pA to 10 nA ranges:
± (setting accuracy + 12 % of range)
For 100 nA to 1 A ranges:
± (setting accuracy + 2.5 % of range)
For MCSMU:
± (setting accuracy + 2.5 % of range)

SMU pulse setting accuracy (fixed measurement range):
For HPSMU, MPSMU, and HRSMU:
Width: ±0.5% ± 50 µs
Period: ±0.5% ± 100 µs
For MCSMU:
Width: ±0.1% ± 2 µs
Period: ±0.1% ± 100 µs

Minimum pulse measurement time:
16 µs (HPSMU, MPSMU, and HRSMU)
2 µs (MCSMU)

Voltage source output resistance:
(Force line, non-Kelvin connection)
0.2 Ω (HPSMU)
0.3 Ω (MPSMU, HRSMU)

Voltage measurement input resistance:
≥ 10^{13} Ω (HPSMU, MPSMU, and HRSMU)
≥ 10^{9} Ω (MCSMU, ≤ 1 A)

Current source output resistance:
≥ 10^{13} Ω (HPSMU, MPSMU, and HRSMU)
≥ 10^{9} Ω (MCSMU, ≤ 1 A),

Maximum allowable cable resistance:
(Kelvin connection)
For HPSMU, MPSMU, and HRSMU:
Sense: 10 Ω
Force: 10 Ω (≤ 100 mA),1.5 Ω (>100 mA)
For MCSMU
Sense: 10 Ω
Force : 1 Ω
between High and Low

Maximum allowable inductance:
Force 3 µH with Low Force as shield (MCSMU)

Maximum load capacitance:
For HPSMU, MPSMU, and HRSMU:
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 MCSMU:
10 µA to 10 mA range : 12 nF
100 mA to 1 A range : 100 µF

Maximum guard capacitance:
900 pF (HPSMU, MPSMU, and HRSMU)
660 pF (HRSMU/MPSMU with ASU)

Maximum shield capacitance:
5000 pF (HPSMU, MPSMU, and HRSMU)
3500 pF (HRSMU/MPSMU with ASU)

Noise characteristics:
For HPSMU, MPSMU, and HRSMU (filter ON)
Voltage source: 0.01% of V range (rms.)
Current source: 0.1% of I range (rms.)
For MCSMU
Voltage/Current source: 200 mV (0 to peak) max

Overshoot (filter ON):
For HPSMU MPSMU, and HRSMU
Voltage source: 0.03% of V range
Current source: 1% of I range
For MCSMU
Voltage/Current source: 10% of range

Range switching transient noise:
For HPSMU, MPSMU, and HRSMU (filter ON):
Voltage ranging: 250 mV
Current ranging: 70 mV
For MCSMU:
Voltage ranging: 250 mV
Current ranging: 70 mV

Maximum guard offset voltage:
±1 mV (HPSMU)
±3 mV (MPSMU, HRSMU)
±4.2 mV (HRSMU/MPSMU with ASU, Iout≤100 µA)

Maximum slew rate:
0.2 V/µs (HPSMU, MPSMU, and HRSMU)
1 V/µs (MCSMU)

Maximum DC floating voltage:
±200 V DC between low force and common (MCSMU)

MFCMU (multi frequency capacitance measurement unit) module specifications

Measurement functions

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

Ranging:
Auto and fixed

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

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

Test signal

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

Output signal level:
Range: 10 mV_{rms} to 250 mV_{rms}

Resolution: 1 mV_{rms}

Accuracy:
±(10.0 % + 1 mV_{rms})
at the measurement port of the MFCMU

±(15.0 % + 1 mV_{rms})
at the measurement port of the MFCMU cable (1.5 m or 3.0 m)

Output impedance: 50 Ω, typical

Signal level monitor:
Range: 10 mV_{rms} to 250 mV_{rms}

Accuracy (open load):
±(10.0 % of reading + 1 mV_{rms})
at the measurement port of the MFCMU

±(15.0 % of reading + 1 mV_{rms})
at the measurement port of the 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 of the MFCMU or the MFCMU cable (1.5 m or 3.0 m)

Maximum DC bias current (supplemental characteristics)

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

Output impedance: 50 Ω, typical

DC bias monitor:
Range: 0 to ±25 V

Accuracy (open load):
±(0.2 % of reading + 10.0 mV) at the measurement port of the MFCMU or the MFCMU cable (1.5 m or 3.0 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 3.0 m).

Z_X: Impedance measurement value (Ω)

D_X: Measurement value of D

$E = E_P' + (Z_S'/|Z_X| + Y_0'|Z_X|) \times 100$ (%)

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

$Y_0' = Y_{0L} + Y_{OSC} + Y_0$ (S)

$Z_S' = Z_{SL} + Z_{OSC} + Z_S$ (Ω)

|Z| accuracy
±E (%)

θ accuracy
±E/100 (rad)

C accuracy
at $D_X \leq 0.1$
±E (%)

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

D accuracy
at $D_X \leq 0.1$
±E/100

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

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

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

Note: measurement accuracy is specified under the following conditions:
Temperature: 23 °C ±5 °C
Integration time: 1 PLC or 16 PLC

Parameters E_{POSC} Z_{OSC}

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

V_{OSC} is oscillator level in mV.

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

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

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

Parameters Y_{OSC} Y_O E_P Z_S

Frequency	Y_{OSC} (nS)	Y_O (nS)	E_P (%)	Z_S (mΩ)
1 kHz ≤ f ≤ 200 kHz	1 x (125/ V_{OSC} – 0.5)	1.5	0.095	5.0
200 kHz < f ≤ 1 MHz	2 x (125/ V_{OSC} – 0.5)	3.0	0.095	5.0
1 MHz < f ≤ 2 MHz	2 x (125/ V_{OSC} – 0.5)	3.0	0.28	5.0
2 MHz < f	20 x (125/ V_{OSC} – 0.5)	30.0	0.28	5.0

f is frequency in Hz.
V_{OSC} is oscillator level in mV.

Example of calculated C/G measurement accuracy

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

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

Atto-sense and switch unit (ASU) specifications

AUX path specification

Maximum voltage
- 100 V (AUX input to AUX common)
- 100 V (AUX input to circuit common)
- 42 V (AUX common to circuit common)

Maximum current
- 0.5 A (AUX input to force output)

ASU supplemental characteristics

Band width (at -3 dB)
- 30 MHz (AUX port)

SMU CMU unify unit (SCUU) and guard switch unit (GSWU) specifications

The SCUU multiplexes the outputs from two SMUs (MPSMUs and/or HRSMUs) and the CMU. The SCUU outputs are two sets of Kelvin triaxial ports (Force and Sense). The SCUU also allows the SMUs to act as DC bias sources in conjunction with the CMU. Special cables are available to connect the SMUs and CMU with the SCUU, and an auto-detect feature automatically compensates for the cable length going to the SCUU.

The GSWU contains a relay that automatically opens for IV measurements and closes for CV measurements, forming a guard return path to improve CV measurement accuracy.

Supported SMU
- MPSMU and HRSMU

For SCUU

Inputs:
- Triaxial ports: Force1, Sense1, Force2, and Sense2
- BNC ports: for MFCMU
- Control port: for MFCMU

Outputs:
- Triaxial ports: Force1/CMUH, Sense1, Force2/CMUL, and Sense2
- Control port: for GSWU
- LEDs: SMU/CMU output status indicator

Docking mode:
- Direct and indirect mode

For GSWU

Input:
- Control port: for SCUU
- Mini pin plug ports: Guard1, Guard2

Output:
- LED: Connection status indicator

SCUU supplemental characteristics

SMU path:
- Offset current: < 20 fA
- Offset voltage: < 100 µV at 300 sec
- Closed channel residual resistance: < 200 mΩ
- Channel isolation resistance: > 10^{15} Ω

CMU path:

Test signal

Signal output level additional errors (CMU bias, open load):
- ±2 % (direct docking)
- ±7 % (indirect docking)

Signal output level additional errors (SMU bias, open load):
- ±5 % (direct docking, ≥ 10 kHz)
- ±10 % (indirect docking, ≥ 10 kHz)

Output impedance: 50 Ω, typical

Signal level monitor additional errors (open load):
- ±2 % (CMU bias), direct docking
- ±5 % (SMU bias), direct docking
- ±7 % (CMU bias), indirect docking
- ±10 % (SMU bias), indirect docking

DC bias function

DC voltage bias (CMU bias):
- Range: 0 to ±25 V
- Resolution: 1 mV
- Additional errors (for CMU bias): ±100 µV (open load)

DC voltage bias (SMU bias):
- Range: 0 to ±100 V
- Resolution: 5 mV
- Additional errors (for SMU voltage output accuracy): ±100 µV (open load)

DC bias monitor additional errors (open load):
- ±20 mV, direct docking
- ±30 mV, indirect docking

Output impedance:
- 50 Ω, typical

DC output resistance: 50 Ω (CMU bias), 130 Ω (SMU bias)

Measurement accuracy

Impedance measurement error is given by adding the following additional error E_e to the MFCMU measurement error.

$E_e = \pm(A + Z_S/|Z_X| + Y_0|Z_X|) \times 100$ (%)

Z_X: Impedance measurement value (Ω)

A: 0.05 % (direct docking) or 0.1 % (indirect docking)

Z_S: 500 + 500 x f (mΩ)

Y_0: 1 + 1000 x f/100 (nS) (direct docking, x2 for indirect docking)
Note: f is frequency in MHz.

When the measurement terminals are extended by using the measurement cable, the measurement accuracy is applied to the data measured after performing the open/short/load correction at the DUT side cable end.

Note: The error is specified under the following conditions:
- Temperature: 23 °C ±5 °C
- Integration time: 1 PLC or 16 PLC

HV-SPGU (high voltage semiconductor pulse generator unit) module specification

Specifications

Number of output channels:
2 channels per module

Modes: pulse, constant, and freerun

Standard pulse mode:
- Two level pulse
- Three level pulse per one channel
- Pulse period: 30 ns to 10 s

Delay range: 0 s to 9.99 s

Delay resolution: 2.5 ns (minimum)

Output count: 1 to 1,000,000

Voltage monitor minimum sampling period: 5 µs

Trigger output:
Level: TTL
Timing: Synchronized with pulse period
Trigger width:
Pulse period x 1/2 (pulse period ≤ 10 µs)
Maximum 5 µs (pulse period > 10 µs)

SPGU supplemental characteristics

Pulse width jitter: 0.001 % +150 ps

Pulse period jitter: 0.001 % +150 ps

Maximum slew rate: 1000 V/µs (50 Ω load)

Noise: 10 mV_{rms} (at DC output)

Advanced feature:
Voltage monitor: The HV-SPGU has a voltage monitor function to measure the voltage at the DUT terminal.

Measurement accuracy (open load): ±(0.1 % of reading + 25 mV)

Measurement resolution: 50 µV

Note: Specified at 1 PLC (20 ms = (5 µs sample + 5 µs interval) x 2000 samples.)

Voltage compensation: The HV-SPGU can measure the impedance of DUT and adjust the output voltage according to the DUT impedance.

ALWG (arbitrary linear waveform generator) function

Arbitrary linear waveform generator (ALWG) mode:
- Output complex waveform per one channel of HV-SPGU
- Define multi-level pulse and multi-pulse waveform including open state pulse with ALWG GUI editor
- Sequential pulse waveform from user-defined pulse waveform
- 1024 points per one channel
- Programmable timing range: 10 ns to 671.088630 ms, 10 ns resolution

Pulse/DC output voltage and accuracy

Output voltage (Vout)	50 Ω load	–20 V to +20 V
	Open load	–40 V to +40 V
Accuracy[1]	Open load	±(0.5 % + 50 mV)
Amplitude resolution	50 Ω load	0.2 mV (±10 V range) 0.8 mV (±40 V range)
	Open load	0.4 mV (±10 V range) 1.6 mV (±40 V range)
Output connectors		SMA
Source impedance		50 Ω[2]
Short circuit current		800 mA peak (400 mA average[3])
Overshoot/ pre-shoot/ringing[4]	50 Ω load	±(5 % + 20 mV)
Output limit		Monitoring over current limit

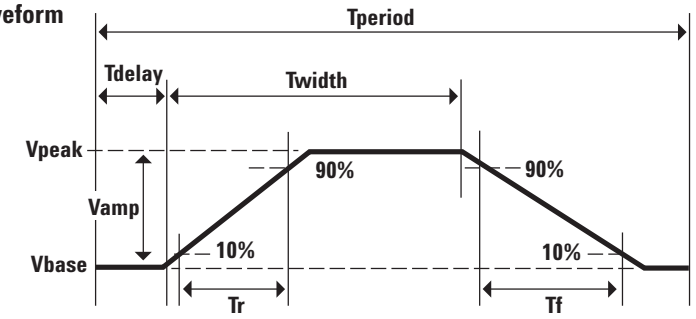
1. At 1 µs after completing transition.
2. Typical (±1 %)
3. This value is specified under the following condition: [(Number of installed HV-SPGUs) x 0.2 A] + [DC current output by all modules (including HV-SPGUs)] < 3.0 A
4. Following the specified condition with transition time.

Pulse range and pulse parameter[1]

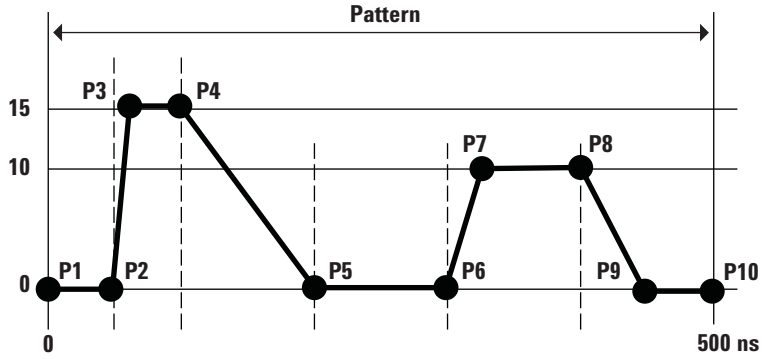
Frequency range		0.1 Hz to 33 MHz
Pulse period	Programmable range	30 ns to 10 s
	Resolution	10 ns
	Minimum	100 ns[3]
	Accuracy	±1 % (±0.01 %[2])
Width	Programmable range	10 ns to (period – 10 ns)
	Resolution	2.5 ns (Tr and Tf ≤ 8 µs) 10 ns (Tr or Tf > 8 µs)
	Minimum	50 ns (25 ns typical)[3]
	Accuracy	±(3 % + 2 ns)
Transition time[5] (Tr and Tf)	Programmable range	8 ns to 400 ms
	Resolution	2 ns (Tr and Tf ≤ 8 µs) 8 ns (Tr or Tf > 8 µs)
	Minimum (typical)	< 15 ns[3]
	Minimum	20 ns (Vamp ≤ 10 V) 30 ns (Vamp ≤ 20 V) 60 ns (Vamp > 20 V)
	Accuracy	–5 % to 5 % + 10 ns (Vamp ≤ 10 V) –5 % to 5 % + 20 ns (Vamp ≤ 20 V)
Output relay switching time[4]	Open/close	< 100 µs

1. Unless otherwise stated, all specifications assume a 50 Ω termination.
2. Typical minimum. This is supplemental characteristics.
3. This is specified at Vamp ≤ 10 V.
4. The time it takes the open state relay to open or close.
5. The time from 10 % to 90 % of Vamp which is the amplitude of output pulse.

Pulse waveform

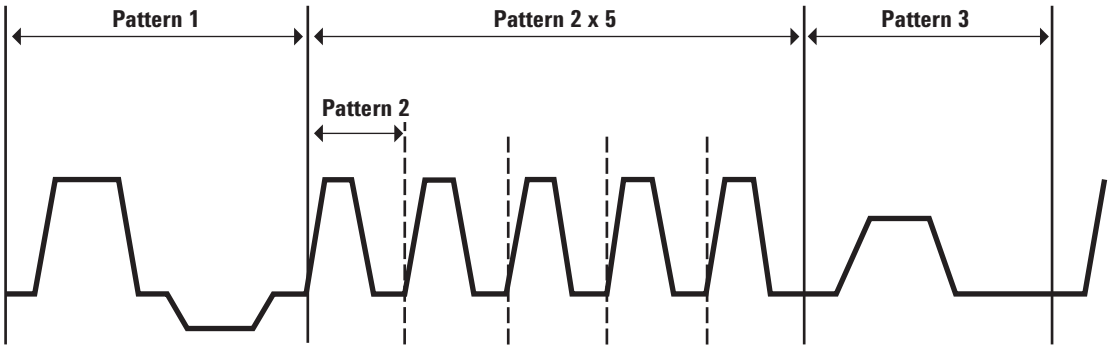


Example 1. ALWG setup table and pattern



Point	Time	Voltage
1	0	0.0 V
2	50 ns	0.0 V
3	70 ns	15.0 V
4	100 ns	15.0 V
5	200 ns	0.0 V
6	300 ns	0.0 V
7	320 ns	10.0 V
8	400 ns	10.0 V
9	450 ns	0.0 V
10	500 ns	0.0 V

Example 2. ALWG complex waveform



16440A SMU/pulse generator selector

The Agilent 16440A SMU/pulse generator selector switches either a SMU or PGU to the associated output port. You can expand to four channels by adding an additional 16440A. The PGU port on channel 1 provides a "PGU OPEN" function, which can disconnect the PGU by opening a semiconductor relay. The Agilent B1500A and 16445A are required to use the 16440A.

The following specifications data is specified at 23 °C ± 5 °C and 50% relative humidity.

- Channel configuration:
  2 channels (CH 1 and CH 2).
  Can add an additional 2 channels (CH 3 and CH 4) by adding another 16440A (selector expander).

	Input	Output
Channel 1 (CH 1)	2 (SMU and PGU [1])	1
Channel 2 (CH 2)	2 (SMU and PGU)	1
Channel 3 (CH 3) [2]	2 (SMU and PGU [1])	1
Channel 4 (CH 4) [2]	2 (SMU and PGU)	1

1. PGU channels 1 & 3 have a built-in series semiconductor relay.
2. Available when a second 16440A (selector expander) is installed.

- Voltage and current range

Input port	Maximum voltage	Maximum current
SMU	200 V	1.0 A
PGU	40 V	0.4 A [1]

1. This is peak-to-peak current.

16445A SMU/PGU selector connection adaptor

The Agilent 16445A selector adapter is required to control and to supply DC power to the Agilent 16440A SMU/pulse generator selector.

Power requirement: 100 to 240 V, 50/60 Hz

Maximum volt-amps (VA): 20 VA

WGFMU (waveform generator/fast measurement unit) module specification

Overview

The WGFMU is a self-contained module offering the combination of arbitrary linear waveform generation (ALWG) with synchronized fast current or voltage (IV) measurement. The ALWG function allows you to generate not only DC, but also various types of AC waveforms. In addition to this versatile sourcing capability, the WGFMU can also perform measurement in synchronization with the applied waveform, which enables accurate high-speed IV characterization.

Specifications

Number of output channels:
2 channels per module

Modes: Fast IV, PG (pulse generator), DC, and SMU pass-through

RSU:

Output Connector: SMA
Source Impedance: 50 Ω (nominal) at DC in PG mode

SMU path: Maximum voltage ±25 V, Maximum current ±100 mA

V monitor terminal:
Connector: BNC

Source Impedance: 50 Ω (nominal) at DC

The terminal outputs a buffered signal equal to 1/10 of Vout (into a 50 Ω load)

WGFMU to RSU cable length:
The WGFMU and RSU are connected by a special composite cable. The following configurations are available:

- 3 m
- 5 m
- 1.5 m
- 2.4 m + connector adapter + 0.6 m
- 4.4 m + connector adapter + 0.6 m

Note: The connector adapter is used when routing the cable through the prober's connector panel.

Measurement functions, voltage forcing, voltage measurement, and current measurement

Mode	Function	V force ranges	V measure ranges	I measure ranges
Fast IV	V force/I measure, V force/V measure	-3 V to +3 V -5 V to +5 V -10 V to 0 V 0 V to +10 V	-5 V to +5 V -10 V to +10 V	1 µA, 10 µA, 100 µA, 1 mA, 10 mA.
PG	V force/V measure	-3 V to +3 V -5 V to +5 V	-5 V to +5 V	—
DC	V force/I measure, V force/V measure	-3 V to +3 V -5 V to +5 V -10 V to 0 V 0 V to +10 V	-5 V to +5 V -10 V to 10 V	1 µA, 10 µA, 100 µA, 1 mA, 10 mA
SMU pass-through	Measurement using SMU	Max ±25 V	—	Max ±100 mA

Voltage force accuracy, resolution, and timing

V force (Fast IV mode)	-5 V to 5 V, -10 V to 0 V, 0 V to 10 V
V force (PG mode)	-5 V to 5 V (open load) -2.5 V to 2.5 V (50 Ω load)
Accuracy	±0.1% of setting ±0.1% of range [1]
Resolution [2]	96 µV (-3 to 3V) 160 µV (all ranges except for -3 V to 3 V)
Overshoot/undershoot	±(5%+20 mV) [3]
Noise	Maximum 0.1 mV_{rms} [4]
Rise time T_{rise} (10 to 90%)/ Fall time T_{fall} (90 to 10%)	Accuracy: -5% to (+5% +10 ns) of setting [5] Minimum: 24 ns, PG mode and 50 Ω load
Pulse period	Timing Accuracy: ±1% of setting [6] Minimum:100 ns, PG mode and 50 Ω load
Pulse width	Accuracy: ±(3%+2 ns) [7] Minimum: 50 ns, PG mode and 50 Ω load

Voltage measurement accuracy, resolution, and noise

Accuracy	±(0.1% of reading ±0.1% of range) [8]
Resolution [9]	680 µV (-5 V to +5 V range) 1.4 mV (-10 V to +10 V range)
Noise [10]	Maximum 4 mV_{rms} (-5 V to +5 V range)

1. Independent of the range or the mode. DC constant voltage output. Load impedance must be ≥ 1 MΩ (1 µA range) or ≥ 200 kΩ (all other current ranges) for Fast IV mode, or ≥ 1 MΩ for PG mode.
2. Can vary at most 5% based on the result of calibration.
3. PG mode, 50 Ω load, T_{rise} and T_{fall} >16 ns with the 1.5 m cable, >32 ns with 3 m cable, or >56 ns with 5 m cable.
4. Theoretical value for observed time 100 ns to 1 ms, supplemental characteristics.
5. PG mode, 50 Ω load, T_{rise} and T_{fall} ≥ 24 ns.
6. PG mode, 50 Ω load, pulse period ≥ 100 ns.
7. PG mode, 50 Ω load, pulse width ≥ 50 ns.
8. Independent of the range or the mode. DC constant voltage output. Applicable condition: 10,000 averaging samples for 10 µA range and above; 100,000 averaging samples for the 1 µA range.
9. Display resolution. Can vary at most 5% based on the result of calibration.
10. 0 V output, open load, no averaging. Maximum 1.5 mV_{rms} as supplemental characteristics.

Current measurement accuracy and resolution

Accuracy	±(0.1% of reading ±0.2% of range) [1]
Resolution [2]	0.014% of range
Noise (Effective resolution)	Maximum 0.2% of range [3]

1. Independent of the range or the mode. DC constant voltage output. Applicable condition: 10,000 averaging samples for 10 µA range and above; 100,000 averaging samples for the 1 µA range.
2. Display resolution. Can vary at most 5% based on the result of calibration.
3. Effective value at 0 V output, open load, and no averaging. Supplemental characteristics.

ALWG function

Maximum number of vectors	2048
Maximum number of sequences	512
Maximum number of loop counts	1 to 10^{12}
Length of a vector	10 ns to 10,000 s with 10 ns resolution
Sampling rate	5 ns, or 10 ns to 1 s with 10 ns resolution
Averaging time	10 ns to 20 ms with 10 ns resolution
Hardware memory	About 4 M data points/channel (typical)

Trigger output

Level: TTL

Trigger width: 10 ns

Generated synchronously with ALWG waveform.

Supplemental characteristics

RSU SMU path:

Leak current: < 100 pA

Residual resistance: <300 mΩ

Jitter: <1 ns

Skew between channels: <3 ns, under no electrostatic discharge condition.

Trigger output skew: <3 ns

Current range change time: <150 µs*

* The time until the measured current settles within ± 0.3 % of the final result value after the range change.

Minimum timing parameters for current measurement[1]

Voltage applied to DUT		**10 V**					
Current applied to DUT		**100 nA**	**1 µA**	**10 µA**	**100 µA**	**1 mA**	**10 mA**
Applied voltage condition	Recommended minimum pulse width[2]	47 µs	38.7 µs	6.8 µs	950 ns	240 ns	145 ns
Current measurement condition	Measurement Range	1 µA	1 µA	10 µA	100 µA	1 mA	10 mA
	Recommended minimum measurement window	10 µs	1.64 µs	1 µs	130 ns	40 ns	20 ns
	Settling time[3]	37 µs	37 µs	5.8 µs	820 ns	200 ns	125 ns
	Noise (rms)[4]	160 pA	425 pA	2.5 nA	47 nA	280 nA	1.9 µA

1. Measurement conditions: The DUT is a resistive load chosen to adjust the flowing current to the specified current in the table above. The capacitance of the cable between the RSU and the DUT is 20 pF. Voltage is applied to the DUT by a channel of WGFMU/RSU in Fast IV mode and in the 10 mA range, and current measurement is performed by another channel at 0 V in Fast IV mode.
2. Recommended minimum pulse width = settling time + recommended minimum measurement window.
3. The time until the measured value settles to within ± 0.6 % of the final result value after the output voltage is changed from the initial value (0 V). Minimum rise/fall time of 70 ns is recom mended for minimizing overshoot.
4. RMS noise measured over the recommended minimum measurement window.

Minimum timing parameters for voltage measurement[1]

Voltage applied to DUT		5V	10 V
Applied voltage condition	Recommended minimum pulse width[2]	105 ns	130 ns
Voltage measurement condition	Measurement Range	5 V	10 V
	Recommended minimum measurement window	20 ns	20 ns
	Settling time[3]	85 ns	110 ns
	Noise (rms)[4]	1.4 mV	1.4 mV

1. Measurement conditions: The DUT is a resistive load between 1 kΩ and 10 MΩ. The capacitance of the cable between the RSU and the DUT is 20 pF. Voltage is applied to the DUT by a channel of WGFMU/RSU, and voltage measurement is performed by the same channel. (PG mode for 5 V, Fast IV mode for 10 V)
2. Recommended minimum pulse width = settling time + recommended minimum measurement window.
3. The time until the measured value settles to within ± 0.6 % of the final result value after the output voltage is changed from the initial value (0 V). Minimum rise/fall time of 70 ns for 10 V, or 30ns for 5 V is recommended for minimizing overshoot.
4. RMS noise measured over the recommended minimum measurement window.

Software

Instrument library for WGFMU control

Operating system:
Microsoft Windows XP Professional SP3 or later, Windows Vista Business SP2 or later (32bit only), and Windows 7 Professional SP1 or later (32 bit and 64bit)

Supported language: English (US)

NBTI and general-purpose EasyEXPERT Application Tests

Sample programs (NBTI and general-purpose measurement using WGFMU and RTS data analysis)

WGFMU supported prober vendors

Cascade Microtech

Suss MicroTec

Vector Semicon

Note: The maximum number of installable RSUs for a given prober depends upon the available space. Please contact your local sales representative for details on connecting and mounting the WGFMU and RSU.

Agilent EasyEXPERT software

Agilent EasyEXPERT, resident GUI-based software running on the B1500A's embedded Windows 7 platform, supports efficient and repeatable device characterization ranging from interactive manual measurements all the way up to test automation across a wafer in conjunction with a semiautomatic wafer prober. With hundreds of ready-to-use measurements (application tests) furnished at no charge, EasyEXPERT makes it easy to perform complex device characterization immediately. The EasyEXPERT GUI can be accessed using the B1500A's 15-inch touch screen, as well as through an optional USB keyboard and mouse. EasyEXPERT also allows you the option of storing test condition and measurement data automatically after each measurement in unique workspaces, 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

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

Application library

EasyEXPERT comes with over 300 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.

Device Type	Application Tests
CMOS Transistor	Id-Vg, Id-Vd, Vth, breakdown, capacitance, QSCV, etc.
Bipolar Transistor	Ic-Vc, diode, Gummel plot, breakdown, hfe, capacitance, etc.
Discrete device	Id-Vg, Id-Vd, Ic-Vc, diode, etc.
Memory	Vth, capacitance, endurance test, etc.
Power device	Pulsed Id-Vg, pulsed Id-Vd, breakdown, etc.
Nano Device	Resistance, Id-Vg, Id-Vd, Ic-Vc, etc.
Reliability test	NBTI/PBTI, charge pumping, electro migration, hot carrier injection, J-Ramp, TDDB, etc.
And more	And more

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'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 set ups created in tracer test mode can be seamlessly and instantaneously transferred to classic test mode for further detailed measurement and analysis.

Oscilloscope view (available for MCSMU)

The oscilloscope view (available in tracer test mode) displays measured MCSMU module 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. It is available when a tracer test has one or more MCSMU channels being used in pulsed mode. The oscilloscope view can display the pulsed waveform timings at any (user specified) sweep step of the sweep output.

Sampling interval: 2 µs

Sampling points: 2000 Sa

Sampling duration: 22 µs to 24 ms

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

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 Agilent B1500A 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[1]
  - Binary search[1]
- C measurement
  - Spot C
  - CV (DC bias) sweep
  - Pulsed spot C
  - Pulsed sweep CV
  - C-t sampling
  - C-f sweep
  - CV (AC level) sweep
  - Quasi-Static CV (QSCV)

1. They are supported by FLEX command only.

Sweep measurement

Number of steps: 1 to 10001 (SMU), 1 to 1001 (CMU)

Sweep mode: Linear or logarithmic (log)
Sweep direction: Single or double sweep

Hold time:
0 to 655.35 s, 10 ms resolution

Delay time:
0 to 65.535 s, 100 µs resolution
0 to 655.35 s, 100 µs resolution (CV (AC level) sweep, C-f sweep)

Step delay time:
0 to 1 s, 100 µs resolution

Step output trigger delay time:
0 to (delay time) s, 100 µs resolution

Step measurement trigger delay time:
0 to 65.535 s, 100 µs resolution

Sampling (time domain) measurement

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

Sampling channels: Up to 10

Sampling mode: Linear, logarithmic (log)

Sampling points:
For linear sampling:
1 to 100,001/(number of channels)
For log sampling:
1 to 1+ (number of data for 11 decades)

Sampling interval range:
100 µs +20 µs x (num. of channels – 1) to 2 ms, 10 µs resolution
2 ms to 65.535 s, 1 ms resolution

* Sampling interval less than 2ms is only supported in linear mode.

Hold time, bias hold time:
-90 ms to -100 µs, 100 µs resolution
0 to 655.35 s, 10 ms resolution

Measurement time resolution: 100 µs

Other measurement characteristics

Measurement control
Single, repeat, append, and stop

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

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

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 B1500A 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 clip board or mass storage device. (File type: bmp, gif, png, emf)

Scale:
Auto scale and zoom

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

Cursor:
Direct cursor

Line:
Two lines, normal mode, grad mode, tangent mode, and regression mode

Overlay graph comparison:
Graphical plots can be overlaid.

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

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

Automatic analysis function

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

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

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

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

Arithmetic functions

User functions

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

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

Arithmetic operators

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

Physical constants

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

Engineering units

The following unit symbols are also available on the keyboard:

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

Workspace and data management

Workspace

Workspaces are separate work environments residing on the B1500A's internal hard disk drive. Every workspace supports the following features:

- Setup and execute the measurement
- Save/Recall "My Favorite Setups"
- Save/Recall measurement data and settings
- Import/Export device definition, measurement settings, my favorite setup, measurement data, and application library
- Test result data management
- Private/public accessibility setting

Data auto record/auto export

EasyEXPERT 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. You can save data to any storage drive connected to the PC.

Import/export files

File type:
Agilent EasyEXPERT format, XML-SS format, CSV format

Workspace management

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

External instrument control

Switching matrix operation panel (GUI)

Agilent B2200A, B2201A and E5250A (E5252A cards) switching matrix are supported.

Supported external instruments by application tests

Agilent 4284A/E4980A, 81110A 3458A

Prober control

All popular semiautomatic wafer probers are supported by EasyEXPERT. You can combine wafer prober control with either Quick Test mode or an application test based test sequence to perform multiple testing on various devices across the wafer.

Program and interface capabilities

Data storage

Hard disk drive, DVD-R drive

Interfaces

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

Remote control capabilities

- FLEX commands (GPIB)
- EasyEXPERT 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

- Prober control execution files
- Desktop EasyEXPERT software
- A VXIplug&play driver for the B1500A
- 4155/56 setup file converter tool

This tool can convert 4155 and 4156 measurement setup files (file extensions MES or DAT) into equivalent EasyEXPERT/Desktop EasyEXPERT classic test mode setup files.

- MDM file converter

  This tool can convert the EasyEXPERT file (XTR/ZTR) to Agilent 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

Agilent Desktop EasyEXPERT software

Desktop EasyEXPERT provides the same capability, look and feel of EasyEXPERT software on a standalone PC. Desktop EasyEXPERT supports all aspects of device characterization as well as EasyEXPERT and it also provides a unified measurement environment for the B1500A, 4155B/C (Semiconductor parameter analyzer) and 4156B/C (Precision semiconductor parameter analyzer). In online mode it can control these instruments and coordinate test automation in conjunction with a semiautomatic wafer prober. In offline mode it can be used to develop new application tests and to analyze data. This maximizes your efficiency and permits you to use your parametric instruments in their primary role of making measurements

Supported instruments

- B1500A
- 4155B, 4156B, 4155C, and 4156C

  Supported 4155/4156 firmware:
  HOSTC: 03.08 or later
  SMUC: 04.08 or later

Supported 4155/4156 functionality

- I/V Sweep
- I/V-t sampling (except thinned out mode)
- VSU/VMU (except differential voltage measurement using VMU)
- PGU (41501B)
- Switching matrix GUI control for B2200A, B2201A and E5250A (E5252A cards)

Prerequisites

The followings are prerequisites for Desktop EasyEXPERT and all furnished software.

Desktop EasyEXPERT	All furnished software	Operating system and service pack	Microsoft Windows XP Professional SP3 or later	Microsoft Windows Vista Business SP2 or later	Microsoft Windows 7 Professional SP1 or later
		Supported language	English		
		.NET Framework	Microsoft .NET Framework 3.5 SP1		
		Processer	Intel Celeron 2 GHz	Vista certified PC	Windows 7 certified PC
		Memory	512 MB DDR266	1 GB memory	2 GB memory
		Display	XGA 1024 x 768 (SXGA 1280 x 1024 recommended)		
		HDD	1GB free space on the C drive, 10GB (30GB recommended) free space on a drive for test setup / result data storage.		

Recommended GPIB I/F

		Interface	B1500A	4155B/C 4156B/C
Agilent	82350B	PCI	✓[1]	✓
	82357A	USB	✓[2]	✓
	82357B	USB	✓[2]	✓
National Instruments	GPIB-USB-HS	USB	✓[2]	

1. A 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 Agilent 82357B is recommended for speed.

General specifications

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

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

Power requirement
AC voltage: 100-240 V (±10 %)
Line frequency: 50/60 Hz

Maximum volt-amps (VA)
B1500A: 900 VA

Regulatory compliance
EMC:
IEC61326-1/EN61326-1
AS/NZS CISPR 11
KC: RRA Notification amending Radio Waves Act Article 58-2
Safety:
IEC61010-1/EN61010-1
CAN/CSA-C22.2 No. 61010-1-04, C/US

Certification
CE, cCSAus, C-Tick, KC

Dimensions
B1500A:
420 mm W x 330 mm H x 575 mm D
N1301A-100 SMU CMU unify unit (SCUU):
148 mm W x 75 mm H x 70 mm D
N1301A-200 guard switch unit (GSWU):
33.2 mm W x 41.5 mm H x 32.8 mm D
E5288A Atto-sense and switch unit (ASU):
132 mm W × 88.5 mm H × 50 mm D
B1531A RSU:
45.2 mm W x 70 mm H x 82 mm D
N1255A 2 channel connection box for MCSMU: 184.4 mm W x 61.6 mm H x 169.6 mm D
16440A SMU/PGU selector:
250 mm W × 50 mm H × 275 mm D
16445A Selector adaptor:
250 mm W × 50 mm H × 260 mm D

Weight
B1500A mainframe: 20 kg
B1510A HPSMU: 2.0 kg
B1511B MPSMU: 1.0 kg
B1514A MCSMU: 1.3 kg
B1517A HRSMU: 1.2 kg
B1520A MFCMU: 1.5 kg
B1525A HV-SPGU: 1.3 kg
B1530A WGFMU: 1.3 kg
B1531A RSU: 0.13 kg
E5288A ASU: 0.5 kg
N1301A-100 SCUU: 0.8 kg
N1301A-200 GSWU: 0.1 kg
N1255A 2 channel connection box for MCSMU: 0.7 kg
16440A SMU/PGU selector: 1.1 kg
16445A Selector adapter: 1.0 kg

Furnished accessories

Power cable
Manual CD-ROM
Desktop EasyEXPERT CD-ROM
Software CD-ROM (including VXI*plug&play* driver and utility tools)
License-to-use for EasyEXPERT and Desktop EasyEXPERT.

Order information

Mainframe

B1500A	Semiconductor device analyzer mainframe The following accessories are included 16444A-001 Keyboard 16444A-002 USB mouse 16444A-003 Stylus pen 16493J-001/002 Interlock cable 1.5m or 3.0m* 16493L-001/002 GNDU cable 1.5m or 3.0m * 16494A-001/002 Tri-axial cable 1.5m or 3.0m * N1254A-100 GNDU to Kelvin adaptor CD-ROMs Manuals, Others *Select B1500A-015 or B1500A-030 to specify cable length
B1500A-015	1.5m cable (Cable length is set to 1.5m for standard and add-on packages)
B1500A-030	3.0m cable (Cable length is set to 3.0m for standard and add-on packages)
B1500A-050	50 Hz line frequency
B1500A-060	60 Hz line frequency
B1500A-A6J	ANSI Z540 compliant calibration
B1500A-UK6	Commercial calibration certificate with test data
B1500A-ABA	English paper document
B1500A-ABJ	Japanese paper document

Standard packages

B1500A-A00	Empty Package for Custom Solution
B1500A-A01	Standard Package (MPSMU 4ea. & Cables)
B1500A-A02	High Resolution Package (HRSMU 4ea & Cables)
B1500A-A03	High Power Package (HPSMU 2ea, MPSMU 2ea & Cables)
B1500A-A04	Basic Flash Memory Cell Package (MPSMU 2ea, HRSMU 2ea, SPGU, Accessories)

Add-on packages

B1500A-A10	HPSMU Add-on (HPSMU 1ea. & Cables)
B1500A-A11	MPSMU Add-on (MPSMU 1ea. & Cables)
B1500A-A17	HRSMU Add-on (HRSMU 1ea. & Cables)
B1500A-A1A	MCSMU Add-on (MCSMU 1ea. connection box & cables)
B1500A-A1B	MCSMU Add-on (MCSMU 2ea. connection box & cables)
B1500A-A20	MFCMU Add-on (MFCMU, Cable)
B1500A-A25	HVSPGU Add-on (HVSPGU 1ea. & Cables)
B1500A-A28	ASU (Atto Sense Unit) Add-on for HRSMU (ASU 1ea. & Cables)
B1500A-A29	ASU (Atto-sense and switch unit) Add-on for MPSMU (ASU 1ea. & Cables)
B1500A-A30	WGFMU Add-on (WGFMU 1ea. RSU 2ea. & Cables)
B1500A-A31	WGFMU Add-on with Connector Adapter (WGFMU 1ea, RSU 2ea, Cables & Connector Adapter)
B1500A-A3P	WGFMU probe cable kit (8 probe cables. WGFMU is not included.)
B1500A-A5F	Test fixture for packaged device measurement (16442B 1ea)

Other accessories

N1301A	CMU Accessories for B1500
N1301A-100	SMU CMU unify unit (SCUU)
N1301A-102	SMU CMU unify unit cable (3m)
N1301A-110	SMU CMU unify unit magnetic stand
N1301A-200	Guard switch unit (GSWU)
N1301A-201	Guard switch unit cable (1 m)
N1301A-202	Guard switch unit cable (3 m)
B1542A	Pulse IV Package for B1500 / EasyEXPERT

Package Option Contents [1]

Standard packages

B1500A-A01 Standard package

Item	Description	Qty
B1511B	MPSMU (Medium Power SMU)	4
16494A-001/002	Triaxial cable 1.5m or 3.0m	8

B1500A-A02 High resolution package

B1517A	HRSMU (High Resolution SMU)	4
16494A-001/002	Triaxial cable 1.5m or 3.0m	8

B1500A-A03 High power package

B1511B	MPSMU (Medium Power SMU)	2
B1510A	HPSMU (High Power SMU)	2
16494A-001/002	Triaxial cable 1.5m or 3.0m	8

B1500A-A04 Basic flash memory cell package

B1511B	MPSMU (Medium Power SMU)	2
B1517A	HRSMU (High Resolution SMU)	2
B1525A	HVSPGU (Pulse Generator Unit)	1
16493P-001 / 002	SPGU CABLE (SMA-TO-COAXIAL) 1.5m or 3.0m	2
16440A	SMU/PGU Pulse Selector	1
16440A-003	Control Cable 40cm (2nd Selector)	1
16445A	Selector Connection Unit	1
16445A-001	Control Cable For B1500A To 16440A 1.5m	1
16494A-001	Tri-axial cable 1.5m	2
16494A-001/002	Triaxial cable 1.5m or 3.0m	8

Add-on packages

B1500A-A10 HPSMU Add-on package

B1510A	HPSMU (High Power SMU)	1
16494A-001/002	Triaxial cable 1.5m or 3.0m	2

B1500A-A11 MPSMU Add-on package

B1511B	MPSMU (Medium Power SMU)	1
16494A-001/002	Triaxial cable 1.5m or 3.0m	2

B1500A-A17 HRSMU Add-on package

B1517A	HRSMU (High Resolution SMU)	1
16494A-001/002	Triaxial cable 1.5m or 3.0m	2

B1500A-A1A MCSMU Add-on package

B1514A	MCSMU (Medium Current SMU)	1
16494A-001/002	Triaxial cable 1.5m or 3.0m	2
N1255A	2 Channel connection box for MCSMU	1

B1500A-A1B MCSMU Add-on package

B1514A	MCSMU (Medium Current SMU)	2
16494A-001/002	Triaxial cable 1.5m or 3.0m	4
N1255A	2 Channel connection box for MCSMU	1

B1500A-A20 MFCMU Add-on package

Item	Description	Qty
B1520A	MFCMU	1
N1300A-001/002	CMU cable for B1500A 1.5m or 3.0m	1

B1500A-A25 HVSPGU Add-on package

Item	Description	Qty
B1525A	HVSPGU	1
16493P-001/002	SPGU cable (SMA to Coaxial) 1.5m or 3.0m	2

B1500A-A28/A29 ASU Add-on package

E5288A	ASU (Atto-sense and switch unit)	1
E5288A-001/002	Triaxial and Dsub cable for ASU 1.5m or 3.0m	1

B1500A-A30 WGFMU Add-on package [2]

B1530A	One WGFMU and two RSUs	1
B1530A-005/002	Two WGFMU cables (1.5m or 3.0m) to connect between WGFMU and RSU	1

B1500A-A31 WGFMU Add-on package with connection adapter [2]

B1530A	One WGFMU and two RSUs	1
B1530A-001	Two set of WGFMU cables (0.6m + 2.4m)	1
16493R-801	WGFMU connector adapter	2

B1500A-A3P WGFMU Probe cable kit

16493R-101	SSMC-SSMC cable (50mm) for current return path	2
16493R-102	SSMC-SSMC cable (70mm) for current return path	2
16493R-202	SMA-SSMC cable (200mm) between RSU and DC probe	2
16493R-302	SMA-SMA cable (200mm) between RSU and RF probe	2

B1500A-A5F Test fixture for packaged device measurement

16442B	Test fixture		1
	Test fixture adapter	1	
	Universal socket module	2	
	28 pin DIP socket module	1	
	Blank PTFE board	1	
	Cables used in test fixture adapter	39	
	Carrying case	1	

1. Cable length is set by B1500A-015 or B1500A-030 option
2. Order 16493R-802 if magnet stand is necessary for RSU

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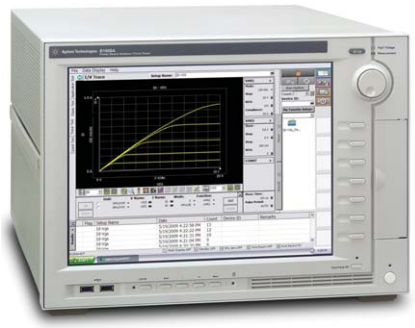

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