# Agilent 4083A
# DC/RF Parametric Test System

Data Sheet


**Contents**



## General Description

The Agilent 4083A DC/RF Parametric Test System is designed to perform fast and precise DC measurements, capacitance measurements, Flash cell test, high frequency applications such as ring oscillator measurement, and RF S-parameter and RFCV measurement.

The system supports up to eight Source Monitor Units (SMUs). Each SMU is self-calibrating, and can be individually configured to force either current or voltage, as well as simultaneously measure either current or voltage. The system also supports a fully guarded switching matrix customizable from 12 to 48 pins. One special additional pin is dedicated as a chuck connection.

The 4083A can be constructed in either a low-current or an ultra low-current configuration, depending upon the type of matrix card specified. Only 4083A models containing the ultra low-current matrix cards can use the high-resolution SMU (HRSMU).

The 4083A comes with two RF input ports and the test head has an RF docking interface with 10 RF output ports. An optional 8 x 10 RF matrix is available and measurements from DC to 20 GHz are also possible. The system hardware and software support an Agilent PNA network analyzer for making S-parameter and RFCV measurements. The system software supplies an automatic and interactive calibration tool that enables full two-port SOLT and one-port SOL, and open/short de-embedding for RF measurement.

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## General Description (continued)

An optional High-Speed Capacitance Measurement Unit (HS-CMU) is available for the 4083A, which enables the measurement of capacitance and impedance with unprecedented speed. External instruments can be integrated into the system via six auxiliary input ports or forty-eight extended path inputs. The extended path inputs allow the user to connect external signals directly to the DUT pins.

Another 4083A option is a high-frequency switching matrix with optional integrated semiconductor pulse generator unit control. The high-frequency matrix is organized as two 3 x 24 matrices (six inputs total), and 1 TO 2 furnished cables may be used on each matrix pair to create one 3 x 48 matrix (three inputs in total). The system also has one 1.6 A ground unit.

### Measurement Functions

DC Current, DC Voltage, Capacitance and Conductance, Impedance and Differential voltage and Pulse force.

### DC Measurements

Spot, Sweep, Pulse Bias, and Pulse Sweep.
Measurement unit:
HRSMU (High Resolution SMU),[1] MPSMU (Medium Power SMU and HPSMU (High Power SMU)
Measurement range:
1 fA[2] to 100 mA, 2 µV to 100 V (using the two low current SMU ports) 10 fA to 1 A[3], 2 µV to 200 V[3] (using the 6 standard SMU ports)

[1] Can be used only with ultra-low current matrix cards
[2] Using HRSMU. Using MPSMU, 10 fA to 100 mA, 2 µV to 100 V
[3] Using optional HPSMU. Using MPSMU, 10 fA to 100 mA, 2 µV to 100 V

### Capacitance/Conductance Measurement Using Optional HS-CMU

C/G, C/G -V, C/G -V/f
Measurement unit:
High Speed Capacitance Measurement Unit (HS-CMU)
Measurement Frequencies:
1 kHz - 2 MHz, 34 points
Measurement range:
1 fF to 100 nF, 0.1 nS to 7.5 mS
DC Bias Voltage: ±10 V

### Impedance Measurements Using Optional HS-CMU

Z/θ and Z/θ - f
Measurement unit: HS-CMU
Measurement Frequencies:
1 kHz - 2 MHz, 34 points
DC Bias Voltage: ±10 V

### Capacitance/Conductance Measurements Using Optional Agilent E4980A LCR Meter

Measurements: C/G and C/G-V

Measurement unit: Agilent E4980A LCR Meter

Measurement Frequency: 1 kHz, 10 kHz, 100 kHz, and 1 MHz

Measurement range: 1 fF to 100 nF, 0.1 nS to 7.5 mS
DC Bias Voltage: ±40 V

### Two Terminal Differential Voltage Measurements

Measurement Unit: Agilent 3458A
Measurement range: 0.1 µV to 100 V (only when using ultra-low-current matirx cards), or 1 µV to 100 V

### High-Frequency Pulse Force Option

The 4083A cabinet supports an optional high-voltage semiconductor pulse generator unit (HV-SPGU) mainframe that contains the SPGU modules.

Maximum number of installable HV-SPGU modules: 5

Number of channels per HV-SPGU: 2

Pulse level support: Each HV-SPGU channel supports 2-level and 3-level pulses

Pulse Level (at open load): ±40 V (at 2-level and 3-level)

Pulse Period (at 50 Ω load): 350 ns to 10 s with 10 ns resolution

Pulse Width (at 50 Ω load): 50 ns to [Period −50 ns] with 2.5 ns[1] or 10 ns[2] resolution

Pulse Delay (at 50 Ω load): 0 s to [Period −75 ns] with 2.5 ns[1] or 10 ns[2] resolution

Transition Time Setting Range (at 50 Ω load): 20 ns to 400 ms with 2 ns[1] or 8 ns[2] resolution

Transition Time Minimum (at 50 Ω load): 20 ns[3], 30 ns[4]

[1] Transition time setting ≤10 µs
[2] Transition time setting >10 µs
[3] |Vamp| ≤10 V (to 50 Ω)
[4] 10 V <|Vamp| ≤20 V (to 50 Ω)

### Switching Matrix Measurement Pins

Between 12 and 48 pins
Note: One additional pin is dedicated for the prober chuck connection.

### Switching Matrix Instrument Ports

Up to eight SMUs
One ground unit (GNDU)
Eight auxiliary (AUX) ports (Two ports are used for HS-CMU)
48 extended paths
Six optional high-frequency (HF) ports and pulse switch input/output ports

### Test Head RF Measurement Ports

Up to 10

### RF 20 GHz S-Parameter Measurements

Supported network analyzer: Agilent E8362B PNA Series
Network Analyzer Test Frequencies: 10 MHz to 20 GHz (E8362B)

### RF Matrix Option

Number of Input Ports: 8
Number of Output Ports: 10
Frequency Range: DC to 20 GHz



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## Switching Matrix Subsystem

### Maximum DUT Pins

48 output pins plus one pin for the prober chuck connection (triaxial connector). Two types of DC switching matrix cards are available: standard low-current and ultra low-current.

### Maximum Number of Instrument Ports

SMU Ports in Testhead (Eight SMUs + one GNDU):
- Two ports for low-current measurement (Non-Kelvin)
- Four ports (Kelvin)
- Two ports (Non-Kelvin)
- One port for GNDU (Kelvin)

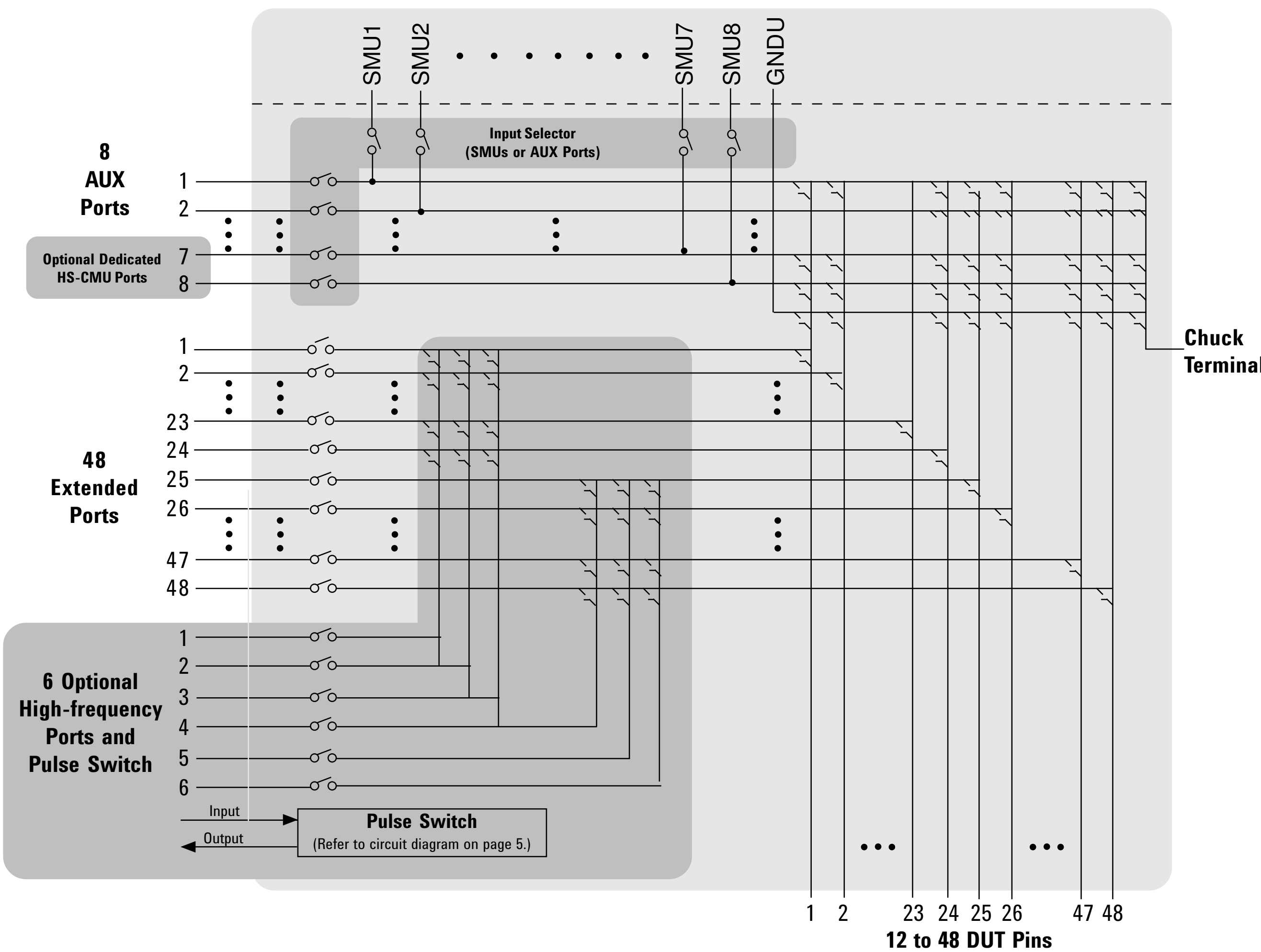
Auxiliary (AUX) ports:
- Six for external instruments (Digital voltmeter, etc.) and two for HS-CMU or E4980A
- 2 triaxial input ports (Force/ Guard/Common, AUX ports 1 and 2)
- Four BNC two-pair input ports (Force/Common and Sense/ Common, AUX ports 3 to 6)
- Two BNC input ports (Force/ Common, AUX ports 7 and 8, connected to HSCMU in default)

Extended path:
- 48 extended paths – The system provides one on/off relay for each path.

### Optional High Frequency (HF) ports:

Six for external instruments. HF ports 1 through 3 can access measurement pins 1 through 24, and HF ports 4 through 6 can access measurement pins 25 through 48. The user has the option of connecting any of the following HF port pairs together

### Testhead Circuit Diagram



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## Switching Matrix Subsystem (continued)

via a 1 TO 2 cable in order to access all (1 through 48) measurement pins: HF ports 1 and 4, HF ports 2 and 5, and HF ports 3 and 6.

Optional pulse switch input/ output ports:

Please refer to page 5.

**Maximum Voltage at Each Port**

SMU port in Test Head: ±200 V

AUX port:

- ±200 V (AUX ports 1 and 2)
- ±100 V (AUX ports 3 to 8)

Optional HF ports:

- ±100 V (between force and common of each HF port)
- ±100 V (between two of forces of all HF ports)
- ±100 V (between any force of HF ports and any force of extended paths)

Extended path:

- ±100 V (between force and common of each extended path)
- ±100 V (between any force of the optional HF ports and any force of extended paths)

Zero reference: ±200 mV

**Maximum Current, Port to DUT Pin**

| | |
|---|---|
| SMU port in Test Head: | ±1.0 A |
| GNDU: | ±1.6 A |
| AUX port: | ±1.0 A |
| Optional HF port: | ±0.5 A |
| Extended path: | ±0.5 A |

**Maximum Residual Resistance**

Through AUX port

| | |
|---|---|
| Low current port: | Force 1.0 Ω |
| Kelvin port: | Force 1.0 Ω |
| | Sense 2.5 Ω |
| Non-Kelvin port: | Force 1.0 Ω |

Through optional HF port (supplemental characteristics):

2.0 Ω

**Maximum Stray Capacitance between DUT Pins (supplemental characteristics)**

3 pF

**Isolation Resistance (supplemental characteristics)**

Low Current (with Guard):

$1 \times 10^{15}$ Ω

**Optional HF Port Bandwidth (@–3dB) (supplemental characteristics)**

60 MHz (50 Ω load impedance: from port to DUT pin, 3 × 24 configuration)

**Optional HF Port Cross Talk Between Pins (supplemental characteristics)**

±2 % (5 kΩ load impedance: from port to DUT pin, 20 ns pulse transition time)



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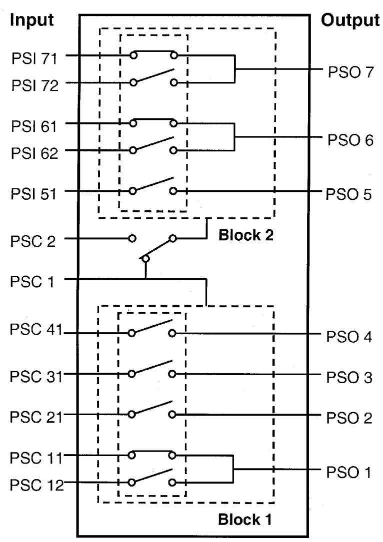
## Optional Pulse Switch

The optional pulse switch includes seven semiconductor switching relays, for reliable and direct control of pulse shaping by the pulse generator or CPU. The pulse switch is integrated into the 4083A test head.




**Pulse Switch**

### Number of Blocks

Two blocks

### Number of Switches of Each Block

Block 1:
Three relays (make or break, selectable type) and 1 relay (transfer type to create multi-level pulse)

Block 2:
One relay (make or break, selectable type) and two relays (transfer type to create multi-level pulse)

### Control Input Port

One input per each block (PSC1 and PSC2)

### Control Method

Both the PG and CPU can control all switches. PG or CPU control is independent for every block. In the case of PG control, block 1 can be controlled by the PSC1 input, and block 2 can be controlled by either PSC1 or PSC2 (selectable).

### Mode of Relay Control

Make or break, selectable type relay:
Normally open or Normally closed modes are selectable.

Transfer type relay:
Normally open and Normally closed modes are not selectable.

### Maximum Voltage

±40 V (between force and common of each switch)

±40 V (between PSI 21 and PSO 2, between PSI 31 and PSO 3, between PSI 41 and PSO 4, between PSI 51 and PSO 5)

±40 V between PSI 11 (or PSI 12) and PSO 1, between PSI 11 and PSI 12, between PSI 61 (or PSI 62) and PSO 6, between PSI 61 and PSI 62, between PSI 71 (or PSI 72) and PSO 7, between PSI 71 and PSI 72)

### Maximum Current

±0.4 A (from input to output)

### Residual Resistance (supplemental characteristics)

Nominal 1.5 Ω (from IN to OUT)

### OFF Capacitance (supplemental characteristics)

50 pF (between IN and OUT: Vin–Vout = 0 V)

100 pF (force <-> common @ output of make or break, selectable type relay: Vin–Vout = 0 V)

### Operating Time of Switching (supplemental characteristics)

Max. 500 μs



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# DC Measurement Subsystem SMU (Source and Monitor Unit)

### Voltage Source/Monitor Range, Resolution, and Accuracy using HRSMU

| Full Scale Voltage Range | Force Resolution | Measure Resolution: High Speed | Measure Resolution: Precision | Measure Accuracy | Force Accuracy |
|---|---|---|---|---|---|
| ±2 V | 100 μV | 100 μV | 2 μV | a: 0.02%<br>b: 0.025%<br>c: Rmat × Io | a: 0.03%<br>b: 0.035%<br>c: Rmat × Io |
| ±20 V | 1 mV | 1 mV | 20 μV | a: 0.02%<br>b: 0.015%<br>c: Rmat × Io | a: 0.03%<br>b: 0.02%<br>c: Rmat × Io |
| ±40 V | 2 mV | 2 mV | 40 μV | | |
| ±100 V | 5 mV | 5 mV | 100 μV | | |

### Voltage Source/Monitor Range, Resolution, and Accuracy using MPSMU and HPSMU

| Full Scale Voltage Range | Force Resolution | Measure Resolution: High Speed | Measure Resolution: Precision | Force Accuracy | Measure Accuracy |
|---|---|---|---|---|---|
| ±2 V | 100 μV | 100 μV | 2 μV | a: 0.05%<br>b: 0.05%<br>c: Rmat × Io | a: 0.04%<br>b: 0.04%<br>c: Rmat × Io |
| ±20 V | 1 mV | 1 mV | 20 μV | | |
| ±40 V | 2 mV | 2 mV | 40 μV | | |
| ±100 V | 5 mV | 5 mV | 100 μV | | |
| ±200 V[1] | 10 mV | 10 mV | 200 μV | | a: 0.045%<br>b:0.04%<br>c: Rmat × Io |

Force Accuracy is calculated as follows:
±(a % of output setting value + b% of output voltage range + c) (V)
Measure Accuracy is calculated as follows:
±(a % of measure value + b% of measurement voltage range + c) (V)
Io = Output Current, Rmat = Residual Resistance of Swithing Matrix Force Port
Note: Rmat is different at each port. When using prober chuck connection pin, add 0.1 Ω to Rmat.
Low Current Port (SMU1 and SMU2): 1.0 Ω
Kelvin Port: (SMU3 to SMU6); 3 mΩ
Non-Kelvin Port (SMU7 and SMU8): 1.0 Ω

[1]Using HPSMU



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### Current Source/Monitor Range, Resolution, and Accuracy using an MPSMU connected to ports SMU1 and SMU2

| Full Scale Current Range | Force Resolution | Measure Resolution: High Speed | Measure Resolution: Precision | Force Accuracy | Measure Accuracy |
|---|---|---|---|---|---|
| ±100 mA | 5 µA | 5 µA | 100 nA | a: 0.12%<br>b: 0.1 + 0.0005 × Vo %<br>c: 0 | a: 0.1%<br>b: 0.05 + 0.0005 × Vo %<br>c: 0 |
| ±10 mA | 500 nA | 500 nA | 10 nA | | |
| ±1 mA | 50 nA | 50 nA | 1 nA | | |
| ±100 µA | 5 nA | 5 nA | 100 pA | | |
| ±10 µA | 500 pA | 500 pA | 10 pA | | |
| ±1 µA | 50 pA | 50 pA | 1 pA | a: 0.2%<br>b: 0.1 + 0.0005 × Vo %<br>c: 0.02 pA/V × Vo | a: 0.2%<br>b: 0.05 + 0.0005 × Vo %<br>c: 0.02 pA/V × Vo |
| ±100 nA | 5 pA | 5 pA | 100 fA | | |
| ±10 nA | 500 fA | 500 fA | 10 fA | a: 1%<br>b: 0.1 + 0.0005 × Vo %<br>c: 3 pA + 0.02 pA/V × Vo | a: 1%<br>b: 0.1 + 0.0005 × Vo %<br>c: 3 pA + 0.02 pA/V × Vo |
| ±1 nA | 50 fA | 50 fA | 10 fA | | |

Note: The HPSMU cannot be connected to SMU1 and SMU2 ports.
Current measurement ccuracy of the SMU may be affected by elecromagnetic field strength over 3 V/m at a frequency of 26 MHz to 1 GHz.

### Current Source/Monitor Range, Resolution, and Accuracy using HRSMU connected to SMU1 and SMU2 ports

| Full Scale Current Range | Force Resolution | Measure Resolution: High Speed | Measure Resolution: Precision | Force Accuracy | Measure Accuracy |
|---|---|---|---|---|---|
| ±100 mA | 5 µA | 5 µA | 100 nA | a:0.12 %<br>b: 0.05 + 0.0001 × Vo %<br>c: 0 | a: 0.1 %<br>b: 0.04 + 0.0001 × Vo %<br>c: 0 |
| ±10 mA | 500 nA | 500 nA | 10 nA | a: 0.06 %<br>b: 0.04 + 0.0001 × Vo %<br>c: 0 | a: 0.06%<br>b: 0.03 + 0.0001 × Vo %<br>c: 0 |
| ±1 mA | 50 nA | 50 nA | 1 nA | a: 0.06 %<br>b: 0.05 + 0.0001 × Vo%<br>c: 0 | a: 0.06%<br>b: 0.04 + 0.0001 × Vo %<br>c: 0 |
| ±100 µA | 5 nA | 5 nA | 100 pA | a: 0.07 %<br>b: 0.04 + 0.0001 × Vo %<br>c: 0 | a: 0.06%<br>b: 0.035 + 0.0001 × Vo %<br>c: 0 |
| ±10 µA | 500 pA | 500 pA | 10 pA | a: 0.07 %<br>b: 0.05 + 0.0001 × Vo %<br>c: 0 | a: 0.06%<br>b: 0.04 + 0.0001 × Vo %<br>c: 0 |
| ±1 µA | 50 pA | 50 pA | 1 pA | a: 0.12 %<br>b: 0.04 + 0.0001 × Vo %<br>c: 0 | a: 0.12%<br>b: 0.035 + 0.0001 × Vo %<br>c: 0 |
| ±100 nA | 5 pA | 5 pA | 100 fA | a: 0.12 %<br>b: 0.05 + 0.0001 × Vo %<br>c: 1 fA/V × Vo | a: 0.12%<br>b: 0.04 + 0.0001 × Vo %<br>c: 1 fA/V × Vo |
| ±10 nA | 500 fA | 500 fA | 10 fA | a: 1 %<br>b: 0.05 + 0.0001 × Vo %<br>c: 3 pA + 1 fA/V × Vo | a: 1%<br>b: 0.04 + 0.0001 × Vo %<br>c: 3 pA + 1 fA/V × Vo |
| ±1 nA | 50 fA | 50 fA | 10 fA | a: 1%<br>b: 0.07 + 0.0001 × Vo %<br>c: 3 pA + 1 fA/V × Vo | a: 1%<br>b: 0.04 + 0.0001 × Vo %<br>c: 3 pA + 1 fA/V × Vo |
| ±100 pA | 5 fA | 5 fA | 2 fA | a: 4 %<br>b: 0.4 + 0.0001 × Vo %<br>c: 500 fA + 1 fA/V × Vo | a: 4%<br>b: 0.12 + 0.0001 × Vo %<br>c: 500 fA + 1 fA/V × Vo |
| ±10 pA | 1 fA | 2 fA | 1 fA | a: 4 %<br>b: 4.0 + 0.0001 × Vo %<br>c: 500 fA + 1 fA/V × Vo | a: 4%<br>b: 1.0 + 0.0001 × Vo %<br>c: 500 fA + 1 fA/V × Vo |



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# DC Measurement Subsystem SMU (continued)

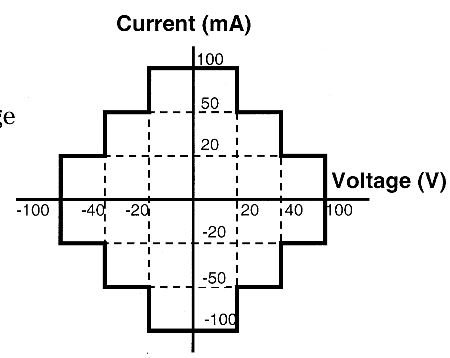
**Current Source/Monitor Range, Resolution, and Accuracy using an MPSMU or HPSMU connected to the SMU3 to SMU8 ports**

| Full Scale Current Range | Force Resolution | Measure Resolution: High Speed | Measure Resolution: Precision | Force Accuracy | Measure Accuracy |
|---|---|---|---|---|---|
| ±1 A[1] | 50 µA | 50 µA | 1 µA | a: 0.5 %<br>b: 0.1 + 0.0005 × Vo%<br>c: 0 | a: 0.5 %<br>b: 0.05 + 0.0005 × Vo %<br>c: 0 |
| ±100 mA | 5 µA | 5 µA | 100 nA | a: 0.12 %<br>b: 0.1 + 0.0005 × Vo %<br>c: 0 | a: 0.1 %<br>b: 0.05 + 0.0005 × Vo %<br>c: 0 |
| ±10 mA | 500 nA | 500 nA | 10 nA | | |
| ±1 mA | 50 nA | 50 nA | 1 nA | | |
| ±100 µA | 5 nA | 5 nA | 100 pA | | |
| ±10 µA | 500 pA | 500 pA | 10 pA | | |
| ±1 µA | 50 pA | 50 pA | 1 pA | a: 0.2 %<br>b: 0.1 + 0.0005 × Vo %<br>c: 300 pA + 10 pA/V × Vo | a: 0.2 %<br>b: 0.05 + 0.0005 × Vo %<br>c: 300 pA + 10 pA/V × Vo |
| ±100 nA | 5 pA | 5 pA | 100 fA | | |
| ±10 nA[2] | 500 fA | 500 fA | 10 fA | a: 1%<br>b: 0.1 + 0.0005 × Vo %<br>c: 303 pA + 10 pA/V × Vo | a: 1 %<br>b: 0.1 + 0.0005 × Vo %<br>c: 303 pA + 10 pA/V × Vo |
| ±1 nA[2] | 50 fA | 50 fA | 10 fA | | |

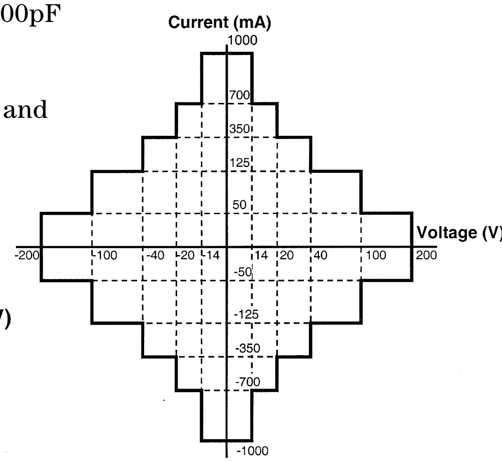
Force Accuracy is calculated as follows: ±(a % of output setting value + b% of output current range + c) (A)
Measure Accuracy is calculated as follows: ±(a % of measured value + b% of current measurement range + c) (A)
Note: The HPSMU can only be connected to the SMU3 and SMU4 ports.
Note: Current measurement ccuracy of the SMU may be affected by elecromagnetic field strength over 3 V/m at a frequency of 26 MHz to 1 GHz.
[1] Using HPSMU, [2] Suplemental characteristics when using the SMU3 to SMU8 ports
Vo = Output voltage

## Maximum Output Voltage/Current

Over Current Range:
  15% of range (0% for 100 mA range of MPSMU/HRSMU, 0% for 1 A range of HPSMU, 5% for 10 pA/100 pA range of HRSMU)
Over Voltage Range:
  V Force: % of range
  V Measure: 10% of range
    (0% for 100 V range of MPSMU, 0% for 200 V range of HPSMU)
Current Compliance Setting Range:
  1 pA to maximum current
Accuracy of converse polar current limit: [3]
  ±2% of range (100 nA to 1 A ranges)
  ±10% of range (10 pA to 10 nA ranges)
Maximum Capacitive Load: ≤1000pF
Maximum Allowable Guard Capacitance:
  250 pF (between signal line and guard line outside of matrix)
Maximum Slew Rate: 0.2 V/µs




Using MPSMU/HRSMU




Using HPSMU

**DC Mearurement Subsystem: Ground Unit (GNDU)**

This unit is used for ground when making measurements.
  Output Voltage: 0 V
  Maximum Current: ±1.6 A
  Offset Voltage: ±200 µV
  Maximum Capacitance Load (Supplemental Charactaristics):
    1 µF

**DC Measurement Subsystem: Digital Volt Meter (Agilent 3458A)**

Voltage Measurement Range, Resolution, and Accuracy (at number of Power Line Cycles ≥1)

| Full-Scale Voltage Range | Resolution | Accuracy (% of reading + volt) |
|---|---|---|
| 0.1 V | 0.1 µV | 0.01% + 100 µV |
| 1 V | 1 µV | 0.01% + 100 µV |
| 10 V | 10 µV | 0.01% + 200 µV |
| 100 V | 100 µV | 0.02% + 1 mV |



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**SMU configuration**

The default SMU configuration depends upon the matrix card that is chosen (standard low-current or ultra low-current). Please refer to the tables below, which show the SMU installation configuration associated with different combinations of SMU resource options.

**SMU installation when using standard low-current matrix cards**

**No HPSMU**

| Port Number | Installed SMU | Installation Order |
|---|---|---|
| 1 | MPSMU | 2 |
| 2 | MPSMU | Fixed |
| 3 | MPSMU | Fixed |
| 4 | MPSMU | Fixed |
| 5 | MPSMU | 1 |
| 6 | MPSMU | 3 |
| 7 | MPSMU | 4 |
| 8 | MPSMU | 5 |

**One HPSMU**

| Port Number | Installed SMU | Installation Order |
|---|---|---|
| 1 | MPSMU | 1 |
| 2 | MPSMU | Fixed |
| 3 | **HPSMU** | **Fixed** |
| 4 | MPSMU | Fixed |
| 5 | MPSMU | Fixed |
| 6 | MPSMU | 2 |
| 7 | MPSMU | 3 |
| 8 | MPSMU | 4 |

**Two HPSMUs**

| Port Number | Installed SMU | Installation Order |
|---|---|---|
| 1 | MPSMU | Fixed |
| 2 | MPSMU | Fixed |
| 3 | **HPSMU** | **Fixed** |
| 4 | **HPSMU** | **Fixed** |
| 5 | MPSMU | Fixed |
| 6 | MPSMU | 1 |
| 7 | MPSMU | 2 |
| 8 | MPSMU | 3 |

**SMU installation when using ultra low-current matrix cards**

**One HRSMU, No HPSMUs**

| Port Number | Installed SMU | Installation Order |
|---|---|---|
| 1 | MPSMU | 2 |
| 2 | **HRSMU** | **Fixed** |
| 3 | MPSMU | Fixed |
| 4 | MPSMU | Fixed |
| 5 | MPSMU | 1 |
| 6 | MPSMU | 3 |
| 7 | MPSMU | 4 |
| 8 | MPSMU | 5 |

**One HRSMU, One HPSMU**

| Port Number | Installed SMU | Installation Order |
|---|---|---|
| 1 | MPSMU | 1 |
| 2 | **HRSMU** | **Fixed** |
| 3 | **HPSMU** | **Fixed** |
| 4 | MPSMU | Fixed |
| 5 | MPSMU | Fixed |
| 6 | MPSMU | 2 |
| 7 | MPSMU | 3 |
| 8 | MPSMU | 4 |

**One HRSMU, Two HPSMUs**

| Port Number | Installed SMU | Installation Order |
|---|---|---|
| 1 | MPSMU | Fixed |
| 2 | **HRSMU** | **Fixed** |
| 3 | **HPSMU** | **Fixed** |
| 4 | **HPSMU** | **Fixed** |
| 5 | MPSMU | Fixed |
| 6 | MPSMU | 1 |
| 7 | MPSMU | 2 |
| 8 | MPSMU | 3 |

**Two HRSMUs, No HPSMUs**

| Port Number | Installed SMU | Installation Order |
|---|---|---|
| 1 | **HRSMU** | **Fixed** |
| 2 | **HRSMU** | **Fixed** |
| 3 | MPSMU | Fixed |
| 4 | MPSMU | Fixed |
| 5 | MPSMU | 1 |
| 6 | MPSMU | 2 |
| 7 | MPSMU | 3 |
| 8 | MPSMU | 4 |

**Two HRSMUs, One HPSMU**

| Port Number | Installed SMU | Installation Order |
|---|---|---|
| 1 | **HRSMU** | **Fixed** |
| 2 | **HRSMU** | **Fixed** |
| 3 | **HPSMU** | **Fixed** |
| 4 | MPSMU | Fixed |
| 5 | MPSMU | Fixed |
| 6 | MPSMU | 1 |
| 7 | MPSMU | 2 |
| 8 | MPSMU | 3 |

**Two HRSMUs, Two HPSMUs**

| Port Number | Installed SMU | Installation Order |
|---|---|---|
| 1 | **HRSMU** | **Fixed** |
| 2 | **HRSMU** | **Fixed** |
| 3 | **HPSMU** | **Fixed** |
| 4 | **HPSMU** | **Fixed** |
| 5 | MPSMU | Fixed |
| 6 | MPSMU | Fixed |
| 7 | MPSMU | 1 |
| 8 | MPSMU | 2 |

Note:
Installation Order indicates the order in which additional MPSMUs must be installed.



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## Capacitance Measurement Subsystem High-Speed CMU (Capacitance Measurement Unit)

Measurement accuracy is specified between any two measurement pins except the chuck connection pin.

Measurement Range:

1 fF to 1.2 nF and 10 nS to 7.5 mS (1 MHz)

1 fF to 10 nF and 1 nS to 6.3 mS (100 kHz)

1 fF to 100 nF and 0.1 nS to 6.3 mS (10 kHz)

10 fF to 100 nF and 0.1 nS to 63 mS (1 kHz)

**Measurement Frequency:**

Setting range 1 kHz to 2 MHz (34 points.

Note: Capacitance and conductance measurement accuracy is specified only when the measurement frequency is set to 1 kHz, 10 kHz, 100 kHz or 1 MHz,

**Test Signal Level:**

Setting range 10 mV, 30 mV, 50 mV, and 100 mV

**DC Bias Range and Accuracy**

Full-scale voltage range: ±10 V

Setting resolution: 1 mV

Force accuracy: ±(0.1% of setting + 10 mV)

**C/G Measurement Range, Resolution, and Accuracy**

| Frequency | C Range | C Accruacy ±(% of reading + % of range) | G Range | G Accuracy ±(% of reading + % of range) |
|---|---|---|---|---|
| 2 MHz* | 7 pF | 3.2 % + [6.3 + (2.3 × Gm/88 μS)]% | 88 μS | 3.2% + [6.5 + (2.5 × Cm/7 pF)]% |
| | 70 pF | 2.8 % + [2.3 + (1.9 × Gm/880 μS)]% | 880 μS | 2.8% + [2.4 + (2.1 × Cm/70 pF)]% |
| 1 MHz | 10 pF* | 0.8% + [1.1 + (0.6 × Gm/63 μS)]% | 63 μS* | 0.8% + [1.1 + (0.6 × Cm/10 pF)]% |
| | 100 pF | 0.7% + [0.4 + (0.5 × Gm/630 μS)]% | 630 μS | 0.7% + [0.4 + (0.5 × Cm/100 pF)]% |
| | 1 nF | 1.5% + [0.3 + (2.1 × Gm/6.3 mS)]% | 6.3 mS | 1.5% + [0.3 + (2.2 × Cm/1 nF)]% |
| 100 kHz | 10 pF* | 0.4% + [1.1 + (0.3 × Gm/6.3 μS)]% | 6.3 μS* | 0.4% + [1.1 + (0.4 × Cm/10 pF)]% |
| | 100 pF | 0.2% + [0.4 + (0.2 × Gm/63 μS)]% | 63 μS | 0.2% + [0.4 + (0.2 × Cm/100 pF)]% |
| | 1 nF | 0.2% + [0.3 + (0.4 × Gm/630 μS)]% | 630 μS | 0.2% + [0.3 + (0.4 × Cm/1 nF)]% |
| | 10 nF | 0.5% + [0.3 + (1.0 × Gm/6.3 mS)]% | 6.3 mS | 0.5% + [0.3 + (1.0 × Cm/10 nF)]% |
| 10 kHz | 100 pF | 0.3% + [0.2 + (0.3 × Gm/6.3 μS)]% | 6.3 μS | 0.3% + [0.2 + (0.3 × Cm/100 pF)]% |
| | 1 nF | 0.2% + [0.2 + (0.2 × Gm/63 μS)]% | 63 μS | 0.2% + [0.2 + (0.2 × Cm/1 nF)]% |
| | 10 nF | 0.2% + [0.2 + (0.2 × Gm/630 μS)]% | 630 μS | 0.2% + [0.2 + (0.2 × Cm/10 nF)]% |
| | 100 nF | 0.3% + [0.2 + (1.0 × Gm/6.3 mS)]% | 6.3 mS | 0.7% + [0.2 + (0.7 × Cm/100 nF)]% |
| 1 kHz | 100 pF* | 0.3% + [0.4 +(0.3 × Gm/0.63 μS)]% | 0.63 μS* | 0.3% + [0.4 + (0.3 × Cm/100 pF)]% |
| | 1 nF | 0.3% + [0.1 + (0.3 × Gm/6.3 μS )]% | 6.3 μS | 0.3% + [0.1 + (0.3 × Cm/1 nF)]% |
| | 10 nF | 0.3% + [0.1 + (0.3 × Gm/63 μS)]% | 63 μS | 0.3% + [0.1 + (0.3 × Cm/10 nF)]% |
| | 100 nF | 0.3% + [0.1 + (0.3 × Gm/630 μS)]% | 630 μS | 0.3% + [0.1 + (0.3 × Cm/100 nF)]% |

* Supplemental Characteristics

Gm: Measured conductance
Cm: Measured capacitance
Conductance and capacitance measurements are specified under the following conditions:
Measurement frequency: 1 kHz, 10 kHz, 100 kHz, or 1 MHz
Integration time: MEDIUM or LONG
Test signal level: 30 mVrms
Stray capacitance: Mustbe under 5 pF between force and guard
Calibration and offset cancel: Specifications are valid for the data after calibration data measurement and offset canel.
Capacitance measurement accuracy of HSCMU may be affected by conducted RF field strength over 3 $V_{rms}$ at frequency range of 1 MHz to 20 MHz.



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## Z/θ Measurement Accuracy (Supplemental Characteristics)

The following table shows the supplemental characteristics of the impedance (Z) and phase (θ) measurement accuracy:

| Frequency | C Range | C Accuracy ± (% of reading + % of range) | θ Accuracy |
|---|---|---|---|
| 1 MHz | 10 kΩ<br>1 kΩ<br>100 Ω | 0.8% + 1.8%<br>0.7% + 0.6%<br>1.5% + 0.5% | ±0.26 rad<br>±0.02 rad<br>±0.02 rad |
| 100 kHz | 100 kΩ<br>10 kΩ<br>1 kΩ<br>100 Ω | 0.4% + 1.8%<br>0.2% + 0.6%<br>0.2% + 0.5%<br>0.5% + 0.5% | ±0.03 rad<br>±0.01 rad<br>±0.01 rad<br>±0.01 rad |
| 10 kHz | 100 kΩ<br>10 kΩ<br>1 kΩ<br>100 Ω | 0.3% + 0.3%<br>0.2% + 0.3%<br>0.2% + 0.3%<br>0.3% + 0.3% | ±0.01 rad<br>±0.01 rad<br>±0.01 rad<br>±0.01 rad |
| 1 kHz | 100 kΩ<br>10 kΩ<br>1 kΩ | 0.3% + 0.2%<br>0.3% + 0.2%<br>0.3% + 0.2% | ±0.01 rad<br>±0.01 rad<br>±0.01 rad |

## Agilent E4980A LCR Meter

Accuracy is specified between any two output pins except chuck connection pin.

Measurement range:

1 fF to 1.2 nF and 10 nS to 7.5 mS (1 MHz)

1 fF to 10 nF and 1 nS to 6.3 mS (100 KHz)

1 fF to 100 nF and 0.1 nS to 6.3 mS (10 KHz)

10 fF to 100 nF and 0.1 nS to 0.63 mS (1 KHz)

Measurement frequency:

1 KHz, 10 KHz, 100 KHz, and 1 MHz

DC Bias Voltage: ±40V

Measurement speed:

MEDIUM or LONG

Note: Above specifications are valid after calibration data measurement and offset cancel.

| Full-Scale Voltage Range | Force Accuracy ±(% of reading % of range + volt) |
|---|---|
| ±40 V | 0.1% + 10 mV |

### DC Bias Range and Accuracy

Accuracy is specified between CMH and CML pins.

Test signal level: 30 mV (rms)

Bias Current Isolation Function: OFF

### C/G Measurement Range, Resolution, and Accuracy

| Frequency | C Range | C Accuracy % of reading + % of range | G Range | G Accuracy % of reading + % of range |
|---|---|---|---|---|
| 1 MHz | 10 pF [1] | 0.8% + [1.0 + (0.6 × $Gm^2$/63 µS)]% | 63 µS[1] | 0.8% + [1.0 + (0.6 × $Cm^3$/10 pF)]% |
| | 100 pF | 0.8% + [0.3 + (0.6 × Gm/630 µS)]% | 630 µS | 0.8% + [0.3 + (0.6 × Cm/100 pF)]% |
| | 1 nF | 1.5% + [0.2 + (1.7 × Gm/6.3 mS)]% | 6.3 mS | 1.3% + [0.2 + (2.2 × Cm/1 nF)]% |
| 100 KHz | 10 pF [1] | 0.4% + [1.0 + (0.3 × Gm/6.3 µS)]% | 6.3 µS[1] | 0.4% + [1.0 + (0.4 × Cm/10 pF)]% |
| | 100 pF | 0.3% + [0.3 + (0.3 ´ Gm/63 µS)]% | 63 µS | 0.3% + [0.3 + (0.3 × Cm/100 pF)]% |
| | 1 nF | 0.3% + [0.2 + (0.4 × Gm/630 µS)]% | 630 µS | 0.3% + [0.2 + (0.4 × Cm/1 nF)]% |
| | 10 nF | 0.5% + [0.2 + 1.0 × (Gm/6.3 mS)]% | 6.3 mS | 0.7% + [0.2 + (0.8 × Cm/10 nF)]% |
| 10 KHz | 100 pF | 0.3% + [0.2 + (0.3 × Gm/6.3 µS)]% | 6.3 µS | 0.3% + [0.2 + (0.3 × Cm/100 pF)]% |
| | 1 nF | 0.3% + [0.1 + (0.3 × Gm/63 µS)]% | 63 µS | 0.3% + [0.1 + (0.3 × Cm/1 nF)]% |
| | 10 nF | 0.3% + [0.1 + (0.3 × Gm/630 µS)]% | 630 µS | 0.3% + [0.1 + (0.3 × Cm/10 nF)]% |
| | 100 nF | 0.3% + [0.1 + (1.0 × Gm/6.3 mS)]% | 6.3 mS | 0.7% + [0.1 + (0.7 × Cm/100 nF)]% |
| 1 KHz | 100 pF [1] | 0.4% + [0.5 +(0.4 × Gm/0.63 µS)]% | 0.63 µS[1] | 0.4% + [0.5 + (0.4 × Cm/100 pF)]% |
| | 1 nF | 0.3% + [0.1 + (0.3 × Gm/6.3 µS )]% | 6.3 µS | 0.3% + [0.1 + (0.3 × Cm/1 nF)]% |
| | 10 nF | 0.3% + [0.1 + (0.3 × Gm/63 µS)]% | 63 µS | 0.3% + [0.1 + (0.3 × Cm/10 nF)]% |
| | 100 nF | 0.3% + [0.1 + (0.3 × Gm/630 µS)]% | 630 µS | 0.3% + [0.1 + (0.3 × Cm/100 nF)]% |

[1]Supplemental Characteristics
[2]Gm = Measured conductance
[3]Cm = Measured capacitance

Note: Accuracy is specified between any DUT pins. Stray capacitance between force and guard must be under 5 pF.
Frequency accuracy: ±0.1%; Test signal level: 30 mVrms ± 5 $mV_{rms}$
When measurement speed is set to SHORT, add 0.25% to the % of reading and 0.1% to the % of range.
When Open/Short calibrations at the DUT pins are carried out, accuracy is the same as in the above table. (Note that the length of cable from the output pins must be less than 1 meter, and capacitance to guard must be under 100 pF.)



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## Optional Pulse Force Unit

**Supported Pulse Generators**
High-voltage semiconductor pulse generator unit (HV-SPGU) modules

**Installable HV-SPGU modules:**
5 maximim

**Channels per HV-SPGU module**
2

**Pulse Force Mode**
Pulse Signal: Each HV-SPGU module supports 2-level and 3-level pulses

**Output Mode**
All pulse generator channels (up to 10) can force synchro nously

**HV-SPGU Output Impedance**
50 Ω

**HV-SPGU Load Impendance**
0.1 Ω to 1 MΩ

### Pulse Setting Range

**Pulse Level** (at open load)
±40 V (at 2-level and 3-level)

**Pulse Period** (at 50 Ω load)
350 ns to 10 s with 10 ns resolution

**Pulse Width** (at 50 Ω load)
50 ns to [Period –50 ns] with 2.5 ns[1] or 10 ns[2] resolution

**Pulse Delay** (at 50 Ω load)
0 s to [Period –75 ns] with 2.5 ns[1] or 10 ns[2] resolution

**Transition Time** (at 50 Ω load)
20 ns to 400 ms with 2 ns[1] or 8 ns[2] resolution

**Transition Time Minimum** (at 50 Ω load)
20 ns[3], 30 ns[4]

[1] Transition time setting ≤10 µs
[2] Transition time setting >10 µs
[3] |Vamp| ≤10 v (to 50 Ω)
[4] 10 V <|Vamp| ≤20 V (to 50 Ω)

**Pulse Amplitude** (at open load)
0 to 80V peak-to-peak

**Pulse Level Resolution** (at open load)
2 mV (Vout ≤10 V)
10 mV (Vout >10 V)

**Pulse Level Accuracy** (at open load)
±(2% + 150 mV)

**Pulse Shape Accuracy** (at 50 Ω load)
Delay: ±(3% + 1 ns)
Transition Time: –5% to (+ 5% + 35 ns)
Overshoot/Ringing: + (5% of amplitude +20 mV)
Skew between pins: ±10 ns

**Pulse Shape Accuracy** (reference data at 50 kΩ load)
Transition Time: –5% to (+ 5% + 35 ns)
Overshoot/Ringing: ±(5% of amplitude +20 mV)
Skew between pins: ±10 ns

## RF Measurement Subsystems

### Direct Docking RF Interface

The 4083A provides the following:
- Ten SMA-compatible precision blindmate RF connectors
- Frequency range of DC to 20 GHz

### RF S-Parameter and RFCV Measurement

Supported Network Analyzer:
Agilent E8362B PNA Series Network Analyzer

RF Ports: Up to 2

Frequency Range:
10 MHz to 20 GHz (E8362B)

Output Power Range:
–87 dBm to 0 dBm at 10 GHz
–87 dBm to –5 dBm at 20 GHz

Damage Level:
30 dBm or ±40 V (Using Direct Connect)
30 dBm or ±7 V (Using RF Matrix)

Dynamic Range:
110 dB

DC Absolute Voltage:
±40 V (Using Direct Connect)
±7 V (Using RF Matrix)

DC Absolute Current:
200 mA (Using Direct Connect)
140 mA (Using RF Matrix)

### RF Direct Connect Path

Number of RF Input Ports: 2

Number of RF Output Ports:
10 available (2 usable)

Frequency Range: DC to 20 GHz

Damage Level:
30 dBm or ±40 V

Supplemental Characteristics:
Input Impedance: 50 Ω
Insertion Loss: 1 dB at 1 GHz; 3 dB at 10 GHz; 4 dB at 20 GHz
Standing Wave Ratio (SWR): 1.5 at 10 GHz; 2.0 at 20 GHz
Crosstalk: 100 dB at 20 GHz
Propagation Delay: 6 ns

### Optional RF Matrix

Number of RF Input Ports: 8

Number of RF Output Ports: 10

Frequency Range: DC to 20 GHz

Damage Level:
30 dBm or ±7 V (Wet switching not allowed)

Supplemental Characteristics:
Input Impedance: 50 Ω
Insertion Loss: 2 dB at 1 GHz; 4 dB at 10 GHz; 6 dB at 20 GHz
Standing Wave Ratio (SWR): 1.5 at 10 GHz; 2.0 at 20 GHz
Crosstalk: 100 dB at 20 GHz
Propagation Delay: 10 ns
Switching Speed: 15 ms



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## Linux System Controller

**Supported Computer**
HP xw8400 Workstation

**Operating System**
RedHat Enterprise Linux WS4 Update3

BASIC/LX (12.2-1), SICL or C/ANSI C, SICL

**Required Memory**
1 GB

**Required Disk**
20 GB

## System Software

Standard 4083A software provides the following capabilities:

- System Management
- Control of subsystems (TIS Library)
- Parameter measurement utility (PARA Library)
- Off-line debugging
- Interactive Debugging Panel (IDP: Includes Test Algorithm Code Generating Function)
- Automatic Diagnostics

## Agilent Semiconductor Process Evaluation Core Software (SPECS)[1]

Agilent SPECS is a test shell environment for the 4080 Series. Users have full access to the Linux environment from within the test shell

**Test Development**
User interaction occurs via a graphical interface with spreadsheet-like operation. Test plans require simple specifications: wafer, die, test, and probe.

**Customization**
Agilent supplies basic development, engineering, and operator test shell frameworks, which users can tailor or modify to create entirely new frameworks.

**Analysis & Output**
All data is output into a flat ASCII file which users can manipulate to allow for input into database software. In addition, the data management structure supports x-y graphs, histograms, and wafer maps.

[1] The 4080 Series requires SPECS version D.03.10 or later.

## Agilent SPECS-FA

SPECS-FA, the factory automation version of Agilent's SPECS test shell, runs on all models of the 4080 Series tester family. SPECS-FA fully supports SEMI automation standards E5 (SECS II), E30 (GEM), E87 (CMS), E39 (OSS), E40 (PMS), E90 (STS), and E94 (CJM).

## Parallel Test Capability

4080 Series testers support both synchronous and asynchronous parallel test. Agilent SPECS and SPECS-FA support a powerful virtual multiple testhead technology that enables separate measurement threads to run completely independently of one another. This eliminates measurement "dead time" (time spent waiting for other measurement threads to complete) and maximizes throughput.



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## General Specifications

Accuracy is specified at:
Temperature: 23°C ± 5°C
Humidity: 15% to 70% RH[1]
Warm up: At least 60 min.
Self-calibration: Within one hour after calibration
Integration Time: Medium or Long[2]

[1] 5% to 60% RH (no condensation) for current measurement accuracy of the HRSMU in 10 pA to 100 nA range and isolation resistance of the low-current port

[2] For SMU current ranges that are less than or equal to 1 nA, the integration time must be Long (16 PLC or longer).

Note: The temperature changes after calibration must be less than 3 °C.

### Power Requirement

| Nominal Line Voltage[3] | Allowable Voltage Range | Required Maximum Current |
|---|---|---|
| 200 Vac | 180 - 220 Vac | 30 A |
| 208 Vac | 188 - 228 Vac | 24 A |
| 220 Vac | 198 - 242 Vac | 30 A |
| 240 Vac | 216 - 252 Vac | 30 A |

[3] Line frequency must be 48 Hz to 63 Hz.

Operating Temperature Range: 5°C to 30°C (no condensation)
Operating Humidity range: 15% to 70% (no condensation)
Storage Temperature Range: –20°C to 50°C (< 80% RH, no condensation) [4]
Warm up time: at least 60 minutes

[4] For an unpacked system, –20° C to 60 °C (< 90% RH, <12 hrs).

### Regulatory and Standard Compliance:

EMC:
EMC Directive 89/336/EEC, 93/68/EEC
EN61326-1
ICES-001
AS/NZS 2064.1

Safety:
Low Voltage Directive 73/23/EEC, 93/68/EEC
EN61010-1
CSA C22.2 No. 61010-1-4
UL Standard No 61010 (2nd Edition)

### Certification marking

CE, CSA, NRTL/C, C-tick, ICES/NMB-001

### Dimensions

System Cabinet: 600 mm (W) x 905 mm (D) x 1800 mm (H)

Test Head: 780 mm (W) x 680 mm (D) x 480 mm (H)

### Weight

System Cabinet: 294 kg (including 3458A, SPGU with 5 x HV-SPGU, system controller)

Test Head: 166 kg (including 7 MPSMUs, 1 HPSMU, 1 HS-CMU, 48 pins, HF Matrix, RF Matrix, Manipulator Extension Shelf and PNA (E8363B) with enclosure, fan, and duct)

### Supported Auto Probers[5]

TEL P12XL and Precio
ACCRETECH UF3000 and UF3000EX

### Recommended Probe Cards[5]

The following probe cards are for making standard low-current measurements.
JEM (Japan Electronic Material), MJC (Micronics Japan Co.), SV Probe, FormFactor, CMI (Cascade Microtech, Inc.), and GGB (GGB Industries, Inc.)

Note: CMI and GGB also supply probe cards that are capable of making RF measurements up to 20 GHz.[6]

[5] Please contact your local sales representative regarding the latest information on recommended probers and probe cards.

[6] When making RF measurements, the RF docking interface may strike your existing probe card if the card has a handle or plate that exceeds the allowable dimensions. Please contact your local sales representative regarding this issue.

For probe cards capable of making ultra low-current measurement, please refer to the recommendations in the section on the following page.



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## Recommended Conditions for Ultra-Low Current and Low Voltage Measurements[7]

In addition to the conditions listed in General Specifications, Agilent Technologies recommends that the following additional conditions be satisfied for measuring precise low current and low voltage with the 4083A.

[7]The information is this section applies only to systems configured with ultra low-current matrix cards and a high-resolution SMU.

Probe cards:[8]
JEM and MJC
Temperature: Within ±1°C after calibration
Temperature change period: ≥10 minutes
Humidity: ≤50 %
Warm up time: ≥60 minutes
Floor vibration: ≤1 mG
Floor vibration frequency: ≥10 Hz

Air cleanliness: ≤class 10,000
Line voltage: Burst noise ≤1 kV,
Surge noise ≤1 kV
This line voltage enviroment applies EN61326–1

[8]Please contact your local sales representative regarding the latest information on recommended probers and probe cards. The 4083A requires special prober functionalitiy to perform RF measurements. Please contact your prober vendor to obtain the proper prober configuration when making RF measurements with the 4083A.



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**Americas**
Brazil (11) 4197-3600
Canada (French) 1 877 894-4414
Canada (English) 1 800 447-8378
Mexico 33 134-5841
United States 1 800 829-4444

**Asia/Asia Pacific**
Australia 1 800 629-485
China 1 800 276-3059
Hong Kong 852 2599 7889
India 91/11 690-6156
Japan 0120 421-345
Malaysia 1 800 880-780
New Zealand 0 800 738 378
Philippines 1 800 1651-0135
Singapore 1 800 276-3059
South Korea 080 778-0011
Taiwan 0 800 047-662
Thailand 1 800 2758-5822

**Europe**
Austria (01) 25 125-7183
Belgium (0) 2 404-9380
Denmark 080301040
Finland 20 547-9999
France (0) 825 010710
Germany (0) 18 05 24-63 34
Greece 20 547-9999
Ireland 016158393
Italy 02 92 60 8333
Luxembourg (0) 2 404-9340
Netherlands (0) 20 547-9999
Poland 20 547-9999
Russia 20 547-9999
Spain 91 631 3383
Sweden 020 120-9975
Switzerland (Italian) (0) 2 92 60 8484
Switzerland (German) (0) 1 735-9300
Switzerland (French) (0) 825 010 700
United Kingdom (0) 7004 222-222

**Middle East**
Israel 20 547-9999



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