

# 4082F Flash Memory Cell Parametric Test System

Keysight 4080 Series

Easy to use and simple to operate NAND flash cell testing system is essential to evaluate and produce NAND cell in volume manufacturing. Keysight offers the fast and precise measurements with 4082F flash memory cell parametric test system including built-in semiconductor pulse generator unit (SPGU) and optional high-frequency switching matrix.



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## Solution Overview

Keysight 4082F flash memory cell parametric test system is designed to perform fast and precise DC measurements, capacitance measurements, flash cell test and other high frequency applications such as ring oscillator 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 pin is dedicated to chuck connection.

The Keysight 4082F comes standard with a semiconductor pulse generator unit (SPGU) mainframe that supports up to five high-voltage SPGUs (HV-SPGUs). An optional Keysight 4082F flash memory cell parametric test system high frequency (HF) switching matrix with integrated SPGU is also available. The HF matrix is organized as 3 x 4 matrices (six inputs in total), and 1 TO 2 furnished cables may be used on each matrix pair to create 3 x 48 matrix (three inputs in total). The system also has one 1.6 A ground unit.

The 4082F can be provided in either a low-current or an ultra-low current configuration, depending upon the type of matrix card specified. Only 4082F models containing the ultra-low current matrix cards can be the high-resolution SMU (HRSMU). An optional high-speed capacitance measurement unit (HS-CMU) is available for the 4082F, 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.

## Primary Test Target

NAND flash cell testing in R&D and volume manufacturing.

## Measurement Functions

DC current, DC voltage, capacitance and conductance, impedance, and differential voltage.

## Key Measurement Capabilities

- DC measurements (spot, sweep, pulse bias, pulse sweep)
- Capacitance, conductance and impedance measurements
- Two terminal differential voltage measurements
- High frequency pulse force
- Switching matrix

DC measurement		
Measurement unit		HRSMU (High Resolution SMU) <sup>1</sup>
		MPSMU (Medium Power SMU)
		HPSMU (High Power SMU)
Measurement functions		Spot, sweep, pulse bias, and pulse sweep
Measurement range	Using two low current SMU ports	1 fA <sup>2</sup> to 100 mA, 2 $\mu$ V to 100 V
	Using six standard SMU ports	10 fA to 1 A <sup>3</sup> , 2 $\mu$ V to 200 V <sup>3</sup>
Capacitance, conductance, and impedance measurement		
Measurement unit		HS-CMU (High Speed Capacitance Measurement Unit)
		Keysight E4980A LCR meter
HS-CMU	Measurement functions	C/G, C/G-V, C/G-V/f, Z/ $\theta$ and Z/ $\theta$ -f
	Measurement frequencies	1 kHz to 2 MHz, 34 points
	Measurement ranges	1 fF to 100 nF, 0.1 nS to 7.5 mS
	DC bias voltage	$\pm$ 10 V
Keysight E4980A	Measurement functions	C/G and C/G-V
	Measurement frequencies	1 kHz, 10 kHz, 100 kHz, and 1 MHz
	Measurement ranges	1 fF to 100 nF, 0.1 nS to 7.5 mS
	DC bias voltage	$\pm$ 40 V

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

<b>Two terminal differential voltage measurements</b>	
Measurement unit	Keysight 3458A/34470A
Measurement range	0.1 $\mu$ V to 100 V (only when using ultra-low current matrix cards), or 1 $\mu$ V to 100V
<b>High frequency pulse force</b>	
The 4082F cabinet supports an optional high-voltage semiconductor pulse generation unit (HV-SPGU) mainframe that contains the SPGU modules.	
Maximum number of installable HV-SPGU modules	5
Number of channels per HV-SPGU modules	2
Pulse level support	Each HV-SPGU channel supports 2-level and 3-level pulses
Pulse level (at open load)	$\pm$ 40 V (at 2-level and 3-level)
Pulse period (at 50 $\Omega$ load)	350 ns to 10 s with 10 ns resolution
Pulse width (at 50 $\Omega$ load)	50 ns to [Period – 50 ns] with 2.5 ns <sup>1</sup> or 10 ns <sup>2</sup> resolution
Pulse delay (at 50 $\Omega$ load)	0 s to [Period – 75 ns] with 2.5 ns <sup>1</sup> or 10 ns <sup>2</sup> resolution
Transition time setting range (at 50 $\Omega$ load)	20 ns to 400 ms with 2 ns <sup>1</sup> or 8 ns <sup>2</sup> resolution
Transition time minimum (at 50 $\Omega$ load)	20 ns <sup>3</sup> , 30 ns <sup>4</sup>
<b>Switching matrix</b>	
Number of measurement pins	Between 12 and 48 pins Note: One additional pin is dedicated for the prober chuck connection.
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

1. Transition time setting  $\leq$  10  $\mu$ s
2. Transition time setting  $>$  10  $\mu$ s
3.  $|V_{amp}| \leq$  10 V (to 50  $\Omega$ )
4.  $10 \text{ V} < |V_{amp}| \leq$  20 V (to 50  $\Omega$ )

## Specifications

Accuracy is specified under the conditions below.

Specification conditions	
Temperature	23 °C ± 5 °C <sup>1</sup>
Humidity	15% to 70% RH <sup>2</sup>
Warm up time	At least 60 minutes
Self-calibration	Within one hour after calibration
Integration time	Medium or long <sup>3</sup>
Performance test	Should be performed annually

1. Less than ±3 °C temperature changes and within one hour after self adjustment
2. 15% 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.
3. 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.

## Switching Matrix Subsystem

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.
SMU port in test head	Eight SMUs + one GNDU <ul style="list-style-type: none"> <li>- Two ports for low-current measurement (Non-Kelvin)</li> <li>- Four ports (Kelvin)</li> <li>- Two ports (Non-Kelvin)</li> <li>- One port for GNDU (Kelvin)</li> </ul>
Maximum number of instrument ports	Six for external instruments (digital voltmeter, etc.) and two for HS-CMU or E4980A <ul style="list-style-type: none"> <li>- Two triaxial input ports (Force/guard/common, AUX ports 1 and 2)</li> <li>- Four BNC two-pair input ports (Force/common and sense/common, AUX ports 3 to 6)</li> <li>- Two BNC input ports (Force/common, AUX ports 7 and 8, connected to HS-CMU in default)</li> </ul>
Extended path	48 extended paths The system provides one on/off relay for each path.
SMU port in test head	±200 V
AUX port	±200 V (AUX ports 1 and 2) ±100 V (AUX ports 3 to 8)
Maximum voltage at each port	Optional HF ports <ul style="list-style-type: none"> <li>±100 V (between force and common of each HF port)</li> <li>±100 V (between two of forces of all HF ports)</li> <li>±100 V (between any force of HF ports and any force of extended paths)</li> </ul>
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 path)
Zero reference	±200 mV

	SMU port in test head	$\pm 1.0$ A
	AUX port	$\pm 1.0$ A
Maximum current, port to DUT pin	GNDU	$\pm 1.6$ A
	Optional HF ports	$\pm 0.5$ A
	Extended path	$\pm 0.5$ A
Maximum residual resistance	Through AUX port	Low current port: Force $1.0 \Omega$ Kelvin port: Force $1.0 \Omega$ , Sense $2.5 \Omega$ Non-Kelvin port: Force $1.0 \Omega$
Maximum stray capacitance between DUT pins		$3 \text{ pF}^1$
Isolation resistance		Low current (with guard): $1 \times 10^{15} \Omega^1$
<b>Optional high frequency (HF) ports</b>		
Maximum number of instrument ports		Six ports for external instruments. HF ports 1 through 3 can access measurement pins 1 through 24, and HF port 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 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.
Maximum residual resistance		$2.0 \Omega^1$
Optional HF port bandwidth (@ -3 dB)		$60 \text{ MHz}^1$ ( $50 \Omega$ load impedance from port to DUT pin, 3 x 24 configuration)
Optional HF port cross talk between pins		$\pm 2\%^1$ ( $5 \text{ k}\Omega$ load impedance: from port to DUT pin, 20 ns pulse transition time)

1. Supplemental characteristics



# Test Head Circuit Diagram

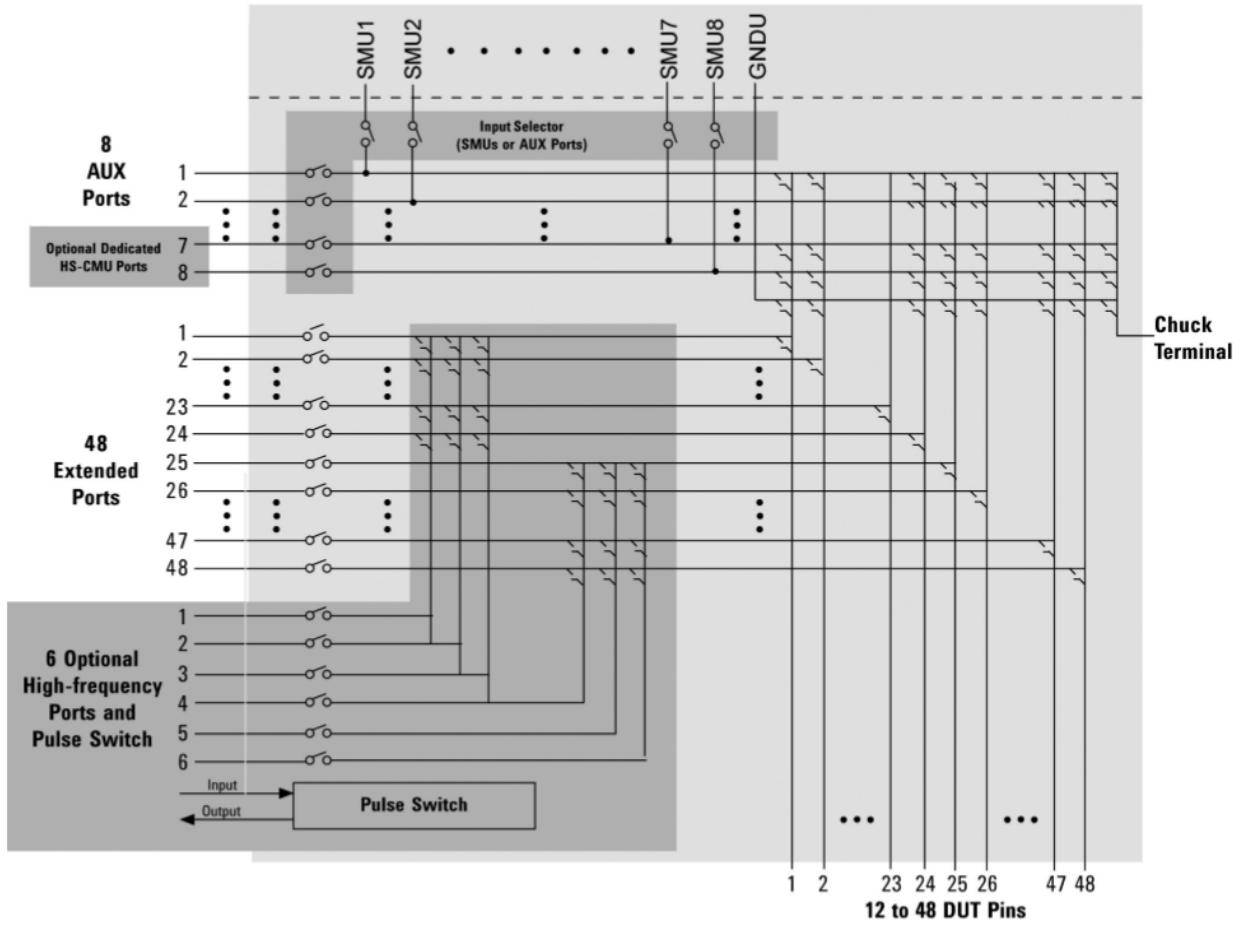


Figure 1: Test Head Circuit Diagram

## 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 4082F test head.

Maximum number of instrument ports	Refer to page 5
Number of blocks	2
Number of switches of each block	Block 1: Three relays (make or break, selectable type) and 1 relay (transfer type to create multilevel pulse) Block 2: One relay (make or break, selectable type) and two relays (transfer type to create multilevel 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 PGH 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 selectable.
Maximum voltage	$\pm 40$ V Between force and common of each switch Between PSI 21 and PSO 2 Between PSI 31 and PSO 3 Between PSI 41 and PSO 4 Between PSI 51 and PSO 5 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	$\pm 0.4$ A (from input to output)
Maximum residual resistance	Nominal $1.5 \Omega^1$ (from IN to OUT)
OFF capacitance	50 pF (between IN and OUT: $V_{in}-V_{out} = 0$ V) <sup>1</sup> 100 pF (between force and common @ output of make or break, selectable type relay: $V_{in}-V_{out} = 0$ V) <sup>1</sup>
Operating time of switching	Max. 500 $\mu$ s <sup>1</sup>

1. Supplemental characteristics

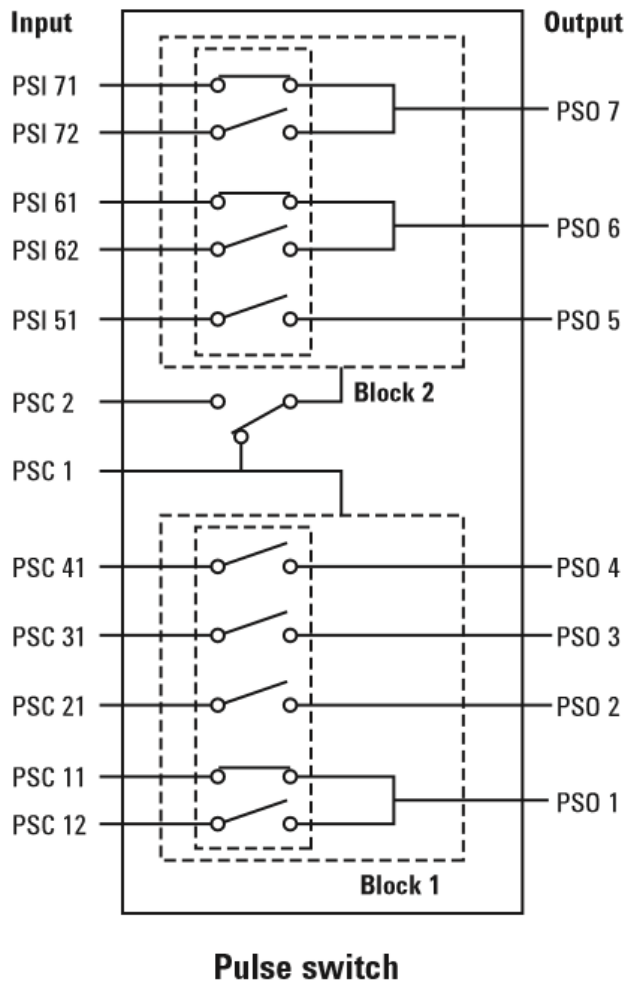


Figure 2: Pulse switch diagram

## 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	Force accuracy	Measure accuracy
±2V	100 µV	100 µV	2 µV	a: 0.02% b: 0.025% c: Rmat x I <sub>o</sub>	a: 0.03% b: 0.035% Rmat x I <sub>o</sub>
±20 V	1 mV	1 mV	20 µV		
±40 V	2 mV	2 mV	40 µV	a: 0.02% b: 0.015% c: Rmat x I <sub>o</sub>	a: 0.03% b: 0.02% c: Rmat x I <sub>o</sub>
±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		
±20 V	1 mV	1 mV	20 µV		
±40 V	2 mV	2 mV	40 µV	a: 0.05% b: 0.05% c: Rmat x I <sub>o</sub>	a: 0.04% b: 0.04% c: Rmat x I <sub>o</sub>
±100 V	5 mV	5 mV	100 µV		
±200 V <sup>1</sup>	10 mV	10 mV	200 µV		a: 0.045% b: 0.04% c: Rmat x I <sub>o</sub>

#### 1. Using HPSMU

Note: Force accuracy is given by ±(a% of output setting value + b% of output range + c) V

Measure accuracy is given by ±(a% if measured value + b% of measurement range + c) V

I<sub>o</sub> = Output current, R<sub>mat</sub> = Residual resistance of switching matrix force port

Note: R<sub>mat</sub> is different at each port. When using prober chuck connection pin, add 0.1 Ω to R<sub>mat</sub>.

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

Current source/monitor range, resolution, and accuracy using 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		
±10 mA	500 nA	500 nA	10 nA		
±1 mA	50 nA	50 nA	1 nA	a: 0.12% b: 0.1 + 0.0005 x Vo % c: 0	a: 0.1% b: 0.05 + 0.0005 x Vo % c: 0
±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% b: 0.1 + 0.0005 x Vo % c: 0.02 pA/V x Vo	a: 0.2% b: 0.05 + 0.0005 x Vo % c: 0.02 pA/V x Vo
±100 nA	5 pA	5 pA	100 fA		
±10 nA	500 fA	500 fA	10 fA	a: 1% b: 0.1 + 0.0005 x Vo % c: 3 pA + 0.02pA/V x Vo	a: 1% b: 0.1 + 0.0005 x Vo % c: 3 pA + 0.02pA/V x Vo
±1 nA	50 fA	50 fA	10 fA		

Note: The HPSMU cannot be connected to SMU1 and SMU2 ports.

Current measurement accuracy of the SMU may be affected by electromagnetic field strength over 3 V/m at a frequency of 80 MHz to 1 GHz.

Current source/monitor range, resolution, and accuracy using HRSMU 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% b: 0.05 + 0.0001 x Vo % c: 0	a: 0.1% b: 0.04 + 0.0001 x Vo % c: 0
±10 mA	500 nA	500 nA	10 nA	a: 0.06% b: 0.04 + 0.0001 x Vo % c: 0	a: 0.06% b: 0.03 + 0.0001 x Vo % c: 0
±1 mA	50 nA	50 nA	1 nA	a: 0.06% b: 0.05 + 0.0001 x Vo % c: 0	a: 0.06% b: 0.04 + 0.0001 x Vo % c: 0
±100 µA	5 nA	5 nA	100 pA	a: 0.07% b: 0.04 + 0.0001 x Vo % c: 0	a: 0.06% b: 0.035 + 0.0001 x Vo % c: 0
±10 µA	500 pA	500 pA	10 pA	a: 0.07% b: 0.05 + 0.0001 x Vo % c: 0	a: 0.06% b: 0.04 + 0.0001 x Vo % c: 0
±1 µA	50 pA	50 pA	1 pA	a: 0.12% b: 0.05+ 0.0001 x Vo % c: 0	a: 0.12% b: 0.035 + 0.0001 x Vo % c: 0
±100 nA	5 pA	5 pA	100 fA	a: 0.12% b: 0.05+ 0.0001 x Vo % c: 1 fA/V x Vo	a: 0.12% b: 0.04+ 0.0001 x Vo % c: 1 fA/V x Vo

Current source/monitor range, resolution, and accuracy using HRSMU connected to ports SMU1 and SMU2 (continues)

Full scale current range	Force resolution	Measure resolution: high speed	Measure resolution: precision	Force accuracy	Measure accuracy
±10 nA	500 fA	500 fA	10 fA	a: 1% b: 0.05 + 0.0001 x Vo % c: 3 pA + 1 fA/V x Vo	a: 1% b: 0.04 + 0.0001 x Vo % c: 3 pA + 1 fA/V x Vo
±1 nA	50 fA	50 fA	10 fA	a: 1% b: 0.07 + 0.0001 x Vo % c: 3 pA + 1 fA/V x Vo	a: 1% b: 0.04 + 0.0001 x Vo % c: 3 pA + 1 fA/V x Vo
±100 pA	5 fA	5 fA	2 fA	a: 4% b: 0.04 + 0.0001 x Vo % c: 500 fA + 1 fA/V x Vo	a: 4% b: 0.12 + 0.0001 x Vo % c: 500 fA + 1 fA/V x Vo
±10 pA	1 fA	2 fA	1 fA	a: 4% b: 0.04 + 0.0001 x Vo % c: 500 fA + 1 fA/V x Vo	a: 4% b: 1.0 + 0.0001 x Vo % c: 500 fA + 1 fA/V x Vo

Current source/monitor range, resolution, and accuracy using MPSMU or HPSMU connected to ports SMU3 to SMU8

Full scale current range	Force resolution	Measure resolution: high speed	Measure resolution: precision	Force accuracy	Measure accuracy
±1 A <sup>1</sup>	50 µA	50 µA	1 µA	a: 0.5% b: 0.1 + 0.0005 x Vo % c: 0	a: 0.5% b: 0.05 + 0.0005 x Vo % c: 0
±100 mA	5 µA	5 µA	100 nA		
±10 mA	500 nA	500 nA	10 nA		
±1 mA	50 nA	50 nA	1 nA	a: 0.12% b: 0.1 + 0.0005 x Vo % c: 0	a: 0.1% b: 0.05 + 0.0005 x Vo % c: 0
±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% b: 0.1 + 0.0005 x Vo % c: 300 pA + 10 pA/V x Vo	a: 0.2% b: 0.05 + 0.0005 x Vo % c: 300 pA + 10 pA/V x Vo
±100 nA	5 pA	5 pA	100 fA		
±10 nA <sup>2</sup>	500 fA	500 fA	10 fA	a: 1% b: 0.1 + 0.0005 x Vo % c: 303 pA + 10 pA/V x Vo	a: 1% b: 0.1 + 0.0005 x Vo % c: 303 pA + 10 pA/V x Vo
±1 nA <sup>2</sup>	50 fA	50 fA	10 fA		

1. Using HPSMU

2. Supplemental characteristics when using the SMU3 to SMU8 ports

Note: Force accuracy is given by ±(a% of output setting value + b% of output range + c) A

Measure accuracy is given by ±(a% if measured value + b% of measurement range + c) A

Note: The HPSMU can only be connected to the SMU3 and SMU4 ports.

Note: Current measurement accuracy of the SMU may be affected by electromagnetic field strength over 3 V/m at a frequency of 80 MHz to 1 GHz.

Vo = Output voltage



### SMU other specifications

Over current range	15% of range (0% of 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: 0% 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	$\pm 2\%$ of range (100 nA to 1 A ranges) $\pm 10\%$ of range (10 pA to 10 nA ranges)
Maximum capacitive load	$\leq 1000$ pF
Maximum allowable guard capacitance	250 pF (between single line and guard lone outside of matrix)
Maximum slew rate	0.2 V/ $\mu$ s

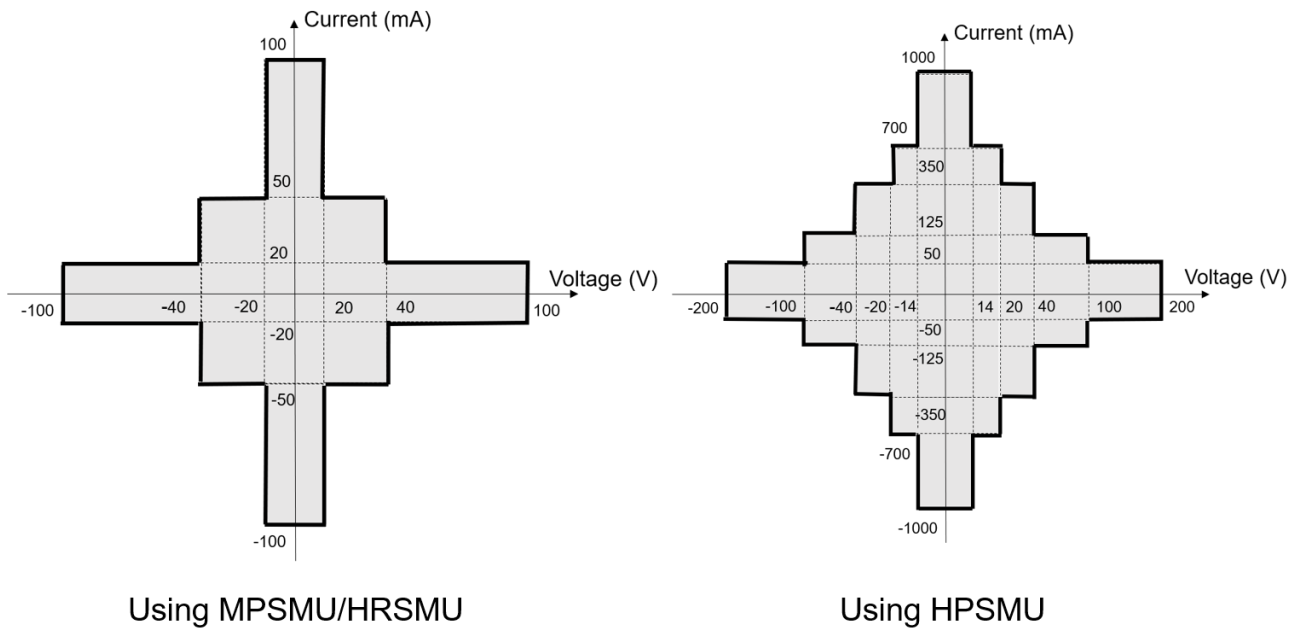


Figure 3: Measurement and output range (using MPSMU/HRSMU and HPSMU)

## Ground Unit (GNDU)

This unit is used for ground when making measurements.

Specifications	
Output voltage	0 V
Maximum current	$\pm 1.6$ A
Offset voltage	$\pm 200$ $\mu$ V
Maximum capacitance load	1 $\mu$ F <sup>1</sup>

1. Supplemental characteristics

## Digital Volt Meter (Keysight 3458A/34470A)

Voltage measurement range, resolution, and accuracy (at number of power line cycle  $\geq 1$ ).

Specifications		
Full scale voltage range	Resolution	Accuracy $\pm$ (% of reading + volt)
0.1 V	0.1 $\mu$ V	0.01% + 100 $\mu$ V
1 V	1 $\mu$ V	0.01% + 100 $\mu$ V
10 V	10 $\mu$ V	0.01% + 200 $\mu$ V
100 V	100 $\mu$ V	0.02 % + 1 mV

## SMU Configuration

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

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

No HPSMU			One HPSMU			Two HPSMUs		
Port number	Installed SMU	Installation order	Port number	Installed SMU	Installation order	Port number	Installed SMU	Installation order
1	MPSMU	2	1	MPSMU	1	1	MPSMU	Fixed
2	MPSMU	Fixed	2	MPSMU	Fixed	2	MPSMU	Fixed
3	MPSMU	Fixed	3	<b>HPSMU</b>	<b>Fixed</b>	3	<b>HPSMU</b>	<b>Fixed</b>
4	MPSMU	Fixed	4	MPSMU	Fixed	4	<b>HPSMU</b>	<b>Fixed</b>
5	MPSMU	1	5	MPSMU	Fixed	5	MPSMU	Fixed
6	MPSMU	3	6	MPSMU	2	6	MPSMU	1
7	MPSMU	4	7	MPSMU	3	7	MPSMU	2
8	MPSMU	5	8	MPSMU	4	8	MPSMU	3

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

One HRSMU, no HPSMUs			One HRSMU, one HPSMU			One HRSMU, two HPSMUs		
Port number	Installed SMU	Installation order	Port number	Installed SMU	Installation order	Port number	Installed SMU	Installation order
1	MPSMU	2	1	MPSMU	1	1	MPSMU	Fixed
2	<b>HRSMU</b>	<b>Fixed</b>	2	<b>HRSMU</b>	<b>Fixed</b>	2	<b>HRSMU</b>	<b>Fixed</b>
3	MPSMU	Fixed	3	<b>HPSMU</b>	<b>Fixed</b>	3	<b>HPSMU</b>	<b>Fixed</b>
4	MPSMU	Fixed	4	MPSMU	Fixed	4	<b>HPSMU</b>	<b>Fixed</b>
5	MPSMU	1	5	MPSMU	Fixed	5	MPSMU	Fixed
6	MPSMU	3	6	MPSMU	2	6	MPSMU	1
7	MPSMU	4	7	MPSMU	3	7	MPSMU	2
8	MPSMU	5	8	MPSMU	4	8	MPSMU	3
Two HRSMUs, no HPSMUs			Two HRSMUs, one HPSMU			Two HRSMUs, two HPSMUs		
Port number	Installed SMU	Installation order	Port number	Installed SMU	Installation order	Port number	Installed SMU	Installation order
1	<b>HRSMU</b>	<b>Fixed</b>	1	<b>HRSMU</b>	<b>Fixed</b>	1	<b>HRSMU</b>	<b>Fixed</b>
2	<b>HRSMU</b>	<b>Fixed</b>	2	<b>HRSMU</b>	<b>Fixed</b>	2	<b>HRSMU</b>	<b>Fixed</b>
3	MPSMU	Fixed	3	<b>HPSMU</b>	<b>Fixed</b>	3	<b>HPSMU</b>	<b>Fixed</b>
4	MPSMU	Fixed	4	MPSMU	Fixed	4	<b>HPSMU</b>	<b>Fixed</b>
5	MPSMU	1	5	MPSMU	Fixed	5	MPSMU	Fixed
6	MPSMU	2	6	MPSMU	1	6	MPSMU	Fixed
7	MPSMU	3	7	MPSMU	2	7	MPSMU	1
8	MPSMU	4	8	MPSMU	3	8	MPSMU	2

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

## Capacitance Measurement Subsystem

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

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

Specifications		
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	Setting range 1 kHz to 2 MHz (34 points)	
Test signal level	Setting range 10 mV, 30 mV, 50 mV, and 100 mV	
DC bias	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 accuracy ±(% of reading + % of range)	G range	G accuracy ±(% of reading + % of range)
2 MHz <sup>1</sup>	7 pF	3.2% + [6.3 + (2.3 x Gm <sup>2</sup> / 88 μS)]%	88 μS	3.2% + [6.5 + (2.5 x Cm <sup>3</sup> / 7 pF)]%
	70 pF	2.8% + [2.3 + (1.9 x Gm / 880 μS)]%	880 μS	2.8% + [2.4 + (2.1 x Cm / 70 pF)]%
1 MHz	10 pF <sup>1</sup>	0.8% + [1.1 + (0.6 x Gm / 63 μS)]%	63 μS <sup>1</sup>	0.8% + [1.1 + (0.6 x Cm / 10 pF)]%
	100 pF	0.7% + [0.4 + (0.5 x Gm / 630 μS)]%	630 μS	0.7% + [0.4 + (0.5 x Cm / 100 pF)]%
	1 nF	1.5% + [0.3 + (2.1 x Gm / 6.3 mS)]%	6.3 mS	1.5% + [0.3 + (2.2 x Cm / 1 nF)]%
100 kHz	10 pF <sup>1</sup>	0.4% + [1.1 + (0.3 x Gm / 6.3 μS)]%	6.3 μS <sup>1</sup>	0.4% + [1.1 + (0.4 x Cm / 10 pF)]%
	100 pF	0.2% + [0.4 + (0.2 x Gm / 63 μS)]%	63 μS	0.2% + [0.4 + (0.2 x Cm / 100 pF)]%
	1 nF	0.2% + [0.3 + (0.4 x Gm / 630 μS)]%	630 μS	0.2% + [0.3 + (0.4 x Cm / 1 nF)]%
	10 nF	0.5% + [0.3 + (1.0 x Gm / 6.3 mS)]%	6.3 mS	0.5% + [0.3 + (1.0 x Cm / 10 nF)]%

C/G measurement range, resolution, and accuracy (continues)

Frequency	C range	C accuracy ±(% of reading + % of range)	G range	G accuracy ±(% of reading + % of range)
10 kHz	100 pF	0.3% + [0.2 + (0.3 x Gm / 6.3 μS)]%	6.3 μS	0.3% + [0.2 + (0.3 x Cm/ 100 pF)]%
	1 nF	0.2% + [0.2 + (0.2 x Gm / 63 μS)]%	63 μS	0.2% + [0.2 + (0.2 x Cm/ 1 nF)]%
	10 nF	0.2% + [0.2 + (0.2 x Gm / 630 μS)]%	630 μS	0.2% + [0.2 + (0.2 x Cm/ 10 nF)]%
	100 nF	0.3% + [0.2 + (1.0 x Gm / 6.3 mS)]%	6.3 mS	0.7% + [0.2 + (0.7 x Cm/ 100 nF)]%
1 kHz	100 pF <sup>1</sup>	0.3% + [0.4 + (0.3 x Gm / 0.63 μS)]%	0.63 μS <sup>1</sup>	0.3% + [0.4 + (0.3 x Cm/ 100 pF)]%
	1 nF	0.3% + [0.1 + (0.3 x Gm / 6.3 μS)]%	6.3 μS	0.3% + [0.1 + (0.3 x Cm/ 1 nF)]%
	10 nF	0.3% + [0.1 + (0.3 x Gm / 63 μS)]%	63 μS	0.3% + [0.1 + (0.3 x Cm/ 10 nF)]%
	100 nF	0.3% + [0.1 + (0.3 x Gm / 630 μS)]%	630 μS	0.3% + [0.1 + (0.3 x Cm/ 100 nF)]%

1. Accuracy of this range is supplemental characteristics.
2. Gm: Measured conductance
3. 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: Must be under 5 pF between force and guard
- Calibration and offset cancel: Specifications are valid for the data after calibration data measurement and offset cancel
- Capacitance measurement accuracy of HS-CMU may be affected by conducted RF field strength over 3 Vrms at frequency range of 1 MHz to 20 MHz.

**Z/θ measurement accuracy (supplemental characteristics)**

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

## Keysight E4980A LCR Meter

Measurement accuracy is specified between any two measurement pins except the chuck connection pin and valid after calibration data measurement and offset cancel.

Specifications		
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
Test signal level		30 mV (rms)
DC bias	Full-scale voltage range	$\pm 40$ V
	Force accuracy	$\pm(0.1\%$ of setting + 10 mV)
	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 <sup>1</sup>	0.8% + [1.0 + (0.6 x Gm <sup>2</sup> / 63 μS)]%	63 μS <sup>1</sup>	0.8% + [1.0 + (0.6 x Cm <sup>3</sup> / 10 pF)]%
	100 pF	0.8% + [0.3 + (0.6 x Gm / 630 μS)]%	630 μS	0.8% + [0.3 + (0.6 x Cm / 100 pF)]%
	1 nF	1.5% + [0.2 + (1.7 x Gm / 6.3 mS)]%	6.3 mS	1.3% + [0.2 + (2.2 x Cm / 1 nF)]%
100 kHz	10 pF <sup>1</sup>	0.4% + [1.0 + (0.3 x Gm / 6.3 μS)]%	6.3 μS <sup>1</sup>	0.4% + [1.0 + (0.4 x Cm / 10 pF)]%
	100 pF	0.3% + [0.3 + (0.3 x Gm / 63 μS)]%	63 μS	0.3% + [0.3 + (0.3 x Cm / 100 pF)]%
	1 nF	0.3% + [0.2 + (0.4 x Gm / 630 μS)]%	630 μS	0.3% + [0.2 + (0.4 x Cm / 1 nF)]%
	10 nF	0.5% + [0.2 + (1.0 x Gm / 6.3 mS)]%	6.3 mS	0.7% + [0.2 + (0.8 x Cm / 10 nF)]%
10 kHz	100 pF	0.3% + [0.2 + (0.3 x Gm / 6.3 μS)]%	6.3 μS	0.3% + [0.2 + (0.3 x Cm / 100 pF)]%
	1 nF	0.3% + [0.1 + (0.3 x Gm / 63 μS)]%	63 μS	0.3% + [0.1 + (0.3 x Cm / 1 nF)]%
	10 nF	0.3% + [0.1 + (0.3 x Gm / 630 μS)]%	630 μS	0.3% + [0.1 + (0.3 x Cm / 10 nF)]%
	100 nF	0.3% + [0.1 + (1.0 x Gm / 6.3 mS)]%	6.3 mS	0.7% + [0.1 + (0.7 x Cm / 100 nF)]%
1 kHz	100 pF <sup>1</sup>	0.4% + [0.5 + (0.4 x Gm / 0.63 μS)]%	0.63 μS <sup>1</sup>	0.4% + [0.5 + (0.4 x Cm / 100 pF)]%
	1 nF	0.3% + [0.1 + (0.3 x Gm / 6.3 μS)]%	6.3 μS	0.3% + [0.1 + (0.3 x Cm / 1 nF)]%
	10 nF	0.3% + [0.1 + (0.3 x Gm / 63 μS)]%	63 μS	0.3% + [0.1 + (0.3 x Cm / 10 nF)]%
	100 nF	0.3% + [0.1 + (0.3 x Gm / 630 μS)]%	630 μS	0.3% + [0.1 + (0.3 x Cm / 100 nF)]%

1. Accuracy of this range is 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 mVrms

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 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.)

## Pulse Force Unit

Specifications	
Supported pulse generators	High-voltage semiconductor pulse generator unit (HV-SPGU) modules
Maximum number of installable HV-SPGU modules	5
Number of channels per HV-SPGU modules	2
Pulse force mode	Each HV-SPGU channel supports 2-level and 3-level pulses
Output mode	All pulse generator channels (up to 10) can force synchronously
HV-SPGU output impedance	50 $\Omega$
HV-SPGU load impedance	0.1 $\Omega$ to 1 M $\Omega$
Pulse level (at open load)	$\pm 40$ V (at 2-level and 3-level)
Pulse period (at 50 $\Omega$ load)	350 ns to 10 s with 10 ns resolution
Pulse width (at 50 $\Omega$ load)	50 ns to [Period – 50 ns] with 2.5 ns <sup>1</sup> or 10 ns <sup>2</sup> resolution
Pulse delay (at 50 $\Omega$ load)	0 s to [Period – 75 ns] with 2.5 ns <sup>1</sup> or 10 ns <sup>2</sup> resolution
Transition time (at 50 $\Omega$ load)	20 ns to 400 ms with 2 ns <sup>1</sup> or 8 ns <sup>2</sup> resolution
Transition time minimum (at 50 $\Omega$ load)	20 ns <sup>3</sup> , 30 ns <sup>4</sup>
Pulse amplitude (at open load)	0 to 80 V peak-to-peak
Pulse level resolution (at open load)	0.4 mV (Vout $\leq$ 10 V) 1.6 mV (Vout > 10 V)
Pulse level accuracy (at open load)	$\pm(2\% + 150$ mV)
Pulse shape accuracy (at 50 $\Omega$ load)	Delay: $\pm(3\% + 1$ ns) Transition time: -5% to (+5% + 35 ns) Overshoot/ringing: +(5% of amplitude + 20 mV) Skew between pins: $\pm 10$ ns
Pulse shape accuracy (at 5 k $\Omega$ load, supplemental characteristics)	Transition time: -5% to (+5% + 35 ns) Overshoot/ringing: +(5% of amplitude + 20 mV) Skew between pins: $\pm 10$ ns

1. Transition time setting  $\leq 10$   $\mu$ s
2. Transition time setting > 10  $\mu$ s
3. |Vamp|  $\leq 10$  V (to 50  $\Omega$ )
4. 10 V < |Vamp|  $\leq 20$  V (to 50  $\Omega$ )

## System Controller and System Software

### System Controller

Item	Description
Supported controller	Dedicated System Controller (Keysight N9171B)
Operating system	RedHat Enterprise Linux 7.1 (for Keysight N9171B)

### System Software

#### Standard 4080 software provides following capabilities

Item	Description
System management	
Control of subsystems	Test Instrument Set (TIS) library for C language
Parameter measurement utility	PARA library
Off-line debugging	
Interactive debugging panel (IDP)	Includes test algorithm code generation function
System maintenance	Automatic diagnostics

### Keysight SPECS (Semiconductor Process Evaluation Core Software)

Keysight SPECS is a test shell environment for the 4080 Series. Users have full access to the Linux environment within the test shell. The 4080 Series requires SPECS version 3.10-20 or later.

#### Test development

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

#### Customization

Keysight 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.

### Keysight SPECS-FA (Factory Automation)

Keysight SPECS-FA, the factory automation version of Keysight SPECS test shell, runs on the 4080 Series testers. The 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. Keysight SPECS and SPECS-FA support a powerful virtual multiple test head 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 maximize throughput.

## General Specifications

Operating and storage requirements		
Temperature range	Operating	5 °C to 30 °C (no condensation)
	Storage	-20 °C to 50 °C -20 °C to 60 °C (for an unpacked system)
Humidity range	Operating	15% to 70% (no condensation)
	Storage	< 80% RH (no condensation) < 90% RH, < 12 hrs (for unpacked system)
Power requirement		
Nominal line voltage <sup>1</sup>	Allowable voltage range	Required maximum current
200 Vac	180 – 200 Vac	30 A
208 Vac	188 – 228 Vac	24 A
220 Vac	198 – 242 Vac	30 A
240 Vac	216 – 252 Vac	30 A

1. Line frequency must be 48 Hz to 63 Hz.

## General Specifications (continues)

Regulatory and standard compliance	
EMC	IEC 61326-1 ICES/NMB-001 AS/NZS CISPR 11 KC
Safety	IEC 61010-1 Canada: CAN/CSA-C22.2 No. 61010-1, C/US SEMI S2-0703 and S8-1103
Certifications	CE, CSA C/US, RCM, ICES/NMB-001
Dimensions	
System cabinet	600 mm (W) by 905 mm (D) by 1800 mm (H)
Test head	780 mm (W) by 680 mm (D) by 440 mm (H)
Weight	
System cabinet (max.)	294 kg (including 3458A, SPGU with 5 x HV-SPGU, system controller)
Test head	137 kg (including 7 MPSMUs, 1 HPSMU, 1 HS-CMU, 48 pins, HF matrix, and manipulator extension shelf with enclosure, fan, and duct)
Supported probers and probe cards <sup>2</sup>	
Prober	TEL (Tokyo Electron) ACCRETECH
Probe card	JEM (Japan Electronic Material) MJC (Micronics Japan Co.) FormFactor

2. Please contact your local sales representative regarding the latest information on supported prober and probe cards.

## Recommended Conditions for Ultra-Low Current and Low Voltage Measurements

In addition to the conditions listed in general specifications, Keysight recommends that the following additional conditions be satisfied for measuring precise low current and low voltage with the 4082F.

Recommended conditions for ultra-low current and low voltage measurements <sup>1</sup>	
Probe cards <sup>2</sup>	JEM and MJC
Temperature	Within $\pm 1^\circ\text{C}$ after calibration
Temperature change period	$\geq 10$ minutes
Humidity	$\leq 50\%$
Warm up time	$\geq 60$ minutes
Floor vibration	$\leq 1$ mG
Floor vibration frequency	$\geq 10$ Hz
Air cleanliness	$\leq$ class 10,000
Line voltage	Burst noise $\leq 1$ kV Surge noise $\leq 1$ kV This line voltage environment applies IEC 61326-1

1. The information in this section applies only to system configured with ultra-low current matrix cards and a high-resolution SMU.
2. Please contact your local sales representative regarding the latest information on supported prober and probe cards.

Learn more at: [www.keysight.com](http://www.keysight.com)

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: [www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)

