Agilent 4073B

Ultra Advanced Parametric Tester

Data Sheet

Contents

General Description

The Agilent 4073B Ultra Advanced Parametric Tester is the flagship of the 4070 Series. It is designed to perform fast and precise DC measurements, capacitance measurements, Flash memory cell tests, and other high-frequency applications. 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 includes the High-Speed Capacitance Measurement Unit (HSCMU) that enables the measurement of capacitance and impedance with unprecedented speed. External instruments can be integrated into the system via six auxiliary input ports or 48 extended path inputs. The extended path inputs allow the user to connect external signals directly to the DUT pins. A low-leakage switching matrix connects all of the inputs to fully-guarded Kelvin output pins, which are customizable from 12 to 48 pins. One special additional pin is dedicated as a chuck connection. The 4073B also has a high-frequency switching matrix with integrated pulse generator control. The high-frequency matrix is organized as two 3 ´ 24 matrices (six inputs in total), and 1 TO 2 furnished connectors may be used on each matrix pair to create one 3 ´ 48 matrix (three inputs in total). The system also has one 1.6 A ground unit.

General Description(continued)

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

DC Measurements
Spot, Sweep, Pulse Bias, and Pulse Sweep.

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

[1] Using HRSMU. Using MPSMU, 100 fA to 100 mA, 2 μV to 100 V

[2] Using optional HPSMU. Using MPSMU, 100 fA to 100 mA, 2 μV to 100 V

Capacitance/Conductance Measurements
C/G, C/G-V and C/G-V/f

Measurement unit:
High Speed Capacitance Measurement Unit (HSCMU)
Test Frequencies:
1 kHz - 2 MHz, 34 points (Measurement accuracies are guaranteed at the following frequency points: 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: ±10 V

Impedance Measurements
Z/θ and Z/θ - f

Measurement unit:
HSCMU
Test Frequencies:
1 kHz - 2 MHz, 34 points
DC Bias Voltage: ±10 V

Two Terminal Differential Voltage Measurements
Measurement Unit: Agilent 3458A
Measurement range:
0.1 μV to 100 V

High Frequency Pulse Force
Supported pulse generators:
Agilent 81110A and 8114A
Maximum number of installable pulse generators:
5 × 81110A
(without 8114A)
4 × 81110A
(with 1 × 8114A)
2 × 81110A
(with 2 × 8114A)
Pulse level (at open load):
±19 V (81110A),
–49.9 V to + 50 V (8114A)
Pulse period:
350 ns to 999 s (81110A)
350 ns to 999 ms (8114A)
Pulse width:
50 ns to 999 ms (81110A)
150 ns to 150 ms (8114A)
Pulse delay: 0 s to 998 ms
Transition time:
20 ns to 200 ms (81110A)
65 ns (8114A)

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 HSCMU)
Six high frequency (HF) ports
48 extended paths
Pulse switch input/output ports

Switching Matrix Subsystem

Maximum DUT Pins

48 output pins plus one pin for the prober chuck connection (triaxial connector). Only the E3122A (high-resolution pin board) can be used for the 4073B (The E3121A cannot be used).

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 HSCMU
- 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)

High Frequency (HF) ports:
- Six for pulse generator (81110A or 8114A) or other 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 via a 1 TO 2 ADAPTOR 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.

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

Pulse switch input/output ports:
- Please refer to page 4.

Maximum Voltage at Each Port

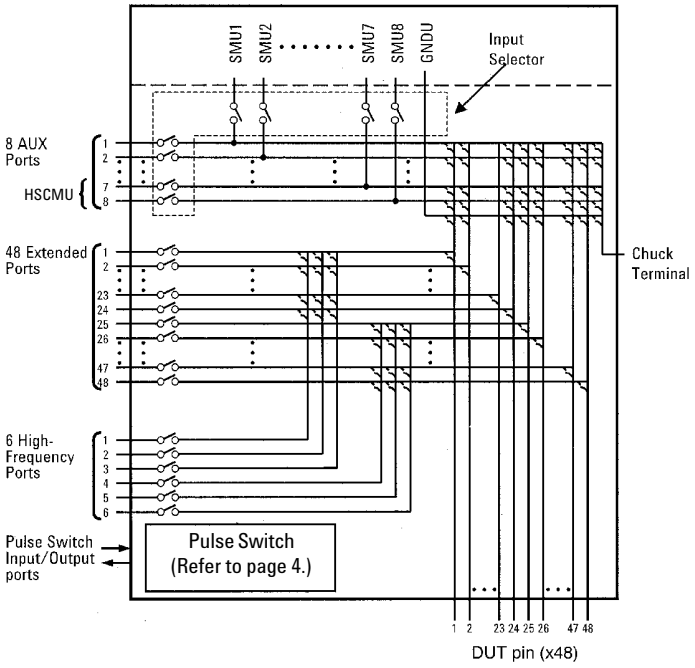
SMU port in Test Head: ±200 V

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

HF port:
- ±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 HF ports and any force of extended paths)

Zero reference: ±200 mV



Testhead Circuit Diagram

Maximum Current, Port to DUT Pin

SMU port in Test Head:	±1.0 A
GNDU:	±1.6 A
AUX port:	±1.0 A
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 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): 1×10^{15} Ω

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

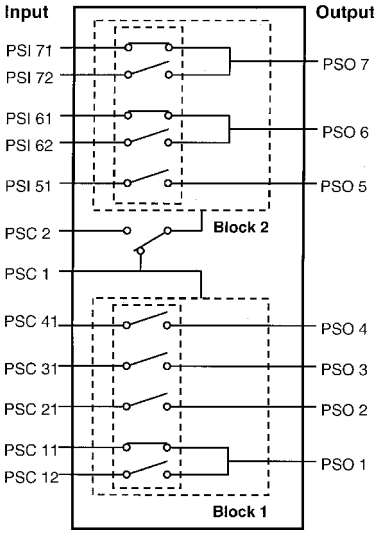
60 MHz (50 Ω load impedance: from port to DUT pin, 3 × 24 configuration)

HF Port Cross Talk Between Pins (supplemental characteristics)

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

Pulse Switch

The 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 4073B 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

±60 V (between force and common of each switch)

±60 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)

±60 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 2 Ω (from IN to OUT)

OFF Capacitance (supplemental characteristics)

80 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. 2 ms

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% b: 0.025% c: Rmat × Io	a: 0.03% b: 0.035% c: Rmat × Io
±20 V	1 mV	1 mV	20 µV	a: 0.02% b: 0.015% c: Rmat × Io	a: 0.03% b: 0.02% 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% b: 0.05% c: Rmat × Io	a: 0.04% b: 0.04% 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% b:0.04% 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

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 % b: 0.05 + 0.0001 × Vo % c: 0	a: 0.1 % b: 0.04 + 0.0001 × Vo % c: 0
±10 mA	500 nA	500 nA	10 nA	a: 0.06 % b: 0.04 + 0.0001 × Vo % c: 0	a: 0.06% b: 0.03 + 0.0001 × Vo % c: 0
±1 mA	50 nA	50 nA	1 nA	a: 0.06 % b: 0.05 + 0.0001 × Vo% c: 0	a: 0.06% b: 0.04 + 0.0001 × Vo % c: 0
±100 µA	5 nA	5 nA	100 pA	a: 0.07 % b: 0.04 + 0.0001 × Vo % c: 0	a: 0.06% b: 0.035 + 0.0001 × Vo % c: 0
±10 µA	500 pA	500 pA	10 pA	a: 0.07 % b: 0.05 + 0.0001 × Vo % c: 0	a: 0.06% b: 0.04 + 0.0001 × Vo % c: 0
±1 µA	50 pA	50 pA	1 pA	a: 0.12 % b: 0.04 + 0.0001 × Vo % c: 0	a: 0.12% b: 0.035 + 0.0001 × Vo % c: 0
±100 nA	5 pA	5 pA	100 fA	a: 0.12 % b: 0.05 + 0.0001 × Vo % c: 1 fA/V × Vo	a: 0.12% b: 0.04 + 0.0001 × Vo % c: 1 fA/V × Vo
±10 nA	500 fA	500 fA	10 fA	a: 1 % b: 0.05 + 0.0001 × Vo % c: 3 pA + 1 fA/V × Vo	a: 1% b: 0.04 + 0.0001 × Vo % c: 3 pA + 1 fA/V × Vo
±1 nA	50 fA	50 fA	10 fA	a: 1% b: 0.07 + 0.0001 × Vo % c: 3 pA + 1 fA/V × Vo	a: 1% b: 0.04 + 0.0001 × Vo % c: 3 pA + 1 fA/V × Vo
±100 pA	5 fA	5 fA	2 fA	a: 4 % b: 0.4 + 0.0001 × Vo % c: 500 fA + 1 fA/V × Vo	a: 4% b: 0.12 + 0.0001 × Vo % c: 500 fA + 1 fA/V × Vo
±10 pA	1 fA	2 fA	1 fA	a: 4 % b: 4.0 + 0.0001 × Vo % c: 500 fA + 1 fA/V × Vo	a: 4% b: 1.0 + 0.0001 × Vo % c: 500 fA + 1 fA/V × Vo

DC Measurement Subsystem (continued)

Current Source/Monitor Range, Resolution, and Accuracy using MPSMU 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% b: 0.1 + 0.0005 × Vo % c: 0	a: 0.1% b: 0.05 + 0.0005 × Vo % 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% b: 0.1 + 0.0005 × Vo % c: 0.02 pA/V ´ Vo	a: 0.2% b: 0.05 + 0.0005 × Vo % c: 0.02 pA/V ´ Vo
±100 nA	5 pA	5 pA	100 fA		
±10 nA	500 fA	500 fA	10 fA	a: 1% b: 0.1 + 0.0005 × Vo % c: 3 pA + 0.02 pA/V ´ Vo	a: 1% b: 0.1 + 0.0005 × Vo % 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.

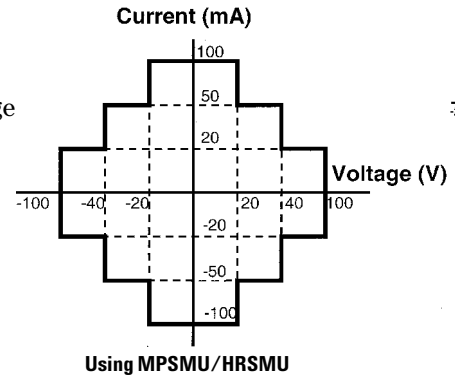
Current Source/Monitor Range, Resolution, and Accuracy using an MPSMU or HPSMU connected to the SMU3 through SMU8 ports

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 % b: 0.1 + 0.0005 × Vo% c: 0	a: 0.5 % b: 0.05 + 0.0005 × Vo % c: 0
±100 mA	5 µA	5 µA	100 nA	a: 0.12 % b: 0.1 + 0.0005 × Vo % c: 0	a: 0.1 % b: 0.05 + 0.0005 × Vo % 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 % b: 0.1 + 0.0005 × Vo % c: 300 pA + 10 pA/V × Vo	a: 0.2 % b: 0.05 + 0.0005 × Vo % 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% b: 0.1 + 0.0005 × Vo % c: 303 pA + 10 pA/V × Vo	a: 1 % b: 0.1 + 0.0005 × Vo % c: 303 pA + 10 pA/V × Vo
±1 nA[2]	50 fA	50 fA	10 fA		

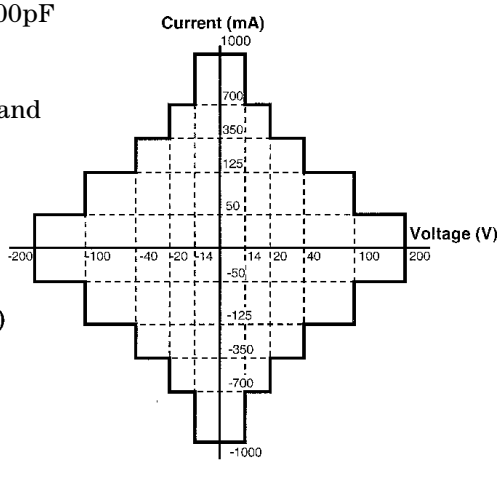
Force Accuracy is calculated as follows: ±(a % of output setting value + b% of output current range + c) (A)
Measure Accuracy is calculated as follows: ±(a % of measured value + b% of current measurement range + c) (A)
Note: The HPSMU cannot be connected only to SMU3 and SMU4 ports. It can be connected only to 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 SMU3 and SMU4 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

SMU configuration

Minimum configuration:
One HRSMU and two MPSMUs (default configuration)

A maximum of two HRSMUs can be installed and connected only to the SMU1 and SMU2 ports. A maximum of two HPSMUs can be installed and connected only to the SMU3 and SMU4 ports. The first HPSMU must be connected to SMU3 and the second to SMU4. The default configuration of the 4073B has one HRSMU (connected to the SMU2 port) and two MPSMUs (connected to the SMU3 and SMU4 ports). The following tables indicate the installation order for additional SMUs.

One HRSMU and no HPSMU installed in addition to MPSMUs

Port Number	Installed SMU	Installation order for additional SMUs
1	MPSMU	2
2	MPSMU	Default
3	HRSMU	Default
4	MPSMU	Default
5	MPSMU	1
6	MPSMU	3
7	MPSMU	4
8	MPSMU	5

Two HRSMUs and no HPSMUs installed in addition to MPSMUs

Port Number	Installed SMU	Installation order for additional SMUs
1	HRSMU	Optional HRSMU
2	HRSMU	Default
3	MPSMU	Default
4	MPSMU	Default
5	MPSMU	1
6	MPSMU	2
7	MPSMU	4
8	MPSMU	5

Two HRSMU and one HPSMU installed in addition to MPSMUs

Port Number	Installed SMU	Installation order for additional SMUs
1	MPSMU	1
2	HRSMU	Default
3	HPSMU	Optiona HPSMU
4	MPSMU	Default
5	MPSMU	Default
6	MPSMU	2
7	MPSMU	3
8	MPSMU	4

Two HRSMUs and one HPSMU installed in addition to MPSMUs

Port Number	Installed SMU	Installation order for additional SMUs
1	HRSMU	Optional HRSMU
2	HRSMU	Default
3	HPSMU	Optional HPSMU
4	MPSMU	Default
5	MPSMU	Default
6	MPSMU	1
7	MPSMU	2

One HRSMU and two HPSMUs installed in addition to MPSMUs

Port Number	Installed SMU	Installation order for additional SMUs
1	MPSMU	Default
2	HRSMU	Default
3	HPSMU	Optional HPSMU
4	HPSMU	Optional HPSMU
5	MPSMU	Default
6	MPSMU	1
7	MPSMU	2

Two HRSMUs and two HPSMUs installed in addition to MPSMUs

Port Number	Installed SMU	Installation order for additional SMUs
1	HRSMU	Optional HRSMU
2	HRSMU	Default
3	HPSMU	Optional HPSMU
4	HPSMU	Optional HPSMU
5	MPSMU	Default
6	MPSMU	Default

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 Accuracyv(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

Capacitance Measurement Subsystem: High-Speed 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 1 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 m)

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.

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	0.8% + 1.8%	±0.26 rad
	1 kΩ	0.7% + 0.6%	±0.02 rad
	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

Pulse Force Unit

Supported Pulse Generators:
81110A and 8114A

Maximum Number of Installable Pulse Generators:
81110A × 5 (without 8114A)
81110A × 4 (with 8114A × 1)
81110A × 2 (with 8114A × 2)

Pulse Force Mode
Pulse Signal:
2-level and 3-level output
Burst Count:
10^9 (max.) or infinite

Output mode
Normal mode or Pattern mode

Normal mode
All pulse generators (up to five) can force synchronously.

Pattern mode
All pulse generators except the master pulse generator can force synchronously (more accurate pulse width and pulse delay than normal mode).

Note: Agilent 8114A does not support pattern mode.

Load impedance
999 kΩ (default), selectable from 2.5 Ω to 999 kΩ (81110A)
999 kΩ (default), selectable from 10 Ω to 999 kΩ (8114A)

Pulse Setting Range

Pulse Period
Normal mode
81110A:
Range: 350 ns to 999 s
Resolution: 4 digits
(min. 100 ps)
8114A:
Range: 350 ns to 999 ms
Resolution: 3 digits
(min. 1 ns)
Pattern mode
81110A:
Range: 120 µs to 999 s
Resolution: 4 digits
(min. 100 ns)
8114A:
Range: 120 ns to 999 ms
Resolution: 3 digits
(min. 1 µs)

Pulse Width
Normal mode
81110A:
Range: 50 ns to 999 ms
Resolution: 3.5 digits
(min. 50 ps)
8114A:
Range: 150 ns to 150 ms
Resolution: 3 digits
(min. 1 ns)
Pattern mode
81110A in the master unit
Range: 50 ns to 999 ms
Resolution: 3 digits
(min. 100 ps)
8114A in the master unit
Range: 150 ns to 150 ms
Resolution: 3 digits
(min. 1 ns)
81110A in slave units
Range: 100 ns to 999 ms
Resolution:
1×10^{-n} (at $1000 \times 10^{-n} < T \leq 4000 \times 10^{-n}$)
2×10^{-n} (at $4000 \times 10^{-n} < T \leq 8000 \times 10^{-n}$)
2.5×10^{-n} (at $8000 \times 10^{-n} < T \leq 10000 \times 10^{-n}$)

Pulse Force Unit (continued)

T means the maximum value of (pulse width + delay time) among all the channels. For example, if T is 250 µs, then according to the above table, the resolution is 0.1 µs (1×10^{-7}) because T= 250×10^{-6} = 2500×10^{-7}.

Pulse Delay

Normal mode
- 81110A Range: 0 to 998 ms
  Resolution: 3.5 digits (min. 5 ps)
- 8114A Range: 0 to 998 ms
  Resolution: 3 digits (min. 10 ps)

Pattern mode
- Range: 0 to 998 ms
- Resolution:
  - 81110A and 8114A in the master unit
    3 digits (min. 10 ps)
  - 81110A in slave units
    1×10^{-n} (at $1000 \times 10^{-n} < T \leq 4000 \times 10^{-n}$)
    2×10^{-n} (at $4000 \times \times 10^{-n} < T \leq 8000 \times 10^{-n}$)
    2.5×10^{-n}(at $8000 \times 10^{-n} < T \leq 10000 \times 10^{-n}$)

T means pulse period specified in the Force_pg subprogram. If not specified, T is the maximum value of 1.1 × (pulse width + delay time + 30 ns) among all specified PGs.

Transition Time

20 ns to 200 ms (81110A)
65 ns (fixed) (8114A)

Pulse Level (at open load)

81110A:
±19 V (at 2 level)
±19 V (at 3 level)
Restriction for "3-level pulse with one PG" output mode: the sum of the absolute values of both amplitudes cannot exceed 20 V.

8114A:
–49.9 V to +50 V (at 2 level)
–49.9 V to +50 V (at 3 level)
There is no "3-level pulse with one PG" output mode on the Agilent 8114A because it has only one Output.

81110A + 8114A:
–49.9 V to +50 V (at 3 level)

Pulse Level Accuracy (at open load)

81110A level:
± ((2 % of amplitude) + 150 mV)
8114A amplitude:
± ((2 % of amplitude) + 200 mV)
8114A baseline:
± ((2 % of baseline) + (1 % of amplitude)+ 200 mV)

Pulse Shape Accuracy (at 50 Ω load impedance)

81110A width:
± (3%of setting + 2 ns) or
± (0.5%of setting + 2 ns)*
(in normal mode, width ≥50 ns)
81110A delay:
± (3%of setting + 1 ns)
± (0.5%of setting + 1 ns)*
(in normal mode, width ≥ 50 ns)
81110A transition:
(–10%of setting) to (+10%of setting + 20 ns) (transition time ≥ 20ns)
81110A overshoot:
± (5%of amplitude + 20 mV)
(transition time ≥20 ns)

*Supplemental characteristics after timing calibration

8114A width:
± (5%of setting + 3.5 ns)
(width ³ 200 ns)
± (5%of setting + 6.0 ns)
(width ³ 150 ns)
8114A delay:
± (5%of setting + 1 ns)
8114A transition:
65 ns ± 20 ns
8114A overshoot:
± (5%of amplitude + 50 mV)

Pulse Shape Accuracy (at 5 kΩ load impedance: reference data)

Agilent 81110A overshoot/ringing:
± (5%of amplitude + 20 mV)
8114A overshoot/ringing:
(–8% of amplitude) to (+4% of amplitude)
81110A transition time:
±(10%of setting + 5 ns)
8114A transition time:
56 ns ± 5 ns
Skew between pins: ± 10 ns

System Controller

Supported Computers
HP Visualize workstation C 3600, C3700B, C3750
Operating System
HP-UX 11i
BASIC/UX (C.08.04), SICL (11i-2.1) or C/ANSI C, SICL
Required Memory
256 MB is recommended
Required Disk
8 GB
Required GP-IB Interfaces
Agilent recommends two external GP-IB interface cards, one for instruments controlled by 4073B TIS commands (e.g., 3458A) and another for an automatic wafer prober

System Software

Standard 4073B 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)
- Probing pattern generation and wafer maps display (PPG, MAP)
- Prober Control Library (Sample program): Electroglas, TEL, and TSK
- Application program (Sample program): Flash memory cell evaluation, Charge pumping method
- Automatic Diagnostics

Agilent Semiconductor Process Evaluation Core Software (SPECS)

Agilent SPECS is a test shell environment for the Agilent 4070 Series.

Input

User interaction occurs via a windows-based 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.

UNIX

Users have full access to the UNIX environment from within the test shell.

General Specifications

Accuracy is specified at:
Temperature: 23° C ± 5° C
Humidity: 5% to 70% RH[1]
Warm up: at least 40 min.
Self-calibration: Within one hour after calibration
Integration Time: Medium or longer

[1] 5% to 60% RH (no condensation) for isolation resistance of low current port.

Note: Temperature change after calibration must be less than 3° C.

Power Requirement

Nominal Line Voltage[2]	Allowable Voltage Range	Required Maximum Current
200 Vac	180 - 220 Vac	20 A
208 Vac	188 - 228 Vac	24 A
220 Vac	198 - 242 Vac	20 A
240 Vac	216 - 252 Vac	20 A

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

Operating Temperature Range:
5°C to 30°C
Operating Humidity range:
5% to 70% (no condensation)
Storage Temperature Range:
–20°C to 50°C (< 80% RH, no condensation)
Warm up time: At least 40 minutes

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.1010.1
UL3111-1
SEMI S2-0200/S8-0999

Certification marking

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

Dimensions

System Cabinet:
600 mm (W) by 900 mm (D) by 1600 mm (H)
Testhead:
640 mm (W) by 642 mm (D) by 400 mm (H)

Weight

System Cabinet:
235 kg (including 3458A, 81110A × 4, 8114A and system controller)
Testhead:
75 kg (including 4 SMUs, HSCMU and 48 pins)

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Printed in USA October 10, 2003
5988-9002EN

Agilent Technologies