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Agilent TS-5000 Family of Automotive Electronics Functional Test Systems

Configuration Guide

This document outlines Agilent's custom test racks, comprised of standard systems and fixtures and optimized software.

The standard system platforms consist of:



TS-5400 High Performance System

- VXI, switch-load unit
- 50 - 300 test points
- MAC Panel test adapter
- Types of modules: engine control, transmission control, complex body control



TS-5400 SPC System

- Switch-load unit
- 25 - 150 test points
- ExpressConnect
- Types of modules: air bag, body control



TS-5020 Mid-Size Test System

- Up to 112 test points
- 34980A switch/ measure unit
- ExpressConnect/ MAC Panel
- Types of modules: automotive sensors, small body electronic modules, ABS sensors, HVAC (climate control) modules (heated seats)



TS-5030 Automotive Infotainment Test System

- Single/multi-satellite GPS, digital/analog audio
- DVB, GSM, FM/AM IQ file
- Audio load box
- TS-5020 base platform
- Types of modules: in-car entertainment, video, audio electronics and networking



TS-5040 Compact System

- 0.75 m rack
- Up to 112 points (compact)
- Up to 2 LXI/GPIB instrumentations
- L2000 MAC Panel interface
- Mini switch-load unit up to 6 slots
- 34980A DMM/ Switch up to 8 slots

Agilent Technologies

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Value Propositions

- Rack and accessories
- PC, accessories, interface cards, cables
- Test instruments
- Switching units, interface cables
- RF enclosure, fixture, nesting, cables
- Test software development, database, reports
- UUT interface, fixture



Figure 1. Defining value propositions

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Automotive Electronics Testing Philosophy

Full emulation – simulates real-time environment
Full parallel stimulus/response
R&D/design verification, technology leaders

DUT assisted – sequential channel testing
Test sub-systems with fewer resources
May require test firmware in DUT

Self test via serial communications
Instrument cluster, displays



A Typical Automotive ECU Manufacturing Line

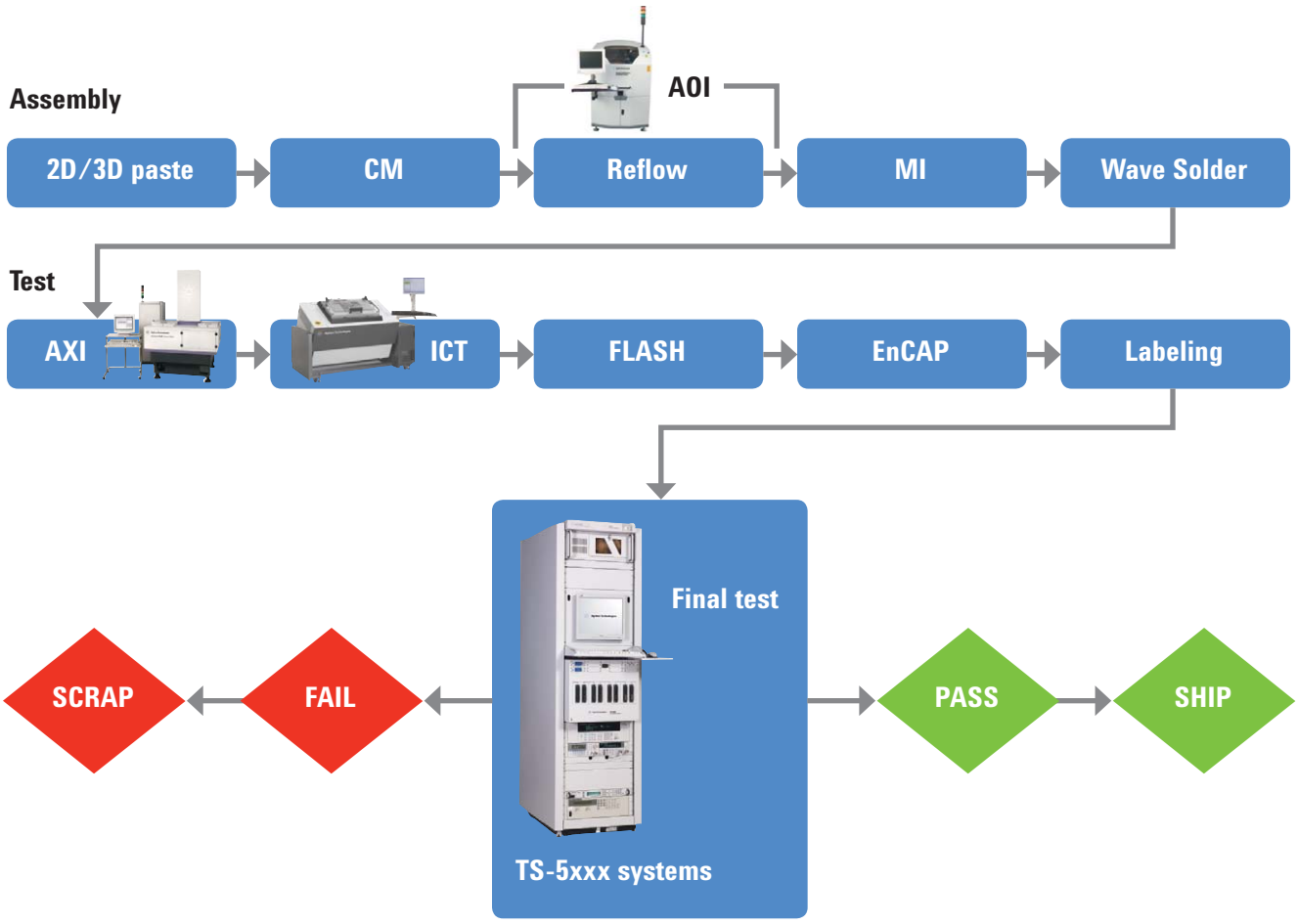


Figure 2. Typical automotive ECU manufacturing line

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System Configuring Basics

In every system, there are numerous options to configure for each end user application.

To determine the system configuration that the customer needs, it is crucial to consider the following:

- Rack height (2 meter or 0.75 meter); One factory usually has a standard or preferred rack height
- Number of loading paths (channels) required and respective maximum loading current. In usual applications, loading will be required to simulate actual conditions to the DUT. For example, a passive component such as high power resistors or inductors will be used in between the DUT target pin and a power supply (which is usually connected to a power bus in the TS-5000 series systems) through a load card channel.
- Single DUT tester or multi DUT
- Other test conditions: It is important to understand if the testing requires any stimulus such as a sinusoid waveform to be input to a pin or a digitizer, it is required to capture a 100 ms sample of an output pin.



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Step 1 Mass Interconnect

Available only in 2 m racks.

Following are the steps to choose the right system.



Figure 3. TS-5400 Series II

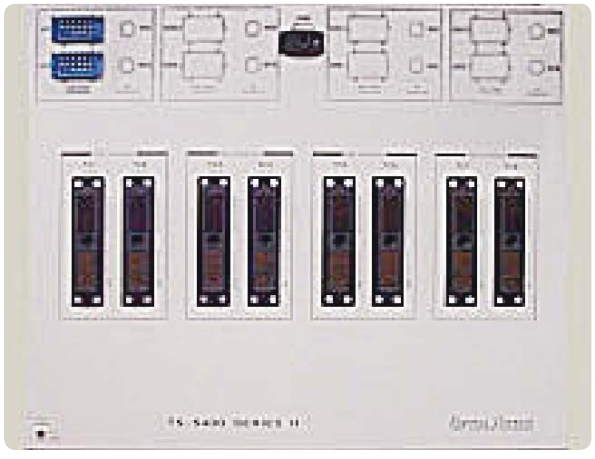


Figure 4. ExpressConnect interface

Choose an interface type

The interface is the hardware connection between the tester to the fixture or DUT.

The TS-5400 offers a Series 75 MAC Panel interface or an ExpressConnect. The MAC Panel is more robust than the ExpressConnect.

The MAC Panel consists of two parts, the ICA and the ITA. The ICA is included into every system order but the ITA is an accessory that can be purchased. The ICA is the connector assembly that is fixed onto the front of the system.

The ITA is the mating part that is wired to the customer's fixture. The main reason that the interface is divided into two parts is to allow the customers to change to different DUTs using the same system.

The Series 75 MAC Panel has 21 slots, each of which can handle up to 32 module pins or 32 high/medium current loads or 96 low current loads or other instruments.

The ExpressConnect is a cheaper solution that offers value for money. It is connector based and each set consists of 2 connectors. The system can accommodate to a maximum 4 sets; TC 1 and 2, TC 3 and 4, TS 5 and 6 and TC 7 and 8 and the customer can choose the number of sets required based on the test pin counts and paths that will be used.



Figure 5. MAC Panel (interface)

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Step 1 Mass Interconnect

It handles up to 64 high current loads, 256 module pins, and 192 low current loads or 128 medium current loads. Table 1.0 shows the characteristics of the two interfaces as well as the L2000 MAC Panel which is not offered in the TS-5400 but in the other systems.

Once the interface has been decided, the proper corresponding part number is required to choose the base of the system.

TS-5400 – Series 75 MAC Panel – LEVEL 1 Part number E8786B

TS-5400 – ExpressConnect – LEVEL 1 Part number E8780B

Each system has a core of material which is mandatory and is included as a minimum.

E8786B CORE includes:
2.0 meter rack
One Switch Load Unit (SLU)
2 m GPIB cable
One E1135C Power Distribution Unit (PDU)
One complete Series 75 MAC Panel ICA interface set
Parallel port interface
Site preparation and getting started guide
Misc. cables, screws, panel fillers, etc.
1 year warranty

E8780B CORE includes:
2.0 meter rack
One E6198A-FG Switch Load Unit (SLU)
2m GPIB cable
One E1135C Power Distribution Unit (PDU)
One complete ExpressConnect ICA interface set
Parallel port interface
Site preparation and getting started guide
Misc. cables, screws, panel fillers, etc.
1 year warranty

Both systems include the following options as a minimum:
E2235A-ATO; TS-5400 family controller, includes 1024 MB RAM, DVD-RW, floppy drive, keyboard
TestExec SL 6.1 test executive software license
TestExec SL Test Routines Library TS-5400 System Software

For more TS-5400 options and configurations, refer to APPENDIX 5.

Table 1.0

Properties	ExpressConnect	Series 75 MAC Panel	L2000 MAC Panel
Connectivity durability	10,000 cycles min	20,000 cycle min	20,000 cycles min
Contact resistance	15 mΩ max	5 mΩ	5 mΩ
Current rating	5 A max	5 A, 10 A, 50 A	5 A, 10 A, 50 A
Operating temperature	–55 degC to 105 degC	–10 degC to 55 degC	–10 degC to 55 degC
No of I/O pin	156 pin receiver * 8 receiver assembly = 1248 pin/assembly	64 pin/slots X 21 slots = 1344 pins	2400 pin/assembly (low DC configuration)
RF I/O capability	No	Yes, 2, 3, 4, 26 GHz	Yes - 2 GHz, 3 GHz, 4 GHz and 26 GHz
Assembly height	8.77 RU	9 RU	5 RU

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Step 2 VXI Instruments

Decide whether VXI is required (optional)

The VXI mainframe delivers innovative cooling technology, improved backplane design, high reliability, easy maintenance, and versatile accessories.

- 13-slot, C-size
- Low cost for general purpose applications
- 500 watts of usable power
- Efficient, quiet cooling improves VXI module performance
- Basic mainframe monitoring for confident measurements
- Compliant with VXIbus and VXI plug and play specifications

The option includes the following mandatory core products:
E6171B Measurement Control Module
An isolated voltage source
An isolated current source with a programmable voltage limit
A 16 X 5 instrument multiplexer that multiplexes four analog buses plus Device Under Test (DUT) common
Multiplexing for eight external triggers and eight VXIbus TTL triggers to and from each other or to and from the DUT
An analog comparator, with programmable thresholds, whose output connects to the trigger multiplexer
A programmable high-voltage attenuator
An amplifier with programmable gain that can amplify the output of an Agilent E6173A Arbitrary Function Generator module (formerly the Agilent Z2471A) via a step-up transformer to provide output for simulating VRS (Variable Reluctance Sensors) signals
A programmable IRQ
A programmable general-purpose timer whose output also can be used to generate interrupts, trigger delays, and pacing

E1411B high-speed DMM
1-slot, C-size, register-based
5.5 digit low-noise integrating A/D
13 kHz high-speed sampling A/D
Balanced differential isolated inputs
Flexible triggering built-in timer pacer
Shared memory available

The following options are available:

0.2	E8780B-OC-VXICARDS	VXI cards option class
..3	E8780B-320	E6173A dual real-time Arb including cable
..3	E8780B-322	E1333A counter, E1403C adapter including cable
..3	E8780B-324	E1563A 800 kSa/s, 2 channel digitizer, including cable
..3	E8780B-331	16-channel non-isolated dac module including cable for MAC Panel
..3	E8780B-332	8-channel non-isolated DAC module, including cable
..3	E8780B-333	16-channel isolated DAC module, including cable 16-channel isolated DAC module
..3	E8786B-822	E1564A 4 channel VXI Digitizer Card and cable
..3	E8780B-341	16-channel non-isolated DAC module including cable for ExpressConnect
..3	E8780B-342	8/16-channel D/A converter has independent output channels without terminal block

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Step 3 GPIB Instruments

Choosing the right GPIB equipment (optional)

There are a few scenarios where one or more GPIB instruments are required:

- The VXI option is not selected
- Additional instrumentation is required to complement the VXI instruments
- The instrument required cannot be satisfied by the VXI instrumentation
- Low cost

The following instruments are available as options:

0.2	E8780B-OC-GPIB	GPIB instruments option class
..3	E8780B-080	33220A GPIB function/arbitrary waveform generator
..3	E8780B-085	53131A GPIB universal counter
..3	E8780B-060	34401A GPIB digital multimeter, 6.5 digit
..3	E8780B-061	34411A GPIB/LXI/USB digital multimeter/digitizer, 6.5 digit

There is little space constraint concerns when choosing these options except for the most extreme of cases for a 2 m rack.

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Step 4 Switch/Load Unit (SLU)

Choosing load simulation options (optional)

The system comes with a Switch Load Unit (SLU) which is the true core of the platform. The programmable 21-slot SLU is used for instrumentation switching (GPIB, Serial or VXIbus-based), plus switching power supply and loads to the target application. Test system resources (instrumentation, loads and power supplies) are routed to the DUT through the Pin Matrix cards and Load Cards that plug into the Switch/Load Unit.

To find out more about the Pin Matrixes, please refer to the SLU APPENDIX section.

In addition, to cater for more load simulation, an additional SLU card cage, E6198-FG can be added to the system by choosing the option below. The second SLU will be daisy-chained to the first SLU.

The following options are available:

0.2	E8780B-OC-PINCRD	Pin card option class
..3	E8792A-FG	TS-5400 SLU pin card with instrumentation matrix
..3	E8793A-FG	TS-5400 SLU pin card without instrumentation matrix
..3	E8794A-FG	TS-5400 Series II custom card

0.2	E8780B-OC-SLUCRD	SLU cards option class
..3	E6175A-FG	8-channel loadcard
..3	E6176A-FG	16-channel loadcard
..3	E6177A-FG	24-channel loadcard
..3	E6178B-FG	8-channel 30A loadcard
..3	N9377A-FG	16-channel dual-load loadcard
..3	N9378A-FG	24-channel low resistance loadcard
..3	N9379A-FG	48-channel high density loadcard

The corresponding cables must be selected to the choice of SLU card options above.

0.2	E8780B-OC-ADDSLU	Additional Switch Load Unit option class
..3	E6198A-FG	TS-5400 Switch/Load Unit

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Step 5 Power Supply

Choosing the right power supplies (mandatory)

Power supplies are chosen per load simulation supply or/and power-up the DUT.

The TS-5400 system provides four power-bus lines that can be connected to power supplies or ground. Any instrumentation and load simulation can be switched onto these buses.

Typically, either GPIB power supplies is chosen OR N6700 Series modular power supplies. However, there are scenarios where both are required although this is rare.

If the maximum power rating required does not exceed 100W, it is an advantage to use the Olympus power supply mainframe with the relevant modules to save space, speed and overall costs.

The following options are available. Please refer to the Modular Power Supply APPENDIX.

...4	E2233A-OC-MODULE	DC Power Modules
....5	E2233A-002	N6762A Precision 100W DC power module
....5	E2233A-001	N6752A High Performance 100W DC power module
....5	E2233A-003	N6751A High Performance 50W DC Power Module
....5	E2233A-004	N6761A 100W module
....5	E2233A-005	N6734A 300W module

For higher maximum power rating up to 2100W, the following options are available. Please refer to the GPIB Power Supply APPENDIX.

0.2	E8780B-OC-PWRSUP	Power supply option class
..3	E8780B-140	6643A power supply, including cable
..3	E8780B-141	6653A power supply, including cable
..3	E8780B-143	6672A power supply, including cable
..3	E8780B-144	6652A power supply, including cable
..3	E8780B-145	6642A power supply, including cable
..3	E8780B-142	6673A power supply, including cable
..3	E8780B-199	No power supplies included
..3	E8780B-146	6674A power supply, including cable
..3	E8780B-198	Custom power supply Installed
..3	E8786B-610	6628A power supply Installed
..3	E8780B-197	No power supplies included

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Step 6 Industrial PC

Choosing industrial PC options (mandatory)

The TS-5400 system comes with an industrial PC.

First, the E2235A-001 MS Windows XP Pro option is mandatory.

0.2	E2235A-AT0	TS-5400 Family controller, includes 1024MB RAM, DVD-RW, floppy drive, keyboard
..3	E2235A-OC-OPSYS	Operating system option class
...4	E2235A-001	MS Windows® XP Pro

The following are GPIB card options to enable the IPC to communicate via GPIB to the other equipment in the system. Typically, option E2235A-020 is chosen.

..3	E2235A-OC-GPIB	GPIB card option class
...4	E2235A-020	Agilent 82350B GPIB PCI card
...4	E2235A-021	NI GP-IB PCI card

The following options are available if digital I/O is required.

..3	E2235A-OC-ADDPCI	PCI Cards Option Class
...4	E2235A-040	8-channel Serial PCI Card
...4	E2235A-045	32-channel Digital I/O PCI card and cabling

Option E6249A-005 is an optional hardware that increases the total number of serial ports available in the system by 8.

...4	E6249A-005	8-channel Serial Port expander with unterminated 8-connector cable
...4	E6249A-015	8-channel Serial Port L2000 cable kit

If a communication (CAN) box is not desired, the system offers a PCI CAN card as an alternative at a cost of speed, features and flexibility.

...4	E2235A-050	PCI SOFTING CAN card and exp. conn. cabling
...4	E2235A-051	PCI CAN plug-in board 16-bit microcontroller
...4	E2235A-055	32 channel DIO card W2500 VDC isolation
...4	E2235A-052	PCI SOFTING CAN card and L2000 cabling

If the VXI mainframe option has been selected, Option E8780B-305 or E8780B-306 is mandatory to enable the IPC to communication to the VXI mainframe. Usually, Option E8780B-306 is selected.

..3	E2235A-OC-VXISLT0	VXI Slot Zero option class
...4	E2235A-305	IEEE-1394/PCI card
...4	E2235A-306	MXI PCI Card

Finally, a 17-inch LCD display can be customized per a variety of needs.

..3	E2235A-OC-DISP	PC Display options
...4	E6249A-010	17-inch LCD display with rackmount kit
...4	E6249A-012	17-inch LCD display for E2230A system
...4	E6249A-013	17-inch LCD display with rackmount kit without BNCs
...4	E6249A-023	17-inch LCD display with rackmount kit without BNCs

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Step 7 Serial Communications

Choosing the right DUT communication tool

Most, if not all ECUs use a communication protocol such as CAN, LIN, MOST and other standards. Our system offers CAN communication boxes that cater for the most widely used applications.

The following options are available:

...4	E8791A-OC-OPT	E8791A options
....5	E8791A-211	CAN/J1939 PIM
....5	E8791A-213	Ford SCP/J1850 PIM
....5	E8791A-214	GM Class II/J1850 PIM
....5	E8791A-219	Fault tolerant CAN PIM
....5	E8791A-217	Single wire CAN PIM
....5	E8791A-218	High-speed dual wire CAN PIM

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Step 8 Miscellaneous Parts

Choosing the miscellaneous

By default, E6249A-009 fixed keyboard and mouse pad tray is selected.

0.2	E8780B-OC-ACCY	Accessories
..3	E6249A-002	RS-232 handheld scanner kit
..3	E6249A-006	Strip printer
..3	E6249A-008	Shelf for TS-5400 Series II strip printer
..3	E6249A-009	Fixed keyboard and mouse pad tray
..3	E8780B-0B2	Add manual set

The TS-5400 can be configured in a 1.6 m rack as an alternative.

0.2	E8780B-OC-SPLCFG	Special configuration option class
..3	E8780B-831	Special configuration using 1.6 m rack

If E8780B system with ExpressConnect is selected, one accumulator card is required.

0.2	E8780B-OC-ACCUM	Accumulator card option class
..3	E8780B-122	Accumulator card

The rack fan is required and must be selected to suit the main power supply voltage to the system.

0.2	E8780B-OC-RKFAN	Rack fan option class
..3	E8780B-021	Rack fan assembly for 110 V system
..3	E8780B-022	Rack fan assembly for 220 V system

For TS-5400 with E8786B MAC Panel, the followings are required if SLU load cards have been selected. These are automatically calculated and should not be altered unless necessary.

0.2	E8786B-OC-ICA	ICA frame and receiver blocks
..3	E6180A-002	General purpose receiver block
..3	E6180A-003	High-power 36-pin receiver block
..3	E6180A-004	High-power 64-pin receiver block

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Step 8 Accessories

The following accessories are automatically selected depending on the system configuration and should not be altered unless special case calls for it.

0.2	E8780B-OC-COMBO	Combo material option class
..3	E8780B-CH1	One half rack instrument
..3	E8780B-CH2	Two half rack instruments
..3	E8780B-CH0	No half rack instruments
..3	E8780B-CL1	SLU slot filler
..3	E8780B-CX1	MAC Panel ICA slot filler
..3	E8780B-CX3	MAC Panel material required for second E8792A
..3	E8780B-CP2	2 U filler for missing power supplies
..3	E8780B-CP3	3 U filler for missing power supplies
..3	E8780B-CB1	Ballast combo material for power supplies
..3	E2233A-CA1	Cables for modular power supply
..3	E2233A-CA2	Cables for modular power supply and 6673A
..3	E8780B-CL2	Material for second SLU in TS-5400 system

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APPENDIX 1

Series 75 MAC Panel



Figure 6. Series 75 MAC Panel

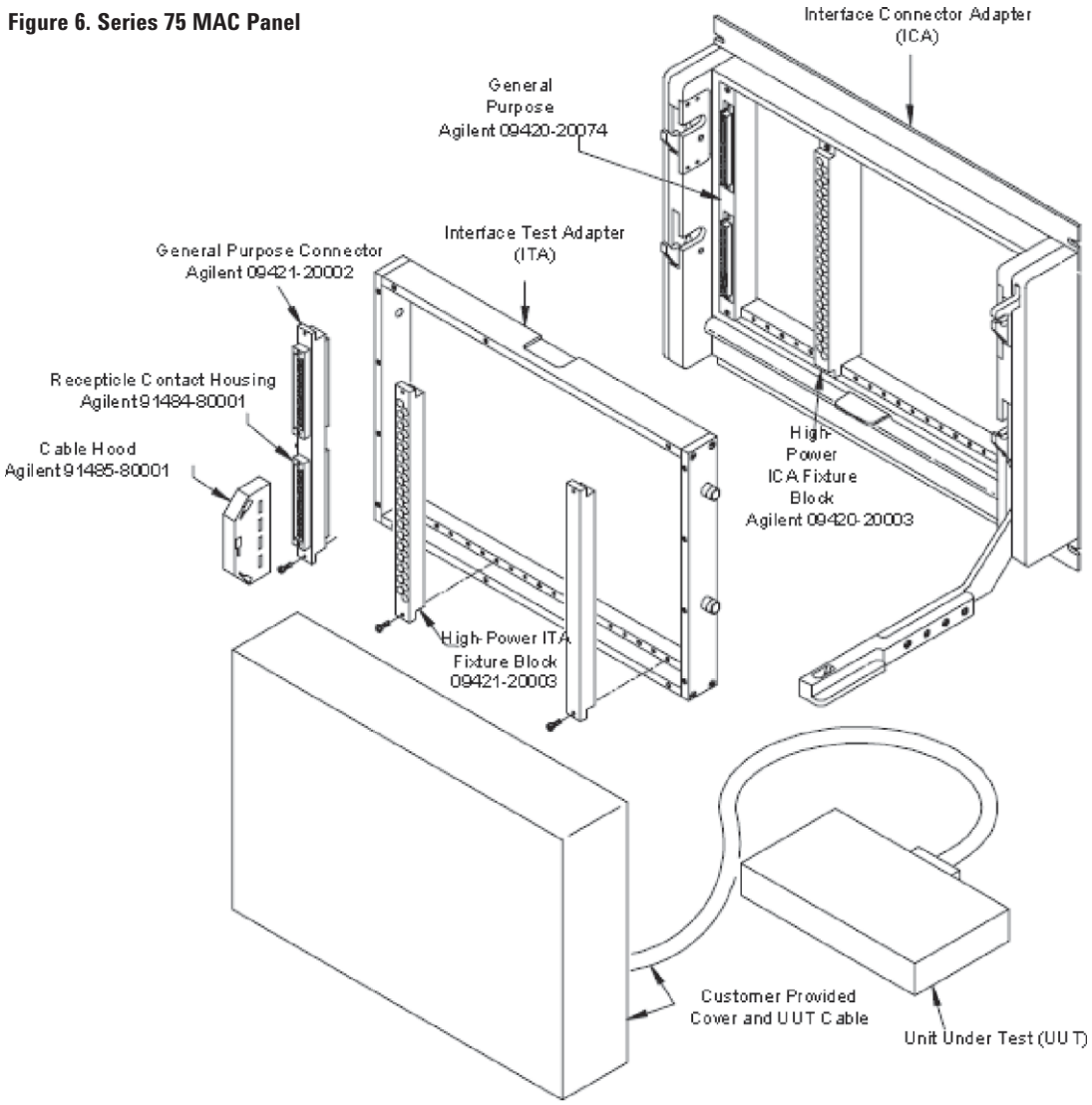


Figure 7. MAC Panel

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APPENDIX 1

Series 75 MAC Panel

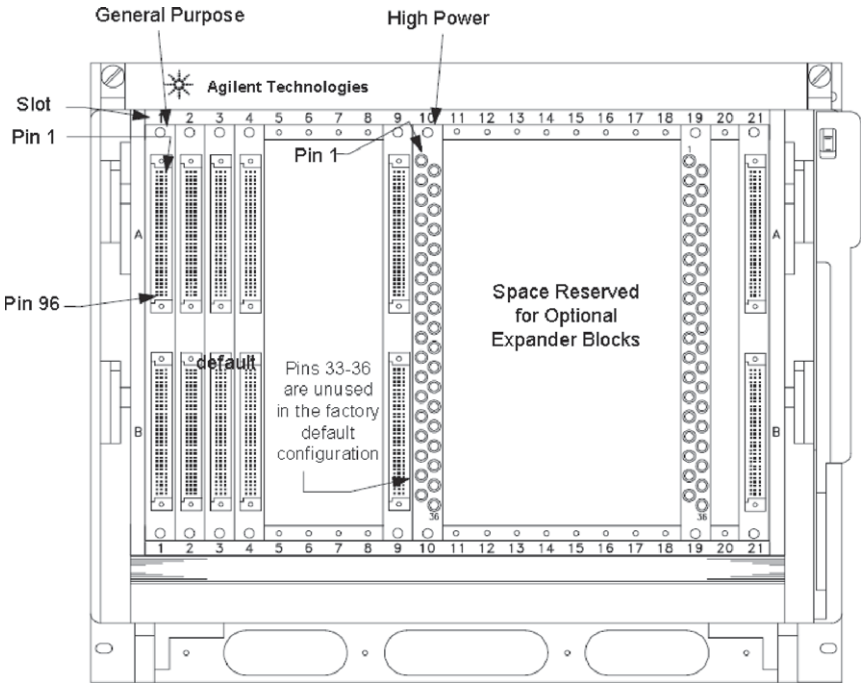


Figure 8. Typical interface connector assembly (fixture receiver) connector block locations

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ICA 1B switch/load unit connector block pinouts

Default factory connections to the ICA 1B signal block.
Signals on this connector originate from the Agilent E6198A switch/load unit backplane through an Agilent E3750-61607 cable.

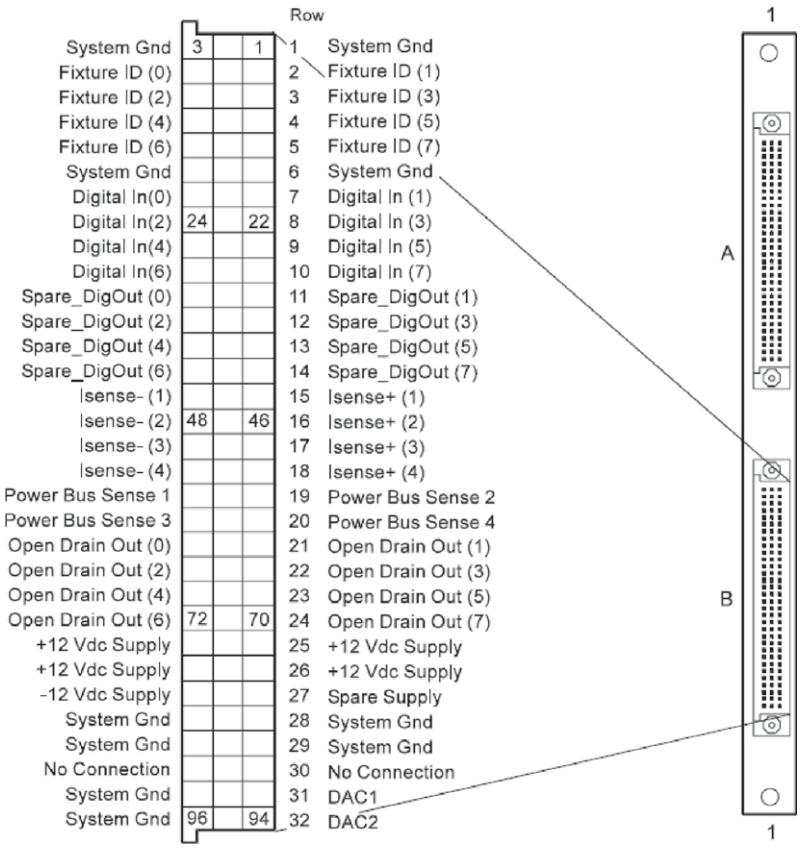


Figure 9. ICA 1B cable connections

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ICA slot 2A/2B connector block pinouts

ICA cable termination for the Agilent E8792/93 32-pin matrix module.
Uses an Agilent E3751-61601 cable.

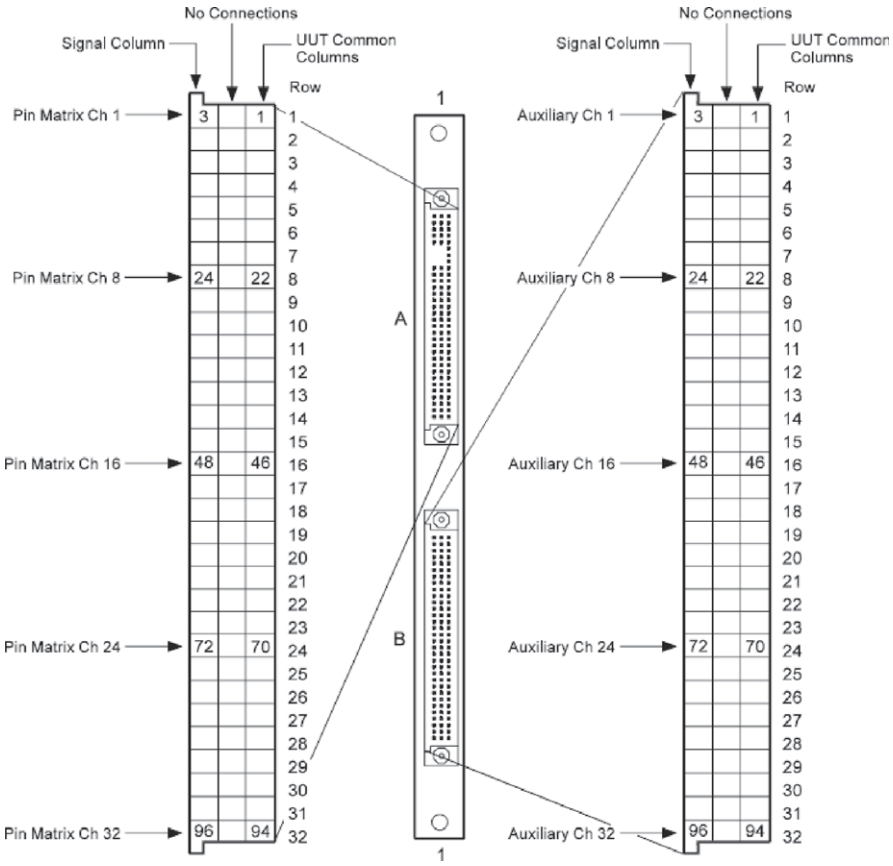


Figure 10. ICA connectors slot 2A/2B factory default connections

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Series 75 MAC Panel

ICA digital/analog converter pinout

ICA connector pinouts for both one and two Agilent E1418 16-channel DACs. Two cables, Agilent E3750-61623 and Agilent E3750-61622, connect the first DAC to the ICA connector. A second Agilent E3750-61622 cable is required for the second DAC.

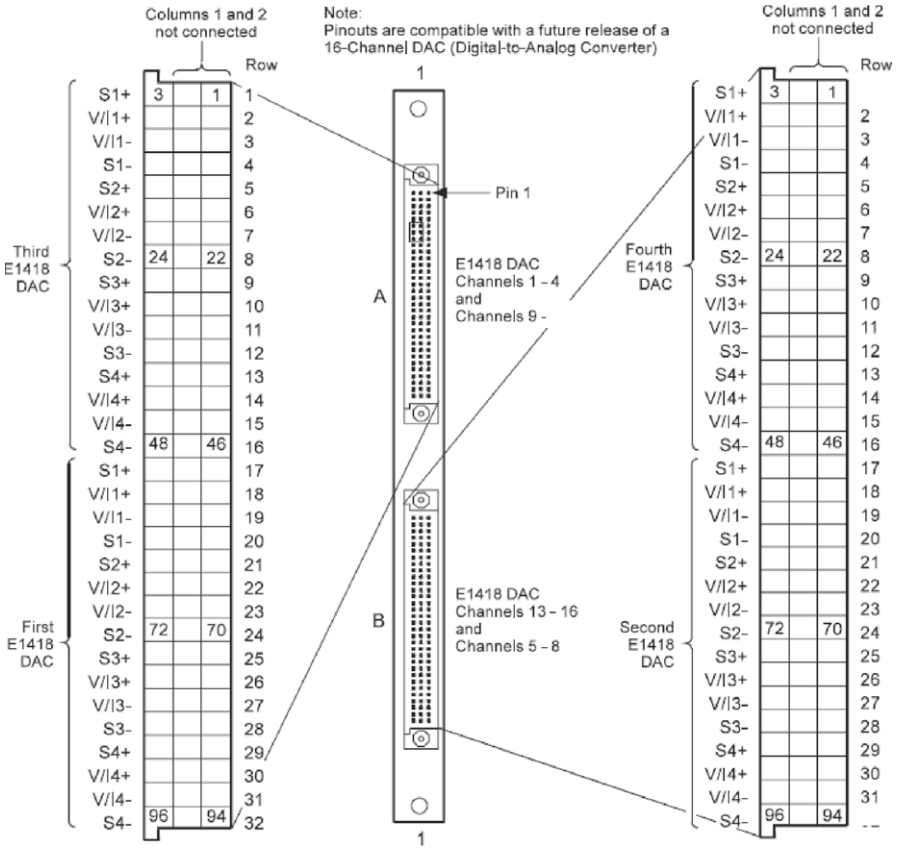


Figure 11. ICA connector pinout for the Agilent E1418A DACs

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ICA event detector pinout

ICA connector pinout for the Agilent E6174A event detector (formerly the Agilent Z2902A). Mates with an Agilent E3751A-61601 cable.

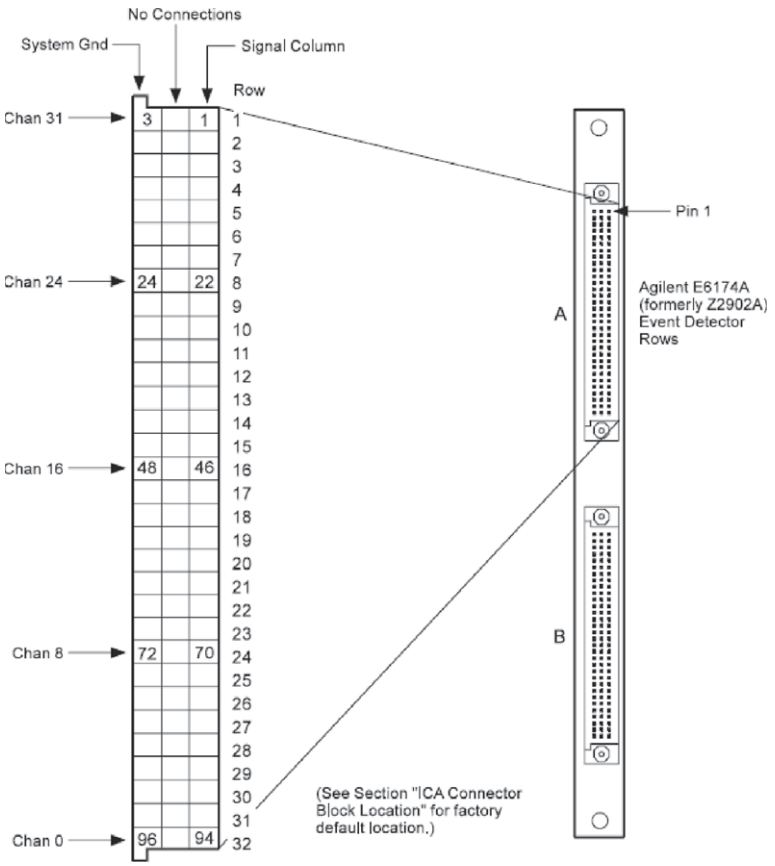


Figure 12. ICA connector pinout for the Agilent E6174A event detector

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APPENDIX 1

Series 75 MAC Panel

Part number cross-reference

Table 2-1 shows the Agilent model and part numbers, the former part number and, where applicable, the Mac Panel part number.

Table 2-1. Part number cross-reference

Description	Former part number	Remark	Agilent model number	Agilent part number	Mac Panel part number
General purpose connector	91421B	ICA side	E6177A Option 050	09420-20074	753001/4530
General purpose connector	91451A	ITA side	see below*	09421-20002	754000/4530
Receptacle contact housing	91484A	see below*	NA	91484-80001	
Cable hood	91485A	see below*	NA	91485-80001	
Receptacle contact	91487A	Crimp type female	NA	1252-6533	NA
High-power ITA fixture block	91453A	ITA side	E6243A Option 020	09421-20003	754001/4530
High-power receptacle contact	91462A	ITA side	E6243A Option 022 (qty. 36)	09421-20009	7851211-5
High-power ICA fixture block	91423A	ICA side E6178B Option 050	09420-20003	753003/4530	
High-power ICA contact	91463A	ICA side	NA	09420-20009	7850211

* E6243A option 010 includes: 91451A (qty 1), 91484A (qty 2), 91485A (qty 2), retainer clip E3750-01206 (qty 1)

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APPENDIX 2

VXI Instrumentations

Sequence #1

E6171B MCM specifications

General	
Module size/device type	C-Size VXIbus, register based, A16/D16, static configuration
Power requirements	+5 and +12 Vdc
Operating temperature	5 to 40 °C
Operating humidity	80% Relative Humidity, 5 to 40 °C

External instrument multiplexer	
No. of analog instrument channels	16
Analog channel	
Voltage (max.)	200 volts
Resistance	<1 Ω
Unbalanced bandwidth	10 MHz (minimum)
Balanced pair bandwidth	5 MHz (minimum)
Relay type	dry reed
Relay life	
No load	$1x10^8$ operations
Full load	$1x10^5$ operations
Relay switching speed	
Close	500 µS
Open	400 µS
Relay switching characteristics	1.0 A carry 0.5 A while switching 7.5 Volt-Amps max. instantaneous switching
Other relay parameters	300 VDC standoff voltage 200 VDC switching voltage

Voltage source (low voltage)	
Voltage range	±16 Vdc at rated current (0.2 Amp) (4 quadrant operation) rated accuracy, no load ±(0.06% + 0.006 V)
DAC resolution	16 bits
Output resistance	2 Ω max.
Current sense accuracy	to ABus 1to Abus2 - 4, UUTCommon
200 mA range	±(1.25% + 150 µA) ± (2.0% + 150 µA)
20 mA range	±(0.21% + 15 µA) ± (0.29% + 15 µA)
2 mA range	±(0.30% + 1.5 µA) ± (0.31% + 1.5 µA)
200 uA range	±(0.12% + 0.75 µA) ± (0.12% + 0.75 µA)
Short circuit current limit protected	0.225 A

Voltage source (high voltage)	
Voltage range	–10 to +100 Vdc or –100 to +10 Vdc at rated current (0.02 A) (4 quadrant operation) rated accuracy, no load ±(0.06% + 0.06 V)
DAC resolution	16 bits
Output resistance	2 Ω max.
Current sense accuracy	to ABus 1to Abus2 - 4, UUTCommon ±(0.25% + 150 µA) ± (0.33% + 150 µA)
Short circuit current limit protected	0.025 A

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APPENDIX 2

VXI Instrumentations

Sequence #2

E1411B digital multimeter

Performance characteristics of the E1411B

Form factor	Module (VXI)
DC volts minimum range	125 mV
DC volts maximum range	300 V
DC volts no. of ranges	5 qty
DC volts maximum sensitivity	488 µV
DC volts basic 1 yr accuracy	0.0145%
AC volts minimum range	87.5 mV
AC volts maximum range	300 V
AC volts no. of ranges	5 qty
AC volts minimum frequency	20 Hz
AC volts maximum frequency	10 kHz
AC volts maximum sensitivity	122 µV
AC volts basic 1 Year accuracy	0.84 %
True Rms (?)	Yes
Normal mode rejection ratio	84 dB
Common mode rejection ratio	150 dB
Resistance 2 wire/4 wire	2 wire,4 wire
Resistance minimum range	256 Ω
Resistance maximum range	1 MΩ
Resistance no. of ranges	5 qty
Resistance maximum sensitivity	1 Ω

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VXI Instrumentations

Sequence #3

E1418A

- Voltage source
  - +16 V, 448 µV resolution, >20 mA compliance for 0 to +12 V
- Current source
  - +0.02 A, 610 nA steps, +12 V compliance

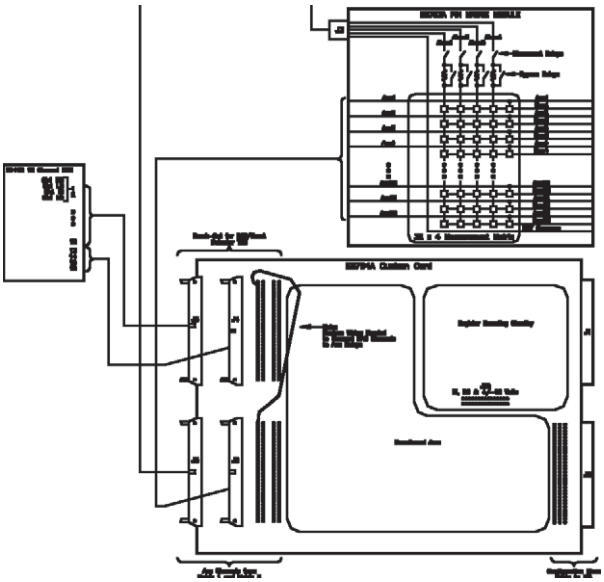


Figure 13. E1418A 16-channel isolated DAC

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APPENDIX 2

VXI Instrumentations

E6171B MCM specifications

Current source (low voltage)	
Current range	±200 mA over ±16V range (4 quadrant operation)
Current accuracy	
200 mA range	±(0.3% + 500 µA)
20 mA range	±(0.1% + 50 µA)
2 mA range	±(0.3% + 5 µA)
200 µA range	±(0.1% + 0.5 µA)
DAC resolution	16 bits
Voltage compliance limit range	±(1.5 to 16) Vdc
Voltage compliance limit accuracy	±0.25 Volts, specified at no load
Output resistance	
200 mA range	> 20 kΩ minimum
20 mA range	> 200 kΩ minimum
2 mA range	> 2 MΩ minimum
200 µA range	> 20 MΩ minimum

Current source (high voltage)	
Current range	±20 mA at rated voltage (4 quadrant operation) (–10 to +100 Vdc or –100 to +10 Vdc) rated accuracy, no load ±(0.3% + 0.46 mA)
DAC resolution	16 bits
Current accuracy	±(0.3% + 500 µA)
Voltage compliance limit range	±(10 to 100) Vdc
Voltage compliance limit accuracy	±2.5 Volts specified at no load
Output resistance	140 kΩ

Step up transformer	
Transformer ratio	10.2:1
Voltage accuracy	10, +5% maximum error, 150 Hz to 5 kHz
Output voltage	160 VPP max into a 10 kΩ load
Output current	10 mA maximum
Output impedance	1.0 kΩ maximum at 1.0kHz

Hi-voltage attenuator	
Attenuation	20:1 nominal
Accuracy, DC[1]	±3 mV maximum unattenuated ±(2.5% + 250 mV) maximum attenuated
Settling time (to within 2.0% of final value)	20 µS maximum unattenuated 5 µS maximum attenuated
Input impedance	20 kΩ
Maximum input voltage	±100 DCV, ±200 Pulse < 1 mS, < 1.0% DC (500 Volts maximum with external series resistor and clamp protection at 200 Volts)
Programmable knee	±(1 to 10) Volts (2.5 Volts default)

1 Accuracy specification are with respect to the default knee voltage of 2.5V with no external source resistance. Unattenuated range of ±2.0 V. Attenuated range of ±(20 to 200) V.

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E6171B MCM specifications

MCM trigger subsystem	
Resources (trigger inputs/outputs)	
External triggers	Eight (TTL bi-directional, chassis referenced)
VXI TTL triggers	Eight (bi-directional)
Timer	One timer done, one timer start
Software	One input, one output
Comparator	One (input only, ref. to DUT common, programmable edge)
Digital trigger	One (output only, ref. to DUT common, internal pullup to +5 V)
Time delay[1]	VXI TTL trig in, any EXT trig in, or timer done - to any other VXI TTL trig, any other EXT trig, or timer start: 100 nS max. VXI TTL trig in, any EXT trig in, or timer done -to- digital trigger out: 150 nS max. Comparator threshold in - to any VXI TTL trig out, any EXT trig out, or timer start: 350 nS max. Comparator threshold in -to- digital trigger out: 400 nS max.
Analog comparator	
Maximum voltage	±100 Vdc or ±200 V pulse ≤ 10 mS, ≤ 2% duty cycle
Input resistance	100 kΩ (typical)
Input bandwidth	250 kHz (min.)
Comparator 200 V range	
Programmable threshold range	±200 V
Programmable threshold accuracy	±4 Volts
Threshold sensitivity (hysteresis)	5.0 VPP max., 1.0 VPP min.
Comparator 20 V range	
Programmable threshold range	±20
Programmable threshold accuracy	±0.4 Volts
Threshold sensitivity (hysteresis)	0.5 VPP max., 0.1 VPP min.
Digital trigger output	
Nominal internal pull-up	5 V
Sink current	10 mA at Vol ≤ 0.4 Vdc or 150 mA at Vol ≤ 1 Vdc
Maximum external pull-up voltage	30 Vdc
General purpose timer	
Resolution	10 µS typical
Range	20 µS to 655.37mS
Accuracy	±(0.02 % + 10 µS)
Programmable modes	One-shot or programmable
Programmable start events	Software or trigger
Programmable outputs	Busy bit in status register, 10 µS trigger pulse, or interrupt (IRQ)

1 All trigger timing specifications except comparator threshold, are from +1.5 V driven edge to +1.5 V driven edge.

All comparator timing specifications are referenced to the input crossing the nominal programmed threshold at 85 V/ µS with 1 V overdrive for the 20 V range or 10 V overdrive for the 200 V range.

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E6171B MCM specifications

Relay life	
	Electromechanical relays are subject to normal wear-out. Relay life depends on several factors including loading and switching frequency.
Relay load	In general, higher power switching reduces relay life. In addition, capacitive/inductive loads and high inrush currents (e.g. turning on a lamp or starting a motor) reduce relay life. Exceeding specified maximum inputs can cause catastrophic failures.
Switching frequency	Relay contacts heat when switched. As the switching frequency increases, the contacts have less time to dissipate heat. The resulting increase in contact temperature reduces relay life.

End-of-life detection	
	A preventative maintenance routine can prevent problems caused by unexpected relay failure. The end-of-life of a relay can be determined by using one or more of the three methods described below. The best method (or combination of methods), as well as the failure criteria, depends on the application in which the relay is used.
Contact resistance	As the relay begins to wear out, its contact resistance increases. For the Agilent E6171B, the total resistance measured through and external instrument connector to an analog bus connector is less than 1Ω. Since most of this resistance is trace resistance, an increase of 1 or 2 Ω s indicates relay deterioration.
Stability of contact resistance	The stability of contact resistance decreases with age. Using this method, the contact resistance is measured several (5 - 10) times, and the variance of the measurement is determined. An increase in the variance indicates deteriorating performance.
Number of operations	Relays can be replaced after a predetermined number of contact closures. However, this method requires knowledge of the applied load and life specifications for the applied load. The expected life of the relays range from 1x105 operations at full load to 1x108 operations for mechanical end-of-life (no load).

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APPENDIX 3

Agilent 34410A and 34411A Multimeters

Setting the Standard for Next Generation Benchtop and System Testing

Fully compliant to LXI Class C specification



Figure 14. 34410A and 34411A multimeters

Agilent 34410A 6 1/2-digit high-performance DMM

- 10,000 readings/s @ 5 1/2 digits direct to PC
- 1,000 readings/s @ 6 1/2 digits direct to PC
- 30 PPM 1-year Basic DC accuracy
- LAN, USB and GPIB
- DCV, ACV, DCI, ACI, 2-wire and 4-wire resistance, frequency, period, continuity, and diode test
- Capacitance and temperature measurements
- Expanded measurement ranges
- Data logger with 50 k reading non-volatile memory

Agilent 34411A 61/2-digit enhanced-performance DMM

All the features of the 34410A, plus:

- 50,000 readings/s @ 41/2-digits direct to PC
- 1 million reading memory
- Analog level triggering
- Programmable pre/post triggering

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Agilent 34410A and 34411A Multimeters

Setting the Standard for Next Generation Benchtop and System Testing

Accuracy Specifications ± (% of reading + % of range)[1]

Function	Range[3]	Frequency, Test Current or Burden Voltage	24 Hour[2] Tcal ±1°C	90 Day Tcal ±5°C	1 Year Tcal ±5°C	Temperature Coefficient/°C 0°C to (Tcal -5°C) (Tcal +5°C) to 55°C
DC Voltage	100.0000 mV		0.0030 + 0.0030	0.0040 + 0.0035	0.0050 + 0.0035	0.0005 + 0.0005
	1.000000 V		0.0020 + 0.0006	0.0030 + 0.0007	0.0035 + 0.0007	0.0005 + 0.0001
	10.00000 V		**0.0015 + 0.0004**	**0.0020 + 0.0005**	**0.0030 + 0.0005**	**0.0005 + 0.0001**
	100.0000 V		0.0020 + 0.0006	0.0035 + 0.0006	0.0040 + 0.0006	0.0005 + 0.0001
	1000.000 V[4]		0.0020 + 0.0006	0.0035 + 0.0006	0.0040 + 0.0006	0.0005 + 0.0001
True RMS AC Voltage[5,6]	100.0000 mV to 750.000 V	3 Hz – 5 Hz	0.50 + 0.02	0.50 + 0.03	0.50 + 0.03	0.010 + 0.003
		5 Hz – 10 Hz	0.10 + 0.02	0.10 + 0.03	0.10 + 0.03	0.008 + 0.003
		10 Hz – 20 kHz	**0.02 + 0.02**	**0.05 + 0.03**	**0.06 + 0.03**	**0.005 + 0.003**
		20 kHz – 50 kHz	0.05 + 0.04	0.09 + 0.05	0.10 + 0.05	0.010 + 0.005
		50 kHz – 100 kHz	0.20 + 0.08	0.30 + 0.08	0.40 + 0.08	0.020 + 0.008
		100 kHz – 300 kHz	1.00 + 0.50	1.20 + 0.50	1.20 + 0.50	0.120 + 0.020
True RMS AC Voltage[5,7]	100.0000 mV to 750.000 V	3 Hz – 5 Hz	0.50 + 0.02	0.50 + 0.03	0.50 + 0.03	0.010 + 0.003
		5 Hz –10 Hz	0.10 + 0.02	0.10 + 0.03	0.10 + 0.03	0.008 + 0.003
		10 Hz – 20 kHz	**0.02 + 0.02**	**0.04 + 0.02**	**0.045 + 0.02**	**0.005 + 0.002**
		20 kHz – 50 kHz	0.04 + 0.025	0.08 + 0.025	0.090 + 0.025	0.010 + 0.0025
		50 kHz – 100 kHz	0.10 + 0.040	0.20 + 0.040	0.200 + 0.040	0.020 + 0.0040
		100 kHz – 300 kHz	1.00 + 0.250	1.20 + 0.250	1.200 + 0.250	0.120 + 0.0200
Resistance[8]	100.0000 Ω	1 mA	0.0030 + 0.0030	0.008 + 0.004	0.010 + 0.004	0.0006 + 0.0005
	1.000000 kΩ	1 mA	0.0020 + 0.0005	0.007 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	10.00000 kΩ	**100 µA**	**0.0020 + 0.0005**	**0.007 + 0.001**	**0.010 + 0.001**	**0.0006 + 0.0001**
	100.0000 kΩ	10 µA	0.0020 + 0.0005	0.007 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	1.000000 MΩ	5 µA	0.0020 + 0.0010	0.010 + 0.001	0.012 + 0.001	0.0010 + 0.0002
	10.00000 MΩ	500 nA	0.0100 + 0.0010	0.030 + 0.001	0.040 + 0.001	0.0030 + 0.0004
	100.0000 MΩ	500 nA || 10 MΩ	0.200 + 0.001	0.600 + 0.001	0.800 + 0.001	0.1000 + 0.0001
	1.000000 GΩ	500 nA || 10 MΩ	2.000 + 0.001	6.000 + 0.001	8.000 + 0.001	1.0000 + 0.0001
DC Current	100.0000 µA	< 0.03 V	0.010 + 0.020	0.040 + 0.025	0.050 + 0.025	0.0020 + 0.0030
	1.000000 mA	**< 0.3 V**	**0.007 + 0.006**	**0.030 + 0.006**	**0.050 + 0.006**	**0.0020 + 0.0005**
	10.00000 mA	< 0.03 V	0.007 + 0.020	0.030 + 0.020	0.050 + 0.020	0.0020 + 0.0020
	100.0000 mA	< 0.3 V	0.010 + 0.004	0.030 + 0.005	0.050 + 0.005	0.0020 + 0.0005
	1.000000 A	< 0.8 V	0.050 + 0.006	0.080 + 0.010	0.100 + 0.010	0.0050 + 0.0010
	3.000000 A	< 2.0 V	0.100 + 0.020	0.120 + 0.020	0.150 + 0.020	0.0050 + 0.0020
True RMS AC Current[9]	100.0000 µA to 3.00000 A	**3 Hz – 5 kHz**	**0.10 + 0.04**	**0.10 + 0.04**	**0.10 + 0.04**	**0.015 + 0.006**
		5 kHz – 10 kHz	0.20 + 0.04	0.20 + 0.04	0.20 + 0.04	0.030 + 0.006
Frequency or Period	100 mV to 750 V	3 Hz – 5 Hz	0.070 + 0.000	0.070 + 0.000	0.070 + 0.000	0.005 + 0.000
		5 Hz – 10 Hz	0.040 + 0.000	0.040 + 0.000	0.040 + 0.000	0.005 + 0.000
		10 Hz – 40 Hz	0.020 + 0.000	0.020 + 0.000	0.020 + 0.000	0.001 + 0.000
		40 Hz – 300 kHz	**0.005 + 0.000**	**0.006 + 0.000**	**0.007 + 0.000**	**0.001 + 0.000**
Capacitance[10]	1.0000 nF	500 nA	0.50 + 0.50	0.50 + 0.50	0.50 + 0.50	0.05 + 0.05
	10.000 nF	1 µA	0.40 + 0.10	0.40 + 0.10	0.40 + 0.10	0.05 + 0.01
	100.00 nF	10 µA	0.40 + 0.10	0.40 + 0.10	0.40 + 0.10	0.01 + 0.01
	1.0000 µF	10 µA	0.40 + 0.10	0.40 + 0.10	0.40 + 0.10	0.01 + 0.01
	10.000 µF	100 µA	0.40 + 0.10	0.40 + 0.10	0.40 + 0.10	0.01 + 0.01
Temperature[11]						
RTD	-200°C to 600°C		0.06°C	0.06°C	0.06°C	0.003°C
Thermistor	-80°C to 150°C		0.08°C	0.08°C	0.08°C	0.002°C
Continuity	1000.0 Ω	1 mA	0.002 + 0.010	0.008 + 0.020	0.010 + 0.020	0.0010 + 0.0020
Diode Test[12]	1.0000 V	1 mA	0.002 + 0.010	0.008 + 0.020	0.010 + 0.020	0.0010 + 0.0020

[1] Specifications are for 90 minute warm-up and 100 PLC..
[2] Relative to calibration standards..
[3] 20% overrange on all ranges, except DCV 1000 V, ACV 750 V, DCI and ACI 3 A ranges.
[4] For each additional volt over ± 500 V add 0.02 mV of error.
[5] Specifications are for sinewave input > 0.3% of range and > 1 mVrms. Add 30 uV error for frequencies below 1 kHz.
750 VAC range limited to 8×10^7 Volts-Hz. For each additional volt over 300 Vrms add 0.7 mVrms of error.
[6] 34410A and 34411A with serial numbers lower than: 34410A: MY47XXXXXX, SG47XXXXXX, 34411A: MY48XXXXXX, SG48XXXXXX.
[7] 34410A and 34411A with serial numbers greater than: 34410A: MY47XXXXXX, SG47XXXXXX, 34411A: MY48XXXXXX, SG48XXXXXX.
[8] Specifications are for 4-wire resistance measurements, or 2-wire using Math Null. Without Math Null, add 0.2 Ω additional error in 2-wire resistance measurements.
[9] Specifications are for sinewave input > 1% of range and > 10 µArms. Frequencies > 5 kHz are typical for 1 A and 3 A ranges.
[10] Specifications are for 1-hour warm-up using Math Null. Additional errors may occur for non-film capacitors.
[11] For total measurement accuracy, add temperature probe error.
[12] Accuracy specifications are for the voltage measured at the input terminals only. 1 mA test current is typical.
Variation in the current source will create some variation in the voltage drop across a diode junction.

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APPENDIX 3

GPIB Power Supplies



Figure 15. 66XXA power supply

Model	Voltage	Current	Max power	Dimensions (mm)
6642A	20 V	10 A	200 W	W = 426, H = 88, D = 439
6643A	35 V	6 A	210 W	W = 426, H = 88, D = 439
6652A	20 V	25 A	500 W	W = 425, H = 133, D = 498
6653A	35 V	15 A	525 W	W = 425, H = 133, D = 498
6672A	20 V	100 A	2000 W	W = 426, H = 145, D = 640
6673A	35 V	60 A	2100 W	W = 426, H = 145, D = 640
6674A	60 V	35 A	2100 W	W = 426, H = 145, D = 640

Model	Max power	Output 1 low/high range	Output 2 low/high range	Dimensions (mm)
6628A	50 W	Range 1: 3.2 W, 16 V, 200 mA Range 2: 50 W, 50 V, 1 A Range 3: 32 W, 16 V, 2 A	Range 1: 3.2 W, 16 V, 200 mA Range 2: 50 W, 50 V, 1 A Range 3: 32 W, 16 V, 2 A	W = 426, H = 133, D = 498

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APPENDIX 3

GPIB Power Supplies

Specifications (at 0° to 55°C unless otherwise specified)	6642A	6643A
Number of outputs	1	1
GPIB	Yes	Yes
Output ratings		
Output voltage	0 to 20 V	0 to 35 V
Output current (40 °C)	0 to 10 A	0 to 6 A
Maximum current (50 °C/55 °C)	9 A/8.5 A	5.4 A/5.1 A
Programming accuracy at 25 °C ±5 °C		
Voltage 0.06% +	10 mV	15 mV
Current 0.15% +	13 mA	6.7 mA
Ripple and noise from 20 Hz to 20 MHz		
Voltage rms	300 µV	400 µV
Voltage peak-to-peak	3 mV	4 mV
Current rms	5 mA	3 mA
Readback accuracy at 25 °C ±5 °C (percent of reading plus fixed)		
Voltage 0.07% +	15 mV	25 mV
+Current 0.15% +	9.1 mA	5 mA
–Current 0.35% +	20 mA	12 mA
Load regulation		
Voltage	2 mV	3 mV
Current	0.5 mA	0.25 mA
Line regualtion		
Voltage	0.5 mV	1 mV
Current	0.5 mA	0.25 mA
Transient response time: less than 100 µs for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply or 20 mV, whichever is greater) following any step change in load current of up to 50% of rated current		

Supplemental Characteristics	(Non-warranted characteristics determined by design and useful in applying the product)	
Average resolution		
Voltage	5 mV	10 mV
Current	3 mA	2 mA
OVP	30 mV	54 mV
OVP accuracy	400 mV	700 mV

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APPENDIX 3

GPIB Power Supplies

Specifications (at 0° to 55°C unless otherwise specified)	6652A	6653A	6654A
Number of outputs	1	1	1
GPIB	Yes	Yes	Yes
Output ratings			
Output voltage	0 to 20 V	0 to 35 V	0 to 60 V
Output current (40 °C)	0 to 25 A	0 to 15 A	0 to 9 A
Maximum current (50 °C/55 °C)	22.5 A/21.3 A	13.5 A/12.8 A	8.1 A/7.7 A
Programming accuracy at 25 °C ±5 °C			
Voltage 0.06% +	10 mV	15 mV	26 mV
Current 0.15% +	25 mA	13 mA	8 mA
Ripple and noise from 20 Hz to 20 MHz			
Voltage rms	300 µV	400 µV	500 µV
Voltage peak-to-peak	3 mV	4 mV	5 mV
Current rms	10 mA	5 mA	3 mA
Readback accuracy at 25 °C ±5 °C (percent of reading plus fixed)			
System models only			
Voltage 0.07% +	15 mV	25 mV	40 mV
+Current 0.15% +	26 mA	15 mA	7 mA
–Current 0.35% +	44 mA	24 mA	15 mA
Load regulation			
Voltage	2 mV	3 mV	4 mV
Current	1 mA	0.5 mA	0.5 mA
Line regualtion			
Voltage	0.5 mV	1 mV	1 mV
Current	1 mA	0.75 mA	0.5 mA
Transient response time: less than 100 µs for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply or 20 mV, whichever is greater) following any step change in load current of up to 50% of rated current			

Supplemental Characteristics	(Non-warranted characteristics determined by design and useful in applying the product)		
Average resolution			
Voltage	5 mV	10 mV	15 mV
Current	7 mA	4 mA	2.5 mA
OVP	30 mV	54 mV	93 mV
OVP accuracy	400 mV	700 mV	1.2 V

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APPENDIX 3

GPIB Power Supplies

Specifications (at 0° to 55°C unless otherwise specified)	6673A	6674A
Number of outputs	1	1
GPIB	Yes	Yes
Output ratings		
Output voltage	0 to 35 V	0 to 60 V
Output current	0 to 60 A	0 to 35 A
Programming accuracy at 25 °C ±5 °C		
Voltage 0.04% +	35 mV	60 mV
Current 0.1% +	40 mA	25 mA
Ripple and noise from 20 Hz to 20 MHz		
Voltage rms	800 µV	1.25 mV
Voltage peak-to-peak	9 mV	11 mV
Current rms	40 mA	25 mA
Readback accuracy at 25 °C ±5 °C (percent of reading plus fixed)		
Voltage 0.05% +	50 mV	90 mV
±Current 0.1% +	60 mA	35 mA
Load regulation		
Voltage 0.002% +	1.2 mV	2 mV
Line regualtion		
Current 0.005% +	4 mA	2 mA
Transient response time: less than 900 µs for the output voltage to recover 100 mV following a change in load from 100% to 50% or 50% to 100% of the output current rating of the supply		

Supplemental Characteristics	(Non-warranted characteristics determined by design and useful in applying the product)	
Average resolution		
Voltage	10 mV	15 mV
Current	15 mA	8.75 mA
OVP	65 mV	100 mV
Output Voltage programming response time* (excluding command processing time)	130 ms	130 ms

* Full load programming rise/fall time (10% to 90% or 90% to 10%) with full resistive load equal to rated output voltage/rated output current.

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GPIB Power Supplies

6628A

Specifications (at 0° to 55°C unless otherwise specified)	50 W output
Output power	
Low-range volts, amps	0 to 16 V, 0 to 200 mA
High range volts, amps	0 to 50 V, 0 to 1 A or 0 to 16 V, 0 to 2 A
Output combinations for each model (total number of outputs)	
6628A (2) Precision	2
Programming accuracy at 25 °C ±5 °C	
Voltage	3 mV + 0.016% (low), 10 mV + 0.016% (high)
Current	185 µA + 0.04% (low), 500 µA + 0.04% (high)
Readback accuracy at 25 °C ±5 °C	
Voltage	0.016% + 3.5 mV (low), 0.016% + 10 mV (high)
±Current	0.04% + 250 µA (low), 0.04% + 550 µA (high)
Ripple and noise (peak-to-peak, 20 Hz to 20 MHz; rms, 20 Hz to 10 MHz)	
Constant voltage rms	500 µV
Peak-to-peak	3 mV
Constant current rms	0.1 mA
Load regulation	
Voltage	0.5 mV
Current	0.01 mA
Load cross regulation	
Voltage	0.25 mV
Current	0.01 mA
Line regualtion	
Voltage	0.5 mV
Current	0.01 mA
Transient response time: less than 75 µs for the output to recover to within 75 mV of nominal value following a load change within specfications	

Supplemental Characteristics	(Non-warranted characteristics determined by design and useful in applying the product)
Average programming resolution	
Voltage	1 mV (low), 3.2 mV (high)
Current	13 µA (low), 131 µA (high)
OVP	230 mV
Output programming response time (time to settle within 0.1% of full scale output, after Vset command has been processed)	6 ms

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APPENDIX 3

Modular Power Supplies



Figure 16. Modular power supply

		N6751A/N6752A	N6753A	N6754A	N6761A/N6762A
DC Output Ratings	• Voltage	50 V	20 V	60 V	50 V
	• Current (derated 1% per °C above 40°C)	5 A/10 A	50 A	20 A	1.5 A/3 A
	• Power	50 W/100 W	300 W	300 W	50 W/100 W
Output Ripple and Noise (PARD) (from 20 Hz – 20 MHz)	• CV peak-to-peak	4.5 mV	5 mV	6 mV	4.5 mV
	• CV rms	350 µV	1 mV	1 mV	350 µV
Load Effect (Regulation) (for any output load change, with a maximum load-lead drop of 1 V per lead)	• Voltage	2 mV	2 mV	2 mV	0.5 mV
	• Current (at 0 - 7 V)	2 mA	12 mA	5 mA	30 µA
	• (at 0 - 50 V)	2 mA	12 mA	5 mA	65 µA
Source Effect (Regulation)	• Voltage	1 mV	0.5 mV	1.2 mV	0.5 mV
	• Current	1 mA	5 mA	2 mA	30 µA
Programming Accuracy (at 23 °C ±5 °C after 30 minute warm-up. Applies from min. to max. programming range)	• Voltage high range	0.06% + 19 mV	0.06% + 10 mV	0.06% + 25 mV	0.016% + 6 mV
	• Voltage low range (≤ 5.5 V)	N/A	N/A	N/A	0.016% + 1.5 mV
	• Current high range	0.1% + 20 mA	0.10% + 30 mA	0.10% + 8 mA	0.04% + 200 µA
	• Current low range (≤ 100 mA, at 0 - 7 V)	N/A	N/A	N/A	0.04% + 15 µA
	• (≤ 100 mA, at 0 - 50 V)	N/A	N/A	N/A	0.04% + 55 µA
Measurement Accuracy (at 23 °C ±5 °C)	• Voltage high range	0.05% + 20 mV	0.05% + 10 mV	0.05% + 25 mV	0.016% + 6 mV
	• Voltage low range (≤ 5.5 V)	N/A	N/A	N/A	0.016% + 1.5 mV
	• Current high range	0.1% + 4 mA	0.10% + 30 mA	0.10% + 8 mA	0.04% + 160 µA
	• Current low range (≤ 100 mA, at 0 - 7 V)[1]	N/A	N/A	N/A	0.03% + 15 µA[2]
	• (≤ 100 mA, at 0 - 50 V)	N/A	N/A	N/A	0.03% + 55 µA
Load Transient Recovery Time (time to recover to within the settling band following a load change) • from 60% to 100% and from 100% to 60% of full load for models N6751A and N6761A • from 50% to 100% and from 100% to 50% of full load for models N6752A-N6754A and N6762A	• Voltage settling band	± 75 mV[2]	± 30 mV	± 90 mV[3]	± 75 mV
	• Time	< 100 µs	< 100 µs	< 100 µs	< 100 µs

1 Applies when measuring 4096 data points (SENSe:SWEep:POINts = 4096).
2 Settling band is ±125 mV for Model N6752A when relay option 761 is installed.
3 Settling band is ±350 mV for Model N6754A when relay option 760 or 761 is installed.

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Modular Power Supplies

		N6731B/ N6741B	N6732B/ N6742B	N6733B/ N6743B	N6734B/ N6744B	N6735B/ N6745B	N6736B/ N6746B
DC Output Ratings	• Voltage	5 V	8 V	20 V	35 V	60 V	100 V
	• Current[1]	10 A/ 20 A	6.25 A/ 12.5 A[3]	2.5 A/ 5 A	1.5 A/ 3 A	0.8 A/ 1.6 A	0.5 A/ 1 A
	• Power	50 W/ 100 W	50 W/ 100 W	50 W/ 100 W	52.5 W/ 105 W	50 W/ 100 W	50 W/ 100 W
Output Ripple and Noise (PARD) (from 20 Hz – 20 MHz)	• CV peak-to-peak	10 mV/ 11 mV	12 mV	14 mV	15 mV	25 mV	30 mV
	• CV rms	2 mV	2 mV	3 mV	5 mV	9 mV	18 mV
Load Effect (Regulation) (with output change from no load to full load, up to a maximum load-lead drop of 1 V/lead)	• Voltage	5 mV	6 mV	9 mV	11 mV	13 mV/ 16 mV	20 mV/ 30 mV
	• Current	2 mA	2 mA	2 mA	2 mA	2 mA	2 mA
Source Effect (Regulation)	• Voltage	1 mV	2 mV	2 mV	4 mV	6 mV	10 mV
	• Current	1 mA	1 mA	1 mA	1 mA	1 mA	1 mA
Programming Accuracy (at 23 °C ±5°C after 30 minute warm-up. Applies from minimum to maximum programming range)	• Voltage	0.1% + 19 mV	0.1% + 19 mV	0.1% + 20 mV	0.1% + 35 mV	0.1% + 60 mV	0.1% + 100 mV
	• Current	0.15% + 20 mA	0.15% + 20 mA	0.15% + 20 mA	0.15% + 20 mA	0.15% + 20 mA	0.15% + 10 mA
Measurement Accuracy (at 23 °C ±5 °C)	• Voltage	0.1% + 20 mV	0.1% + 20 mV	0.1% + 20 mV	0.1% + 35 mV	0.1% + 60 mV	0.1% + 100 mV
	• Current	0.15% + 20 mA	0.15% + 10 mA	0.15% + 5 mA	0.15% + 4 mA	0.15% + 4 mA	0.15% + 2 mA
Load Transient Recovery Time (time to recover to within the settling band following a load change from 50% to 100% and from 100% to 50% of full load.)	• Voltage settling band	±0.08 V/ 0.1 V[2]	±0.08 V/ 0.1 V[2]	± 0.2 V/ 0.3 V	± 0.2 V/ 0.3 V	± 0.4 V/ 0.5 V	± 0.5 V/ 1.0 V
	• Time	< 200 µs	< 200 µs	< 200 µs	< 200 µs	< 200 µs	< 200 µs

1 Output current is derated 1% per °C above 40 °C.
2 Settling band is ±0.10 V/0.125 V for 5 V and 8 V Models when relay options 760 and 761 are installed.
3 For N6742B, output current is limited to 10 A when option 760 Output Disconnect/Polarity Reversal Relays is installed.

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Modular Power Supplies

Agilent N6700B, N6701A, N6702A MPS Mainframes

	N6700B, N6701A, N6702A	
Maximum Total Output Power (= Sum of Total Module Output Power)	N6700B N6701A N6702A	400 W when operating from 100 – 240 VAC input 600 W when operating from 100 – 240 VAC input 1200 W when operating from 200 – 240 VAC input 600 W when operating from 100 – 120 VAC input
Command Processing Time	From receipt of command to start of the output change	≤ 1 ms
Protection Response Characteristics	INH input Fault on coupled outputs	5 µs from receipt of inhibit to start of shutdown < 10 µs (from receipt of fault to start of shutdown)
Digital Control Characteristics	Maximum voltage ratings	16.5 VDC/–5 VDC between pins (pin 8 is internally connected to chassis ground).
	Pins 1 and 2 as FLT output	Maximum low-level output voltage = 0.5 V at 4 mA Maximum low-level sink current = 4 mA Typical high-level leakage current = 0.14 mA at 16.5 VDC
	Pins 1 - 7 as digital/trigger outputs (pin 8 = common)	Maximum low-level output voltage = 0.5 V at 4 mA; 1 V at 50 mA; 1.75 V at 100 mA Maximum low-level sink current = 100 mA Typical high-level leakage current = 0.12 mA at 16.5 VDC
	Pins 1 - 7 as digital/trigger inputs and pin 3 as INH input (pin 8 = common)	Maximum low-level input voltage = 0.8 V Minimum high-level input voltage = 2 V Typical low-level current = 2 mA at 0 V (internal 2.2 k pull-up) Typical high-level leakage current = 0.12 mA at 16.5 VDC
Interface Capabilities	GPIB LXI Compliance USB 2.0 10/100 LAN Built-in Web server	SCPI - 1993, IEEE 488.2 compliant interface Class C (applies to mainframes with firmware revision C.00.02 and up) Requires Agilent IO Library version M.01.01 and up, or 14.0 and up Requires Agilent IO Library version L.01.01 and up, or 14.0 and up Requires Internet Explorer 5+ or Netscape 6.2+
Environmental Conditions	Operating environment Temperature range Relative humidity Altitude Storage temperature LED statement	Indoor use, installation category II (for AC input), pollution degree 2 0 °C to 55 °C (current is derated 1% per °C above 40 °C ambient temperature) Up to 95% Up to 2000 meters –30 °C to 70 °C Any LEDs used in this product are Class 1 LEDs as per IEC 825-1

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Modular Power Supplies

Agilent N6700B, N6701A, N6702A MPS Mainframes

	N6700B, N6701A, N6702A	
Regulatory Compliance	EMC	Complies with the European EMC directive 89/336/EEC for Class A test and measurement products. Complies with the Australian standard and carries the C-Tick mark. This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme à la norme NMB-001 du Canada. Electrostatic discharges greater than 1 kV near the I/O connectors may cause the unit to reset and require operator intervention.
	Safety	Complies with the European Low Voltage Directive 73/23/EEC and carries the CE-marking. This product also complies with the US and Canadian safety standards for test and measurement products.
Acoustic Noise Declaration	This statement is provided to comply with the requirements of the German Sound Emission Directive, from 18 January 1991.	Sound Pressure Lp < 70 dB(A) *At Operator Position, *Normal Operation, *According to EN 27779 (Type Test) Schalldruckpegel Lp <70 dB(A) *Am Arbeitsplatz, *Normaler Betrieb, *Nach EN 27779 (Typprüfung)
Output Terminal Isolation	Maximum Rating	No output terminal may be more than 240 VDC from any other terminal or chassis ground
AC Input	Nominal Input Ratings Input Range Power Consumption	100 VAC – 240 VAC; 50/60 Hz/400 Hz 86 VAC – 264 VAC 1000 VA typical (N6700B mainframes) 1500 VA typical (N6701A mainframes) 3000 VA typical (N6702A mainframes)
	Fuse	Internal fuse (not customer accessible)
Dimensions	Height Width Depth (including handles)	44.45 mm; 1.75 in. 432.5 mm; 17.03 in. 585.6 mm; 23.06 in. (N6700B/N6701A mainframes) 633.9 mm; 24.96 in. (N6702A mainframes)
Weight	N6700B with 4 installed modules N6701A with 4 installed modules N6702A with 4 installed modules Single-wide power module Double-wide power module	Net: 12.73 kg; 28 lbs. Net: 11.82 kg; 26 lbs. Net: 14.09 kg; 31 lbs. Net: 1.23 kg; 2.71 lbs. Net: 2.18 kg; 4.8 lbs.

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APPENDIX 4

Switch Load Unit (SLU)

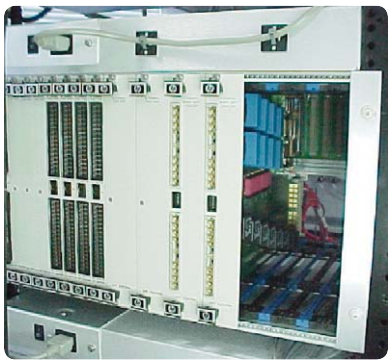


Figure 17. Switch load unit

Summary

- Interface to PC using the parallel port
- Pin Matrix Cards (32 channels)
- 2-channel of ±16 V (14 bit) DAC, ± 25 mA
- 8-channel digital I/O TTL level thresholds, 24 Volt tolerant
- 8-channel O.C. output, 200 mA, 40 V clamp
- 8-channel cards
- Internal loads; 7.5 Amps (15 A pk)
- External loads; 30 Amps (200 A pk)
- 16-channel loads
- External loads; 7.5 Amps (15 A pk)
- 24-channel loadcard to 2 Amps

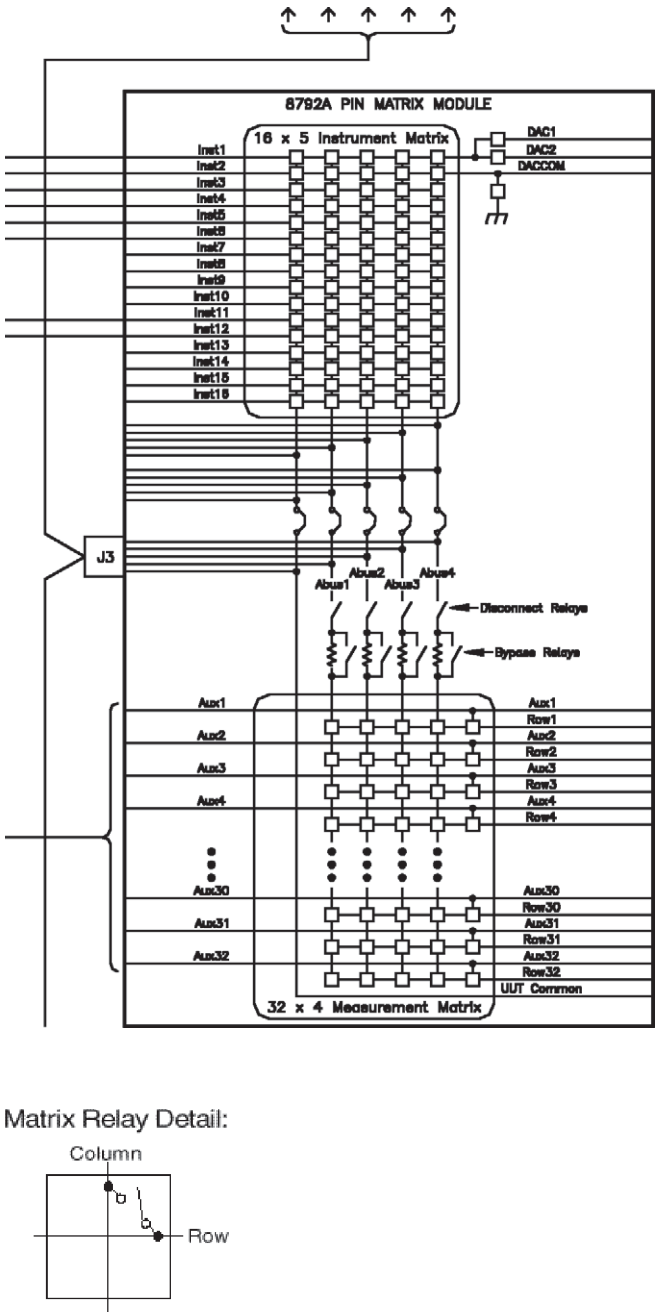


Figure 18. E8792A pin matrix with instrumentation

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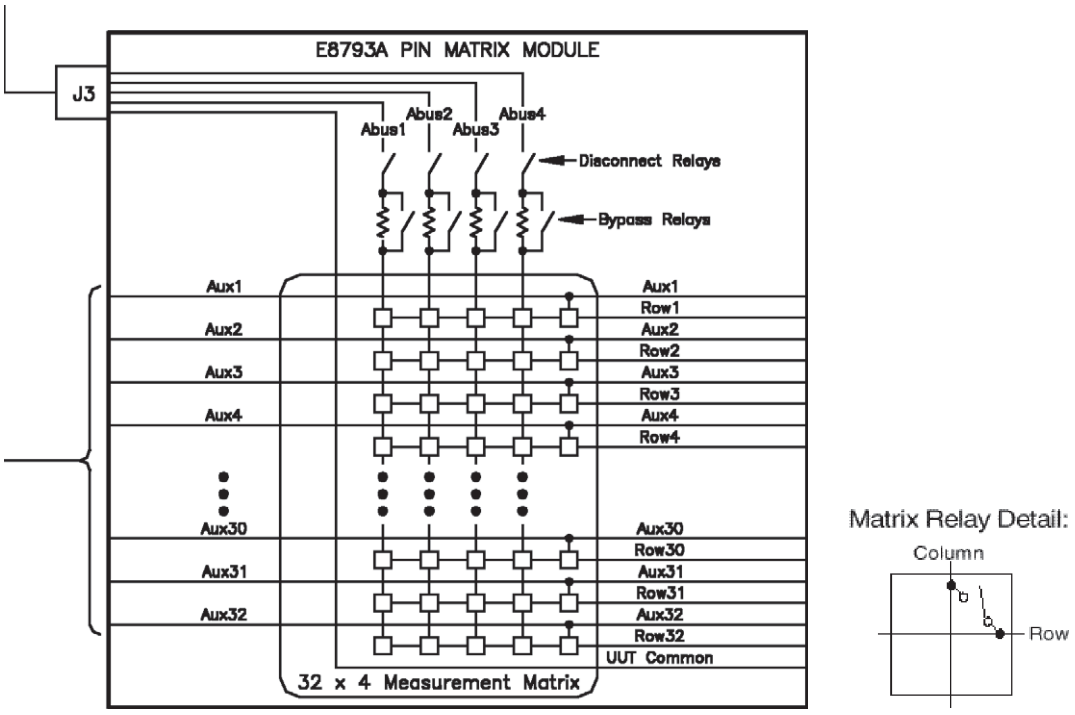


Figure 19. E8793A pin matrix (without instrumentation)

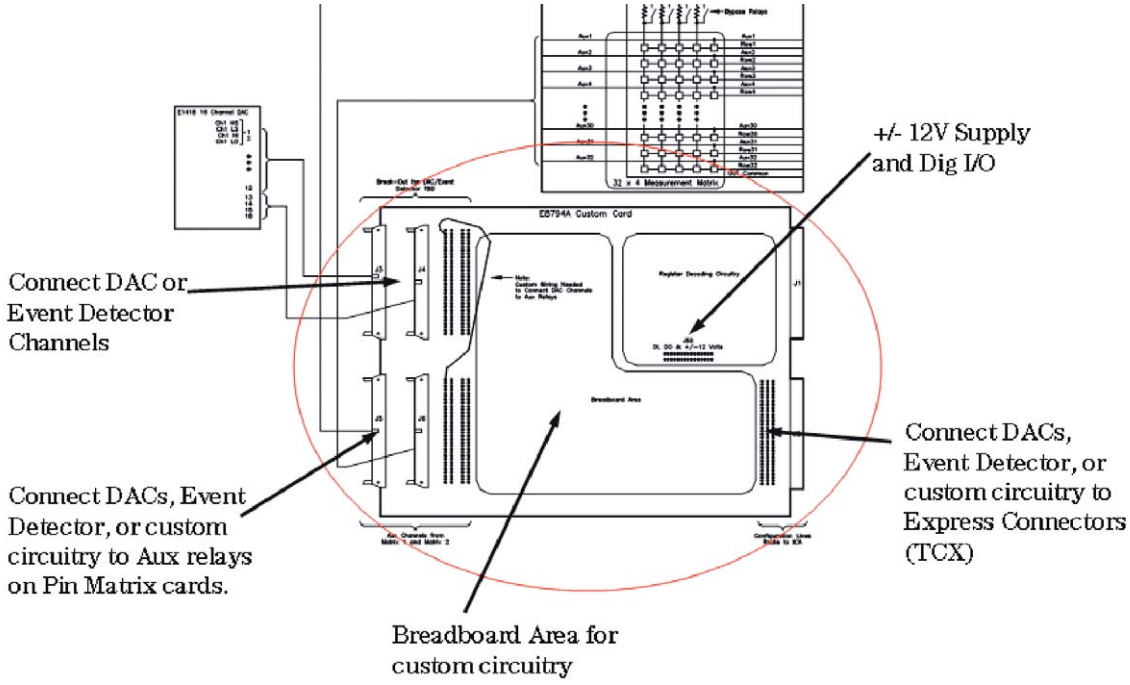


Figure 20. E8794A custom card

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APPENDIX 4

Switch Load Unit (SLU)

Built-in digital I/O

The Switch/Load Unit provides 8-bits of digital input, 8-bits of digital output (Open Drain Out), and 8-bits of TTL-level digital output (Spare Digital Out). There is no handshaking capability.

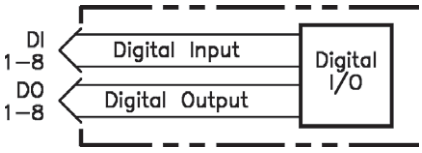
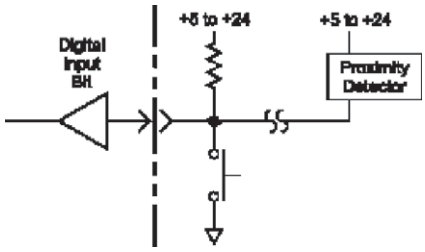


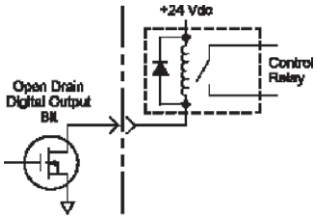
Figure 21. Digital I/O

Digital input
The digital input bits have TTL thresholds (0.55 Vdc for low, 3.0 Vdc for high) and are protected to ±24 Vdc.



Digital input example

Open drain digital output
The digital output bits use open drain drive circuitry designed for pull-ups up to +24 Vdc. The output port FET can sink up to 250 mA.



Digital output example

Figure 22. Example of usage for the digital I/O

Built-in DAC channels

The two non-isolated 14-bit channels of DAC provide ±16 volts at 10 mA each. In order to provide this voltage swing, a charge pump is used to step-up the ±12 volt supply. The DAC channels are typically used for controlling differential input, voltage-controlled power supplies.

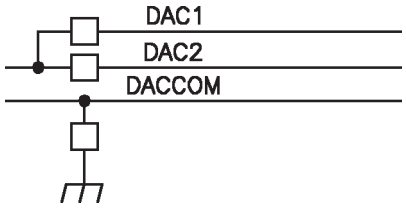


Figure 23. DAC channels

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APPENDIX 4

Switch Load Unit (SLU)

General Specifications

Agilent Loadcards Specifications

Function	E6175A	E6176A	E6177A	E6178A	N9377A	N9378A	N9379A
Number of channels (maximum)	8	16	24	8	16, dual-load	24, quad-load	48, dual-load
Number of channels - unshared relays	4	16	24	8	16	24	48
Maximum current per channel	7.5 A (15 A peak)	7.5 A (15 A peak)	3 A	30 A	7.5 A (15 A peak)	2 A	2 A
Current measuring with sense resistor	Yes	Yes	No	No	Yes	No	No
Current measuring with current transducer	Yes	No	No	Yes	No	No	No
Flyback protection available (user installed)	Yes	Yes	No	Yes	Yes	No	No
Engineered for application	Inductive load	Common load	Low current	High current	High current dual-load	Low current quad-load	Low current quad-load

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APPENDIX 4

Switch Load Unit (SLU)

Switching Specifications

Agilent Single-Load Loadcards Specifications

Function	E6175A	E6176A	E6177A	E6178B
Path resistance from power bus to loadcard connect	0.25 Ω maximum	0.4 Ω maximum	0.5 Ω maximum	0.030 Ω typical, 0.075 Ω maximum
Load path relay operate/ release time	10/8 msec typical, 16/10 msec maximum, 30 cps maximum	10/8 msec typical, 16/10 msec maximum, 30 cps maximum	3.3/2.4 msec typical, 8/8 msec maximum, 10 cps maximum	15/10 msec typical, 20 cps maximum without load, 6 cpm maximum with rated load
Peak voltage to earth	60 V continuous 500 V maximum transient, non-switching (delays to < 60 V in 200 mS)	60 V continuous 500 V maximum transient, non-switching (delays to < 60 V in 200 mS)	60 V continuous 500 V maximum transient, non-switching (delays to < 60 V in 200 mS)	60 V continuous
Load carry/switching current (per channel)	7.5 A maximum non-switching, continuous	7.5 A maximum non-switching, continuous	3 A maximum	30 A maximum (1)
Load carry peak current (non-switching)	15 A maximum, (< 100 msec, < 2% duty cycle)	15 A maximum, (< 100 msec, < 2% duty cycle)	6 A maximum, (< 100 msec, < 2% duty cycle)	200 A maximum, (< 100 mS, < 2% duty cycle (1))
Load switching power	150 W maximum, resistive load	150 W maximum, resistive load	60 W maximum, resistive load	500 W maximum at 25 Vdc maximum resistive load; 100 W maximum at 40 Vdc maximum resistive load
Load switching voltage	60 V maximum	60 V maximum	60 V maximum	40 V maximum, V*I not to exceed load switching power (2)
Minimum permissible load	1 mA, 1 V	1 mA, 1 V	10 uA, 10 mV DC	N/A
Basic current sense accuracy with standard 0.05 W sense resistor	0.1% maximum	0.1% maximum	0.1% maximum	0.1% maximum

(1) One channel at a time. Special accessories required to support multi-channel 30 A load switching at any one time.
(2) Exclusive of load

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APPENDIX 4

Switch Load Unit (SLU)

Agilent Multi-Load Loadcards Specifications

Function	N9377A	N9378A	N9379A
Switch topology	16-channel / 2 loads per channel, off-board loads	24-channel / 4 loads per channel with common, on-board loads	48-channel / 2 loads per channel with common, on-board loads
Path resistance channel to common	N/A	0.130 Ω maximum	0.300 Ω maximum
Path resistance from power bus to loadcard connect	0.4 Ω maximum	0.5 Ω maximum	0.5 Ω maximum
Load path relay operate/release time	10/5 msec maximum, 30 cps maximum	4/4 msec maximum, 10 cps maximum	4/4 msec max, 10 cps maximum
Peak voltage to earth	60 V continuous 500 V maximum transient, non-switching (delays to < 60 V in 200 mS)	60 V continuous 500 V maximum transient, non-switching (delays to < 60 V in 200 mS)	60 V continuous 200 V maximum transient, non-switching (delays to < 60 V in 200 mS)
Load carry/switching current (per channel)	7.5 A maximum non-switching, continuous	2 A maximum	2 A maximum
Load carry peak current	15 A maximum, non-switching (< 100 msec, < 2% duty cycle)	1 A maximum	1 A maximum
Load switching power	150 W maximum, resistive load	N/A	N/A
Load switching voltage	60 V maximum	30 V maximum (relay switching)	30 V maximum (relay switching)
Minimum permissible load	10 mA, 5 V	10 uA, 10 mV DC	10 uA, 10 mV DC
Basic current sense accuracy with standard 0.05 Ω sense resistor	0.1% maximum	N/A	N/A
Basic current sense accuracy with different amplifier engaged (Vcm = 0 V)	0.2% + 30 mA	N/A	N/A
Basic current sense accuracy with different amplifier engaged (Vcm = 16 V)	0.2% + 100 mA	N/A	N/A
Isense differential amplifier 3 dB bandwidth	500 kHz typical	N/A	N/A
Isense differential amplifier slew rate	40 A/uS typical	N/A	N/A
Power dissipation, individual load mounted on loadcard	N/A	2 W maximum, each load	2 W maximum, each load
Average power for loads mounted on loadcard	N/A	20 W maximum total, per card	20 W maximum total, per card

(1) One channel at a time. Special accessories required to support multi-channel 30 A load switching at any one time.
(2) Exclusive of load

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APPENDIX 4

Switch Load Unit (SLU)

Safety and CE Compliance

Safety	IEC 61010-1 (1990)+A2: 1995/EN61010-1 : 1993+A2 : 1995 CSA C22.2 #1010.1 (1992) UL 3111
EMC	CISPR 11: 1990/EN55011 1991: Group1, Class A EN50082-1: 1992 IEC 61000-4-2: 1995/: 4kV CD IEC 61000-4-3: 1995/: 3V/m IEC 61000-4-4: 1995/: 1kV power line

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Switch Load Unit (SLU)

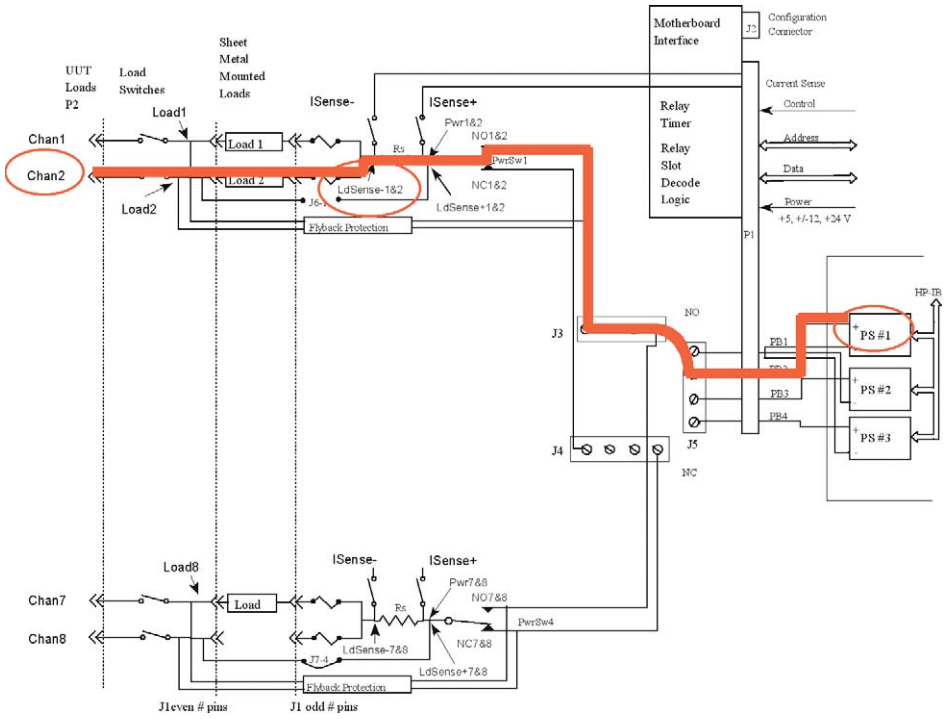


Figure 24. E6175A 8-channel high current load card block diagram

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Switch Load Unit (SLU)

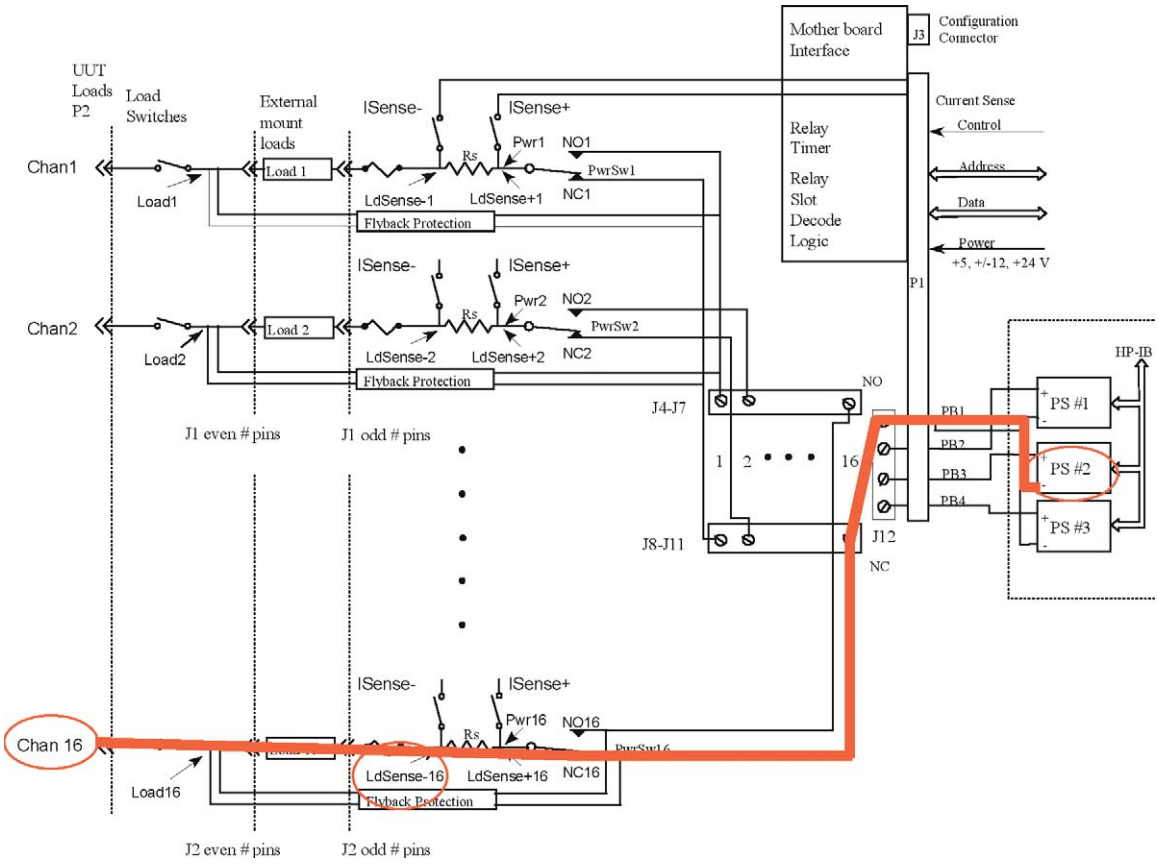


Figure 25. E6176A 16-channel high current load card block diagram

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Switch Load Unit (SLU)

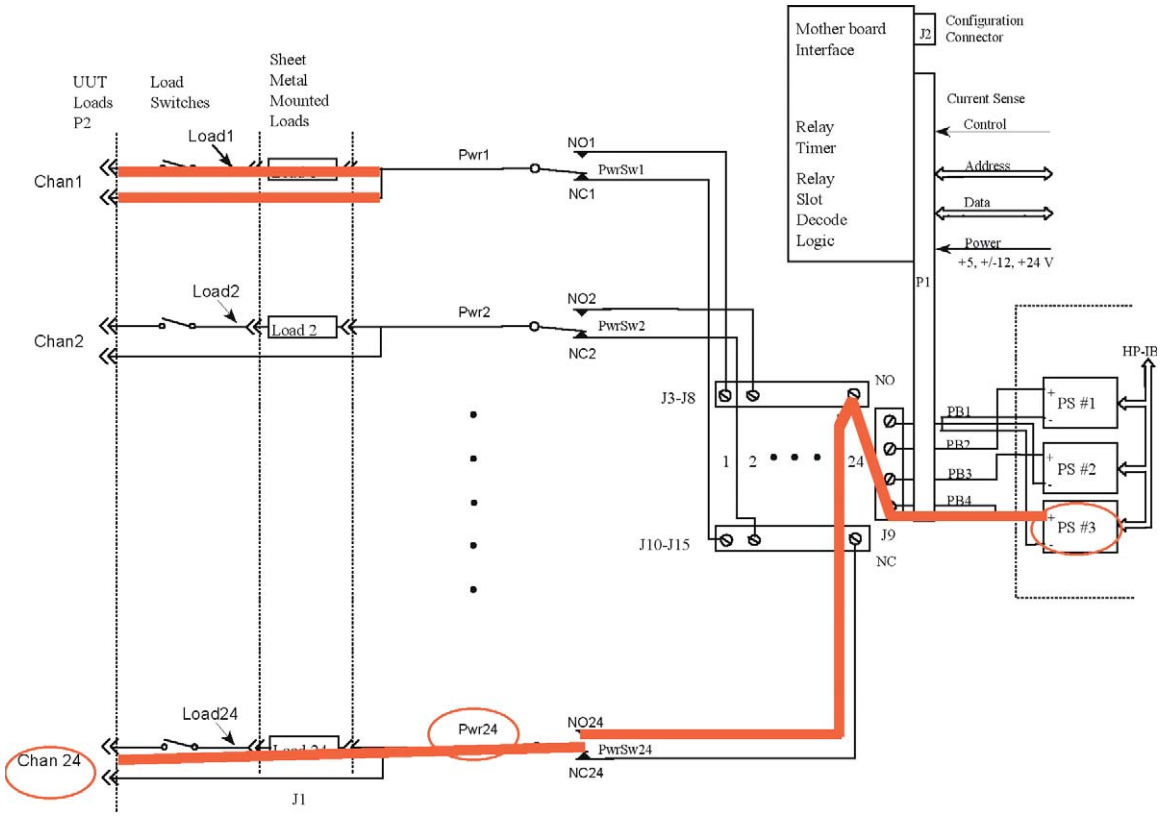


Figure 26. E6177A 24-channel medium current load card block diagram

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Switch Load Unit (SLU)

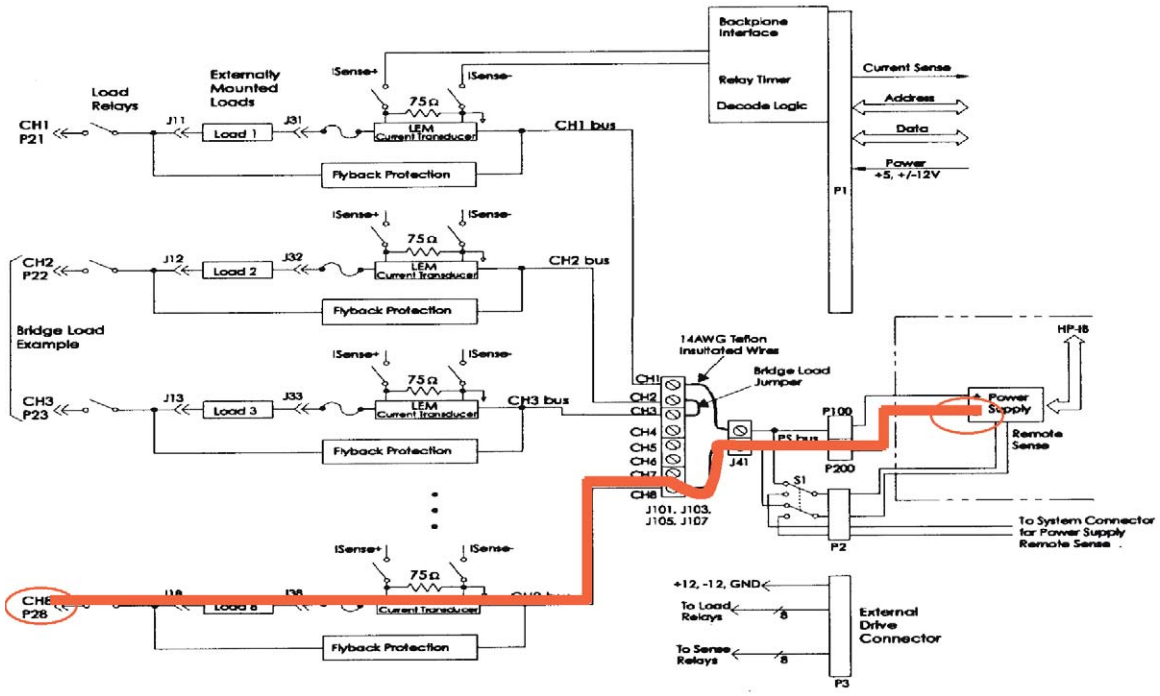


Figure 27. E6178B 8-channel 30 amp load card block diagram

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Switch Load Unit (SLU)

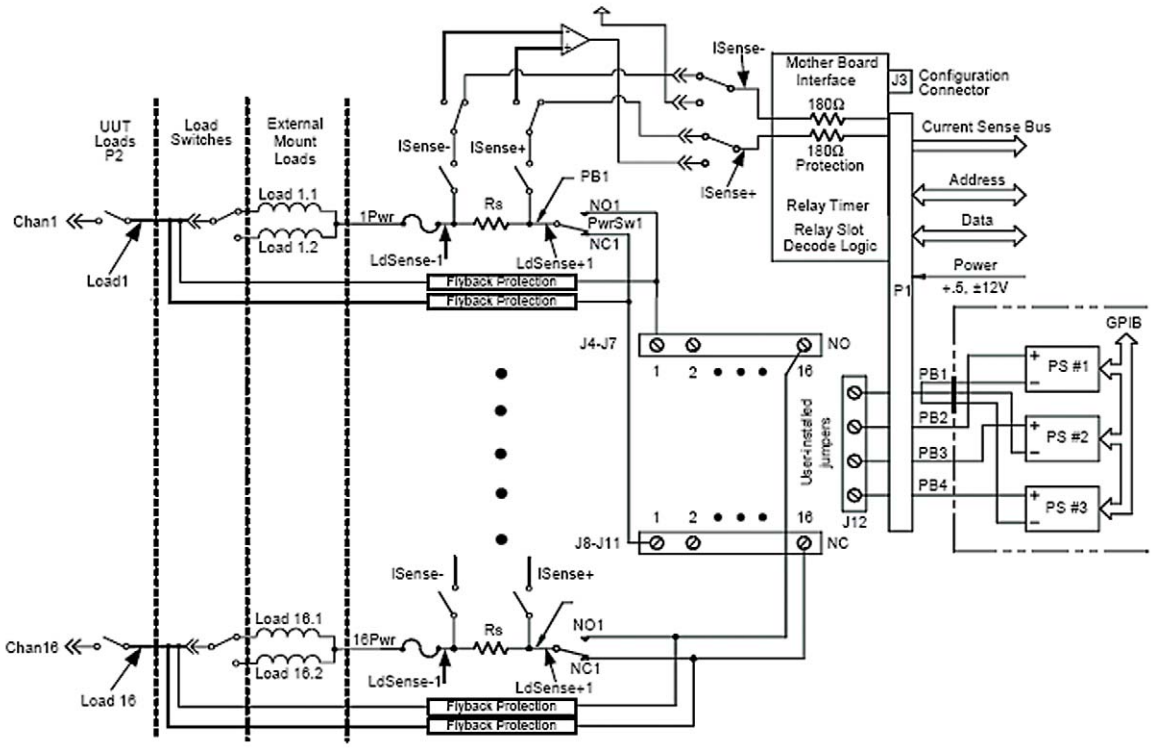


Figure 28. N9377A 16-Channel Dual-Load Load Card Block Diagram

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Switch Load Unit (SLU)

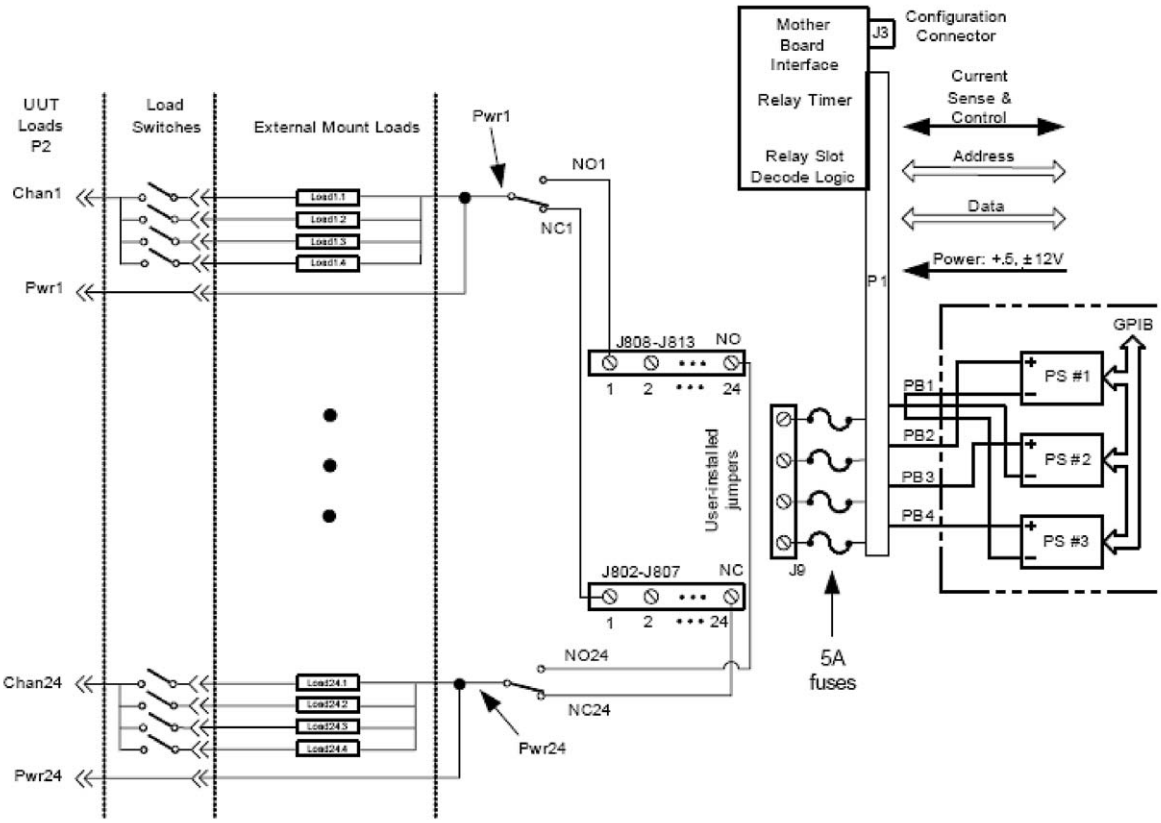


Figure 29. N9378A 24-Channel Low Resistance Load Card Block Diagram

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APPENDIX 4

Switch Load Unit (SLU)

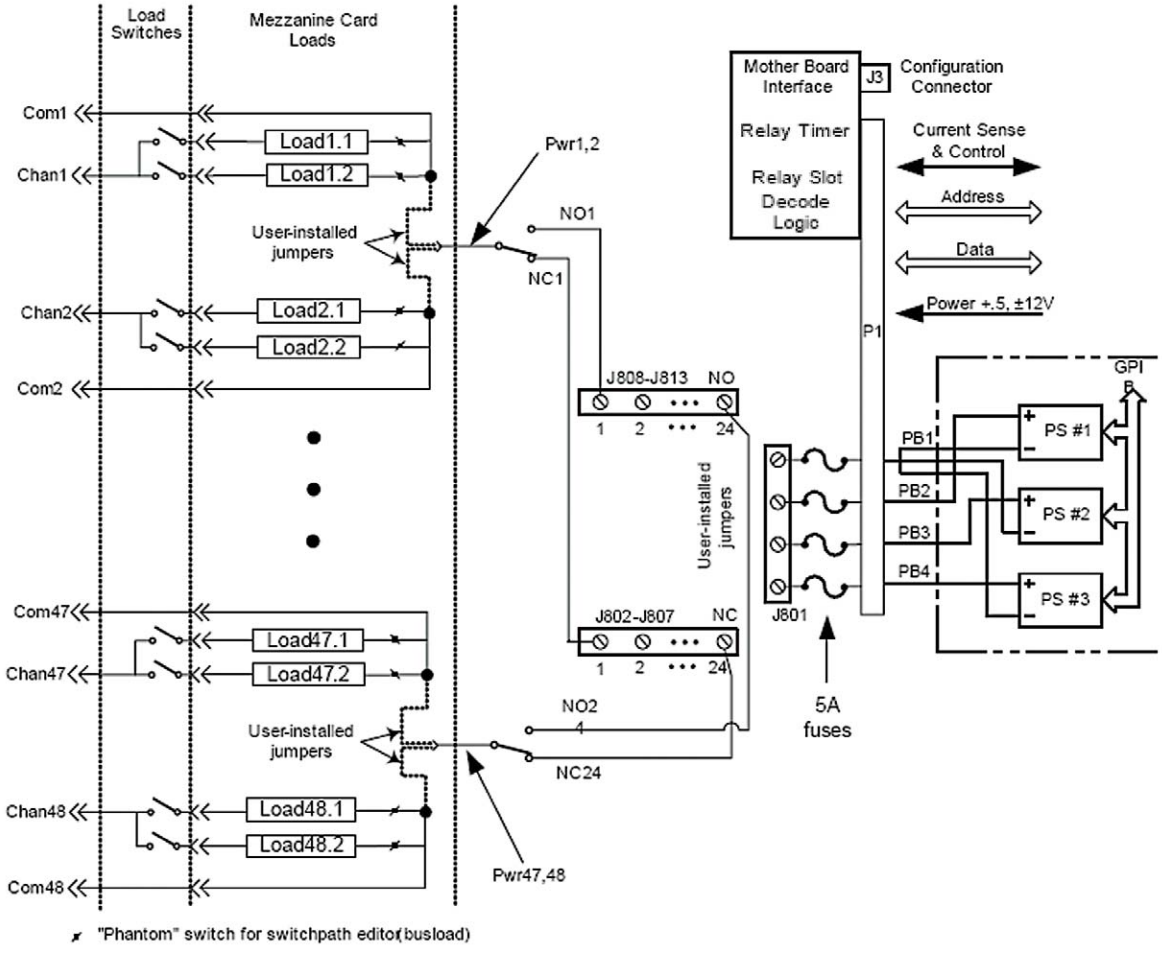


Figure 30. N9379A 48-Channel High Density Load Card Block Diagram

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E8786B configuration options

Level	Part number	Description
1	E8786B-ATO	TS-5400 High Performance Functional Test System with MAC Panel Interface
0.2	E8786B-OC-SPLCFG	Special configuration option class
..3	E8786B-820	Add E6174A Event Detector VXI Card and cable
..3	E8786B-821	Add E1420B VXI Counter Card and cable
0.2	E8780B-OC-PDUWRG	PDU Wiring Option Class
..3	E8780B-3PD	200-240VAC Delta 3-Phase 4-Wire
..3	E8780B-3PN	220/380-240/415VAC Wye 3-Phase w/ Neu 5-Wire
..3	E8780B-3PY	120/208-127/220VAC Wye 3-Phase w/ Neu 5-Wire
..3	E8780B-1LN	100-127VAC 1-Phase Grounded 3-Wire
..3	E8780B-1PN	220/380-240/415VAC 1-Phase Grounded 3-Wire
..3	E8780B-2PN	220/380-240/415VAC 1-Phase Wye w/ Neu 4-Wire
..3	E8780B-2PL	100/200-120/240VAC 1-Phase Grounded 3-Wire
0.2	E8780B-OC-VXIMFM	VXI option class
..3	E8780B-300	VXI standard configuration, includes mainframe MCM and DMM
..3	E8780B-399	VXI not included
0.2	E2235A-ATO	TS-5400 Family Controller, includes 1024MB RAM, DVD-RW, Floppy Drive, Keyboard,
..3	E2235A-OC-OPSYS	Operating System Option Class
...4	E2235A-001	MS Windows XP Pro
...4	E2235A-802	Siemens Flashing Station Operating System Install
...4	E2235A-901	Special IPC and Software Bundle Value for Siemens VDO
..3	E2235A-OC-GPIB	GPIB Card Option Class
...4	E2235A-020	Agilent 82350B GPIB PCI Card
...4	E2235A-021	NI GP-IB PCI Card
..3	E2235A-OC-ADDPCI	PCI Cards Option Class
...4	E2235A-040	8-Channel Serial PCI Card
...4	E2235A-045	32-channel Digital I/O PCI card and cabling
...4	E6249A-005	8-channel Serial Port expander with unterminated 8-connector cable
...4	E2235A-050	PCI SOFTING CAN CARD AND EXP. CONN. CABLING
...4	E2235A-051	PCI CAN PLUG-IN BOARD 16BIT MICROCONTROLLER
...4	E2235A-055	32 CHANNEL DIO CARD W2500VDC ISOLATION
...4	E6249A-015	8-channel Serial Port L2000 cable kit
...4	E2235A-052	PCI SOFTING CAN CARD AND L2000 CABLING
..3	E2235A-OC-APPSW	Application Software Option Class
...4	E2235A-011	TestExec SL rev. 5.1 Software License, installed on TS-5400 Controller
...4	E2235A-019	Recovery CD
...4	E2235A-015	Upgrade software from previous version. Includes both TxSL 5.1 and TS-5400 5.1V
...4	E2235A-005	Serial Communications Software 1.0
...4	E2235A-012	TestExec SL rev. 6.1 Software License, installed on TS-5400 Controller
...4	E2235A-016	Upgrade software from previous version. Includes both TxSL 6.1 and TS-5400 6.0V

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TS-5400 Series II System Configuration Basics

Level	Part number	Description
1	E8786B-ATO	TS-5400 High Performance Functional Test System with MAC Panel Interface
...3	E2235A-OC-VXISLT0	VXI Slot Zero option class
...4	E2235A-305	IEEE-1394/PCI card
...4	E2235A-306	MXI PCI Card
..3	E2235A-OC-DISP	PC Display options
...4	E6249A-010	17 Inch LCD display with rackmount kit
...4	E6249A-012	17 Inch LCD Display for E2230A system
...4	E6249A-013	17 Inch LCD display w Rackmount Kit w/o BNCs
...4	E6249A-023	17 INCH LCD DISPLAY W RACKMOUNT KIT W/O BNCS
0.2	E8780B-OC-PWRSUP	Power supply option class
..3	E8780B-140	6643A Power Supply, including cable
..3	E8780B-141	6653A Power Supply, including cable
..3	E8780B-143	6672A Power Supply, including cable
..3	E8780B-144	6652A Power Supply, including cable
..3	E8780B-145	6642A Power Supply, including cable
..3	E8780B-142	6673A Power Supply, including cable
..3	E8780B-199	No power supplies included
..3	E8780B-146	6674A Power supply, including cable
..3	E8780B-198	Custom Power Supply Installed
..3	E8786B-610	6628A Power Supply Installed
..3	E8780B-197	No power supplies included
0.2	E8780B-OC-SERINT1	Serial Interface One Options
..3	E8791A-ATO	TS-5400 Series II Serial Interface, includes ISO 9141
...4	E8791A-OC-OPT	E8791A Options
....5	E8791A-211	CAN / J1939 PIM
....5	E8791A-213	Ford SCP / J1850 PIM
....5	E8791A-214	GM Class II / J1850 PIM
....5	E8791A-219	Fault Tolerant CAN PIM
....5	E8791A-217	Single Wire CAN PIM
....5	E8791A-218	High Speed Dual Wire CAN PIM
..3	E8791A-CH1	Combo rackmounting for E8791A in E8780 systems
0.2	E8780B-OC-SERINT2	Serial Interface Two Options
..3	E8791A-ATO	TS-5400 Series II Serial Interface, includes ISO 9141
...4	E8791A-OC-OPT	E8791A Options
....5	E8791A-211	CAN / J1939 PIM
....5	E8791A-213	Ford SCP / J1850 PIM
....5	E8791A-214	GM Class II / J1850 PIM
....5	E8791A-219	Fault Tolerant CAN PIM
....5	E8791A-217	Single Wire CAN PIM
....5	E8791A-218	High Speed Dual Wire CAN PIM

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APPENDIX 5

TS-5400 Series II System Configuration Basics

Level	Part number	Description
1	E8786B-ATO	TS-5400 High Performance Functional Test System with MAC Panel Interface
0.2	E8780B-OC-PINCRD	Pin Card option class
..3	E8792A-FG	TS-5400 SLU Pin Card with Instrumentation Matrix
..3	E8793A-FG	TS-5400 SLU Pin Card without Instrumentation Matrix
..3	E8794A-FG	TS-5400 Series II Custom Card
0.2	E8786B-OC-PINCBLS	Pin Card Cables option class
..3	E8792A-110	E8792A MAC Panel Cabling With ICA Connector Block
..3	E8793A-110	E8793A MAC Panel Cabling With ICA Connector Block
..3	E8794A-110	E8794A MAC Panel Cabling
..3	E8794A-150	E8794A Cable - custom card to matrix AUX
0.2	E8780B-OC-SLUCRD	SLU Cards option class
..3	E6175A-FG	8-channel Loadcard
..3	E6176A-FG	16-channel Loadcard
..3	E6177A-FG	24-channel Loadcard
..3	E6178B-FG	8-channel 30A Loadcard
..3	N9378A-FG	24-channel low resistance loadcard
..3	N9379A-FG	48-channel high density loadcard
..3	N9377A-FG	16-channel dual-load loadcard
0.2	E8786B-OC-LDCBLS	SLU Card Cables Option Class
..3	E6175A-110	E6175A MAC Panel Cabling for TS-5400 Series II
..3	E6176A-110	E6176A MAC Panel Cabling for TS-5400 Series II
..3	E6177A-110	E6177A MAC Panel Cabling for TS-5400 Series II
..3	E6178B-110	E6178B MAC Panel Cabling for TS-5400 Series II
..3	E6177A-111	E6177A MAC PANEL CABLING FOR TS-5400 SERIES II (Bridge type)
..3	N9377A-110	N9377A MAC Panel Cabling for TS-5400 Series II
..3	N9378A-110	N9378A MAC Panel Cabling for TS-5400 Series II
..3	N9378A-111	N9378A MAC Panel Low Resistance Cabling for TS-5400 Series II
..3	N9379A-110	N9379A MAC Panel Cabling for TS-5400 Series II
0.2	E8780B-OC-ADDSLU	Additional Switch Load Unit option class
..3	E6198A-FG	TS-5400 Switch/Load Unit
0.2	E8780B-OC-VXICARDS	VXI Cards option class
..3	E8780B-320	E6173A Dual Real-time Arb including cable
..3	E8780B-322	E1333A Counter, E1403C Adapter Including Cable
..3	E8780B-324	E1563A 800 kSa/s, 2 Channel Digitizer, including cable
..3	E8780B-331	16-Channel non-isolated dac module including cable for macpanel
..3	E8780B-332	8-Channel Non-isolated DAC module, including cable
..3	E8780B-333	16-Channel Isolated DAC module, including cable16-Channel Isolated DAC module, i
..3	E8786B-822	E1564A 4 channel VXI Digitizer Card and cable
..3	E8780B-341	16-Channel Non-Isolated DAC module including cable for express connect
..3	E8780B-342	8/16-CHANNEL D/A CONVERTER HAS INDEPENDENT OUTPUT CHANNELS W/O Terminal Block

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APPENDIX 5

TS-5400 Series II System Configuration Basics

Level	Part number	Description
1	E8786B-ATO	TS-5400 High Performance Functional Test System with MAC Panel Interface
0.2	E8780B-OC-GPIB	GPIB Instruments option class
..3	E8780B-080	33220A GPIB FUNCTION/ARBITRARY WAVEFORM GENERATOR
..3	E8780B-085	53131A GPIB UNIVERSAL COUNTER
..3	E8780B-060	34401A GPIB DIGITAL MULTIMETER, 6.5 DIGIT
..3	E8780B-061	34411A GPIB / LXI / USB DIGITAL MULTIMETER/DIGITIZER, 6.5 DIGIT
0.2	E8780B-OC-VXISLT0	VXI Slot Zero option class
..3	E8780B-305	IEEE-1394 VXI Interface Card
..3	E8780B-306	MXI-II/VXI Slot O Module and Cable
0.2	E8786B-OC-ICA	ICA Frame and receiver blocks
..3	E6180A-002	General Purpose Receiver Block
..3	E6180A-003	High Power 36 pin Receiver Block
..3	E6180A-004	High Power 64 pins Receiver Block
0.2	E8780B-OC-ACCY	Accessories
..3	E6249A-002	RS-232 Handheld Scanner Kit
..3	E6249A-006	Strip Printer
..3	E6249A-008	Shelf for TS-5400 Series II Strip Printer
..3	E6249A-009	Fixed Keyboard and Mouse Pad Tray
..3	E8780B-0B2	Add Manual Set
0.2	E8780B-OC-RKFAN	Rack fan option class
..3	E8780B-021	Rack Fan Assembly for 110V system
..3	E8780B-022	Rack fan assembly for 220V system
0.2	E8780B-OC-COMBO	Combo material option class
..3	E8780B-CH1	One half rack instrument
..3	E8780B-CH2	Two half rack instruments
..3	E8780B-CH0	No half rack instruments
..3	E8780B-CL1	SLU slot filler
..3	E8780B-CX1	MAC Panel ICA Slot Filler
..3	E8780B-CX3	MAC Panel material required for 2nd E8792A
..3	E8780B-CP2	2 U filler for missing power supplies
..3	E8780B-CP3	3 U filler for missing power supplies
..3	E8780B-CB1	Ballast combo material for power supplies
..3	E2233A-CA1	Cables for Modular Power supply
..3	E2233A-CA2	Cables for Modular Power supply and 6673A
..3	E8780B-CL2	Material for second SLU in TS-5400 system
0.2	E8780B-OC-MODPS	Modular Power Supply Options
..3	E2233A-ATO	Modular Power Supply for TS-5400 systems
...4	E2233A-OC-COMBO	Combination Materials
....5	E2233A-P01	Brick Filler
....5	E2233A-P02	Mounting HW for E878x CA2 & CA3
....5	E2233A-P03	Mounting HW for E2230 CA1

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APPENDIX 5

TS-5400 Series II System Configuration Basics

Level	Part number	Description
1	E8786B-ATO	TS-5400 High Performance Functional Test System with MAC Panel Interface
...4	E2233A-OC-MODULE	DC Power Modules
....5	E2233A-002	N6762A Precision 100W DC power module
....5	E2233A-001	N6752A High Performance 100W DC power module
....5	E2233A-003	N6751A High Performance 50W DC Power Module
....5	E2233A-004	N6761A 100W module
....5	E2233A-005	N6734A 300W module
...4	E2233A-OC-CABLES	Power Supply Cables
....5	E2233A-CA1	Cables for Modular Power supply
....5	E2233A-CA2	Cables for Modular Power supply and 6673A
....5	E2233A-CA3	Cables - Standard Prog Interconnect for N67XX Series PS
....5	E2233A-CA4	Cable - direct connect N6700A to E6198A SLU
....5	E2233A-CA6	Cable - N6700B to L2000
....5	E2233A-CA5	Cable - N6700B to L2000 & SLU
0.2	E8780B-OC-APPSW	TS-5400 APPLICATION SOFTWARE OPTION CLASS
..3	E8780B-001	TS-5400 Family Application Software 6.0V
0.2	E8786B-OC-ADDFIX	Special Fixtures Option Class
..3	E8786B-AC1	AC to DC Converter
0.2	E2240A-OC-RFINST	RF Instruments Option Class
..3	E2240A-SA1	E4402B ESA-E 9KHZ-3.0 GHZ SPECTRUM ANALYZER
..3	E2240A-SG1	3 GHZ ESG-D DIGITAL SERIES RF SIGNAL GENERATOR
..3	E2240A-SA2	E4404B ESA-E 9kHz–6.7GHz SPECTRUM ANALYZER
0.2	E8786B-OC-CUSTOM	Customization Option Class
1	R1992A	Automotive Warranty and Service Plans

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TS-5400 Series II System Configuration Basics

E8780B configuration options

Level	Part number	Description
1	E8780B-ATO	TS-5400 High Performance Functional Test System with ExpressConnect Interface
0.2	E8780B-OC-PDUWRG	PDU Wiring Option Class
..3	E8780B-3PD	200-240VAC Delta 3-Phase 4-Wire
..3	E8780B-3PN	220/380-240/415VAC Wye 3-Phase w/ Neu 5-Wire
..3	E8780B-3PY	120/208-127/220VAC Wye 3-Phase w/ Neu 5-Wire
..3	E8780B-1LN	100-127VAC 1-Phase Grounded 3-Wire
..3	E8780B-1PN	220/380-240/415VAC 1-Phase Grounded 3-Wire
..3	E8780B-2PN	220/380-240/415VAC 1-Phase Wye w/ Neu 4-Wire
..3	E8780B-2PL	100/200-120/240VAC 1-Phase Grounded 3-Wire
0.2	E8780B-OC-VXIMFM	VXI option class
..3	E8780B-300	VXI standard configuration, includes mainframe MCM and DMM
..3	E8780B-399	VXI not included
0.2	E2235A-ATO	TS-5400 Family Controller, includes 1024MB RAM, DVD-RW, Floppy Drive, Keyboard,
..3	E2235A-OC-OPSYS	Operating System Option Class
...4	E2235A-001	MS Windows XP Pro
...4	E2235A-802	Siemens Flashing Station Operating System Install
...4	E2235A-901	Special IPC and Software Bundle Value for Siemens VDO
..3	E2235A-OC-GPIB	GPIB Card Option Class
...4	E2235A-020	Agilent 82350B GPIB PCI Card
...4	E2235A-021	NI GP-IB PCI Card
..3	E2235A-OC-ADDPCI	PCI Cards Option Class
...4	E2235A-040	8-Channel Serial PCI Card
...4	E2235A-045	32-channel Digital I/O PCI card and cabling
...4	E6249A-005	8-channel Serial Port expander with unterminated 8-connector cable
...4	E2235A-050	PCI SOFTING CAN CARD AND EXP. CONN. CABLING
...4	E2235A-051	PCI CAN PLUG-IN BOARD 16BIT MICROCONTROLLER
...4	E2235A-055	32-CHANNEL DIO CARD W2500VDC ISOLATION
...4	E6249A-015	8-channel Serial Port L2000 cable kit
...4	E2235A-052	PCI SOFTING CAN CARD AND L2000 CABLING
..3	E2235A-OC-APPSW	Application Software Option Class
...4	E2235A-011	TestExec SL rev. 5.1 Software License, installed on TS-5400 Controller
...4	E2235A-015	Upgrade software from previous version. Includes both TxSL 5.1 and TS-5400 5.1V
...4	E2235A-005	Serial Communications Software 1.0
...4	E2235A-012	TestExec SL rev. 6.1 Software License, installed on TS-5400 Controller
...4	E2235A-016	Upgrade software from previous version. Includes both TxSL 6.1 and TS-5400 6.0V

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APPENDIX 5

TS-5400 Series II System Configuration Basics

Level	Part number	Description
1	E8780B-ATO	TS-5400 High Performance Functional Test System with ExpressConnect Interface
..3	E2235A-OC-VXISLT0	VXI Slot Zero option class
...4	E2235A-305	IEEE-1394/PCI card
...4	E2235A-306	MXI PCI Card
..3	E2235A-OC-DISP	PC Display options
...4	E6249A-010	17 Inch LCD display with rackmount kit
...4	E6249A-012	17 Inch LCD Display for E2230A system
...4	E6249A-013	17 Inch LCD display w Rackmount Kit w/o BNCs
...4	E6249A-023	17 INCH LCD DISPLAY W RACKMOUNT KIT W/O BNCS
0.2	E8780B-OC-PWRSUP	Power supply option class
..3	E8780B-140	6643A Power Supply, including cable
..3	E8780B-141	6653A Power Supply, including cable
..3	E8780B-143	6672A Power Supply, including cable
..3	E8780B-144	6652A Power Supply, including cable
..3	E8780B-145	6642A Power Supply, including cable
..3	E8780B-142	6673A Power Supply, including cable
..3	E8780B-199	No power supplies included
..3	E8780B-146	6674A Power supply, including cable
..3	E8780B-198	Custom Power Supply Installed
..3	E8786B-610	6628A Power Supply Installed
..3	E8780B-197	No power supplies included
0.2	E8780B-OC-SERINT1	Serial Interface One Options
..3	E8791A-ATO	TS-5400 Series II Serial Interface, includes ISO 9141
...4	E8791A-OC-OPT	E8791A Options
....5	E8791A-211	CAN / J1939 PIM
....5	E8791A-213	Ford SCP / J1850 PIM
....5	E8791A-214	GM Class II / J1850 PIM
....5	E8791A-219	Fault Tolerant CAN PIM
....5	E8791A-217	Single Wire CAN PIM
....5	E8791A-218	High Speed Dual Wire CAN PIM
..3	E8791A-CH1	Combo rackmounting for E8791A in E8780 systems
0.2	E8780B-OC-SERINT2	Serial Interface Two Options
..3	E8791A-ATO	TS-5400 Series II Serial Interface, includes ISO 9141
...4	E8791A-OC-OPT	E8791A Options
....5	E8791A-211	CAN / J1939 PIM
....5	E8791A-213	Ford SCP / J1850 PIM
....5	E8791A-214	GM Class II / J1850 PIM
....5	E8791A-219	Fault Tolerant CAN PIM
....5	E8791A-217	Single Wire CAN PIM
....5	E8791A-218	High Speed Dual Wire CAN PIM

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APPENDIX 5

TS-5400 Series II System Configuration Basics

Level	Part number	Description
1	E8780B-ATO	TS-5400 High Performance Functional Test System with ExpressConnect Interface
0.2	E8780B-OC-PINCRD	Pin Card option class
..3	E8792A-FG	TS-5400 SLU Pin Card with Instrumentation Matrix
..3	E8793A-FG	TS-5400 SLU Pin Card without Instrumentation Matrix
..3	E8794A-FG	TS-5400 Series II Custom Card
0.2	E8780B-OC-PINCBLS	Pin Card Cables Option class
..3	E8792A-120	E8792A ExpressConnect Cabling
..3	E8793A-120	E8793A ExpressConnect Cabling
..3	E8794A-120	E8794A ExpressConnect Cabling
..3	E8794A-150	E8794A Cable - custom card to matrix AUX
0.2	E8780B-OC-SLUCRD	SLU Cards option class
..3	E6175A-FG	8-Channel Loadcard
..3	E6176A-FG	16-Channel Loadcard
..3	E6177A-FG	24-Channel Loadcard
..3	E6178B-FG	8-Channel 30A Loadcard
..3	N9378A-FG	24-channel low resistance loadcard
..3	N9379A-FG	48-channel high density loadcard
..3	N9377A-FG	16-channel dual-load loadcard
0.2	E8780B-OC-LDCBLS	SLU Card Cables Option Class
..3	E6175A-120	E6175A ExpressConnect Cabling for TS-5400 Series II
..3	E6176A-120	E6176A ExpressConnect Cabling for TS-5400 Series II
..3	E6177A-120	E6177A ExpressConnect Cabling for TS-5400 Series II
..3	E6178B-120	E6178B ExpressConnect Cabling for TS-5400 Series II
..3	N9378A-120	N9378A ExpressConnect Cabling for TS-5400 Series II
..3	N9379A-120	N9379A ExpressConnect Cabling for TS-5400 Series II
..3	N9377A-120	N9377A ExpressConnect Cabling for TS-5400 Series II
..3	E6176A-130	E6176A L2000 MAC Panel Cabling
..3	E6177A-130	E6177A L2000 MAC Panel Cabling (single)
..3	E6177A-131	E6177A L2000 MAC Panel Cabling (dual)
..3	E6178B-130	E6178B L2000 MAC Panel Cabling
..3	N9378A-130	N9378A L2000 MAC Panel Cabling (single)
..3	N9378A-131	N9378A L2000 MAC Panel Cabling (dual)
..3	E6175A-130	E6175A L2000 MAC Panel Cabling
..3	N9379A-130	N9379A L2000 MAC Panel Cabling
..3	N9377A-130	N9377A L2000 MAC Panel Cabling
0.2	E8780B-OC-ADDSLU	Additional Switch Load Unit option class
..3	E6198A-FG	TS-5400 Switch/Load Unit

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APPENDIX 5

TS-5400 Series II System Configuration Basics

Level	Part number	Description
1	E8780B-ATO	TS-5400 High Performance Functional Test System with ExpressConnect Interface
0.2	E8780B-OC-VXICARDS	VXI Cards option class
..3	E8780B-320	E6173A Dual Real-time Arb including cable
..3	E8780B-322	E1333A Counter, E1403C Adapter Including Cable
..3	E8780B-324	E1563A 800 kSa/s, 2 Channel Digitizer, including cable
..3	E8780B-331	16-Channel non-isolated dac module including cable for MAC Panel
..3	E8780B-332	8-Channel Non-isolated DAC module, including cable
..3	E8780B-333	16-Channel Isolated DAC module, including cable16-Channel Isolated DAC module, i
..3	E8786B-822	E1564A 4 channel VXI Digitizer Card and cable
..3	E8780B-341	16-Channel Non-Isolated DAC module including cable for ExpressConnect
..3	E8780B-342	8/16-CHANNEL D/A CONVERTER HAS INDEPENDENT OUTPUT CHANNELS W/O Terminal Block
0.2	E8780B-OC-GPIB	GPIB Instruments option class
..3	E8780B-080	33220A GPIB FUNCTION/ARBITRARY WAVEFORM GENERATOR
..3	E8780B-085	53131A GPIB UNIVERSAL COUNTER
..3	E8780B-060	34401A GPIB DIGITAL MULTIMETER, 6.5 DIGIT
..3	E8780B-061	34411A GPIB / LXI / USB DIGITAL MULTIMETER/DIGITIZER, 6.5 DIGIT
0.2	E8780B-OC-VXISLT0	VXI Slot Zero option class
..3	E8780B-305	IEEE-1394 VXI Interface Card
..3	E8780B-306	MXI-II/VXI Slot 0 Module and Cable
0.2	E8780B-OC-ACCY	Accessories
..3	E6249A-002	RS-232 Handheld Scanner Kit
..3	E6249A-006	Strip Printer
..3	E6249A-008	Shelf for TS-5400 Series II Strip Printer
..3	E6249A-009	Fixed Keyboard and Mouse Pad Tray
..3	E8780B-0B2	Add Manual Set
0.2	E8780B-OC-SPLCFG	Special Configuration option class
..3	E8780B-831	Special configuration using 1.6m rack
0.2	E8780B-OC-ACCUM	Accumulator card option class
..3	E8780B-122	Accumulator Card
0.2	E8780B-OC-RKFAN	Rack fan option class
..3	E8780B-021	Rack Fan Assembly for 110V system
..3	E8780B-022	Rack fan assembly for 220V system

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APPENDIX 5

TS-5400 Series II System Configuration Basics

Level	Part number	Description
1	E8780B-ATO	TS-5400 High Performance Functional Test System with ExpressConnect Interface
0.2	E8780B-OC-COMBO	Combo material option class
..3	E8780B-CH1	One half rack instrument
..3	E8780B-CH2	Two half rack instruments
..3	E8780B-CH0	No half rack instruments
..3	E8780B-CL1	SLU slot filler
..3	E8780B-CX1	MAC Panel ICA Slot Filler
..3	E8780B-CX3	MAC Panel material required for 2nd E8792A
..3	E8780B-CP2	2 U filler for missing power supplies
..3	E8780B-CP3	3 U filler for missing power supplies
..3	E8780B-CB1	Ballast combo material for power supplies
..3	E2233A-CA1	Cables for Modular Power supply
..3	E2233A-CA2	Cables for Modular Power supply and 6673A
..3	E8780B-CL2	Material for second SLU in TS-5400 system
0.2	E8780B-OC-MODPS	Modular Power Supply Options
..3	E2233A-ATO	Modular Power Supply for TS-5400 systems
...4	E2233A-OC-COMBO	Combination Materials
....5	E2233A-P01	Brick Filler
....5	E2233A-P02	Mounting HW for E878x CA2 & CA3
....5	E2233A-P03	Mounting HW for E2230 CA1
...4	E2233A-OC-MODULE	DC Power Modules
....5	E2233A-002	N6762A Precision 100W DC power module
....5	E2233A-001	N6752A High Performance 100W DC power module
....5	E2233A-003	N6751A High Performance 50W DC Power Module
....5	E2233A-004	N6761A 100W module
....5	E2233A-005	N6734A 300W module
...4	E2233A-OC-CABLES	Power Supply Cables
....5	E2233A-CA1	Cables for Modular Power supply
....5	E2233A-CA2	Cables for Modular Power supply and 6673A
....5	E2233A-CA3	Cables - Standard Prog Interconnect for N67XX Series PS
....5	E2233A-CA4	Cable - direct connect N6700A to E6198A SLU
....5	E2233A-CA6	Cable - N6700B to L2000
....5	E2233A-CA5	Cable - N6700B to L2000 & SLU
0.2	E8780B-OC-APPSW	TS-5400 APPLICATION SOFTWARE OPTION CLASS
..3	E8780B-001	TS-5400 Family Application Software 6.0V
0.2	E8780B-OC-CUSTOM	Customization Option Class
1	R1992A	Automotive Warranty and Service Plans

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Revised: July 17, 2008

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Printed in USA, August 27, 2008
5989-7890EN

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