

User's Guide

Agilent 16440A SMU/Pulse Generator Selector



Agilent Technologies

Agilent Part No. 16440-90000
Printed in Japan January 2000
Edition 4

Legal Notice

The information contained in this document is subject to change without notice.

Copyright © 1994 - 2000 Agilent Technologies

This document contains information which is protected by copyright. All rights are reserved. Reproduction, adaptation, or translation without prior written permission is prohibited, except as allowed under the copyright laws.

- **Product Warranty**

Agilent Technologies warrant Agilent Technologies hardware, accessories and supplies against defects in materials and workmanship for the period of one year from the warranty start date specified below. If Agilent Technologies receive notice of such defects during the warranty period, Agilent Technologies will, at its option, either repair or replace products which prove to be defective. Replacement products may be either new or like-new.

Warranty service of this product will be performed at Agilent Technologies. Buyer shall prepay shipping charges to Agilent Technologies and Agilent Technologies shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to Agilent Technologies from another country.

Agilent Technologies do not warrant that the operation of Agilent Technologies products will be uninterrupted or error free. If Agilent is unable, within a reasonable time, to repair or replace any product to a condition as warranted, customer will be entitled to a refund of the purchase price upon prompt return of the product.

The Agilent Technologies products may contain remanufactured parts equivalent to new in performance or may have been subject to incidental use.

The warranty period begins on the date of delivery or on the date of installation if installed by Agilent Technologies. If customer schedules or delays Agilent Technologies installation more than 30 days after delivery, warranty begins on the 31st day from delivery.

Warranty does not apply to defects resulting from (a) improper or inadequate maintenance or calibration, (b) software, interfacing, parts or supplies not supplied by Agilent Technologies, (c) unauthorized modification or misuse, (d) operation outside of the published environmental specifications for the product, or (e) improper site preparation or maintenance.

To the extent allowed by local law, the above warranties are exclusive and no other warranty or condition, whether written or oral, is expressed or implied and Agilent Technologies specifically disclaim any implied warranties or conditions of merchantability, satisfactory quality, and fitness for a particular purpose.

Agilent Technologies will be liable for damage to tangible property per incident up to the greater of \$300,000 or the actual amount paid for the product that is the subject of the claim, and for damages for bodily injury or death, to the extent that all such damages are determined by a court of competent jurisdiction to have been directly caused by a defective Agilent Technologies product.

To the extent allowed by local law, the remedies in this warranty statement are customer's sole and exclusive remedies. Except as indicated above, in no event will Agilent Technologies or its suppliers be liable for loss of date or for direct, special, incidental, consequential (including lost profit or date), or other damage, whether based in contract, tort, or otherwise.

For consumer transactions in Australia and New Zealand: the warranty terms contained in this statement, except to the extent lawfully permitted, do not exclude, restrict or modify and are in addition to the mandatory statutory rights applicable to the sale of this product to you.

- **Assistance**

Product maintenance agreements and other customer assistance agreements are available for Agilent Technologies products.

For any assistance, contact your nearest Agilent Technologies Sales Office.

- **Certification**

Agilent Technologies Inc certifies that this product met its published specifications at the time of shipment from the factory. Agilent further certifies that its calibration measurements are traceable to the National Institute of Standards and Technology (NIST), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

- **Safety Summary**

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual may impair the protections provided by the equipment. In addition, it violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies Inc. assumes no liability for customer's failure to comply with these requirements.

- *GROUND THE INSTRUMENT*

This is Safety Class I instrument. To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The power terminal and the power cable must meet International Electrotechnical Commission (IEC) safety standards.

- *DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE*

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

- *KEEP AWAY FROM LIVE CIRCUITS*

Operation personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

- *DO NOT SERVICE OR ADJUST ALONE*

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

- *DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT*

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Agilent Technologies Sales and Service Office for services and repair to ensure that safety features are maintained.

- *DANGEROUS PROCEDURE WARNINGS*

Warnings, such as example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous Voltage, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

- **Safety Symbols**

The general definitions of safety symbols used on equipment or in manuals are listed below.



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.



Indicates dangerous voltage and potential for electrical shock. Do not touch terminals that have this symbol when instrument is on.



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.



Indicates earth (ground) terminal.



Alternating current.



Direct current.



ON (Supply).



OFF (Supply).



STANDBY (Supply).

CAT 1

Means INSTALLATION CATEGORY I. Measurement terminals on the rear panel comply with INSTALLATION CATEGORY I.

WARNING

The warning sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personal.

CAUTION

The caution sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

- **Herstellerbescheinigung**
GEÄUSCHEMISSION
Lpa < 70 dB
am Arbeitsplatz
normaler Betrieb
nach DIN 45635 T. 19
- **Manufacturer's Declaration**
ACOUSTIC NOISE EMISSION
Lpa < 70dB
operator position
normal operation
per ISO 7779

Printing History

Edition 1:	February 1994
Edition 2:	April 1995
Edition 3:	August 1997
Edition 4:	January 2000



User's Guide

Agilent 16440A SMU/Pulse Generator Selector is one of the accessories available for Agilent 4155/4156 Semiconductor Parameter Analyzers. The selector is for automatically switching the unit (SMU or PGU) that is connected to a DUT pin according to the state (stress force state or measurement state).

NOTE

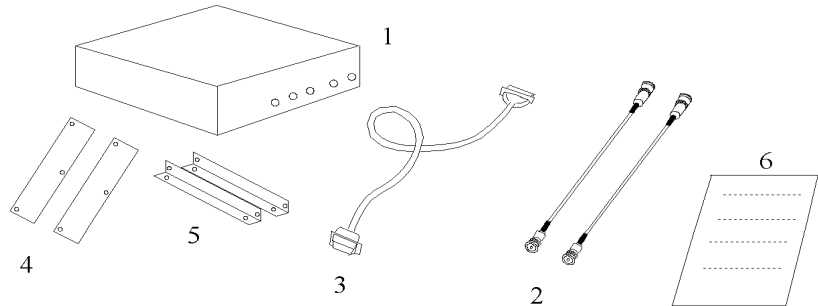
To use the selector, the 4155/4156 must be equipped with Agilent 41501 SMU/pulse generator expander that contains two PGUs.

This manual consists of the following sections.

- Introduction
- Operation
- Installation
- Maintenance
- Specifications

Introduction

The 16440A selector contains the following accessories:



	Description	Agilent Part Number	Quantity
1	SMU/Pulse Generator Selector	16440A	1
2	40 cm triaxial cable	04155-61605	2
3	(option 001) 1.5 m control cable	04155-61612	1
	(option 002) 3 m control cable	04155-61611	1
	(option 003) 40 cm control cable	04155-61608	1
4	plate ^a	16440-60001	2
5	(option 001/002) angle ^b	16440-60002	2
6	(option 001/002) <i>User's Guide</i> (this document)	16440-90000	1

a. Three screws are furnished for each plate.

b. Two screws are furnished for each angle.

NOTE

Inspecting the 16440A upon Receiving

When the 16440A arrives at your site, make sure that nothing is missing or damaged. Unpack the carton, then check the contents against figure and table above.

If anything is missing or damaged, contact your nearest Agilent Technologies sales office.

Operation

This section describes the operating theory of the selector.

Agilent 4155/4156 can control the selector to automatically switch the unit (SMU or PGU) that is connected to a DUT pin according to the state (stress force state or measurement state).

This is useful for performing reliability testing (stress testing) of DUTs. For example, the selector can connect a PGU to the DUT for forcing ac stress, then can switch and connect an SMU for measuring dc characteristics.

You define the selector connections in SMU/PG SELECTOR table on the STRESS: CHANNEL DEFINITION page. The switching state specified in the STRESS column is automatically performed during stressing. The switching state specified in the MEASURE column is automatically performed during measurement. See "STRESS: CHANNEL DEFINITION screen" in the 4155/4156 *User's Guide*.

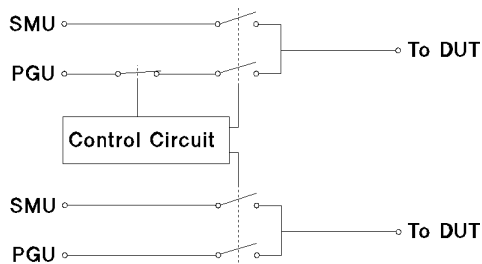
For example, you can specify to connect the PGU to the DUT during stress, and connect the SMU to the DUT during measurement. So, when you press the **Stress** key, the PGU is automatically connected to the DUT. And when you press a measurement key, the SMU is automatically connected to the DUT.

The 4155/4156 controls the switching of the selector.

Each selector has two channels. If you want to add two more channels for a total of four, you can order 16440A option 003, which is called the "selector expander".

The selector and selector expander have identical circuits. The only difference is the channel naming. The selector has CH 1 and CH 2, and the selector expander has CH 3 and CH 4.

The following figure shows a simple circuit diagram of the selector (selector expander).



SUG02001.GAL_65mmWx40mmH

The CH 1 and CH 3 circuits are different from the CH 2 and CH 4 circuits. Each channel has one mechanical relay for SMU and one mechanical relay for PGU, but the CH 1 and CH 3 circuits also have a semiconductor relay for PGU. The relays are controlled by the 4155/4156 via the control circuit.

The semiconductor relay is useful when you need to perform a lot of switching (for example, read/write tests of flash ROM) because the semiconductor relay is more durable than mechanical relays.

CH 1 and CH 3 can have four switching states: all open, SMU on, PGU on, and PGU open. CH 2 and CH 4 can have three switching states: all open, SMU on, and PGU on.

User's Guide
Operation

The switching state of a channel is indicated by the green LEDs on the selector front panel. The following table shows the relation of the relays and the LEDs for each switching state.

States	CH 1 and CH 3	CH 2 and CH 4
All open	 	
SMU on	 	
PGU on	 	
PGU open	 	

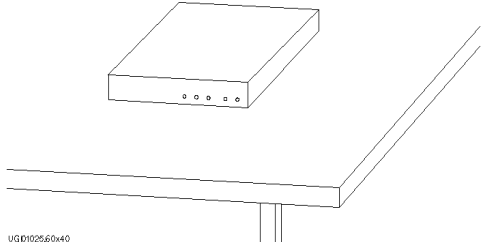
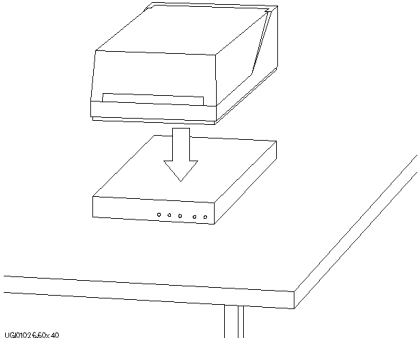
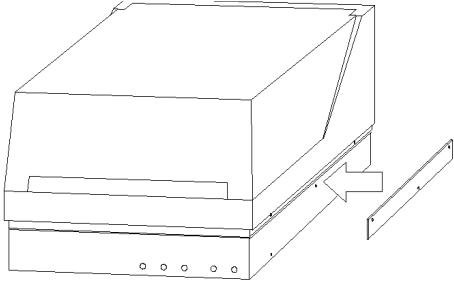
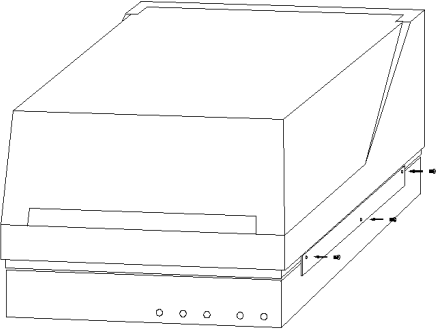
The "PGU open" state is useful if a lot of switching needs to be performed. When the switching state changes from "PGU on" to "PGU open", only the semiconductor relay switches. This reduces the amount of times the mechanical relay is switched. The semiconductor relay has a much longer switching life than the mechanical relay.

Installation

This section describes how to attach the selector to Agilent 16442A test fixture or to a shielding box, and how to connect it to Agilent 4155/4156.

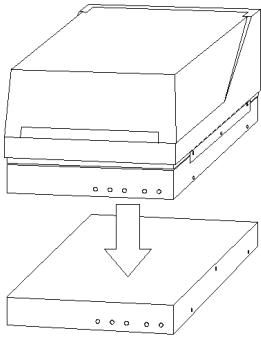
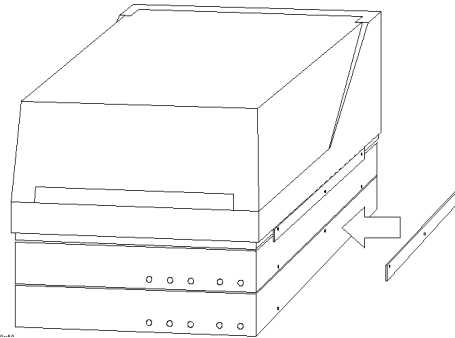
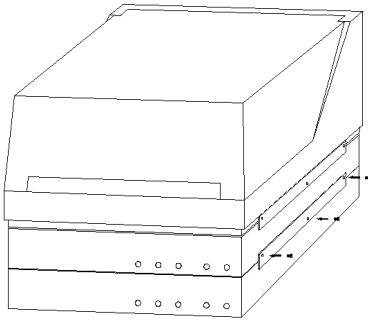
To Attach the Selector to Test Fixture

You can attach your selector to the 16442A test fixture. You need a standard screwdriver.

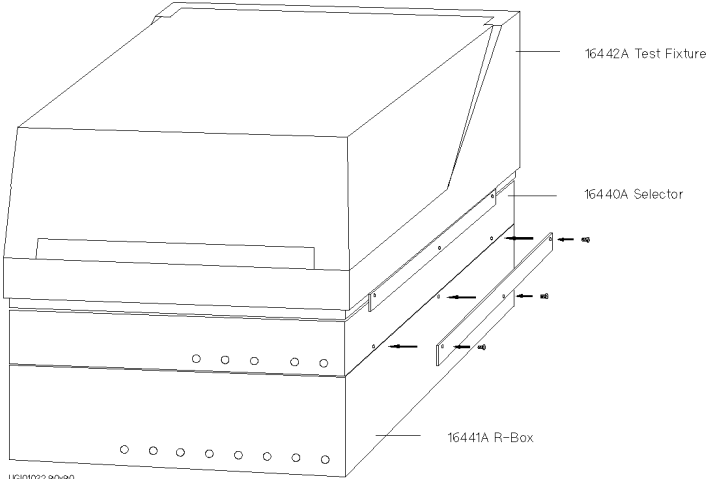
<p>1. Place the selector on your workbench.</p>	<p>2. Place the test fixture on top of the selector.</p>
 <p>UG01025,6.0v4.0</p>	 <p>UG01025,6.0v4.0</p>
<p>3. Position a plate on both sides.</p>	<p>4. Attach each plate using the three flathead screws supplied with the instrument.</p>
 <p>UG01025,6.0v4.0</p>	 <p>UG01025,6.0v4.0</p>

User's Guide
Installation

The following steps apply when using two selectors:

<p>5. Place the second selector on your workbench. Place the selector and the test fixture on top of the second selector.</p>	 <p>The diagram shows a rectangular selector unit with a hinged lid. Below it, a flat rectangular plate is shown with a large downward-pointing arrow indicating it should be placed on top of the selector. The selector has four small circles on its front face.</p>
<p>6. Position a plate on both sides.</p>	<p>7. Attach each plate using the three flathead screws supplied with the instrument.</p>
 <p>The diagram shows the selector unit with a rectangular plate being slid into a slot on its side. A large arrow points to the right, indicating the direction of movement. The selector has four small circles on its front face.</p>	 <p>The diagram shows the selector unit with two rectangular plates attached to its sides. Three screws are shown being inserted into the side of the selector to secure the plates. The selector has four small circles on its front face.</p>

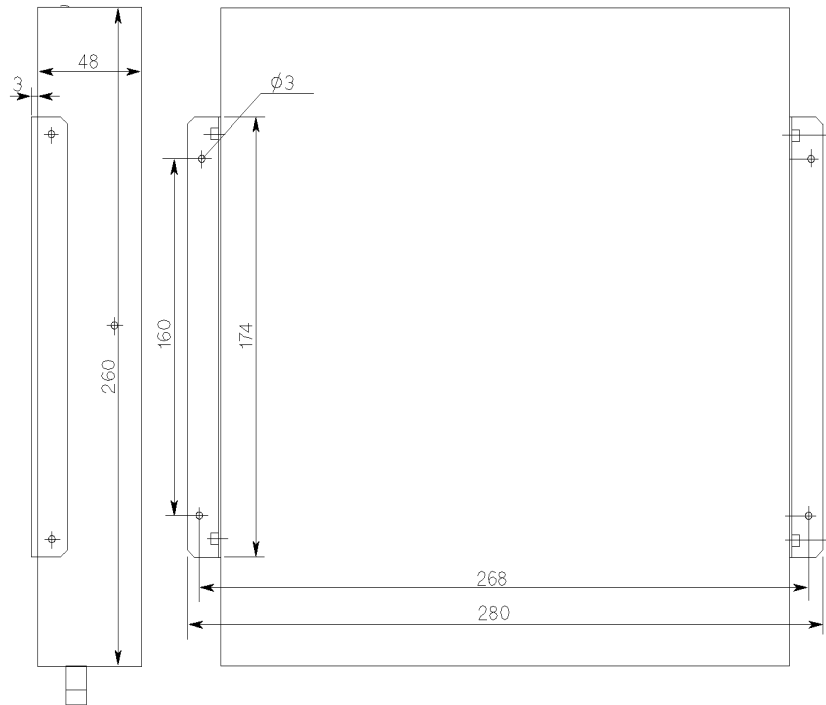
If you use the 16441A R-box, attach the R-Box to the selector as shown below:



To Attach the Selector to Shielding Box

You can attach your selector to a shielding box. You need a standard screwdriver.

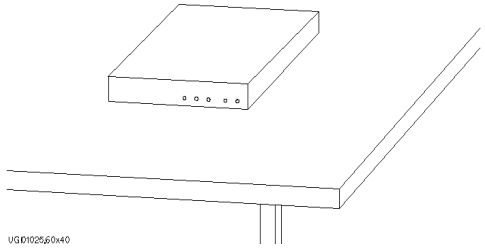
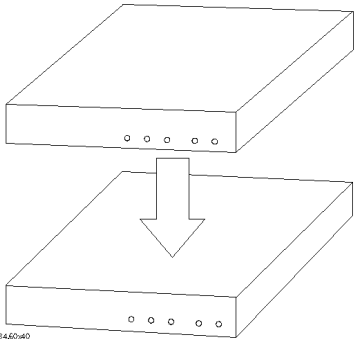
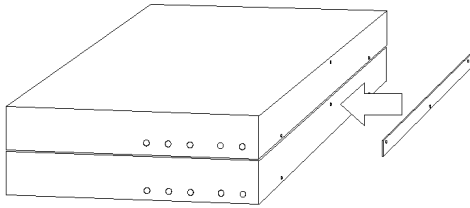
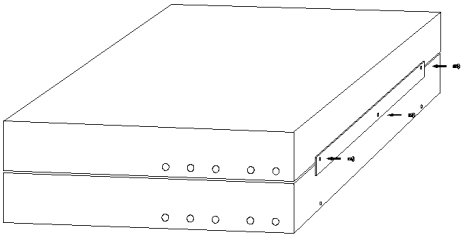
The following figure shows the spacing of the 16440A screw holes. You need to prepare four screws and nuts to match the screw holes.



Units: mm

SUG01072, 020999Wx102mmH

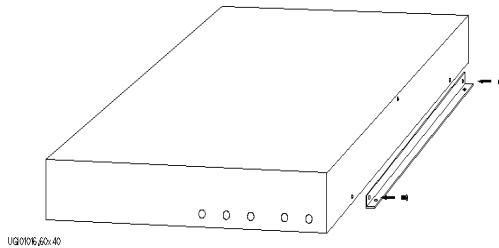
If you use two selectors, connect selectors before attaching to the shielding box, as shown below:

<p>1. Place the selector on your workbench.</p>	<p>2. Place the second selector on top of the selector.</p>
 <p>UG01025660x40</p>	 <p>UG0103460x40</p>
<p>3. Position a plate on both sides.</p>	<p>4. Attach each plate using the three flathead screws supplied with the instrument.</p>
 <p>UG0103660x40</p>	 <p>UG0103660x40</p>

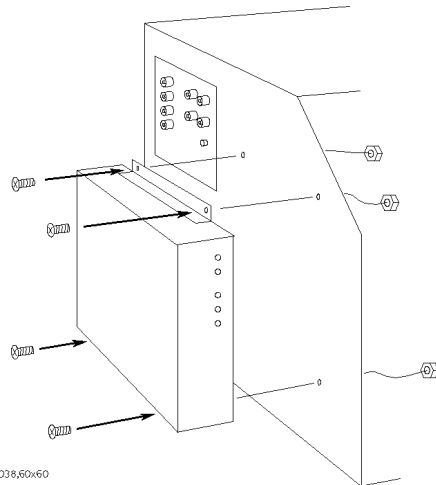
User's Guide
Installation

Attach the selector to the shielding box as shown below:

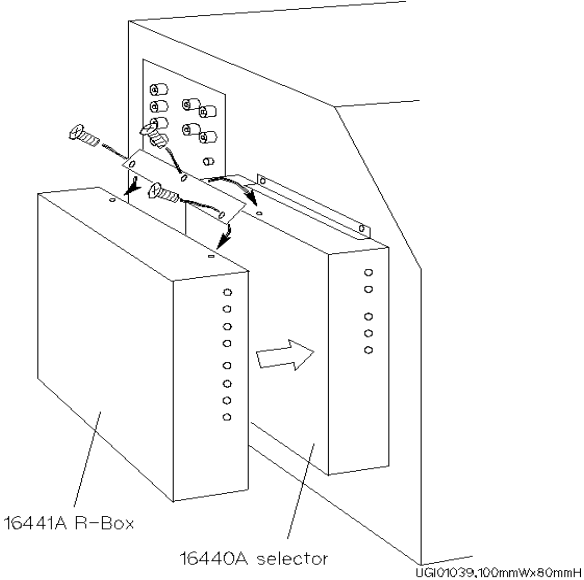
1. Attach an angle bracket to each side of the selector, using the screws supplied.



2. Place the selector(s) on the side panel of the shielding box.
3. Position four nuts on the inside panel of the shielding box.
4. Attach the angle bracket to the shielding box using four flathead screws.



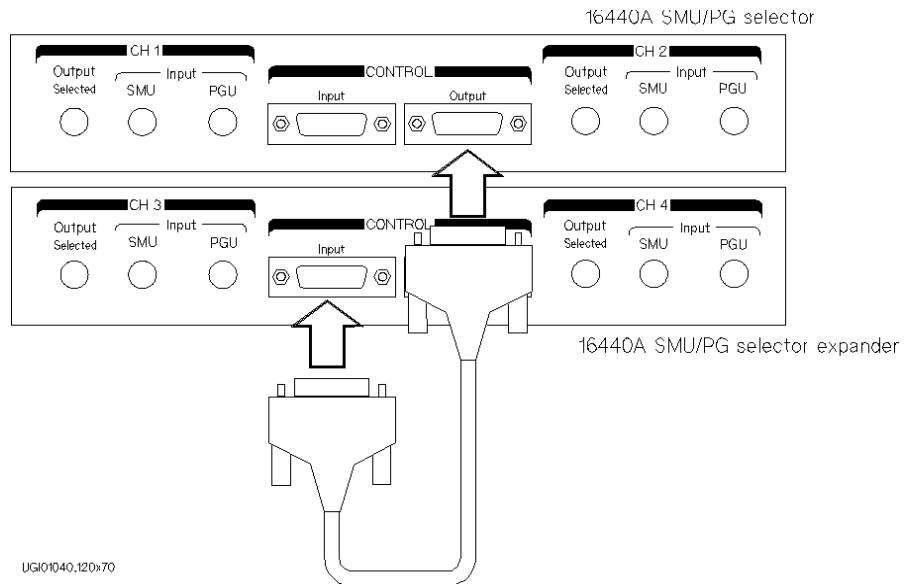
If you use the 16441A R-box, attach the R-Box to the selector on the shielding box as shown below:



Connecting the Selector to the 4155/4156

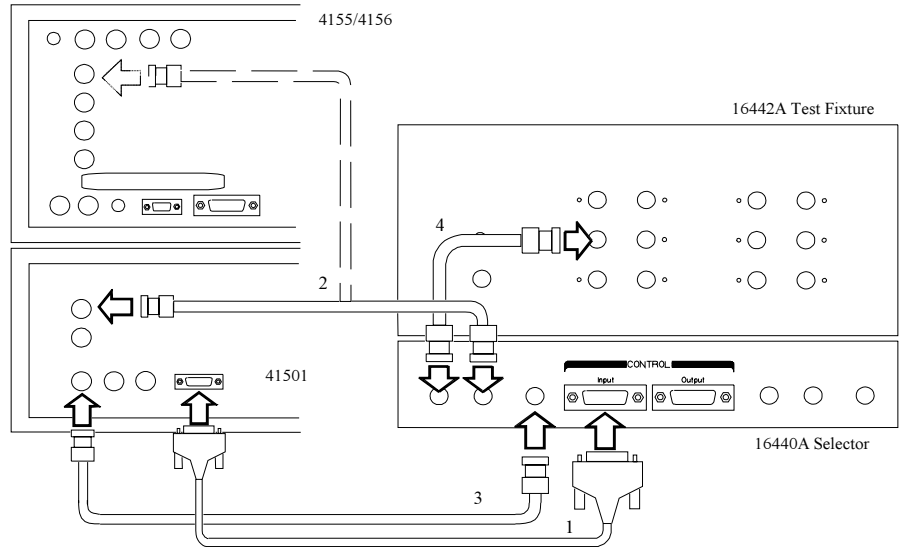
- Connecting two selectors

If you use two selectors, connect the Control Output terminal of the selector to the Control Input terminal of the second selector using a 40 cm control cable as shown below.



- Connecting the selector to the 4155/4156

Turn off the 4155/4156 and 41501 before connecting the instruments. Then connect as shown below.



Instrument	Terminal	16440A Terminal	Cable
41501	To SMU/Pulse Generator Selector Interface	CONTROL Input	3.0 m or 1.5 m Control Cable
	PGU	Input PGU ^a	3.0 m or 1.5 m Coaxial Cable
	MPSMU or HPSMU	Input SMU	3.0 m or 1.5 m Triaxial Cable
4155	MPSMU		
4156	HRSMU		
16442A	SMU	Output Selected ^b	40 cm Triaxial Cable
Connector Plate	SMU		

- You can use two inputs for one selector, and four inputs for two selectors.
- You can use two outputs for one selector and four outputs for two selectors. Selector output is either one of the PGU outputs or the SMU output.

Maintenance

This section provides the following maintenance information:

- Cleaning
- Servicing

Cleaning the Selector

To maintain high performance, the selector must be kept clean. Oil, perspiration, hair, dust, and dirt will degrade the board insulation, which increases leakage current and decreases measurement accuracy.

Agilent Technologies recommend the following cleaning procedure:

1. Make sure that voltage or current is *not* present at any channel.
2. Disconnect all cables from the selector.
3. Using lint-free paper, gently wipe the chassis. For any area that will not come clean, dip the lint-free paper into alcohol and wipe the area gently.

Servicing the Selector

This section provides information for trained service personnel to repair the selector.

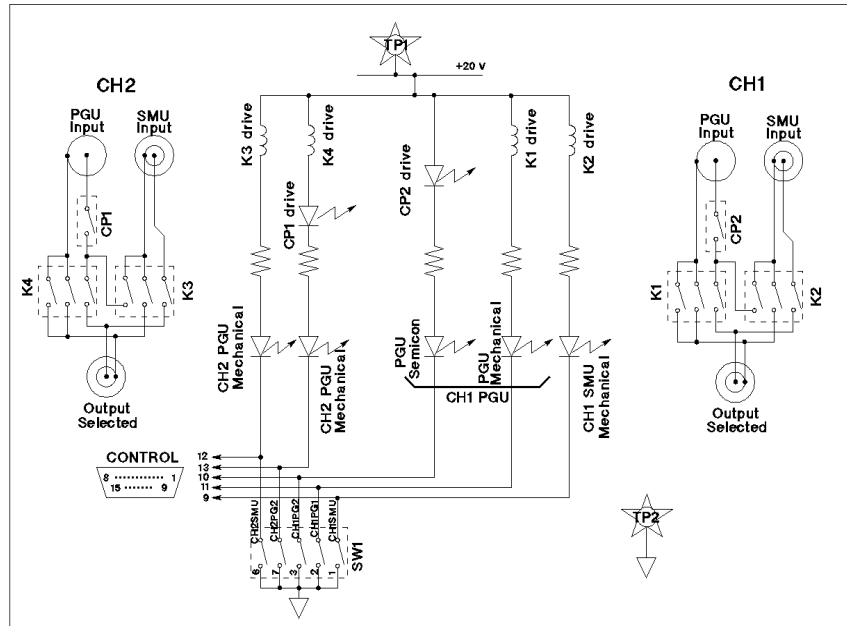
When a replaceable part, which is shown with the Agilent part number in this section, needs to be replaced, order the parts from the nearest Agilent Technologies Sales and Service Office.

WARNING

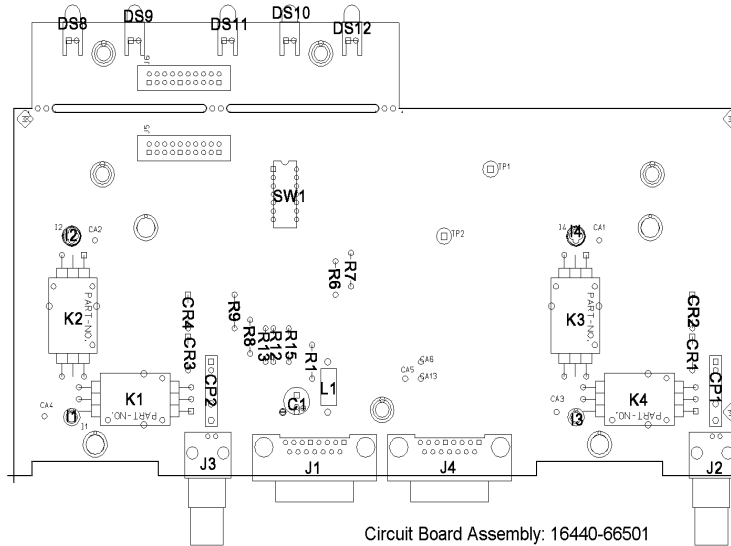
High voltages may be present in the selector when voltage or current is applied. Be careful to avoid electric shock.

Before you repair the selector, make sure that terminals are not connected to any instrument.

Circuit Block Diagram



Replaceable Parts



When soldering, use low hydrochloric acid solder (Agilent part number: 8090-0433) to prevent the flux in the solder from spreading unnecessarily, and make sure that adjacent terminals are not bridged. After soldering, make sure that there are no lint bridges, which would increase the leakage current.

Reference Designation	Agilent Part Number	Description
R1	0757-0442	Resistor 10 k Ω , 1%, 0.125 W
R6	0698-3440	Resistor 196 Ω , 1%, 0.125 W
R7	0757-0402	Resistor 110 Ω , 1%, 0.125 W
R8	0698-3440	Resistor 196 Ω , 1%, 0.125 W
R9	0698-3440	Resistor 196 Ω , 1%, 0.125 W
R12	0698-0085	Resistor 2.61 k Ω , 1%

Reference Designation	Agilent Part Number	Description
R13	0698-0085	Resistor 2.61 k Ω , 1%
R15	0757-0279	Resistor 3.16 k Ω , 1%
CR1	1901-0050	Diode
CR2	1901-0050	Diode
CR3	1901-0050	Diode
CR4	1901-0050	Diode
L1	9140-0210	Inductor 100 μ H \pm 5%
C1	0180-3468	Capacitor 47 μ F 50 V
CP1	1990-1625	Opto-isolator
CP2	1990-1625	Opto-isolator
K1	0490-1791	Reed Relay
K2	0490-1791	Reed Relay
K3	0490-1791	Reed Relay
K4	0490-1791	Reed Relay
DS8	1990-0967	LED Green
DS9	1990-0967	LED Green
DS10	1990-0967	LED Green
DS11	1990-0967	LED Green
DS12	1990-0967	LED Green
J1	1252-1481	Connector
J2	1250-1842	Connector BNC
J3	1250-1842	Connector BNC
J4	1252-1481	Connector
SW1	3101-2885	Switch - DIP
I1	0360-1641	Terminal
I2	0340-0060	Terminal
I3	0360-1641	Terminal
I4	0340-0060	Terminal

Specifications

The "supplemental information" and "typical" entries, in the following specifications are not warranted, but provide useful information about the functions and performance of the instruments.

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

- Function

Agilent 16440A switches either a SMU or PGU to the associated output port. You can expand to 4 channels by adding an additional 16440A. The channel 1 PGU port provides "PGU OPEN" function, which can disconnect the PGU by opening a semiconductor relay. The 16440A can not work without two pulse generator units of Agilent 41501 SMU and Pulse Generator Expander.

- Channel configuration: 2 channels (CH1 and CH2). Can add additional 2 channels (CH3 and CH4) by adding another 16440A (selector expander).

	Input	Output
Channel 1 (CH 1)	2 (SMU and PGU)	1
Channel 2 (CH 2)	2 (SMU and PGU)	1
Channel 3 (CH 3) ^a	2 (SMU and PGU)	1
Channel 4 (CH 4) ^a	2 (SMU and PGU)	1

a. These channels are available when an 16440A SMU/PG selector expander is installed.

- Voltage and current range

Input port	Maximum Voltage	Maximum Current
SMU	200 V	1.0 A
PGU	40 V	0.2 A ^a

a. This is peak-to-peak ac current.

- Accessories (furnished). See Section 1 for details.
 - Option 001
 - 1.5 m control cable (Agilent part number 04155-61612)
 - 40 cm triaxial cable (Agilent part number 04155-61605)
 - Option 002
 - 3.0 m control cable (Agilent part number 04155-61611)
 - 40 cm triaxial cable (Agilent part number 04155-61605)
 - Option 003
 - 40 cm control cable (Agilent part number 04155-61608) for connecting selector to selector expander
 - 40 cm triaxial cable (Agilent part number 04155-61605)

- General specifications

- Environment

Operating temperature	5 °C to 40 °C
Storage temperature	–40 °C to 70 °C
Operating Humidity	5 % to 80 % relative humidity (at no condensation)
Storage Humidity	5 % to 90 % relative humidity at 65 °C

- Weight

Approximately 1.1 kg (2.43 lb)

Supplemental Information

The following reference data is specified at 23 ± 5 °C (73 ± 9 °F) and 50 % relative humidity.

- SMU channel
 - Leakage current** less than 100 fA at 100 V
 - Residual resistance** 0.2 Ω typical
 - Stray capacitance (force common)** 0.3 pF typical at 1 MHz
 - Stray capacitance (force guard)** 15 pF typical at 1 MHz
 - Stray capacitance (guard common)** 130 pF typical at 1 MHz
- PGU channel
 - Residual resistance** 3.4 Ω
 - Stray capacitance (relay off)** 5 pF typical
 - Stray capacitance (open)** 700 pF typical (at 1 MHz $V_{in} - V_{out} = 0$ V)
 - Signal transfer characteristics** Overshoot < 5 % of pulse amplitude (at 20 ns leading and trailing time, 50 Ω pulse generator source impedance, 50 pF 1 M Ω in parallel load)