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Keysight 16440A SMU/Pulse Generator Selector

KEYSIGHT TECHNOLOGIES

User's Guide

Notices

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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. Keysight Technologies 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 Keysight 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 equipment will be marked with this symbol when it is necessary for the user to refer to the instruction manual.


Hazardous voltage and potential for electrical shock. Do not touch terminals that have this symbol when the equipment 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.


Grounded terminal which indicates the earth potential.


Direct current.

Alternating current.

On supply.


Off supply.


Standby supply. The equipment will be marked with this symbol is not completely disconnected from AC mains when power switch is in the standby position.

CAT I IEC Measurement 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 equipment.

Product Stewardship



Waste Electrical and Electronic Equipment (WEEE)

The crossed out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation.

Please refer to http://keysight.com/go/takeback to understand your Trade in options with Keysight in addition to product takeback instructions.

User's Guide

KEYSIGHT TECHNOLOGIES

Keysight 16440A SMU/Pulse Generator Selector (B1500A-A04) is one of the accessories available for Keysight 4155/4156 Semiconductor Parameter Analyzers and Keysight B1500A Semiconductor Device Analyzer. The selector is for automatically switching the measurement resource that is connected to a DUT pin. The measurement resource can be SMU, PGU, or SPGU.

This manual consists of the following sections.

- "Introduction"
- "Operation"
- "Installation"
- "Maintenance"
- "Specifications"

NOTE

To Use the Selector

The 4155/4156 must be equipped with Keysight 41501 SMU/pulse generator expander that contains two PGUs.

The B1500A needs Keysight 16445A selector adapter.

NOTE

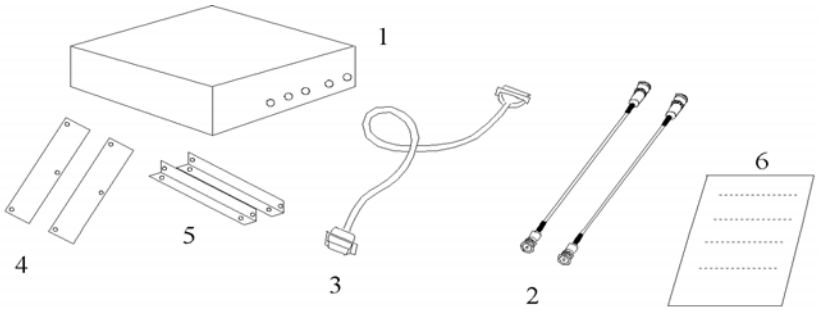
Inspecting the 16440A upon Receiving

When the 16440A selector (B1500A-A04) arrives at your site, make sure that nothing is missing or damaged. Unpack the carton, then check the contents against figure and table shown in "Introduction".

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

Introduction

The 16440A selector (B1500A-A04) contains the following accessories.



	Description	Keysight Part Number	Quantity
1	SMU/Pulse Generator Selector	16440A (B1500A-A04)	1
2	40 cm triaxial cable	04155-61605	2
3	1.5 m control cable (16440A-001)	04155-61612	1
	3 m control cable (16440A-002)	04155-61611	1
	40 cm control cable (16440A-003)	04155-61608	1
4	plate [a]	16440-60001	2
5	angle [b]	16440-60002	2
6	*User's Guide* [c]	16440-90005	1

a. Three screws are furnished for each plate.
b. Furnished with 16440A-001/002. Two screws are also furnished for each angle.
c. This document. Furnished with 16440A-001/002.

Operation

The selector provides the automatic switching capability of the measurement resource SMU or PGU connected to a DUT terminal. 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.

The selector has the channels CH 1 and CH 2 which provide the following conditions.

CH 1 All open (no connection), SMU on, PGU on, and PGU open

CH 2 All open (no connection), SMU on, and PGU on

The PGU open is available only for the CH 1, and is made by keeping the PGU side mechanical relay close and opening the semiconductor relay. This is effective for frequent switching applications such as endurance tests of flash memory because the semiconductor relay is more durable than mechanical relays.

If you want to add two more channels for a total of four, you can order another 16440A, 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.

- Controlling the selector by using the 4155/4156

  Selector connections can be set by using the SMU/PG SELECTOR table on the STRESS: CHANNEL DEFINITION screen. See the 4155/4156 *Setup Screen Reference* manual.

  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.

  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.

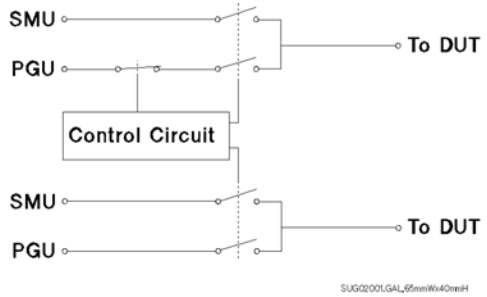
- Controlling the selector by using the B1500A

  Selector connections can be set by using the SMU/PG Selector tab screen of the Configuration window. And the PGU open can be set by using the Advanced window of the Measurement Setup. See the B1500A *User's Guide*.

  If the *Input/Output Path* is set to *Normally PGU (AUX)* in the SMU/PG Selector tab screen, the selector performs automatic switching in every test. The selector channel normally makes the "PGU on" state and makes the "SMU on" state only for the test which uses the SMU connected to the *Input SMU* terminal.

  If the *Semiconductor Relays* on the Advanced window is set to *PGU OPEN*, the selector channel makes the "PGU open" state during the test.

- Simplified circuit diagram



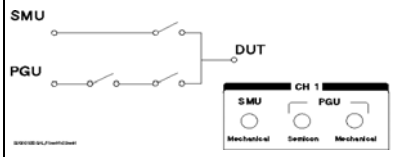
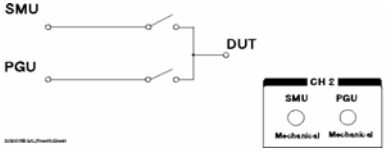
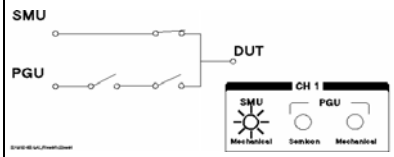
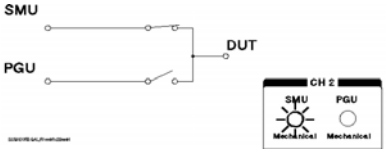
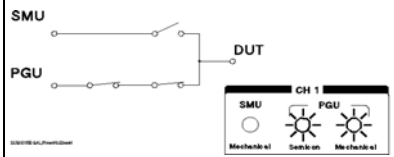
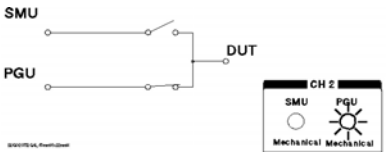
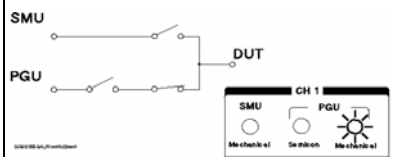
  This figure shows a simple circuit diagram of the selector (selector expander).

  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/B1500A 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.

- Switching state

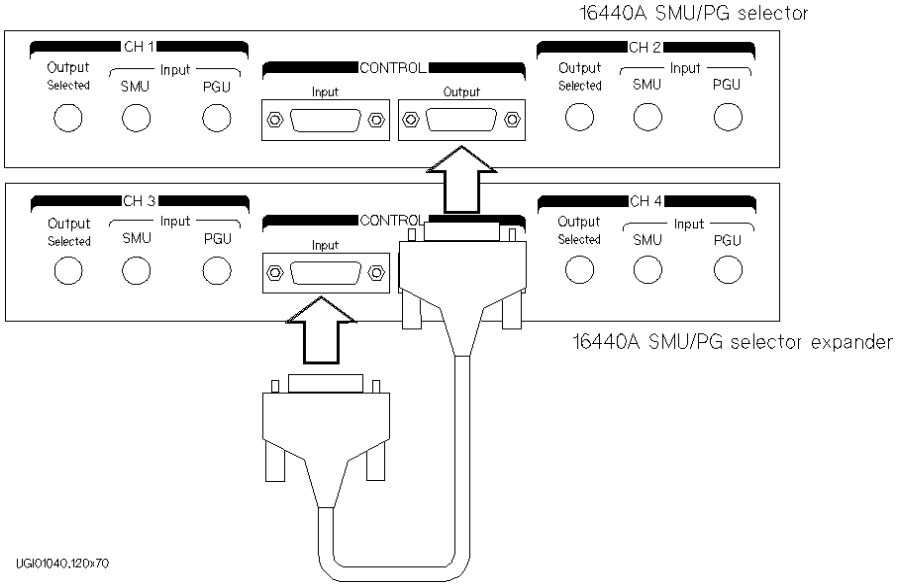
States	CH 1 and CH 3	CH 2 and CH 4
All open		
SMU on		
PGU on		
PGU open		

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

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.

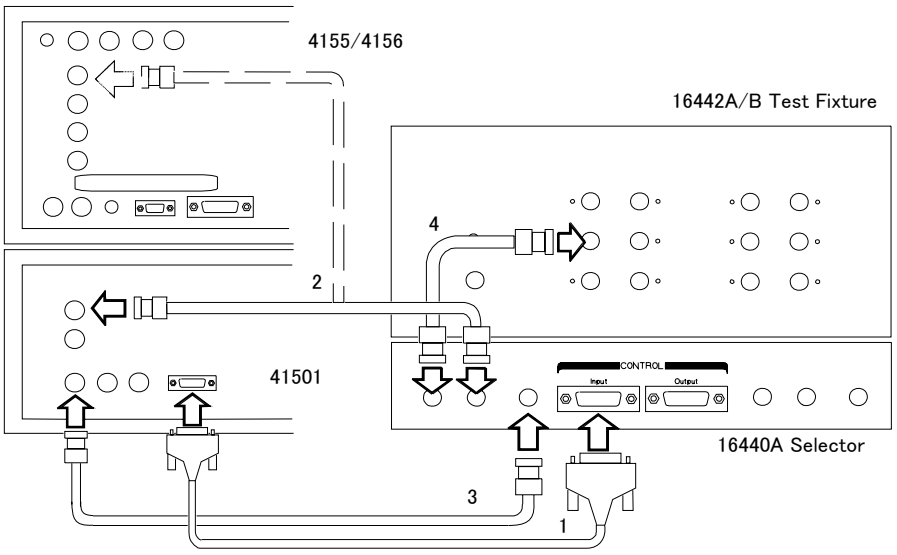
- Connecting two selectors

  If you use two selectors to have four channels, 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.

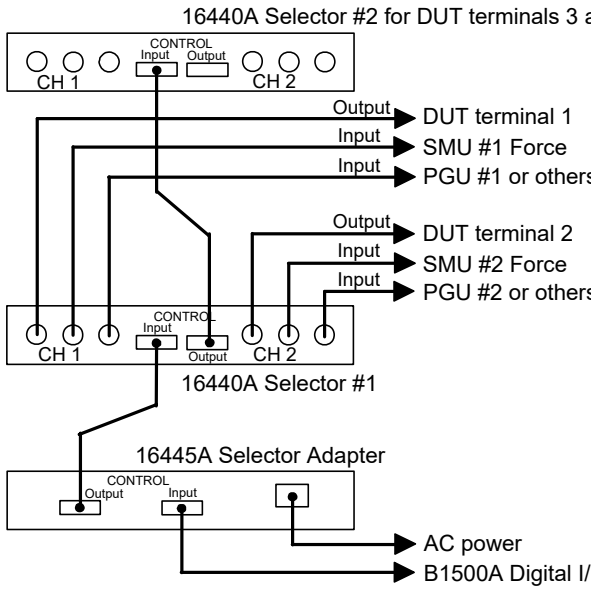


Selector terminal	Cable	Connect to
CONTROL Input	16440A-001/002 Control cable	41501 To SMU/Pulse Generator Selector Interface
Input SMU [a]	3.0 m or 1.5 m Triaxial cable	4156 HRSMU Force
		4155 MPSMU Force
		41501 MPSMU or HPSMU Force
Input PGU [a]	3.0 m or 1.5 m Coaxial cable	41501 PGU
Output Selected [b]	40 cm Triaxial cable	DUT interface (16442A or connector plate)

a. You can use two inputs for one selector, and four inputs for two selectors.
b. 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.

- Connecting the selector to the B1500A

  Turn off the B1500A before connecting the instruments. Then connect as shown below.



Selector terminal	Cable	Connect to
CONTROL Input	16440A-003 Control cable	16445A CONTROL Output
16445A CONTROL Input	16445A-001/002 Control cable	B1500A Digital I/O
Input SMU [a]	3.0 m or 1.5 m Triaxial cable	B1500A MPSMU Force
		B1500A HRSMU Force
		B1500A HPSMU Force
Input PGU [a]	3.0 m or 1.5 m Coaxial cable	B1500A SPGU Output
Output Selected [b]	40 cm Triaxial cable	DUT interface (16442A or connector plate)

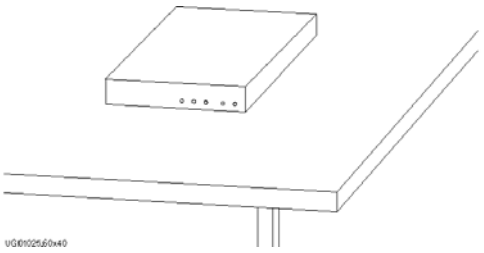
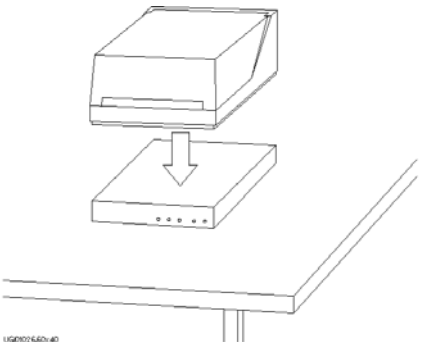
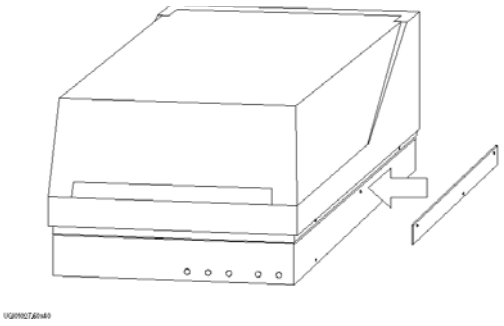
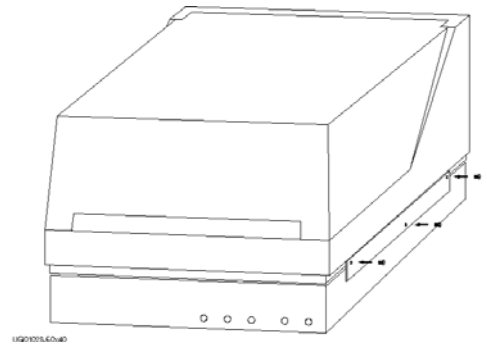
a. You can use two inputs for one selector, and four inputs for two selectors.
b. You can use two outputs for one selector and four outputs for two selectors. Selector output is either one of the PGU outputs or the SMU output.

Installation

This section describes how to attach the selector to Keysight 16442A test fixture or to a shielding box.

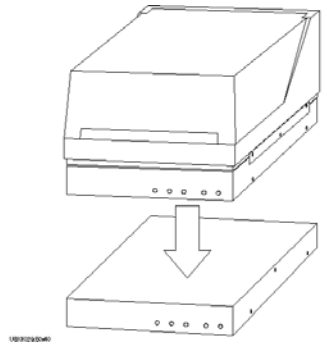
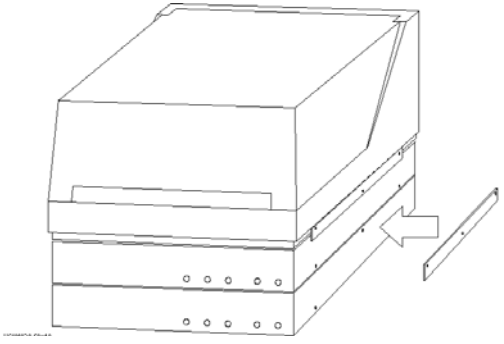
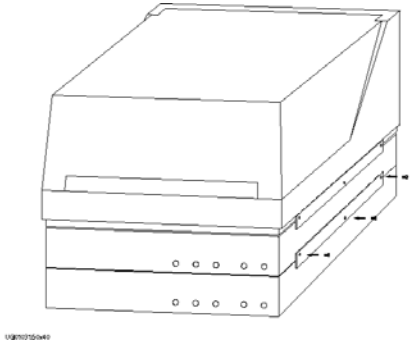
To Attach the Selector to Test Fixture

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

1. Place the selector on your workbench.	2. Place the test fixture on top of the selector.
	
3. Position a plate on both sides.	4. Attach each plate using the three flathead screws supplied with the instrument.
	

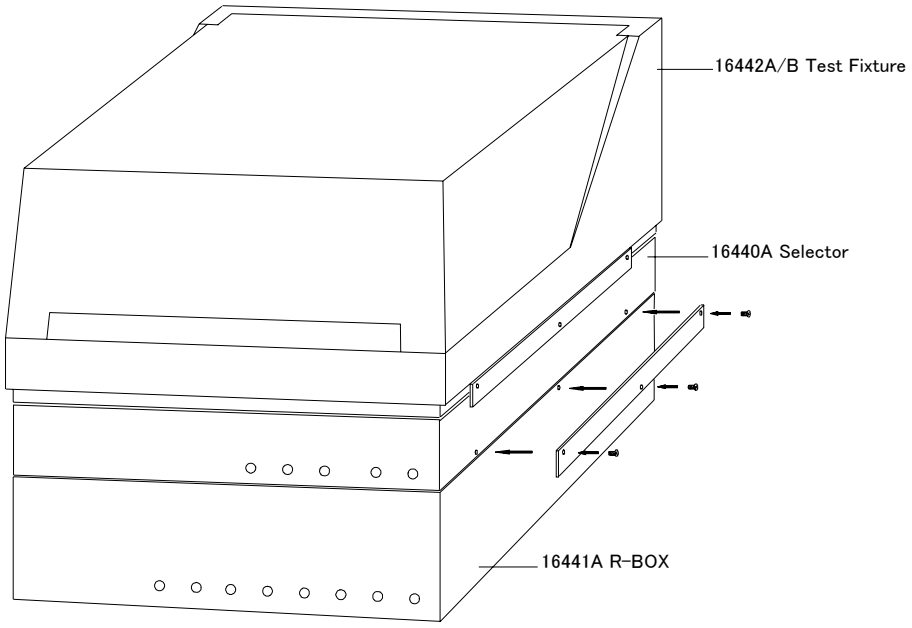
NOTE If you use the 16445A selector adapter, fix it under the selector by similar method.

The following steps apply when using two selectors.

5. Place the second selector on your workbench. Place the selector and the test fixture on top of the second selector.	
6. Position a plate on both sides.	7. Attach each plate using the three flathead screws supplied with the instrument.
	

NOTE If you use the 16445A selector adapter, fix it under the selector by similar method.

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

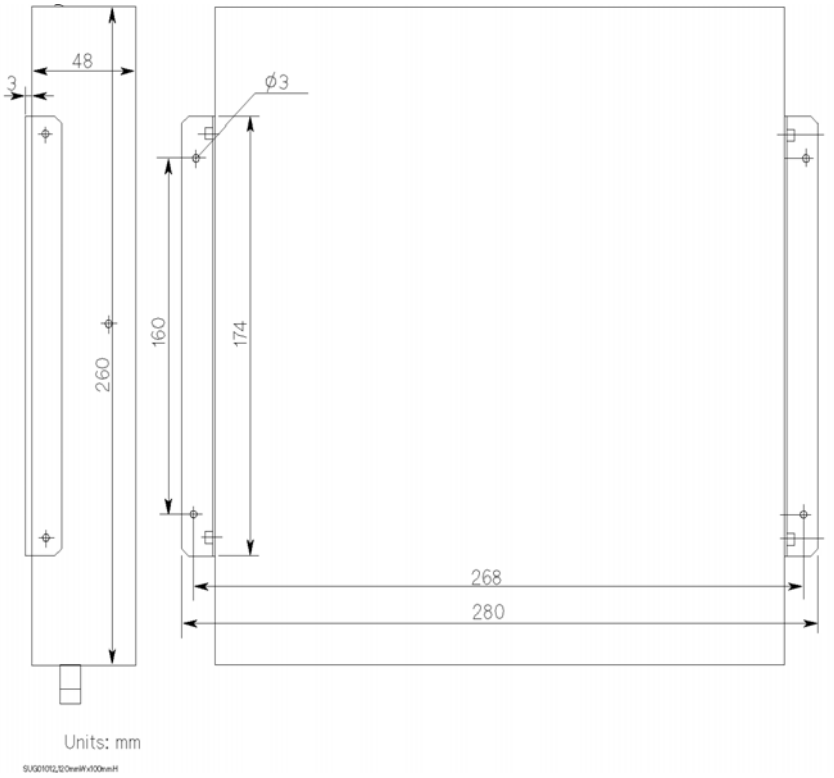


NOTE If you use the 16445A selector adapter, fix it under the R-box by similar method.

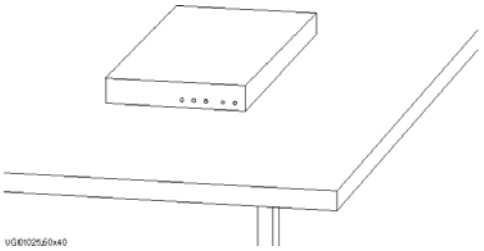
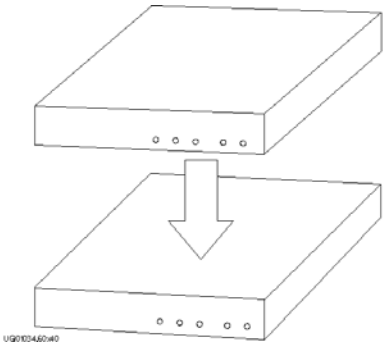
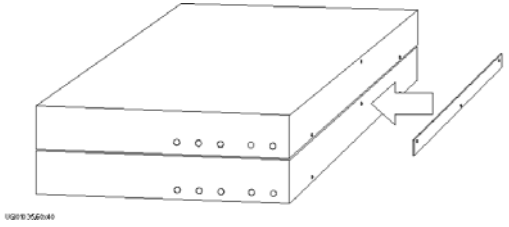
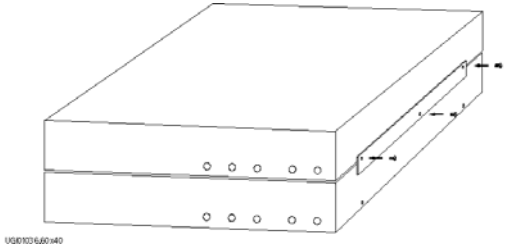
To Attach the Selector to Shielding Box

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

The following figure shows the spacing of the 16440A (B1500A-A04) screw holes. You need to prepare four screws and nuts to match the screw holes.



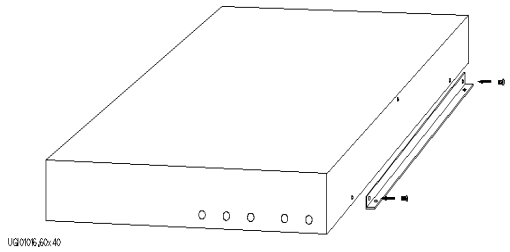
If you use two selectors, connect selectors before attaching to the shielding box, as shown below.

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

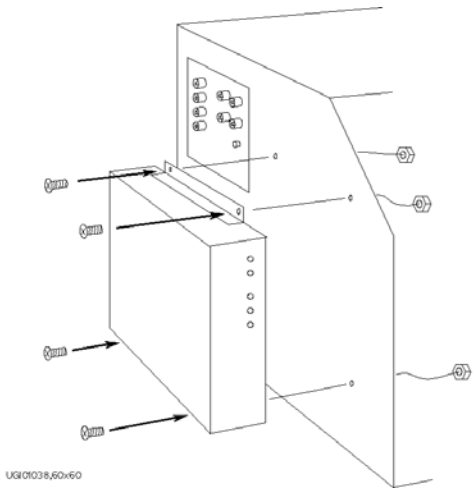
NOTE If you use the 16445A selector adapter, fix it on top of the selector by similar method.

Attach the selector to the shielding box as shown below.

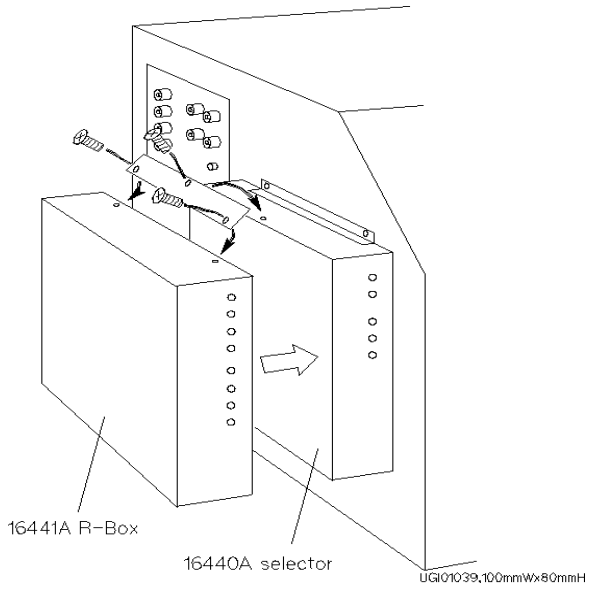
1. Attach an angle bracket to each side of the selector, using the screws supplied.



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.



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.

Keysight 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

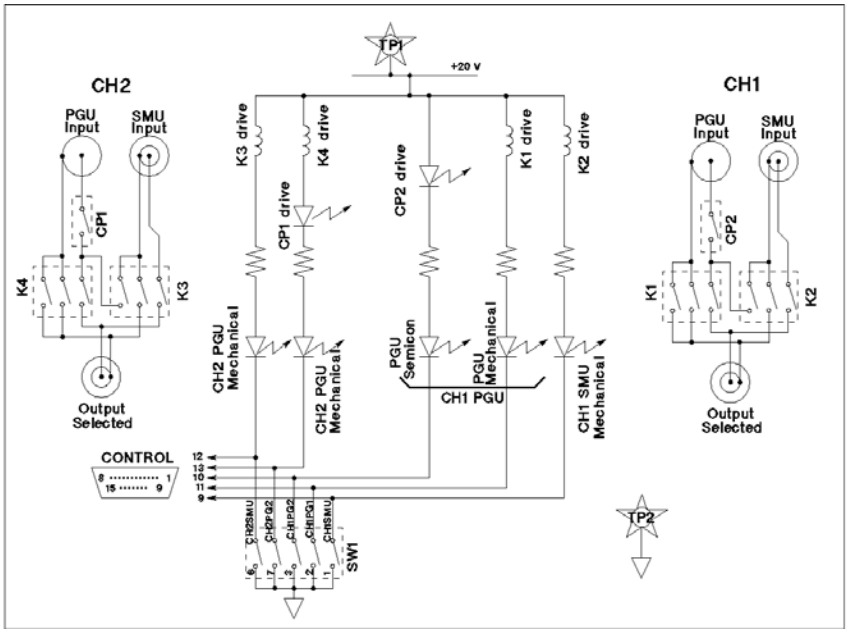
This section provides information for trained service personnel to repair the selector.

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

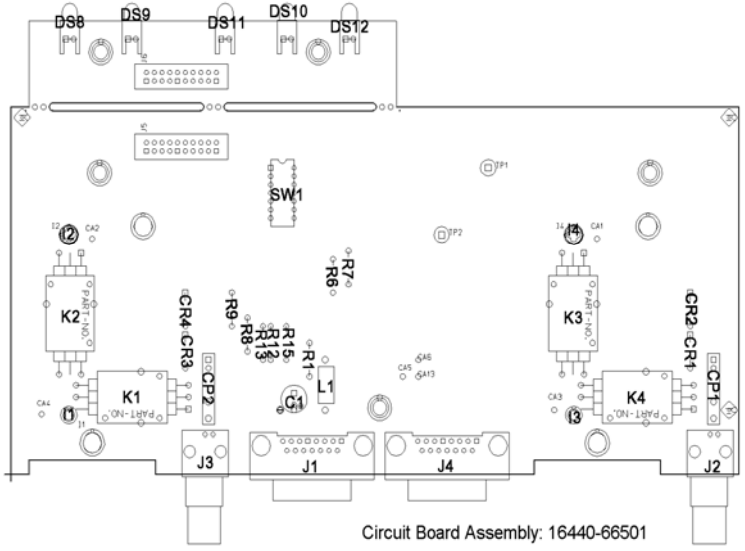
WARNING **High voltages may be present in the selector when voltage or current is applied. Be careful to avoid electric shock.**

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 (Keysight 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	Keysight Part Number	Description
R1	0757-0442	Resistor 10 kΩ, 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 kΩ, 1%

Reference Designation	Keysight Part Number	Description
R13	0698-0085	Resistor 2.61 kΩ, 1%
R15	0757-0279	Resistor 3.16 kΩ, 1%
CR1	1901-0050	Diode
CR2	1901-0050	Diode
CR3	1901-0050	Diode
CR4	1901-0050	Diode
L1	9140-0210	Inductor 100 μH ±5%
C1	0180-3468	Capacitor 47 μF 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 (73 ± 9 °F) and 50 %RH.

- Function

  Keysight 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 Keysight 4155/4156 with 41501A/B-402/412/422 or Keysight B1500A with 16445A.

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

	Input	Output
Channel 1 (CH 1)	2 (SMU and PGU [a])	1
Channel 2 (CH 2)	2 (SMU and PGU)	1
Channel 3 (CH 3) [b]	2 (SMU and PGU [a])	1
Channel 4 (CH 4) [b]	2 (SMU and PGU)	1

a. CH 1/3 PGU channel has built-in series semiconductor relay.
b. Available when the selector expander is installed.

- Voltage and current range

Input port	Maximum Voltage	Maximum Current
SMU	200 V	1.0 A
PGU	40 V	0.4 A [a]

a. This is peak-to-peak ac current. For 50 Ω load. If DUT impedance is lower than 50 Ω, SPGU output voltage should be decreased for preventing the selector from over current.

- Temperature Range

  Operating +5 °C to +40 °C

  Storage −40 °C to +70 °C

- Humidity

  Operating 5 % to 80 %RH, non-condensing

  Storage 5 % to 90 %RH, at 65 °C

- Dimensions

  250 mm (W) × 50 mm (H) × 275 mm (D)

- Weight

  Approximately 1.1 kg (2.43 lb)

Accessories

See Section 1 for details.

- Option 001
  - 1.5 m control cable (Keysight part number 04155-61612)
  - 40 cm triaxial cable (Keysight part number 04155-61605)
- Option 002
  - 3.0 m control cable (Keysight part number 04155-61611)
  - 40 cm triaxial cable (Keysight part number 04155-61605)
- Option 003
  - 40 cm control cable (Keysight part number 04155-61608) for connecting selector to selector expander
  - 40 cm triaxial cable (Keysight part number 04155-61605)

Supplemental Information

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

- 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
OFF capacitance	5 pF typical
OPEN capacitance	700 pF typical (at 1 MHz, Vin–Vout = 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 MΩ in parallel load)

Keysight 16445A Selector Adapter Specifications

Keysight 16445A Selector Adapter is the connection box required to transfer the control signal from the B1500A and apply DC power to the Keysight 16440A SMU/Pulse Generator Selector.

- Temperature Range

  Operating +5 °C to +40 °C

  Storage −20 °C to +60 °C

- Humidity

  Operating 20 % to 70 %RH, non-condensing

  Storage 20 % to 90 %RH, at +40 °C, non-condensing

- Power Requirement

  100 to 240 V, 50/60 Hz

- Maximum Volt-Amps (VA)

  20 VA

- Dimensions

  250 mm (W) × 50 mm (H) × 260 mm (D)

- Weight

  1.0 kg

This information is subject to change without notice.
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