

**KEITHLEY**

# 4500-QIVC and 4501-QIVC Quad IV Cards User's Manual

A GREATER MEASURE OF CONFIDENCE

# WARRANTY

Keithley Instruments, Inc. warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment.

Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, rechargeable batteries, diskettes, and documentation.

During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local Keithley representative, or contact Keithley headquarters in Cleveland, Ohio. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

## LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without Keithley's express written consent, or misuse of any product or part. This warranty also does not apply to fuses, software, non-rechargeable batteries, damage from battery leakage, or problems arising from normal wear or failure to follow instructions.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE. THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES.

NEITHER KEITHLEY INSTRUMENTS, INC. NOR ANY OF ITS EMPLOYEES SHALL BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF ITS INSTRUMENTS AND SOFTWARE EVEN IF KEITHLEY INSTRUMENTS, INC., HAS BEEN ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES. SUCH EXCLUDED DAMAGES SHALL INCLUDE, BUT ARE NOT LIMITED TO: COSTS OF REMOVAL AND INSTALLATION, LOSSES SUSTAINED AS THE RESULT OF INJURY TO ANY PERSON, OR DAMAGE TO PROPERTY.



### Keithley Instruments, Inc.

28775 Aurora Road • Cleveland, Ohio 44139 • 440-248-0400 • Fax: 440-248-6168  
1-888-KEITHLEY (534-8453) • [www.keithley.com](http://www.keithley.com)

### Sales Offices:

BELGIUM:	Bergensesteenweg 709 • B-1600 Sint-Pieters-Leeuw • 02-363 00 40 • Fax: 02/363 00 64
CHINA:	Yuan Chen Xin Building, Room 705 • 12 Yumin Road, Dewai, Madian • Beijing 100029 • 8610-8225-1886 • Fax: 8610-8225-1892
FINLAND:	Tietäjantie 2 • 02130 Espoo • Phone: 09-54 75 08 10 • Fax: 09-25 10 51 00
FRANCE:	3, allée des Garays • 91127 Palaiseau Cédex • 01-64 53 20 20 • Fax: 01-60 11 77 26
GERMANY:	Landsberger Strasse 65 • 82110 Germering • 089/84 93 07-40 • Fax: 089/84 93 07-34
GREAT BRITAIN:	Unit 2 Commerce Park, Brunel Road • Theale • Berkshire RG7 4AB • 0118 929 7500 • Fax: 0118 929 7519
INDIA:	1/5 Eagles Street • Langford Town • Bangalore 560 025 • 080 212 8027 • Fax: 080 212 8005
ITALY:	Viale San Gimignano, 38 • 20146 Milano • 02-48 39 16 01 • Fax: 02-48 30 22 74
JAPAN:	New Pier Takeshiba North Tower 13F • 11-1, Kaigan 1-chome • Minato-ku, Tokyo 105-0022 • 81-3-5733-7555 • Fax: 81-3-5733-7556
KOREA:	2FL., URI Building • 2-14 Yangjae-Dong • Seocho-Gu, Seoul 137-888 • 82-2-574-7778 • Fax: 82-2-574-7838
NETHERLANDS:	Postbus 559 • 4200 AN Gorinchem • 0183-635333 • Fax: 0183-630821
SWEDEN:	c/o Regus Business Centre • Frosundaviks Allé 15, 4tr • 169 70 Solna • 08-509 04 600 • Fax: 08-655 26 10
TAIWAN:	13F-3. No. 6, Lane 99 Pu-Ding Road • Hsinchu, Taiwan, R.O.C. • 886-3-572-9077 • Fax: 886-3-572-9031

# 4500-QIVC and 4501-QIVC Quad IV Cards User's Manual

Microsoft® Windows, Microsoft® Excel, and Visual Basic®  
are either registered trademarks or trademarks of  
Microsoft® Corporation in the United States and/or other countries.

©2003, Keithley Instruments, Inc.  
All rights reserved.  
Cleveland, Ohio, U.S.A.  
First Printing, March 2003  
Document Number: 450XQIVC-900-01 Rev. A

# Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

Revision A (Document Number 450XQIVC-900-01) ..... March 2003

# Model 450x-QIVC Series

The 450x-QIVC cards incorporate four independent, isolated measurement channels on a single card.

Each channel consists of a:

- Programmable multi-range current source with programmable voltage clamp, source read-back, and precision voltage measurement.
- Programmable voltage source with source read-back and precision multi-range current measurement.

The 450x-QIVC cards are recommended for use only with the 4500-MTS Product.

## CURRENT SOURCE

Range	Model	Programming Resolution	Programming Accuracy (1 Year) (23°C ±5°C)			Programming Accuracy (24 hr) <sup>1</sup> (23°C ±1°C)			Noise Typical <sup>2</sup> (peak to peak) 0.1Hz – 150kHz
			±(%rdg. + amps	+ amps*	$( V_O/V_{IS}  -  I_O/I_{IS} )^5$	±(%rdg. + amps	+ amps*	$( V_O/V_{IS}  -  I_O/I_{IS} )^5$	
±30.0000mA	4500	2µA	0.08%	7.4µA	4.3µA	0.065%	3.5µA	4.3µA	100µA
±100.000mA	4500/4501	5µA	0.08%	25µA	14.3µA	0.065%	13µA	14.3µA	100µA
±300.000mA	4501	15µA	0.08%	75µA	43µA	0.065%	40µA	43µA	200µA
±500.000mA	4500	25µA	0.08%	122µA	72µA	0.065%	42µA	72µA	250µA
±1.000A	4501	50µA	0.08%	250µA	144µA	0.065%	84µA	144µA	500µA

Range	Model	Default Measurement Resolution	Measurement Accuracy (1 Year) (23°C ±5°C)			Measurement Accuracy (24 hr) <sup>1</sup> (23°C ±1°C)			Typical <sup>2,7</sup> Output Slew Rate mA/µs
			±(%rdg. + amps	+ amps*	$( V_O/V_{IS}  -  I_O/I_{IS} )^5$	±(%rdg. + amps	+ amps*	$( V_O/V_{IS}  -  I_O/I_{IS} )^5$	
±30.0000mA	4500	0.1µA	0.065%	2.5µA	4.3µA	0.065%	1.5µA	4.3µA	.3
±100.000mA	4500/4501	1µA	0.065%	8µA	14.3µA	0.065%	4µA	14.3µA	1
±300.000mA	4501	3µA	0.065%	12µA	43µA	0.065%	9µA	43µA	3
±500.000mA	4500	5µA	0.065%	20µA	72µA	0.065%	10µA	72µA	5
±1.000A	4501	10µA	0.065%	40µA	143µA	0.065%	20µA	143µA	10

**CURRENT OUTPUT SETTLING TIME:** 150µs to 0.1% of final value typical, resistive load after command is processed<sup>3</sup>.

**CURRENT SOURCE SHORTING RELAY:** Shorts load when output is turned off or when interlock condition exists.

**CURRENT SOURCE OVERSHOOT:** < 0.1%, full-scale step, resistive load.

**CURRENT SOURCE LONG TERM STABILITY:** ±20 ppm/hour typical, ±1°C ambient, 30 minute warm-up required.

**OVER TEMPERATURE PROTECTION:** Internally sensed temperature overload puts unit in standby mode.

**LOAD INDUCTANCE:** 200µH maximum<sup>4</sup>.

## CURRENT SOURCE LOAD VOLTAGE MEASUREMENT

Range	Measurement Accuracy (1 Year) (23°C ±5°C) ±(%rdg. + volts)	Measurement Accuracy (24 hr) <sup>1</sup> (23°C ±1°C) ±(%rdg. + volts)	Default Measurement Resolution
±6.0000V	0.06% + 2mV	0.025% + 250µV	10µV

**REMOTE/LOCAL SENSE:** Automatic; remote sense and proper zero are required to meet rated accuracy.

**REMOTE SENSE:** Up to 0.5V drop from card bracket to DUT.

**CURRENT SOURCE VOLTAGE COMPLIANCE:**

Range	Programming Resolution	Programming Accuracy (1 Year) (23°C ±5°C) ±(%rdg. + volts)	Programming Accuracy (24 hr) <sup>1</sup> (23°C ±1°C) ±(%rdg. + volts)
±6.000V	200µV	0.1% + 4.7mV	0.07% + 3.7mV

**MINIMUM COMPLIANCE VOLTAGE:** 100 mV.

## VOLTAGE SOURCE

Full Scale	Programming Resolution	Programming <sup>6</sup> Accuracy (1 Year) (23°C ±5°C) ±(%rdg. + volts)	Programming Accuracy (24 hr) <sup>1</sup> (23°C ±1°C) ±(%rdg. + volts)	Default Measurement Resolution	Measurement Accuracy (1 Year) (23°C ±5°C) ±(%rdg. + volts)	Measurement Accuracy (24 hr) <sup>1</sup> (23°C ±1°C) ±(%rdg. + volts)
±5.000 V	200µV	0.1% + 3mV	0.07% + 2mV	10µV	0.05% + 510µV	0.03% + 260µV

**VOLTAGE OUTPUT SETTLING TIME:** < 150 µs to 0.1% typical, resistive load after command is processed<sup>3</sup>.

**VOLTAGE OUTPUT SLEW RATE:** < 0.01 V/µs typical<sup>2</sup>, resistive load after command is processed.

**VOLTAGE NOISE:** 10 µV RMS, 0.1Hz to 10Hz typical<sup>2</sup>.

**CURRENT LIMIT:** 11 mA to 30 mA<sup>3,8</sup>

**MAXIMUM CAPACITIVE LOAD:** 20nF on 100uA range. 35nF on 1mA and 10mA ranges.

# Model 450x-QIVC Series

## MISCELLANEOUS

**AUTOMATIC OFFSET COMPENSATION:** The user can command the 450x-QIVC to disconnect itself from the device under test and measure and store any offsets in the source and measure circuitry so that future measurements are appropriately compensated.

## VOLTAGE SOURCE CURRENT MEASUREMENT

Range	Measurement Accuracy (1 Year) (23°C ±5°C) ±(%rdg. + current)	Measurement Accuracy (24 hr) <sup>1</sup> (23°C ±1°C) ±(%rdg. + current)	Default Measurement Resolution
±100.000µA	0.1% + 14 nA	0.063% + 11 nA	1nA
±1.00000mA	0.1% + 140 nA	0.063% + 110 nA	10nA
±10.0000mA	0.1% + 1.4 µA	0.063% + 1.1µA	100nA

**VOLTAGE BURDEN:** < 14 mV<sup>3</sup>.

## GENERAL SPECIFICATIONS

### DIGITAL INTERFACE:

#### Safety Interlock:

- Customer provided closed contact on a per-channel basis, to enable output.
- On a channel group basis, opening of customer provided contacts disconnects the sources from loads on the Voltage Sourced and Current Source. 5-volt level, 500Ω input impedance.

**Supplies:** +5V (fused ¼ amp) and Ground.

**OVERRRANGE:** 105% of Range (Source Functions), 110% of Measure (Measure Functions).

**COMMON MODE VOLTAGE:** ±20V DC maximum.

**WARM UP TIME:** 1 hour.

**OVER-TEMPERATURE:** Two on-board over-temperature detectors.

**ENVIRONMENT:** Accuracy specifications are multiplied by one of the following factors, depending upon the ambient temperature and humidity.

TEMPERATURE	% RELATIVE HUMIDITY	
	5-60	60-70
10° - <18° C	X3	X3
18° - 28° C	X1	X3
>28° - 40° C	X3	X5

**WEIGHT (approx.):** 0.9kg (2lbs)

### Notes:

1. The 24 hour specification applies only for the 24 hour period immediately following an Auto-Offset, and ±1°C of the temperature at which the Auto-Offset was performed, and within 1 year of calibration.
2. 95% CI based on measured data on 20 sample units.
3. As guaranteed by design.
4. Includes cable inductance.
5. For example the total uncertainty of a current sourcing 1A on the 1A range into a perfect short of 0V would be:  

$$(0.08\% \times 1A) + (250\mu A) + (144\mu A \times (|0V/6V| - |1A/1A|)) =$$

$$(80\mu A) + (250\mu A) + (144\mu A) =$$

$$474\mu A$$

The generic equation of the third error term: 
$$Amps \times \left( \left| \frac{V_{out}}{V_{FS}} \right| - \left| \frac{I_{out}}{I_{FS}} \right| \right)$$

6. Includes 2 meter accessory cable while excluding IR drop in DUT leads.
7. Slewrates apply for resistive loads: Rload < 200 Ω for 30mA range, Rload < 60 Ω for 100mA range, and Rload < 12 Ω for 500mA range.
8. Hardware limited.

Specifications subject to change without notice

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the manual for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product may be impaired.

The types of product users are:

**Responsible body** is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

**Operators** use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

**Maintenance personnel** perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

**Service personnel** are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are rated Installation Category I and Installation Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Installation Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Installation Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the Manual.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided, in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If  or  is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The  symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

# Table of Contents

---

## 1 Getting Started

Introduction .....	1-2
General information .....	1-2
Features .....	1-2
Intended applications .....	1-3
Supported operating systems .....	1-3
Supported software platforms .....	1-3
Supplied software .....	1-3
Specifications .....	1-3
Warranty information .....	1-3
Contact information .....	1-4
Safety symbols and terms .....	1-4
Unpacking and Inspection .....	1-4
Optional accessories .....	1-4
Card configuration .....	1-5
Card side view .....	1-5
Card edge view .....	1-6

## 2 Installation & Connections

Introduction .....	2-2
Connection precautions .....	2-2
Card installation .....	2-3
Cover removal .....	2-3
Installation procedure .....	2-4
Card removal .....	2-5
Card configuration .....	2-5
Software installation .....	2-5
Connections .....	2-6
Connector terminal designations .....	2-6
Block diagram .....	2-7
DUT connections .....	2-8
Output switching .....	2-9
Laser diode considerations .....	2-10
Interlock .....	2-10
Interlock events .....	2-10
Interlock connections .....	2-11
Interlock connector and cables .....	2-12
Interlock terminal designations .....	2-13
Multiple card interlock connections .....	2-13

## 3 Basic Operation

Introduction .....	3-2
Environmental conditions .....	3-2
Temperature and humidity .....	3-2
Warm-up period .....	3-2
Basic software operation .....	3-2
4500-MTS folder .....	3-2
Enabling the demo mode .....	3-3
Using the demo software .....	3-4
Overview .....	3-4
Running the 4500-MTS demo software .....	3-6
Connecting to an instrument with a QIVC card .....	3-7
Building a new channel group .....	3-8
Removing a channel from a channel group .....	3-9
Configuring a channel .....	3-9
Running a test .....	3-12
Saving test data to a file .....	3-13

## 4 Programming

Introduction .....	4-2
Operation overview .....	4-2
Channel designation description .....	4-2
Channel groups .....	4-3
Sweep and sourcing terminology .....	4-3
Using the driver with various programming environments .....	4-5
References to online help .....	4-5
Basic assumptions .....	4-5
Using specific programming environments .....	4-5
User programming .....	4-6
Key terminology .....	4-6
Driver summary .....	4-7
Driver functions .....	4-7
Applications .....	4-13
Recommended equipment .....	4-13
Connections .....	4-13
Source code .....	4-13
Block diagrams .....	4-14
Telecom laser diode .....	4-15
Vertical cavity surface emitting laser .....	4-15
Tunable laser diode module .....	4-16

# List of Illustrations

---

## 1 Getting Started

Figure 1-1	4500 card side view .....	1-5
Figure 1-2	4500 card edge view .....	1-6

## 2 Installation & Connections

Figure 2-1	Card installation .....	2-4
Figure 2-2	Card block diagram .....	2-7
Figure 2-3	DUT connections .....	2-8
Figure 2-4	Output off switching .....	2-9
Figure 2-5	Output on switching .....	2-10
Figure 2-6	Connections directly to card interlock connector .....	2-11
Figure 2-7	Connections to interlock cable 9-pin connector .....	2-12
Figure 2-8	Multiple card interlock connections .....	2-14

## 3 Basic Operation

Figure 3-1	Typical 4500-MTS folder contents .....	3-3
Figure 3-2	4500-MTS control panel System Settings tab .....	3-3
Figure 3-3	Demo software initial window .....	3-6
Figure 3-4	Typical card configuration window .....	3-7
Figure 3-5	Typical channel group configuration window .....	3-8
Figure 3-6	Typical card properties window .....	3-9
Figure 3-7	Typical data window .....	3-12

## 4 Programming

Figure 4-1	Channel designation example .....	4-2
Figure 4-2	Sweeping .....	4-4
Figure 4-3	Applications block diagram with photodiode detector .....	4-14
Figure 4-4	Applications block diagram with optical spectrum and wavelength analyzers .....	4-15



# List of Tables

---

## **2 Installation & Connections**

Table 2-1	Connector terminal designations (each channel) .....	2-6
Table 2-2	Interlock connector and cable terminal designations .....	2-13

**1**

# Getting Started

---

# Introduction

This user's manual describes operation of the 4500-QIVC and 4501-QIVC Quad IV cards. After reading this document, you should be able to perform the following tasks.

- Open up the mainframe.
- Plug a card into the mainframe.
- Connect the hardware necessary to operate a card with the mainframe.
- Use the Keithley 4500-QIVC and 4501-QIVC (Modular Test System) Demo Software.
- Perform basic programming tasks to control and take measurements with the card using the supplied library of driver calls.

# General information

## Features

The 4500-QIVC and 4501-QIVC cards are intended to provide manufacturers of tunable laser diodes, VCSEL (Vertical Cavity Surface Emitting Laser) arrays, edge emitting lasers, and Erbium Doped Fiber Amplifiers, with a modular, compact, and cost-effective test platform for current and emerging DC and optical production test requirements. The module designs address the need for higher channel density while utilizing innovative functional combinations.

The 4500-QIVC provides three current source ranges: 30mA, 100mA, and 0.5A, at up to 6V compliance. The 4501-QIVC is a higher current unit also providing three source current ranges at 100mA, 300mA, and 1A without compromising instrument specifications or functionality. Together these cards provide coverage for a wide variety of source/measure applications.

The following list summarizes the major features of 4500-QIVC and 4501-QIVC:

- **Channel Density** — The channel density provided by the 4500-QIVC and 4501-QIVC allows for testing of VCSEL arrays, tunable lasers, etc. Channel density allows you to test four tunable laser diodes (each a quad section device) using either four or eight slots. This channel density applies to no more than one mainframe.
- **Source/Measure Combinations** — The 4500-QIVC and 4501-QIVC provide for all requirements of LIV (Light Current Voltage) testing for applicable component segments.
- **Integrated Test System** — The internal PC and Windows<sup>®</sup> 2000 Operating System of the 4500 system allows users to eliminate the test system controller from new test stands. With ethernet interface capability, the 4500 can interface directly with facility databases for transfer of test data.
- **Feed Forward Capability** — Tunable laser diodes require manufacturers to bias sections of the diode during an LIV test sweep. Bias values for the various sections are based on calculations performed on the LIV sweep data from the previous section. Therefore, the ability to feed forward data from one test to the next during execution of the test sweep is critical. This feed forward ability is provided for by the software of the 4500-QIVC and 4501-QIVC.
- **User Safety** — The 4500-QIVC and 4501-QIVC provide for user safety (electrical and optical) for the target component types. Voltage source capability will not exceed 48V on any circuit. The system also provides for software and hardware abort capability upon interlock activation (rapid return to zero for the laser diode drive circuit) for operator eye safety.
- **Compatibility with External Optical Head** — The 4500-QIVC and 4501-QIVC are fully compatible with the 2500INT family of optical heads so users can obtain fiber-coupled light intensity measurements.

- **High Test Throughput and Accuracy** — The 4500-QIVC and 4501-QIVC provide fast and accurate measurements.
- **User Interface** — The 4500 comes with standard drivers for the LabView, LabWindows/CVI, Visual C/C++, and Visual Basic® programming environments. The software allows users to load their own proprietary algorithms for kink and threshold current calculations. This is also critical for a programmable feed forward capability. In addition, application demo programs in LabView, LabWindows/CVI, and Visual Basic® are provided to supplement the development of test programs.

## Intended applications

The 4500-QIVC and 4501-QIVC cards are designed to test laser diode modules for a fiberoptic network. The object of this testing is to measure in parallel the current proportional to the amount of light.

## Supported operating systems

The 450x-QIVC driver software is compatible with the following operating systems:

- Windows® 98
- Windows® NT 4
- Windows® 2000 Workstation

## Supported software platforms

The 450x-QIVC drivers are compatible with the following test software platforms:

- MS Visual BASIC Version 5 and 6
- MS Visual C/C++ (32 bit)
- NI LabView Version 5.1, 6i, and 6.1
- NI LabWindows/CVI Version 5.5 and 6.0

## Supplied software

The following software is supplied with the 450x-QIVC cards:

- Win32 DLL driver for the card that supports the above software platforms.
- Visual BASIC demo program that demonstrates basic card capabilities.
- Example application programs.

## Specifications

Detailed specifications are located at the front of this manual. For the latest specifications, check [www.keithley.com](http://www.keithley.com).

## Warranty information

Warranty information is located at the front of this manual. Should your Model 4500-QIVC or 4501-QIVC require warranty service, contact the Keithley representative or authorized repair facility in your area for further information. When returning the instrument for repair, be sure to fill out and include the service form at the back of this manual to provide the repair facility with the necessary information.

## Contact information

Worldwide phone numbers are listed at the front of this manual. If you have any questions, please contact your local Keithley representative or call one of our Application Engineers at 1-800-348-3735 (U.S. and Canada only).

## Safety symbols and terms

The following symbols and terms may be found on the instrument or used in this manual:

If  or  is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The  symbol on an instrument shows that high voltage may be present on the terminal(s). Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading used in this manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading used in this manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

## Unpacking and Inspection

### Inspection for damage

The Model 450x-QIVC card was carefully inspected electrically and mechanically before shipment. After unpacking all items from the shipping carton, check for any obvious signs of physical damage that may have occurred during transit. Report any damage to the shipping agent immediately. Save the original packing carton for possible future shipment.

### Package content

The following items are included with every Model 4500 card order:

- Model 4500-QIVC or 4501-QIVC card
- Signal connecting cable (2m) with connectors (part number 4500-CQIV-2)
- Interlock cable (2m) with connectors (part number 4500-CILK-2)
- Software disk
- Product Information CD-ROM that contains PDFs of the 4500-MTS Mainframe and Card Manuals
- Model 4500-MTS Quick Start Guide
- Additional accessories as ordered

## Optional accessories

For more information on optional accessories, refer to [www.keithley.com](http://www.keithley.com).

The following cables are available:

- **4500-CQIV-\*** — This cable has a 40-pin connector that mates with the 450x-QIVC card signal connector on one end and a 15-pin D-Sub connector for each of the four channels on the other end.

**NOTE** *This cable is available in 0.5, 1, 2, and 3 meters. 0.5 to 2 meter lengths are recommended for use with the 4501-QIVC. 3 meter length is recommended for use with the 4500-QIVC.*

- **4500-CILK-\*** — This cable has a 14-pin male connector that mates with the 450x-QIVC card interlock on one end and a 9-pin D-Sub female connector at the other end.

**NOTE** This cable is available in 0.5, 1, 2, and 3 meters.

- **4500-ILK-KIT-1** — This kit contains a mating connector and housing for wiring. The connector mates to the 450x-QIVC card interlock connector.
- **4500-CIV-KIT-1** — This kit contains a mating connector for wiring. This kit is for use with the 4500-CQIV-\*.

## Card configuration

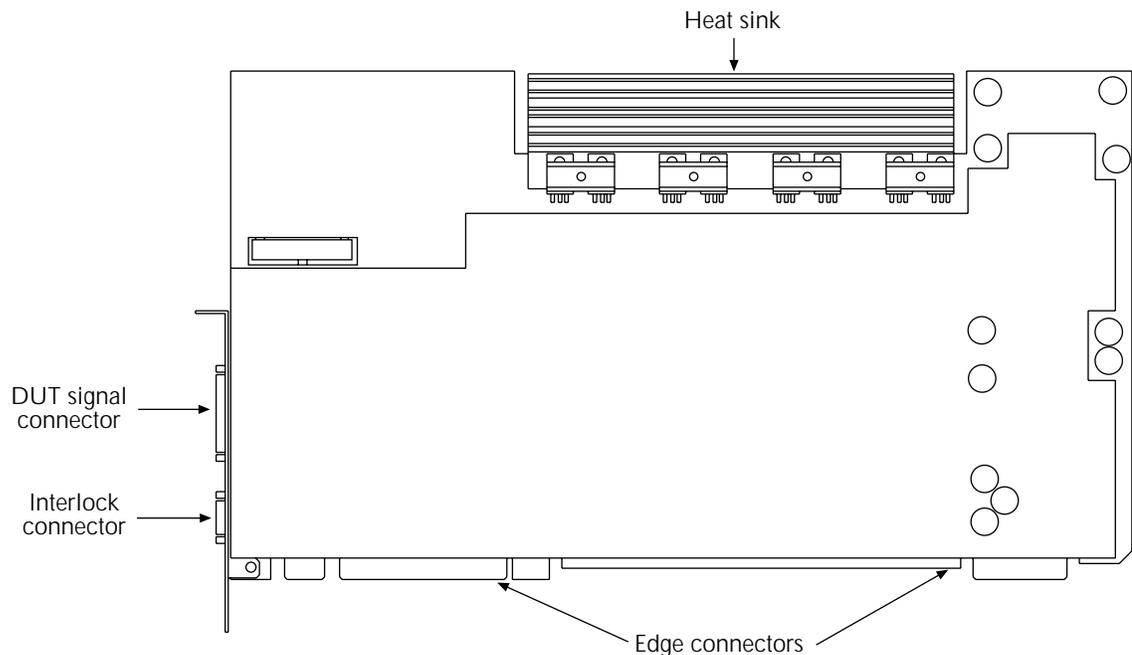
### Card side view

Figure 1-1 shows the card side view. Key components include:

- **DUT signal connector** — provides connections to the DUTs using the supplied connecting cable (see “Connections,” page 2-6).
- **Interlock connector** — connects to a test fixture interlock (see “Interlock,” page 2-10).
- **Edge connectors** — connects the card to the PCI bus, analog power bus, and trigger bus of the mainframe (see Section 2 of the 4500-MTS Mainframe User's Manual).
- **Heat sink** — cools power output stages of card.

**CAUTION** The heat sink may be hot after extended operation at higher power levels. Do not touch the heat sink or adjacent power components until the card has cooled sufficiently.

Figure 1-1  
4500 card side view

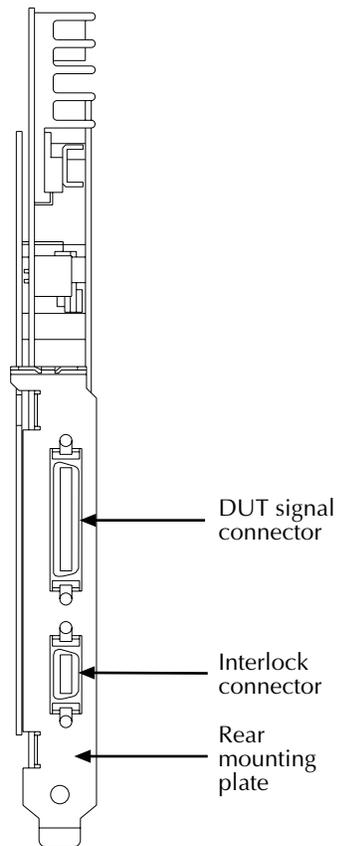


## Card edge view

Figure 1-2 shows the edge view of the card. Key components include:

- **DUT connector** — provides signal connections for all four channels to the DUTs using the supplied connecting cable (see Section 2).
- **Interlock connector** — provides connections to a test fixture interlock for safety purposes (see Section 2).
- **Rear mounting plate** — secures card to rear panel of mainframe (see Section 2).

Figure 1-2  
**4500 card edge view**



# 2

## Installation & Connections

---

# Introduction

This section includes information on card installation, software installation, and connecting DUTs (Device Under Test) to the card.

## Connection precautions

**WARNING** While the 4500-QIVC and 4501-QIVC cards do not incorporate a laser, they are designed to operate (power) laser diode devices. Read all safety precautions listed at the beginning of this manual. The following safety practices must be used to protect operators and other users of this product from potential exposure to laser radiation:

- Operators must be protected from radiation and electrical hazards at all times.
- The installer must comply with all applicable laws and regulations on laser safety. This requirement includes warning signs and operator training.
- The interlock is required for safe operation. The test fixtures must ensure that the interlock circuit is disabled (source outputs inhibited) so that an operator is not exposed to any radiation. The test fixture interlock must not be defeated. See [“Interlock,” page 2-10](#) for interlock information.
- When servicing the test system, any required personnel protection equipment (e.g. laser safety goggles) must be provided by the customer's responsible body.
- The customer's laser safety officer (LSO) must review and approve all installations before being put into operation. Any safety concerns must be immediately reported to the customer's LSO.
- Maximum isolation from earth ground is  $\pm 20V$ . Exceeding this value may result in a shock hazard.
- When making connections, do not leave any exposed connections. Be sure that all external circuits are properly insulated.

## Card installation

**WARNING** The following information is intended only for qualified service personnel. Do not attempt these procedures unless you are qualified to do so. Some of these procedures may subject you to electric shock, possibly causing personal injury or death.

**NOTE** *The 4500-MTS mainframe is shipped from the factory with ordered measurement cards already installed. The following procedure is intended for those who wish to install additional cards in the field.*

### Cover removal

**WARNING** Disconnect the line cord and all other cables from the mainframe before removing the cover.

To remove the case cover:

1. Remove the screws that secure the cover to the case.
2. Carefully remove the cover from the case by sliding it off the top of the chassis.
3. Remove screws that secure the flat top chassis plate underneath, then remove the plate to gain access to components.

**WARNING** The safety shield that covers the fan and front area should not be removed for card installation/removal or cover removal, and it should be removed only for servicing. Hazardous voltages will be exposed when the shield is removed. Rotating fan blades can cause minor cuts or injury. Keep hands clear when servicing.

4. To re-install, install the top cover plate with the screws, place the cover on the case, then attach it with screws that were removed earlier.

## Installation procedure

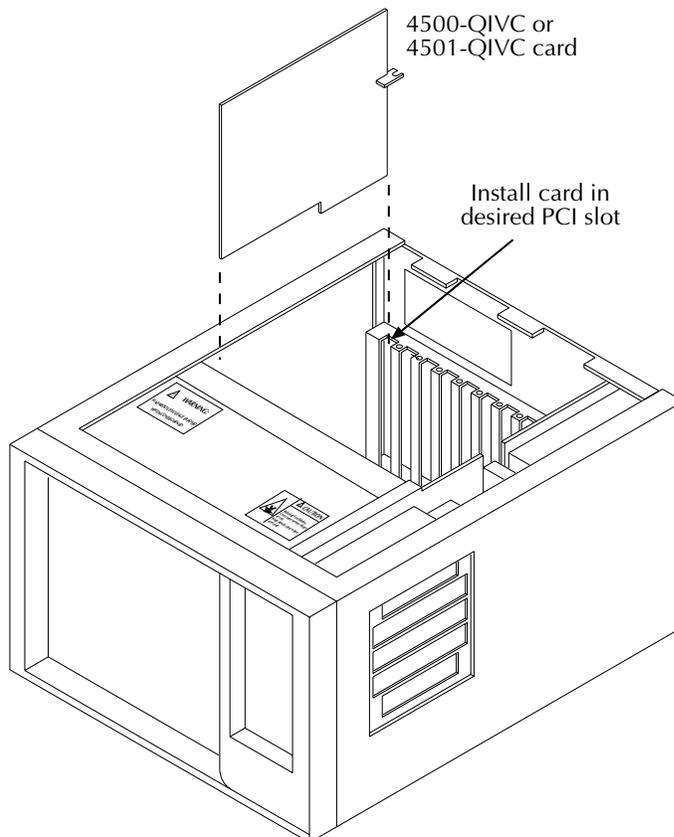
Install a 4500-QIVC or 4501-QIVC card using the procedure below and [Figure 2-1](#) as a guide. This procedure assumes that the case cover is already removed as discussed above.

**CAUTION** Handle the card only by the edges to avoid contamination that could affect measurement quality. Do not touch PC board traces or edge connector contacts. Use a ground strap and proper grounding techniques to avoid damage caused by static discharge.

**NOTE** A maximum of eight 4501-QIVC cards should be installed in a 4500-MTS mainframe. Operation with nine 4501-QIVC cards is not recommended.

1. Remove the cover plate for the slot in which you intend to install the card from the rear panel.
2. Remove the PCI card retainer.
3. Carefully remove the card from its antistatic (shipping) bag.
4. Line up the edge connectors with the slot connectors on the backplane, and then carefully insert the card into those connectors. Make sure the card is properly seated in all connectors by applying firm, even pressure to the top edge of the card.
5. Install the screw at the rear panel location to secure the card.
6. Re-install the PCI card retainer.
7. Replace the mainframe top plate and cover.

*Figure 2-1*  
**Card installation**



## Card removal

To remove a card, first disconnect any cables connected to the card, remove the rear plate screw, and then remove the card from the slot.

## Card configuration

The operating system software will automatically recognize and configure the card the next time the mainframe power is turned on. Card operation is covered in [Section 3](#).

# Software installation

*NOTE*      *The software will be already installed on the 4500-MTS hard drive. The procedure below should be used to re-install or upgrade software.*

1. Install CD. **Setup.exe** should run automatically. Accept all of the installation defaults.
2. Reboot the 4500-MTS and login.
3. Exit (close) the 4500-MTS Real-Time Manager.
4. Upgrade the QIVC firmware through the Control Panel applet labeled 4500-MTS.
5. In **Start->Settings->Control Panel**, double-click the **4500-MTS** icon, and select the **Flash Upgrade** tab. After pressing the **Start Flash Upgrade** button, navigate to the **C:\Program Files\Keithley Instruments\4500-MTS\bin\QIVC Flash Upgrade** folder and select the file named **45856Sv...fx** for the 4500-QIVC, or **45857Sv...fx** for the 4501-QIVC. Select **Open**. After a few seconds, the applet should signal completion with a series of three beeps and a status message.
6. Upgrade the Digital FPGA image. Repeat step 5 using the \*.dx file type selector and the file named **45859Sv...dx** in the same directory.
7. Upgrade the Analog FPGA image. Repeat step 5 using the \*.ax file type selector and the file named **45860Sv...ax** in the same directory.
8. Start the 4500-MTS Real-Time Manager located in the **4500-MTS** folder.
9. Run the **VB Demo App** program, located in the **4500-MTS** folder.
10. Click **Connect**, and confirm the digital FPGA, analog FPGA, and firmware were successfully programmed. Version information is displayed in the **Card Identification** field. Repeat steps 4 through 7 if incorrect.

# Connections

**WARNING** The following information is intended only for qualified service personnel. Do not attempt these procedures unless you are qualified to do so. Some of these procedures may subject you to electric shock, possibly causing personal injury or death.

## Connector terminal designations

The supplied 4500-CQIV-2 signal connecting cable is designed to mate with the rear panel signal connector on the card. The cable branches out to four connectors on the other end, one for each of the four identical channels, labeled A through D. [Table 2-1](#) lists card connector terminal designations for each of the four channels.

Table 2-1

### Connector terminal designations (each channel)

Signal	Connector pin(s)
I-SOURCE HI <sup>1</sup>	3 and 11
V-MEASURE HI <sup>1</sup>	4
V-MEASURE LO <sup>1</sup>	12
I-SOURCE LO <sup>1</sup>	5 and 13
V-BIAS HI <sup>2</sup>	1
GUARD <sup>2</sup>	2
V-BIAS SENSE LO <sup>2</sup>	10
V-BIAS LO <sup>2</sup>	9

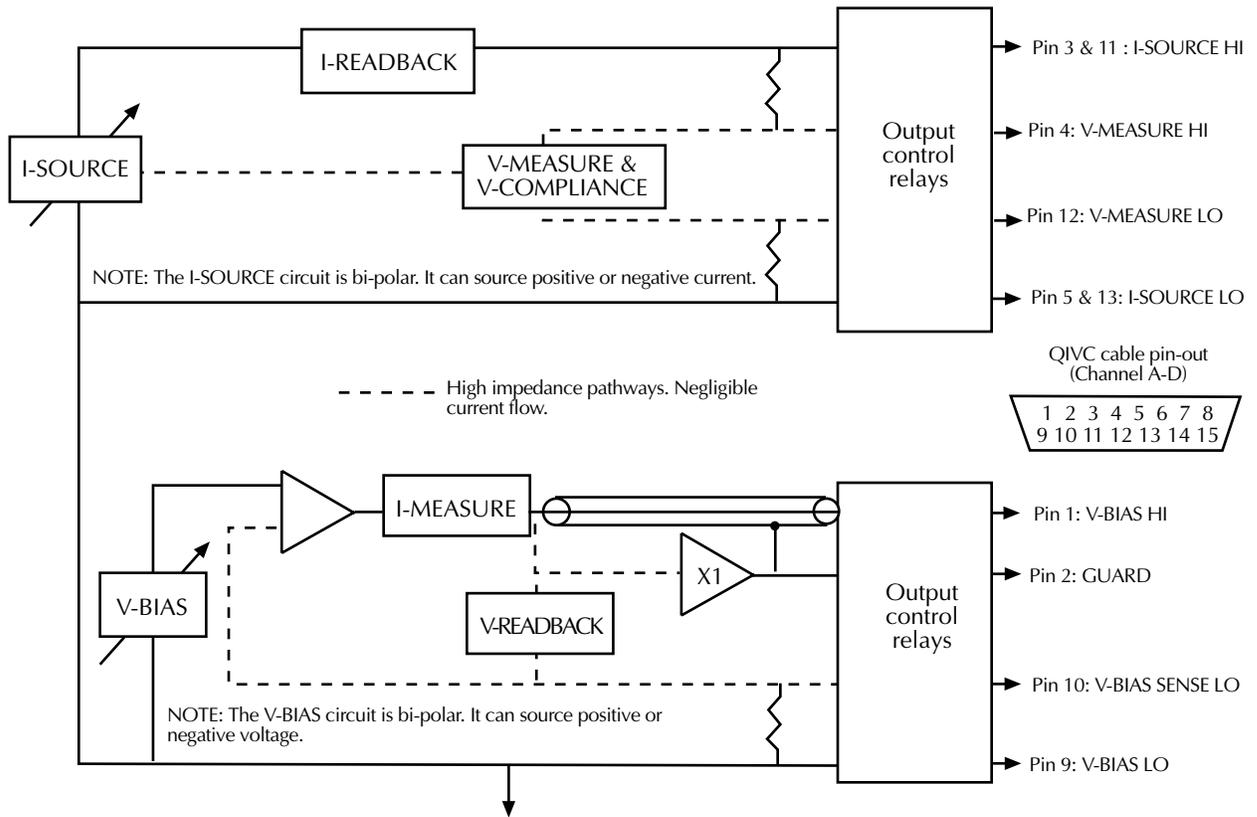
1. Laser diode connections
2. Photodiode connections

## Block diagram

Figure 2-2 shows a block diagram of the 450x-QIVC cards. Only one channel is shown; each of the four channels is identical.

Each of the four channels includes a current source, which is intended to excite and measure laser diode parameters, and a voltage source, which biases the photodiode and measures its current. The current source sections includes circuitry for current readback, voltage measurement, and compliance, while the voltage bias source section has current measurement and voltage readback circuits. Both sections include output relays that control connections to the DUTs.

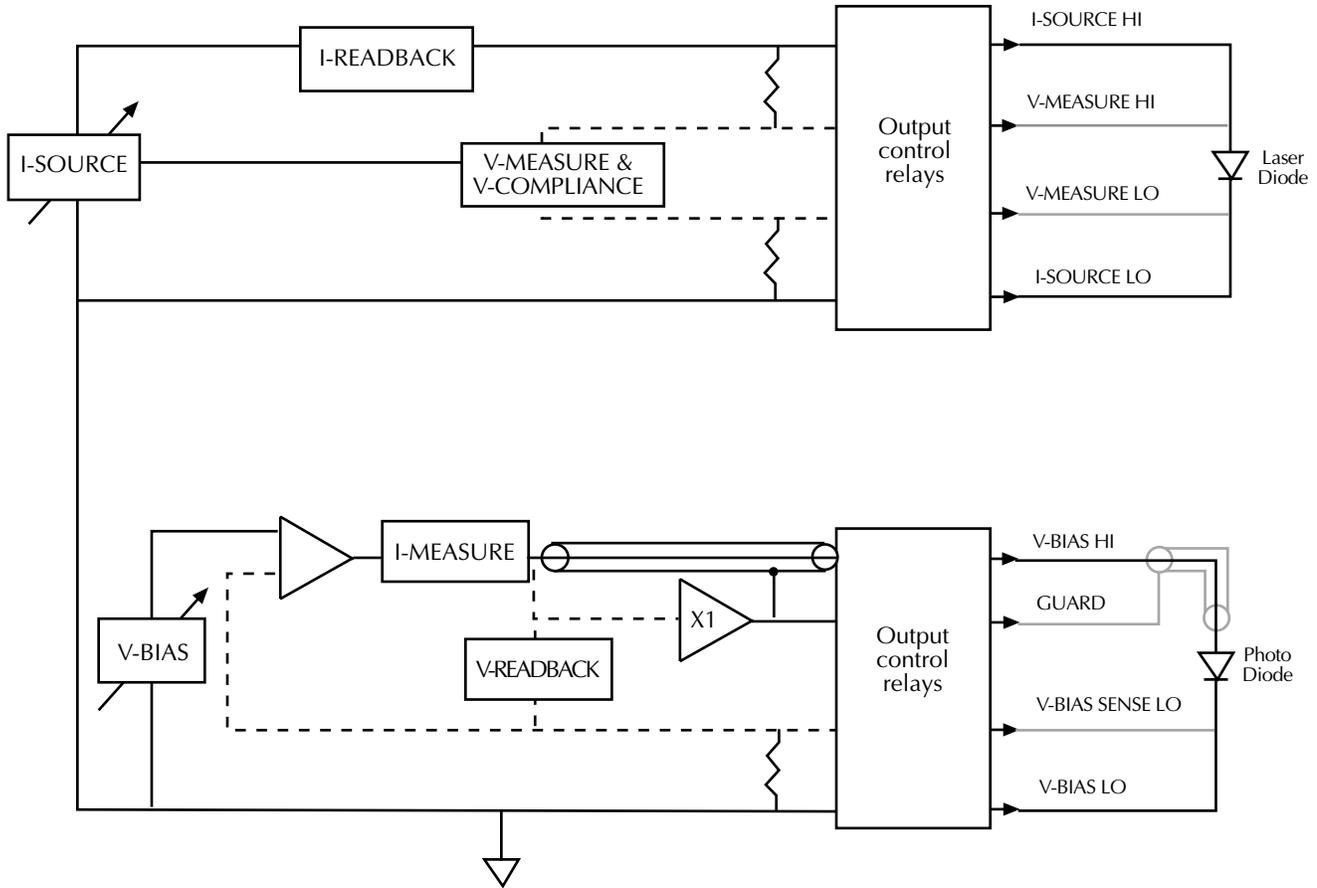
Figure 2-2  
Card block diagram



### DUT connections

Figure 2-3 shows DUT connections. I-SOURCE HI and V-MEASURE HI are connected to the laser diode anode, while I-SOURCE LO and V-MEASURE LO are connected to the laser diode cathode. V-BIAS HI is connected to the photodiode anode, while V-BIAS LO and V-BIAS SENSE LOW are connected to the photodiode cathode. GUARD is connected to the shield of the cable connected to V-BIAS HI to shield the sensitive signal path against interference.

Figure 2-3  
DUT connections



## Output switching

A comparison of output switching during output off and output on switching states is shown in Figure 2-4 and Figure 2-5, respectively. When the outputs are turned off (Figure 2-4), the I-SOURCE is disconnected from the laser diode, and the laser diode terminals are shorted together. The photodiode terminals are also shorted together by internally connecting V-BIAS HI and V-BIAS LO. When the outputs are turned on (Figure 2-5), the internal terminal shorts are opened, and the I-SOURCE terminals are connected to the laser diode.

Figure 2-4  
**Output off switching**

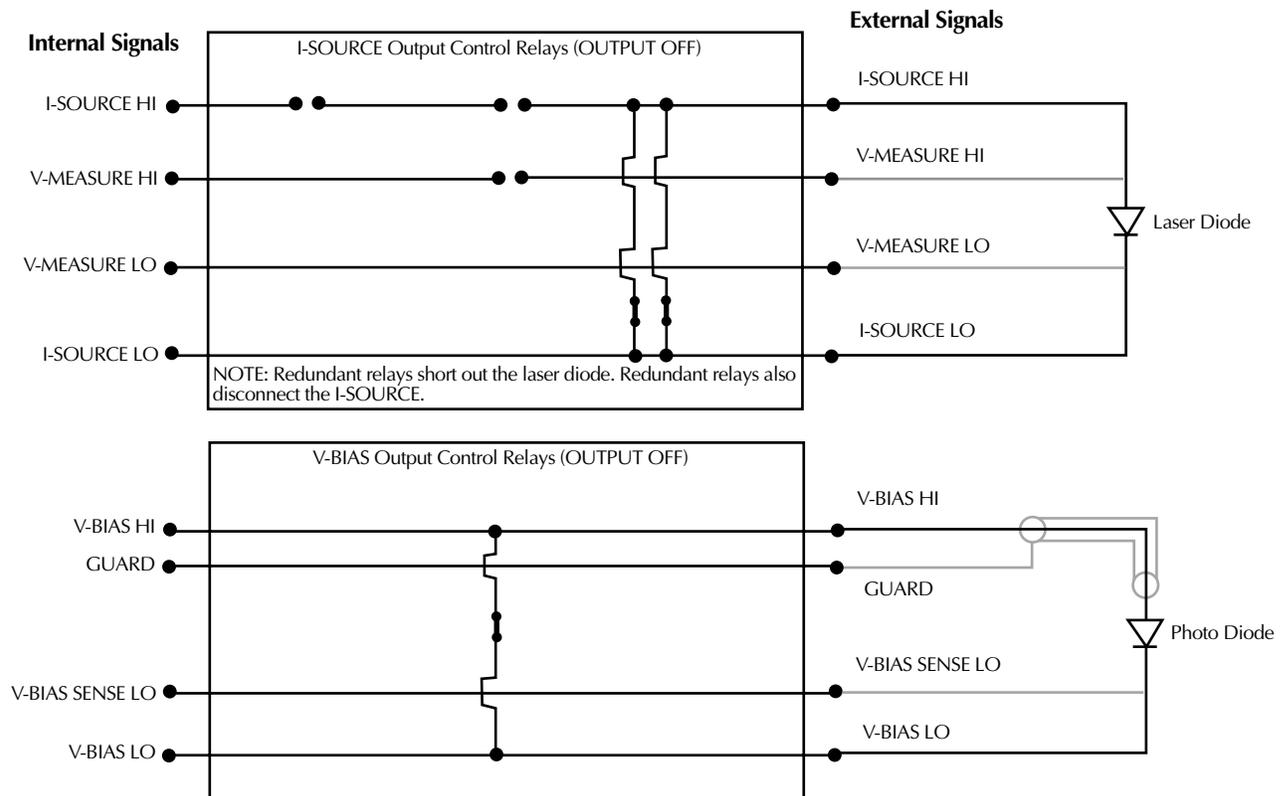
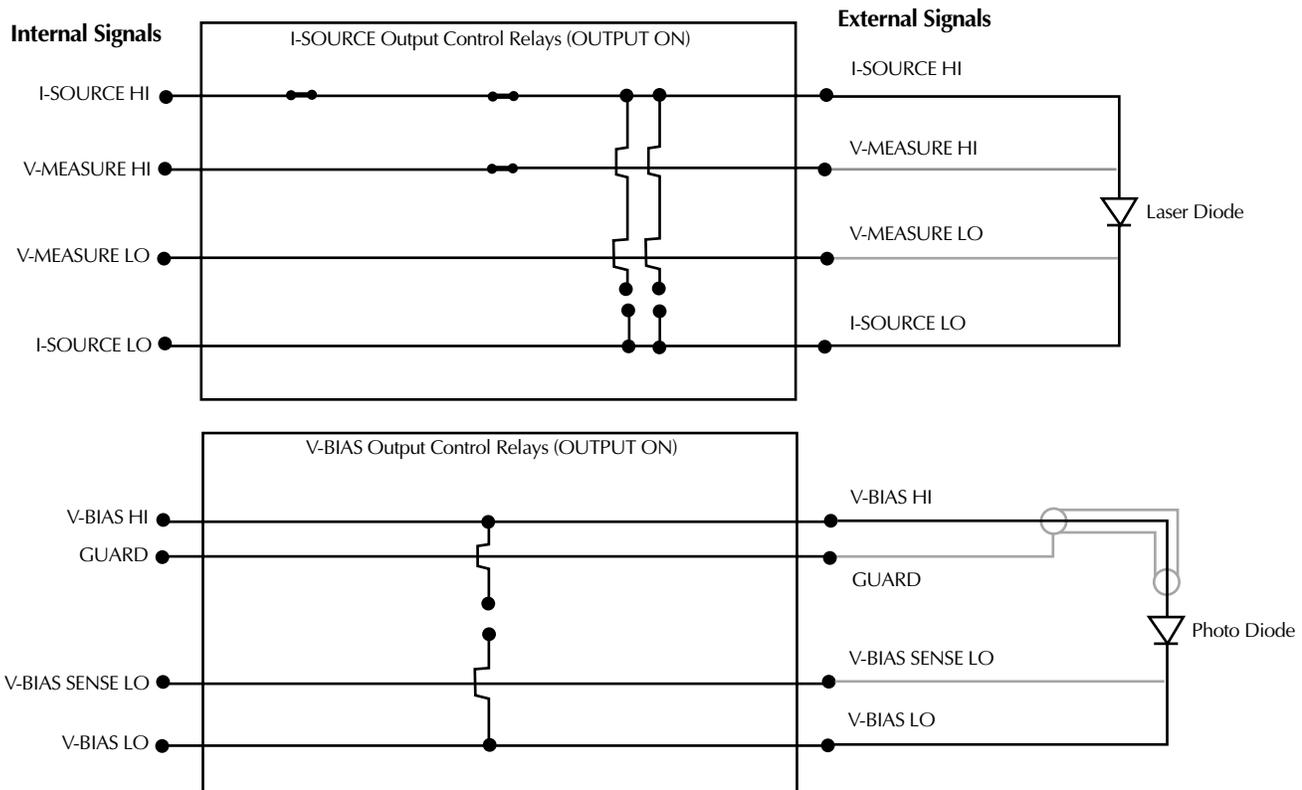


Figure 2-5  
Output on switching



## Laser diode considerations

Laser diodes are very sensitive and generally tolerate very little reverse current. The product specifications show that there is a small ambiguity of the current source at zero current, which is shown as the offset specification. If this current has an objectionable magnitude for your laser diode application, you should adjust the source value positive by this offset when the desired output current is zero (but guaranteed to be positive).

## Interlock

Each card is equipped with an interlock connector that can be used to inhibit the source outputs of each individual channel when an external switch is open.

**WARNING** The interlock should always be used to protect operators and other users from potential exposure to laser radiation and other safety hazards.

## Interlock events

When an interlock event occurs:

1. The hardware relay closes the output relays immediately for that channel's interlock line.
2. An interrupt is generated, and the test sequence is halted for the channel group containing that channel, passing the event to the Real-Time Manager.
3. The test cannot be resumed. The test must be re-initiated after the interlock is recovered.

## Interlock connections

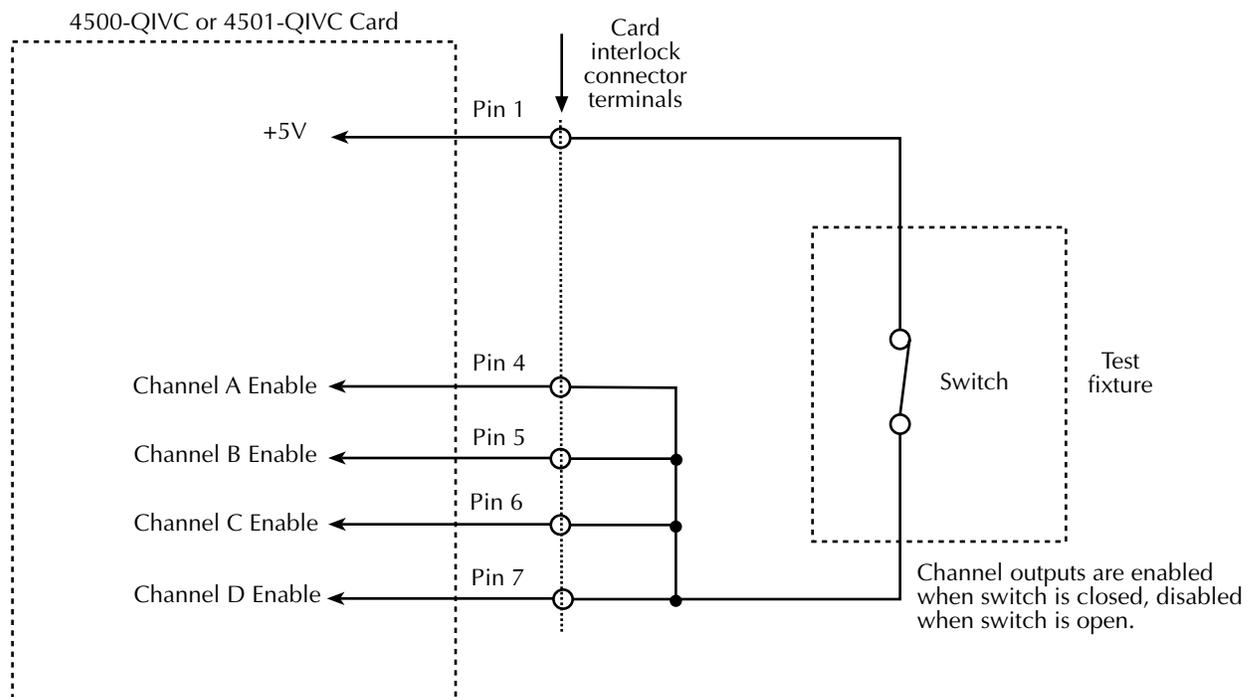
Figure 2-6 shows typical connections directly from the 450x-QIVC card interlock connector to an interlock switch in a test fixture. In this instance, a single interlock switch is connected to the enable lines of all four channels. Other applications that require the output of each channel to be individually controlled will require a separate switch for each channel. In either case, outputs will be enabled (turned on) when the switch is closed. When the switch is open, output(s) will be turned off and cannot be turned on. See Figures 2-4 and 2-5 for output off and output on states.

**CAUTION** Under no circumstances should the interlock lines be intentionally shorted to chassis ground. Improper operation will result.

The interlock is not designed to protect the DUT during an interlock event. In the interest of protecting the operator, the output relays of the interlock circuit close immediately and before the output is driven to a low voltage potential. As a result, the DUT will see the energy in the DUT cable. This energy may display as a significant negative (opposite polarity of the source current) voltage at the DUT. Activating the interlock may damage the DUT.

**NOTE** The +5V line on the interlock connector (pin 1) is internally protected with a 0.75A fuse. Inadvertently shorting this line to chassis ground will trip the fuse, disabling the interlock control circuits, and outputs cannot be turned on. The fuse will automatically reset a few minutes after the overload condition is removed.

Figure 2-6  
Connections directly to card interlock connector

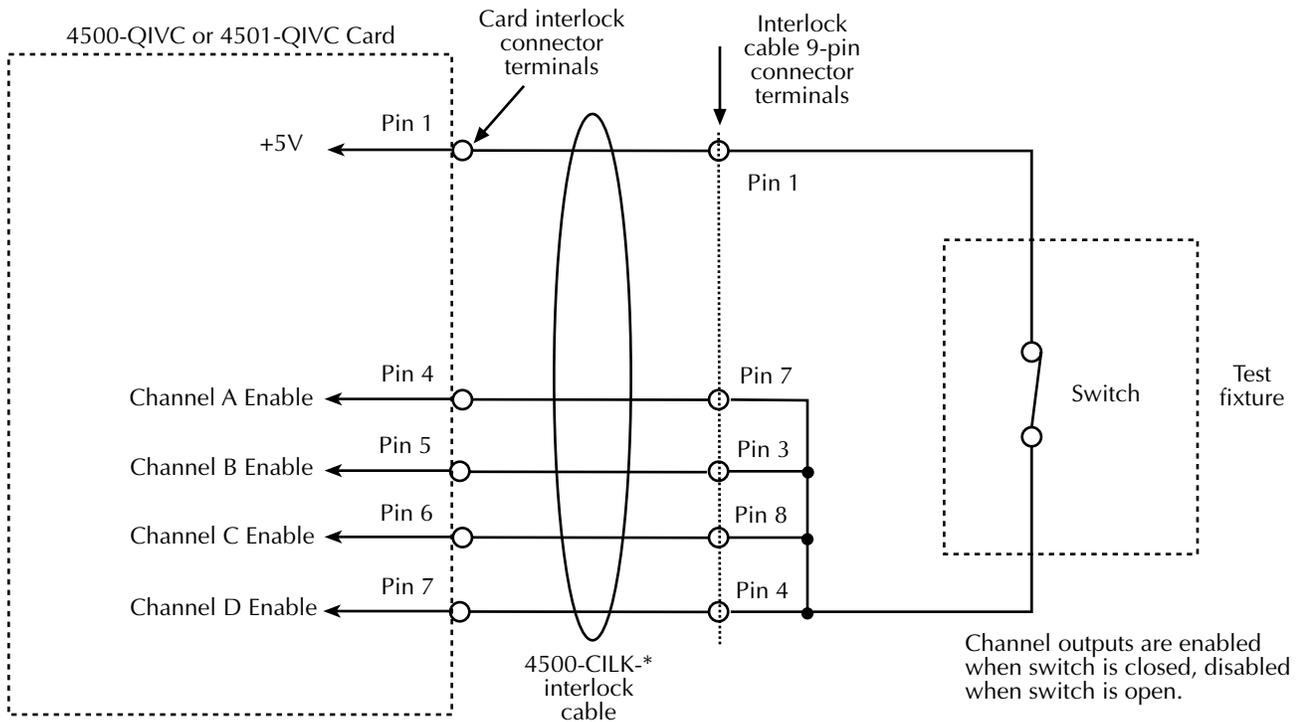


## Interlock connector and cables

To facilitate interlock connections, the following connector and cable kit are available:

- **Mating connector for rear panel interlock connector** — Keithley model number 4500-ILK-KIT-1
- **Interlock cable kit** — Keithley model # 4500-CILK-\*, where \* relates to available cable lengths (0.5, 1, 2, 3 meters). See [Figure 2-7](#) for connections to the 9-pin connector on the end of this cable.

Figure 2-7  
Connections to interlock cable 9-pin connector



## Interlock terminal designations

Table 2-2 summarizes terminal designations for the 14-pin interlock connector on the 450x-QIVC and the 9-pin connector on the interlock cable.

Table 2-2

### **Interlock connector and cable terminal designations**

14-pin interlock connector	9-pin cable connector	Signal description
1	1	+5VD (+5V digital supply)
2	6	DIAG – RX (not implemented)
3	2	DIAG – TX (not implemented)
4	7	Interlock Channel A Enable
5	3	Interlock Channel B Enable
6	8	Interlock Channel C Enable
7	4	Interlock Channel D Enable
8	9	D – GND (digital ground)
9 – 14	N.C.	—

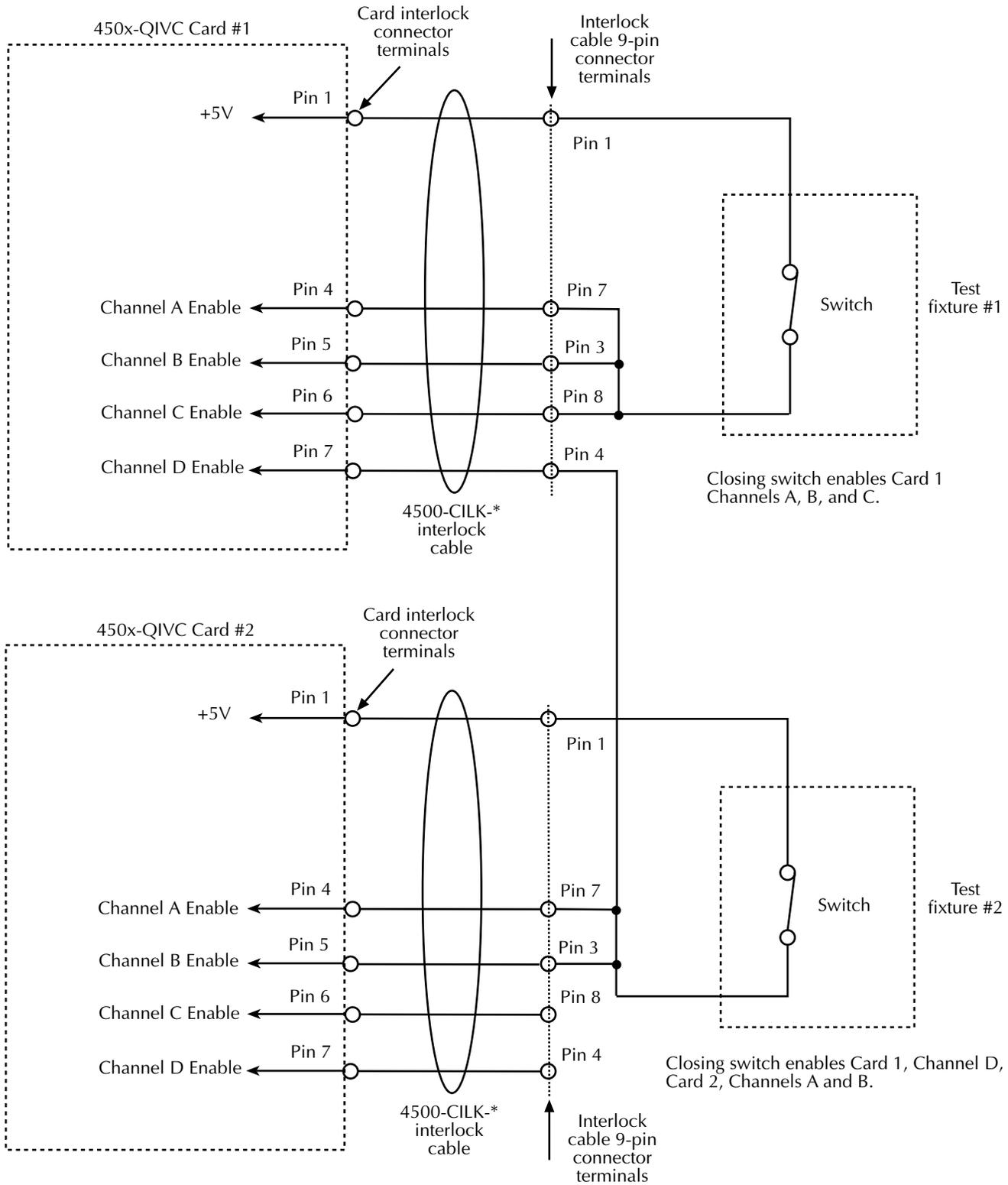
## Multiple card interlock connections

When channel groups span cards, interlocks may be tied together across cards. For more than four channels, use a separate +5V fused line (pin 1) for every four channel interlock enable lines.

An example of multiple card interlock connections is shown in [Figure 2-8](#). This example has two channel groups:

- **Group 1**— Card 1 Channel A, Card 1 Channel B, Card 1 Channel C
- **Group 2** — Card 1 Channel D, Card 2 Channel A, Card 2 Channel B.

Figure 2-8  
Multiple card interlock connections



# 3

## Basic Operation

---

# Introduction

This section contains basic information for using the 4500-QIVC and 4501-QIVC Quad IV cards, including environmental conditions, basic software operation, and using the demo program.

## Environmental conditions

### Temperature and humidity

For optimum accuracy, the 4500-QIVC and 4501-QIVC cards should be operated at an ambient temperature of 18° to 28°C at a relative humidity of 5% to 60%. For operating environments outside these ranges, accuracy specifications must be derated (see specifications).

### Warm-up period

For optimum accuracy, turn the system on and allow a one-hour warm-up period before use.

## Basic software operation

### 4500-MTS folder

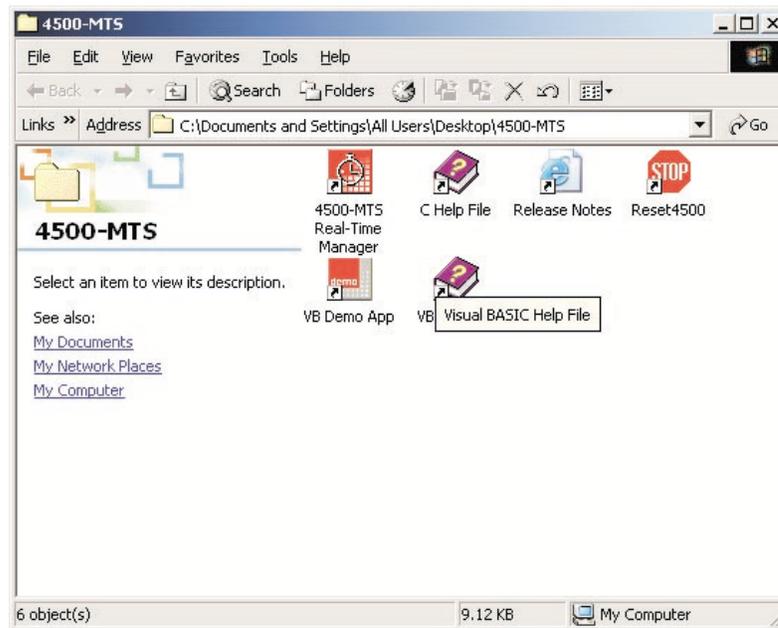
Figure 3-1 shows the typical contents of the 4500-MTS folder located on the main desktop.

*NOTE* Actual 4500-MTS folder contents may vary, depending on installed cards and software version.

Briefly, contents include:

- **Release notes** — Includes information on this particular version of 4500-MTS software.
- **Help files** — contains detailed information for using card driver function calls for the software platforms supported by the 4500-MTS.
- **4500 Real-Time Manager** — the user interface to the 4500 kernel, which runs in the background. The real-time manager is responsible for starting the kernel when the system boots and the user logs in.
- **Reset 4500** — resets the mainframe to default conditions.
- **VB demo app** — a Visual Basic® application that demonstrates basic card capabilities.

Figure 3-1  
Typical 4500-MTS folder contents

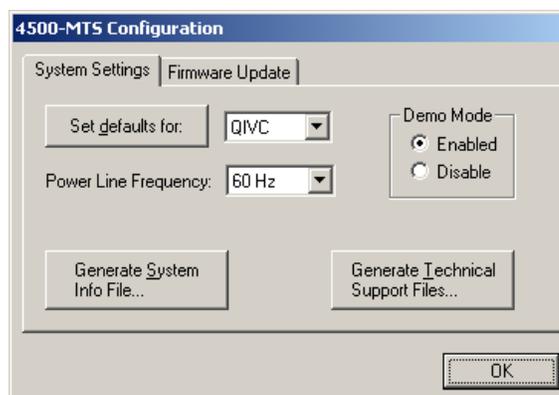


## Enabling the demo mode

There are two basic operating modes for the 4500-MTS system: demo mode and card access mode. Demo mode lets you run programs in an emulation mode for testing without 4500 cards in your system. The card access mode (demo mode disabled) lets programs actually control 4500 cards in the system.

To select the operating mode, double-click on the **4500-MTS** icon in the Windows Control Panel, click on the **System Settings** tab, and then **Enable** or **Disable** the demo mode as desired. Click **OK** to complete your selection. Figure 3-2 shows the control panel **System Settings** tab; refer to the 4500-MTS Mainframe User's Manual for other mainframe settings.

Figure 3-2  
4500-MTS control panel System Settings tab



# Using the demo software

## Overview

### Demo software capabilities

The supplied Visual BASIC demo software lets you demonstrate basic 4500-QIVC and 4501-QIVC capabilities. If the demo mode is enabled, you can run the demo software in emulation mode without any cards in the system. If the demo mode is disabled, you can use the demo software to control the card, set source values, and make measurements. You can enable or disable the demo mode in the **4500-MTS** icon located in the Windows Control Panel.

### Multiple channel groups

A single instance of the 4500 Demo Application can be used to configure different channel groups. However, it can only run one channel group at a time. Multiple channel groups can only be run sequentially after the previous test has stopped. If you would like to run a simultaneous test on another channel group, configure a second instance of the demo application.

### Memory limitations

There are limits to heap memory for each channel and card. Each QIVC card has a total heap space of approximately 8.19MB. The QIVC card uses this heap allocation dynamically for greater flexibility. Each channel requests memory based on the buffer needs of the configured sweep.

For example, consider a single QIVC card in which each channel can make a total of four measurements per point (maximum). If all channels are set to take all possible measurements per point, the total measure usage will be:

$$8 \text{ bytes/point} \times 4 \text{ measurements} \times 4 \text{ channels} = 128 \text{ bytes/point.}$$

If the current source is set to sweep, it will use an additional eight bytes/point for a total of 136 bytes/point. The largest sweep possible in this case would be:

$$8,190,000 \text{ bytes heap} / 136 \text{ bytes/point} = 60,220 \text{ points.}$$

60,220 is the total number of points including all order multipliers (higher order counts multiplied by lower order points).

The four measurements that can be selected per channel per point:

- Vsrc I (PD I)
- Isrc V (LD V)
- Vsrc V (PD V readback)
- Isrc I (LD I readback)

### Example #1

Assume there are two channels in the channel group, each channel is set up to take two measurements per point and set up for a current source sweep results in a total of 40 bytes/point.

The largest sweep possible in this case = 204,750 points.

If a sweep test is set up with the following number of points:

2nd = 20, 1st = 100 equals a total of 2,000 points, which is well within limits.

### Example #2

Assume a channel group of six channels, all making the maximum of four measurements per point:

Total usage = 8 bytes/point  $\times$  4 measurements (max)  $\times$  6 channels = 192 bytes/point

The largest sweep possible in this case would be:

8,190,000 bytes heap / 192 bytes/point = 42,656 points.

So the sweep test is shown having an order with a channel taking a certain number of points:

6th = 2, 5th = 2, 4th = 2, 3rd = 8, 2nd = 10, 1st = 30 equals a total of 19,200 points, which is within limits.

However, if the number of points in a few sweep orders increase:

6th = 2, 5th = 2, 4th = 5, 3rd = 10, 2nd = 10, 1st = 30 equals a total of 60,000 points, which exceeds memory limitations.

## Demo software configuration

As shown in [Figure 3-3](#), the Demo Software contains a tree control on the left side of the screen with a **4500-MTS** icon in the upper left corner. To the right of the tree control is a tab control.

When you make a connection to an instrument by clicking **Connect**, the fields on the right side of the tree are populated to show what cards are present in the system. By clicking on one of the channel groups in the tree and clicking on the **Configuration** tab on the right side, you can see which channels are available ([Figure 3-4](#)). By selecting one of the unused channels and clicking on **Add to Group**, you can build a new channel group.

When you click **Apply**, the tree shows the new channel group and the channels in the group ([Figure 3-5](#)). You can configure channels by selecting them in the tree. The tab control will show an appropriate dialog to configure the type of channel you select. [Figure 3-6](#) shows a typical card properties window.

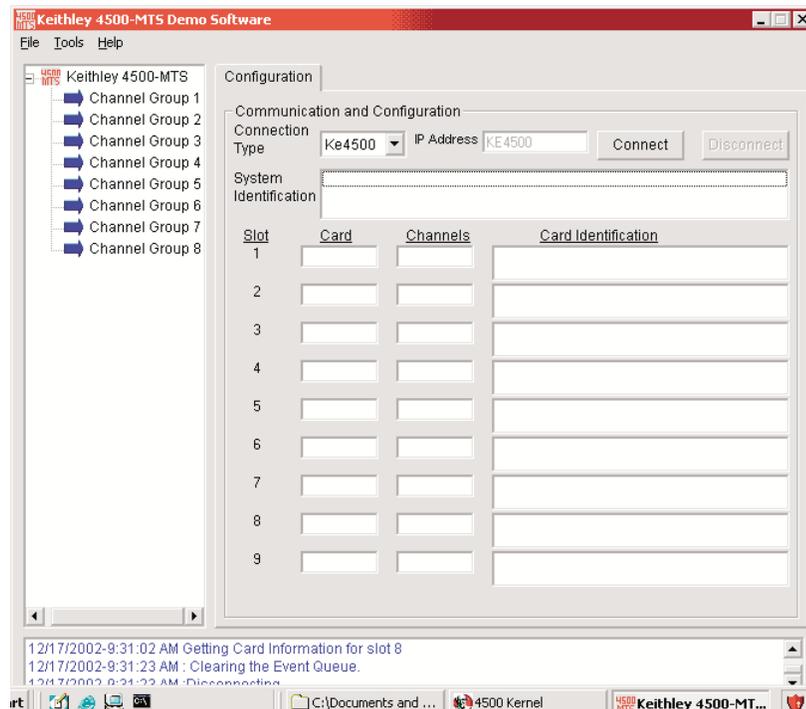
By selecting one of the channel groups in the tree control, you can run a test and retrieve data into a grid control ([Figure 3-7](#)). You can save this data to a file for future analysis.

## Running the 4500-MTS demo software

To run the 4500-MTS demo software, perform the following steps.

1. To run the demo software in the demo mode, click on the **System Settings** tab in the 4500-MTS control panel located in the Windows Control Panel, and then **Enable** the demo mode. To run the software in the card access mode, click on the **System Settings** tab in the control panel, and then **Disable** the demo mode. Click **OK** to complete your selection. If you are using the card access mode, make sure at least one 4500 card is present in the mainframe.
2. Double-click **VB Demo App** to start the program and display the initial window (Figure 3-3).

Figure 3-3  
**Demo software initial window**



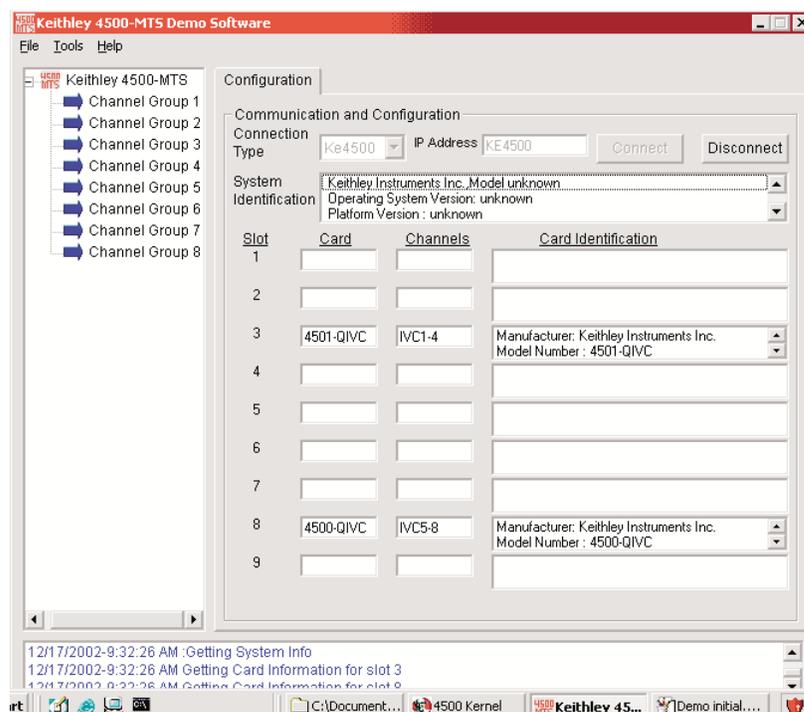
## Connecting to an instrument with a QIVC card

The Up & Running 4500-MTS Software Application (the Application) can run with a Controller Mode 4500-MTS that is on the same computer as the 4500-MTS. Alternatively, the Application can connect to slave (remote) units via ethernet and TCP/IP.

To connect the 4500-MTS mainframe to an instrument by using a QIVC card, perform the following steps.

1. In the Configuration tab control dialog, select either a local or remote connection from the **Connection Type** drop-down box. The default connection type is Ke4500, a local connection.
2. If you select Remote, enter an IP address.
3. Click **Connect** to populate the following fields in the **Configuration** tab control dialog (Figure 3-4):
  - **System identification** — For the Keithley Instruments Inc., Model 4500-MTS, this field provides information about the Operating System Version, Platform Version, Serial Number, and System Software Version.
  - **Card** — Identifies the card in a given slot as being a 4500-QIVC or 4501-QIVC card or another type of multi-channel card.
  - **Channels** — Identifies which channels are on a given card.
  - **Card identification** — For each card, this field provides information about the Manufacturer, Model Number, Firmware Version, Digital FPGA Version, Analog FPGA Version, Minimum Channel, and Maximum Channel.
4. If you want to break the connection, click **Disconnect**.

Figure 3-4  
Typical card configuration window



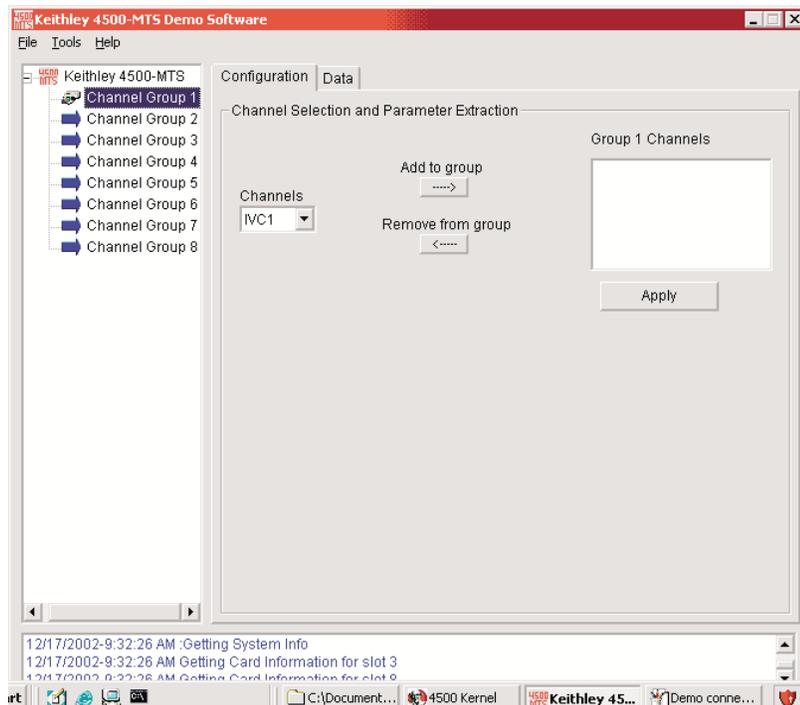
## Building a new channel group

To build a new channel group, perform the following steps:

1. In the tree control, unselected channel groups are indicated by blue arrows. Click a channel group to select it. For example, click **Channel Group 1**. The **Configuration** dialog in the tab control changes to allow channel selection for the group that you select (Figure 3-5).
2. In the **Channels** drop-down box of the **Configuration** dialog, click a channel to select it. For example, click **IVC2**.
3. Click the right-pointing arrow labeled **Add to group**. The selected channel (for example, IVC2) now appears in the **Group 1 Channels** field.
4. Repeat Steps 2 and 3 until you have selected as many channels as you want to add to the new channel group. For example, select IVC4 and IVC6.
5. Click **Apply** to accept the selected channels as part of the new channel group. The selected channels (in this example IVC2, IVC4, and IVC6) are indicated by red arrows. These channels appear in the tree control under the channel group to which you assign them.

**NOTE** *If you add a channel to a channel group and then attempt to add that same channel to another channel group, the following error message appears: “**This channel is already in use. Please select a different channel.**” Click **OK** to resume selecting available channels.*

Figure 3-5  
Typical channel group configuration window



## Removing a channel from a channel group

To remove a channel from a channel group, perform the following steps.

1. In the tree control, click a channel group to select it.
2. From the **Group Channels** field in the **Configuration** dialog, click the channel you wish to remove. For example, click **IVC4** in the **Group 1 Channels** field.
3. Click the left-pointing arrow labeled **Remove from group**. The selected channel disappears from the **Group 1 Channels** field.
4. Repeat Steps 2 and 3 until you have selected the number of channels that you want to remove from the channel group. For example, select IVC6.
5. Click **Apply** to delete the selected channels from the channel group. The selected channels (in this example IVC4 and IVC6) disappear from the tree control under the channel group to which you previously assigned them.

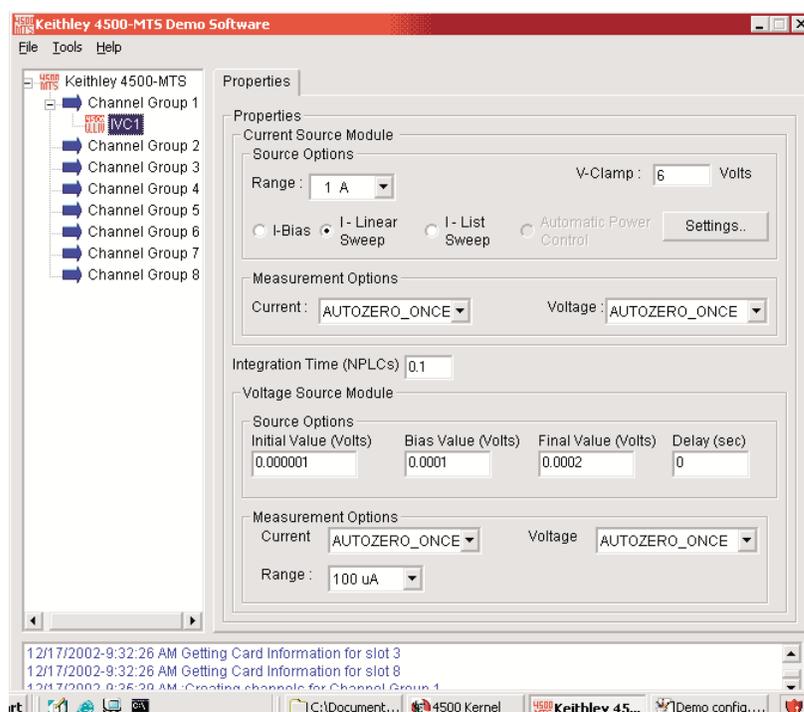
## Configuring a channel

To configure settings for Source Options, perform the following steps.

**NOTE** See [Section 4](#) for information on sweeps.

1. With the **Configuration** dialog showing, click the channel that you want to configure in the tree control. A **Properties** dialog replaces the **Configuration** dialog in the tab control (Figure 3-6). In the **Current Source Module** of the **Properties** dialog, you can configure options for source and measurement.
2. For the 4500-QIVC card, set a range of 30mA, 100mA, or 500mA by selecting a value from the **Range** drop-down box. 500mA is the default value. For the 4501-QIVC card, ranges are 100mA, 300mA, and 1A; the default is 1A.
3. To set a voltage amount for the V-clamp, enter a number in the V-Clamp field.

Figure 3-6  
Typical card properties window



4. Determine which type of test to run by selecting one of the following radio buttons: **I-Bias**, **I-Linear Sweep**, or **I-List Sweep**. I-Linear Sweep is the default selection.
5. To further configure settings for the specific type of test that you chose in Step 3, click **Settings** after you select a type of test to run.
6. A **Properties** dialog specific to the selected test appears.
  - a. If you select **I-Linear Sweep**, a **Properties** dialog labeled **I-Linear Sweep Settings** appears. In this dialog, enter values in the following fields:
    - Initial Value (default value is 0.001)
    - Start Value (default value is 0.001)
    - Stop Value (default value is 0.01)
    - Final Value (default value is 0.01)
    - Number of Points (default value is 100)
    - Order (default value is 1)
    - Delay (default value is 0 seconds)

**NOTE**      *In Steps 6a and 6c, Order is a drop-down box from which you can select 1 to any number of channels in the group, not to exceed 32.*

- b. If you select **I-Bias**, a **Properties** dialog labeled I-Bias Settings appears. In this dialog, enter values in the following fields:
    - Initial Value (default value is 0.000001)
    - Bias Value (default value is 0.0002)
    - Final Value (default value is 0.0002)
    - Delay (default value is 0 seconds)
  - c. If you select **I-List Sweep**, a **Properties** dialog labeled I-List Sweep Settings appears. In this dialog, enter values in the following fields:
    - Initial Value (default value is 0)
    - Number of Points (default value is 10)
    - Order (default value is 1)
    - Final Value (default value is 0.01)
    - Also, for each Point listed in the table, enter the Current Source Value and Delay List. (For Points 1-10, default value is 0.00 for both Current Source Value and Delay List.)

**NOTE**      *Automatic Power Control is not currently supported and is included for future expansion.*

To configure settings for Measurement Options, perform the following steps.

1. In the **Current** drop-down box, select AUTOZERO\_ONCE, NONE, PROGRAMMED, or AUTOZERO. The default selection is AUTOZERO\_ONCE.
2. In the **Voltage** drop-down box, select AUTOZERO\_ONCE, NONE, or AUTOZERO. The default selection is AUTOZERO\_ONCE.

**NOTE** *Measurement accuracy may be degraded if NONE is selected since no readings are taken. AUTOZERO will give the best accuracy over the longest time.*

*PROGRAMMED will not work for list sweeps.*

*Autozero references taken for one measurement on a channel are applicable to all measurements on that channel. However, Autozero all/once is settable on a per-measurement basis. This means that, if for example, you select Autozero-all for LD V measure and Autozero-all for PD I measure on the same channel, references will be taken twice on each point. This will extend measurement time with no significant improvement in accuracy. Therefore, if you desire autozero-all on a channel you should set the first of the measurements to autozero-all and the others to autozero-once for best efficiency. The measurement order is (see MdAPI.h):*

- *Vsource I (PD I)*
- *Isource V (LD V)*
- *Vsource V (PD V readback)*
- *Isource I (LD I readback)*

In the **Integration Time (NPLCs)** field in the center of the **Properties** dialog, enter a value. The default value is 0.1.

**NOTE** *A channel group will acquire readings only as fast as the largest NPLC setting among all channels.*

In the Voltage Source Module of the **Properties** dialog, you can configure options for source and measurement.

To configure settings for Source Options, enter a value in the following fields: Initial Value (Volts), Bias Value (Volts), Final Value (Volts), and Delay (sec).

- Initial Value (Volts) - default value is 0.000001
- Bias Value (Volts) - default value is 0.0001
- Final Value (Volts) - default value is 0.0002
- Delay (sec) - default value is 0

To configure settings for Measurement Options, perform the following steps.

1. In the Current drop-down box, select AUTOZERO\_ONCE, NONE, or AUTOZERO. The default selection is AUTOZERO\_ONCE.
2. In the Voltage drop-down box, select AUTOZERO\_ONCE, NONE, PROGRAMMED, or AUTOZERO. The default selection is AUTOZERO\_ONCE.
3. Set a range of 100 uA, 1 mA, or 10 mA by selecting a value from the **Range** drop-down box. The default value is 100 uA.

## Running a test

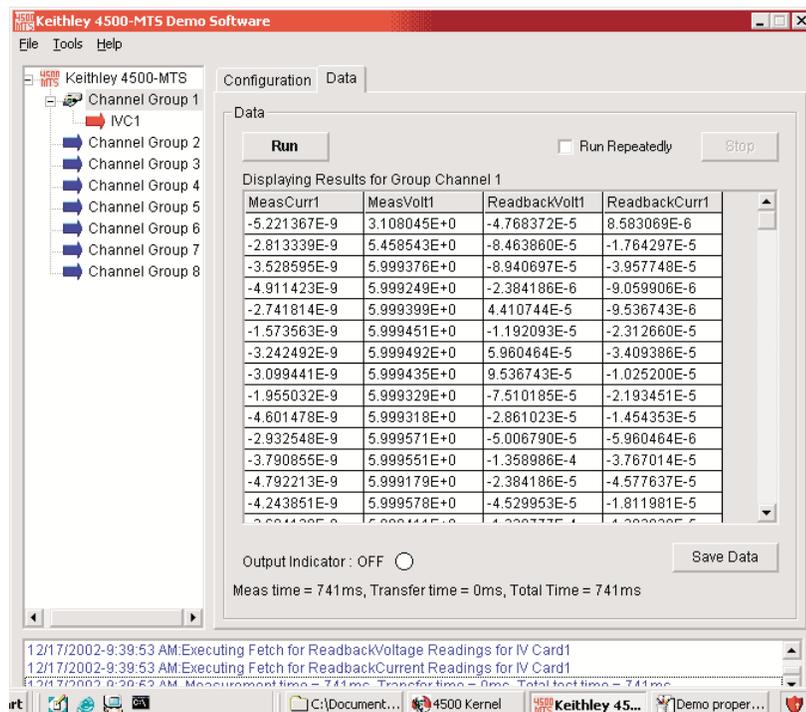
To run a test once, perform the following steps.

1. With the **Data** dialog showing (Figure 3-7), click the channel group for which you want to run a test in the tree control. For example, click **Channel Group 1**.
2. Click **Run** in the **Data** dialog. Test results appear in a grid control under the heading Displaying Results for Group Channel 1. Underneath these results, information on the speed of the test appears in milliseconds for measurement time, transfer time, and total time.

To run a test multiple times, perform the following steps.

1. With the **Data** dialog showing, click the channel group for which you want to run a test in the tree control. For example, click **Channel Group 2**.
2. In the **Data** dialog, click to place a check mark in the Run Repeatedly box.
3. Click **Run** to start the test. The Output Indicator blinks ON, the circle turns red, and the message "Running the test" flashes on the screen.
4. Click **Stop** to end the test. Test results appear in a grid control under the heading Displaying Results for Group Channel 2.
5. If you want to restart the test from the point where you left off, click **Run** again.

Figure 3-7  
Typical data window



## Saving test data to a file

To save test data to a file, perform the following steps.

1. In the **Data** tab, ensure that the Run Repeatedly check box is unchecked.
2. Click **Save Data** to display the Save Data As... window.
3. From **Save in:**, select a folder in which to save the test data file or create a new folder. The default folder, Data, is located in the following path: **4500-mts\Examples\Vb\4500DemoSW\Data**.
4. Enter a name for the test data file in the **File name** field. Use the default file name or type in a new file name. Do not use a name that is already being used. The default file name is **4500Data**.
5. Click **Save**. The test data file is saved as a CSV file, so that you can export it to other applications such as Microsoft<sup>®</sup> Excel.

4

# Programming

---

# Introduction

This section contains information on writing your own programs to use the 4500-QIVC and 4501-QIVC cards. Basic applications are also included.

## Operation overview

### Channel designation description

The 450x Quad IV Card Series have four IV Channels: IVC1 through IVC4. Each channel has a Current Source Measure Module and a Voltage Source Measure Module. The two modules share an analog to digital (A/D) converter so that you can measure voltage and current on both sources. The two modules also share a common ground. Therefore, the API (Application Program Interface) treats the two modules as paired.

When there are two or more cards plugged into a 4500-MTS chassis, the card nearest to the right-hand side of the chassis from the rear becomes channels 1 through 4. The next similar card to the left of the first one becomes channels 5 through 8, and so on.

Besides the 450x-QIVC series cards, there maybe other 4500 Multi-Channel PCI cards installed in the chassis. *Figure 4-1* provides an example of channel designation for the QIVC and other Multi-Channel cards.

*Figure 4-1*  
**Channel designation example**

Slot number:	9	8	7	6	5	4	3	2	1
Back view of 4500-MTS	Empty slot	Multi-channel card 3	QIVC 4	Empty slot	Multi-channel card 2	QIVC 3	Multi-channel card 1	QIVC 2	QIVC 1
Channel assignments:		MCC 9-12	IVC 13-16		MCC 5-8	IVC 9-12	MCC 1-4	IVC 5-8	IVC 1-4

If the chassis is not completely full of QIVC or other multi-channel cards, there can be empty slots in between the plugged-in cards.

**NOTE** *A maximum number of eight 4501-QIVC cards should be installed in a 4500-MTS system. The 4500-MTS is not recommended for use with nine 4501-QIVC cards.*

## Channel groups

This API streamlines the testing of optoelectronic devices. In most cases, users of this product require the ability to source or measure physical parameters, such as current and voltage, on several channels together. To reflect this concept, the software includes the ability to create a channel group.

To set up a test, decide which IVC channels to use in the test, and then add these channels to a channel group by using the **CreateChannelGroup** function. You assign a channel to a group so that the channels in the group can be configured to run together or perform a nested sweep. You can add channels to a channel group from multiple cards, for example, IVC1 through IVC6. A channel group can consist of a minimum of one to the maximum of the total amount of individual channels in the chassis. A maximum of eight channel groups can be created.

The **CreateChannelGroup** function returns a handle to the channel group. This handle is passed into other functions to configure the channels in the group, start or stop the group, and get status on the group or channels within the group.

## Sweep and sourcing terminology

A linear sweep requires that the source output start at a certain value and automatically stop when it reaches a known value. The number of steps between the start and stop values are equally divided by the number of points parameter. The linear sweep can either incrementally step up or step down depending on if the start value is smaller or larger than the stop value.

A list sweep outputs any kind of waveform. The list sweep function allows any values to be output as long as the values are within the limits of the output source.

The linear and list sweep functions have an order parameter that allows the sweeps to be nested. The innermost sweep has an order of 1. Sweep channels that have a higher order value are nested around the inner sweep. The following pseudo code shows how this might work when testing a 5-cavity laser diode module:

```

For ILD = ILD1 to ILDn
  Force ILD
  For IBRAGG = IBRAGG1 to IBRAGGn
    Force IBRAGG
    For IPHASE = IPHASE1 to IPHASEn
      Force IPHASE
      For IGAIN = IGAIN1 to IGAINn
        Force IGAIN
        Measure ISD, IPD1, IPD2, ..., IPDn
        Measure VLD, VBRAGG, VPHASE, VGAIN
      Next IGAIN
    Next IPHASE
  Next IBRAGG
Next ILD

```

The innermost sweep is the I<sub>GAIN</sub> and it has a sweep order of 1.

Next order is 2 for the I<sub>PHASE</sub> sweep.

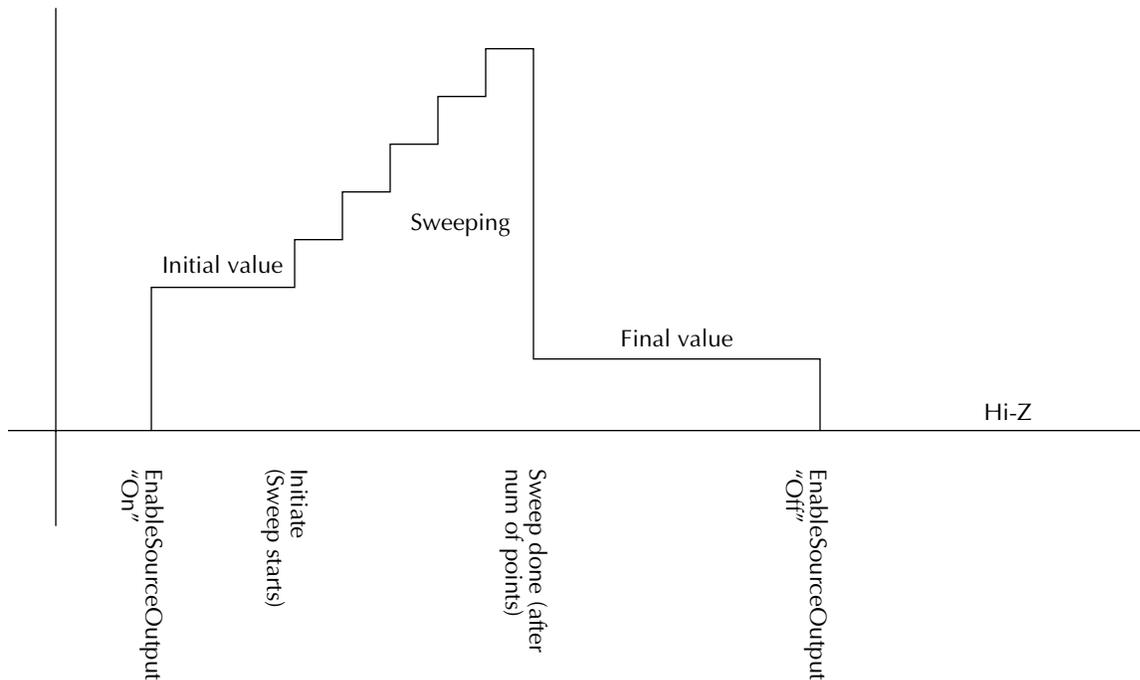
Next order is 3 for the I<sub>BRAGG</sub> sweep.

Next order is 4 for the I<sub>LD</sub> sweep.

Figure 4-2 provides an example of sweeping.

- NOTES**
- 1) You must make sure that there are no gaps in the orders for all the channels in a channel group. For example, if you configure a sweep (List or Linear) on IVC1 with an order of 1, and you then configure channel IVC2 on an order of 3, an error will be generated when the `Ke4500_Initialize` function is called.
  - 2) If two or more sweeps have the same sweep order, then the number of points in all of the sweeps on that order must be the same. If any one of the channels on the same order in the channel group has a different number of points, an error will be generated when the `Ke4500_Initialize` function is called.

Figure 4-2  
Sweeping



Neither the linear sweep nor the list sweep outputs the first value until the 4500-MTS receives an **Initiate** command. An “initial” parameter controls the output value of the source from the time that the **EnableSourceOutput** function switches on the source until the **Initiate** command is sent. Conversely, when the sweep is complete and you want the source to go to an output value before the **EnableSourceOutput** command switches off the source, a “final” parameter is provided. When the set device output is off, the DUT will be in a shorted condition and the current in compliance.

If you require a single output value rather than a sweeping action on the source, use the **ConfigSourceBias** and **ConfigVSourceBias** functions. These functions also have an initial and final parameter so that you can control the output of the source.

The bias functions can also be used in conjunction with sweeps. When the **Initiate** function is called on a channel group, any channels configured with the **ConfigVSourceBias** function are set first. Next, any channels configured with the **ConfigSourceBias** function are sourced. The sweep channels with the highest order value are sourced next.

Any measurement channels that you enable with the **Config** functions are only measured in the innermost sweep, as shown previously in the pseudo code.

# Using the driver with various programming environments

## References to online help

Depending on which programming environment you use, the following list will direct you to the appropriate online help utility. Refer to this help file for detailed information on available functions and how to use them.

- MS Visual BASIC Version 5 and 6 users — Refer to VB Help file in the 4500-MTS folder.
- MS Visual C/C++ (32 bit) users — Refer to the C Help file (4500-MTS folder).
- NI LabView Version 5.1, 6i, and 6.1 users — List functions while in LabView.
- NI LabWindows/CVI Version 5.0, 5.5, and 6.0 users — Refer to C Help file.

## Basic assumptions

The information below assumes the following:

- The 4500-MTS software was installed correctly.
- The programming environment was installed before the 4500-MTS software. This constraint pertains primarily to LabVIEW.

## Using specific programming environments

### Visual BASIC®

1. Run Visual BASIC.
2. From the **Project menu** select **References**.
3. Scroll down in the **Available References** list and select the **Keithley 4500 Modular Test System**. If it is not displayed, the 4500-MTS software has not been installed correctly.
4. To get a list of available functions to call in the driver either:
  - a. Use the **ke4500.hlp** file.
  - b. Run the object browser on the Visual BASIC toolbar and select the **ke4500 library**. You will see a hierarchal list of all the available functions, attributes, and defined constant values.

### Microsoft Visual C or NI LabWindows/CVI

1. Include the **ke4500.h** and **ke4500const.h** files in your C project. These can both be found in the **C:\VXIpnP\WinNT\include** directory.
2. When you link the program, you will need the **ke4500.lib** file, which is located in the **C:\VXIpnP\WinNT\lib\msc** or **C:\VXIpnP\WinNT\lib\bc** directory. The lib in the **msc** directory is for Microsoft C/C++ environments and the one in the **bc** directory is for Borland C/C++ environments.
3. To get a list of available functions to call in the driver, use the **ke4500c.hlp** file.

### LabView

If LabView is installed on the PC prior to installing the 4500-MTS software, the LabView driver will be installed in the **C:\Program Files\National Instruments\LabVIEW 6\instr.lib\Ke4500** directory. This location is for LabView 6i; the folder name will differ slightly for a different version of LabView.

Because the driver is installed in the `\instr.lib\Ke4500` directory, which is off the main LabView directory, when you run LabView, you can navigate to the driver as follows:

1. Right mouse click on the wiring diagram.
2. Select the **Instrument I/O** icon.
3. Select the **Instr Lib** icon.
4. Select the **KE4500** icon.
5. You will then see a hierarchal list of icons for the functions in the driver.

If LabView was not installed on the PC when the 4500-MTS software was installed, the LabView driver will be installed in the `C:\Program Files\Keithley Instruments\4500-MTS\Labview Driver\instr.lib\Ke4500` directory. You can use the driver in this location as follows:

1. From the **File** menu select **Open**.
2. Navigate to the directory described above.
3. Select the **Ke4500.llb** file.
4. You will then get a list of the functions in the driver.

Alternatively you can uninstall the 4500-MTS software, reinstall it, and then follow the procedure outlined above.

## User programming

### NOTE

*Refer to the supplied online help file for your particular programming environments for detailed information on functions. See “Using the driver with various programming environments,” page 4-5 for details on using the 4500-MTS driver with your particular programming environment.*

## Key terminology

<b>Test Executive</b>	An environment for developing computer applications such as LabView. Also, a computer language environment for developing computer applications like Visual BASIC or LabWindows/CVI.
<b>Instrument Driver</b>	A software component that allows a <b>Test Executive</b> to control and interact with an instrument (for example, 4500-QIVC or another multi-channel card).
<b>Up &amp; Running Software</b>	A complete software application that you can run to test the basic functionality of an instrument. This software application is not intended for use in a production environment.
<b>Tester API</b>	Tester Application Programming Interface. The <b>Instrument Driver</b> calls functions in the <b>Tester API</b> layer (transport layer) to make connections and communicate with the 4500-MTS.
<b>Test System Controller</b>	A computer, typically a PC, used to configure and acquire data from various instruments in a test system.
<b>Local Mode</b>	When the <b>Up &amp; Running Software</b> or <b>Test Executive</b> and <b>Instrument Drivers</b> are installed on a 4500-MTS embedded PC, and this PC functions as the <b>Test System Controller</b> .
<b>Remote Mode</b>	When the <b>Up &amp; Running Software</b> or <b>Test Executive</b> and <b>Instrument Drivers</b> are installed on an external PC. In this mode, the external PC becomes the <b>Test System Controller</b> . The external PC communicates with the 4500-MTS via an Ethernet connection and TCP/IP protocol.

## Driver summary

The Instrument Driver is a Win32 DLL created in LabWindows/CVI. The utilities in LabWindows allow the creation of a native LabView and LabWindows driver and a Windows Help file. As the driver is a Win32 DLL, you can use the driver with Visual C/C++, Visual BASIC, and any other Windows-compatible Test Executive that supports 32-bit DLLs. LabWindows also provides the ability to generate a type library. This type library, which you can register with Windows, provides semi-intellisense in Visual BASIC. "Semi" indicates that when you type in the name of the function in the driver you wish to call, the VB intellisense prompts you with the parameters necessary for that function. Full intellisense capability, where VB presents a list of the functions as you type a function name, requires an ActiveX DLL or OCX driver. While this release does not provide full intellisense capability, the ActiveX driver may be written later and layered on top of the Win32 DLL driver.

Driver functions/commands appear in the following lists, along with descriptions.

## Driver functions

### List of general functions

#### KE4500\_Init

**Purpose** Initializes the driver and makes a connection to the local 4500-MTS.

**Description** The resourceName parameter tells the transport layer, TAPI, how to make a connection. The vi session, an out parameter, serves as the first parameter for many of the functions that work on a system basis. This parameter lets the functions know which 4500 you want to communicate with.

If the resetDevice parameter is true, then a hard reset is done on all the cards in the 4500-MTS system. A hard reset pulls on the reset line of the card. The card is reset as if power was just applied to the card.

#### For Local Mode

The resourceName parameter should be "KE4500" or use the constant KE4500\_VAL\_LOCAL.

#### For Remote Mode

If the TcpIP address of the 4500 is known (for example, 1.2.3.4), a connection can be made by passing in the resource string of "1.2.3.4".

#### KE4500\_Close

**Purpose** Closes a connection to a specific 4500-MTS.

**Description** The connection and resources allocated for this session by the init function are cleared. This function works with both a controller 4500-MTS and a remote 4500-MTS.

#### KE4500\_CreateChannelGroup

**Purpose** Creates a group of channels for the test.

**Description** Groups channels together for a nested sweep. This grouping allocates resources and marks the channels in use so that these channels cannot be used in another group.

**KE4500\_ReleaseChannelGroup**

**Purpose** Releases the resources for the channels in the group.

**Description** The channels can now be used in another channel group.

**KE4500\_ResetChannelGroup**

**Purpose** Resets all the channels in the group to their defaults.

**Description** Puts all the channels back to their defaults, except that the channels still belonging to this channel group.

**KE4500\_GetInstalledCards**

**Purpose** Returns a list containing all the information about the Model 4500.

**Description** Returns a array of ViInt32 (long integers) where index 1 indicates the card type in slot 1 and index 2 the card type in slot 2, etc.

**KE4500\_GetCardInfo**

**Purpose** Returns a list of information about a card in the Model 4500.

**Description** Returns a string that is a single piece of information about a particular card in the 4500-MTS. The choices of information include these attributes:

Manufacturer.

Model Number (KE4500\_CARD\_EMPTY, KE4500\_CARD\_QIVC, KE4500\_CARD\_QTEC).

Firmware Version.

Digital FPGA Version.

Analog FPGA Version.

Serial Number of the card.

Initial REV. of main PCB.

Manufacture date.

Modified version.

Minimum Channel Number (e.g., IVC1).

Maximum Channel Number (e.g., IVC4).

**NOTE** Refer to the KE4500.hlp file for the latest list of attributes.

**KE4500\_EnableSourceOutput**

**Purpose** Enables/Disables the channel output.

**Description** The output goes to its initial value if set by using any of the following functions:

KE4500\_ConfigISourceLinearSweep

KE4500\_ConfigISourceListSweep

KE4500\_ConfigISourceBias

KE4500\_ConfigVSourceBias

**KE4500\_Initiate**

**Purpose** Executes a test on a channel group in the 4500-MTS and returns immediately.

**Description** This function is asynchronous, which means that the function returns immediately so that your program can proceed with other tasks while the test is in progress. Use KE4500\_TestStatus to monitor test progress and KE4500\_Fetch to retrieve the data.

**KE4500\_Fetch**

**Purpose** Retrieves the data for a test from the 4500-MTS.

**Description** Returns the data from a 4500-MTS. The channel parameter only accepts a single channel. This restriction to a single channel prevents all the data from coming back in one huge array. Therefore, there is no need to write a parsing algorithm to pull out the particular channel and element that interests you.

Some I-Sources or V-Sources may have their readback enabled so that the data for the channel may contain both a current and a voltage measurement. Use the element parameter to distinguish which type of data you want for this channel.

Use the start and length parameters if you want to break up the data transfer into smaller blocks. If a larger than optimal length of data is requested, the 4500-MTS software will automatically buffer the data for maximum throughput. Avoid making many calls to retrieve just a few data points at a time, as this will increase transmission overhead.

**KE4500\_Abort**

**Purpose** Stops an operation running on a group of channels (for example, a sweep).

**Description** Stops an operation previously started through the Initiate function.

**KE4500\_TestStatus**

**Purpose** Queries the 4500 to find out the status of a channel group.

**Description** Reads the status of the channel group specified. The status value is a 32-bit integer enumeration, which specifies the state the channel group is in. If an error is returned from this function you should call Ke4500\_QueryEventQueue to check if there were any asynchronous errors.

**KE4500\_ConfigMeasurementSpeed**

**Purpose** Configures the speed of measurement or NPLC (Number of Power Line Cycles) for channels.

**Description** Sets the measurement speed for channels in NPLCs. This function affects both the I-Sources and V-Sources of the channel. This speed affects the following functions:

KE4500\_ConfigISourceReadback

KE4500\_ConfigVMeasure

KE4500\_ConfigIMeasure

KE4500\_ConfigVSourceReadback

**KE4500\_OffsetCorrect**

**Purpose/Description** Suppresses system offsets for channel(s).

**KE4500\_QueryEventQueue**

**Purpose** Reads an event code and message from the channel group event queue.

**Description** Reads an event code and a message that explains the event code from the channel group event queue. If the length parameter is not long enough for the message being returned, then the message is truncated and no error is returned.

**KE4500\_GetErrorMessage**

**Purpose** Returns an error message for a given error code.

**Description** This function takes the Status Code returned by the instrument driver functions, interprets the Status Code, and returns the Status Code as a user-readable string. If the length parameter is not long enough for the message being returned, then the message is truncated and no error is returned.

**KE4500\_ClearEventQueue**

**Purpose** Removes all pending status messages and errors from the instrument event queue.

**Description** Events from the 4500-MTS are kept on a per channel group basis. This function removes all pending errors and messages from the channel groups' event queue.

**KE4500\_GetAttributeViInt32**

**Purpose** Recalls a ViInt32 setting for a parameter.

**Description** This function allows you to query the setting of any ViInt32 parameter.

**KE4500\_GetAttributeViBoolean**

**Purpose** Recalls a Boolean setting for a parameter.

**Description** This function allows you to query the setting of any ViBoolean parameter.

**KE4500\_GetAttributeViReal64**

**Purpose** Recalls a double floating point setting for a parameter.

**Description** This function allows you to query the setting of any ViReal64 parameter.

**KE4500\_GetAttributeViString**

**Purpose** Recalls a string setting for a parameter.

**Description** This function allows you to query the setting of any ViString parameter.

## List of functions for the 4500-QIVC and 4501-QIVC cards

### KE4500\_ConfigISource

**Purpose** Configures physical parameters for I-Source channels.

**Description** Configure the parameters associated with sourcing a current on channels. Pass in the IVC channels that you want to configure.

### KE4500\_ConfigISourceReadback

**Purpose** Configures channels to measure the current being sourced.

**Description** Configure readback of the current being sourced on the channel. PROG I is the calculated I value, that is, what the source was told to output. When measuring the real current being sourced there are two options: to auto-zero on every reading or to auto-zero only on the first reading.

### KE4500\_ConfigVMeasure

**Purpose** Configures channels to measure the voltage on the I-Source of a channel.

**Description** Configure voltage measurement on the I-Source of a channel. The 450x-QIVC card has a fixed range of  $\pm 6$  Volts.

### KE4500\_ConfigVSourceReadback

**Purpose** Configures channels to measure back the voltage being sourced on the V-Source of a channel.

**Description** Configure the readback of the voltage being sourced on the V-Source of a channel. There is the option of reading back the actual voltage being output or the calculated voltage. The real readback has the option of auto-zero on every reading, only on first reading, or never.

### KE4500\_ConfigIMeasure

**Purpose/Description** Configures channels to measure the current on the V-Source.

### KE4500\_ConfigISourceLinearSweep

**Purpose** Configures a linear current sweep on the I-Source of channel(s).

**Description** To sweep down, make the stop value less than the start value. The channels in the channel list are stepped as per the start/stop/step parameters. After the delay value, if there is another sweep configured that has a lower order value, then the channels associated with that sweep are stepped.

If there are any channels enabled to measure I or V, then these channels are *ONLY* measured inside the innermost sweep loop. See [“Sweep and sourcing terminology,” page 4-3](#) for more details about how sweeping works.

- NOTES**
- 1) You must make sure that there are no gaps in the orders for all the channels in a channel group. For example, if you configure a sweep (List or Linear) on IVC1 with an order of 1, and you then configure channel IVC2 on an order of 3, an error will be generated when the `Ke4500_Initialize` function is called.
  - 2) If two or more sweeps have the same sweep order, then the number of points in all of the sweeps on that order must be the same. If any one of the channels on the same order in the channel group has a different number of points, an error will be generated when the `Ke4500_Initialize` function is called.

#### **KE4500\_ConfigISourceListSweep**

**Purpose** Configures channels to source current based on a list on the I-Source of channel(s).

**Description** Configure a list current sweep on the I-Source of channel(s). The list can contain current values in any order, as long as the values are within the limits of the range set on the channel.

If there are any channels enabled to measure I or V, then these channels are *ONLY* measured inside the innermost sweep loop. See “[Sweep and sourcing terminology](#),” page 4-3 for more details about how sweeping works.

- NOTES**
- 1) You must make sure that there are no gaps in the orders for all the channels in a channel group. For example, if you configure a sweep (List or Linear) on IVC1 with an order of 1, and you then configure channel IVC2 on an order of 3, an error will be generated when the `Ke4500_Initialize` function is called.
  - 2) If two or more sweeps have the same sweep order, then the number of points in all of the sweeps on that order must be the same. If any one of the channels on the same order in the channel group has a different number of points, an error will be generated when the `Ke4500_Initialize` function is called.

#### **KE4500\_ConfigISourceBias**

**Purpose** Configures the current to output on the I-Source of channel(s).

**Description** Use this function if you just want to output a fixed current level on an I-Source channel.

If no sweeps are configured and you want to output a current level on a channel, set the initial and level parameters to the current value that you want to output. Then call the `EnableSourceOutput` to switch the channels on. The final parameter is not used.

If you are trying to bias a fixed current as part of a sweep, then the initial parameter value will be output when the `EnableSourceOutput` function is called to switch the channel(s) on. The level parameter value will be output immediately after any V-Source channels have been biased and before the outer most sweep is started. After the sweep is complete, the final parameter value will be output. If you do not require the initial and/or final values during a sweep operation, then set them either to 0 or the same value as the level parameter.

### KE4500\_ConfigVSourceBias

**Purpose** Configures the voltage to output on the V-Source of channel(s).

**Description** Use this function if you just want to output a fixed voltage level on the V-Source of a channel.

If no sweeps are configured and you want to output a voltage level on a channel, set the initial and level parameters to the voltage value that you want to output. Then call the EnableSourceOutput to switch the channels on. The final parameter is not used.

If you are trying to bias a fixed voltage as part of a sweep, then the initial parameter value will be output when the EnableSourceOutput function is called to switch the channel(s) on. The level parameter value will be output immediately after an initiate is sent. After the sweep is complete, the final parameter value will be output. If you do not require the initial and/or final values during a sweep operation, then set them either to 0 or the same value as the level parameter.

## Applications

### Recommended equipment

The following equipment is recommended for applications unless otherwise noted:

- Keithley 4500-MTS with 4500-QIVC or 4501-QIVC card(s)
- Keithley Model 2510 TEC SourceMeter for temperature control
- Keithley KPCI-488.2 GPIB card

**NOTE** Use the CEC driver that accompanies the KPCI-488.2 card to exchange data with the Model 2510 and other GPIB equipment.

### Connections

See “Connections,” page 2-6 for connections to laser diodes and photodiodes (where applicable) for these examples.

### Source code

At the time of this publication, code examples were not readily available for each diode/laser application. Please refer to the Online Software help for other code examples.

## Block diagrams

Basic block diagrams for the applications are shown in [Figure 4-3](#) and [Figure 4-4](#). [Figure 4-3](#) shows the configuration for those applications that use a photodiode for optical measurement, while [Figure 4-4](#) shows the configuration for applications that use an optical spectrum analyzer or wavelength meter for measurements.

Briefly, the various components perform the following functions:

- **450x-QIVC card** — excites the laser diode under test with current and measures the voltage across the device. For those applications that use photodiodes to detect laser diode light emission, the card supplies bias voltage and measures the photodiode current.
- **GPIB interface** — provides the control interface to the 2510 TEC SourceMeter and can also be used with additional equipment if required.
- **2510-TEC SourceMeter** — controls the TEC (thermo-electric cooler) to maintain the laser diode at the desired temperature.
- **Optical spectrum analyzer or wavelength meter** — measures the wavelength of the light emitted by the laser diode under test.

Figure 4-3

### Applications block diagram with photodiode detector

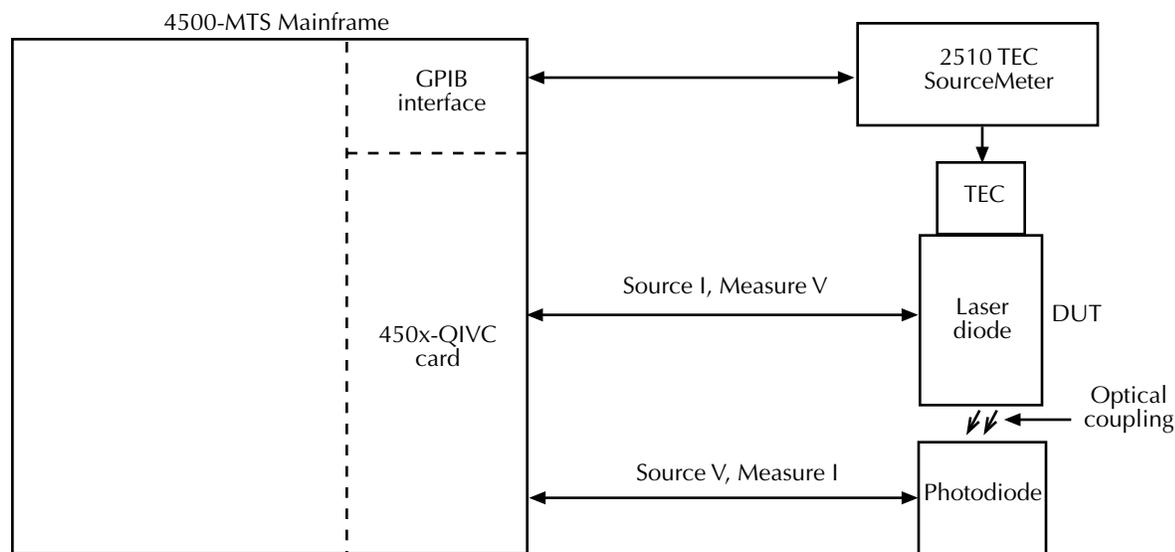
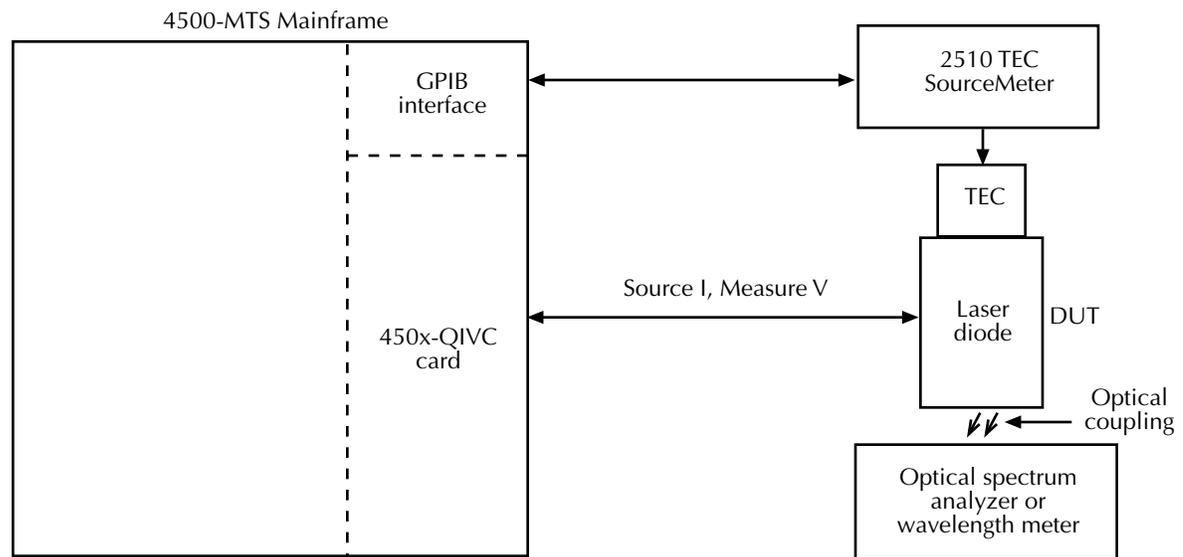


Figure 4-4

**Applications block diagram with optical spectrum and wavelength analyzers**

## Telecom laser diode

### Description

This application provides LIV testing of a telecom laser diode with temperature control. It includes the ability to specify the channel for an IV sweep and channel(s) for photodiode measurements. The program will allow you to measure two photodiodes at each LIV point. Optionally, the Model 2510 can be used for temperature control.

## Vertical cavity surface emitting laser

### Description

This application performs LIV testing of a vertical cavity surface emitting laser. Two versions are included:

- **Application #1** — LIV test with temperature control.
- **Application #2** — LIV test with temperature control and spectral measurement.

These applications include the ability to test up to four VCSEL parts simultaneously. Optional photodiode measurements for each VCSEL tested can also be made. Also, a Model 2510 can be used for temperature control. For Application #2, the following will be necessary to make a spectral measurement:

ISA/PCI Optical Spectrum Analyzer (example: OceanOptics, Bayspec)

**NOTE** Use the driver that accompanies the OSA PCI/ISA card.

## Tunable laser diode module

This application performs LIV testing of a tunable laser diode module. Two versions are included:

- **Application #1** — LIV test with temperature control.
- **Application #2** — LIV test with temperature control and optical power measurement.

These applications can control up to five cavities with a default of four, allowing testing by a single 4500-QIVC or 4501-QIVC card. The ability to measure two photodiodes at each LIV point is also included. For Application #2, the following equipment will be required to measure wavelength:

Optical Wavelength Meter (example: Exfo, WA-1600)

# Index

---

## Numerics

4500-MTS folder 3-2

## A

Applications 4-13

## B

Basic assumptions 4-5  
Basic Operation 3-1  
Basic software operation 3-2  
Block diagram 2-7, 4-14  
Building a new channel group 3-8

## C

Card configuration 1-5, 2-5  
Card edge view 1-6  
Card installation 2-3  
Card removal 2-5  
Card side view 1-5  
Channel designation description 4-2  
Channel groups 4-3  
Configuring a channel 3-9  
Connecting to an instrument with a QIVC card 3-7  
Connection precautions 2-2  
Connections 2-6, 4-13  
Connector terminal designations 2-6  
Contact information 1-4  
    Phone number 1-4  
Cover removal 2-3

## D

Demo software capabilities 3-4  
Demo software configuration 3-5  
Driver functions 4-7  
Driver summary 4-7  
DUT connections 2-8

## E

Enabling the demo mode 3-3  
Environmental conditions 3-2

## F

Features 1-2

## G

General information 1-2  
Getting Started 1-1

## I

Inspection for damage 1-4  
Installation & Connections 2-1  
Installation procedure 2-4  
Intended applications 1-3  
Interlock 2-10  
Interlock connections 2-11  
Interlock connector and cables 2-12  
Interlock events 2-10  
Interlock terminal designations 2-13  
Introduction 1-2, 2-2, 3-2, 4-2

## K

Key terminology 4-6

## L

LabView 4-5  
Laser diode considerations 2-10  
List of functions for the 4500-QIVC and 4501-QIVC  
    cards 4-11  
List of general functions 4-7

## M

- Memory limitations 3-4
- Microsoft Visual C 4-5
- Multiple card interlock connections 2-13
- Multiple channel groups 3-4

## N

- NI LabWindows/CVI 4-5

## O

- Operation overview 4-2
- Optional accessories 1-4
- Output 2-9
- Output switching 2-9

## P

- Package content 1-4
- Programming 4-1

## R

- Recommended equipment 4-13
- References to online help 4-5
- Removing a channel from a channel group 3-9
- Running a test 3-12
- Running the 4500-MTS demo software 3-6

## S

- Safety symbols and terms 1-4
- Saving test data to a file 3-13
- Software installation 2-5

- Source code 4-13
- Specifications 1-3
- Supplied software 1-3
- Supported operating systems 1-3
- Supported software platforms 1-3
- Sweep and sourcing terminology 4-3

## T

- Telecom laser diode 4-15
- Temperature and humidity 3-2
- Tunable laser diode module 4-16

## U

- Unpacking and Inspection 1-4
- User programming 4-6
- Using specific programming environments 4-5
- Using the demo software 3-4

## V

- Vertical cavity surface emitting laser 4-15
- Visual BASIC 4-5

## W

- Warm-up period 3-2
- Warranty information 1-3



# Service Form

Model No. \_\_\_\_\_ Serial No. \_\_\_\_\_ Date \_\_\_\_\_

Name and Telephone No. \_\_\_\_\_

Company \_\_\_\_\_

List all control settings, describe problem and check boxes that apply to problem. \_\_\_\_\_

- |  |  |  |
|--|--|--|
| <input type="checkbox"/> Intermittent            | <input type="checkbox"/> Analog output follows display   | <input type="checkbox"/> Particular range or function bad; specify _____ |
| <input type="checkbox"/> IEEE failure            | <input type="checkbox"/> Obvious problem on power-up     | <input type="checkbox"/> Batteries and fuses are OK                      |
| <input type="checkbox"/> Front panel operational | <input type="checkbox"/> All ranges or functions are bad | <input type="checkbox"/> Checked all cables                              |

Display or output (check one)

- |                                   |  |
|-----------------------------------|--|
| <input type="checkbox"/> Drifts   | <input type="checkbox"/> Unable to zero              |
| <input type="checkbox"/> Unstable | <input type="checkbox"/> Will not read applied input |
| <input type="checkbox"/> Overload |  |

- |   |  |
|---|--|
| <input type="checkbox"/> Calibration only | <input type="checkbox"/> Certificate of calibration required |
| <input type="checkbox"/> Data required    |  |

(attach any additional sheets as necessary)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)

What power line voltage is used? \_\_\_\_\_ Ambient temperature? \_\_\_\_\_ °F

Relative humidity? \_\_\_\_\_ Other? \_\_\_\_\_

Any additional information. (If special modifications have been made by the user, please describe.)

Be sure to include your name and phone number on this service form.

Specifications are subject to change without notice.

All Keithley trademarks and trade names are the property of Keithley Instruments, Inc. All other trademarks and trade names are the property of their respective companies.

**KEITHLEY**

**Keithley Instruments, Inc.**

28775 Aurora Road • Cleveland, Ohio 44139 • 440-248-0400 • Fax: 440-248-6168  
**1-888-KEITHLEY (534-8453) • [www.keithley.com](http://www.keithley.com)**

<b>Sales Offices:</b>	<b>BELGIUM:</b>	Bergensesteenweg 709 • B-1600 Sint-Pieters-Leeuw • 02-363 00 40 • Fax: 02/363 00 64
	<b>CHINA:</b>	Yuan Chen Xin Building, Room 705 • 12 Yumin Road, Dewai, Madian • Beijing 100029 • 8610-8225-1886 • Fax: 8610-8225-1892
	<b>FINLAND:</b>	Tietäjäsentie 2 • 02130 Espoo • Phone: 09-54 75 08 10 • Fax: 09-25 10 51 00
	<b>FRANCE:</b>	3, allée des Garays • 91127 Palaiseau Cédex • 01-64 53 20 20 • Fax: 01-60 11 77 26
	<b>GERMANY:</b>	Landsberger Strasse 65 • 82110 Germering • 089/84 93 07-40 • Fax: 089/84 93 07-34
	<b>GREAT BRITAIN:</b>	Unit 2 Commerce Park, Brunel Road • Theale • Berkshire RG7 4AB • 0118 929 7500 • Fax: 0118 929 7519
	<b>INDIA:</b>	1/5 Eagles Street • Langford Town • Bangalore 560 025 • 080 212 8027 • Fax: 080 212 8005
	<b>ITALY:</b>	Viale San Gimignano, 38 • 20146 Milano • 02-48 39 16 01 • Fax: 02-48 30 22 74
	<b>JAPAN:</b>	New Pier Takeshiba North Tower 13F • 11-1, Kaigan 1-chome • Minato-ku, Tokyo 105-0022 • 81-3-5733-7555 • Fax: 81-3-5733-7556
	<b>KOREA:</b>	2FL., URI Building • 2-14 Yangjae-Dong • Seocho-Gu, Seoul 137-888 • 82-2-574-7778 • Fax: 82-2-574-7838
	<b>NETHERLANDS:</b>	Postbus 559 • 4200 AN Gorinchem • 0183-635333 • Fax: 0183-630821
	<b>SWEDEN:</b>	c/o Regus Business Centre • Frosundaviks Allé 15, 4tr • 169 70 Solna • 08-509 04 600 • Fax: 08-655 26 10
	<b>TAIWAN:</b>	13F-3. No. 6, Lane 99 Pu-Ding Road • Hsinchu, Taiwan, R.O.C. • 886-3-572-9077 • Fax: 886-3-572-9031