Multi-Channel I-V Test System

The Model 4500-MTS Multi-Channel I-V Test System is a DC source-measure test system that is optimized for high speed parallel testing. This multi-channel system supports up to 36 source-measure channels while automatically managing complex channel coordination tasks such as inter channel triggering and communications. In addition, the Model 4500-MTS reduces system complexity by eliminating the need for external trigger control and instrument communications buses.

Unmatched Channel Density

The Model 4510-QIVC and 4511-QIVC plug-in cards offer powerful and precise source-measure capability. Each card provides four channels, and each channel includes a current source subchannel and a voltage source subchannel as shown in Figure 1. Each channel includes an instrument grade A/D converter for the highest possible throughput without compromising precision. With nine available slots, the Model 4500-MTS can be configured for a wide range of applications requiring as few as 4 channels to as many as 72 subchannels.

A current source subchannel consists of a programmable current source with current readback, four-wire voltage measurement, and a programmable voltage clamp. Each QIVC model has three current source ranges:

<table>
<thead>
<tr>
<th>QIVC Model</th>
<th>Current Source Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>4510</td>
<td>30 mA, 100 mA, 500 mA</td>
</tr>
<tr>
<td>4511</td>
<td>100 mA, 300 mA, 1 A</td>
</tr>
</tbody>
</table>

A voltage source subchannel consists of a programmable voltage source of up to 10V with voltage readback and current measurement with three ranges: 10µA, 500µA, and 10mA.

Each subchannel has independently controllable output modes that include high impedance and short circuit modes. The high impedance output mode allows both the current and the voltage source subchannels to source the same DUT (device under test) simultaneously, while each of the subchannels is supporting a different test function. The short circuit mode provides for improved ESD DUT protection when the output is off.

APPLICATIONS

Multi site parallel testing, including:
- Wafer level HiB LED
- Photonic integrated circuit
- MEMS/MOEMS life test
- Used in RFIC test as intelligent power supply subsystem
- Wafer and package level VCSEL test
- Laser diode characterization
- Multi-section tunable laser diode test
- Semiconductor reliability testing
Multi-Channel I-V Test System

Deterministic Performance

Complex tests, such as nested sweeps, can easily be performed with deterministic timing, unaffected by latencies normally associated with multi-channel systems. This is due to the real-time controller (RTC) embedded in each Series 4500 card. These RTCs manage test execution independently from the PC in the chassis. The RTCs, in conjunction with the trigger bus, allow groups of channels spanning one or more cards to act synchronously, yet independently of other groups of channels. The RTCs also record sweep measurement results during a test sequence for transfer via the PCI bus once the test is complete. Additionally, an RTC is able to execute preprogrammed sequences such as linear sweeps and list sweeps.

Parallel Testing Maximizes Throughput

Parallel test is used when throughput is a high priority and the test execution time is significant compared to component handling times. Figure 2 shows how throughput improves when the number of channels dedicated to a synchronous parallel test system is increased. In this case, the test time per channel actually decreases with the addition of channels. This is because channel configuration and test happen in parallel, while only test results are downloaded sequentially. Figure 3 shows a concurrent test environment where groups of channels execute asynchronously. In this case, the RTCs in the Model 4500 cards execute completely independently of other groups and independently of the embedded PC. This allows the PC embedded in the Model 4500-MTS to manage coordination between the channel groups and the component handling system.

Ordering Information

4500-MTS/F
- MTS Chassis with Flat Panel Option
4500-MTS/C
- MTS Chassis without Flat Panel Option

Note: 4500-MTS must be purchased with one or more QIVC cards:
4510-QIVC
- Low Power Quad I/V Card
4511-QIVC
- High Power Quad I/V Card

ACCESSORIES SUPPLIED
w/4500-MTS

4500 User’s Manual
4510-QIVC and 4511-QIVC Quad I/V Cards User’s Manual
OPTO-950-01D CD Manual
4500-QIVC+ QIVC Cable (*= 1, 2, or 3m)
4500-CLIK+ QIVC Interlock Cable (*= 1, 2, or 3m)
4500-QIVC-KIT 15-pin Female D-sub, solder cup, mates with 4500-QIVC+ (4)
4500-QIVC-TLS QIVC Test Lead Set, 15-pin D-sub to 8 alligator clips
4500-QILK-PLUG QIVC Interlock Override Plug, mates to 4500-QILK+ (1)

ACCESSORIES AVAILABLE

4510-QIVC Low Power Quad I/V Card
4511-QIVC High Power Quad I/V Card
4500-QIVC+ QIVC Cable (*= 0.5, 1, 2, 3m)
4500-CLIK+ QIVC Interlock Cable (*= 0.5, 1, 2, 3m)
4500-QIVC-KIT 15-pin Female D-sub, solder cup, mates with 4500-QIVC+
4500-CLIK-KIT 14-pin MDR Connector and Shell for 451x-QIVC
4500-QIVC-TLS QIVC Test Lead Set, 15-pin D-sub to 8 alligator clips
4500-QILK-PLUG QIVC Interlock Override Plug, mates to 4500-QILK+

Figure 1. Basic block diagram of the source and measurement components in one channel of a Model 4500-QIVC.

Figure 2. When test configuration and test execution happen in parallel, the addition of more channels does not increase the test time—it only increases the download time of the test results. Here the download time of the test results is a fraction of the configuration and test time. As a result, the average speed per channel is increased with the addition of more channels.
Simplified Programming

The Model 4500-MTS software architecture allows the unit to be used either as an instrument, being controlled by a remote PC, or as a self-contained system. The architecture allows the same application code to be executed either on a remote PC or on the Model 4500-MTS without any changes. Figure 4 shows the communications flow between the software and hardware components of the system.

The Series 4500 card drivers communicate with the 4500 Real-Time Manager via TCP/IP. This communication layer allows the application code to communicate with the 4500 Real-Time Manager locally or over the Ethernet. In addition to allowing remote control, the 4500 Real-Time Manager also:

- Manages groups of channels – Coordinates groups of channels that execute tests as an organized group. It supports up to eight channel groups. Each channel group executes independently of all other channel groups.

- Configures channels – Configures each channel based on input from the Series 4500 card driver. The 4500 Real-Time Manager greatly reduces the programming complexity by configuring the inter- and intra-card sequencing. It also eliminates complex trigger model programming.

- Manages multiple users – Allows multiple users to connect to the Model 4500-MTS through the Ethernet connection. The 4500 Real-Time Manager ensures that each user has access to unused hardware resources and does not interfere with other users. It also ensures that the resultant test data from a channel group is sent to the channel group’s owner.

Open System Architecture

The Model 4500-MTS’s architecture is based on standard PC technology including Windows 2000, the PCI bus, and the ISA bus. While the Model 4500-MTS can be used as a remotely controlled instrument, it can also be used as a self-contained system.

Application development environments such as Microsoft® Visual Basic or LabVIEW™ can be loaded directly onto the Model 4500-MTS and used to build applications for controlling the Model 4500-MTS and other instruments. Third party PCI cards can be installed in the system to provide a broad range of capabilities, including: a GPIB interface for controlling external instruments, digital I/O to interface with component handlers and robots, etc.
### CURRENT SOURCE

<table>
<thead>
<tr>
<th>RANGE</th>
<th>MODEL</th>
<th>PROGRAM RESOLUTION</th>
<th>PROGRAMMING ACCURACY (1 Year)</th>
<th>PROGRAMMING ACCURACY (24 Hr. 1)</th>
<th>NOISE TYPICAL 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>±50,000 mA</td>
<td>4510</td>
<td>2 µA</td>
<td>0.06%</td>
<td>0.065%</td>
<td>35 µA</td>
</tr>
<tr>
<td>±100,000 mA</td>
<td>4510/4511</td>
<td>5 µA</td>
<td>0.08%</td>
<td>0.065%</td>
<td>43 µA</td>
</tr>
<tr>
<td>±500,000 mA</td>
<td>4511</td>
<td>15 µA</td>
<td>0.08%</td>
<td>0.065%</td>
<td>45 µA</td>
</tr>
<tr>
<td>±1,000 A</td>
<td>4511</td>
<td>25 µA</td>
<td>0.08%</td>
<td>0.065%</td>
<td>72 µA</td>
</tr>
</tbody>
</table>

### CURRENT SOURCE LOAD VOLTAGE MEASUREMENT

<table>
<thead>
<tr>
<th>RANGE</th>
<th>MEASUREMENT ACCURACY (1 Year)</th>
<th>MEASUREMENT ACCURACY (24 Hr.)</th>
<th>DEFAULT MEASUREMENT RESOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>±6.000 V</td>
<td>±0.06%</td>
<td>±0.25%</td>
<td>±0.25%</td>
</tr>
</tbody>
</table>

### CURRENT SOURCE VOLTAGE COMPLIANCE

<table>
<thead>
<tr>
<th>RANGE</th>
<th>PROGRAMME RESOLUTION</th>
<th>PROGRAMMING ACCURACY (1 Year)</th>
<th>PROGRAMMING ACCURACY (24 Hr. 1)</th>
<th>DEFAULT MEASUREMENT RESOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10.000 V</td>
<td>400 µV</td>
<td>0.1%</td>
<td>0.07%</td>
<td>0.1%</td>
</tr>
<tr>
<td>±500 µA</td>
<td>0.1%</td>
<td>0.06%</td>
<td>0.06%</td>
<td>0.06%</td>
</tr>
<tr>
<td>±10.000 mA</td>
<td>0.1%</td>
<td>0.06%</td>
<td>0.06%</td>
<td>0.06%</td>
</tr>
</tbody>
</table>

### MISCELLANEOUS

AUTOMATIC OFFSET COMPENSATION: The user can command the 451x-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.

### REMOTE/LOCAL SENSE

Automatic: remote sense and proper zero are required to meet rated accuracy Remote: Up to 0.5V drop from card bracket to DUT.

### OVER TEMPERATURE PROTECTION

Internally sensed. Operating temperature range is -10°C to 50°C. Over temperature protection: 4500-MTS models have a temperature cut-off at 100°C. Series 4500 card specifications.
Multi-Channel IV Test System

Model 4500-MTS Chassis Specifications

**DESCRIPTION**
The Model 4500-MTS is a fully integrated, instrument grade industrial computer with the following features:

- Total of 10 PCI slots, with 9 PCI instrument slots available to user. One ISA instrument slot. One PICMG CPU slot.
- Trigger bus for cross-card measurement synchronization. Dedicated connector on each instrument slot.
- High power, low noise instrument grade power supply. Dedicated connector on each instrument slot.
- Embedded PC with Windows operating system.
- VGA interface for driving an external monitor.
- 10/100 Base-T LAN interface.
- USB interface.
- RS-232 interface.
- Printer interface.
- Hard disk drive.
- CD-ROM disk drive with software.
- Floppy disk drive.
- Steel chassis with enhanced cooling, painted cover, and plastic front bezel.
- Optional integrated flat panel Display.
- Full size keyboard with integrated pointing device.

**ACCESSORIES**
The following Keithley products are currently validated for use with the 4500-MTS:

- KPCI-PIO32IOA and KPCI-PDISO8A (16I/16O and 8I/8O ISA cards)
- KPCI-PIO32IOA and KPCI-PDISO8A (16I/16O and 8I/8O ISA cards)
- PIO-32 (32-Channel Isolated Digital I/O Card)
- KPCI-3110 (1.25MHz Multifunction AIO PCI Card)
- KPCI-3116 (250kHz Low Gain AIO PCI Card)
- Dual slot (32-Channel Isolated Digital I/O ISA Card)

Other Keithley PCI and ISA cards could be to be used with the Model 4500-MTS, but compatibility has not been verified at the time of this printing.

**SYSTEM BACKPLANE**
**PCI SLOTS:** Ten total. Nine slots are available for PCI instrumentation. One slot reserved for COMPLIANCE: PCI 2.1-2.3 (determined by embedded PC).

**ISA SLOTS:** One 16-bit slot.

**PCI/ISA SLOTS:** One.

**COMPLIANCE:** PICMG 2.0.

**SIDEBAND/TRIGGER BUS**
Reserved for use by 451X instrument cards (internal only).

**SYSTEM POWER SUPPLIES**
The 4500-MTS mainframe utilizes two power supplies. The ATX power supply provides power to the computer components (e.g., embedded PC, disk drives, etc.) and PCI bus. The Instrument power supply provides 48V power to the 451X instrument card output stages.

**ATX POWER SUPPLY:** 70 watts max.

**Output Voltage (Max. Current):** +5V (20A), +12V (6A), –12V (0.8A).

**INSTRUMENT POWER SUPPLY:** +48V (16A max).

**EMBEDDED PC**
**PROCESSOR:** Intel Pentium 4, 2GHz.
**CHIPSET:** Intel 440.
**MEMORY:** Up to 2GB, 200/266MHz DDR SDRAM on two 184-pin DIMM sockets.
**VIDEO:** ATI Mobility Radeon graphics controller. 16MB DDR SDRAM display cache. Flat panel LCD support and simultaneous SVGA support.
**LAN:** 10/100 Base-T RJ-45 connector on option card retainer bracket.
**USB:** One port on option card retainer bracket (Type 2).
**SERIAL:** One port, 9 pin, COM1.
**PARALLEL:** One port, 25 pin.
**IDE:** Two IDE ports with Ultra DMA 33/66/100 support.
**FLOPPY:** One port.

**DISK DRIVES**
**HARD DRIVE:** Interface: IDE, capacity 40GB.
**FLOPPY DISK:** Size: 3.5”, capacity 1.44MB.
**CD-ROM:** Interface: ATAPI, IDE.

**CHASSIS**
**MATERIAL:** Stainless steel inner chassis and rear panel. Painted steel cover.

**FAN:** High reliability cooling fan.

**GENERAL SPECIFICATIONS**

**POWER SUPPLY:**
- Power Per Slot Max.: 90W for 48V/8.75W for ATX Mains: Pushbutton ON/OFF switch/fused/power module combo.
- Temperature: Operating: 0° to +40°C (with no accessory cards).
- Storage: –15° to 60°C.
- Humidity: Operating: 5% to 95% RH, non-condensing.
- Power Requirements: 100–240VAC, 50/60Hz.
- Input Power Rating: 1kVA.
- Warm Up Time: One hour.

**REGULATORY COMPLIANCE:**

**DIMENSIONS:** 22.3cm high × 43.6cm wide × 28.1cm deep (8.75 in. × 17.2 in. × 11 in.).

**WEIGHT (Approx.)**
- 26.3kg (58 lbs.) for base system (excluding multi-channel cards, cables, keyboard, etc.).