

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) ¹ (23°C ±1°C) | | | Noise Typical ² (peak to peak) 0.1Hz – 150kHz |
|------------|-----------|------------------------|---|-------|--------|---|-------|--------|--|
| | | | ±(%rdg. + amps + amps* $[(V_o/V_{fs}) - I_o/I_{fs}])^5$ | 7.4µA | 4.3µA | ±(%rdg. + amps + amps* $[(V_o/V_{fs}) - I_o/I_{fs}])^5$ | 3.5µA | 4.3µA | |
| ±30.000mA | 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) ¹ (23°C ±1°C) | | | Typical ^{2,7} Output Slew Rate mA/µs |
|------------|-----------|--------------------------------|---|-------|--------|---|-------|--------|---|
| | | | ±(%rdg. + amps + amps* $[(V_o/V_{fs}) - I_o/I_{fs}])^5$ | 2.5µA | 4.3µA | ±(%rdg. + amps + amps* $[(V_o/V_{fs}) - I_o/I_{fs}])^5$ | 1.5µA | 4.3µA | |
| ±30.000mA | 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 processed³.

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 maximum⁴.

CURRENT SOURCE LOAD VOLTAGE MEASUREMENT

| Range | Measurement Accuracy (1 Year) (23°C ±5°C) ±(%rdg. + volts) | Measurement Accuracy (24 hr) ¹ (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) ¹ (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 ⁶ Accuracy (1 Year) (23°C ±5°C) ±(%rdg. + volts) | Programming Accuracy (24 hr) ¹ (23°C ±1°C) ±(%rdg. + volts) | Default Measurement Resolution | Measurement Accuracy (1 Year) (23°C ±5°C) ±(%rdg. + volts) | Measurement Accuracy (24 hr) ¹ (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 processed³.

VOLTAGE OUTPUT SLEW RATE: < 0.01 V/µs typical², resistive load after command is processed.

VOLTAGE NOISE: 10 µV RMS, 0.1Hz to 10Hz typical².

CURRENT LIMIT: 11 mA to 30 mA^{3,8}

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

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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) ¹ (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 mV³.

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.

% RELATIVE HUMIDITY

| TEMPERATURE | 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. Slew rates 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.