

## F460 Four-channel Fast Current Measurement Device

### Features

- Four independent fully parallel four-range I-V converters
- Dynamic range 0.1 nA to 1 mA
- Integrated digitization and filtering
- On-board data buffer
- Fibre-optic, RS-232 / RS-485 and Ethernet interfaces
- Integrated calibration test sources
- Independent channel control
- External trigger capability
- Four independent frequency monitor outputs
- Optional dual servo controllers
- Optional high voltage output



### Applications

- Quadrant photodiode readout
- Beam position monitors
- Segmented Faraday collectors
- Current and charge measurement
- Servo control based on current measurement

### Options

- Auxiliary HV output options up to +/- 3000V
- Dual servo controller option

### Current inputs

Number	Four, independent parallel
Operating principle	I-V convertor (transconductance amplifier) with four ranges
Dynamic current range	0.1 nA to 1 mA, bipolar
Individual current ranges	Four, independently selectable for each channel. Range 1: +/- 1 mA full scale Range 2: +/- 100 $\mu$ A full scale Range 3: +/- 10 $\mu$ A full scale Range 4: +/- 1 $\mu$ A full scale
Input impedance	$\leq 40 \Omega$
Input protection	Back to back diodes and spark gaps
Noise	< 0.01% of full scale rms, 1 ms averaging
Absolute accuracy	Readings within +/- 0.1% full scale relative to a traceable external standard current source
Stability	Output drift < 10 ppm hr <sup>-1</sup> +5 ppm °C <sup>-1</sup> hr <sup>-1</sup> with recalibration Output drift < 20 ppm hr <sup>-1</sup> +10 ppm °C <sup>-1</sup> hr <sup>-1</sup> without recalibration
Analogue bandwidth	DC to $\geq 40$ kHz (-3dB)
Gain uniformity	Better than 0.1% across all channels after calibration
Digitization	16 bit successive approximation bipolar, 250 kHz, fully parallel
Downsampling	Averaging adjustable from 1 (4 $\mu$ s period) to 250000 (1s period)

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Simultaneity	All channels converted at once (within 200ns)
Accumulation	Charge accumulation provided via numeric integration
Triggering	External trigger line can start, pause and stop acquisition via TTL level signal to gate input Input impedance 2.5 k $\Omega$
Digital filtering	Block averaging of successive conversions for each reading, 1 to 250000 samples
Data buffering	On-board buffering of up to 50000 contiguous samples at any data rate up to maximum

### Calibration

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Method	Fully automatic calibration of current inputs using internal current sources
Calibration currents	Two internal precision calibration sources, 833 nA and 83.06 $\mu$ A, used for automatic calibration
Calibration values	Gain and offset stored in NVR for each range of each channel
Sensor compensation	Independent calibration input available to compensate sensor variability
Other calibrations	Gain and offset parameters stored for general purpose analogue inputs and outputs, and for high voltage

### Monitor Outputs and General Purpose Input/Output

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Analogue inputs	Two, 16-bit +/- 10 V. Accuracy better than +/- 0.5% of full scale
Analogue outputs	Four, 16 bit +/- 10V (used for servo and monitor outputs). Accuracy better than +/- 0.1% of full scale
Digital outputs	Four, TTL levels into 50 $\Omega$ (used for monitor outputs)

### High Voltage Outputs

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Number	One (optional)
Output power	1 watt
Voltage options	20 to 200 V. Line <0.01%. Load <0.05%. Ripple < 0.01% 50 to 500 V. Line <0.01%. Load <0.01%. Ripple < 0.01% 200 to 2000 V. Line <0.001%. Load <0.01%. Ripple < 0.01% 300 to 3000 V. Line <0.2%. Load <0.3%. Ripple < 0.075% All options available as positive or negative polarity (factory selection)
HV monitoring	Voltage divider on output (20 M $\Omega$ ), 16 bit digitization with calibration

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### Communication Interfaces

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Ethernet	Ethernet 10/100/1000 Base T, TCP/IP and UDP
RS-232	115.2 kbps/ serial
RS-485	115.2 kbps/ serial
Fibre optic	10 Mbps, binary serial protocol, for control of slave devices and integration into FMB Oxford system architectures

### Controls and Indicators

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Controls	Two rotary switches for communications mode and fibre optic loop address Push button processor reset
Indicators	Four green status LEDs "HV on" orange LED

### Power Input

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Voltage	+24V DC (+/- 2V)
Current	300 mA typical, 500 mA maximum. 500 mA PTC fuse

### Case

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Format and materials	Stainless steel sheet metal case with mounting flanges
Protection rating	The case is designed to rating IP43 (protected against solid objects greater than 1mm in size, protected against spraying water)
Weight	1.28kg (2.82 lb)

### Environment

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Operating	10 to 35 °C (20 to 30 °C recommended) < 70% humidity, non-condensing Vibration < 0.1g all axes (1 to 100Hz)
Storage	-10 to 50 °C < 80% humidity, non-condensing Vibration < 2.0g all axes (1 to 100Hz)

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### Interfacing

Interfaces	<p>RS-232 or RS-485, 8-bit ASCII. Selectable baud rate up to 115 kbos. The electrical interface can be set to be RS-232 levels, or full-duplex differential RS-485</p> <p>Fibre-optic loop, 10 Mbit/sec serial, 9-bit asynchronous binary</p> <p>Ethernet 10/100/1000BaseT, auto MDIX. TCP/IP protocol. Average continuous data rate to host up to 1 kHz typical; higher in lightly-loaded systems</p>
Host computer	<p>ASCII serial communications based on SCPI.</p> <p>C++ function libraries available for Windows and Linux systems.</p> <p>Enquire for EPICS, TANGO and SPECS support.</p> <p>Enquire for Labview ® VI availability</p> <p>PSI Diagnostic host software supplied with each F460</p>
Slave devices	<p>Up to 15 slave devices may be connected to the fibre optic loop and can be accessed through the F460 ethernet connection. Example devices include general purpose I/O devices, other current measurement devices and magnetic measurement devices</p>

### Monitor Outputs

Number	<p>Four, independent analog voltage</p> <p>Four, independent frequency TTL levels</p>
Signal type	<p>Analog voltage +/- 10 V into 10 kΩ, 16 bit.</p> <p>Frequency 0 to 1 MHz 5V square wave, 20 mA max</p>
Software-selectable output parameter options	<p>Current, (relative to selected full scale for relevant input) all outputs active</p> <p>Independent position, two outputs</p> $X = (INA - IND) / (INA + IND)$ $Y = (INB - INC) / (INB + INC)$ <p>Quadrant position, two outputs active</p> $X = ((IN1A + INC) - (INB + IND)) / (INA + INB + INC + IND)$ $Y = ((IN1A + INB) - (INC + IND)) / (INA + INB + INC + IND)$ <p>Servo command, one analog output reserved per servo controller</p>

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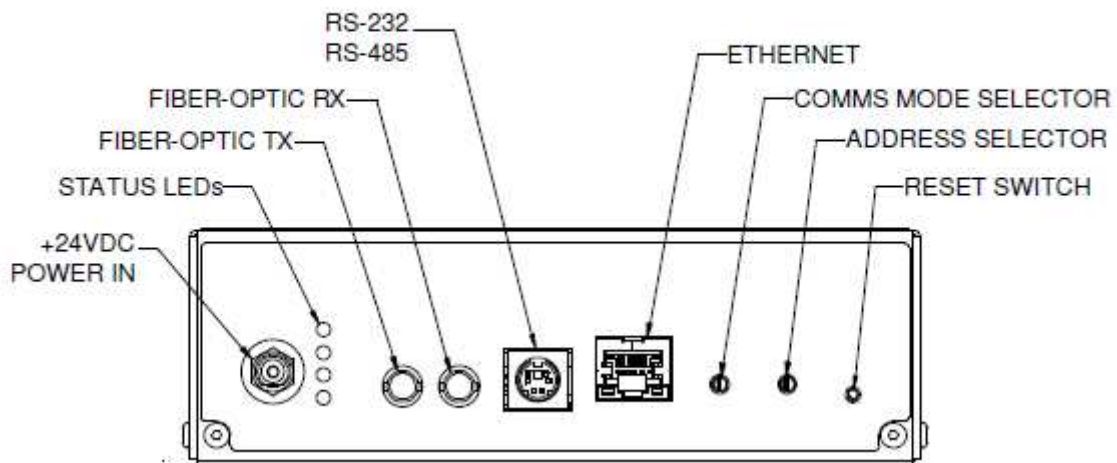
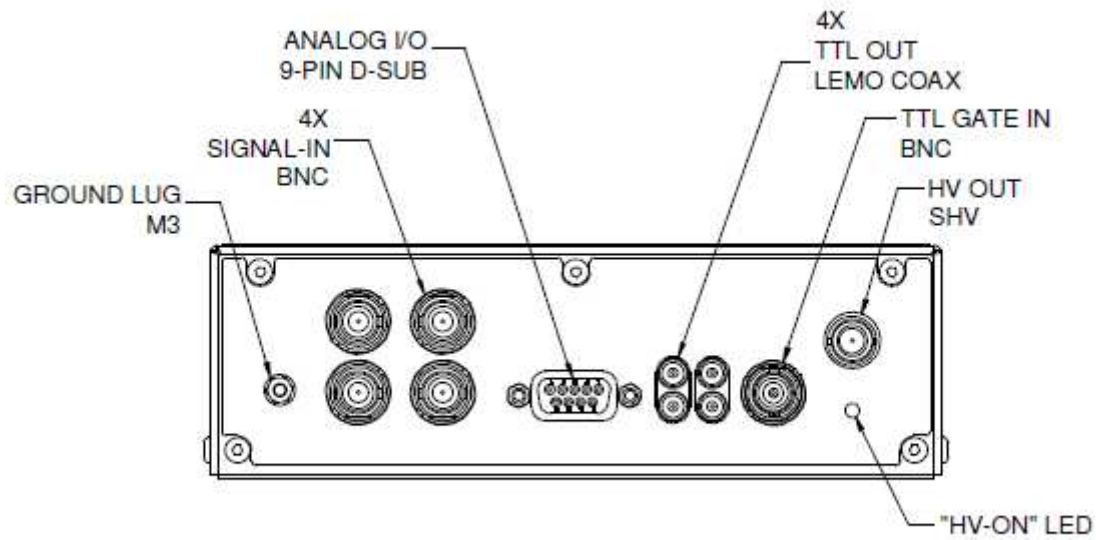
### Servo control option

Principle	The F460 measures four currents, from devices such as ionisation chambers, photodiodes or secondary electron emission electrodes. The value of a process variable formed as an arithmetic function of the measured currents is maintained by adjusting a +/- 10 V control output using a PI control algorithm. An analog input can be used for any direct feedback from the controlled device.
Typical applications	Beam intensity stabilization for Double Crystal Monochromators. Beam position control in charged particle or photon beamlines. Beam current stabilisation in particle beam systems.
Number of controllers	The F460 can run two independent PID controllers, each using a process variable comprising an arithmetic combination of the measured currents.
Process variable options	Individual currents, sums or differences of currents, ratios of currents, ratios of sums and differences of currents. These options allow position functions to be defined as process control variables.
Servo frequency	2000 Hz maximum
Automated functions	Peak scan Suspend on defined control output limits Suspend on low input signal(s) Input signals ratio to value sent by host system (for example electron synchrotron ring current, so that the servo does not attempt to track ring current decay)

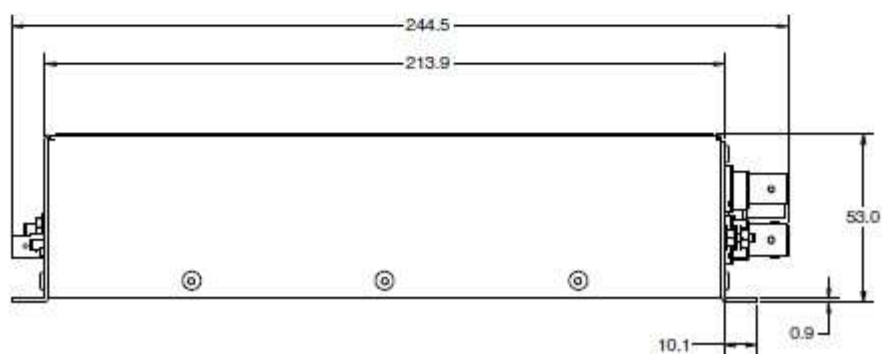
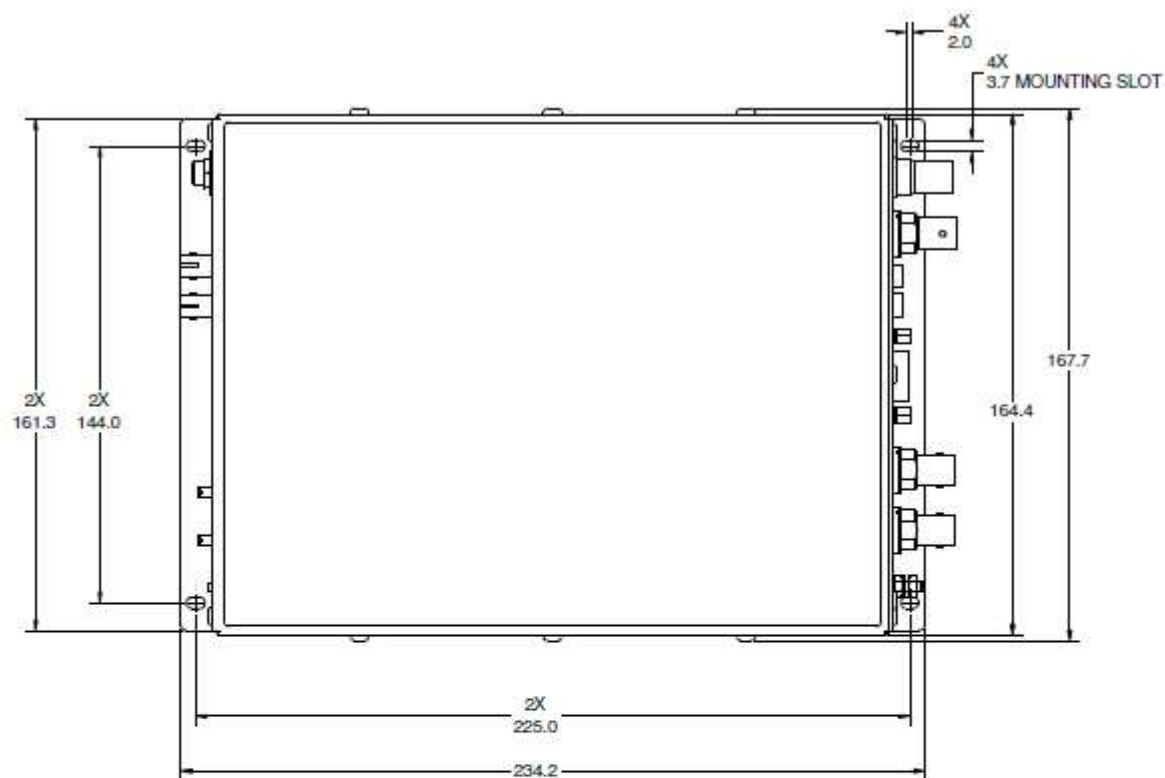
### Connectors

Signal inputs	Four BNC isolated from chassis										
HV bias out	SHV										
External gate in	BNC isolated from chassis										
Monitor outputs (TTL)	Four Lemo coax size 00										
Analog signals	DSub female 9 pin										
	<table border="0" style="width: 100%;"> <tr> <td style="width: 50%;">1 Analog gnd</td> <td style="width: 50%;">6 Analog out 1 (servo1)</td> </tr> <tr> <td>2 Analog in 2</td> <td>7 Analog in 1</td> </tr> <tr> <td>3 +24 V, 200 mA out</td> <td>8 0V</td> </tr> <tr> <td>4 Analog out 2</td> <td>9 Analog out 3</td> </tr> <tr> <td>5 Analog out 4</td> <td></td> </tr> </table>	1 Analog gnd	6 Analog out 1 (servo1)	2 Analog in 2	7 Analog in 1	3 +24 V, 200 mA out	8 0V	4 Analog out 2	9 Analog out 3	5 Analog out 4	
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RS-232 / RS485	Six pin mini-DIN ("PS/2")										
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Fibre optics	TX & RX ST bayonet, suitable for 1mm plastic fibre or 200 µm HCS fibre										
Ethernet	RJ-45 jack										
Power in	2.1mm threaded jack. Mates with Switchcraft S761K or equivalent										
Ground	M3 threaded stud										

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Dims mm

### Ordering Information

F460	F460 four channel electrometer, user manuals, software drivers, calibration data.
-XP3000/2000/1000/500/200	Add auxiliary HV bias supply positive 3000 V / 2000 V / 1000 V / 500 V / 200 V
(-XN)	(negative)
(-S1)	Add PID controller function