F3200E

Thirty-Two Channel
Fast Current Digitizer

User Manual

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1 Contents

2 Figures

3 Safety Information

This unit is designed for compliance with harmonized electrical safety standard EN61010-1:2000. It must be used in accordance with its specifications and operating instructions. Operators of the unit are expected to be qualified personnel who are aware of electrical safety issues. The customer's Responsible Body, as defined in the standard, must ensure that operators are provided with the appropriate equipment and training.

The unit is designed to make measurements in **Measurement Category I** as defined in the standard.

CAUTION. According to installed options the F3200E can generate high voltages as follows, present on the central conductor of the "HV out" SHV (Safe High Voltage) connector.:

+ or – 2000 V DC at 0.5 mA maximum.
or
+ or – 1000 V DC at 1.0 mA maximum
or
+ or – 500 V DC at 2.0 mA maximum
or
+ or – 200 V DC at 5.0 mA maximum

The hazardous live voltages on the SHV central conductor are not accessible under the definitions of EN61010 but may nevertheless give a noticeable shock if misuse were to lead you to come into contact with them. The user must therefore exercise appropriate caution when using the device and when connecting cables. Power should be turned off before making any connections.

In applications where high energy charged particle beams can strike electrodes which are normally connected to the F3200E, voltages limited only by electrical breakdown can build up if the F3200E is not connected to provide the earth return path. The user must ensure that a suitable earth return path is always present when the particle beam may be present.

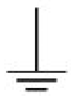
The unit must not be operated unless correctly assembled in its case. Protection from high voltages generated by the device will be impaired if the unit is operated without its case. Only Service Personnel, as defined in EN61010-1, should attempt to work on the disassembled unit, and then only under specific instruction from Pyramid Technical Consultants, Inc.

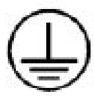
The unit is designed to operate from +24VDC power, with a maximum current requirement of 1100 mA. A suitably rated power supply module is available as an option. Users who make their own power provision should ensure that the supply cannot source more than 5 A.

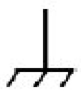
A safety ground must be securely connected to the ground lug on the case.

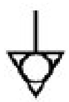
Some of the following symbols may be displayed on the unit and have the indicated meanings.

 Direct current

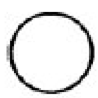
 Earth (ground) terminal

 Protective conductor terminal

 Frame or chassis terminal

 Equipotentiality

 Supply ON

 Supply OFF

 CAUTION – RISK OF ELECTRIC SHOCK

 CAUTION – RISK OF DANGER – REFER TO MANUAL

4 Models

F3200E	Thirty-two channel fast current digitizer.
-XP20/10/5/2	Add positive 0 to 2000V / 1000 V / 500 V / 200 V auxiliary bias output
-XN20/10/5/2	Add negative 0 to 2000V / 1000V /500 V / 200 V auxiliary bias output

Example:

F3200E-XP10 F3200E with 1000V positive auxiliary high voltage output.

5 Scope of Supply

F3200E model as specified in your order.

PSU24-40-1R 24 VDC power supply.

USB memory stick containing:
- F3200E User manual
- F3200E datasheet
- Pyramid DiagnosticG2 software installation files
- Pyramid IG2 software installation files
- Firmware files
- Test data

ADAP-D9F-MINIDIN Serial port adaptor

ADAP-USB-RS232 USB to RS232 adaptor

ADAP-LEMO-BNC Lemo 00 to BNC coaxial adaptor.

Optional items as specified in your order.

OEM customers may not receive all the accessories noted above.

6 Optional Items

6.1 Power supplies

PSU24-40-1R +24 VDC 40W PSU (universal voltage input, plug receptacle for standard IEC C14 three-pin socket) with output lead terminated in two-pin Redel PXG locking connector.

PD-8 Eight output +24 VDC power supply unit, 19” rack mounting

6.2 Signal cables and cable accessories

CAB-D25F-25LN-D25M Cable, low-noise screened, D25 female to D25 male, 25’.

CAB-D25F-25-D25M Cable, standard screened, D25 female to D25 male, 25’.

CAB-SHV-25-SHV Cable, coax HV, SHV to SHV, 25’.

CAB-L00-25-L00 Cable, coax 50 ohm, Lemo 00 to Lemo 00, 25’

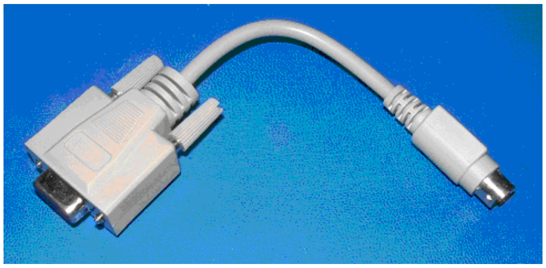
CAB-L00-25-BNC Cable, coax 50 ohm, Lemo 00 to BNC, 25’

Other cable lengths are available from 2’ up to 100’.

ADAP-LEMO-BNC Adaptor, Lemo 00 to BNC (for gate in and out adaption)

6.3 Data cables

ADAP-D9F-MINIDIN AB450K-R Adaptor RS-232 6 pin DIN male to 9 pin D sub female adaptor for serial port.



CAB-ST-HCS-xxx-ST Fiber-optic cable 200 µm multimode silica fiber ST terminated with color-coded sleeves, xxx foot length. A pair of cables is required to connect a single device.

6.4 Fiber-optic loop

A360 Fiber optic loop controller for two loops.

A560 intelligent real-time cell controller for ten loops with Ethernet interface and interlock functions.

X14 fiber optic fanout, one input, four outputs for trigger distribution.

X22 bidirectional TTL to optical converter for trigger distribution.

7 Intended Use and Key Features

7.1 Intended Use

The F3200E is intended for the parallel measurement of currents (from nA to mA) generated by devices such as Faraday cup arrays, ionization chambers, in-vacuum wire grid arrays, multiwire proportional chambers and photodiode arrays. The F3200E has design features which make it tolerant of electrically noisy environments, but the place of use is otherwise assumed to be clean and sheltered, for example a laboratory or light industrial environment. The unit may be used stand-alone or networked with other devices and integrated into a larger system. Users are assumed to be experienced in the general use of precision electronic circuits for sensitive measurements, and to be aware of the dangers that can arise in high-voltage circuits.

7.2 Key Features

Thirty-two fully-parallel multi-range transconductance amplifiers (I-V converters).

Thirty-two fully parallel 1 MSa/s analog to digital converter channels.

External gate input for synchronized data collection.

External gate output for triggering external events.

Analog monitor output which can track any arithmetic sum of selected input channels

Multiple data acquisition modes
- Unbuffered continuous streaming
- Buffered contiguous data capture at high rates
- Sweep mode for repetitive signals with 1 MHz sampling within the sweep.

Dynamic range 0.1nA to 10 mA.

Built-in calibration check current sources which can be switched to each channel.

Fully-automated internal self-calibration.

Built-in switched 5V test voltage for connection to external resistor arrays, for continuity checking.

Ethernet interface with TCP/IP and UDP messaging.

Fiber optic looped device capability (future option).

F3200E can act as a fiber-optic loop controller.

F3200E can be operated in a fiber-optic serial communication loop with up to fifteen other devices.

RS-232, RS-485 serial interfaces built-in. Selectable baud rates.

Actuator I/O port with switched +24 VDC, switched +5 VDC output suitable for driving a pneumatic actuator solenoid plus two opto-isolated digital inputs suitable for reading limit switches.

General purpose I/O port with three precision analog outputs, four precision differential analog inputs, four TTL digital outputs, four TTL digital inputs.

Analog output 1 can be set as a real time monitor of sum of any selected channels.

Two fiber-optic digital outputs for process control

Auxiliary HV output option up to + or – 2000 VDC.

HV input for loopback verification of HV bias on external electrodes.

8 Specification

Current inputs	Thirty-two, independent parallel
Current ranges	Four, 10 mA, 1 mA, 100 µA, 10 µA, fully bipolar. Ranges can be set for each group of two channels (future option).
Input impedance	<= 40 ohm
Input protection	Back to back fast diode pair to analog ground. Optional series resistor.
Equivalent noise current (unloaded)	< 0.1% of full scale, any current range for 1 MHz conversion rate. Improves by $1/\sqrt{N}$ where N is number of conversions averaged into each sample, to a minimum of 0.001% of full scale.
External accuracy	Maximum deviation from a reference external current source < +/-(0.1% of full scale current + 0.1% of nominal current), after calibration.
Internal calibration currents	83.33 (+/- 0.03) mA (10 mA range) 8.333 (+/- 0.003) mA (1 mA range) 833.3 (+/- 0.3) µA (100 µA range) 83.33 (+/- 0.03) µA (10 µA range) Used by automated internal calibration routine to derived gain and offset for each channel on each range.
Analog bandwidth	Anti-aliasing filter DC to 250 kHz (-3dB) with four pole filter roll off on 10 mA and 1 mA ranges. 100 µA and 10 µA ranges have DC to greater than 50 kHz bandwidth.
Measurement drift	< 0.5% over 12 hours (environment 20 (+/- 2) C.
Calibration source drift	< 3 ppm / C
Linearity	Deviation from best fit line of individual readings < 0.1% of full scale.
Digitization	14 bit over bipolar range, 1 MHz. Thirty-two ADC channels. Effective digitization increased by averaging.
Simultaneity	All ADCs convert together to <20 nsec.
Data capture	32 channels converted and transferred to local memory in < 500 nsec.
Digital filtering	Block averages of 1 to 65534 ADC conversions (downsampling). 32 bit counter depth.

Local buffering	Up to 65535 points each of 32 channels in buffered mode. Up to 1000 points each 32 channels in sweep mode.
Acquisition modes	Internal (free running and continuous transfer to host) Buffered mode (on-board buffering of contiguous blocks of readings). Sweep mode (on-board buffering of triggered acquisitions, averaging across multiple sweeps for repetitive signals).
External gate input	0 / +5 V (TTL level), 10 kohm input impedance.
External gate output	TTL levels, 120 mA maximum current.
Analog outputs	Three general purpose, +/-10V, 10 mA compliance. 16 bit resolution, low transition glitch energy. Maximum update rate 250 kHz.
Analog monitor output	Analog output 1 can be assigned to monitor function.
Analog inputs	Four general purpose, differential, two-pole analog low pass filter 17 kHz. 16 bit resolution, maximum conversion rate 400 kHz (downsampled to 10 kHz maximum).
Digital outputs	Four general purpose, TTL levels, 5 mA typical, 35 mA maximum (single output)
Digital inputs	Four general purpose, TTL levels. 50 kohm pull up to +5VD.
Auxiliary HV PSU (option)	0 to 2000 V / 1000 V / 500V / 200V programmable, 1W max output power. Noise and ripple <0.1% of full scale.
Actuator I/O	Two opto-coupled inputs (24 VDC nominal) for limit switch readback, one +24 V relay-switched output for actuator solenoid, one +5 VDC relay-switched test output for general purpose.
Test output	+5 VDC also available on signal inputs for remote test resistor arrays.
Power input	+24 VDC (+/-2 V), 750 mA (excluding current supplied to actuator solenoid).

Communications interfaces	Ethernet 10/100 Base T, TCP/IP and UDP. RS-232 / RS-485 115.2kbps, binary serial protocol. Fiber optic 10 Mb/s binary serial proprietary protocol.

Controls	Two rotary switches for loop address and communications mode.

	One push button for soft-reset.
Indicators	Front panel illuminated logo for power. Front panel LED for HV enabled. Eight rear panel LEDs for power, status and communications.

Case	1U 19” 250 mm deep rack mounting steel chassis with Al alloy front panel and polycarbonate decals. Fan-cooled.
Case protection rating	The case is designed to rating IP43 (protected against solid objects greater than 1mm in size, protected against spraying water).
Weight	2.8 kg (6.2 lb).
Operating environment	0 to 35 C (15 to 25 C recommended to reduce drift and offset) < 70% humidity, non-condensing vibration < 0.1g all axes (1 to 100 Hz)
Shipping and storage environment	-10 to 50C < 80% humidity, non-condensing vibration < 2 g all axes, 1 to 100 Hz
Dimensions	(see figures 1 and 2).

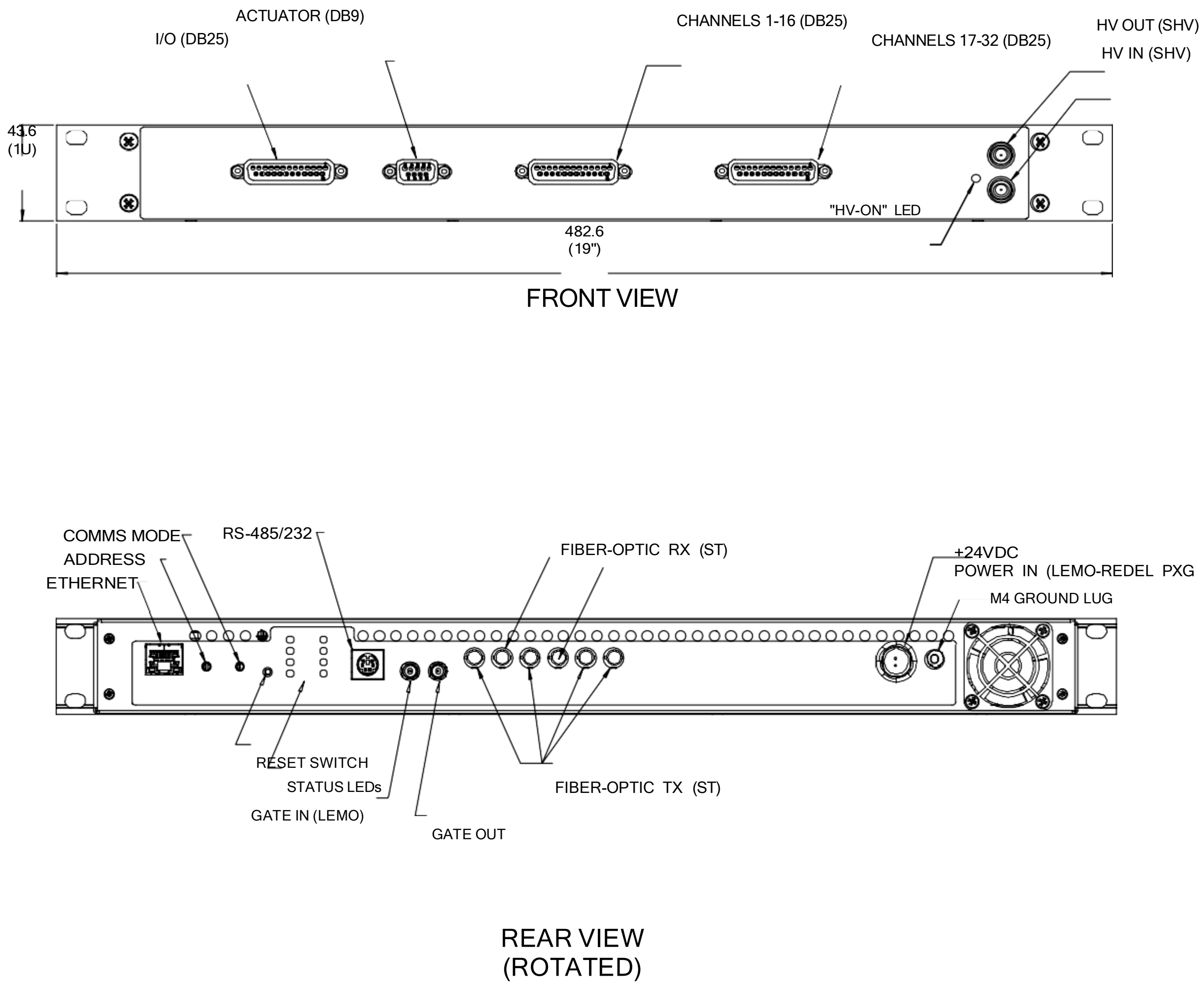


Figure 1. F3200E front and rear panels. Dimensions mm.

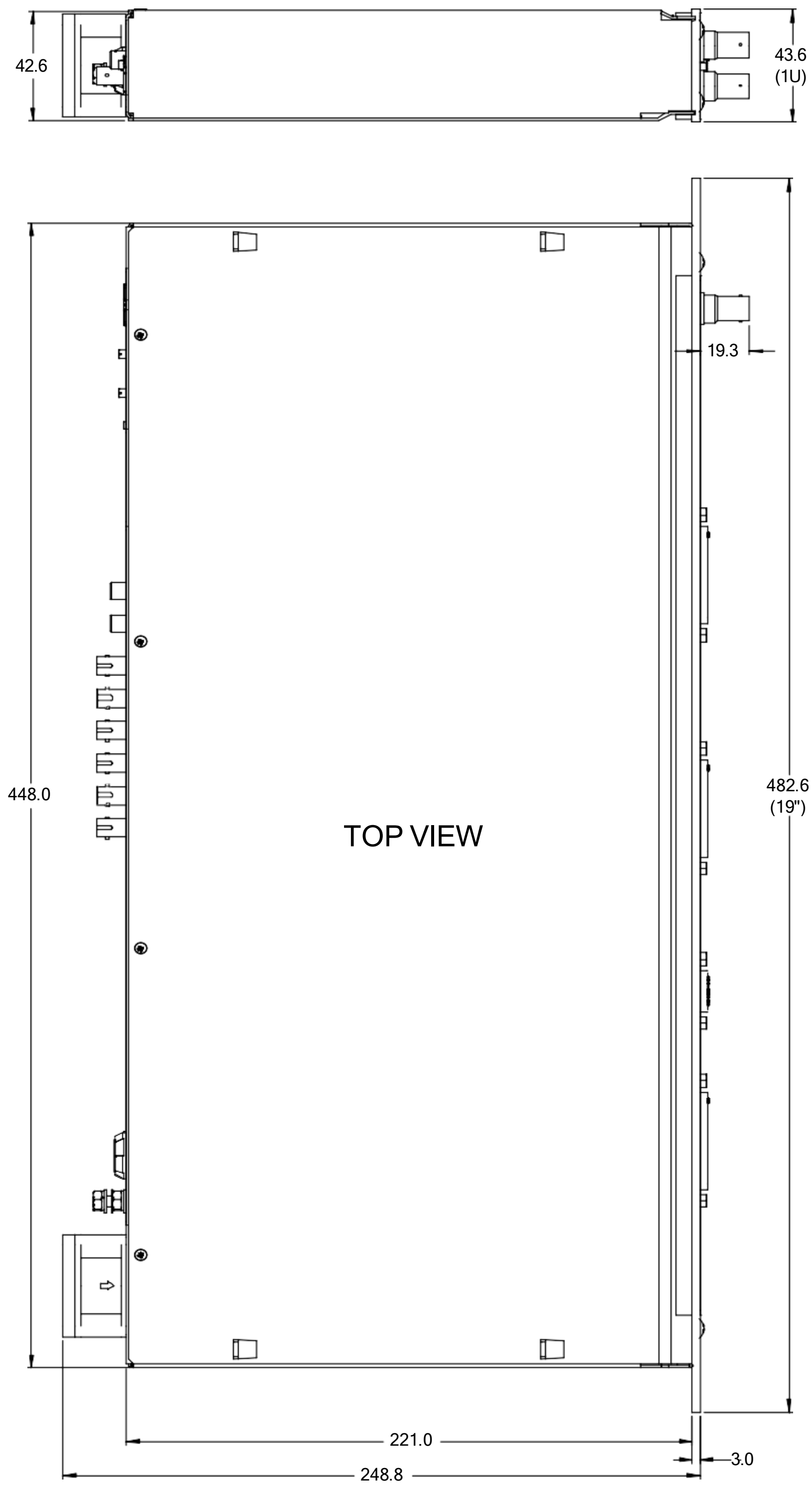


Figure 2. F3200E case plan and side views. Dimensions mm.

9 Installation

9.1 Mounting

The F3200E is intended for 19" rack mounting, but may be mounted in any orientation, or may be simply placed on a level surface. A fixed mounting to a secure frame is recommended in a permanent installation for best low current performance, as this can be degraded by movement and vibration.

The mounting position should allow sufficient access to connectors and cable bend radii. 60 mm minimum clearance is recommended at front and back of the device.

Best performance will be achieved if the F3200E is in a temperature-controlled environment. No forced-air cooling is required in addition to the unit's built-in fan, but free convection should be allowed around the back and sides of the case.

9.2 Grounding and power supply

A secure connection should be made using a ring lug, from the M4 ground lug to local chassis potential. This is the return path for any high voltage discharge passing via the F3200E.

+24 VDC power should be provided from a suitably-rated power supply with the following minimum performance:

Output voltage	+24 +/- 0.5 VDC
Output current	1000 mA minimum, 3000 mA maximum
Ripple and noise	< 100 mV pk-pk, 1 Hz to 1 MHz
Line regulation	< 240 mV

The F3200E includes an internal automatically re-setting PTC fuse rated at 1.1 A. However the external supply should in no circumstances be rated higher than 5 A.

9.3 Connection to signal source

9.3.1 Typical setup

Figure 3 shows an example installation in schematic form. It is only one possible arrangement; many others are possible. In this case thirty-two Faraday collector electrodes in a beamline system are connected to the F3200E inputs via low-noise multi-way cables. In this example, a suppression electrode is biased by the high voltage (HV) output. A loopback HV connection is made so that the F3200E can verify that the bias is reaching the suppression electrode.

A pneumatic actuator which can move the Faraday collector array is connected to the actuator connector. The general purpose I/O port is used to output an analog voltage monitor reflection of the incoming signals, for viewing on an oscilloscope for example. The other analog and digital lines can be used to control and readback other external devices.

A gate signal generated by a remote timing controller triggers the F3200E to measure data. The gate out signal is available to synchronize other equipment to the F3200E acquisition.

The F3200E is connected to the host system by Ethernet in this example, and the fiber optic loop master port is used to connect other Pyramid devices.

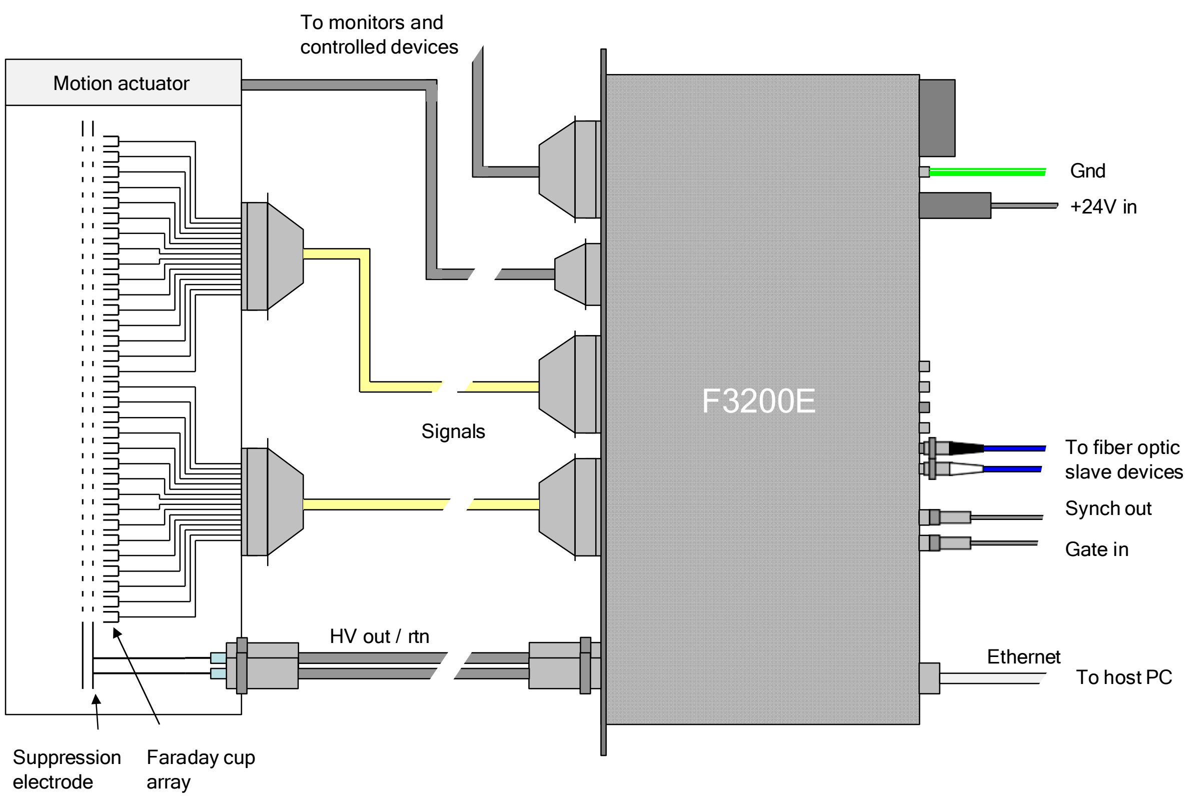


Figure 3. Schematic sample F3200E installation

The F3200E should be located as close to the source of the signal as reasonably possible. Long signal cables increase the chances of seeing unwanted signals and noise, particularly at the highest bandwidths. A maximum length of 10 m and maximum capacitive load per channel of 2000 pF is advised. Longer cables may be used up to a maximum of 50 m, but the lowest detectable current will be increased.

Other signal sources can include diode detectors, ionization chamber electrodes or any sensors which produce currents in the nA to mA range.

9.3.2 Signal cables

25-way screened cable with the minimum practicable capacitance should be used, terminated in good-quality 25-way D subminiature plugs at the F3200E end. Two such cables are required to connect up all thirty-two channels. Measurements at the bottom of the dynamic range may benefit from the use of low-noise cable. This cable is made with semi-conductive coatings on insulators to inhibit the generation of free charge (the triboelectric effect). Low current measurements can be made with standard cable, but you must take particular care that the cable cannot move or vibrate for several minutes before or during measurements.

The cable screen should be connected to chassis through the connector hood at the F3200E, and similarly to the sensor housing or vacuum vessel at the other end. In some cases you may get better noise performance if this screen is connected at one end only. The optimum arrangement can be found by experiment.

You may use any of the AGnd pins on the signal connectors for the current return path, or the cable screen, or a separate path to the chassis.

9.3.3 Signal current path

The currents measured by the F3200E must be allowed to return to their point of generation. If there is no return path, then you will see no current, or get erratic readings. Usually there will be a return path via the common ground of the F3200E chassis and the sensor enclosure, but this is not always true, so if you don’t see the currents you expect, you should look carefully at the circuit.

The currents you are measuring pass along the cable inner conductors to the F3200E inputs. The current flowing into the I-V amplifier inputs are balanced by current in the feedback which is supplied by the power supply to the amplifiers. Thus the measured current effectively flows between the terminals of the input amplifiers to the local circuit ground (AGND), due to the operational amplifier action.

Figure 4 shows a typical current path for conventional current in an application where the current originates in an ion source and is formed into a particle beam by a high voltage supply. The supply may be remote from the place where the current measurement is being made, for example the current measured by an electrode in a charged particle beamline actually originates in the ion or electron source, which could be many metres away.

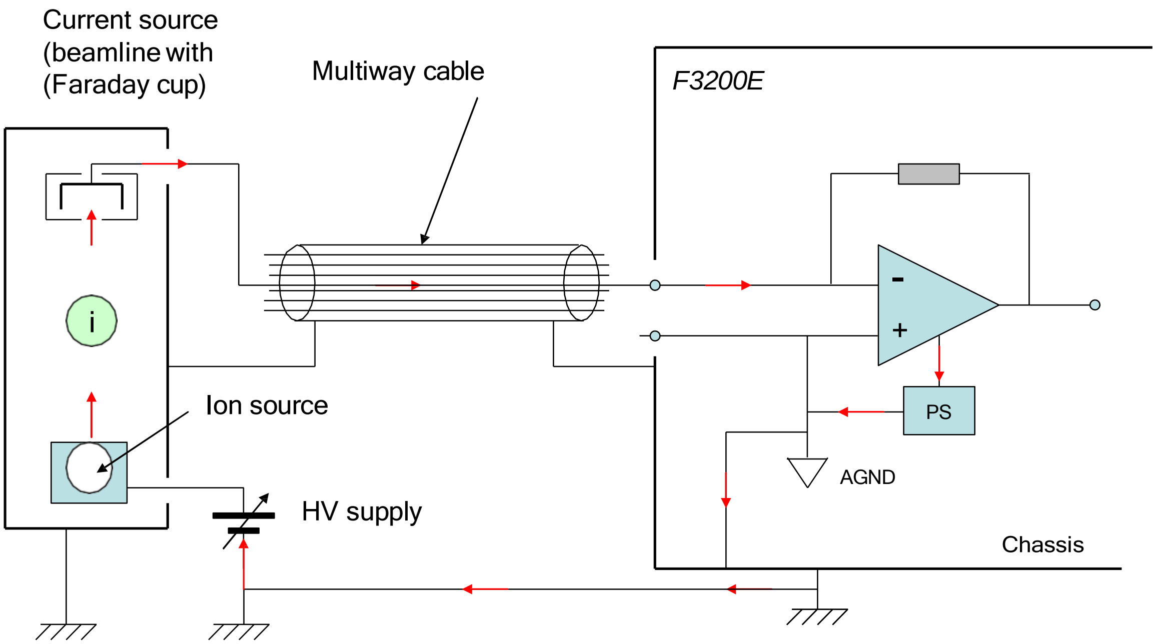


Figure 4. Circuit for measured current using an external power supply

In the case of an ionization chamber or similar device, where the F3200E is providing the bias to the chamber, the return path is through the F3200E HV supply (figure 5) to complete the circuit back to the biased electrode. If the supply is not enabled, then it appears as an impedance of approximately 0.3V kohm, where V is the rating of the supply.

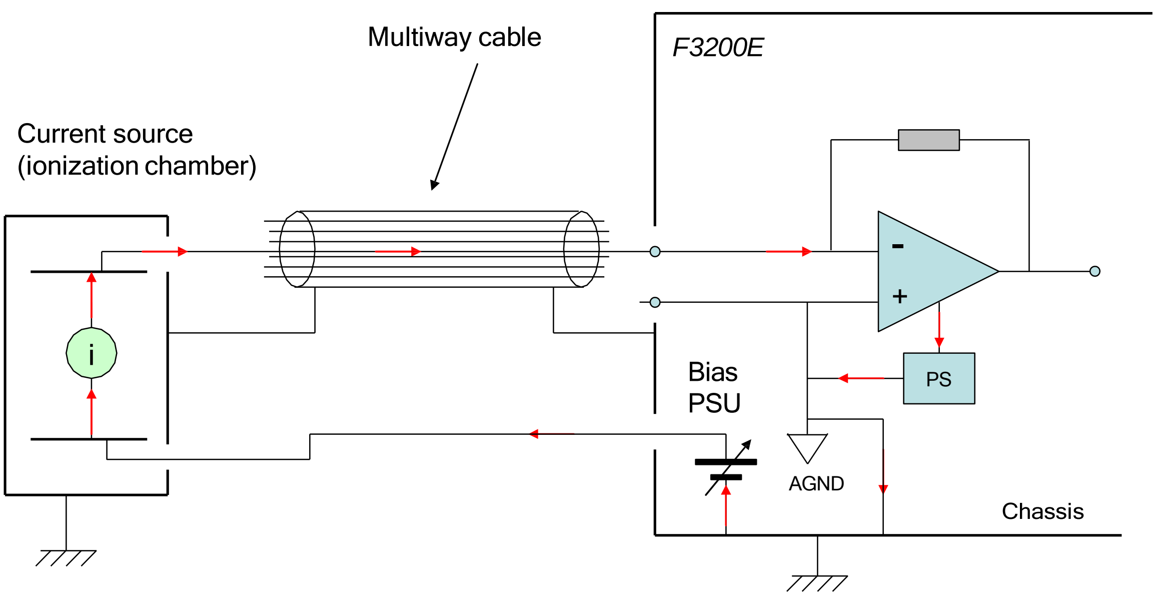


Figure 5. Circuit for measured current using the F3200E HV supply

10 How the F3200E Works - An Overview

The F3200E is a very powerful instrument which provides many facilities for measuring fast current waveforms on multiple channels. In this section we shall take a general overview of these capabilities.

All thirty-two signal channels are identical and work in synchronization. The signal currents entering the circuit are converted to voltages because equal opposite current flows through the precision feedback resistors of transconductance amplifier circuits, also known as I-V converters. After low-pass filtering to prevent aliasing in the digital domain, the voltages are converted to binary values by thirty-two high-speed analog to digital converters (ADCs). All the conversions occur simultaneously. The conversions are read by an FPGA (field-programmable gate array) which handles timing, averaging and buffering. Binary values are converted to floating point values in amps using a stored linear calibration for each channel / range combination. A second FPGA handles communications with the host computer.

10.1 Current ranges

Each F3200E channel has four current ranges ranging from +/-10 mA full scale down to +/-10 µA full scale. This is achieved by switching between amplifiers with different feedback resistor values. All channels are set to the same range. A future software release could allow the ranges to be set independently for each pair of channels if there is an application requirement.

10.2 Triggering

In many cases you will need to coordinate the F3200E measurements with external events. The gate input is a TTL signal which triggers, pauses and stops a pre-defined acquisition, according to the trigger conditions you set. The TTL signal on the gate out connector is a passthrough of the incoming gate allowing multiple devices to be daisy-chained. In sweep mode, the gate out signal indicates the time intervals when the sweep data is being taken.

10.3 Acquisition modes and averaging

The F3200E can generate very large amounts of data, more than can generally be accepted in real time by either the communications link or the host computer. For example, if all thirty-two channels are digitized at 1 MSa/s, the resulting data rate is about 1 Gb/s. The F3200E therefore provides averaging and buffering schemes that allow you to adapt the acquisition to optimize the trade-off between data rate and signal to noise ratio.

Internal mode is a simple free running acquisition. You can set the ADC conversion rate up to 1 MSa/s (1000000 Hz). This data rate will exceed the capability of the host system to absorb the data, so you would expect to see gaps in the data record (figure 6). You can reduce the sample rate to avoid this by reducing the conversion rate (figure 7). However it may be more useful to average and downsample the data by averaging a number of conversions into each reading (figure 8). This has the effect of narrowing the bandwidth, thus improving signal to noise ratio, and increasing the resolution.

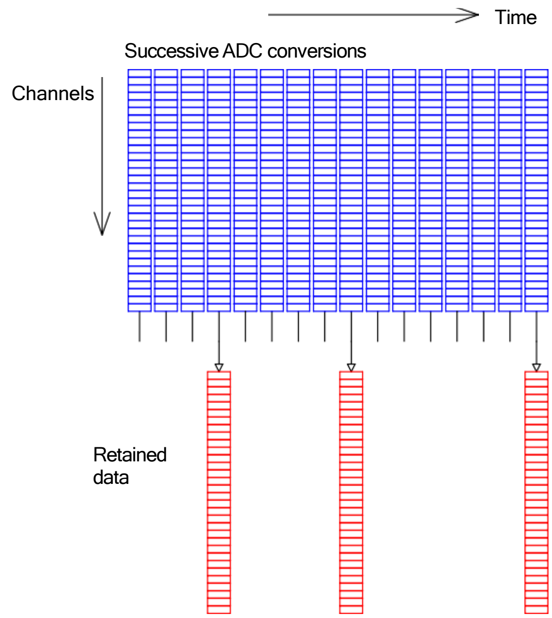


Figure 6. Data acquisition in internal mode; ADC rate exceeds capacity of communications / host computer

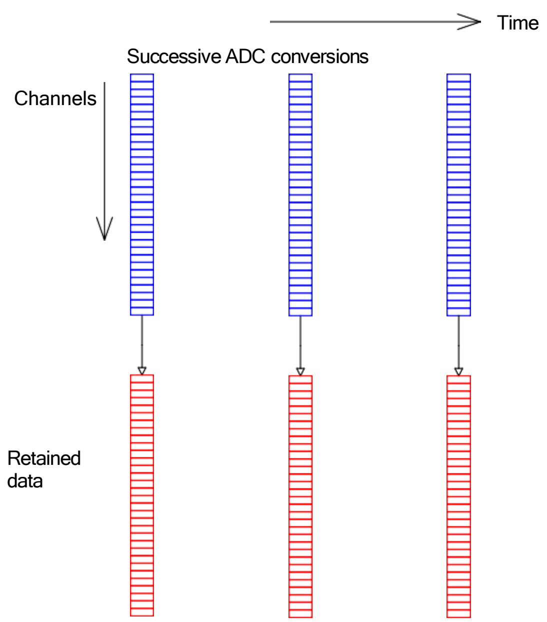


Figure 7. Data acquisition in internal mode; ADC rate reduced to match capacity of communications / host computer

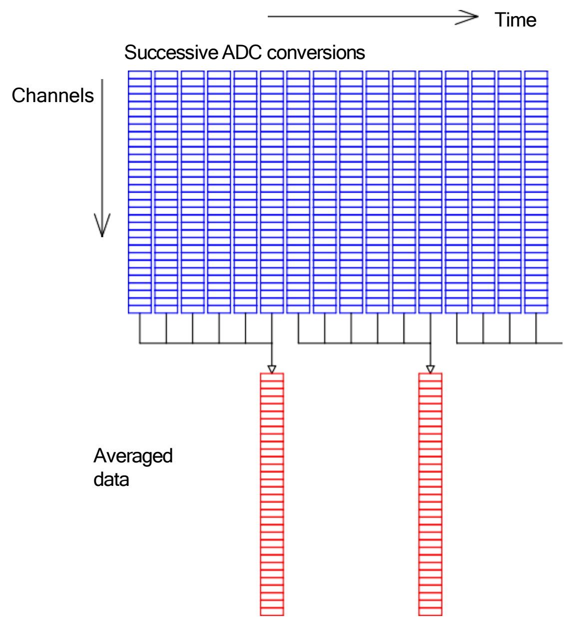


Figure 8. Data acquisition in internal mode; data rate reduced by downsampling to match capacity of communications / host computer

Buffered mode is a means of acquiring a limited contiguous set of data at high rate, so as to preserve the full time resolution. Up to 65535 readings of thirty-two channels each can be buffered in the F3200E and sent up to the host computer as a series of blocks of data. The data display on the host computer will inevitably lag behind the actual measurements because the communications channels cannot keep up with the acquisition rate, but all the data is captured and can be saved and analyzed at your convenience.

The maximum measurement rate is determined by the requested number of readings and the rate at which the internal buffers can be unloaded to the host computer. Typical values are greater than 50 kHz for 10000 readings and greater than 160 kHz for 1000 readings if the F3200E is connected via Ethernet.

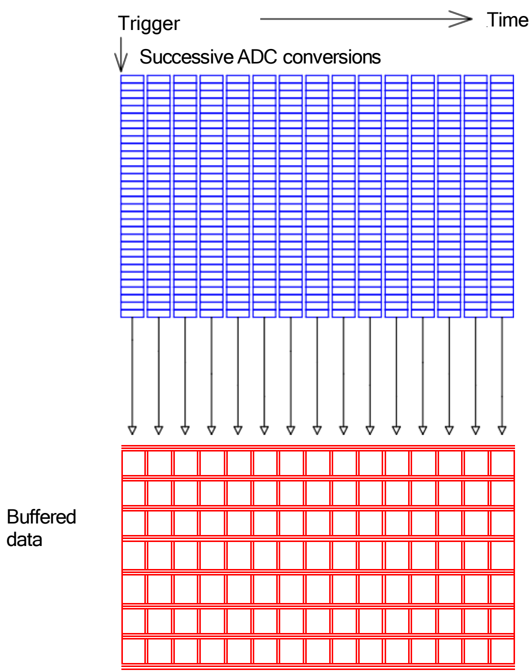


Figure 9. Data acquisition in buffered mode

Sweep mode is designed for situations where there is a repetitive signal, synchronized to some trigger. An example is a scanned charged particle beam which repeatedly passes over apertures in front of Faraday collectors. In this circumstance, we can average across multiple scans without loss of time resolution. The mode is analogous to the averaging mode of digital storage oscilloscopes. Each block of data (a sweep) can be up to 1000 samples, which corresponds to 1 msec of contiguous data at 1 MHz ADC rate, and thus a data rate to the host PC of about 1 kHz. You can average up to 65534 sweeps together to improve the signal to noise ratio, and the data rate to the host PC is correspondingly reduced. Thus if you average 1000 sweeps, each of 100 samples taken at 1 MHz ADC rate, the data rate will be about 10 Hz.

To sample longer events in each sweep, you can reduce the ADC rate; for example 1000 samples at 10 kHz ADC rate would give 0.1 seconds for each sweep.

Figure 10 shows a simplified schematic representation of sweep mode in which three sweeps are averaged, each with just six samples across the sweep (1000 is the more typical number). Note that there is no requirement that the triggers are equally spaced in time, only that the signals in a sweep are synchronized to their initiating trigger.

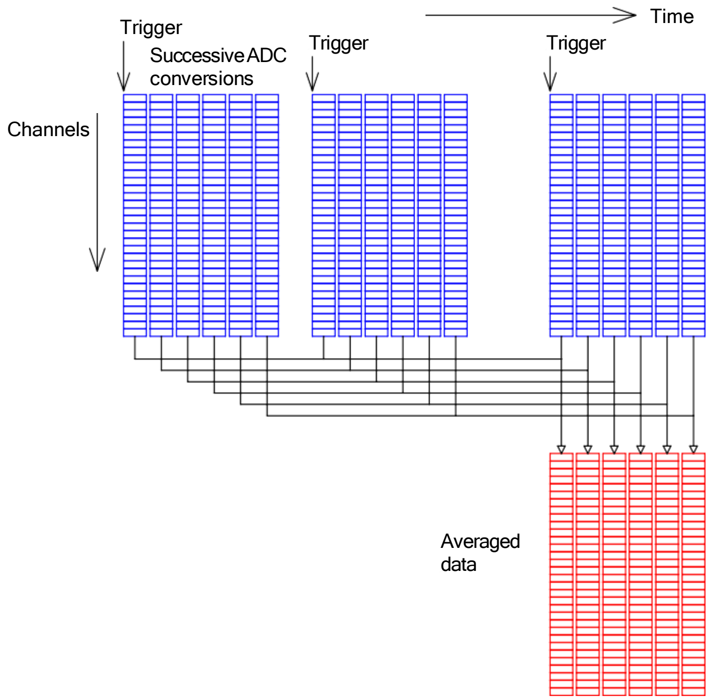


Figure 10. Data acquisition in sweep mode

10.4 Self-testing and calibration

The F3200E has a self-calibration function. It can calibrate itself on all channels fully automatically, on each of the four ranges. It stores the resulting offset and gain factors in non-volatile memory so that it can provide results in amperes from then on by reading off linear calibrations. The calibration sources use high precision, high stability components as these determine the absolute accuracy of the device.

You can turn on the calibration current at any time and send it to any channel to get a verification that a channel is functioning normally.

10.5 Monitor output

The F3200E can be set to generate a realtime analog output that can be used to display the signals on an oscilloscope or meter. The analog voltage is generated by a DAC controlled by the acquisition FPGA and is updated at up to 400 kHz. It is a computed value which can be the arithmetic sum of any subset of the input signals, multiplied by a gain factor. In sweep mode, the gate out signal is set when sweep data is being collected, so its rising transition can be used as a trigger for the oscilloscope.

10.6 Communication to the host computer

The F3200E provides three alternative communications interfaces to the host computer. You must work with a suitable host computer and software to set up acquisitions on the F3200E and read back and display the results.

The most commonly-used is the standard 100/10BaseT Ethernet interface which supports TCP/IP and UDP protocols. The F3200E can serve multiple clients on the network.

There is also a 10 Mbps serial fiber optic channel which provides compatibility with the Pyramid Technical Consultants, Inc. loop controllers, and thus the complete range of Pyramid products. Finally, a serial interface which can be operated with RS-232 or RS-485 levels provides a simple interface for applications where high data rates are not needed or diagnostic work.

As well as being a slave device on a fiber optic loop, the F3200E can also act as a loop controller. This allows other Pyramid devices to connect to a host computer through the F3200E, therefore avoiding the need for a dedicated loop controller in some cases.

The F3200E supports the Ethernet, fiber optic interface as a loop controller and serial interface. Support for use of the F3200E as a slave device on a fiber optic loop may be added in a future software release according to customer need.

10.7 Embedded software

The F3200E runs an embedded version of the Linux operating system on NIOS processors implemented in the FPGAs. Four firmware files make up a full release, and you can update with a single zip file which integrates all the releases, and thus ensures that you have compatible versions.

11 Using the PTC Diagnostic G2 Host Program

The PTC DiagnosticG2 is a stand-alone program which allows you to read, graph and log data from the F3200E, and set all the important acquisition control parameters. It supports communication via any of the interfaces. For some applications it may be adequate for all of your data acquisition needs. The Diagnostic uses the same function library that is exposed for users who develop their own host applications, and therefore also serves as a debugging aid.

PTC DiagnosticG2 was introduced to support the G2 range of Pyramid Technical Consultants, Inc. products which feature embedded Linux processors and built-in Ethernet interfaces. It is not compatible with the PSI Diagnostic G1 program which supports previous Pyramid products. However the PTC Diagnostic G2 program supports most of the previous products also, and will be extended in the future to add support for the full range.

Your F3200E was shipped with a USB memory stick with the installation files you need. We recommend that you copy the files into a directory on your host PC. Currently the program supports connection to the device via Ethernet. The fiber optic and serial ports will be added in a future release. Check the Pyramid Technical Consultants, Inc. web site at www.ptcusa.com for the latest versions.

In this section we'll describe connecting to the device using its Ethernet port and the PTC DiagnosticG2. The other communication and host software options will be described in the following section.

11.1 Installation

The PTC DiagnosticG2 program runs under the Microsoft Windows operating system (Windows versions XP, 7, 8, 10). Linux versions are available to special request for selected Linux distributions. Contact Pyramid Technical Consultants for further information.

Copy the installer file PTCDiagnosticG2Setup.msi to the hard drive of the host computer. The program will run on Windows XP, Vista and 7. The PC must have a standard Ethernet port.

Run the installer and follow the prompts.

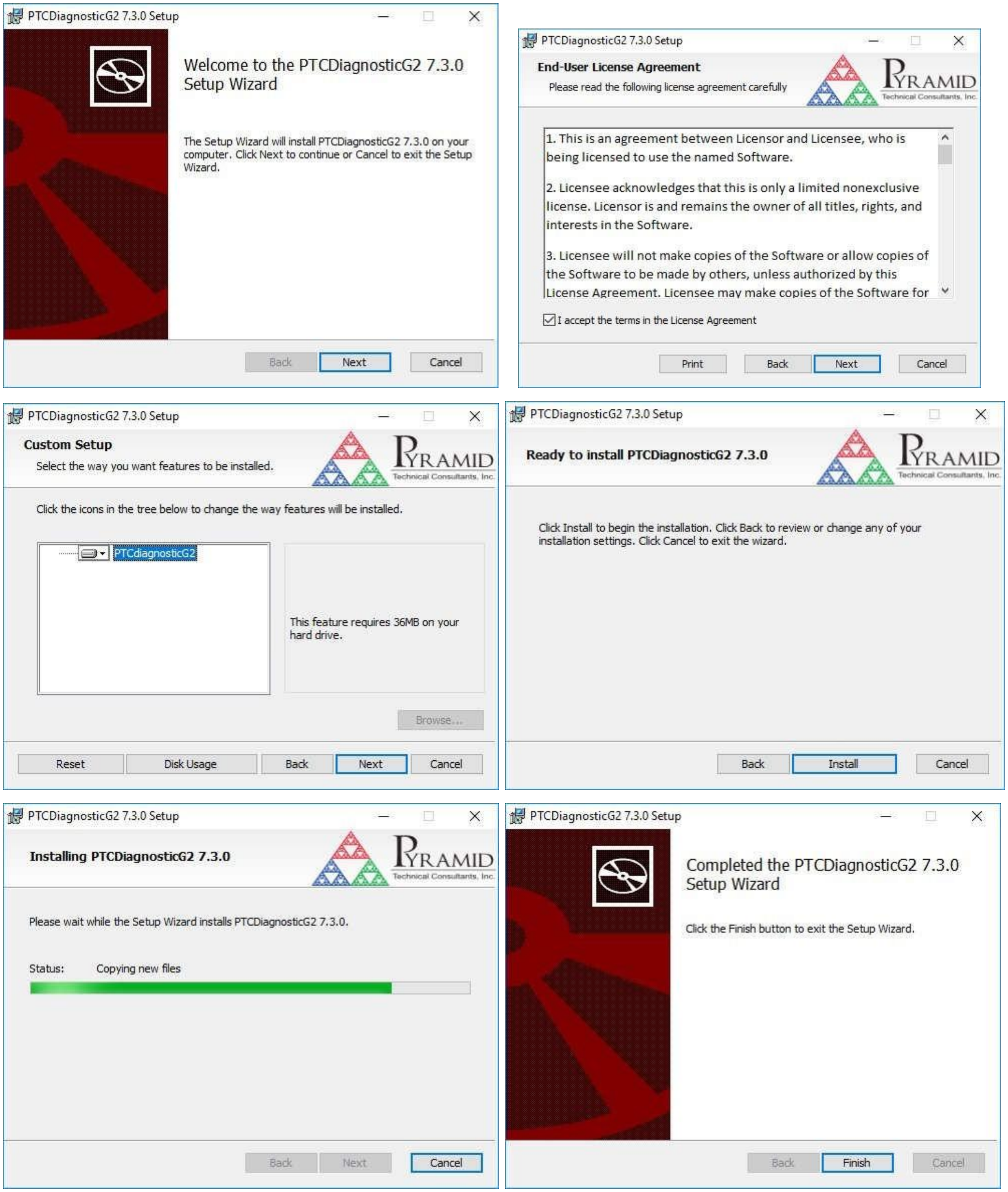


Figure 11. PTC DiagnosticG2 installation stages

The installer will create a subdirectory in the Program Files directory containing all the executables and configuration files.

11.2 Connecting to the F3200E

The following steps take you through the process of connecting to the device.

1) It is simplest to start with a direct connection from your host computer to the F3200E. Once you have established reliable communication, and set a suitable unique IP address, then you can move the F3200E onto a general local area network if required.

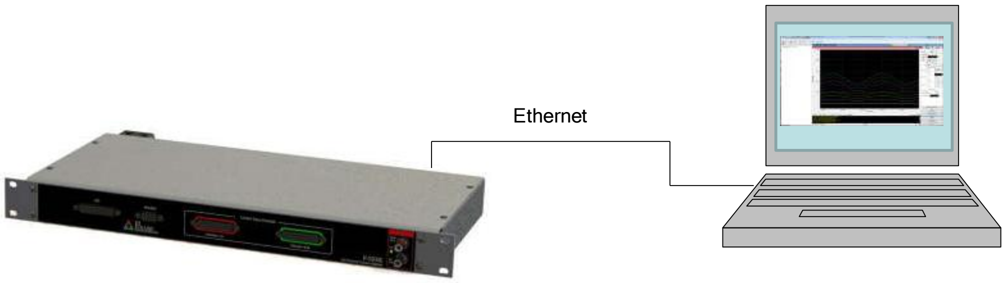


Figure 12. Direct connection to PC host

2) The F3200E is set with static IP address 192.168.100.20 at shipment, unless you requested a particular setting. Once you have a connection you can change this setting as required. Set up your host PC Ethernet port with a different fixed IP address in the same subnet range, for example 192.168.100.11, or 192.168.100.200. Disable Windows firewall, which will block some of the F3200E messages. Later you can set up firewall permissions if you need to operate with the firewall active.

3) Connect 24 V DC power to the F3200E, but no other connections. The front panel Pyramid logo should illuminate when the power is applied. While the device is booting, the rear panel 24 V and 2.5 V power LEDs illuminate and the communication LEDs cycle. Booting takes about 25 seconds. When the device is ready, the cycling stops and the Active LED should be illuminated.

4) Make the Ethernet connection from the host PC to the F3200E. Check that you can ping the device from a command window prompt. You will see the LED on the Ethernet jack respond to the pings.

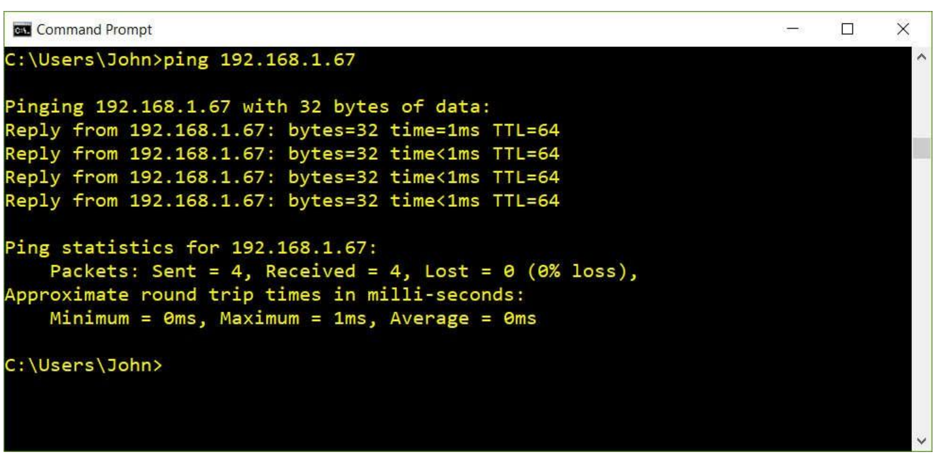


Figure 13. Ping test of the Ethernet connection.

5) Start the PTCDiagnosticG2 software. The program will open the Discover Devices window. If you see the A60 recovery entry you can ignore it for now. It is a device recovery utility in case of firmware corruption.

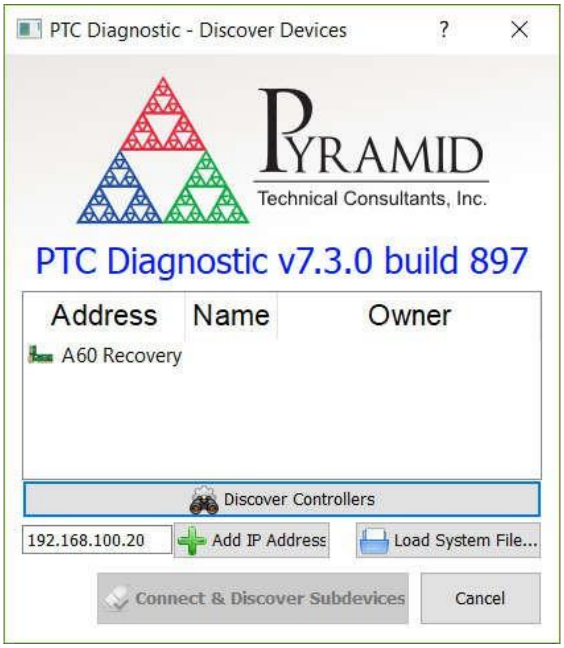


Figure 14. Discover devices window

6) Click on Discover Controllers. The software will search the accessible networks on all active network adaptors for compatible devices.

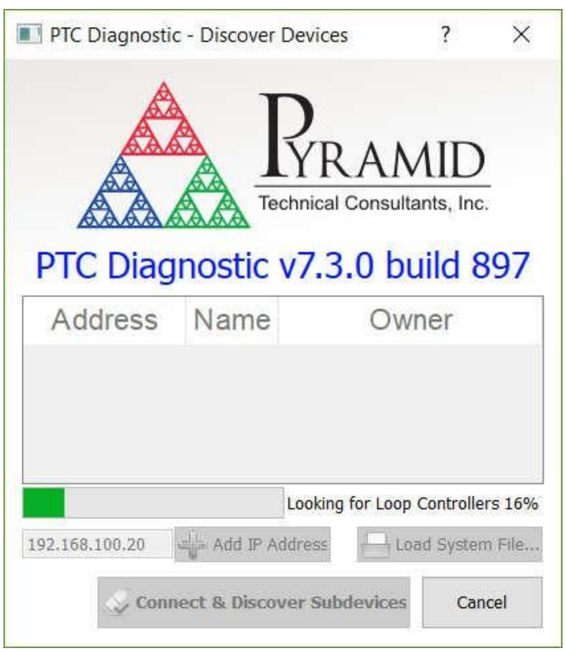


Figure 15. Discovering loop controllers

7) In the case of this very simple setup, only the F3200E will be discovered. Click on the entry to highlight it and enable the Connect & Discover Subdevices button.

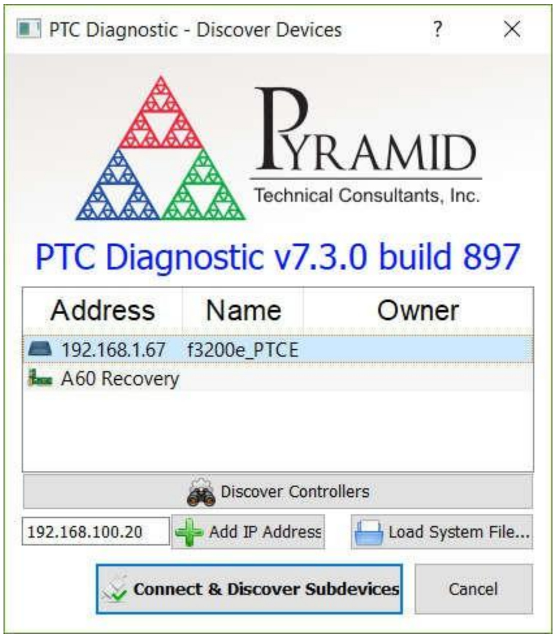


Figure 16. F3200E discovery – ready to connect to the device

8) Click on the Connect & Discover Subdevices button. The software will open the connection to the F3200E and show any slave devices connected to it in the System pane. In the example there are two devices connected to the F3200E on its fiber optic loop port.

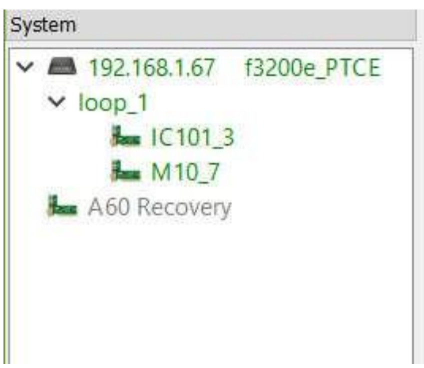


Figure 17. F3200E connected showing slave devices on its fiber optic loop port

Double click the F3200E entry in the table to open its window. The device may start in an error state, but this is of no concern. Pressing the clear errors button  at the bottom of the screen will clear the startup errors.

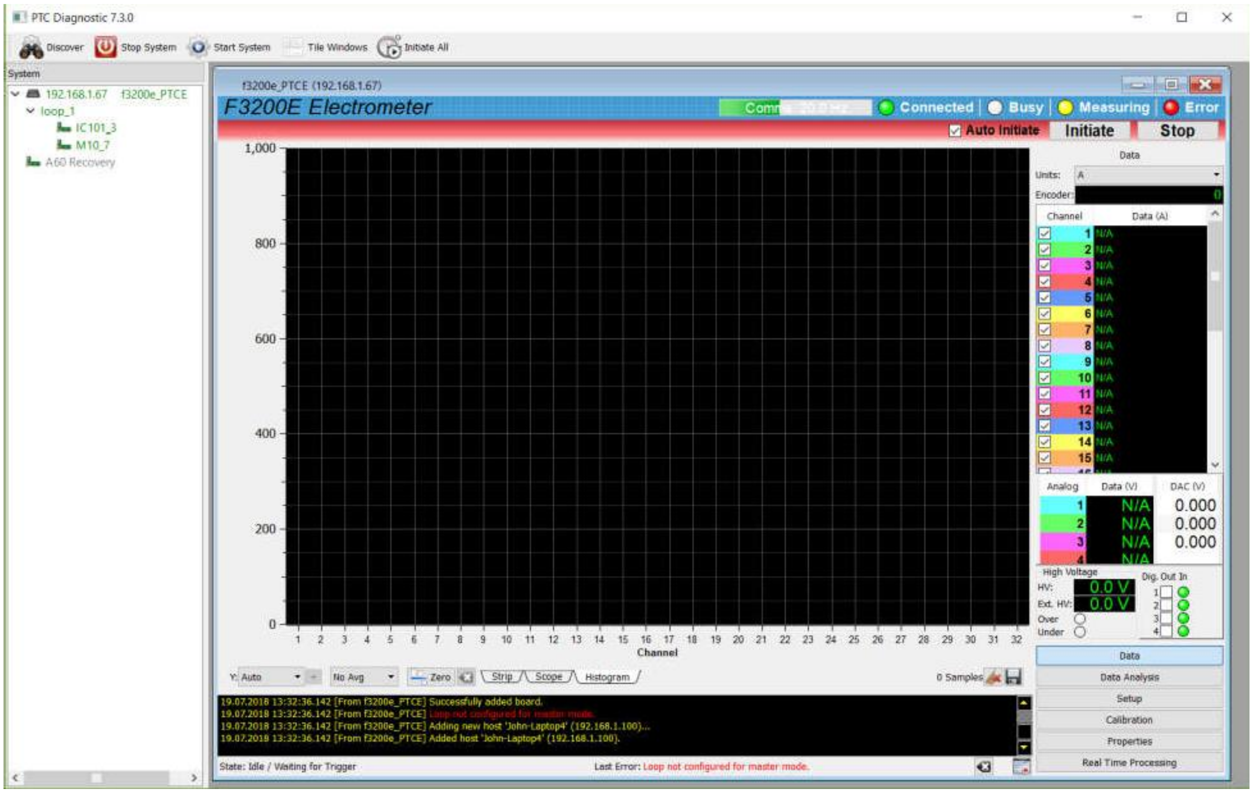


Figure 18. F3200E window after connection

9) Now click the Initiate button at the top right. The F3200E will start streaming data to the host computer, and you should see background noise signals in the digital displays, and in the histogram graphic. Click the Stop button and the acquisition should stop.

In the following section we shall look at the screen controls a displays in detail.

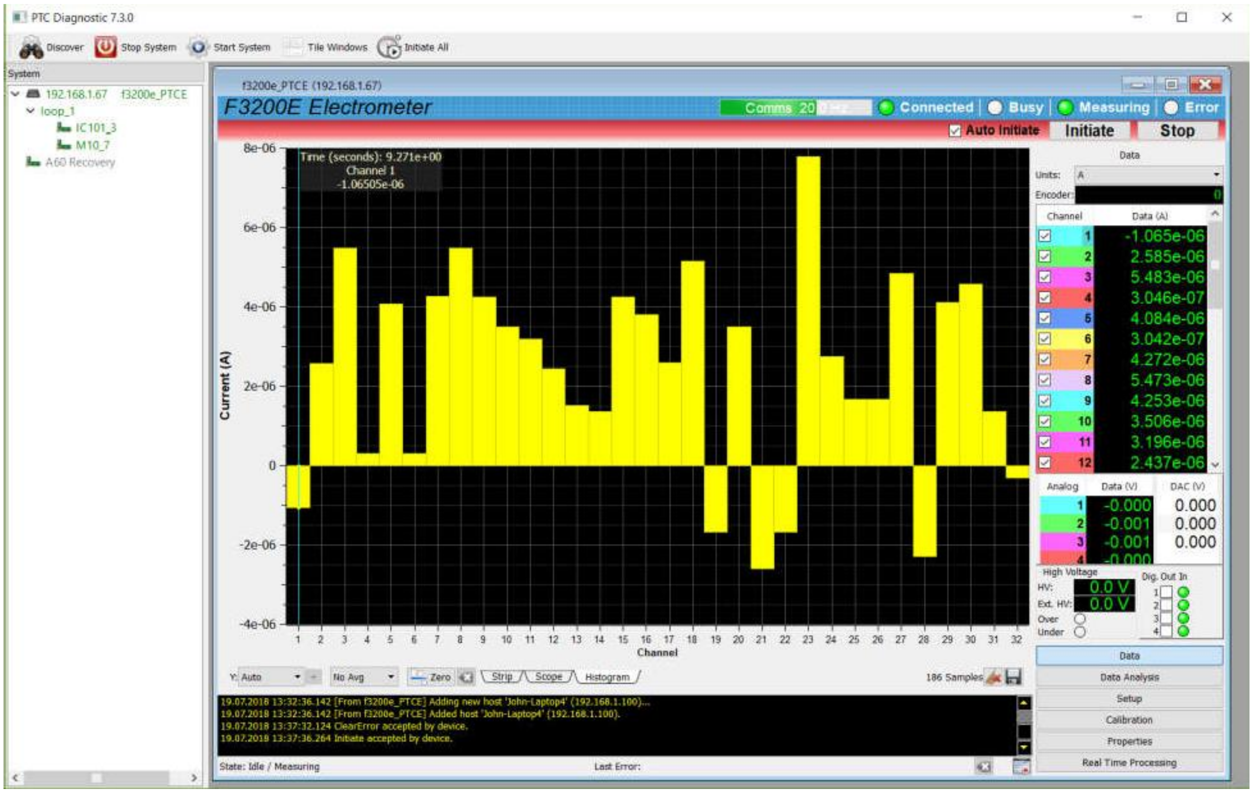


Figure 19. Reading background noise in internal trigger mode

11.3 Screen layout

The F3200E user interface screen is divided into two halves plus a top banner area.

The top banner contains the following indicators and controls:

Comms bar	When moving, this indicates that messages from the F3200E are being received by the PTCDiagnosticG2. The message rate is indicated, typically about 20 Hz.
Connected LED	When lit, this indicates that communications are valid and the system is not in error.
Busy LED	When lit, this indicates the F3200E is busy and cannot respond to inputs, for example while performing a calibration.
Measuring LED	When lit, this indicates that data acquisition has been initiated.
Error LED	When lit, an F3200E error has been latched. There will be a corresponding red error message in the message window. The error can be acknowledged and cleared with the Clear last error button below the message area .
Auto Initiate	If this box is checked, the F3200E will start a new acquisition whenever any parameter is altered.

Initiate	 This button starts an acquisition or restarts an acquisition in progress.
Stop	 This button stops an acquisition.

On the left below the banner there is a graphic display of the data and the message window, which are always visible. On the right there is a screen area which changes according to which display option you select.

Data: A numeric display of the data on each current measurement channel. Readback and output settings for the general-purpose analog and digital lines and high voltage monitoring (models with HV option only). Check boxes to allow you to suppress the graphic display of any subset of the channels. The colour codes correspond to the colours of the traces of the strip chart and scope mode graphics. Any channel which is highlighted in red is overrange. The Encoder readout is a count of the edges detected on the gate input connector.

Data Analysis: The F3200E can perform peak detection and fitting across the 32 input channels using two different calculations. The calculations can be enabled and controlled on this screen.

Setup: Controls to set the acquisition mode and triggering, current ranges and mapping of the input signal to the analog monitor output, high voltage control, encoder pulse counting and actuator controls.

Calibration: Controls for the calibration process and display of the calibration parameters for the four current ranges, the general purpose analog inputs and outputs and the high voltage control and readback.

Properties: Firmware version display and update controls, and IP address setting.

Real Time Processing: Controls to perform complex control and acquisition functions (application-specific options).

11.4 Graphic display

There are three ways of displaying incoming data in a graphical way. These can be selected independently of the acquisition mode, although there are generally displays that are better suited to particular modes. Any subset of the full thirty-two channels can be selected for display by checking and unchecking the channels in the Data area.

11.4.1 Strip chart display

Data from the thirty-two channels, with the selected averaging, is plotted onto a rolling strip chart as it is acquired. This display is well-suited to the Internal acquisition mode. The horizontal axis is the time of acquisition and the vertical (y) axis is the current. You can select automatic or fixed vertical scaling.

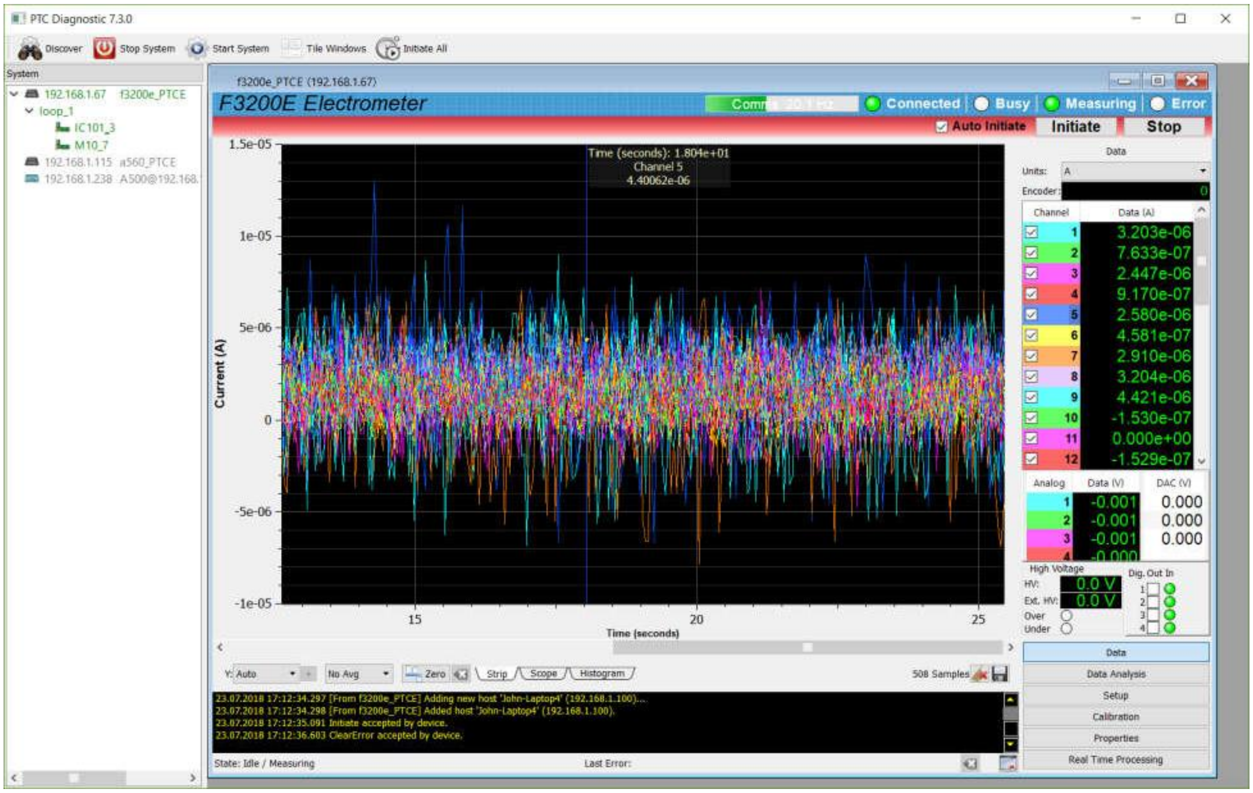


Figure 20. Strip chart display

When the data has filled the display, a slider appears underneath. You can use this to scroll back through the data that has been buffered by the PTC DiagnosticG2 program (up to 100,000 readings). If you click in the graphic area near a trace, a cursor is placed with readout of the channel number, the timestamp and the current at that point.

11.4.2 Scope display

A data block that has been buffered and averaged in the F3200E is displayed as a whole, in a similar manner to a digital oscilloscope transient capture. The next available data block replaces the previous one as a whole. This display is most suited to the display of buffered data, especially the sweep mode.

In buffered mode the number of readings per refresh of the display is given by the burst size. If no burst is defined, the screen is refreshed for each block of data sent up by the F3200E. In sweep mode, the screen is refreshed with each averaged block of data.

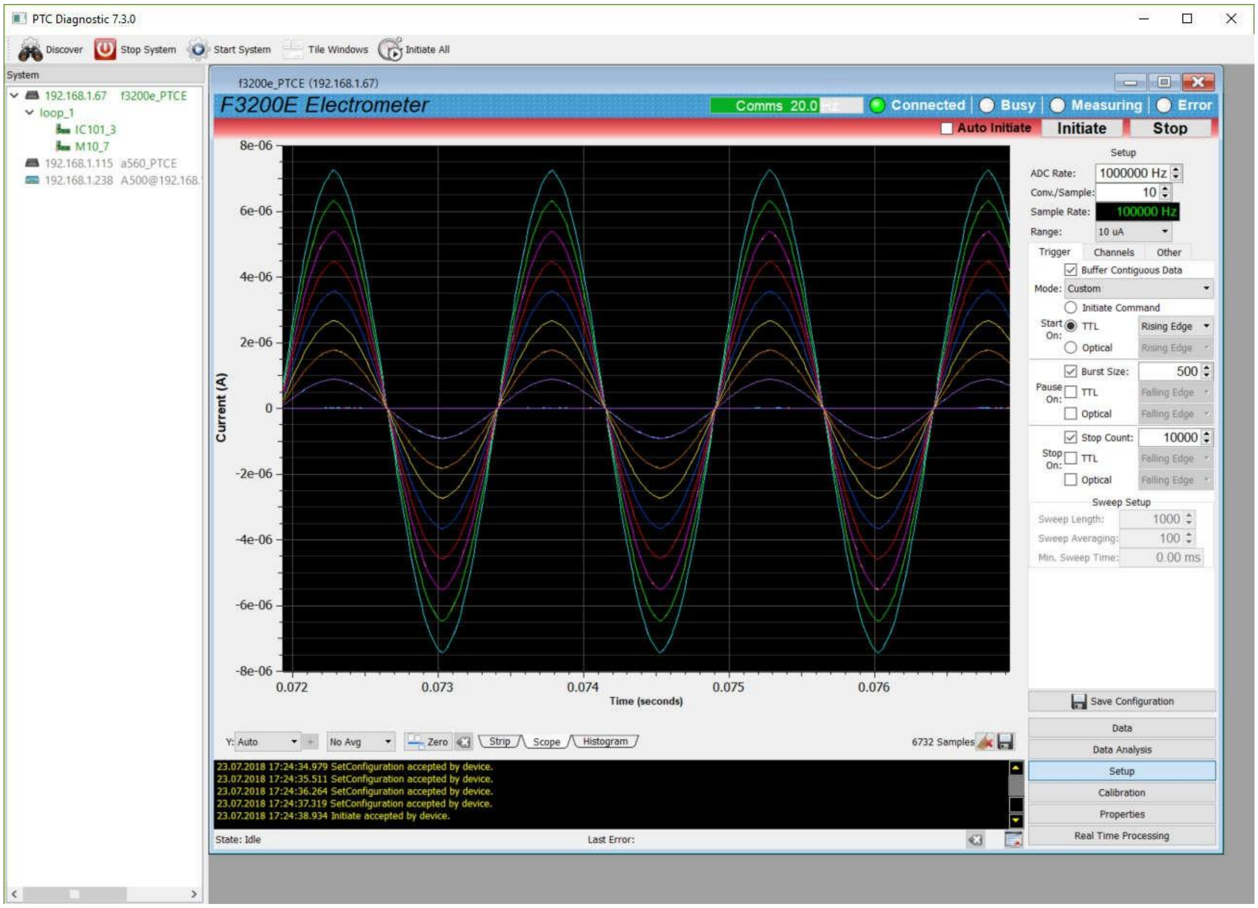


Figure 21. Scope display, buffered acquisition – data sampled at 100 kHz

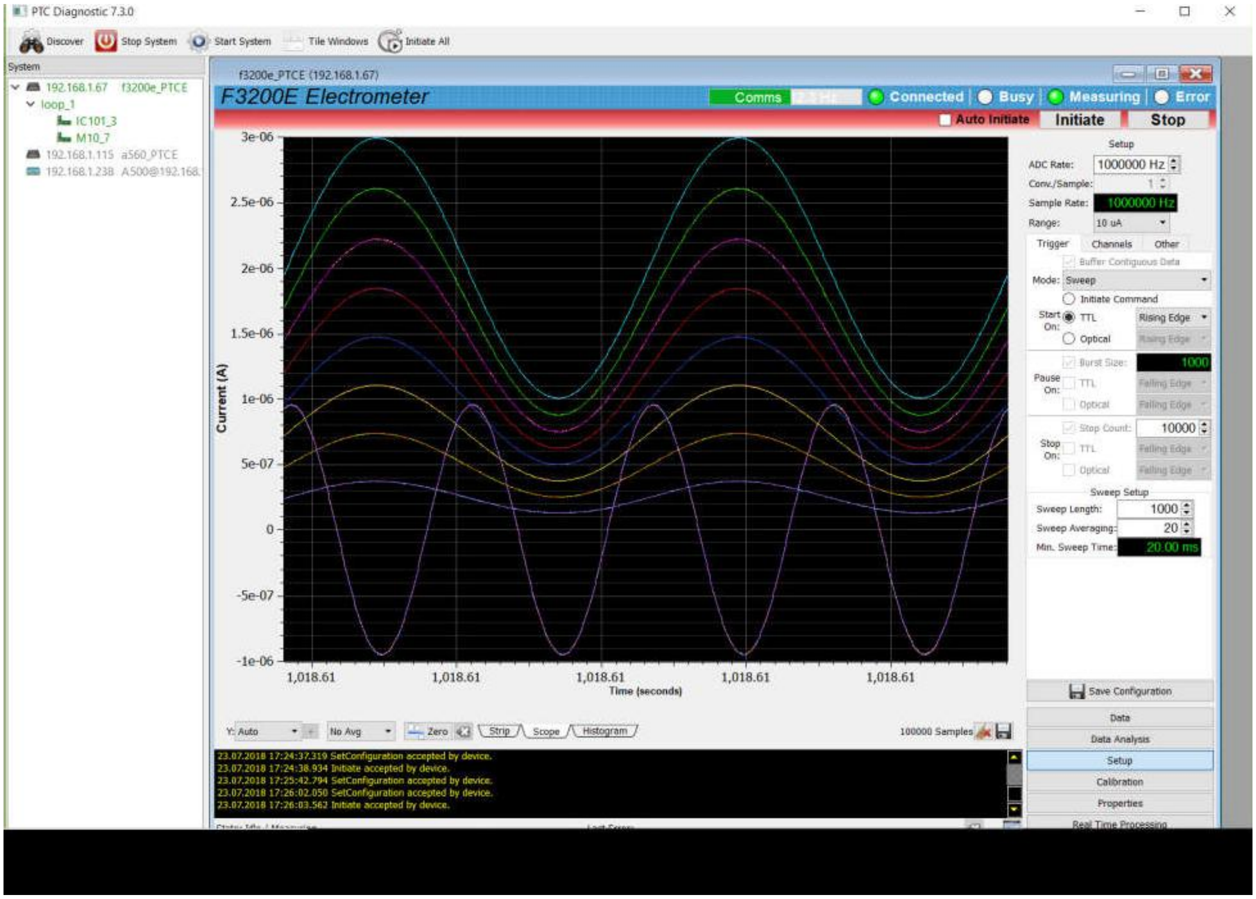


Figure 22. Scope display, sweep acquisition – data sampled at 1 MHz, 20 1000 point sweeps averaged

11.4.3 Histogram display

The current in each channel is displayed as a vertical bar; there are 32 bars arranged from channel 1 on the left to channel 32 on the right. The horizontal axis will be a spatial axis if the F3200E is connected to a sensor with a linear array of sensing elements.

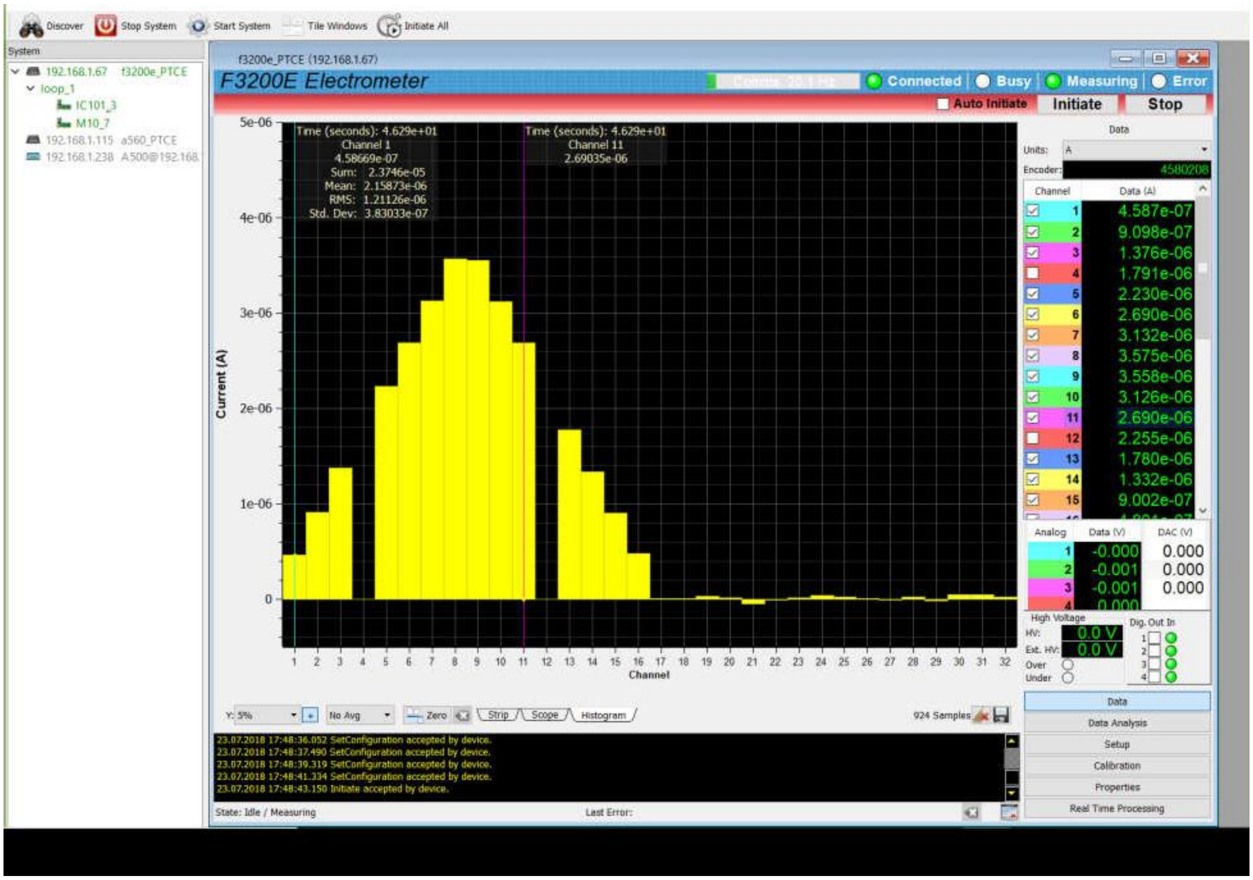


Figure 23. Histogram display. Two channels de-selected for display.

11.4.4 Vertical scale control

The vertical scale can be set to autoscale, or to be various fixed percentages of the full scale of the selected current range using the drop down control.

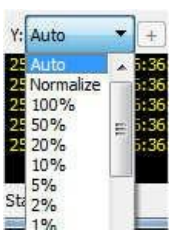


Figure 24. Vertical scale selection and positive values only toggle.

Pressing the "+" button next to the vertical scale selector toggles the vertical scale from +/- Y% of the current range to +Y%, -0.1Y%, which is useful if your signals are positive going only.

11.4.5 Filtering

The PTC Diagnostic G2 can apply low-pass filtering to the displayed data to allow longer term trends to be seen more clearly. This is in addition to averaging performed by the F3200E itself. The filter is a simple exponential IIR type

Yi = Xi/A + (1 - 1/A)Yi-1,

where Yi is the latest output of the filter, Yi-1 is the prior output of the filter and Xi is the latest reading from the F3200E. A is the averaging value from the drop-down list.

Figure 25. Filtering selections.

Note that the data is not altered, only the way it is displayed, so you can change between various filtering settings at any time.

11.4.6 Zero offset suppression

The F3200E should have low offset currents when it is calibrated. However there may be offsets from the sensor system that you wish to suppress. If you press the Zero button (Zero / Zero), the signal at that time is captured for each channel and subtracted from subsequently displayed data. Press the clear button to turn off the zero correction. Note that the data is not altered, only the way it is displayed, so you can turn zeroing on or off at any time.

11.5 Data logging

The PTCDiagnosticG2 software has a data buffer which can accumulate up to 100000 samples, at which point it starts overwriting the oldest data. Accumulation starts automatically when you click Initiate. You can capture the contents to a .csv format file at any time using the Save button. Pressing the Clear button clears the buffer and restarts the logging. The csv file includes timestamps, a trigger count which increments from 1 to 256 with each acquisition, an overrange indication and the 32 channels of current data.

11.6 Data panel

The 32 channels of data are displayed in amperes in exponential format. The units drop down allows you to scale the displayed values into mA, µA or nA. Colour-coded boxes correspond to the colours of the graphic traces, and you can suppress the graphic display of any number of the channels by unchecking the appropriate channels. Use the vertical scroll bar to reveal the higher-numbered channels.

The Analog display shows the measured voltages on the four general-purpose analog inputs. The three analog outputs can be set by entering the required voltage in the range +/- 10V. If monitor output mode is selected, then analog output 1 is used for the monitor output.

The high voltage readings are the monitored voltage leaving the F3200E, and the voltage measured at the HV read back connector. If any value is outside limits defined on the setup page, the relevant Over or Under LED will illuminate.

11.7 Data Analysis panel

The position of one or more peaks in the distribution of signal over the 32 input channels can be determined two different ways. The calculations are enabled by checking the relevant boxes. Checking the Display Full Statistics box displays additional results from the calculations.

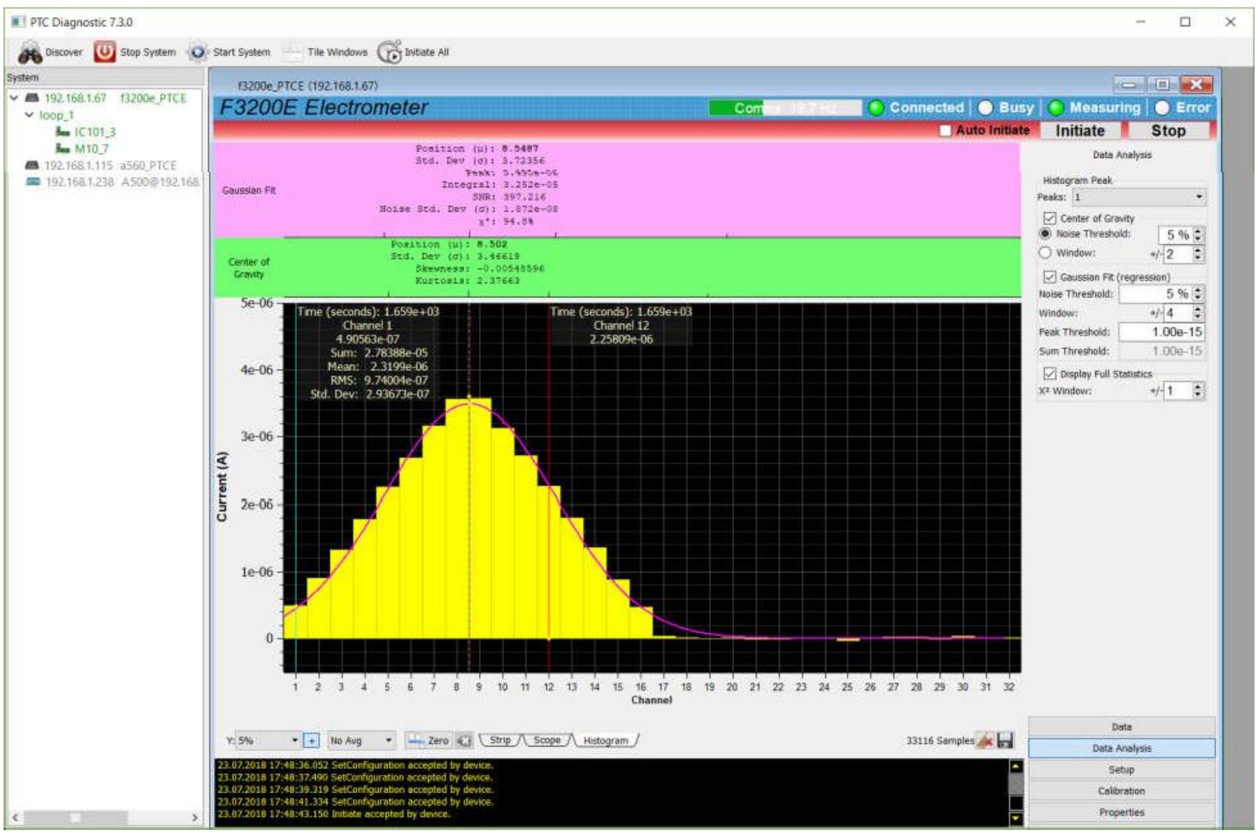


Figure 26. Peak position calculations.

11.7.1 Center of Gravity

The first calculation is a simple center of gravity (first moment) of the distribution of signals in the channels within some window about a local maximum channel. You can set the number of channels include in the calculation by setting a Noise Threshold as a percentage of the highest channel signal. All channels contiguous with the peak channel out to this level will be included, bounded by the window, which is the maximum number of channels to include either side of the peak channel.

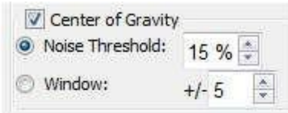


Figure 27. Center of gravity calculation controls

In the following schematic illustration, a threshold of 20% and a window of 2 limits the calculation to the yellow channels.

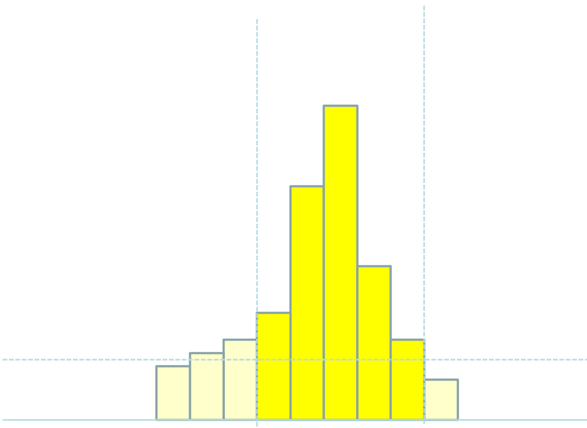


Figure 28. Limiting channels included in the peak position calculation.

11.7.2 Gaussian Fit (regression)

Channels for the fit are chosen in the same way as for the center of gravity calculation. A Gaussian curve is fitted to the data by a weighted regression method. This method works well where signal is spread over several channels, and it is relatively robust in the presence of noise. A minimum of three channels are required in the fit. The Peak Threshold setting allows the fit to be inhibited if the charge in the peak channel is below to the setting, to prevent spurious fits to noise.

Figure 29. Gaussian regression fit control.

11.8 Setup panel

The top section of this panel has controls for the conversion rate for the 32 parallel analog to digital converters (ADCs) and the number of conversions that are averaged into each sample. The sample rate is the ADC rate divided by the conversions per sample number.

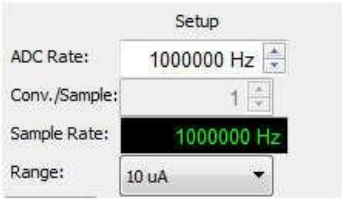


Figure 30. Setup ADC and range control.

The ADC rate can be set between 2000 Hz and 1 MHz. Usually it is best to use a high ADC rate and reduce the sample rate as necessary by increasing the number of conversions per sample, as this improves the resolution and signal to noise ratio. The value can be set between 6 and 65535 in internal and buffered modes. In sweep mode it is set automatically to 1.

The full scale current range can be set to 10 mA, 1 mA, 100 µA or 10 µA. The setting applies to all thirty-two channels. A future firmware release will allow the range to be adjusted individually for pairs of channels.

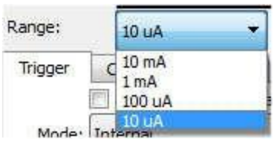


Figure 31. Current range selections.

The remainder of the setup controls are presented on three sub-panels, covering triggering and acquisition modes, channel gain settings and other controls. Below is a Save Configuration button which will save the acquisition parameters to non-volatile memory and the F3200E will recall the configuration when it powers up.

11.8.1 Trigger pane

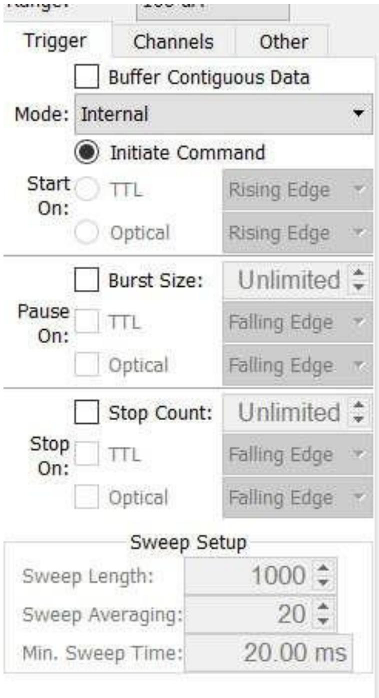


Figure 32. Trigger controls

The Buffer Contiguous Data check box tells the F3200E whether to use its internal memory to buffer data. This allows you to collect blocks of data that are contiguous in time, even though the data rate is greater than the communications channels can accommodate. You should always set a stop condition when using buffering.

11.8.1.1 Acquisition modes

The Mode drop down lets you select the type of acquisition.

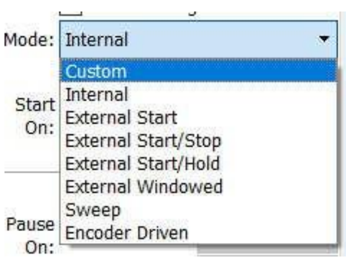


Figure 33. Acquisition modes

Custom	This mode gives you direct access to the parameters that start, pause and stop an acquisition. It is used primarily to set up buffered acquisitions. The following modes are special cases of Custom mode: External Start, External Start/Stop, External Start/Hold, External Windowed.

Internal	This mode is the simplest acquisition mode, and is most useful when used without buffering. Data is sent to the host at the maximum rate that the communications channel allows. The F3200E runs indefinitely after it is initiated.
External Start	The acquisition starts after it is initiated and a trigger edge is detected at the gate input
External Start/Stop	The acquisition starts after it is initiated and a trigger edge is detected at the gate input. It stops when the opposite edge is detected.
External Start/Hold	The acquisition starts after it is initiated and a trigger edge is detected at the gate input. A single measurement is made on each trigger edge.
External Windowed	The acquisition starts after it is initiated and a trigger edge (rising for example) is detected at the gate input. The acquisition pauses on the falling edge, resumes on the rising edge and so on.
Sweep	The acquisition starts after it is initiated and a trigger edge (rising for example) is detected at the gate input. Sweep Length number of samples are buffered. This is repeated for each subsequent rising edge and the data is averaged with the previous until Sweep Averaging number of sweeps have been averaged. The averaged data is returned to the PTC DiagnosticG2 program for display, and the process repeats indefinitely.
Encoder Driven	This mode is not currently supported on the F3200E.

In Custom mode you must specify what starts, pauses and stops an acquisition. In other modes you will need to set up some of the conditions.

11.8.1.2 Start On:

You can start the F3200E acquisition immediately when the Initiate message is received from the host computer, or on the first gate edge after the Initiate. The required gate edge can be configured to be rising or falling. The F3200E can look for the gate as a TTL signal on the Gate In coaxial connector, or on the gate optical input. Note that the gate optical input is the same connector that is used for fiber optic communications where the F3200E is the loop controller. Loop controller function is unavailable if you use the input for triggering.

The start conditions are also the resume conditions if you set up pausing.

11.8.1.3 Pause On:

Pausing is optional. You can pause when a particular number of readings has been made (the Burst Size). This is best used for buffered acquisitions, and in particular you can use it to get a stable scope display. You can also pause on the opposite gate edge. Both Burst Size and gate can be selected at once; the F3200E will pause when the first of the conditions is met.

11.8.1.4 Stop On:

Stopping is optional in unbuffered mode, but you should set a limiting stop count in buffered mode. You can stop when a particular number of readings has been made (the Stop Count). You can also stop on a gate edge, which must be opposite to the start gate edge. Both Stop Count and TTL or optical gate can be selected at the same time; the F3200E will stop when the first of the conditions is met.

11.8.1.5 Sweep Setup

Figure 34. Sweep setup controls

In Sweep mode you need to set up the number of points in each sweep, up to a maximum of 1000, and the number of sweeps that get averaged to create each block of data that is returned to the host computer, up to a maximum of 65534. The Min. Sweep Time is a calculated value

Min. Sweep Time = Sample Rate x Sweep Length x Sweep Averaging

Triggers for the sweeps must no arrive faster than this, or some will be missed.

11.8.2 Channels

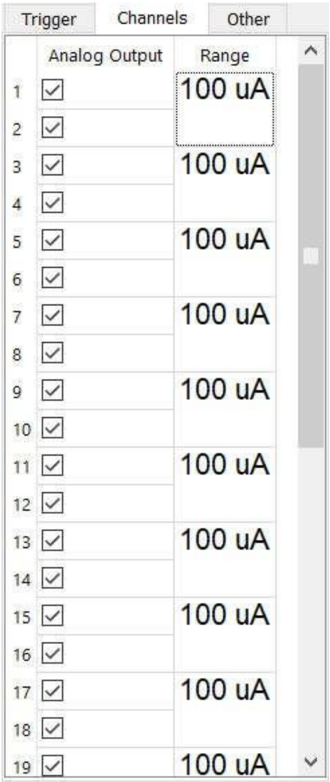


Figure 35. Channels controls

The analog monitor output is formed as the sum of the channels checked in this list multiplied by a gain factor.

The F3200E hardware supports a feature in which the current range can be set individually for each pair of channels, overriding the setting at the top of the Setup pane. This feature may be added in a future software release according to customer application needs.

11.8.3 Other

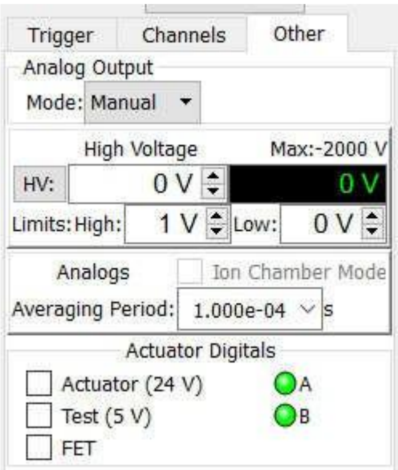


Figure 36. Other setup controls

Analog output 1 (pin 19 relative to pin 9 on the I/O connector) can be assigned to be manually programmed, so that the output voltage is set directly from the host software on your PC, or to be a monitor of the input currents. The currents that sum into the monitor signal are set on the channels pane.

Various high voltage bias modules can be installed as a factory option. Internal jumper settings identify the rating of the module to the internal software. A -2 kV module has been detected in figure 36. The setpoint should be entered in volts including the polarity, for example “-1750”. Pressing the HV button (HV:) enables the supply. The front panel LED will illuminate and you should see a readback voltage similar to the setpoint. The High and Low settings allow soft limits to be imposed on the high voltage settings.

The four general purpose analog inputs are typically used for relatively low bandwidth signals. You can set the averaging period between 100 µsec and 1 second.

The actuator control turns on the 24 VDC output on the actuator connector (pin 1 relative to pin 2), intended for controlling pneumatic actuator solenoids. The Test (5V) output turns on 5 VDC which is available on the actuator connector (pin 3 relative to pin 9) and on the signal input connectors (pin 15 relative to pins 16-23).

11.9 Calibration panel

11.9.1 Current measurement calibration

The F3200E includes four high stability precision current sources which are used for the automatic calibration process. Each source is assigned to one of the ranges.

Range	*Calibration current*
10 mA	8.333 mA
1 mA	833.3 µA

100 µA	83.33 µA
10 µA	8.333 µA

The calibration factors for each channel are displayed in a separate tab for each current range. The gain values are relative to the gains if all relevant electronic components have exactly their nominal value. The offset values are the number of bits that will be added to measured binary values to compensate the electronic offsets.

Clicking the Calibrate button 

will open a warning dialog that the existing calibration is about to be overwritten. If you proceed, new calibrations will be done for the range and stored in non-volatile memory. For maximum accuracy you should only run the calibration process when the F3200E has come to operating temperature, and with nothing connected to the inputs.

Figure 37. Calibration warning dialog

The calibration routine takes about 30 seconds to complete, then the new values are displayed. You can save the values to a csv file for your records .

11.9.2 Using the calibration sources to test individual channels

You can also turn on a current source chosen from the source current options at any time and direct the current to any of the 32 channels, for fault-finding purposes.

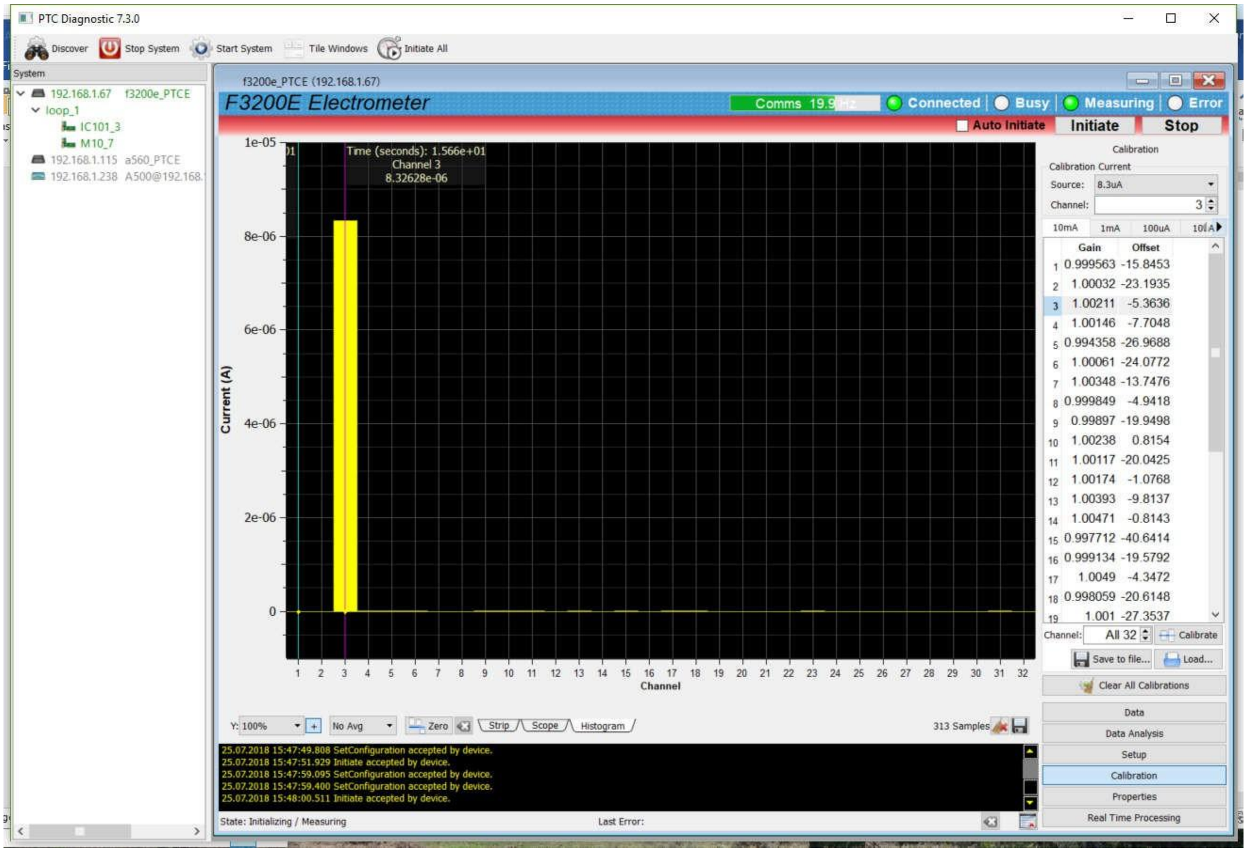
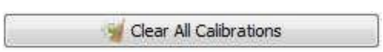


Figure 38. 8.33 µA calibration current directed to channel 3, 10 µA current range

11.9.3 Analog I/O and high voltage calibrations

There are separate calibration tabs for the general purpose analog inputs and outputs, and for the high-voltage supply. These are set at time of manufacture and require external voltage sources and meters to calibrate. You should not need to adjust these calibrations.

11.9.4 Clearing calibrations

The Clear All Calibrations 

button opens a dialog warning that you are about to overwrite all calibrations (all current ranges, analog I/O and high voltage).

Figure 39. Clear Calibrations warning dialog

If you continue, all gains will be set back to 1.000 and all offsets to zero. Be certain that this is what you want to do.

11.10 Real Time Processing panel

The F3200E can run a wide range of user-programmed sequences for control and data logging using the G2 Real Time Processing utility. If the F3200E is acting as a fiber optic loop controller, the controls and data can be on the looped devices as well as the F3200E itself. Examples of applications are coordinated data collection across multiple devices, servo loops and reacting to particular sets of circumstances. Generally development of the file that defines a particular real time application will be initiated by Pyramid, although the use of transparent xml format files makes it relatively easy for users to modify and extend to suit their requirements.

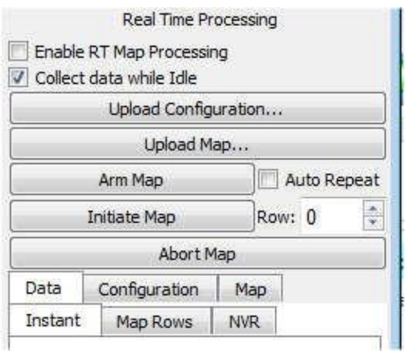


Figure 40. Real Time Processing controls

The Upload Configuration button allows you to select an xml file that tells the F3200E how to behave during real time processing, such as which parameters to set and read, how to compute derived parameters, the paths to the looped devices and so on. Upload Map allows you to select a csv file which provides the sequence of set points for the controlled variables. Once the device is configured and the map is accepted, then you arm and initiate the map to execute it. Measured and calculated values are displayed and graphed while the map executes. See section 18 for further details.

11.11 Properties panel

The properties panel is where you can update the F3200E firmware and change its network settings.

11.11.1 Updating firmware

There are four firmware files that make up a full release, which are shown. For convenience, these are bundled into a single overall Firmware Version zip file that is extracted automatically by the firmware update utility. Note that firmware updates can only be performed over an Ethernet connection to the F3200E, not via fiber optic or serial port.

Figure 41. Firmware information display

Clicking the update button 

opens a warning dialog.

Figure 42. Firmware update warning

If you choose to proceed, the software opens a navigator window so that you can select the firmware file. A countdown timer plus information in the message area show progress, and you will be prompted to reboot the F3200E at the end.

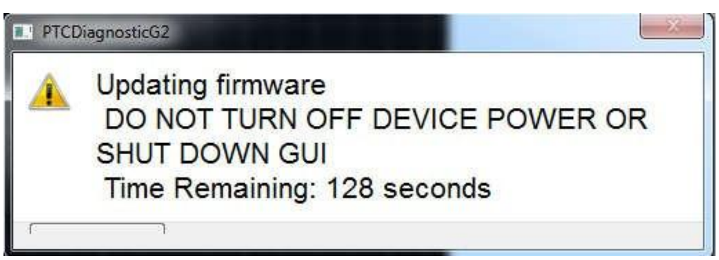


Figure 43. Firmware update progress display

11.11.2 Configuring the network settings

You can set the name of the F3200E to help you recognize it on the network and select static or DHCP address assignment. If you select a static IP address, you must set the address, the subnet mask, and optionally the address of the network external gateway and a destination for error logging.

Figure 44. Network settings

If you set a static address but forget it, you can force the F3200E to boot up at a default address of 192.168.100.20 by pressing the rear panel reset button for several seconds at the start of power up.

12 Fiber Optic Loop Communications

The F3200E supports fiber optic loop communications with other Pyramid products. There are two fiber optic ports on the rear channel, plus two transmitters that can send out digital signals. The first port is used when the F3200E is acting as loop controller. The second port is used when the F3200E is a device on a loop managed by another loop controller.

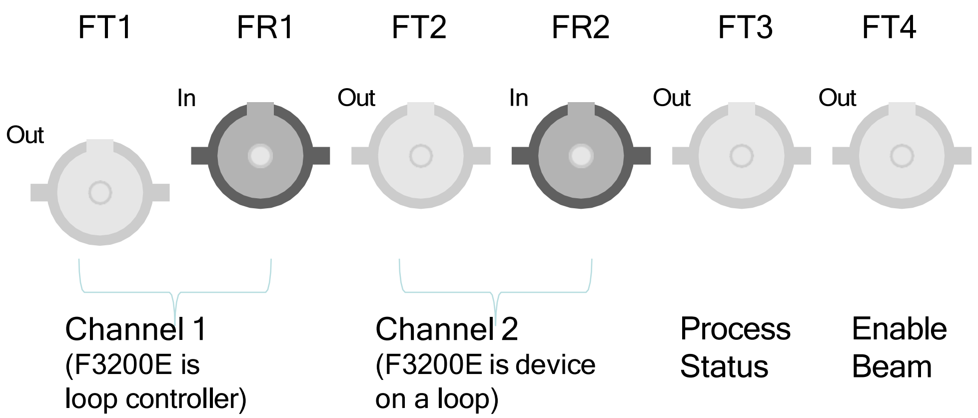


Figure 45. Fiber optic communication ports (view looking at rear panel)

Fiber optic receiver device FR1 is also used as the input for optical gate signals to trigger the F3200E. This function is therefore unavailable if the F3200E is acting as a loop controller.

12.1 Using the F3200E as a loop controller

As a loop master, the F3200E can connect up to sixteen other devices. Each device must have a unique address (0 through F) on the loop, set with a rotary switch on the device. The addresses do not have to be sequential on the loop. The host computer communicates with the slave devices through the F3200E's Ethernet port.

In the schematic example shown below, the F3200E is acting as loop controller to two remote devices, an M10 general purpose I/O device such as might be used to control a power supply, and an H10 dual Hall probe for magnetic field measurements. The fiber optics can be hundreds of meters long, and provide perfect electrical noise immunity. When you press "Connect & Discover Subdevices" in the Discover Devices dialog, the looped devices will be identified and shown in the system tree on the left of the PTC DiagnsoticG2 display. Their windows can then be opened so that you can control them and collect data. They operate independently of the F3200E, which just passes their communications through to the host computer. The only exception is if you are using real time processing, when the F3200E can coordinate subdevices during map execution.

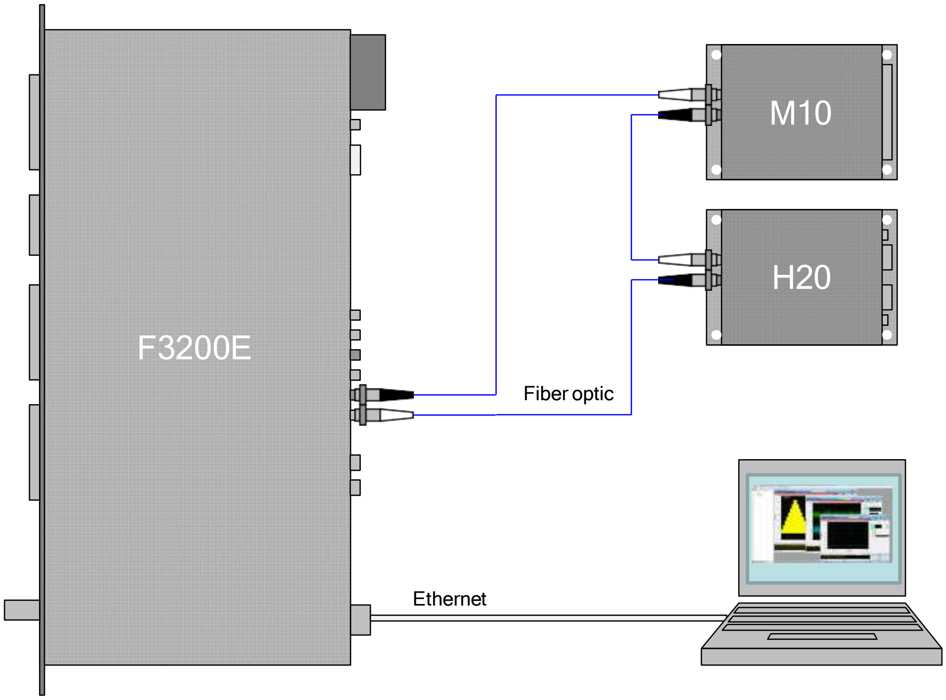


Figure 46. Example fiber optic loop configuration where the F3200E is the loop controller.

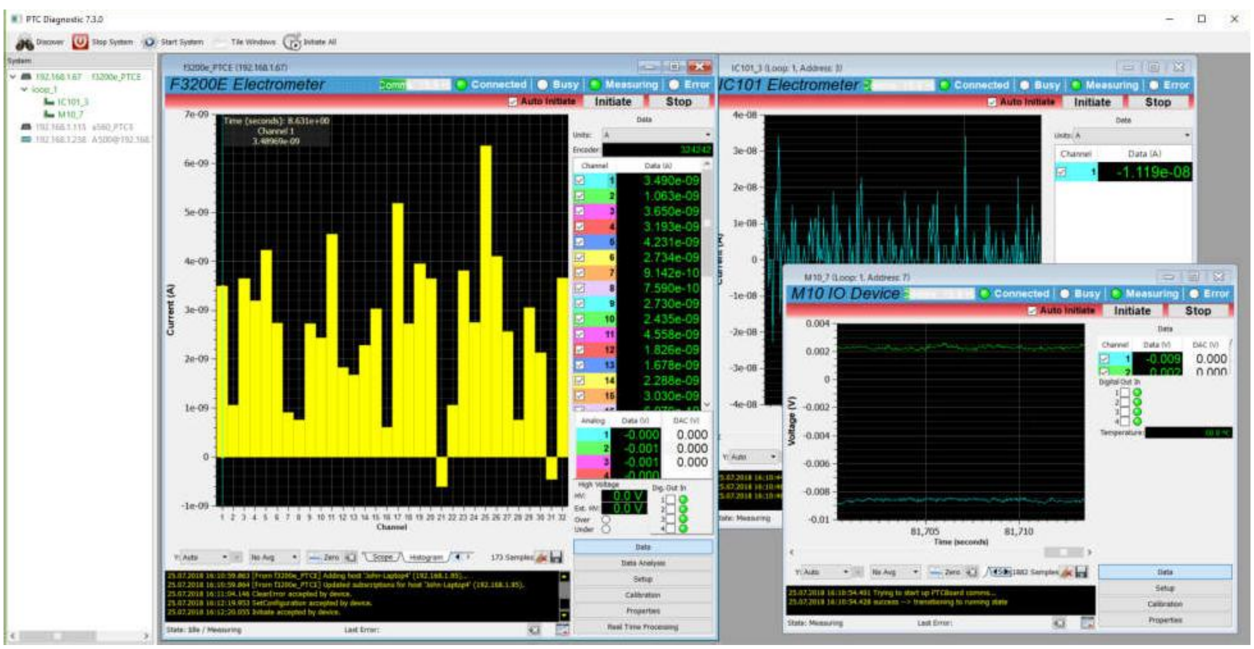


Figure 47. Example fiber optic loop configuration where the F3200E is the loop controller – Diagnostic display.

12.2 Using the F3200E as a looped subdevice

The F3200E can be a subdevice on the loop of another device, such as an A360 or A560 loop controller. This may be more convenient for some systems, but note that the data rates possible over the fiber optics are lower than over Ethernet, so there will be some reduction in the ability to measure fast signals at high rates compared to a direct connection to the F3200E using Ethernet. The F3200E cannot be connected simultaneously via fiber optic and Ethernet. In the schematic example below, an A360 loop controller connects the F3200E on one port and two F100s on its second port.

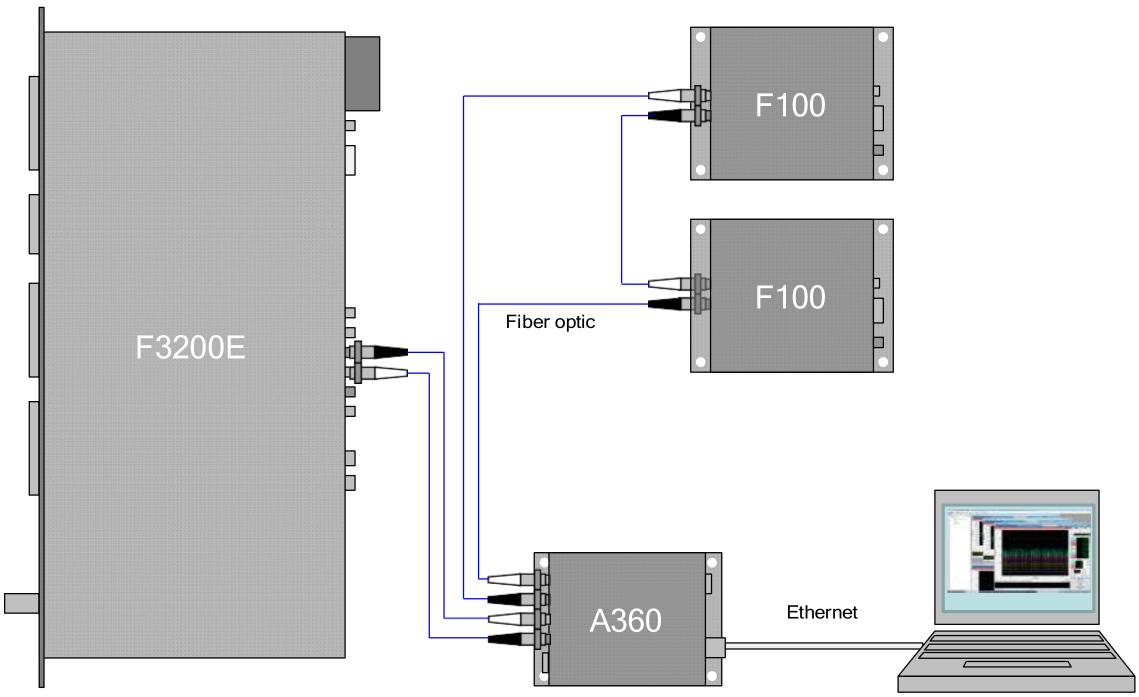


Figure 48. Example fiber optic loop configuration where another device is the loop controller.

When you connect the subdevices on the loop controller, the PTC DiagnosticG2 software will display the tree of looped devices in the system pane.

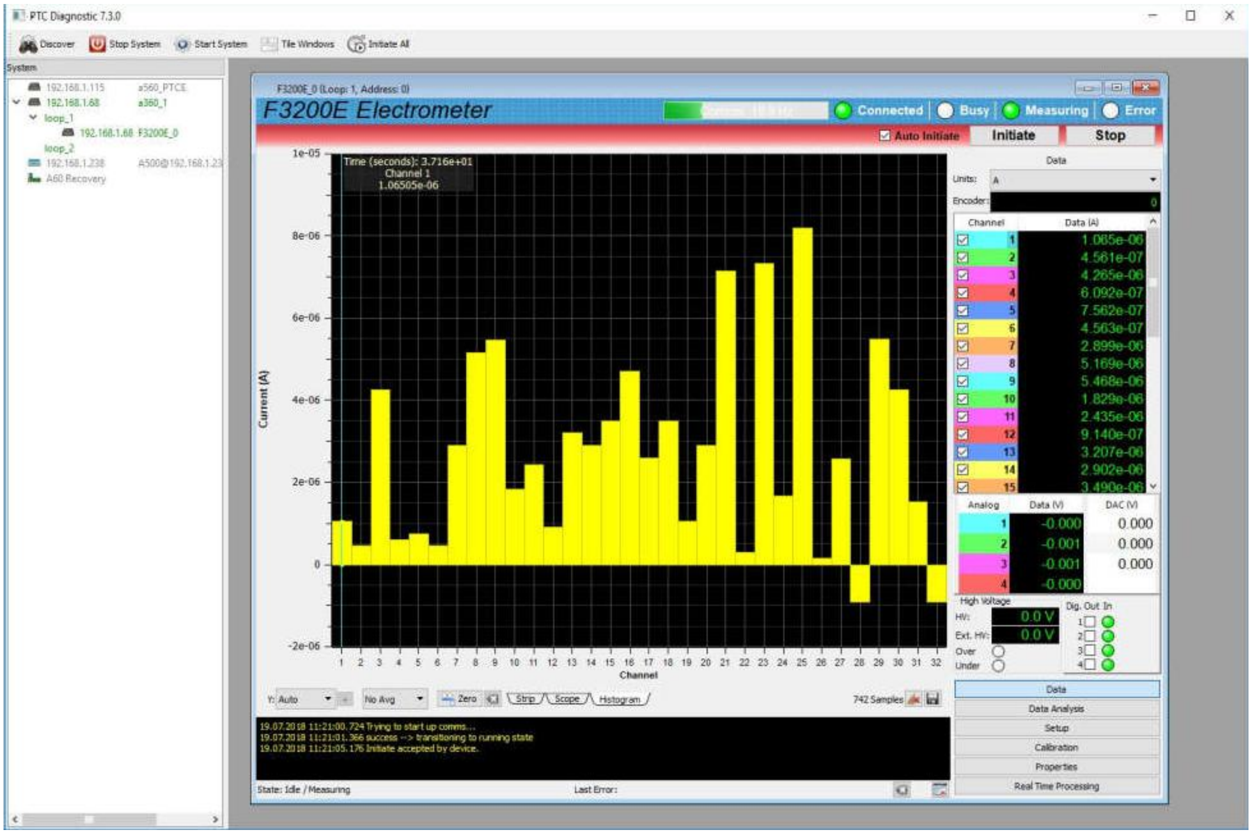


Figure 49. Example fiber optic loop configuration where another device (A360) is the loop controller.

13 IG2 and EPICS Connections

13.1 What is EPICS?

The Experimental Physics and Industrial Control System (EPICS, http://www.aps.anl.gov/epics/) is:

"A set of Open Source software tools, libraries and applications developed collaboratively and used worldwide to create distributed soft real-time control systems for scientific instruments such as particle accelerators, telescopes and other large scientific experiments. EPICS uses Client/Server and Publish/Subscribe techniques to communicate between the various computers. Most servers (called Input/Output Controllers or IOCs) perform real-world I/O and local control tasks, and publish this information to clients using the Channel Access (CA) network protocol. CA is specially designed for the kind of high bandwidth, soft real-time networking applications that EPICS is used for, and is one reason why it can be used to build a control system comprising hundreds of computers."

Pyramid supplies an executable called IG2 which embeds an open source Channel Access Server from the EPICS community. This allows connection via the Ethernet interface. IG2 is configured for the devices you wish to connect using editable xml files. Once IG2 is running on a computer in your network, then any other computer can run a client program which can display and control the process variables for the devices. In the simple network in figure 50, the process variables of a F3200E and an M10 plus H20 attached to the F3200E via fiber optics, are exposed to the network by the IG2 service running on a server computer. One or more client GUI computers can then access the values.

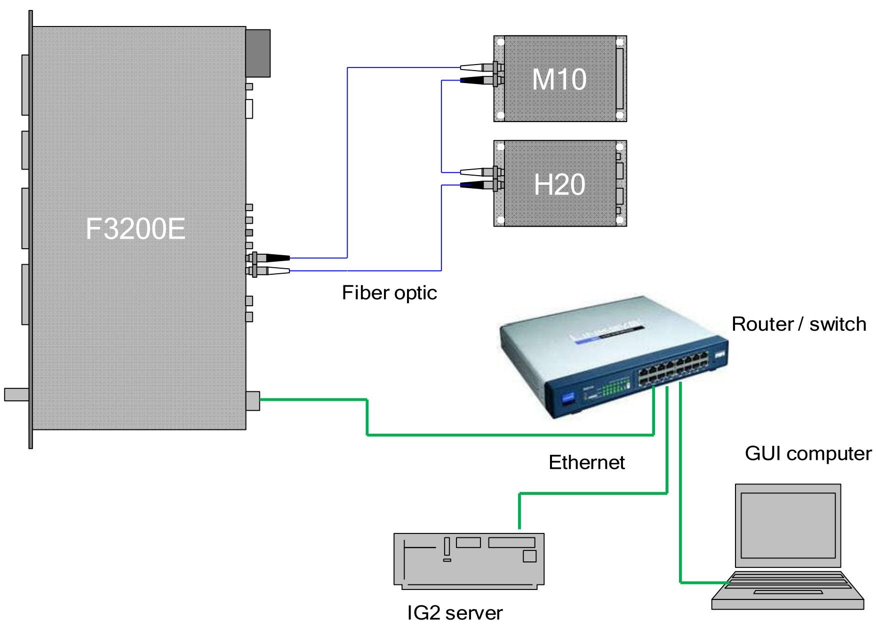


Figure 50. Simple example network for EPICS communications.

There is a wide range of client interfaces from the EPICS community, including interfaces for C++, C#, Java, Python, and Matlab ™. The Control System Studio, or CS Studio, (http://controlsystemstudio.github.io/) is a set of ready-made tools built on Java and Eclipse (http://www.eclipse.org/) that allows users to get started with little or no programming required. There are various logging, plotting, post-processing and alarm point tools. A fully-featured "drag and drop" user interface editor (BOY) allows quite complex customized user interfaces to be created with minimum development time. The figures below show an example GUIs for the F3200E created in CSS BOY.

Figure 51. Example user interface created in Control System Studio BOY.

13.2 Installing and Configuring IG2

The IG2 package is available to users of Pyramid products. A version supporting the F3200E will be added in a forthcoming release. It is supplied as a zip file which should be de-compressed and the entire folder moved to the computer that will act as the server. The server and the user interface computer can be the same machine. The F3200E, the server and the user interface computer should be able to communicate with each other over your network.

In the folders you have saved, there is an xml file that needs to be edited to customize your particular setup. IG2 looks for the file system.xml in the \service subdirectory to establish the configuration of the system. You can locate system.xml elsewhere than the default location, or give it a different name, in which case you need to specify the name and path by means of an argument in the command line that launches IG2. The system.xml file includes all the information about your setup, including all the process variables that you want to expose, and what you want to call them. Since the names must be unique, it is a good idea to include the device name and the process variable description in the name.

The system file comprises a header section on the xml schema, which does not need to change. Then comes a description of the user interface host computer, descriptions of the fiber optic loop controller devices in your system and descriptions of the devices attached to loops. The F3200E is a loop controller, because it has the capability to support multiple slave devices through its fiber optic port. You don’t have to describe every device and every input/output point that is present in your system, but only the ones that you expose in the system file will be visible to EPICS. The following system.xml example corresponds to the CSS GUI shown in the previous figure.

```xml
<?xml version="1.0" encoding="iso-8859-1"?>
<system
  xmlns="http://www.ptcusa.com"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.ptcusa.com A510.xsd" type="pyramid" >
  <hosts>
    <host ip="192.168.1.134" name="PTCE_Server" localhost="true" />
  </hosts>

  <loopcontrollers>

        <loopcontroller type="F3200E" name="F3200E_1" ip="192.168.1.67" >
            <channels>
                <channel name="r_F3200E_1_data" wire="variant_in_data" />
                <channel name="c_F3200E_1_initiate" wire="digital_out_initiate" />


                <channel name="r_F3200E_1_var_range" wire="variant_in_range" />
                <channel name="c_F3200E_1_var_range" wire="variant_out_range_set" />
                <channel name="c_F3200E_1_digital_buff_acq" wire="digital_out_buffered_acquisition" />
                <channel name="c_F3200E_1_acq_mode" wire="int_out_acquisition_mode" />
                <channel name="c_F3200E_1_adc_rate" wire="int_out_adc_rate" />
                <channel name="c_F3200E_1_conversions" wire="int_out_conversions_per_sample" />
                <channel name="c_F3200E_1_start_trigger" wire="int_out_start_trigger_source" />
                <channel name="c_F3200E_1_pause_trigger" wire="int_out_pause_trigger_source" />
                <channel name="c_F3200E_1_stop_trigger" wire="int_out_stop_trigger_source" />
                <channel name="c_F3200E_1_stop_count" wire="int_out_stop_count" />
                <channel name="c_F3200E_1_register_offset" wire="int_out_register_offset" />
                <channel name="c_F3200E_1_register_contents" wire="int_out_register_contents" />
                <channel name="c_F3200E_1_base_address" wire="int_out_base_address" />
                <channel name="c_F3200E_1_register_command" wire="digital_out_register_command" />
                <channel name="c_F3200E_1_burst" wire="int_out_burst_count" />
            </channels>
        </loopcontroller>

  </loopcontrollers>
```

Figure 52. System.xml example.

The convention of "wires" for Pyramid device process variables, and the fixed names of those wires for each supported product, are described in Pyramid document "ig2_scripting_v#.#.pdf", where #.# is the document revision number. The document also describes how you can scale the values, for example to convert voltages from general purpose I/O devices to physical units relevant to the item they are controlling, and how you can set up monitoring against tolerance bands.

The choice of a corresponding working name for each wire is up to the user; you may wish to choose something descriptive that is relevant to what you are measuring or controlling. We nevertheless recommend a naming convention that makes it clear whether a value is a readback or control (the prefixes c_ and r_ are used in the example), which particular device the value is associated with, and a number or letter to indicate the channel for multichannel devices.

14 Serial Communications

Data is generated at too greater rate by the F3200E for a 115 kbps serial interface to be useful for general use. However, it can be useful to check or change network settings or query the setup of the unit for diagnostic purposes. The commands are ASCII and use the SCPI format. A command that ends with a query solicits a response. A command without a query is an instruction to the device.

The F3200E supports 115.2 kbps RS-232 ASCII communication. In the following example the F3200E is asked to return its identity. The Ethernet IP address and mode is requested, then the IP address is set to a new value.

Figure 53. RS-232 terminal session.

14.1 RS-485 connection example

RS-485 is used to extend a serial connection over a long distance. RS-485 is not currently enabled in the F3200E, but may be added for specific customer needs. If you have a RS-232 serial port on the host PC, then an RS-232 to RS-485 converter is used at the host PC end. The built-in RS-485 of the F3200E allows a direct connection at its end.

A commonly-used converter for the beam position monitor application is the MOXA TC100. The Moxa TCC-80 is a low-cost alternative for less critical applications. The converter should be configured for four wire (full duplex) RS-485 operation. The F3200E provides parallel termination for transmit and receive. It is therefore optional whether you also terminate at the TC100 end, but there is no harm if you do. The recommended Dip switch setting for the TC100 is:

Sw1	Sw2	Sw3
OFF	ON	ON

The recommended Dip switch setting for the TCC-80 is:

Sw1	Sw2	Sw3
ON	OFF	ON

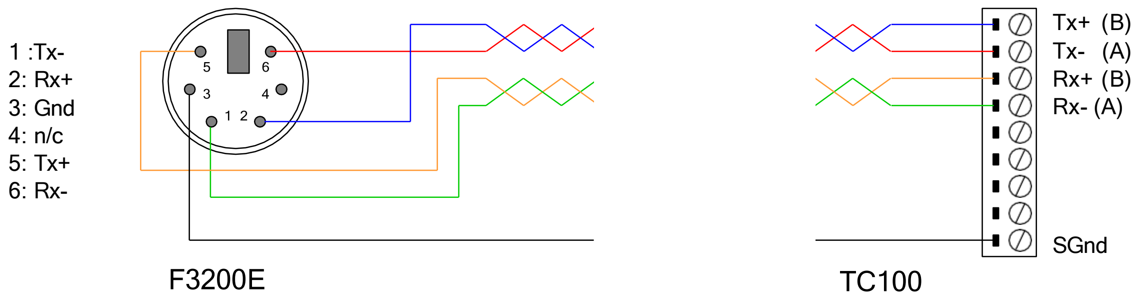


Figure 54. RS-485 cable F3200E to TC100.

15 Principle of Operation

15.1 Transconductance amplifiers

The F3200E uses the transconductance amplifier circuit, or I-V converter, to produce a convenient voltage from the small signal current. You can consider that the signal current I flows through the precision feedback resistor R_f in the amplifier circuit, resulting in a voltage $I.R_f$ at the amplifier output. Provided that the output of the amplifier does not saturate, the input impedance of the amplifier is close to zero ohms. The actual input impedance of the circuit is determined by any series impedance R_s that is upstream of the feedback loop.

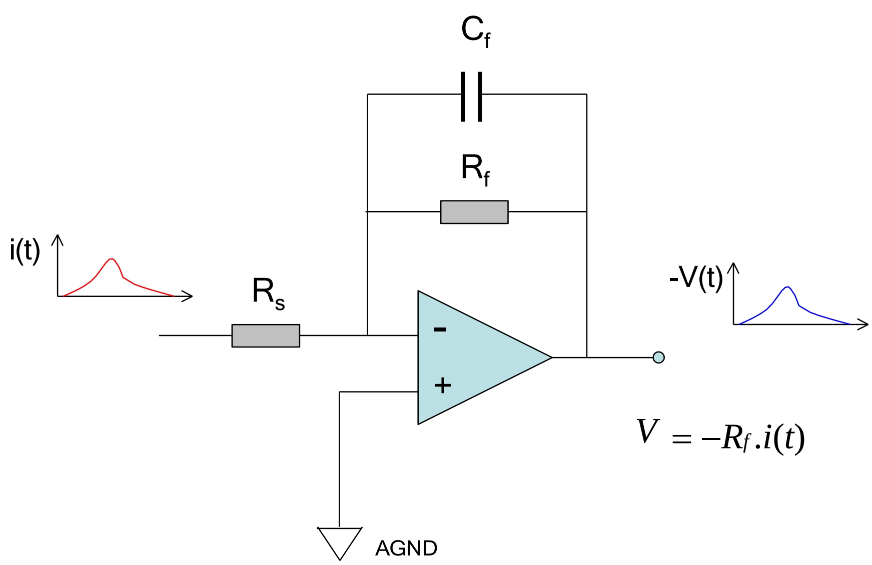


Figure 55. The basic I-V convertor circuit.

The fidelity with which the output voltage tracks the input current over all frequencies depends upon the speed of the amplifier, and any integrating effect of capacitance in the feedback loop, either deliberately added or stray, which will roll off the high frequency response. A small amount of feedback capacitance C_f is often added to ensure that the amplifier is unconditionally stable.

15.2 F3200E Circuit Overview

The circuitry is arranged on a main board plus two daughter boards. The A60 is a standard Pyramid processor card which handles the communications interfaces to the host computer. The fiber optic mezzanine card mounts the six fiber optic devices.

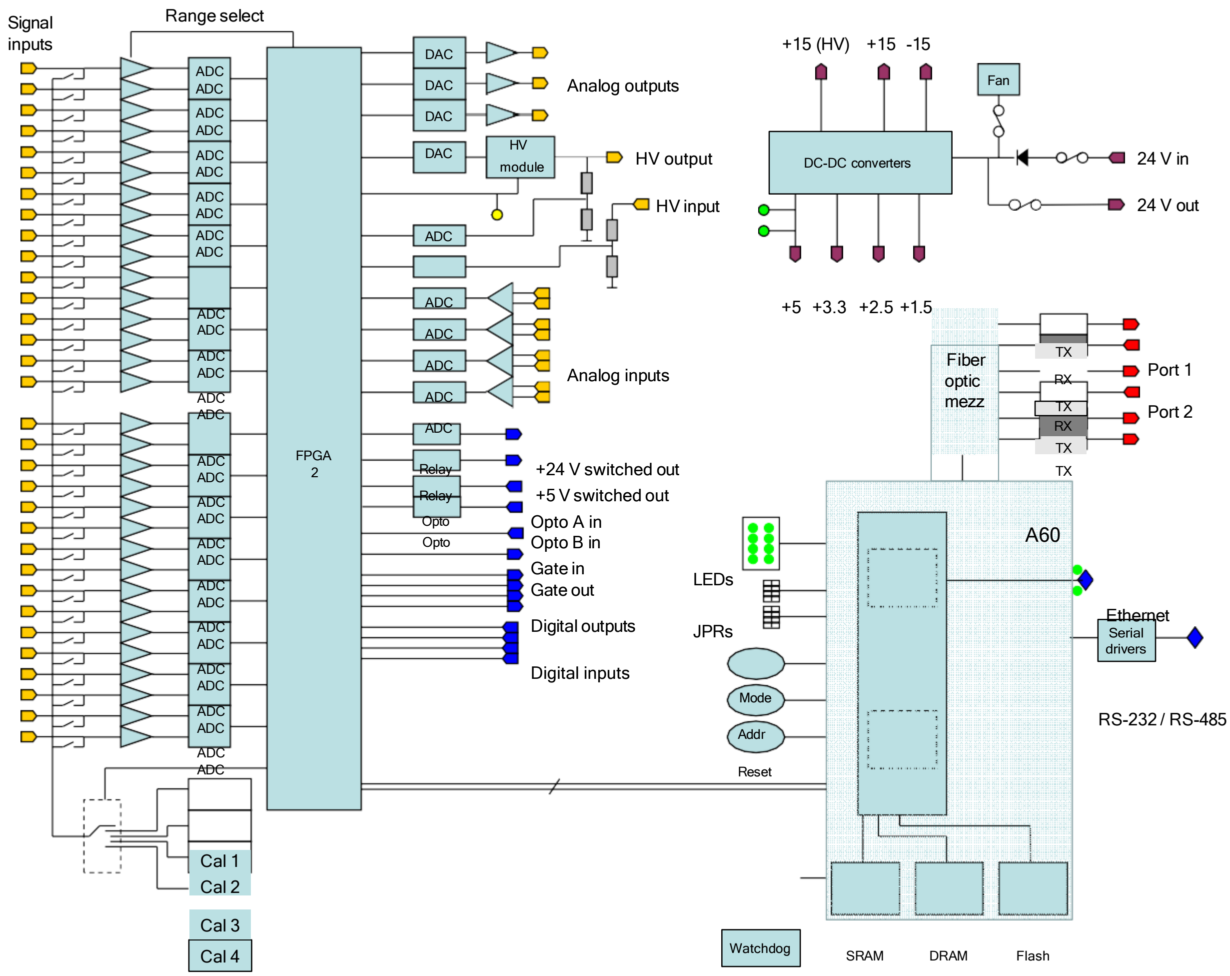


Figure 56. F3200E block schematic.

15.2.1 Signal input stages

Each signal processing channel comprises four distinct I-V converter circuits, differing in the value of the feedback resistors. Stabilization capacitors in the feedback loops give an effective time constant of 0.8 µsec on each range. One of the four circuits is switched in by analog gate switches at any time in order to establish a particular full scale current. The input impedance is determined by the “on” resistance of the analog gate, which is 40 ohms typical.

The I-V converter stage is followed by a four-pole low-pass filter with -3dB rolloff set to 250 kHz, to provide anti-aliasing for the analog to digital converter.

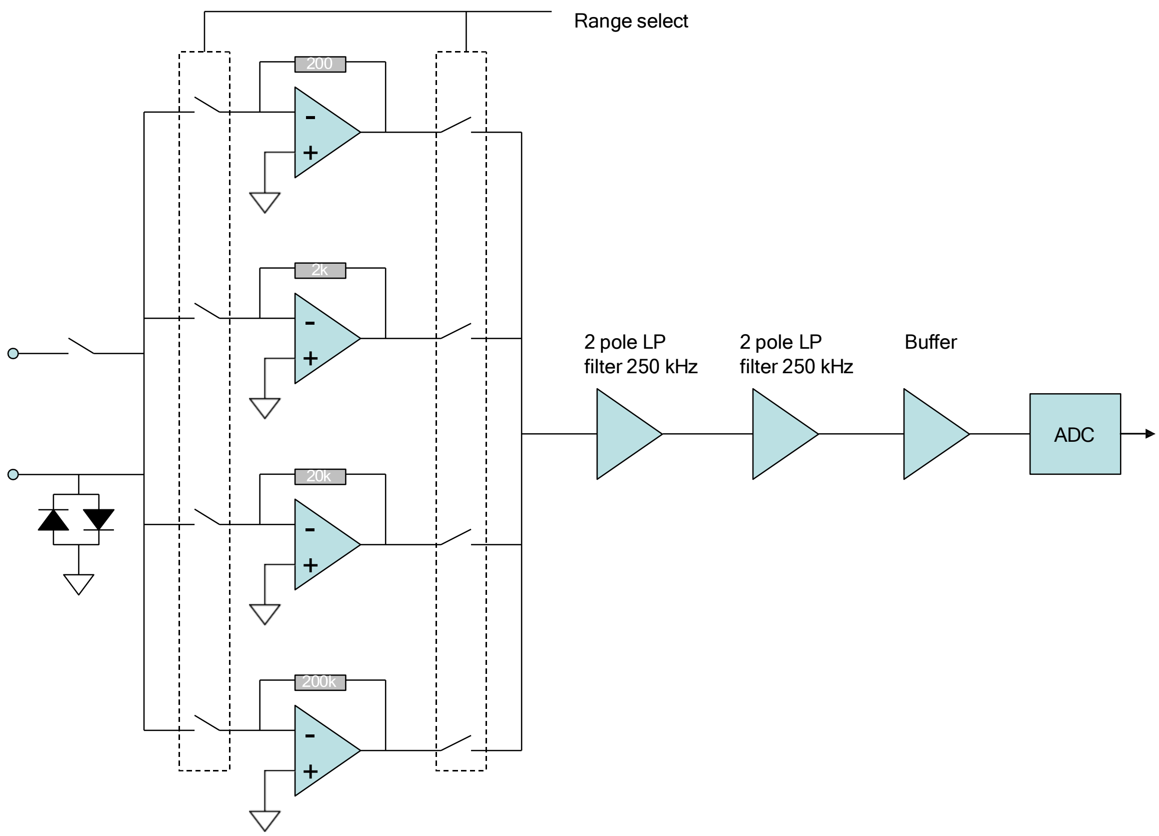


Figure 57. F3200E analog stages block schematic.

The input stage is repeated thirty-two times to make up the full channel count. Each channel has a dedicated 1 MHz 14-bit ADC, and all channels are converted simultaneously. The analog signal is biased in the filter and buffer stages so that the fourteen bit range of the ADC maps to +/- the full scale current.

15.2.2 FPGAs

The digital circuitry is based around two field programmable gate arrays (FPGAs) which handle all data collection, processing and communications.

FPGA 2 on the main board controls all the ADCs and DACs, and collects the conversions over multiple serial lines. The monitor output is generated in real time by the acquisition FPGA (FPGA 2) and delivered to analog output 1 when enabled. The FPGA also handles tasks such as calibration current control, control and readback of the optional HV supply, gate inputs and outputs, and the auxiliary connector I/O lines.

FPGA 1 in the A60 card contains two embedded NIOS II processor cores, one handling the real-time F3200E application written in Embedded C, and the other handling Ethernet communications running on µCLinux. High speed FPU instruction blocks are implemented in the FPGA to provide real time data processing. The application processor communicates with devices on the main board using a fast serial bus. It is connected to external memory for the operating system and application programs. It handles the communication channels to the host PC, reads the rear panel switches and drives the LEDs.

15.2.3 Power supplies

24 VDC input power enters via a 1.1 A fuse, and is used directly to power the cooling fan. It is also available via a fused output on the auxiliary (actuator) connector. The 24 V input is protected against polarity reversal by a series diode, and from transients by series inductors and transorbs to chassis which limit excursions to 6 V (not shown on the block schematic). DC-DC converters generate the +/-12 VDC supplies for the analog circuits, and +5, +3.3, +2.5 and +1.5 VDC for the digital circuits.

16 Triggers and Buffering

The F3200E offers the ability to measure small currents at high rates plus great flexibility for collecting data and triggering to synchronize with external events. The basic internal mode provides a simple to use acquisition that does not need any external trigger. The various external trigger modes require incoming synchronization triggers. Most of the external modes can be also set up in the custom mode, which provides comprehensive controls for choosing the conditions that start, pause and stop an acquisition. Sweep mode is intended for repetitive signals that a synchronous with a trigger signal.

16.1 Internal trigger mode

If you simply want to stream data continuously from the F3200E, then the Internal trigger mode achieves this. Don't check the Burst Count or Stop Count boxes. When you press Initiate, the F3200E will start streaming data to the host computer, and will continue until you abort the acquisition. The PTC DiagnosticG2 strip mode and histogram graphics will keep up with real time, shown under the strip mode plot as the time in seconds since the Initiate. The data rate is limited by communication rates over the Ethernet, however, and by the load on the host computer. Thus, beyond a particular data sampling rate, there will inevitably be missing readings in the record. The critical rate will generally be close to the Comms rate displayed on the PTC DiagnosticG2, normally about 20 Hz. When the sample rate is greater than the communications rate, the proportion of samples that you capture will be given by (communications rate)/(sample rate) to a good approximation.

16.2 Data buffers

16.2.1 F3200E internal buffer

The internal memory of the F3200E allows you to acquire time contiguous data at very high rates. The maximum buffer size you can select is 65,534. However, because the buffer is implemented as a cascade of memory, and because data is always being sent up to the host computer during an acquisition, the amount of available buffering can appear to be variable. Best performance is achieved with a fast network connection to the F3200E. If the device is connected via fiber optic to a loop controller, the maximum rates and buffer sizes before overflow will be lower. When you are acquiring data into the buffer at high rates, the PTC DiagnosticG2 display will generally lag behind real time, underscoring the fact that you are now taking data faster than it can be delivered to the host computer.

The F3200E can capture a single shot capture of the full buffer of 65534 readings with 67 kHz sample rate with a direct Ethernet connection. This corresponds to a 0.98 second burst of contiguous data with 15 µsec time resolution across all 32 channels. At the shortest allowed averaging time of 6 µsec, over 3000 readings can be taken without buffer overflow. It is possible to get time resolved single shot data down to 1 µsec resolution by suitable setup of the sweep mode, as described in section 16.4.

Before taking any critical time-resolved data, you should test the available maximum number of samples under the expected worst-case loading of your network and host computer. We recommend that you also set a maximum number of readings (the Stop Count) when using the data buffers, to avoid arbitrary overwriting of the data.

16.2.2 PTC DiagnosticG2 buffer

The PTC DiagnosticG2 has its own circular data buffer with a maximum of 100,000 entries. This is independent of the F3200E buffering. If you allow an acquisition to run longer than this, and recover the log file, you will see that the data has wrapped around. The oldest entries will be overwritten. You can clear the Diagnostic buffer at any time with the "Clear the data buffer button". You can save the current buffer contents to a csv format file at any time using the "Save the data buffer to a file" button.

16.3 External triggering

16.3.1 Custom triggering

The F3200E will respond to edges on the gate input to start, pause and stop acquisitions. Using the Custom trigger mode allows you great flexibility in choosing when and how the F3200E should take data, and how data taking should be synchronized with external events. Consider an acquisition with start, pause and hold conditions.

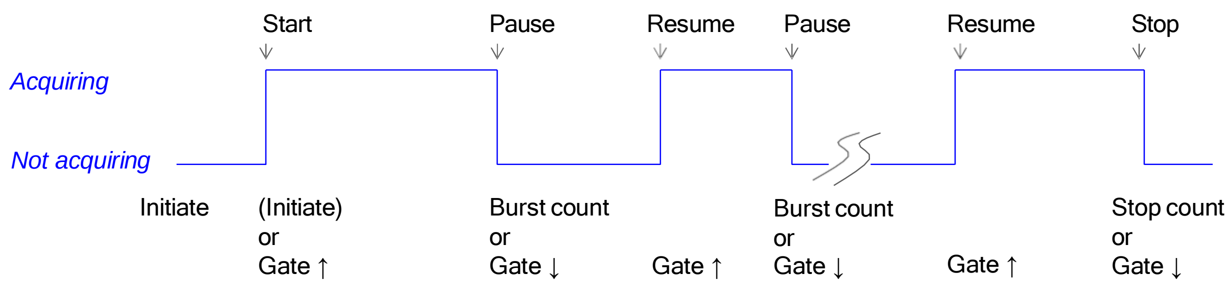


Figure 58. Start, pause and stop conditions.

Every acquisition must start with an Initiate command from the host computer, for example clicking the Initiate button in the PTC DiagnosticG2 program. In Internal mode, this is sufficient on its own to start the acquisition. However to synchronize with an external event, the start condition should be selected to respond to an incoming gate signal edge. The gate edge can be on the Lemo 00 TTL input or the optical gate input (fiber optic channel 1 Rx).

Pausing is optional, and only possible if the start condition was set on the gate input. You can select whether the acquisition pauses when it has reached a defined Burst Size (number of measurements) or when it sees the opposite direction edge on the gate input to that which started the acquisition. Both conditions can be selected, in which case the condition which applies first will pause the acquisition. The acquisition resumes when the gate defined for start is seen again. There is no limit to the number of pauses and resumes.

Stopping is optional, but strongly advised if you are buffering contiguous data, to reduce the risk of buffer overflow. You can stop when a defined Stop Count has been reached, or when the F3200E detects opposite direction edge on the gate input to that which started the acquisition. Both conditions can be selected, in which case the condition which applies first will stop the acquisition.

16.3.2 Pre-defined trigger modes

The F3200E provides a number of pre-defined trigger modes. Most can be achieved by appropriate Custom trigger settings. Similarly, having chosen one of these preset modes, you can alter some settings to add extra Burst Size or Stop Count conditions, as if you are using custom mode. For every trigger mode you can force the F3200E to stop acquisition state at any time by sending the Abort command.

Mode	***Start***	***Pause***	***Stop***	***Notes***
Internal	Internal	n/a	n/a	Acquisition will start immediately you send Initiate, and continue indefinitely if unbuffered, or to the <Stop Count> if buffered.
Custom				Full user control over start, pause, resume and stop.
External Start	Gate	n/a	n/a	Acquisition will start when a valid trigger edge is seen after you send Initiate, and continue indefinitely.
External StartStop	Gate	n/a	Gate	Acquisition will start when a valid trigger edge is seen after you send Initiate. Readings will continue until the opposite polarity trigger edge is seen.
External StartHold	Gate	n/a	n/a	<Burst Size> is forced to a value of 1 in this mode. A single reading is taken for each valid trigger edge. This will continue indefinitely.
External Windowed	Gate	Gate	n/a	Acquisition will start when a valid trigger edge is seen after you send Initiate. Acquisitions continue until the opposite polarity edge is seen, at which point the acquisitions pause. They resume when the next trigger edge is seen.
Sweep	Gate	Gate	n/a	Acquisition will start when a valid trigger edge is seen after you send Initiate, and <Sweep Length> readings will be taken. On the next trigger edge another <Sweep Length> readings will be taken and averaged with the first. This will continue until <Sweep Averaging> number of sweeps have been averaged together, and the data will be sent to the host computer. The averages are reset and the process repeats indefinitely.

16.4 Sweep mode

16.4.1 Repetitive signals

Sweep mode provides the highest available effective sampling rate, but requires a repetitive signal. A typical application is particle accelerators where the beam is scanned across an array of detectors. This schematic illustration shows a linear particle sweep backwards and forwards across a beam dump which includes multiple equispaced beam collector slots, each connected to an F3200E channel. The objective is to create a uniform beam fan from a narrow pencil beam. The signal from the beam collectors is nominally completely repetitive, and synchronized by the scan generator clock. High performance magnet systems are capable of doing such beam scans at rates up to 1 kHz.

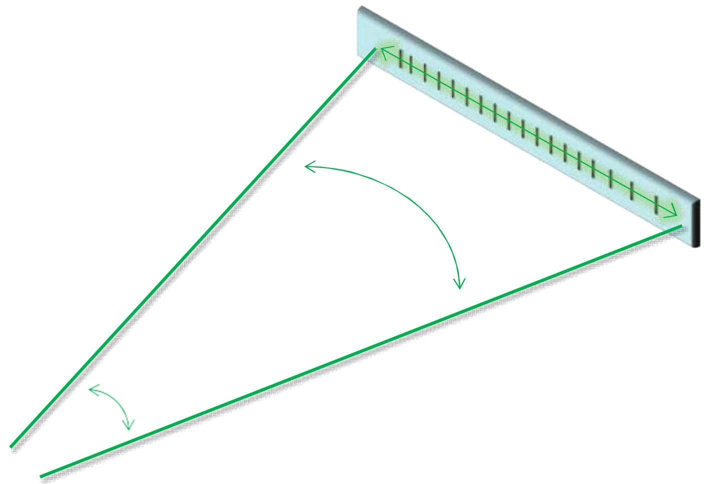


Figure 59. Illustrative scanned beam example.

Assume that the sweep frequency in this example is 500 Hz, so that a single pass of the beam takes 1 msec. Setting up the F3200E in sweep mode with 1 MHz ADC rate and 1000 points per sweep will generate 1000 readings for each pass of the beam and take 1 msec. In practice there needs to be some extra time, about 5-10 µsec, before the next synchronization trigger arrives so that data can be transferred inside the F3200E and a new trigger edge can be detected. So a more sensible setup would be 980 points to provide a 20 µsec period for data transfer.

The number of sweep averages to use will depend upon the signal to noise ratio and the temporal frequency components you need to see in the beam. When it has overlaid and averaged the requested number of sweep averages, the F3200E will return the result and repeat the process. The “comb” of peaks is a mapping into the time domain of the spatial behavior of the beam across the scan. The F3200E is also providing spatial information if the spacing of the slots is well-known, so a measurement of the local beam spot velocity is possible. The data can also be analyzed to check parameters such as constancy of the beam profile and intensity across the sweep. Combining all the data allows the uniformity of the fan beam line to be assessed.

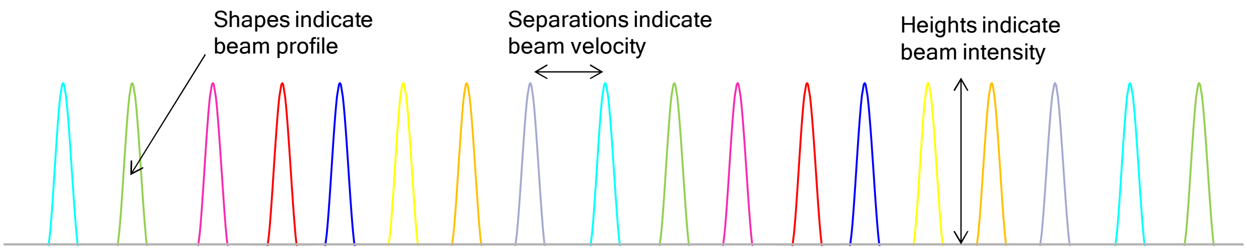


Figure 60. Illustrative scanned beam example - analysis.

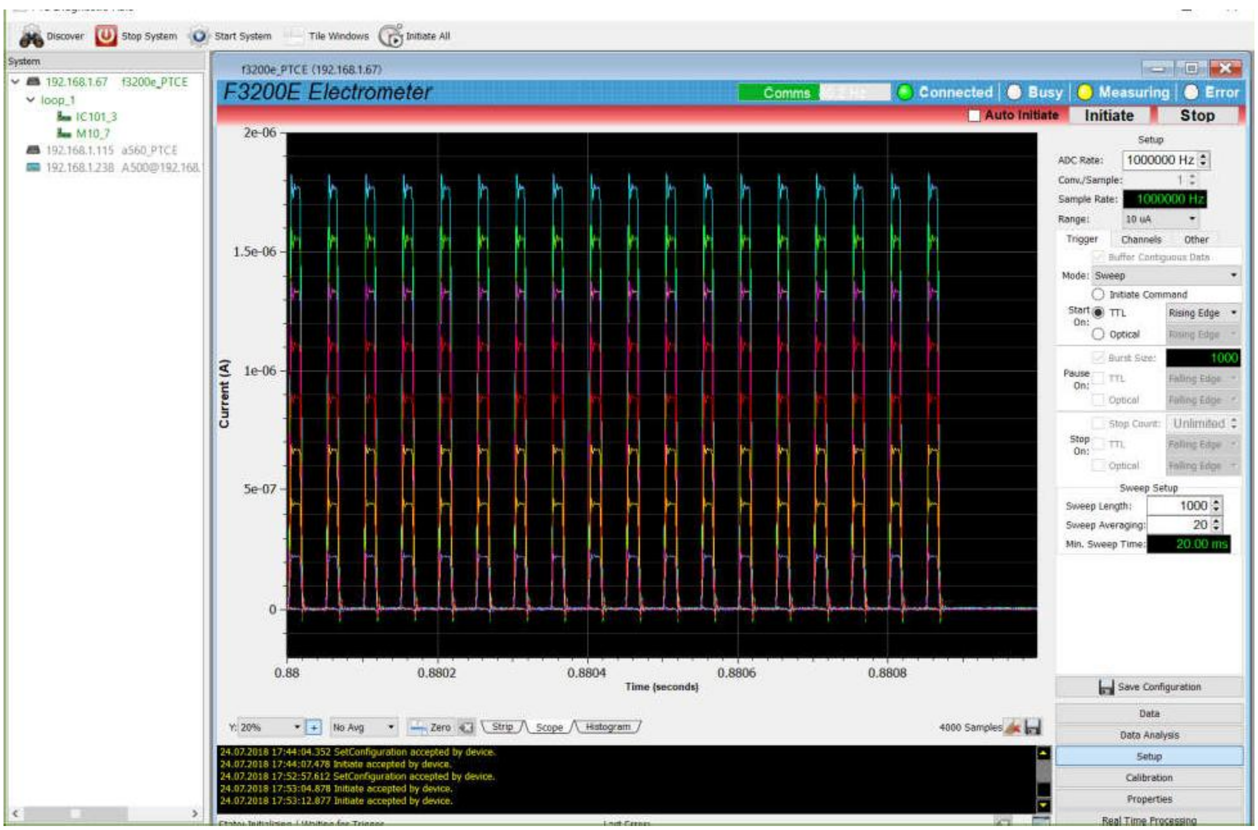


Figure 61. Burst of pulses captured in sweep mode, 20 sweep averaging.

16.4.2 Single shot acquisition at 1 MHz

Normal buffered acquisition is limited to a maximum sampling rate of 167 kHz to minimize buffer overflow risk. However it is possible to use sweep mode to collect single shot data at 1 MHz for up to 1000 samples. Simply set the number of sweep averages to 1, and deliver a single start trigger pulse. The F3200E will capture 1000 readings on each of 32 channels with 1 µsec intervals, and you can save the data to a csv file if you are using the PTC DiagnosticG2 program. Note that you must consider the analog bandwidth when looking at data that has been sampled at this rate.

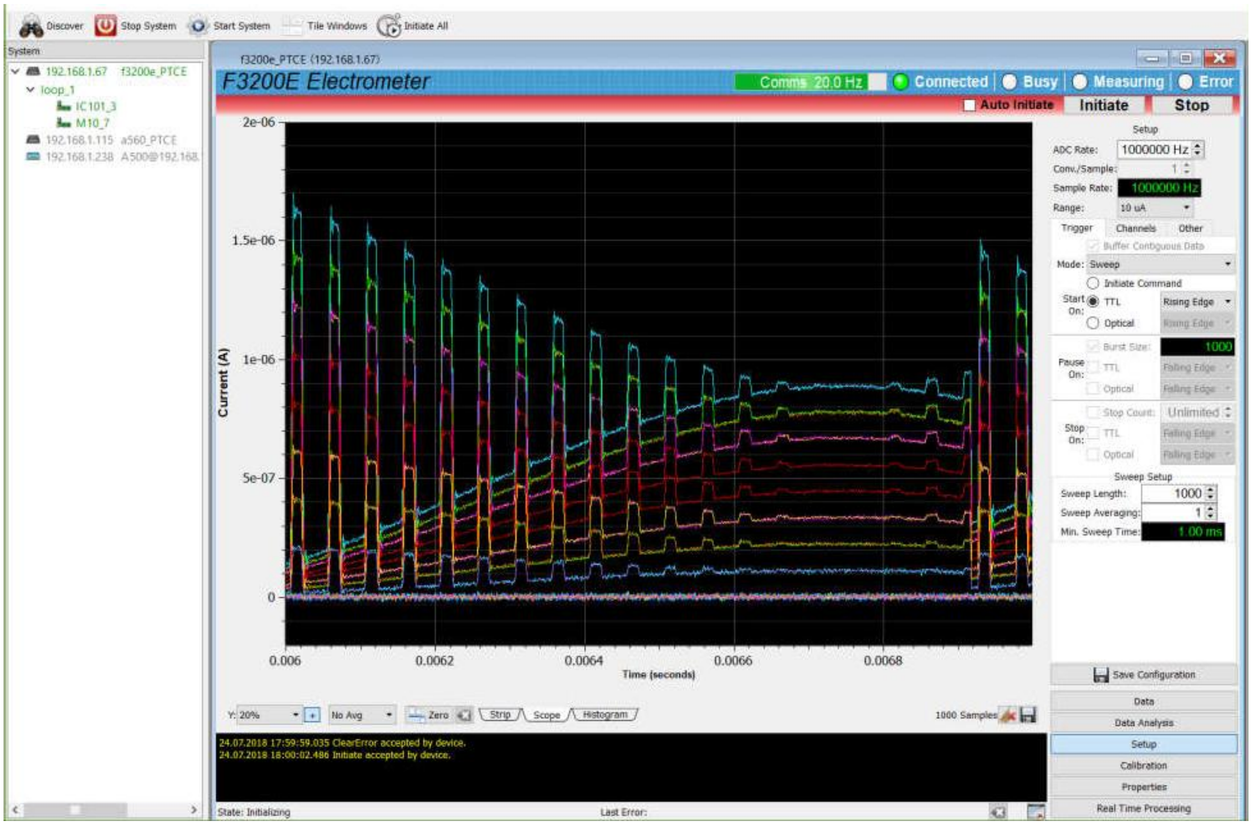


Figure 62. Single shot measurement at 1 MHz sampling.

17 Monitor output

The monitor output analog signal can be selected as the function of analog output 1 (pin 19 on the I/O connector, relative to ground (pins 9 or 13). It provides a wideband real time view of the inputs when the F3200E is measuring, independent of the communication channel to the host computer. When monitor mode is selected, the value is computed as the sum of user-selected channels by the main PCB FPGA and sent to the DAC that drives analog output 1.

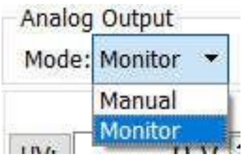


Figure 63. Selecting monitor mode.

The gain factor is given by the full scale current range in use and the number of channels that you have selected for the summation.

Gain = (10 / Current range) * (1 / number of channels)   volts per amp

As an example, if the current measured on channel 1 is 6 µA on the 10 µA range, and you have selected only channel 1 into the summation, the output voltage will be 6e-6 * (10/10e-6) * (1/1), or 6 volts.

In the following example, a 500 Hz sine wave is delivered with equal magnitude to channels 1-16 and a 10 kHz at various amplitudes into channels 19-32. The F3200E was running in sweep mode at 1 MHz sampling.

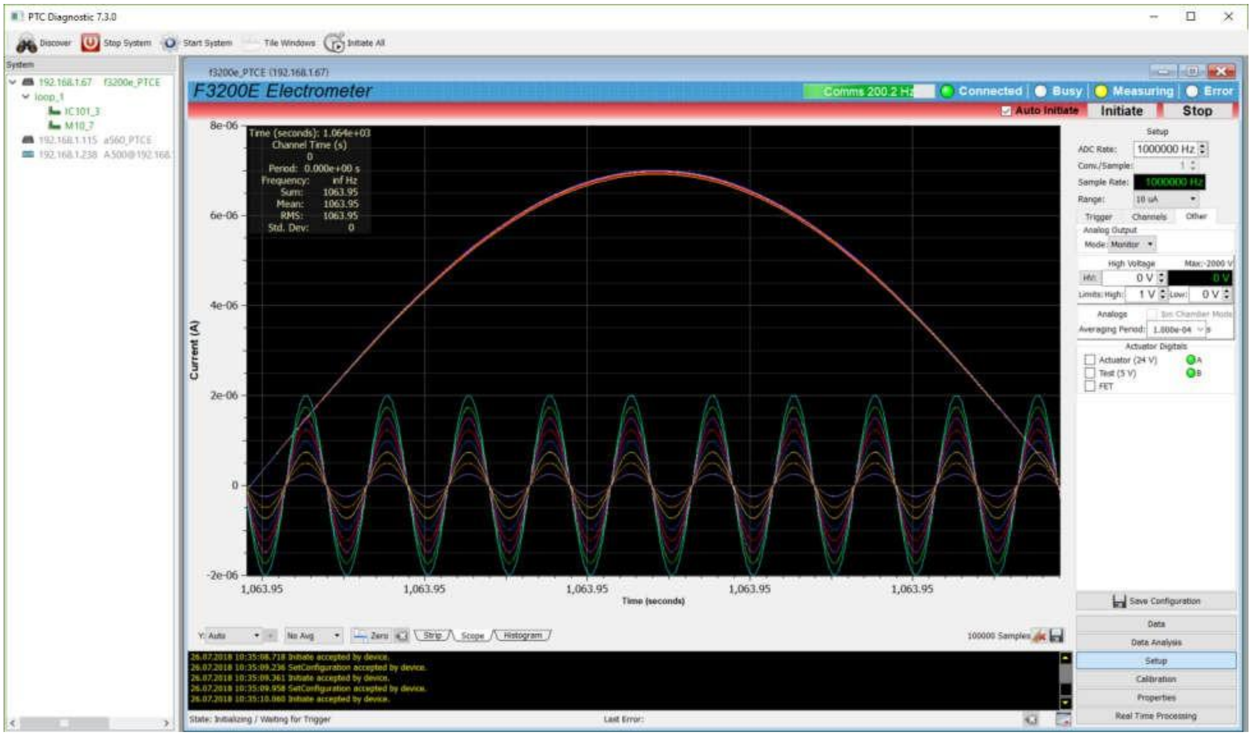


Figure 64. Demonstration acquisition for monitor mode.

If all channels are selected for monitoring, an oscilloscope measuring analog output 1 shows the summed version delivered to the monitor output, shown on the blue trace in figure 64. The monitor output is updated only while the F3200E is measuring (red trace). When it is waiting for the next trigger, the most recent output value is held.

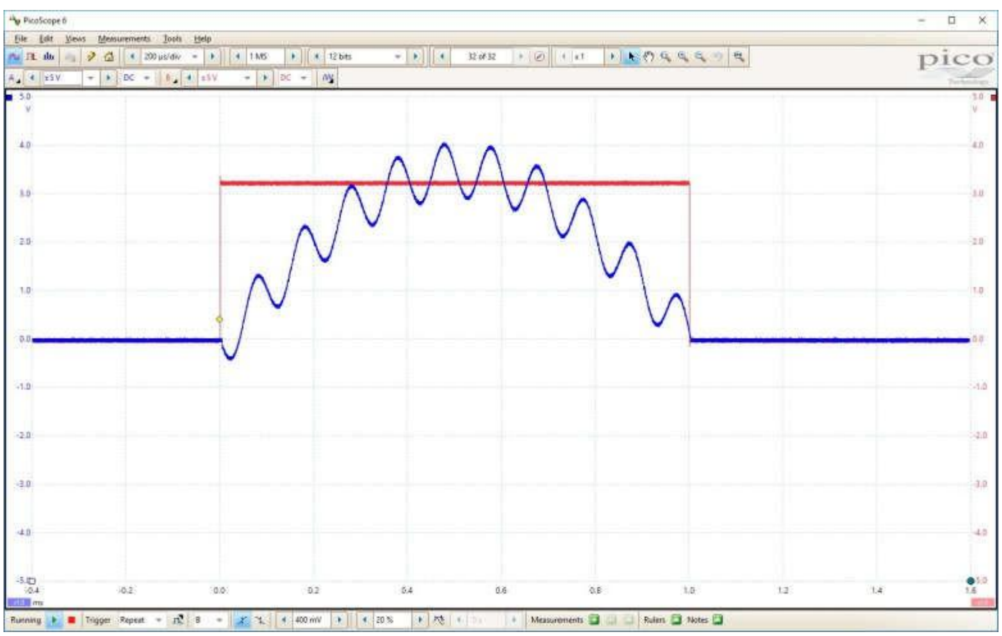


Figure 65. Monitor output voltage with all channels selected for monitoring.

Deselecting channels 1-16 leaves only the 10 kHz signals contributing to the monitor.

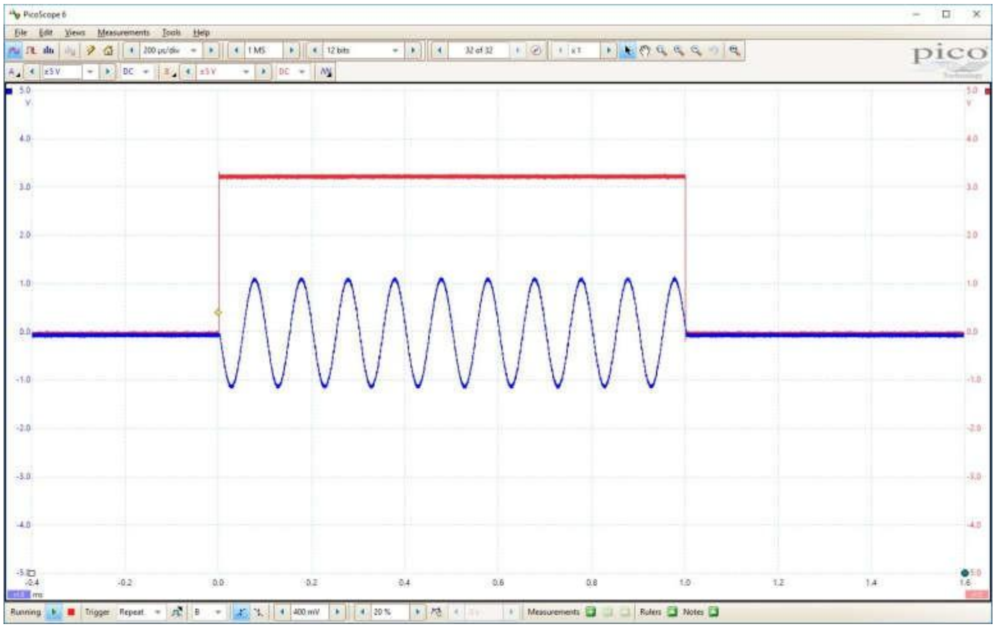


Figure 66. Monitor output voltage with some channels de-selected.

18 Real Time Processing

Custom application code can be loaded into the F3200E using an xml schema. The code can coordinate data across the F3200E itself and devices connected to it as fiber optic loop slaves. Maps which comprise a table of command values plus values to be monitored can be executed in a regular time sequence to create a coordinated data set.

If your application could benefit from a real time processing application we recommend that you contact Pyramid Technical Consultants for assistance to develop an initial set of files.

19 High Voltage Supply

19.1 Setting the High Voltage Supply

The F3200E is available with a one-watt high voltage supply suitable for biasing ionization chambers, diodes, and proportional chambers. The voltage range can be specified at time of purchase from 200, 500, 1000 and 2000V with either polarity.

The front panel HV on LED illuminates when the supply enabled. The set value can be adjusted at any time, independent of what measurements are in progress.

A voltage divider on the HV output senses the actual voltage being delivered. There is a second identical divider on the HV input. This allows an optional loopback verification that the high voltage is reaching the intended electrode. The HV return line should connect to the driven electrode at a different place to the incoming voltage to confirm absolutely that the voltage is reaching its destination.

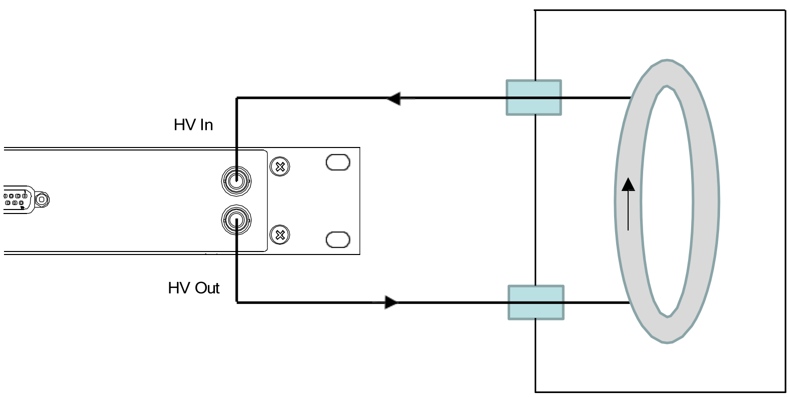


Figure 67. Loopback validation of external high voltage connections

If the monitored values differ significantly from the setpoint, you know that the output is either being loaded down by a low resistance to ground, or that it is being driven by another source of higher compliance. A vacuum chamber with a large free electron population can load down a positive power supply connected to an electrode in that chamber. A charged particle beam striking the electrode connected to the HV supply can have this effect. In all cases you should investigate the cause, because damage may result to the F3200E.

Positive supplies source conventional current, and negative supplies sink conventional current. A bleed resistor fixed load is connected to each high voltage supply output which drains 40 µA at maximum voltage. Transorb protection devices prevent the absolute value of the voltage at the output going more than 80 V above the maximum rating. However these devices are not designed to pass large currents indefinitely, so you should be careful not to overdrive the outputs with other power supplies or with charged particle beam strike currents.

CAUTION

Do not connect external power supplies to the F3200E external high voltage output that will drive the built-in supplies away from the voltages they are trying to regulate, or you may cause damage to the F3200E.

19.2 Changing the High Voltage Supply Range and Polarity

The range and polarity of the high voltage supplies is fixed and must be specified at time of purchase. Units may be returned to the factory to alter the high voltage modules if necessary. It not recommended that users change the high voltage supply module. The following jumper setting information is included for reference only.

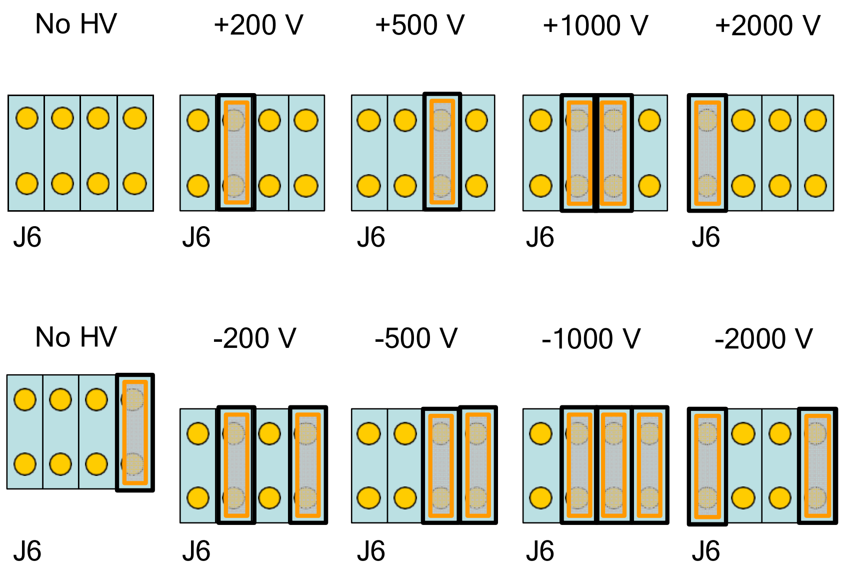


Figure 68. High voltage module jumper settings

20 Using the General I/O Connector

The F3200E provides a general purpose input/output connector with analog and digital lines that may be used for any compatible purpose. All circuits include current limiting resistors (shown in the figures below) and diode clamps (not shown).

20.1 Analog inputs

Four differential inputs, +/- 10V. Current limiting resistors.

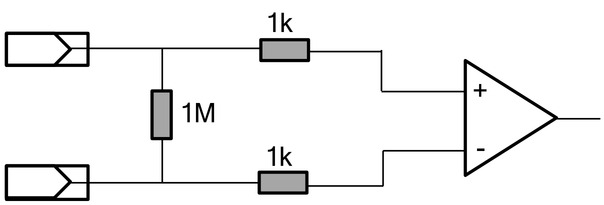


Figure 69. Analog input circuit

20.2 Digital inputs

Four inputs, TTL levels with pull up to 5 V. Series protection resistor.

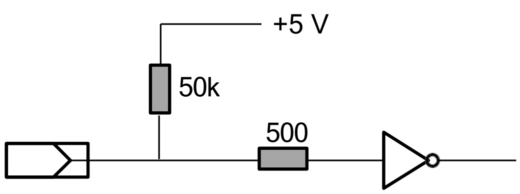


Figure 70. Digital input circuit

20.3 Analog outputs

Three outputs single ended, +/- 10 V, max current 50 mA.

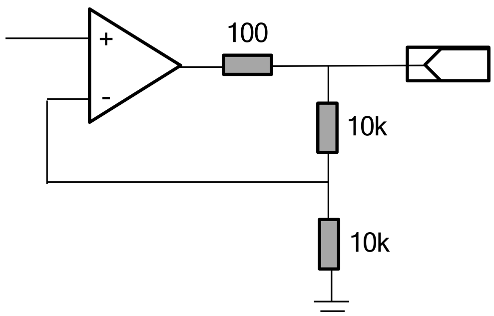


Figure 71. Analog output circuit

20.4 Digital outputs

Four outputs TTL levels, max current 35 mA.

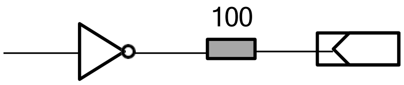


Figure 72. Digital input circuit

21 Using the Actuator Control Connector

Many detector devices are mounted on motion actuator systems so that they can be moved in and out of the path of a beam of charged particles or ionizing radiation. The F3200E provides an auxiliary input / output connector on the front panel intended for control of a pneumatic actuator, but also available for other purposes.

Switched +24 VDC power is available to drive a solenoid, relay coil or similar device. The output is protected by a 130 mA automatically resetting fuse.

Two opto-isolated digital inputs are provided for limit switch sensing or general applications. 24 VDC power is available on pins 4 and 8, protected by 130 mA automatically resetting fuses.

Figure 74 shows a typical arrangement for pneumatic actuator control.

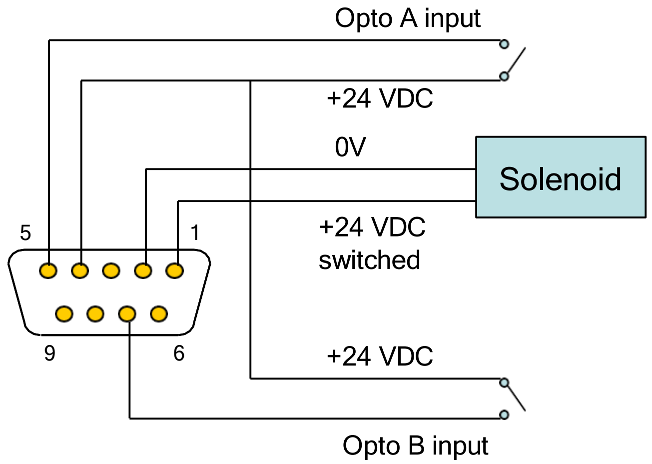


Figure 73. Connecting a solenoid-operated actuator to the actuator control connector.

A relay switched +5 VDC continuity test signal is routed to pin 3 on this connector in parallel to pins on each of the signal input connectors. A FET-switched fast logic signal with 10 kohm pullup to +5 V is provided on pin 6.

Figure 75 shows the F3200E internal circuits, to allow users to design other interfaces to the connector as required.

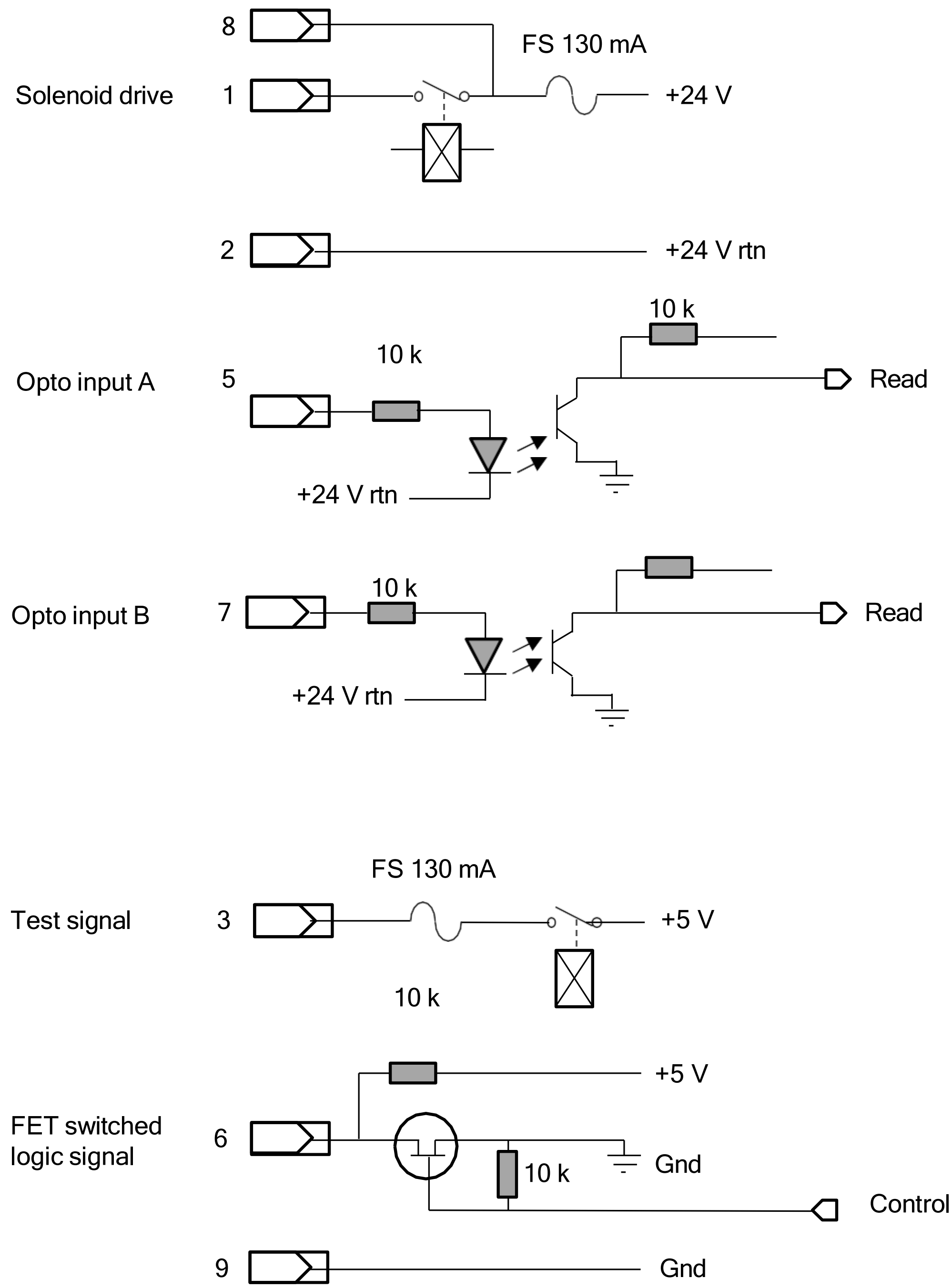


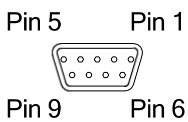
Figure 74. Actuator I/O : F3200E internal circuitry.

22 Connectors

22.1 Front panel connectors

22.1.1 Actuator

Dsub 9 pin female.

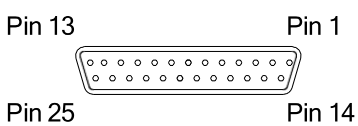


(External view on connector / solder side of mating plug)

1	+24 VDC switched	6	Digital output
2	PSU GND	7	Opto in B
3	+5V relay switched	8	+24 VDC out
4	+24 VDC out	9	DGnd
5	Opto in A		

22.1.2 General purpose I/O port

Dsub 25 pin female.

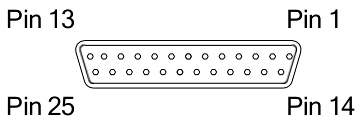


(External view on connector / solder side of mating plug)

1	24 V return	14	+24 V DC out
2	Chassis	15	Analog out 3
3	Analog in 1 +	16	Analog in 1 -
4	Digital out 1	17	Digital out 2
5	Analog in 2 +	18	Analog in 2 -
6	Analog in 3 +	19	Analog out 1
7	Analog in 3 -	20	Analog out 2
8	Analog in 4 -	21	+ 5 VDC out
9	Ground	22	Digital out 3
10	Digital out 4	23	Analog in 4 +
11	Digital in 4	24	Digital in 3
12	Digital in 2	25	Digital in 1
13	Ground		

22.1.3 Signal inputs 1-16 (red cable code)

Dsub 25 pin female.

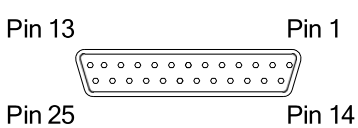


(External view on connector / solder side of mating plug)

1	Input 02	14	Input 01
2	Input 03	15	+5V switched
3	Input 04	16	AGND
4	Input 05	17	AGND
5	Input 06	18	AGND
6	Input 07	19	AGND
7	Input 08	20	AGND
8	Input 09	21	AGND
9	Input 10	22	AGND
10	Input 11	23	AGND
11	Input 12	24	Input 16
12	Input 13	25	Input 15
13	Input 14		

22.1.4 Signal inputs 17-32 (green cable code)

Dsub 25 pin female.



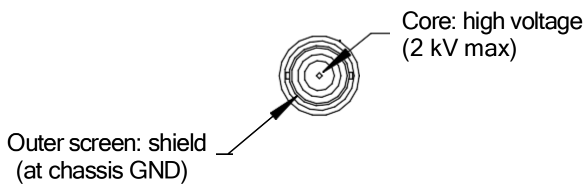
(External view on connector / solder side of mating plug)

1	Input 18	14	Input 17
2	Input 19	15	+5V switched
3	Input 20	16	AGND
4	Input 21	17	AGND
5	Input 22	18	AGND
6	Input 23	19	AGND
7	Input 24	20	AGND
8	Input 25	21	AGND
9	Input 26	22	AGND
10	Input 27	23	AGND

11	Input 28	24	Input 32
12	Input 29	25	Input 31
13	Input 30		

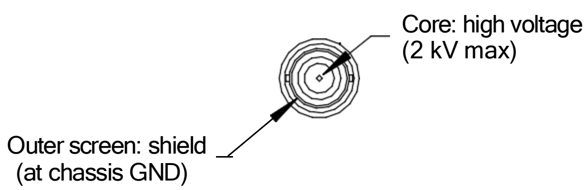
22.1.5 High voltage out

SHV male. To mate with standard SHV connector such as Radiall R317 005.



22.1.6 High voltage in

SHV male. To mate with standard SHV connector such as Radiall R317 005.



22.2 Rear panel connectors

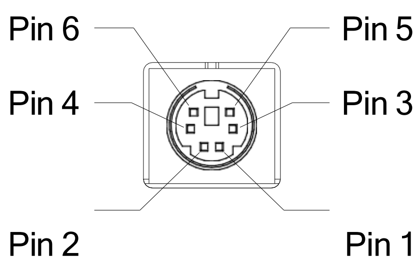
22.2.1 Ethernet communications

RJ-45 jack. To mate with standard RJ-45 plug.

Auto MDIX facility - cable can be direct or crossover type.

22.2.2 RS-232 / RS-485 communications

Six pin mini-DIN socket (PS/2 mouse/keyboard type).



(External view on connector / solder side of mating plug)

1	RS-232 Tx / RS-485 Tx-	4	n/c
2	RS-232 Rx / RS-485 Rx+	5	RS-485 Tx+
3	Gnd	6	RS-485 Rx-

The socket incorporates a sensor switch that allows the F3200E to detect that a plug has been connected. When a connection is made, the RS-232 / RS-485 transceiver is active, and the communication mode is set by the mode switch.

22.2.3 Gate input

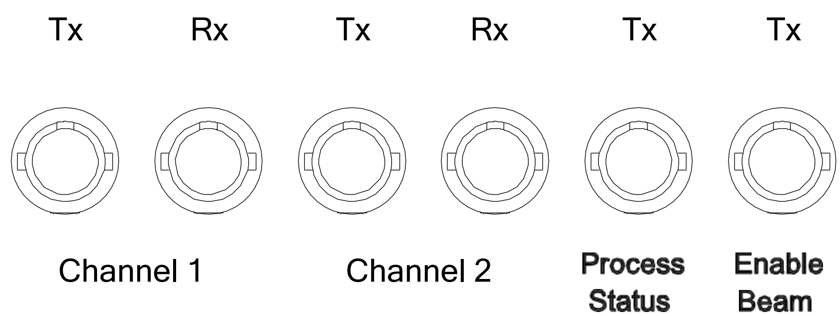
Lemo 00 50 ohm miniature coaxial EPL.00.250.NTN. To mate with Lemo 00 plug (part number FFA.00.250.CTAC31Z). A Lemo to BNC adaptor is available (ADAP-LEMO-BNC). 50 ohm drive capability.

22.2.4 Gate output

Lemo 00 50 ohm miniature coaxial EPL.00.250.NTN. To mate with Lemo 00 plug (part number FFA.00.250.CTAC31Z). A Lemo to BNC adaptor is available (ABF.00.250.CTA, available as ADAP-LEMO-BNC from Pyramid Technical Consultants). 50 ohm drive capability.

22.2.5 Fiber-optic communications:

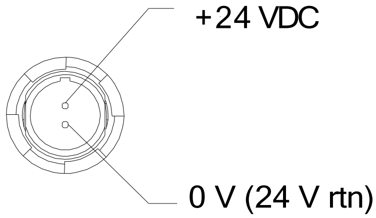
Six HFBR ST bayonets suitable for 1 mm plastic or 200 µm silica fiber. 640 nm (visible red) light. Four transmitters (Tx), two receivers (Rx). Dark casing = receiver, light casing = transmitter.



Channel 1 provides communications when the F3200E is a loop controller. Channel 2 provides communications where the F3200E is a subdevice on a loop. The port 1 receiver also functions as optical trigger input. Two transmitters are available for fast digital signaling to other devices.

22.2.6 Power input

Two-pin Lemo-Redel PXG.MO.2GG.NG. To mate with Redel PXG free connector.



(External view on connector / solder side of mating plug)

22.2.7 Ground lug

M4 threaded stud. To mate with M4 ring lug.

23 Controls and Indicators

23.1 Front panel controls

None.

23.2 Rear panel controls

23.2.1 Reset button

Momentary push-button that forces a warm reset of the on-board processor.

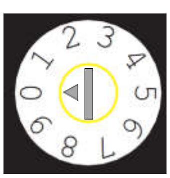
Holding the button in during the first few seconds of powering up forces the device to the default IP address 192.168.100.20.

23.2.2 Address switch

16 position rotary switch setting device address for use when you have the F3200E as a slave on a fiber optic loop. Choice of address is arbitrary, but each device in a fiber-optic loop system must have a unique address. The switch is recessed behind the rear panel – use a fine flat-bladed screwdriver to change the setting.

Setting	*Function*
0-15	Available address settings (x00 to x0F).

23.2.3 Mode switch



10 position rotary switch setting communications mode. This switch may be left at position 0 for RS-232 ASCII communications.

23.3 Front panel indicators

23.3.1 Power

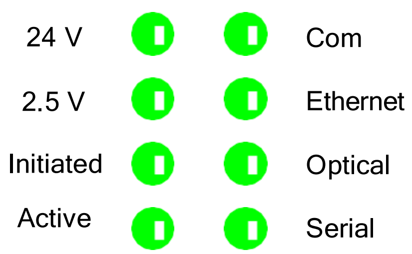
Illuminated logo. +24 VDC power is present, DC-DC converter is running and generating 5 VDC.

23.3.2 HV on

Yellow LED. Illuminated if the HV supply is enabled.

23.4 Rear panel indicators

Eight green LEDs.



23.4.1 24 V

Green LED. 24 VDC power is present, DC-DC converter is running and generating 2.5 VDC.

23.4.2 2.5 V

Green LED. Unit has powered up correctly.

23.4.3 Initiated

Green LED. Device has been initiated for measurements.

23.4.4 Active

Green LED. Device has booted up correctly and is running.

23.4.5 Com

Green LED. A host communication channel is active.

23.4.6 Ethernet

Green LED. Ethernet is the active communication interface.

23.4.7 Optical

Green LED. Fiber optic is the active communication interface.

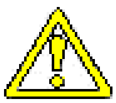
23.4.8 Ethernet

Green LED. Serial (RS-232 or RS-485) is the active communication interface.

24 A60 Recovery

If your F3200E ever suffers corruption of its stored programs, it may no longer be able to communication with it via normal means. This could happen if you were to suffer a power failure or communications interruption during a firmware update. We hope this never happens to you, but in case it ever does, the A60 recovery utility can recover the situation. We recommend that you only use this utility under direction of Pyramid.

CAUTION



Do not use the A60 Recovery utility except under the direction of Pyramid. Misuse could render your F3200E inoperable, and you would then need to return it to the factory for repair.

24.1 Starting the A60 Recovery Utility

You need to start the F3200E in bootloader mode. To invoke this, you must fit a 2mm jumper to position one of jumper JPR5. JPR5 is located close to the fiber optic mezzanine board near the rear of the main circuit board.

Disconnect power from the F3200E. The jumper can be accessed by removing the four small screws at the rear of the top cover of the unit, sliding the cover back and removing it. JPR5 is located near the rear panel, between the gate BNC connectors and the LED indicators. Make sure you are well grounded to the F3200E chassis before touching the jumper or any other internal component, to prevent damaging the electronics by static discharge. Fit the jumper and ensure all other positions on JPR5 are open.

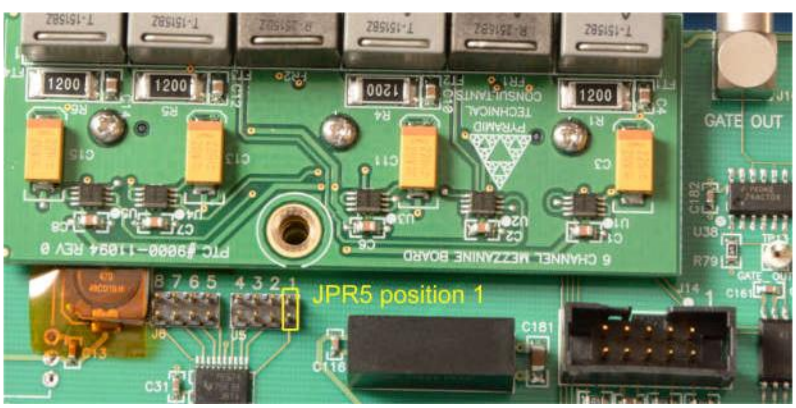


Figure 75. JPR 5 location; bootloader mode jumper position.

24.2 Using the A60 Recovery Utility

Reconnect the power and let the F3200E boot up. Start the PTC DiagnosticG2 software and discover devices. The A60 Recovery will appear. Connect to this and the recover screen will open. You can confirm you are connected to the correct device in case of doubt by looking at the serial number.

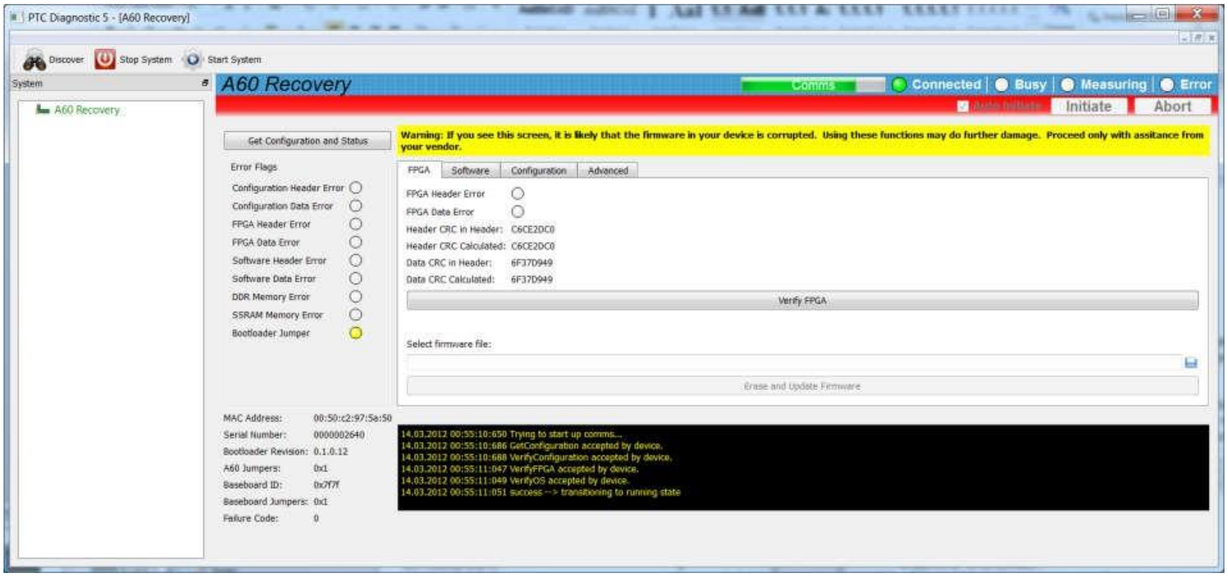


Figure 76. A60 recovery screen.

Using the information on the screen, Pyramid will be able to tell you if any of the firmware is corrupted. It is possible to load individual firmware files without going through the full update process using the Erase and Update firmware button, and this may restore the function of your F3200E.

After using the A60 Recovery utility, power down the F3200E, restore the original jumper setting and refit the top cover

25 Fault-finding

Symptom	Possible Cause	Confirmation	Solution
High noise levels	Insufficient averaging for the signal being measured	Noise level reduces with averaging period	Use an appropriate amount of averaging time for the signal level.
	RF pickup	Noise varies with cable position, status of neighboring equipment.	Check integrity of outer screens of signal cables.
	Line voltage pickup	Noise level drops sharply if averaging period is 16.7 msec (60 Hz) or 20 msec (50 Hz)	Keep F3200E and signal cables clear of unscreened high current mains voltage. Use averaging periods (N/line frequency).
No signal	Small signal lost in noise	Signal appears on more sensitive current range or with more averaging.	Use appropriate current range and averaging.
	Unit is waiting for external trigger.	Check trigger mode.	Use appropriate trigger mode.
Very few samples measured	Unit is in unbuffered mode with a low stop count	Check settings	Use buffered mode or remove stop conditions.
No data seen on PTC DiagnsoticG2 scope display	Number of samples per burst less than the number needed to refresh the display.	Look at strip chart display	Define a burst size that forces scope mode refresh.

Measured currents or charges are inaccurate	Unit not calibrated.	Gain factors are all 1.00 and offsets are all zero.	Calibrate.
	Calibration was carried out while a signal current was present.		Repeat calibration with no external signal present.
	Unit is overheating due to failed fan	Unit feels warm. Fan stopped.	Return unit for fan replacement.
	Unit is overheating due to airflow blockage	Unit feels warm. Performance improves when operated on the bench.	Clear space around the unit and improve airflow.
No signal on analog monitor output	Unit is not measuring.	Signal appears when unit initiated and triggered.	Ensure F3200E is measuring when you want to see the monitor output.
	Analog output is set to manual mode.	Check setting	Set to monitor mode.
	No channels with signal are selected for summation.	Check all channels - signal should appear.	Ensure you select all the relevant channels for summing into the monitor output.
8.3 mA (833 uA, 83 uA, 8.3 uA) background on one channel	Internal calibration source has been turned on.		Turn off calibration source.
No signal seen on analog inputs	Missing ground reference – inputs are differential	Check electrical circuit	If the measured signal is single ended, make sure the analog input – and signal ground are referenced to F3200E ground.
No or incorrect response to	Incorrect gate polarity		Use correct polarity.

external gate	selected.		
	Wrong gate input selected.		Use correct setup.
No or low high voltage	Shorted to ground in external circuit	Monitor HV reading zero or very low relative to setpoint. Monitor value recovers if F3200E disconnected from the external circuit.	Eliminate shorts to ground.
	Effective short to ground via free electrons	Monitored HV reading zero or very low relative to setpoint. Monitor value recovers if F3200E disconnected from the external circuit.	Reduce electron concentration if possible.
High voltage not at setpoint	A high compliance source such as a charged particle beam is driving the HV electrode.	Monitor value recovers if F3200E disconnected from the external circuit.	Change geometry to reduce beam strike.
Cannot set high voltage	Trying to set above the maximum allowed value soft limit.	HV OK if a lower value is chosen.	If allowed, increase the maximum allowed value.
Unable to communicate via Ethernet	Incorrect IP address for F3200E or host.	Check settings of F3200E and host PC.	Use consistent IP addresses.
	F3200E and host have different subnet masks	Check settings of F3200E and host PC.	Use consistent subnet masks.
	Messages being blocked by Windows firewall	Check firewall setting.	Disable firewall (disconnect measurement system network from internet if required for

			security)
	Messages being blocked by anti virus software.	Disable anti-virus software	Set up allowed channels for F3200E messages.
Unexpected changes to F3200E state	Another host is communicating with the F3200E.	Change IP address. Use a direct cable connection instead of a network.	Set up IP addresses and subnet masks to prevent conflicts.
Communications interruptions	Other processes on PC host interfering with comms ports.		Use a dedicated PC with simple configuration and minimum number of processes running.
Unable to connect on fiber optics	Using wrong fiber optic channel	Check connections	Connect on channel 2 if F3200E is a looped device.
	Fiber optic loop topology incorrect.	Check Tx to Rx links around the loop.	Correct loop topology.
	Bad fiber optic	Check fiber optic light attenuation.	Replace or repair bad fiber optic cables.
	Loop controller does not support F3200E	Check loop controller firmware version	Update firmware.
Unable to connect on serial port	Another program is using the COM port.	Try to access the required port with puTTY or RealTerm.	Choose another port or close down the other program.
	Incorrect port settings.	Check port settings	Correct the settings.
	Incorrect cable.		Make up a suitable cable.
	F3200E mode switch not set correctly.	Check setting.	Correct the setting.

26 Optimizing data quality

As with all measurement devices, the F3200E is subject to tradeoffs between noise and bandwidth. It is capable of making wideband measurements at sampling rates of up to 1 MSa/s and low-pass analog roll off at 250 kHz. However you should always ask yourself whether this bandwidth is needed for your application. If you can narrow the bandwidth, you will improve the signal to noise ratio of your data.

The F3200E provides flexible on-board averaging of the ADC values to allow you to tailor the measurement bandwidth to your needs. Measurements have shown that the noise level, expressed as a fraction of the full scale current, is almost independent of the current range in use. The following graph shows how the unloaded noise of the device changes as you increase the amount of averaging, from no averages (1 conversion per sample, 1 M samples per second) up to 10000 (10000 conversions per sample, 100 samples per second).

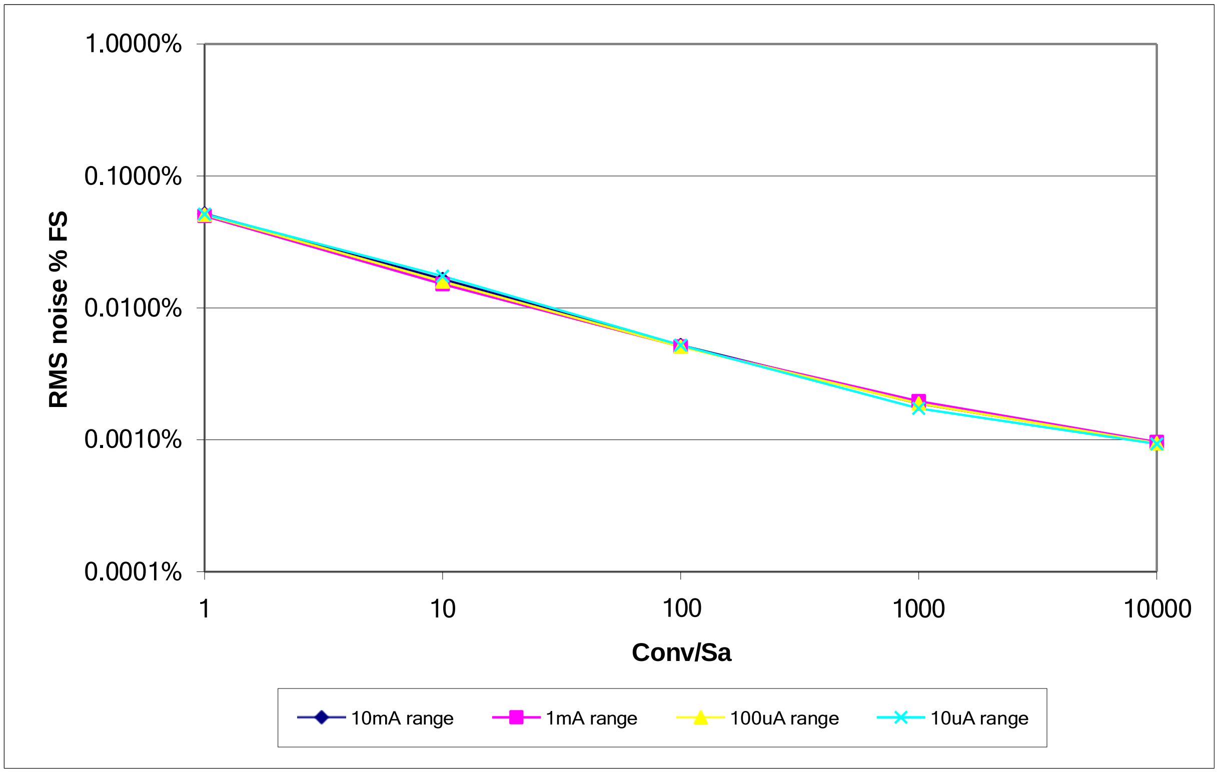


Figure 77.   Noise level as a function of averaging

Note that block averaging of this type is a rectangular filter in the time domain. The resulting frequency domain response has zeroes at N * [(ADC Rate) / (Conversions/Sample)] Hz, where N = 1, 2, 3, …

27 Maintenance

The F3200E does not require routine maintenance, except to clear any dust accumulation in the fan filter.

There is risk of contamination which may degrade performance if the case is opened. There are no user-serviceable parts inside.

CAUTION. High voltages may be present inside the case. Do not open the case when power is applied.

If there is buildup of dust in the filter, you should clear this by vacuum cleaning in situ, or by removing the filter element and cleaning it separately with an air jet. Note that detaching the filter element also detaches the fan from the case.

Figure 78. Fan filter removal

The F3200E is fitted with a 1.1 amp automatically resetting positive temperature coefficient (PTC) fuse in the 24 VDC input, and various similar fuses of lower ratings for 24 V outputs. No user intervention is required if the fuses operate due to overcurrent. The fuse will reset when the overcurrent condition ends.

28 Returns procedure

Damaged or faulty units cannot be returned unless a Returns Material Authorization (RMA) number has been issued by Pyramid Technical Consultants, Inc. If you need to return a unit, contact Pyramid Technical Consultants at support@ptcusa.com, stating

- model
- serial number
- nature of fault

An RMA will be issued, including details of which service center to return the unit to.

29 Support

Manual and software driver updates are available for download from the Pyramid Technical Consultants website at **www.ptcusa.com**. Technical support is available by email from support@ptcusa.com. Please provide the model number and serial number of your unit, plus relevant details of your application.

30 Disposal

We hope that the F3200E gives you long and reliable service. The F3200E is manufactured to be compliance with the European Union RoHS Directive 2002/95/EC, and as such should not present any health hazard. Nevertheless, when your F3200E has reached the end of its working life, you must dispose of it in accordance with local regulations in force. If you are disposing of the product in the European Union, this includes compliance with the Waste Electrical and Electronic Equipment Directive (WEEE) 2002/96/EC. Please contact Pyramid Technical Consultants, Inc. for instructions when you wish to dispose of the device.

31 Declaration of Conformity

Declaration of Conformity

Issued by: Pyramid Technical Consultants, Inc.
1050 Waltham Street, Lexington MA 02421, USA

The undersigned hereby declares, on behalf of Pyramid Technical Consultants, Inc. that the referenced product conforms to the provisions as listed. Refer to the document: *Extension of testing and analysis to the PTC product line, December 10, 2007,* and its continuations, and the *I400 Technical Construction File* for detailed testing information.

Product:	F3200E Fast 32-channel Current Digitizer
Year of initial manufacture:	2010; revised circuit 2014
Applicable Directives:	73/23/EEC Low Voltage Directive: Laws for electrical equipment within certain voltage limits 89/336/EEC – EMC Directive: Laws relating to electromagnetic compatibility
Applicable Standards:	IEC 610101:2002 (2nd Edition) UL 61010-1:2004 EN 61326: 1997+A1:1998+A2:2001 EN 55011:1998, A2:2002 EN 61000-6-2:2001 – Electromagnetic Compatibility Generic Standard, Immunity for Industrial Applications
Issuing Agencies:	Safety: TUV Rheinland North America. 12 Commerce Rd, Newtown, CT 06470 USA EMC: TUV Rheinland North America. 12 Commerce Rd, Newtown, CT 06470 USA
Applicable Markings:	TUV, FCC, CE
Authorized by:	R.P. B[signature] President, Pyramid Technical Consultants, Inc.
Date:	28 July 2014

The Technical Construction File required by theses Directives are maintained at the offices of Pyramid Technical Consultants, Inc, 1050 Waltham Street, Lexington MA 02421, USA
A copy of this file is available within the EU at the offices of Pyramid Technical Consultants Europe, Ltd, 2 Chanctonbury View, Henfield BN5 9TW, United Kingdom.

32 Revision History

The release date of a Pyramid Technical Consultants, Inc. user manual can be determined from the document file name, where it is encoded yymmdd. For example, B10_UM_080105 would be a B10 manual released on 5 January 2008.

Version	***Changes***
F3200E_UM_100603	First general release
F3200E_UM_180726	Revisions to cover revision 2 hardware. Remove certain customer-specific items. Add sections on monitor output, EPICS interfacing, serial interfacing (future), real time processing (future).
F3200E_UM_250722	Updated address and removed outdated references.