ER230 HV Sequencer

User Manual V1.04 Feb 2012

Contents

ER230 HV Sequencer User Manual

INTRODUCTION

This manual is intended to allow the user to install, check and run the system it provides detailed information on the system and its operation. Please read this manual carefully prior to beginning operation.

The ER230 High Voltage Sequencer provides the following functions:

- Two independent Programmable metered HV supplies.
- Two independent Voltmeter or Ammeter functions
- Safety Interlock system
- Software system to allow arbitrary sequences of Voltages to be programmed and generated

Meet the eDAQ HV Sequencer

FRONT PANEL

METER HV INPUT

HV OUTPUT (HSV)

INTERLOCK BNC

METER Function LED

METER Function LED

HV Status LED

System Status LED

ARM/DISARM PB

INTERLOCK LED

REAR PANEL

I2C Connection

GROUND Connection MUST BE CONNECTED

External I/O Connector

USB Connection

Power OK Indicator

Power ON/OFF

12V DC Power Inlet

Caution: Do not connect **OR** disconnect I2C cables while the units are powered ON. This can cause damage to the units.

ATTENTION - READ THIS FIRST: SAFETY ISSUES - CAUTION

This equipment generates high voltages of up to 5000Volts DC at currents of up to 500 microamps. Making contact with such voltages can be extremely dangerous and all precautions must be taken to limit injury in case contact with a live HV circuit is inadvertently made.

Ensure that the HV circuits are housed in an insulated enclosure fitted with an Interlock safety circuit and with no manual access to HV circuits while circuits are alive.

Ensure that the safety interlock circuit is connected to the HV Sequencer and is only active and enabled when no accidental access to High Voltage circuits can be made.

Other safety precautions:
- Wear rubber soled footwear
- Ensure floor is dry
- Stand on a rubber mat when in the vicinity of high voltages

eDAQ has taken considerable precautions to ensure that no accidental application of HV can be made to unprotected circuits. This will in some circumstances prevent the unit from operating but there is usually a good reason why the system does not connect the High Voltage supplies – in such events checks all settings and safety interlocks.

What is an INTERLOCK?

An interlock is a mechanical or electrical system that prevents the inadvertent operation of a potentially dangerous system function.

In the case of the eDAQ HV Sequencer this is achieved by using a switch located in the enclosure in which high voltages are active. This switch is connected via a cable to the front panel INTERLOCK BNC in such a way that the switch is only closed when no access is available to the High voltages inside the enclosure.

For example with the eDAQ supplied ET225 Micronit Chip Electrophoresis Platform, high voltages can only be applied when the top cover is in place. This is detected and the interlock switch enabled to allow the application of high voltages.

If the user is providing the MicroChip enclosure then it is the user's responsibility to provide the required interlock function.

To test the Interlock function it is sufficient to apply a short circuit across the INTERLOCK BNC input pins. This should only be done with no connections to the High Voltage input connectors.

ER230 System Indicators

System indicators as shown in the preceding diagram provide a direct indication of system operation that reflects the state of the internal hardware. These indicators will assist you in monitoring system operation and in diagnosing problems – **study them carefully**:

INTERLOCK LED: Amber LED
> FLASHING = Interlock open, unit disarmed, arming not enabled.
> OFF = Interlock in place and enabled, unit can be ARMED.
> ON = Interlock in place, unit armed and ready for operation.

SYSTEM STATUS LED: RGB LED (Multicoloured)
> GREEN when "on line" and ready as a Master
> BLUE when ready as a Slave

METER FUNCTION LED: RGB LED
> GREEN: Safe (disconnected)

YELLOW: Current Mode
BLUE: Voltage mode

HV STATUS: RED LED
OFF: supply disconnected
ON: supply connected and active.

NOTE 1: On power up the system performs a startup test and flashes the front panel LEDs through the various colors available for display.

NOTE 2: In some cases where the HV supply needs to be used in proximity to light sensitive detectors it is possible to optionally turn off all the LEDs to maintain low background illumination.

Hardware Installation

ATTENTION: When installing the system for the first time ALWAYS perform software installation before connecting the hardware units. This ensures that the correct drivers are installed

After carrying out the software installation described in the next section, perform the following Hardware installation procedure. It will confirm that:

- That safety interlocks are in place and functioning correctly
- The units can be armed and disarmed
-

It is advisable to perform this operation first on a single system and then repeat it with a master/slave arrangement if such a configuration is required.

Single Unit Operation

- Connect the unit to the 12V DC mains power pack.
- Connect the unit to the PC using the USB cable provided.
- **Safety Issue: Connect the unit to a good ground using the terminal post on the rear of the unit.**
- Turn Power ON.
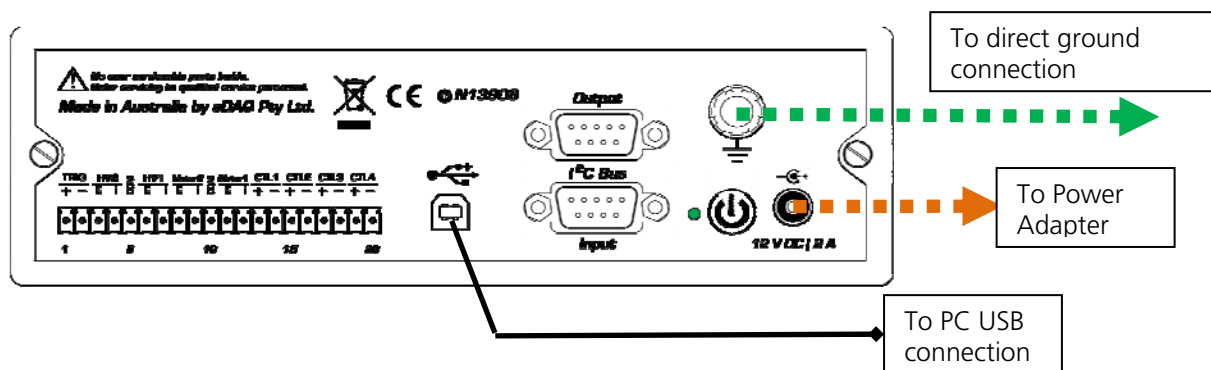
INTERLOCK LED will flash if interlock is not enabled.
HV Status LEDs: Off (no HV output)
STATUS LEDs: Green

TEST INTERLOCK Function

This function can be tested without any software running:

- The INTERLOCK LED will initially be flashing.
- Connect a short circuit to the INTERLOCK BNC.
- INTERLOCK LED will turn OFF.
- Press the ARM Push Button for approximately 1 to 2 seconds. You will hear an audio warning that the HV has been armed (enabled) and the INTERLOCK LED will turn ON.
- At this point **all HV supplies are still inactive** but are in a state where they can be set and controlled by the Sequencer Application software.
- Pressing the Arm button again will DISARM the HV Sequencer, and the INTEROCK LED will turn off.

A short press off the Arm button will always disable all outputs from the HV Sequencer.

Connecting 2 units as Independent units

Two units can be operated independently with each connected via its USB cable to the PC. No I^{2}C connection should be made between them, as it will cause a conflict between two. All control and configuration of each unit is performed via the eDAQ Sequencer Software. The Sequencer software needs to be started twice, selecting a different COM port in each.

Connecting 2 units as Master/Slave

- Connect 12V power to both units.
- **Safety Issue: Connect both units to a good ground using the terminal post on the rear of the unit.**
- Connect your computer's USB to the unit that will become the MASTER.
- Connect the supplied I^{2}C cable from the "output" of the MASTER to the "input" of the SLAVE. This cable provides communication functions between the units.
- Turn on both units. The SLAVE unit's STATUS LED will turn go blue to indicate that the unit has been configured as a slave, and is connected to the MASTER.

A maximum of 2 units can be connected together in a Master/Slave arrangement. There is no physical difference between a master and slave unit, so they can be connected either way around. However, it is important to connect the USB cable to the unit which has the I^{2}C cable connected to its "output" connector.

The required connections are shown in the diagram below.

SLAVE UNIT

MASTER UNIT
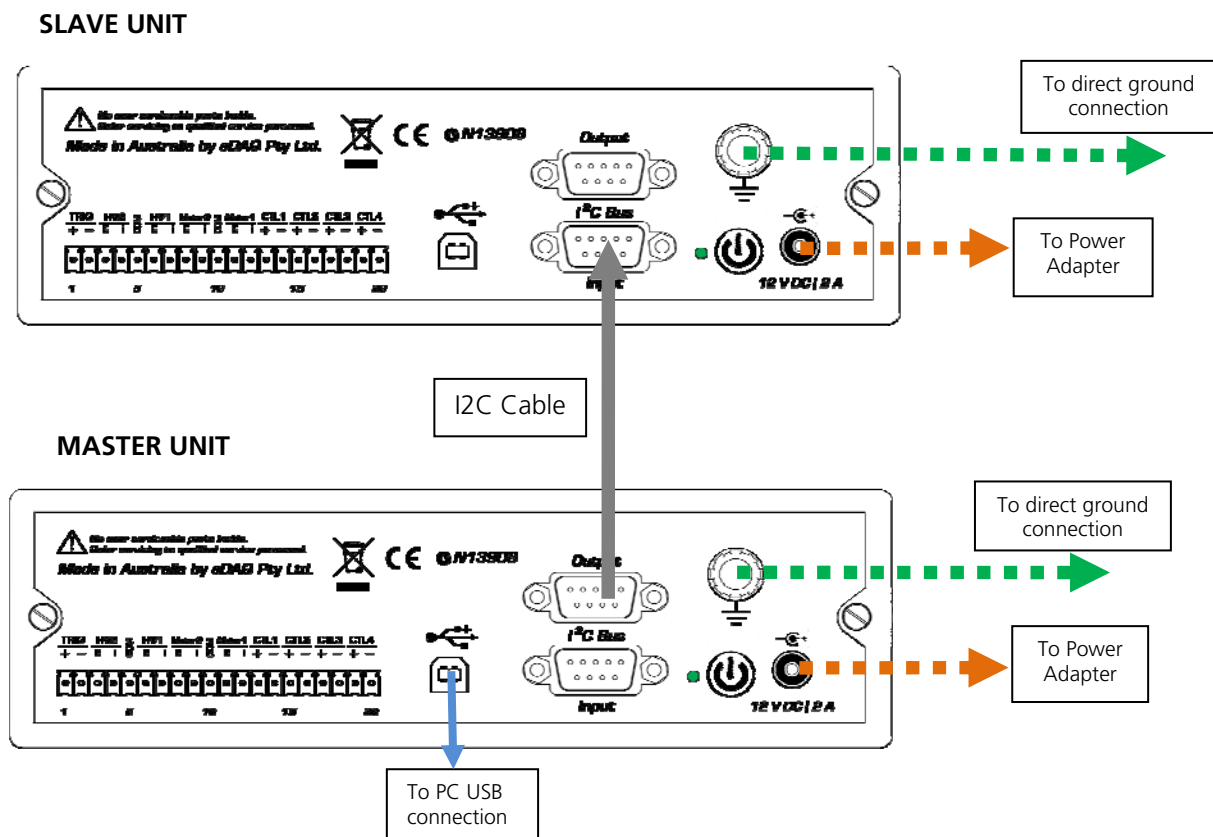
Note on INTERLOCKs

The system is provided with a number of safety features or Interlocks:

- **Chip adapter interlock:** The chip adapter used should provide a safety contact interlock to indicate that the microchip adapter is safe for use. This interlock is a contact closure switch, which is closed when the HV circuit is fully enclosed and protected from user access. This interlock is connected to the front panel Interlock BNC and indicates to the ER230 that it is safe to arm the system.
- **USB Present**: The system cannot be ARMED without an active USB connection
- **Software Control:** Once the system is ARMED High Voltages can only be applied under software control.
- **ARM circuit:** prior to applying HV to an external circuit the system must be armed by the user by depressing the front panel ARM push button for approximately 2 seconds.
- **DISARM:** The system can be disarmed by a momentary push of the ARM button.
- **Power Overloads:** the circuit detects power overloads and situations that lead to the generation of arcs (sparks). The system will switch itself off in such circumstances and in such circumstances may require to be reinitiated with power being turned on Off and On.
- **Master/Slave Configuration:** In a Master/Slave configuration, both interlock inputs must be connected and the system will not operate until safety conditions are met for both units simultaneously.

CAUTION: Do not disconnect HV leads by hand while High voltages are present – this is extremely dangerous and can cause harmful arcs to be generated. To disable power use the ARM/DISARM front panel button or the software's Disarm or Disconnect menu items

You should now be in a position to Install and operate the HV Sequencer Application which will allow you to generate and output a sequence of High voltages.

Software Installation & Operation

eDAQ Sequencer Overview

eDAQ Sequencer is a Windows application that provides the means to setup a series of steps that are executed under computer control. The following functions are provided:

System setup and sequence entry: The software identifies system configuration on startup and allows the operating parameters to be set immediately.

Table driven Sequence: A time based table is filled out, specifying that the operations to be performed in sequence. This includes setting of HV supplies to new voltages, trigger and digital I/O line functions. The following sequence operations are implemented:

Time: set to xxxx seconds
Meter 1&2: Disconnect, Read V, Read I
Output1&2: Set V=xxxx (V and I monitored), Read V, Read I
Digital Out: Low/Open, High/Closed, Short Pulse, Long Pulse
Special commands: Wait for trigger, Wait for Arming, Go Safe
New functions can be readily added to meet customer requirements

Digital outputs can be used to control external devices or the recording of data in an ecorder.

Monitoring: Once a sequence is started the user is able to observe the progress of the sequence on the sequence table. Values of HV supply voltages and currents are displayed during operation.

Installing the HV Sequencer software

Insert the HV Sequencer installation disk into your computer. It is recommended to install the software before plugging in the hardware, as it ensures the drivers are correctly installed.

The eDAQ Sequencer Setup Wizard will display the following start-up screen; follow the prompts to install the program.
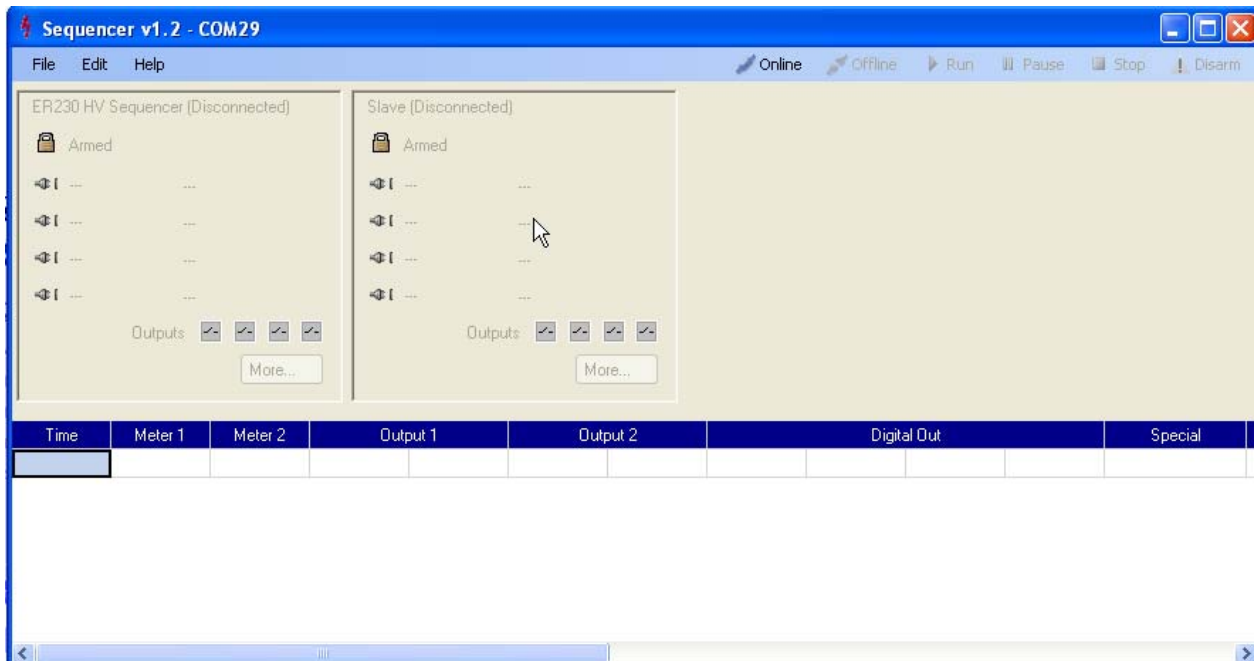

Start up screen

 Final Start up screen

If the "Run eDAQ Sequencer box" is ticked the application will be launched when the installer is closed.

HV Sequencer Main Window

Communication

The HV sequencer uses a virtual USB serial communications (COM) port. When the ER230 hardware is first attached to USB, a free COM port number is automatically assigned by Windows. That COM port will be then used every time that unit is plugged in again.

Note: the first time you connect the system to the computer it may take some time for the system to identify the HV sequencer device driver and install it. You will be notified when the device is ready.

The first time you use the sequencer software, you need to specify the COM port that the hardware has been assigned. Select the **Preferences** option in the **File** menu, then choose your HV Sequencer in the list at the top – see screen shot below. This preference is automatically saved for future use
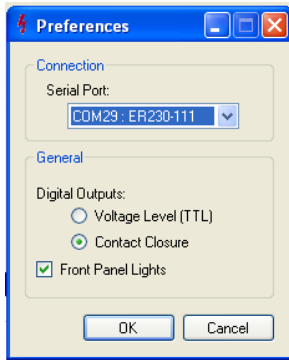
 Preferences panel

If you are uncertain about which COM port to assign use, the Serial Port Monitor application can help identify the COM port assigned to the HV sequencer. This small application is included on the HV Sequencer software CD, and can also be downloaded from the eDAQ Utilities and Tools download webpage:

http://www.edaq.com/utilities_tools.php

The serial port monitor runs as an icon in the notification area. Clicking on it will show a list of eDAQ COM port devices attached to your computer.

The other **Preference** options set the digital output type, and provide control over front panel lights in situations where light pollution needs to be kept to a minimum.

Check if you have installed an interlock as described previously. The INTERLOCK LED should be OFF indicating that the INTERLOCK is in place.
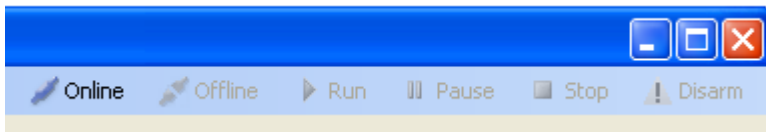
Click the **Online** in the menu bar to attach the selected ER230 unit to the Sequencer application.

Click the **Offline** in the menu bar to disconnect the selected ER230 unit from the Sequencer application.
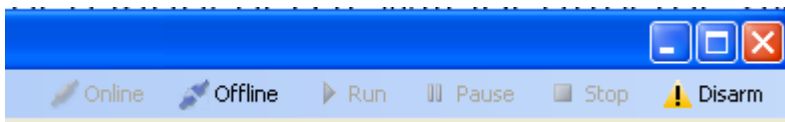
Disarming and Interlock Test

Press and hold the red ARM button to arm the unit. As before, the unit will beep and arm itself. This will also be shown in the software's display.

You can now disarm the unit by either:
- Pressing the red ARM button again
- Clicking "Disarm" in the top-right of the software window.

While the unit is armed, you can test the safety interlock by removing the short-circuit from the BNC connector. The unit should immediately disarm itself, disconnecting the outputs, and turning off any applied voltages.

Manual Settings

After arming the unit, click on the **More…** button to display the controls for making immediate changes to the unit.

The right hand side of the HV Sequencer setup panel provides the means to manually set meter functions, output voltages, and the digital outputs' states. Make some selections, and then click on **Set.** The ER230 hardware will immediately apply the settings you have chosen, and the software will display your choices, along with readings of current and/or voltage.

At this point the system will indicate the voltages set and currents measured. Since no loads are yet connected, the currents will be very near zero.
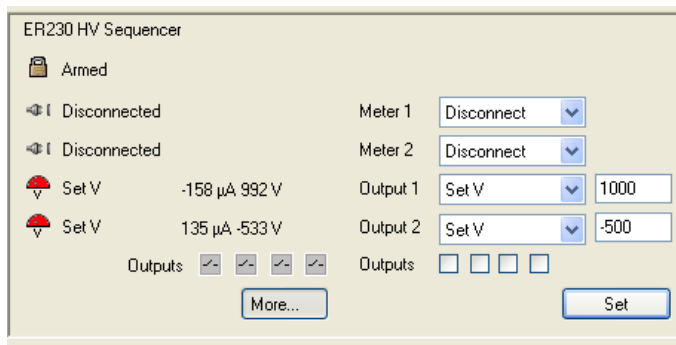
Setup panel

At any time, pressing the **Disarm** button in the top-right hand corner of the Main Window or the **red button** on the front panel of the ER230 will disarm the unit and make it safe.

After disarming, you must press and hold the red button (as before) to re-arm it. The software can not re-arm the device.

Outputs let you control the digital outputs of the unit. In the preference you can set Output configuration as contact closure, or TTL.

HV Sequences

The lower area of the Setup panel provides the means to define a "program" or "sequence" to run. This consists of a number of timed steps, each of which can update the state of one or more of the individual functions or outputs. There are also some "special" commands that can be carried out. Unused connections can have the width of their columns reduced by dragging their column separator.

All changes on a step happen simultaneously (within 2 milliseconds).
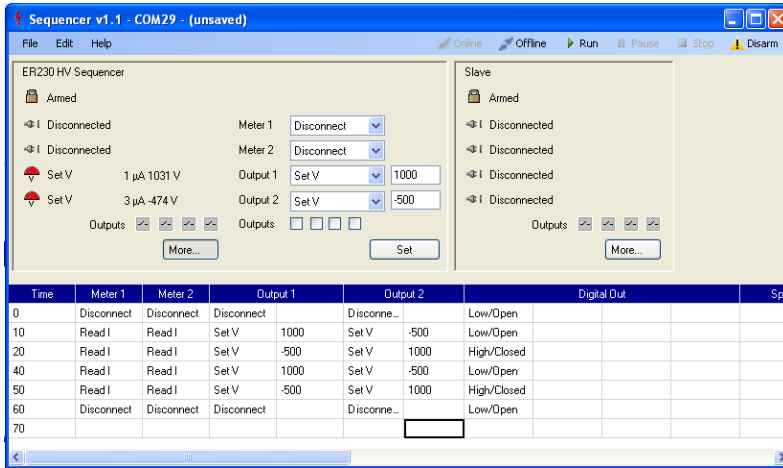
Setup screen with an example

Here is another example program:

Time	Meter 1	Meter 2	Output 1		Output 2		Digital Out	Special
0	Disconnect	Disconnect	Disconnect		Disconnect			
5	Read V	Read I						
8			Set V	500	Set V	500		
12			Set V	1000				
16			Set V	500	Set V	3000		
20	Disconnect	Disconnect	Disconnect		Disconnect			
24								

If a step doesn't have anything entered in its box, the output will remain unchanged from its previous setting.

A time of "0" means "immediately upon starting", and the times are **cumulative**, measured from when the sequence was started**,** i.e.: the delay between the first four of the lines above is 5, 3, and 4 seconds respectively.

It is recommended to have the first row setting every output to a known state, in case the previous run was stopped part-way through, leaving the unit in an unknown state.

When the program finishes, the unit will be left in whatever state it was at the end. It will not automatically disconnect or disarm the outputs, unless explicitly told to do so.

The **Meter** channel functions are:
> Disconnected: Disconnected from the front panel terminal (LED GREEN)
> Read V: Voltmeter connection (LED BLUE)
> Read I: Current Meter connection (LED YELLOW)

The **Output** channel functions are:
> Disconnected: Disconnected from the front panel terminal.
> Read V: Voltmeter connection (LED BLUE).
> Read I: Current meter connection (LED YELLOW).
> Set V: Set the voltage to the value entered in the second column – In this mode the Voltage indicated will be the actual voltage produced within 1%. (LED RED)

Current Polarity Convention

- Neg Current   + Pos Current
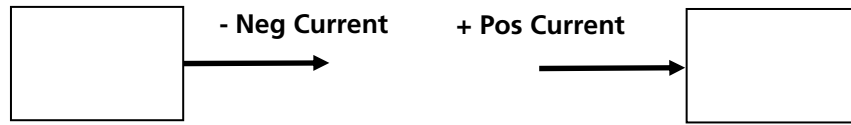
Digital outputs can be set to:

Low/Open: Output goes low or open, as per the "digital output mode" setting in **Preferences**.

High/Closed: Output goes high or closed.

The type of digital output, TTL or Contact Closure, is set from the **Preferences** dialog in the **File** menu.

**Special** is a special function to be performed. You can either:

Disarm: Disconnect HV supplies, and stop the program.

Wait for trigger: Pause, and wait for a high/close on the rear panel's green connector "Trigger" pins.

Simple editing commands are available on the **Edit** menu. The option to **Always show the slave** will force the display of the second control panel and additional program columns, even if a second unit is not attached.
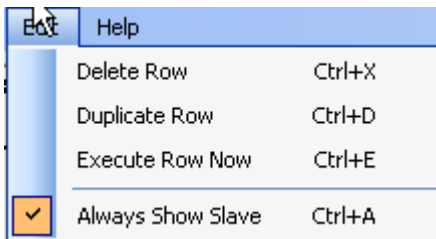
Programs can be saved and loaded using the menu options in the File menu.
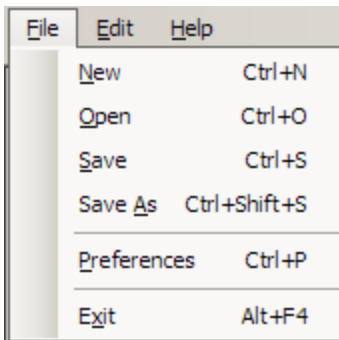
Once you are satisfied with your program, click the **Run** button in the menu bar. The software will step through the program, executing each step at the given time after starting.
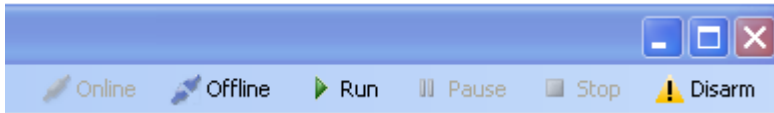
The **Pause** button can be used to pause running of the program. The **Run** button changes to a **Resume** button, which you can click to continue execution.

Stop will stop execution, but it will leave the unit in the current state, with whatever voltages selected still being output.

The **Disarm** button will stop any running program and put the ER230 hardware into a safe state. Various fault and safety switch conditions will also force a disarming (and termination of program), including:

- USB cable being removed
- Front panel safety interlock opened/removed
- Front panel red button being pressed
- When operating with a slave unit, disconnection from the slave unit

Modes of Operation

General:
Disarmed/Safe – High voltages and meters disconnected
Armed- High voltages are active and available for connection to external circuit.

Programmable HV power supplies.

Output Voltage: Adjustable from 200V to 3000V @600µA (lower voltages and higher voltages are available)
Output Polarity: Positive or Negative with respect to the common ground potential

Operating Modes:

O/C mode: Circuit disconnected by high voltage relay.
Voltage Mode: Voltage mode with current and voltage monitoring
HiZ Mode: Voltage monitoring – 10Meg impedance
S/C Mode: Short circuit to ground with current monitoring

Meters

Operating Modes
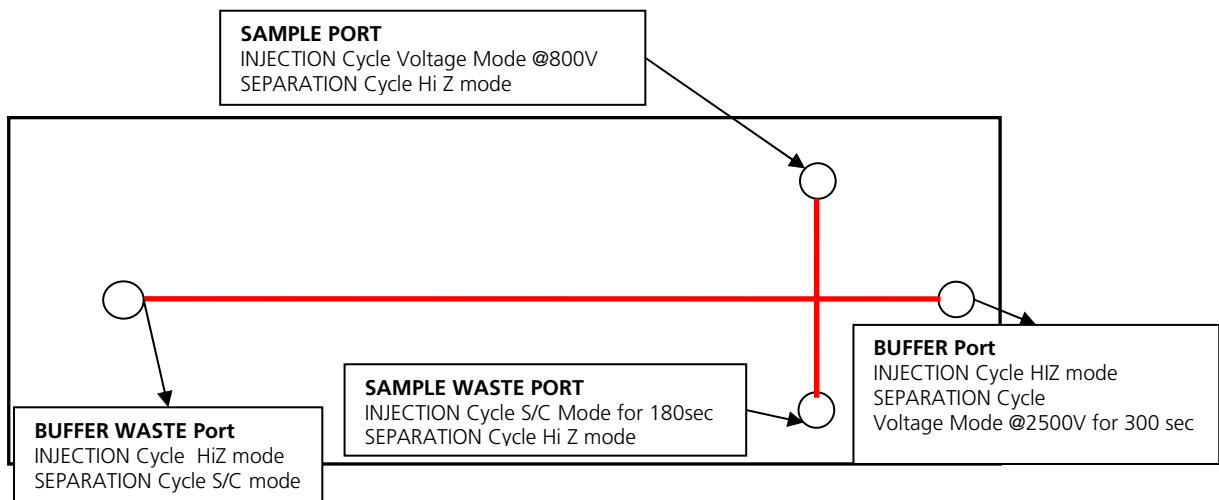O/C mode: Circuit disconnected by high voltage relay
HiZ Mode: Voltage monitoring – 100Meg impedance
S/C Mode: Short circuit to ground with current monitoring

By combining the HV power supplies and meters it is possible to setup the conditions which load the sample into the separation channel and then apply the appropriate voltages to cause separation and detection of the sample components as shown in the example.

Typical Installation

SAMPLE PORT
INJECTION Cycle Voltage Mode @800V
SEPARATION Cycle Hi Z mode

BUFFER Port
INJECTION Cycle HIZ mode
SEPARATION Cycle
Voltage Mode @2500V for 300 sec

SAMPLE WASTE PORT
INJECTION Cycle S/C Mode for 180sec
SEPARATION Cycle Hi Z mode

BUFFER WASTE Port
INJECTION Cycle HiZ mode
SEPARATION Cycle S/C mode
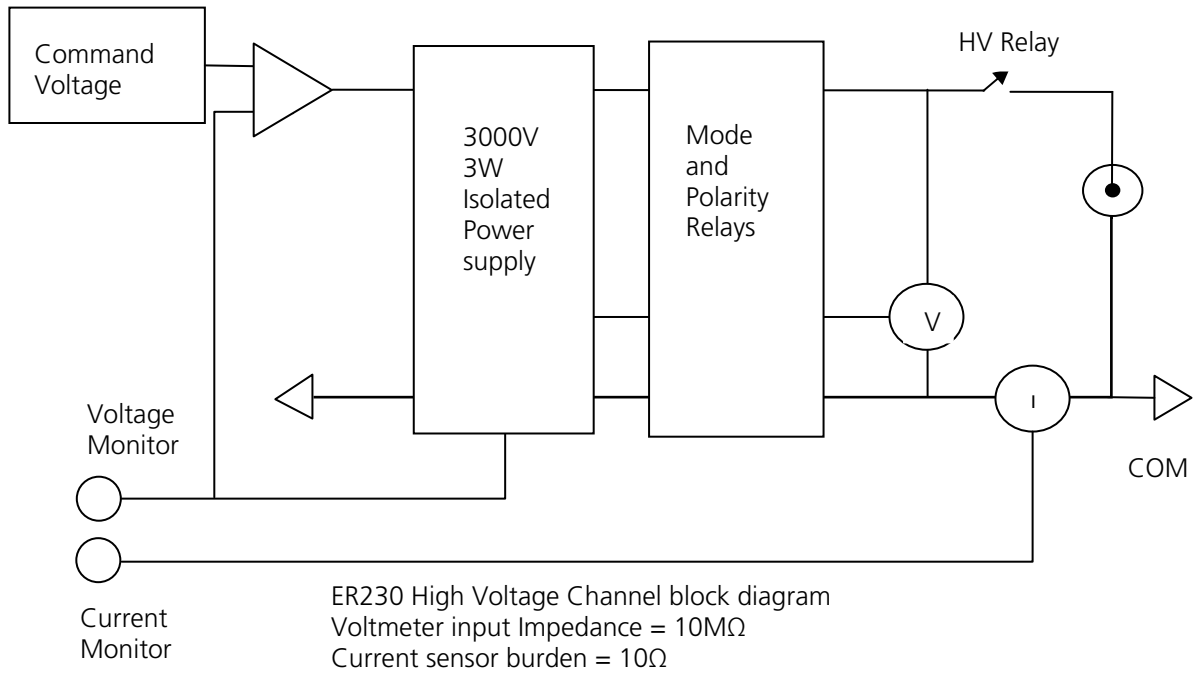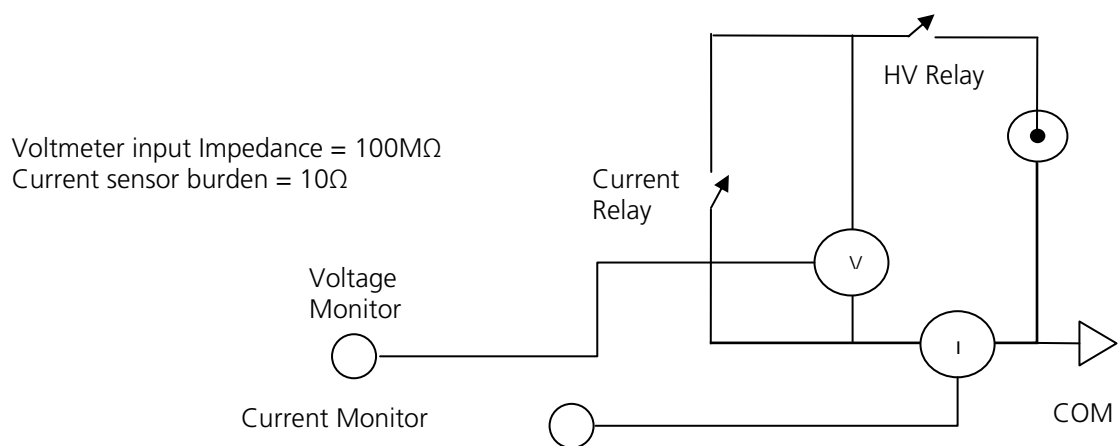
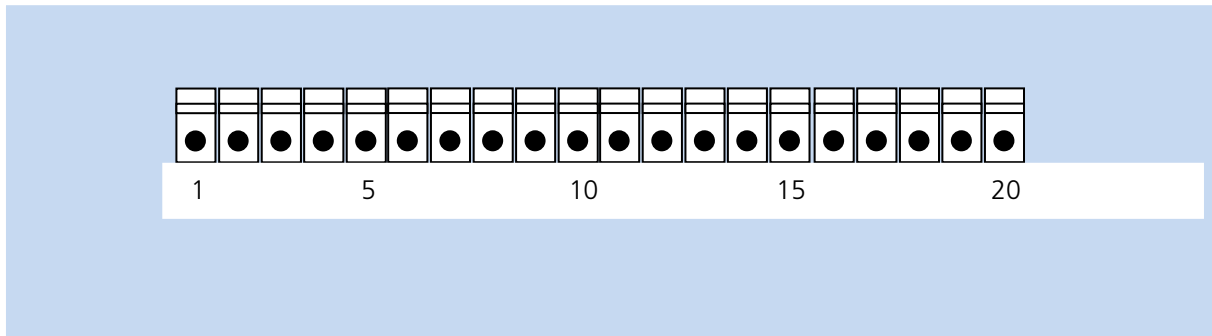# ER230 HV Hardware

ER230 HV Channel Block Diagram

A Block diagram of a HV supply channel is shown below; there are two identical HV channels in each ER230unit:

ER230 High Voltage Channel block diagram
Voltmeter input Impedance = 10MΩ
Current sensor burden = 10Ω

ER230 Meter Channel block diagram

Voltmeter input Impedance = 100MΩ
Current sensor burden = 10Ω

Green Connector Pin Numbers

ER230 HV Sequencer "green" connector Pin functions

1	TRIG +	TTL IN	11	Meter 1 E	Meter 1 Voltage
2	TRIG -	TTL COM	12	Meter 1 I	Meter 1 Current
3	HV2 E	HV E MONITOR 2	13	CTL1 +	DIGITAL IN/OUT 1
4	HV2 I	HV CURRENT MONITOR2	14	CTL1 -	DIGITAL COM
5	COM	COMMON	15	CTL2 +	DIGITAL IN/OUT 2
6	HV1 E	HV E MONITOR1	16	CTL2 -	DIGITAL COM
7	HV1 I	HV CURRENT MONITOR1	17	CTL3+	DIGITAL IN/OUT 3
8	Meter 2 E	Meter 2 Voltage	18	CTL3 -	DIGITAL COM
9	Meter 2 I	Meter 2 Current	19	CTL4 +	DIGITAL IN/OUT 4
10	COM	COMMON	20	CTL4 -	DIGITAL COM

Note:
Digital I/O pins are implemented as contact closure or TTL outputs, software selectable
Trigger input can be a contact closure or TTL input
HV E MONITOR scale factor: 500mV/kV
HV Current Monitor Scale factor: 1000mV/mA

Specifications

HV Supply Specifications and options

Model	Max Output	Min output	Max Current	Operating Modes	Ripple
UR2	+/-2000V	+/-150V	+/-1450µA	Voltage, O/C and S/C	0.1%
UR3*	**+/-3000V**	**+/-200V**	**+/-600µA**	**Voltage, O/C and S/C**	**.1%**
UR5	+/-5000V	+/-250V	+/-550 µA	Voltage, O/C and S/C	0.2%

Output is referred to system common (Case Ground)
*Standard configuration – other configurations available on special order.

Load regulation: <2% specified for 20-90% full load:
Rise and Fall times: <5mS specified for changes within the same polarity regime.
Mode Change: <100mS due to relay operations, safety and software latency

Safety Features:

Interlocks: an interlocks is provided on the mechanical case to ensure that no voltages are present with the case open unless authorized maintenance is in progress. An interlock is also provided on the microchip environment to ensure that accidental contact is not made with the high voltages. It is the responsibility of the user to ensure that adequate protection is provided on the equipment provided by the user. EDAQ provides Microchip adaptors with appropriate interlock features.
Arm/disarm switch: This switch needs to be held for 2 second to arm the system and allow high voltages to become active. Any short contact on the ARM switch will cause the system to be disarmed.

Meter Functions

	Voltage Mon Range	Voltage Mon Resolution	Current Mon Range	Current Mon resolution
Meter 1, 2	+/-5000V	+/- 1V	+/-2000µA	+/-1 µA
Output 1, 2	+/-5000V	+/- 1V	+/-2000 µA	+/-1 µA

Displayed resolution limited to +/- 1 unit

Communications and Inputs and outputs terminals

Daisy Chain connectors: Twin DB9 connectors allow two (2) ER230 units to be daisy chained together.
USB Port: Compatible with USB1 & USB 2 and provides, communications facility to PC's
Output and Meters front panel connectors: SHV (Safe High Voltage) type
20 Way 3.5mm Green screw terminal: 4 x Digital I/O lines, Trigger TTL or CC, 4xVoltage Monitor signals, 4xCurrent Monitor signals.
System/Chassis Earth terminal: 4 mm screw terminal.

System Indicators.

The following LED front panel displays are available.

SYSTEM STATUS LED: RGB LED
       GREEN when "on line" and ready as a Master
       BLUE when ready as a Slave

INTERLOCK: Amber LED
        FLASHING = Interlock open, unit disarmed, arming not allowed.
        OFF = Interlock OK, unit disarmed
        ON = Interlock OK, unit armed and ready for operation.

METER FUNCTION: RGB LED
        GREEN: Safe (disconnected)
        YELLOW: Current Mode
        BLUE: Voltage mode

HV SUPPLY FUNCTION: RGB LED
        GREEN: Safe (supply disconnected)
        YELLOW: Current Mode
        BLUE: Voltage mode

HV SUPPLY STATUS: RED LED
        OFF: supply disconnected
        ON: supply connected and active.

Physical:

Dimensions (w x h x d):200 x 65 x 250 mm (7.9 x 2.6 x 9.8 inch)
Weight: 3.00 kg packed
Operating temperature 0-35ºC
Humidity: 10 to 80% non condensing
Power: 9-16Volts @ 2 Amps max supplied by mains powered AC/DC converter (supplied)