Magnet-DAQ Help

USER MANUAL

American Magnetics, Inc.

Quick Start

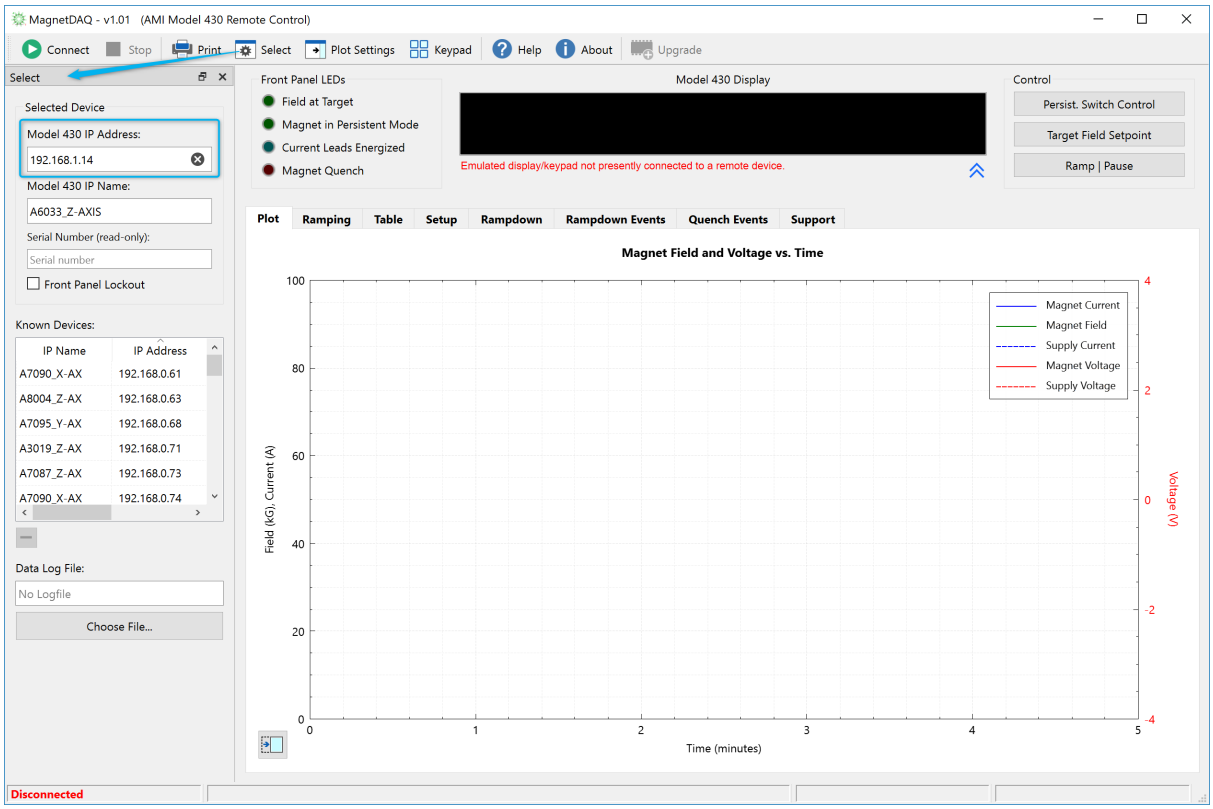
1 Quick Start

The Magnet-DAQ application is designed to be as simple to operate as possible but still provide a comprehensive interface for controlling the AMI Model 430 Programmer. The basic flow is as follows:

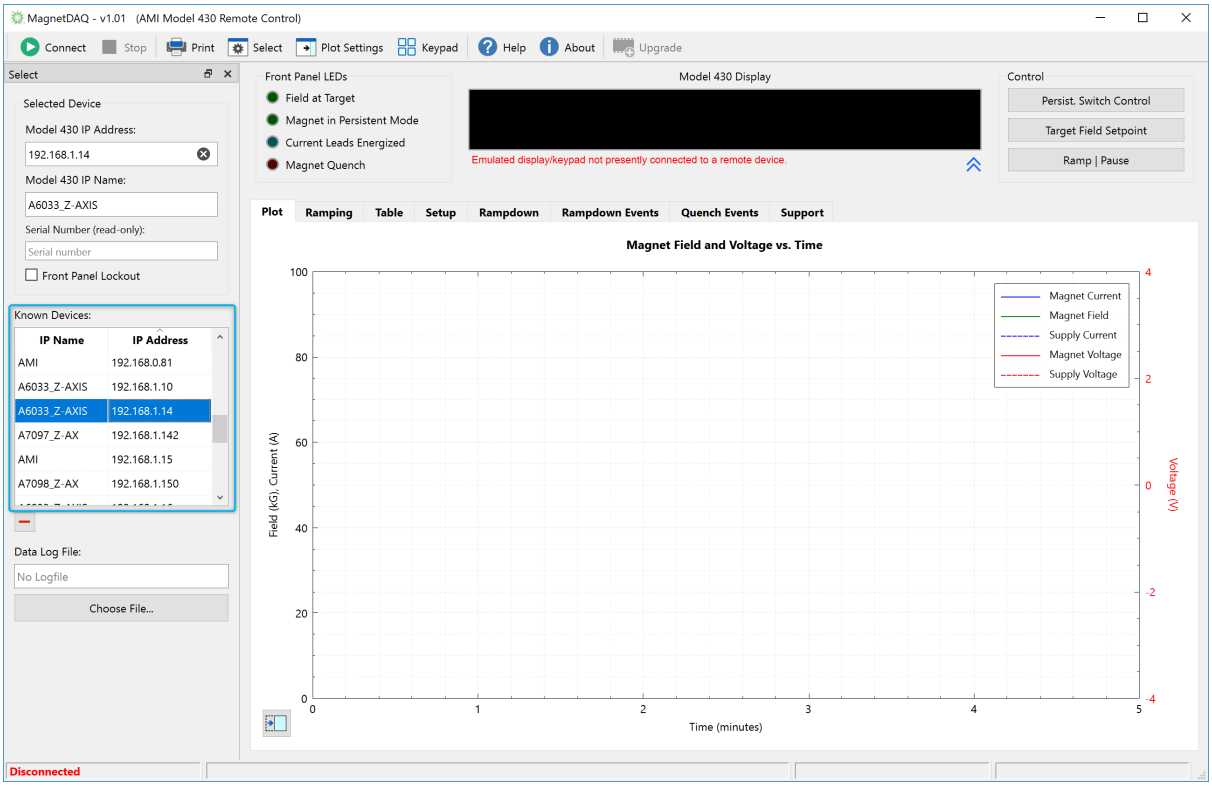
1) **Enter the IP address of the target Model 430.**
2) **Use the "Connect" button to initiate the connection and begin plotting data.**
3) **Control what data you wish to plot.**
4) **Use the remote Keypad and/or Ramping view to control the Model 430.**

Step 1: Enter the IP address of the target Model 430

Use the Select panel to enter the IP address for the target Model 430.

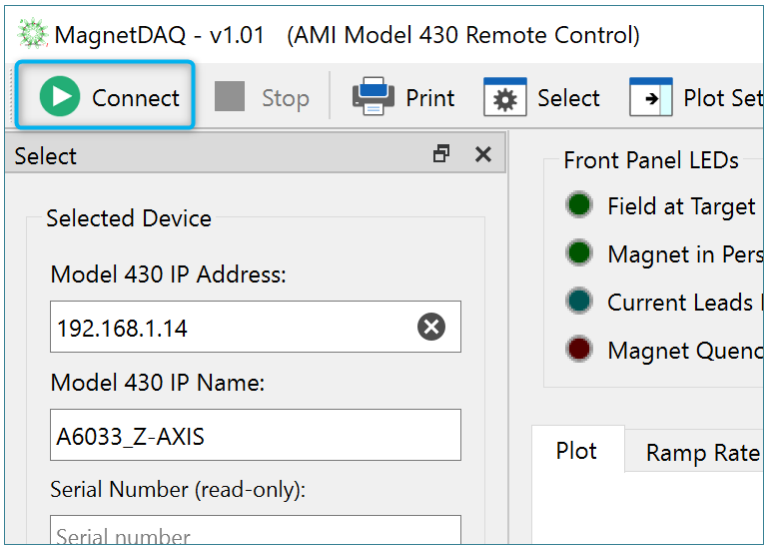


Alternately, if you have connected to the target Model 430 in a previous session, choose a known IP address from the "Known Devices" list.



Step 2: Use the "Connect" button to initiate the connection and begin plotting data

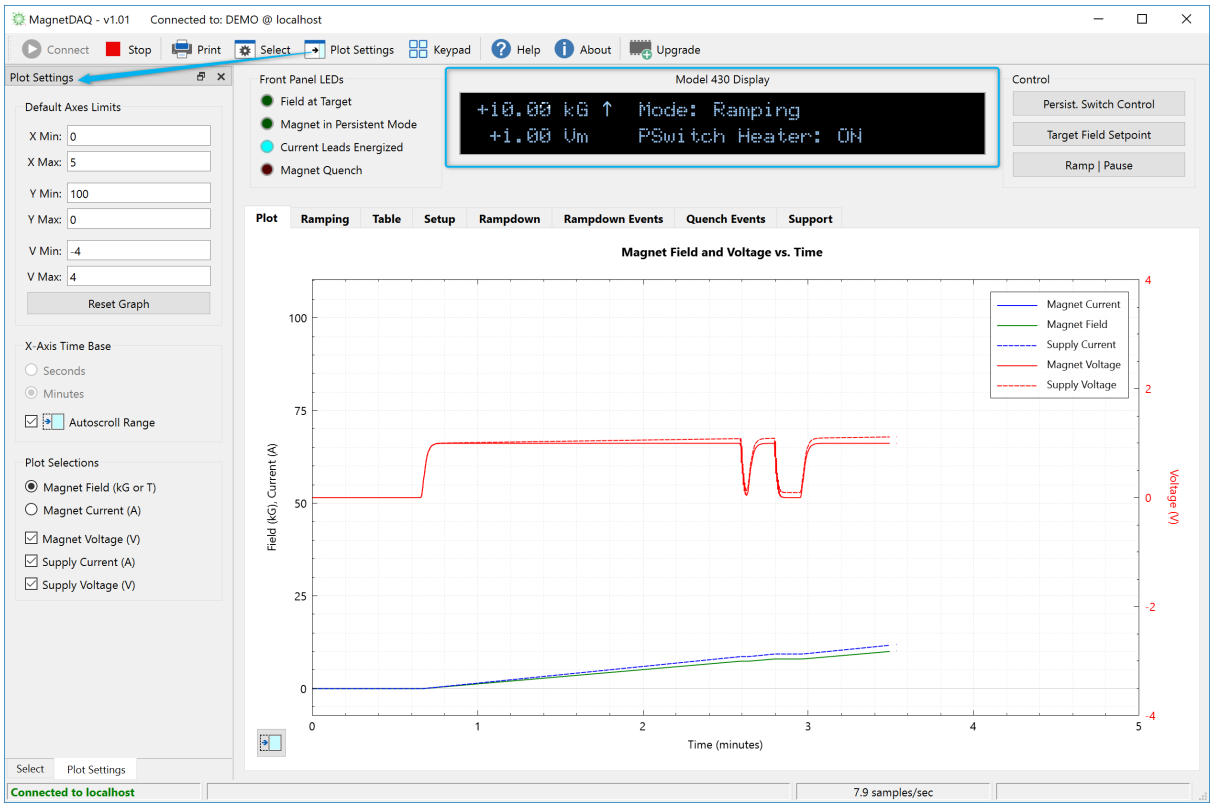
Use the **Connect** button in the toolbar to initiate the connection to the target Model 430. A progress panel will provide feedback during the connection and initial fetch of all the Model 430 settings. If the connection is successful, the dialog status area will display a "Connected to..." message and data acquisition and plotting of the data will start.



NOTE: Do you see a firmware upgrade notice? See this page.

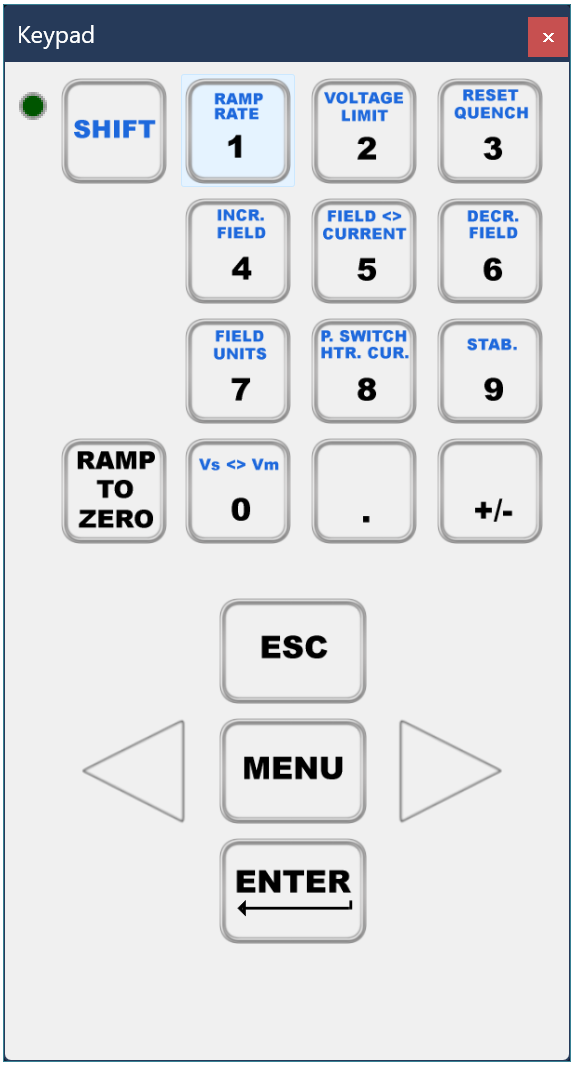
Step 3: Control what you wish to plot

Once an active connection is made, the Model 430 Display in the application will mirror the actual instrument display. Use the Plot Settings configuration panel to choose what data you wish to plot.

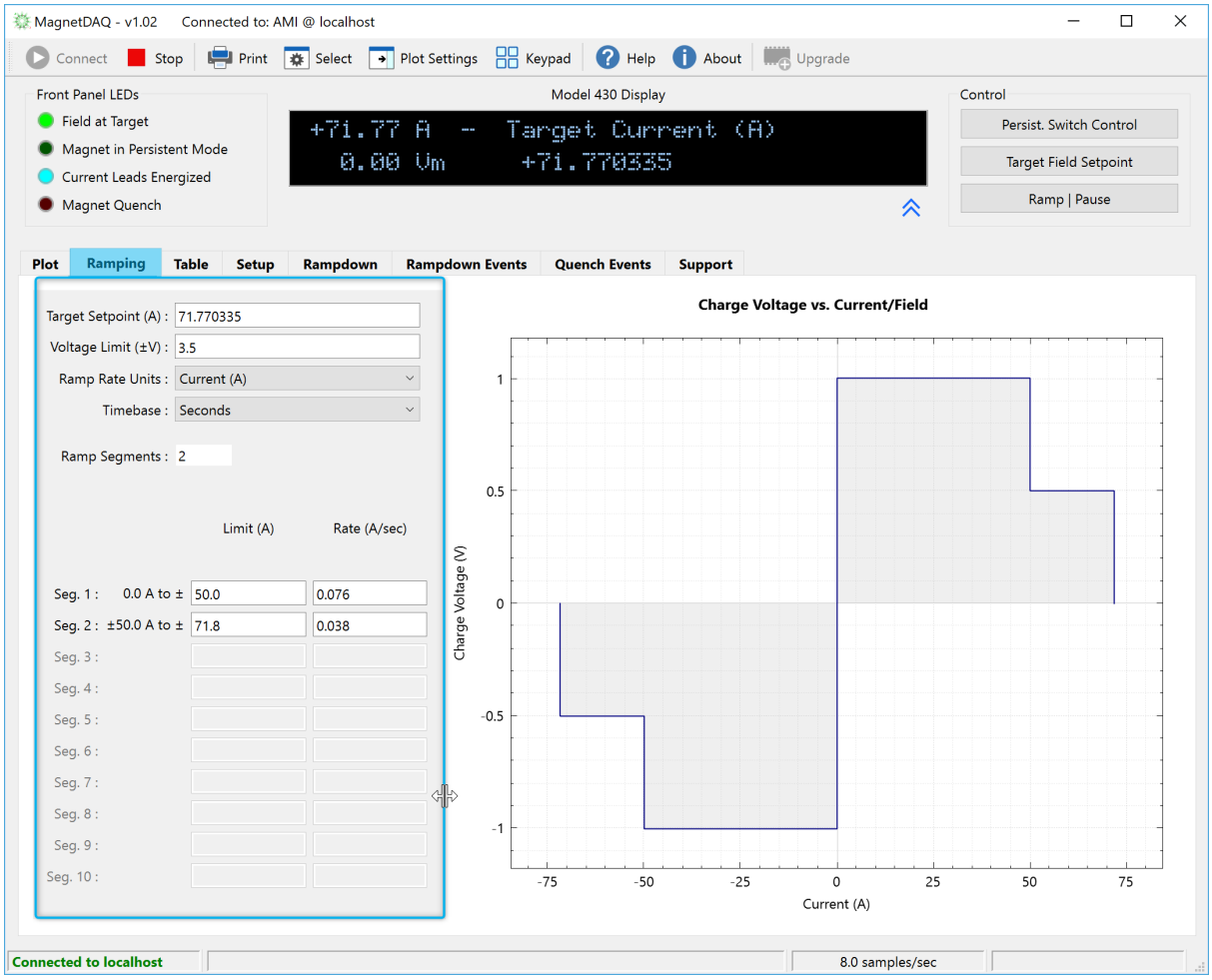


Step 4: Use the remote Keypad and/or the Ramping view to control the Model 430

Use the Keypad panel (bring it front using the "Keypad" toolbar button) to remotely control the target Model 430 just as if you are using the front panel keypad.



Use the Ramping tab view to enter the Target Setpoint, Voltage Limit, and Ramp Segments.

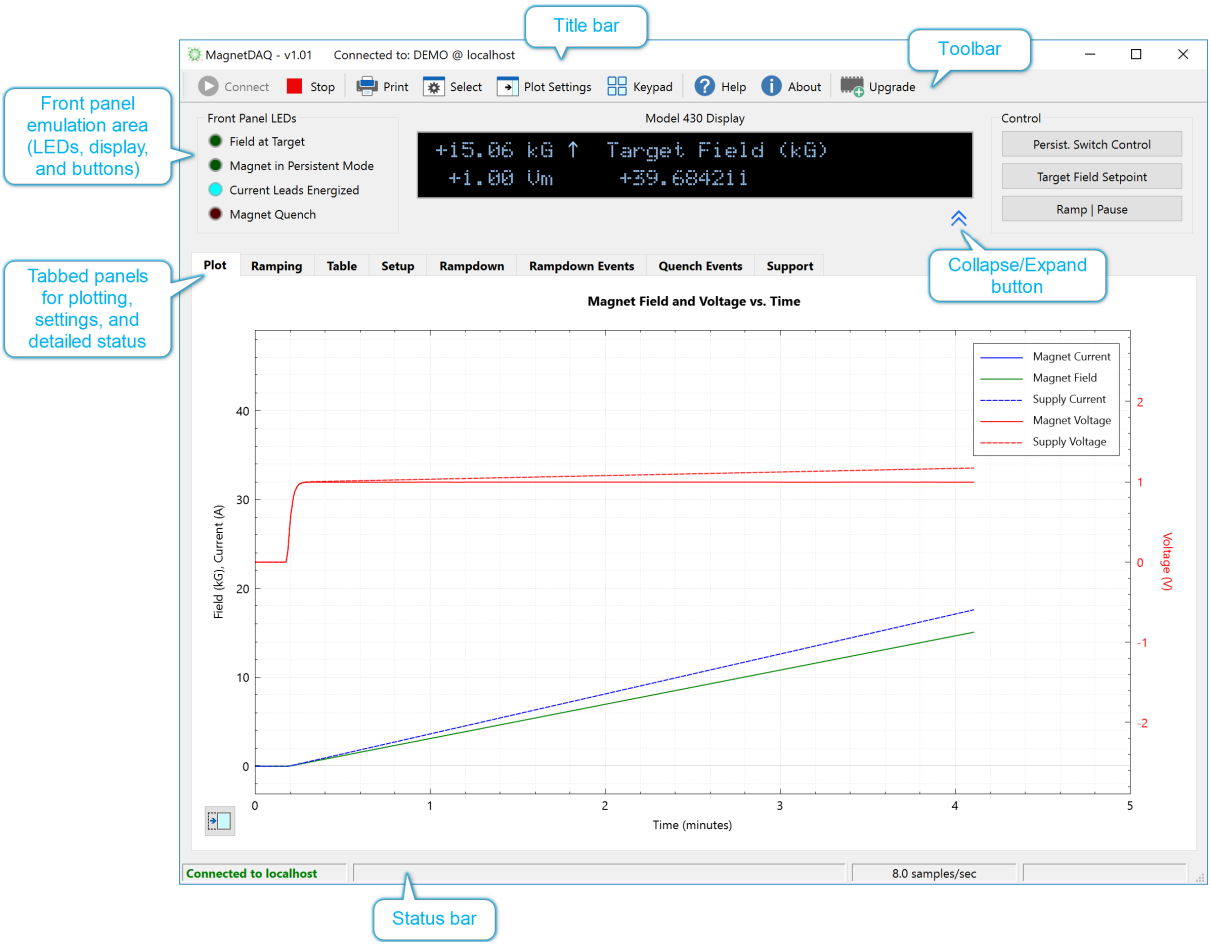


Feature Descriptions

2 Feature Descriptions

2.1 Main Window Layout

The Main Window of the Magnet-DAQ application consists of a title bar, a toolbar, a display/keypad emulation area, tabbed panels, and a status area.



Title bar

The title bar shows the application name and version, along with the present connection status including the IP name and IP address of the target Model 430. If the application is being used in a "slave" mode for multi-axis operation, the axis designation may also be displayed.

Toolbar

The toolbar contains common actions such as connection control, printing, configuration panel display, and help. See the Toolbar Items topic for more details.

Front panel emulation area

The front panel emulation area contains LED indicators, the emulated Model 430 display, and button controls for **Persistent Switch Control**, **Target Field Setpoint** entry, and **RAMP/PAUSE** control. These buttons function identically to those on the front panel of the Model 430.

Collapse/Expand button

The collapse/expand button toggles visibility of the plotting area and docked panels. The collapsed window can be resized and positioned and will remember the size and location separate from the expanded view. To show the plotting area and docked panels from the collapsed state, click the button again.

Tabbed views

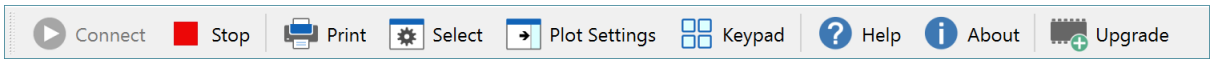
The tabbed area of the main window includes several views:

Plot	A graphical view of variables selected in the Plot Settings configuration panel vs. time.
Ramping	Definition of Target Field/Current, Voltage Limit, and Ramp Segments with charge rate graph of up to 10 ramp rate segments.
Table	A tabular view of target fields or currents with the ability to ramp to each automatically as well as optionally execute an application or script at each target.
Setup	Contains sub-views for the Setup categories of the Model 430.
Rampdown	Definition and a discharge rate graph of up to 10 rampdown segments.
Rampdown Events	Selectable list of rampdown events.
Quench Events	Selectable list of quench events.
Support	A view of all Model 430 settings and an option to compose support emails.

Status bar

The Status bar contains four sub-panels. From left-to-right, the panels include the connection status, general error and status messages, present sampling rate of the magnet state variables, and error notification.

2.2 Toolbar Items



The draggable toolbar, that is by default located at the top of the main window, contains the following items:

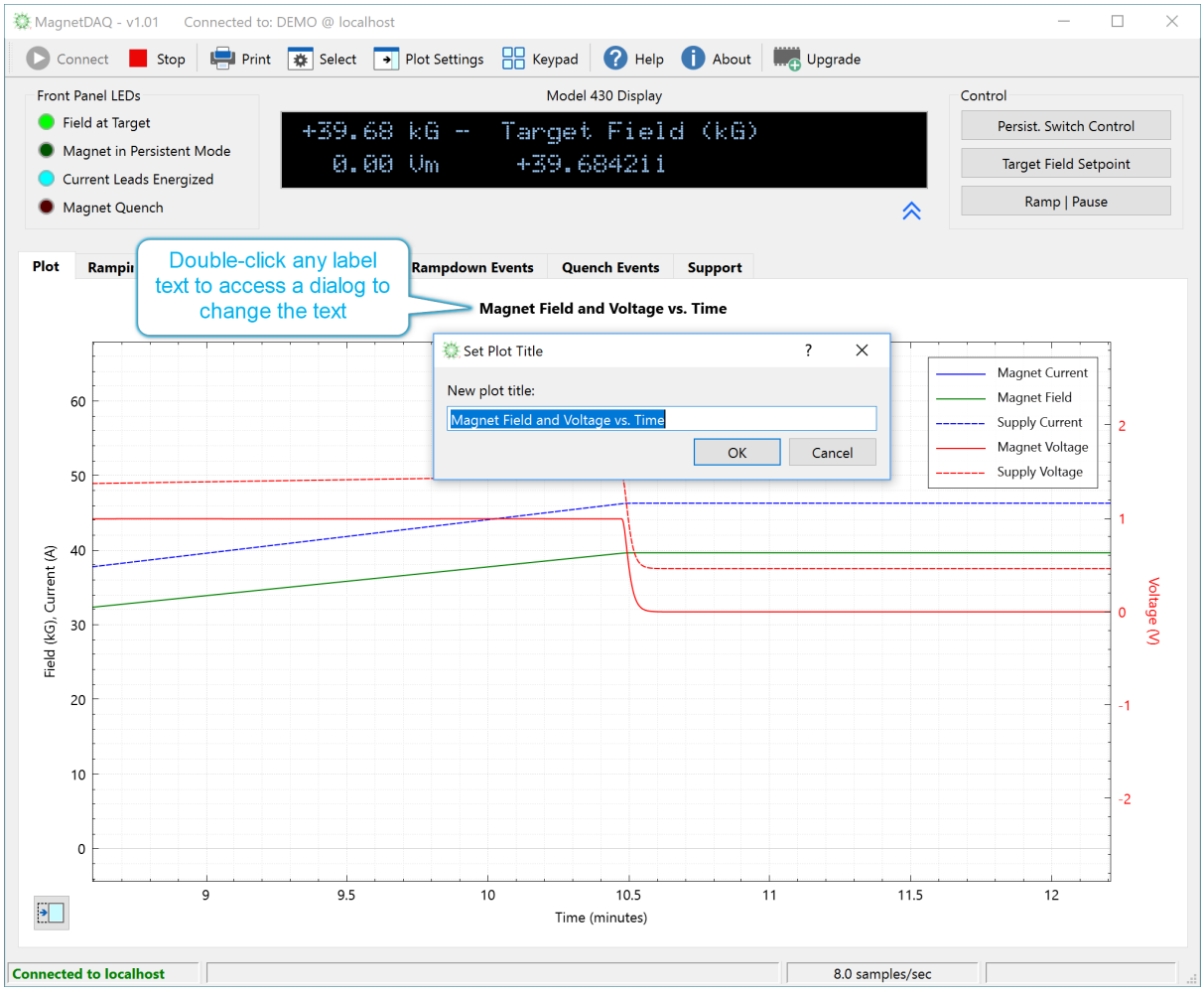
Connect	Initiates a connection to the specified IP address.
Stop	Closes a connection and stops all communication.
Print	Prints the currently displayed graph.
Select	Brings the Select device panel to front.
Plot Settings	Brings the Plots Settings configuration panel to front.
Keypad	Brings the emulated Keypad panel to front.
Help	Displays this Help file.
About	Displays information about the application and Qt version.
Upgrade	Displays the Firmware Upgrade Wizard on demand.

The toolbar can be dragged using the perforation at the left edge of the toolbar area and then docked to any edge of the main window.

2.3 Plot Tab

The Plot Tab provides a graphical view of variables selected in the Plot Settings configuration panel vs. time. The Plot Settings configuration panel provides the interface for selecting which variables are plotted.

The plot axes titles and plot line labels can be customized per your preference by simply double-clicking the axis title (or legend text) to access a dialog where the text can be changed.



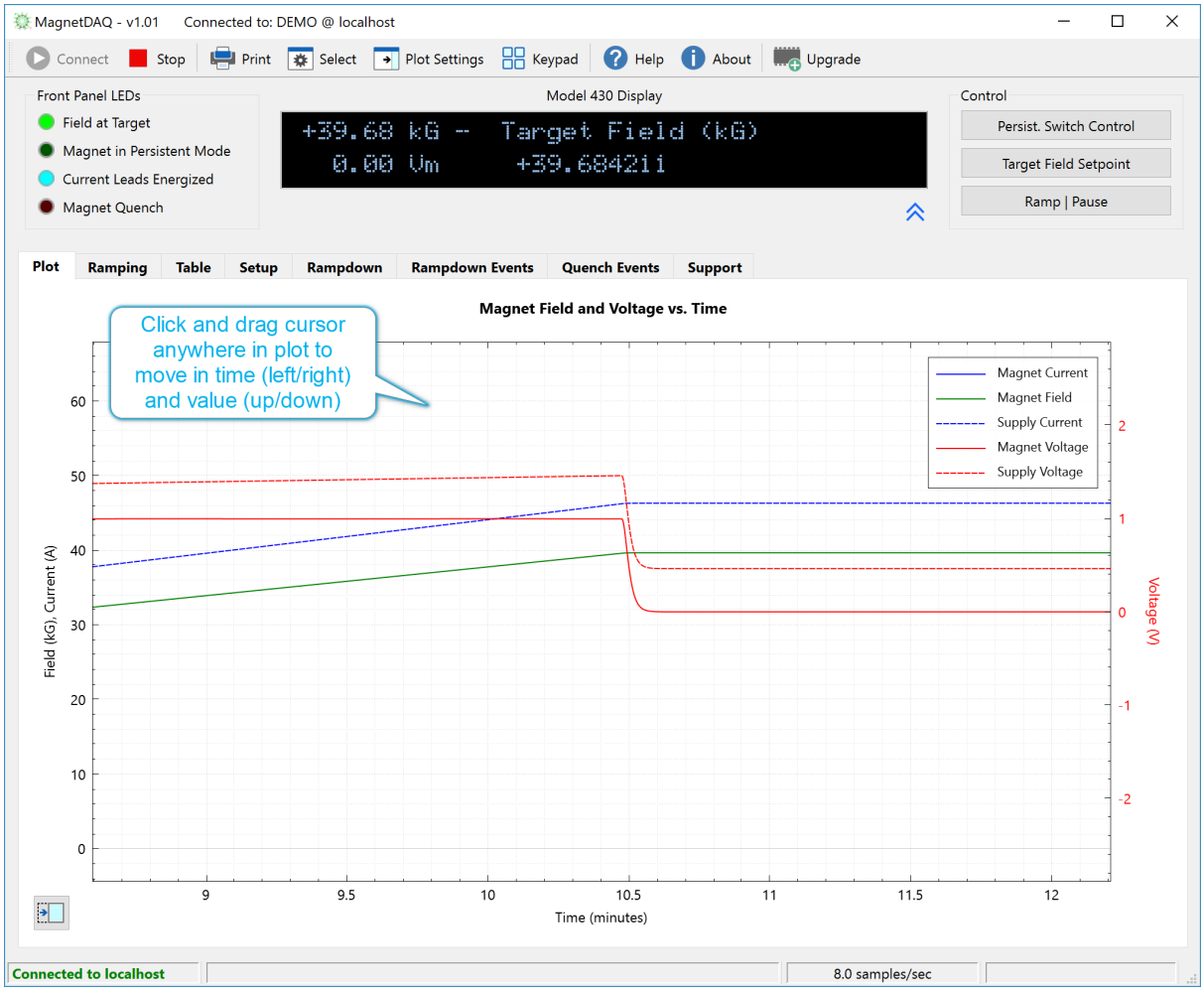
The default time base is minutes, but this can be changed in the Plot Settings configuration panel. The time base selection cannot be changed while connected.

Note that the plot has a bottom axis for the time, a left axis for the current/field values, and a right axis for voltage values. These axes can all be positioned and scaled independently by selecting each and clicking and dragging the cursor or using the scroll wheel (or the equivalent actions for a trackpad). The available actions are described below.

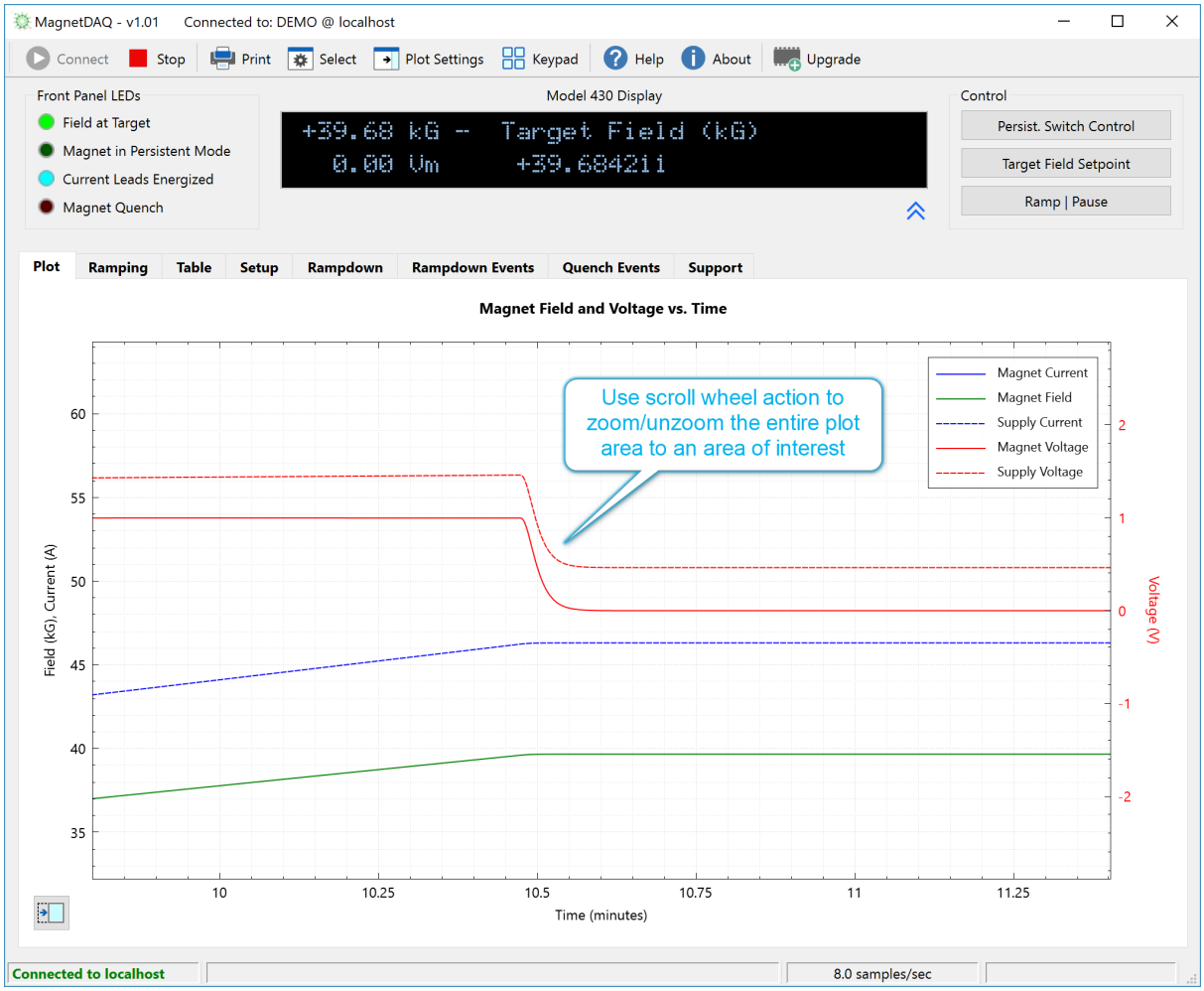
Plot Positioning and Scaling Actions

Click (or tap) in any white space to drag, or zoom/unzoom with scroll wheel

A click and drag action in any white space in the plot, with no axes highlighted, will position the time and left (current/field) axes simultaneously. Use the scroll wheel (or equivalent trackpad action) to simultaneously zoom/unzoom the plot area for the time and left axes. This combination of actions is a quick method for centering and zooming in on an a particular event to show more detail.

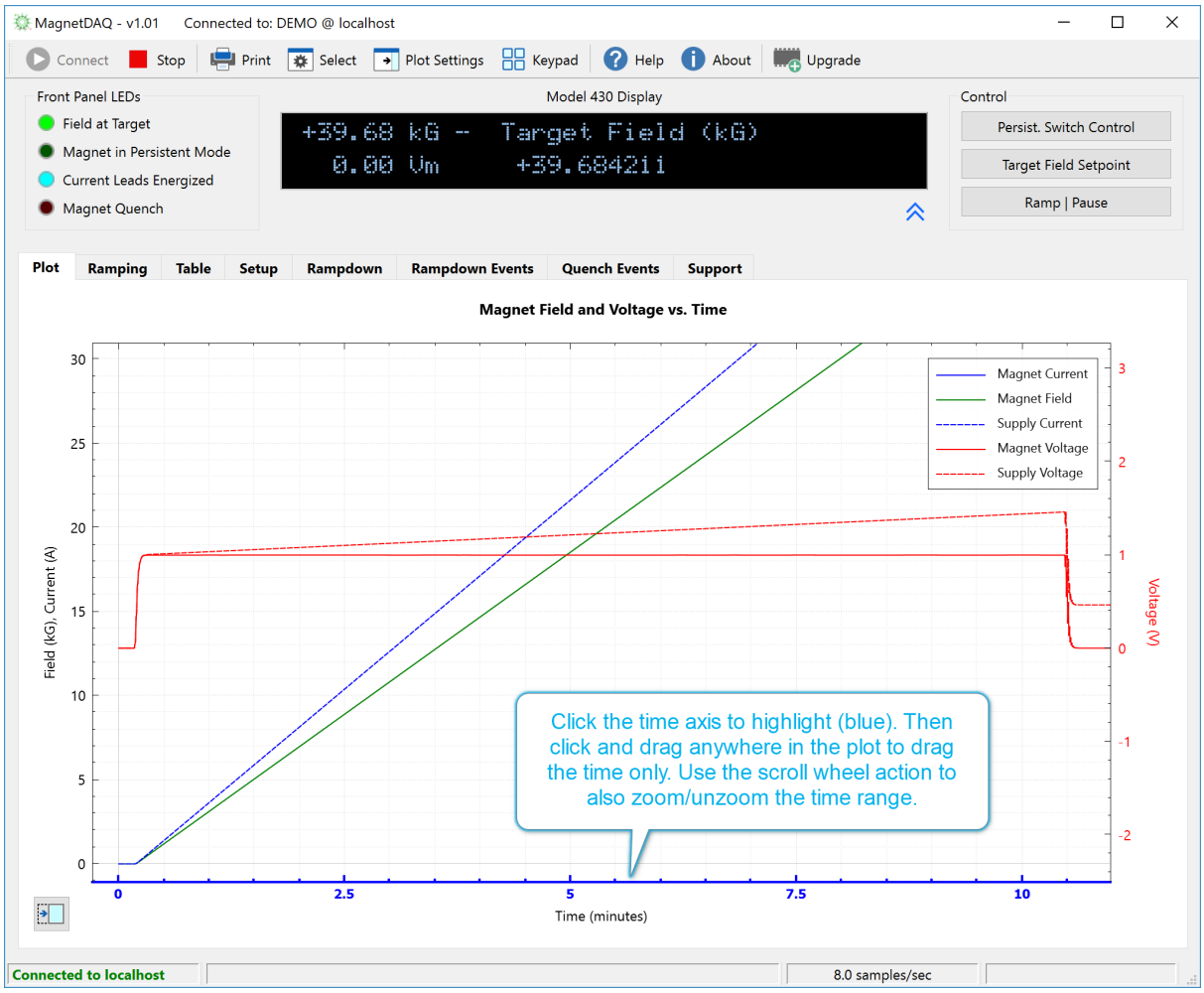


NOTE: With all zoom/unzoom actions, the position of the cursor determines the center point of the scaling action. The zoom/unzoom will hold the plot area at the cursor and scale to the left and right (or above and below) of the cursor position.



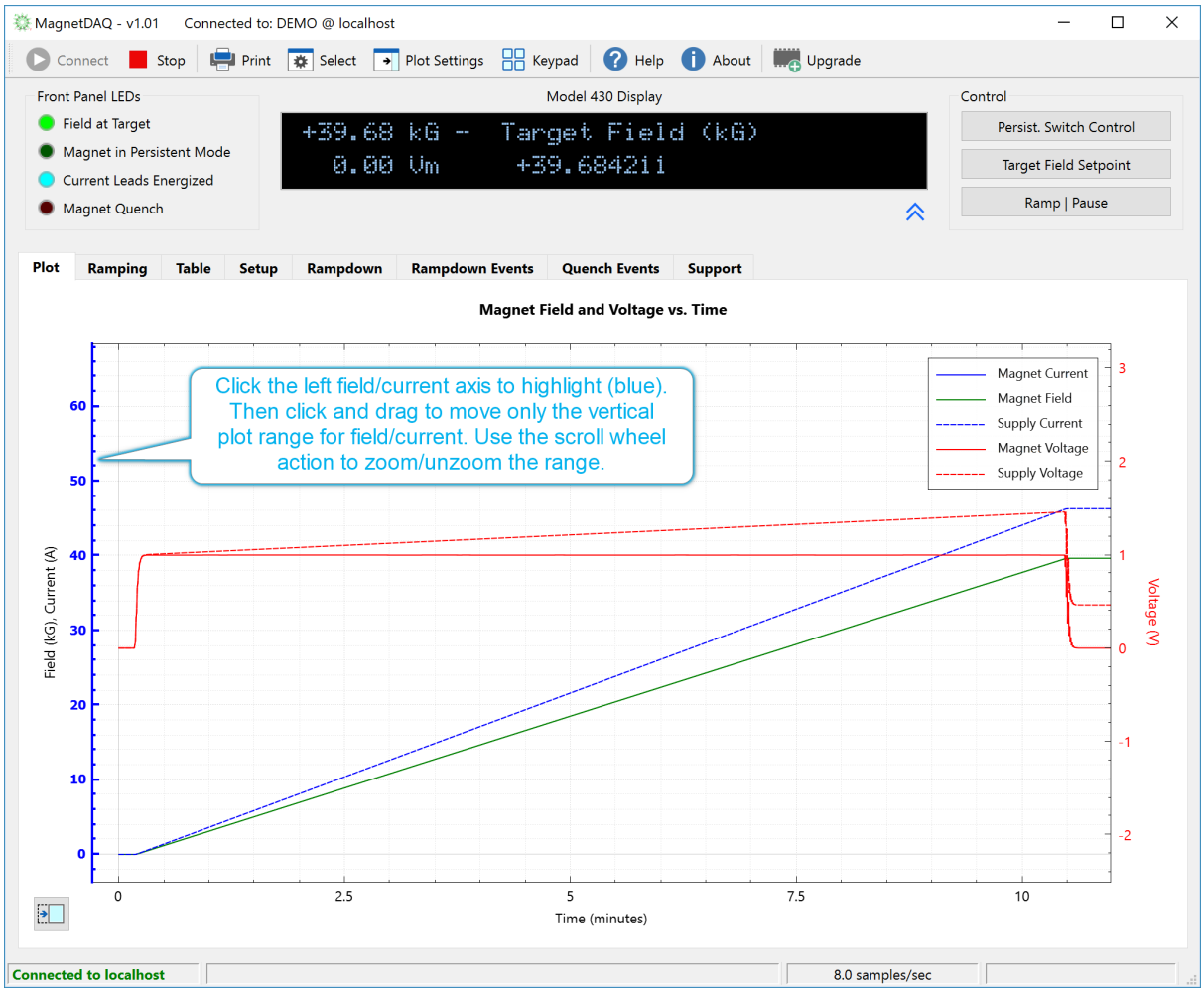
Select the time axis and then click and drag, or zoom/unzoom with scroll wheel

Select the time axis (it will highlight in blue) and then click and drag in any white space to independently position the time axis. While the time axis is selected, use the scroll wheel to independently zoom/unzoom the time axis.



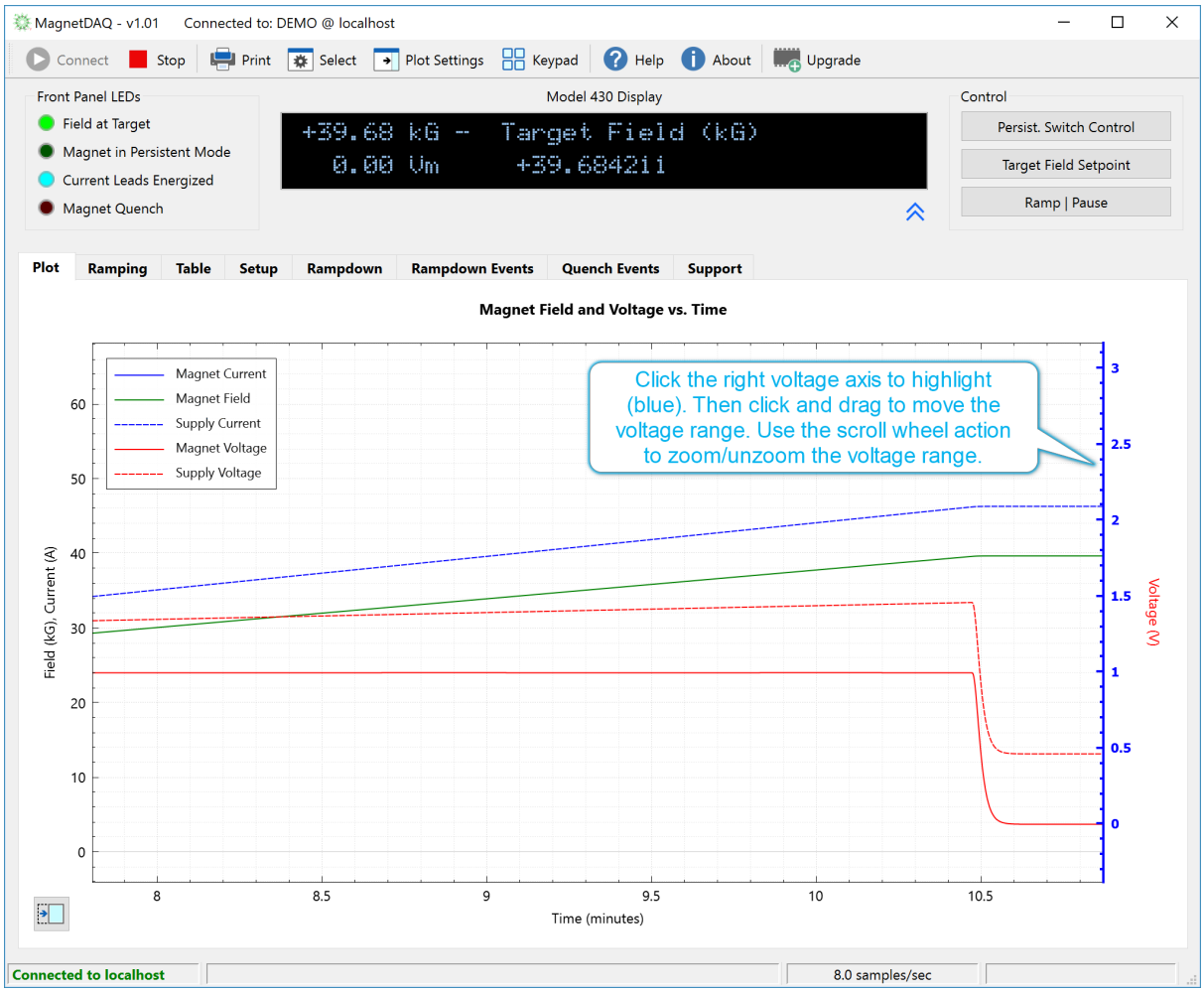
Select the left axis to drag, or zoom/unzoom, the current/field range

Select the left axis and then click and drag in any white space to independently position the current/field axis. While the left axis is selected, use the scroll wheel to independently zoom/unzoom the current/field axis.



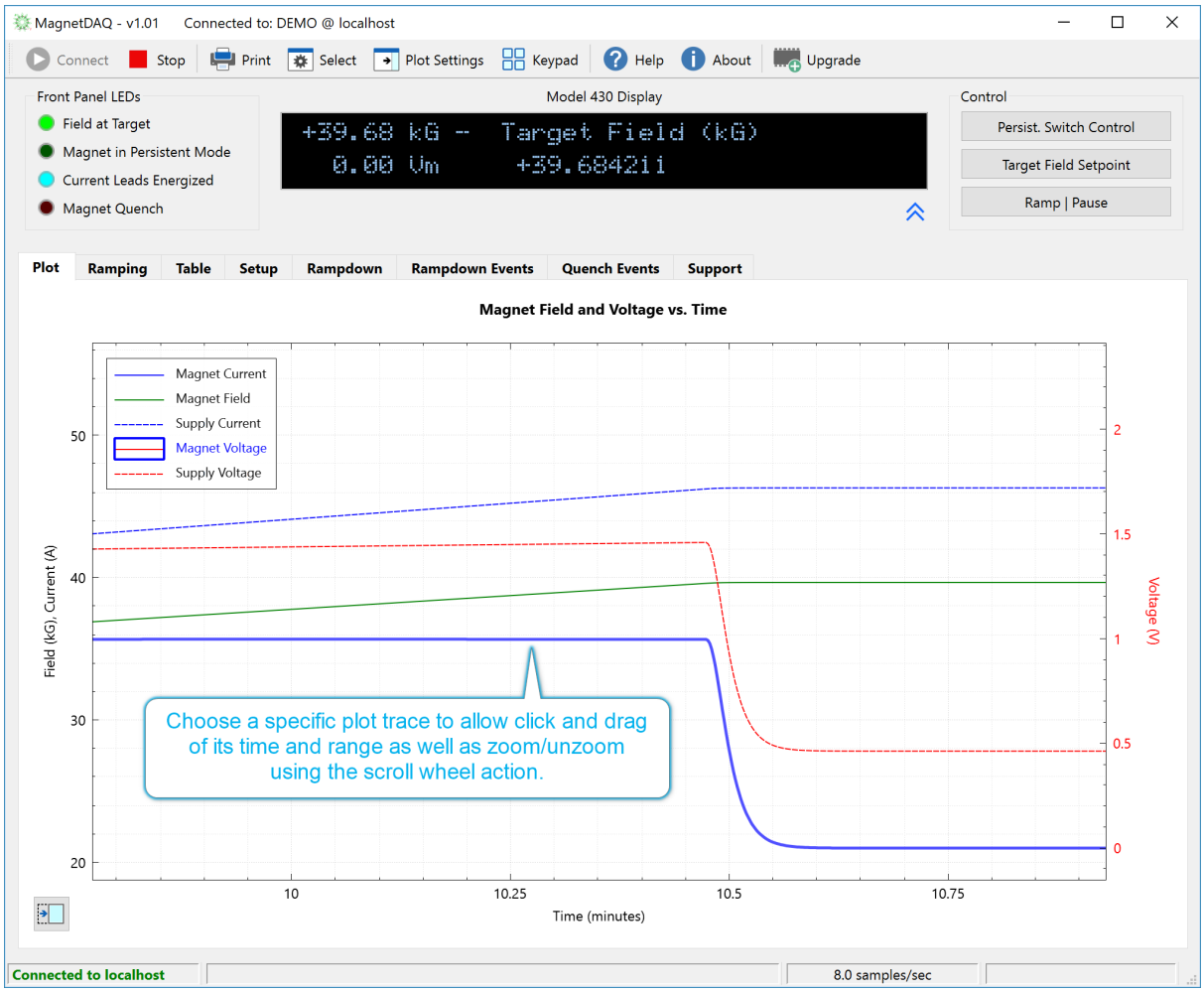
Select the right axis to drag, or zoom/unzoom, the voltage range

Select the right axis and then click and drag in any white space to independently position the voltage axis. While the right axis is selected, use the scroll wheel to independently zoom/unzoom the voltage axis.



Select a particular plot line to position or zoom/unzoom

Directly select any plot line (either in the plot area or in the legend) and click and drag in any white space to position the plot line. Use the scroll wheel to simultaneously zoom/unzoom the time and value axis for the selected plot line.



2.4 Ramping Tab

The Ramping Tab view provides the interface for setting the Target Setpoint, VoltageLimit, and up to ten (10) ramp segments for the target magnet. The ramp segments are bipolar, and the ramping magnitude is the same when charging (increasing current magnitude) and discharging (decreasing current magnitude).

The **Target Setpoint** field may be set to either amperes *or* field units of kilogauss or tesla. This is the target value for the automatic ramping mode.

The **Voltage Limit** field sets the bipolar output voltage limit that is applied to the *power supply output*. The Voltage Limit is an additional safety factor during charge/discharge to prevent accidental change of the magnet field at a higher rate than recommended in the magnet specifications. The Voltage Limit should include some overhead above the charge voltage to account for power lead losses (typically 10 to 20 milliohms x maximum current limit).

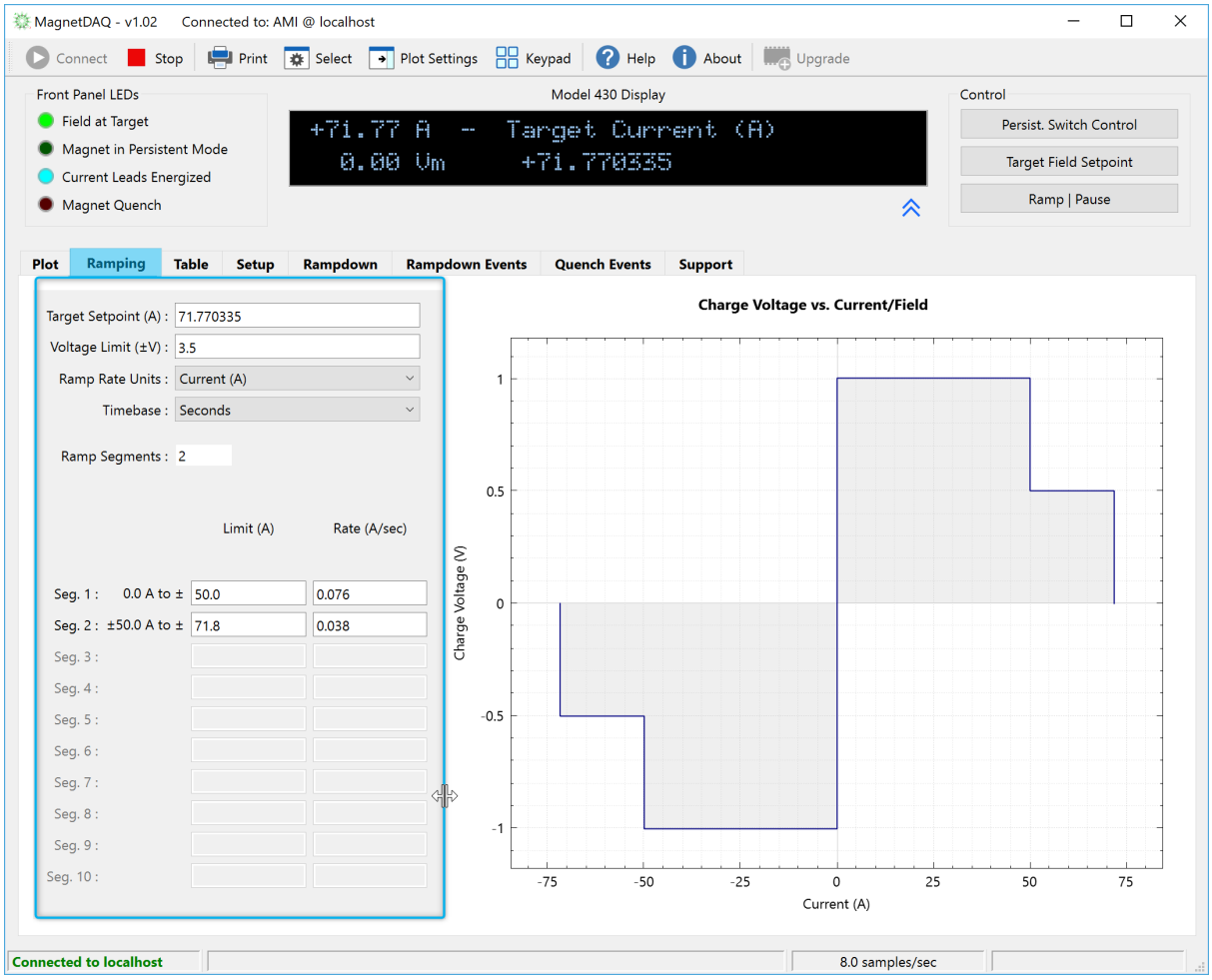
The **Ramp Rate Units** allows the user to choose to display the ramping parameters in amperes *or* field units of kilogauss or tesla. The *field* unit choice is controlled by the Model 430 setting (via the **Setup > Misc > Field Units** setting of the Model 430).

The **Timebase** of the ramp rate may also be set to either seconds or minutes. Minutes are recommended primarily for very low ramp rates as it provides for additional entry precision.

The **Ramp Segments** field allows entry of 1 to 10 ramp segments. As the ramp segments are adjusted, the entry fields for each segment are enabled and disabled as appropriate.

The plot at right in the view shows the charge voltage across the actual magnet for a given Magnet Inductance (see the **Setup > Load** screen). If the Magnet Inductance is not known and/or entered (i.e. zero), then the charge voltage graph is not drawn.

NOTE: If there are *several* ramping segments, the interface may appear more sluggish as the Magnet-DAQ application attempts to keep both the Model 430 and the displayed interface in sync. This is an unfortunate artifact of the underlying network-based communication.



NOTE: The view is split and the space allocated to the settings at left, and the plot at right, can be adjusted by clicking and dragging the split.

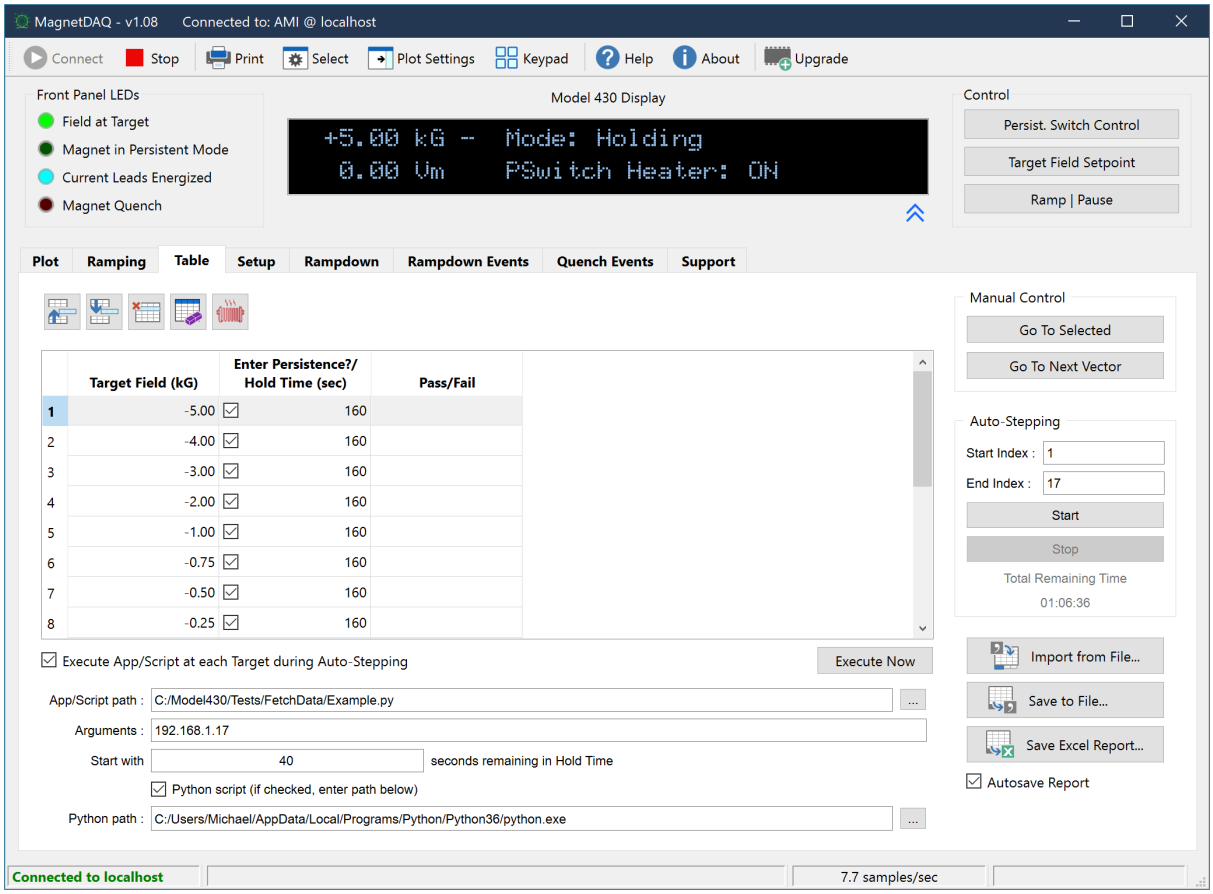
2.5 Table Tab

The Table tab provides an interface for loading, editing, and saving a list of field (or current) targets. Each target can be manually chosen, or the Autostep feature will visit each in order with a hold time as specified in the table.

An interface is also provided to specify an application or Python script that will run at a user-specified remaining time in the hold period at each target. This allows the user to wait for stabilization or other considerations before executing external data collection. The option to execute user code at each target, along with the Autostep feature, is a powerful combination. This means the user can concentrate efforts on developing specific data collection, or other tasks, for an experiment and allow Magnet-DAQ to handle the tedious job of managing the magnet state and field sequencing.

NOTE: This application provides basic table editing. Double-click a value in the table to edit its value. Use the icons above the table (as illustrated below) to add a row above or below the selected row, delete a row, or clear the entire table, respectively. More advanced editing of the table is better performed using Microsoft Excel (or other compatible application) that can load, edit, and save comma-separated values (CSV) files.

Table edit icons



NOTE: If the Model 430 to which the application *is connected* is configured for a persistent switch, then each target row includes an **Enter Persistence?** checkbox. If the box is checked, then the Model 430 will enter persistent mode (by cooling the switch) during the **Hold Time**, and then exit persistence (by heating the switch) at that target field or current. Ensure the heating and cooling times for the persistent switch are set according to the magnet manufacturer's recommendations.

The "heater coil" tool button above the table will toggle the **Enter Persistence?** checkbox states for *all the rows* in the table.

The **Import from File...** button displays a file chooser dialog for selection of a CSV-formatted file to import into the table. All prior values are overwritten. See the Table Import Format topic in the Advanced Features section of this Help for details on the import format.

The **Save to File...** button will export the table contents to the selected file in CSV format.

The **Save Excel Report...** button exports the table contents to a formatted Excel file with additional information such as the ramp segments and date/time.

If **Autosave Report** is checked, the application will attempt to autosave the formatted Excel report when an Autostep session completes (either successfully or unsuccessfully) to the same folder from which the last **Import from File...** file was loaded. Multiple saves will contain an incremented integer value in the filename to avoid overwriting previous autosaves.

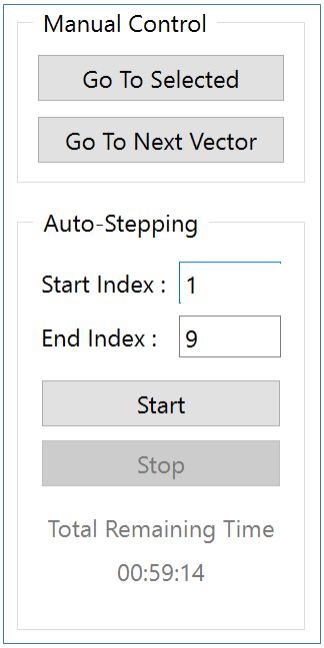
Two important terms are used in reference to the table: *Target* and *Auto-Stepping*

The **Target** is defined as the field that is presently programmed in the magnet system; or in other words, the Target Setpoint along with the ramp rate values for the Model 430 that have been programmed to realize the value. If a target reaches the **HOLDING** state, then it is marked as "Pass" in the Pass/Fail column.

NOTE: The table function observes *all* defined ramping segments in the Ramping tab to reach the desired field.

In addition to manual controls which will hold the Target indefinitely, the table also has an **Auto-Stepping** sequencing feature whereby the list of targets can be sequentially executed by the application. The "Hold Time (sec)" column in the vector table defines how long the Auto-Stepping feature will remain in the **HOLDING** state (i.e. a "dwell time") once the target is reached.

The right-side controls are described below:



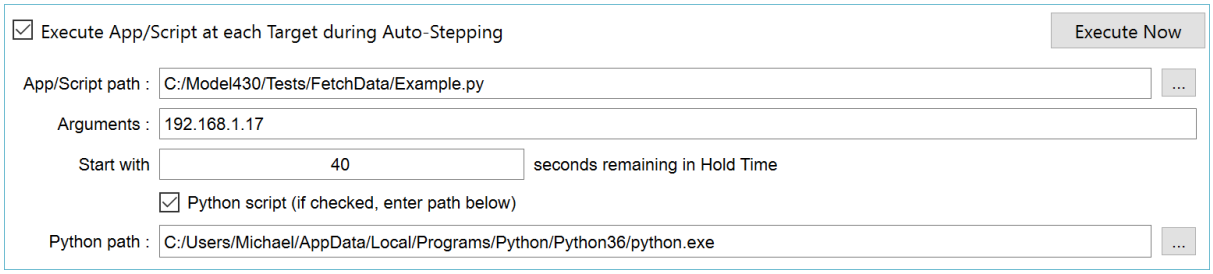
Go To Selected	Makes the presently selected row the Target and commands the Model 430 to ramp to the value.
Go To Next Vector	Makes the next row in the table the Target and commands the Model 430 to ramp to the value.
Start Index	Specifies the starting row index of the Auto-Stepping sequence.
End Index	Specifies the ending row index of the Auto-Stepping sequence.
Start and **Stop**	Starts and stops the Auto-Stepping function.
Total Remaining Time	Estimate of total time (hh:mm:ss) to complete the Auto-Stepping function including any switch heating/cooling times.

Execution of external application or Python script at each Target

If the **Execute App/Script** checkbox is checked, then a details footer appears with options to specify the location, arguments, and launch time within the Hold Time at the target. Ensure enough time is allowed to complete the app/script before the Hold Time expires and the target is changed. The ellipsis button at the end of the **App/Script path** field displays a chooser dialog.

The **Execute Now** button will execute the app/script on-demand (but is disabled when Autostep is active). Among other uses, this can be useful for debugging purposes.

If the **Python script** box is checked, then a text box will appear for specification of the path to the desired Python executable. This allows the user to select a specific Python version for execution rather than relying on the system path.



Example Entries for External Python Script Execution

In the above example, the Example.py script has been specified with a single argument which is the IP address of the digital multimeter device. The script will be executed with 40 seconds remaining in the Hold Time. The Python path field points to an installation of Python version 3.6.

The exact execution command sent to the operating system for this example would be:

C:/Users/Michael/AppData/Local/Programs/Python/Python36/python.exe C:/Model430/Tests/FetchData/Example.py 192.168.1.17

Note that the arguments are ordered for the Python script to consume, and not the Python executable. The Example.py script is provided in the Python Examples section of this Help.

Special variables available for use in the Arguments field

Special variables that pass the present magnet state and/or the target are available in the Arguments field. The following table describes the available variables which are replaced in the execution command sent to the operating system with the present value of each variable. Each command may have several synonyms and can recognize either values *enclosed* in % (Windows shell variables style) or *prefixed* with the $ character (Unix shell variables style). This allows external scripts or executables to access the present field or target field for purposes such as building DAQ tables.

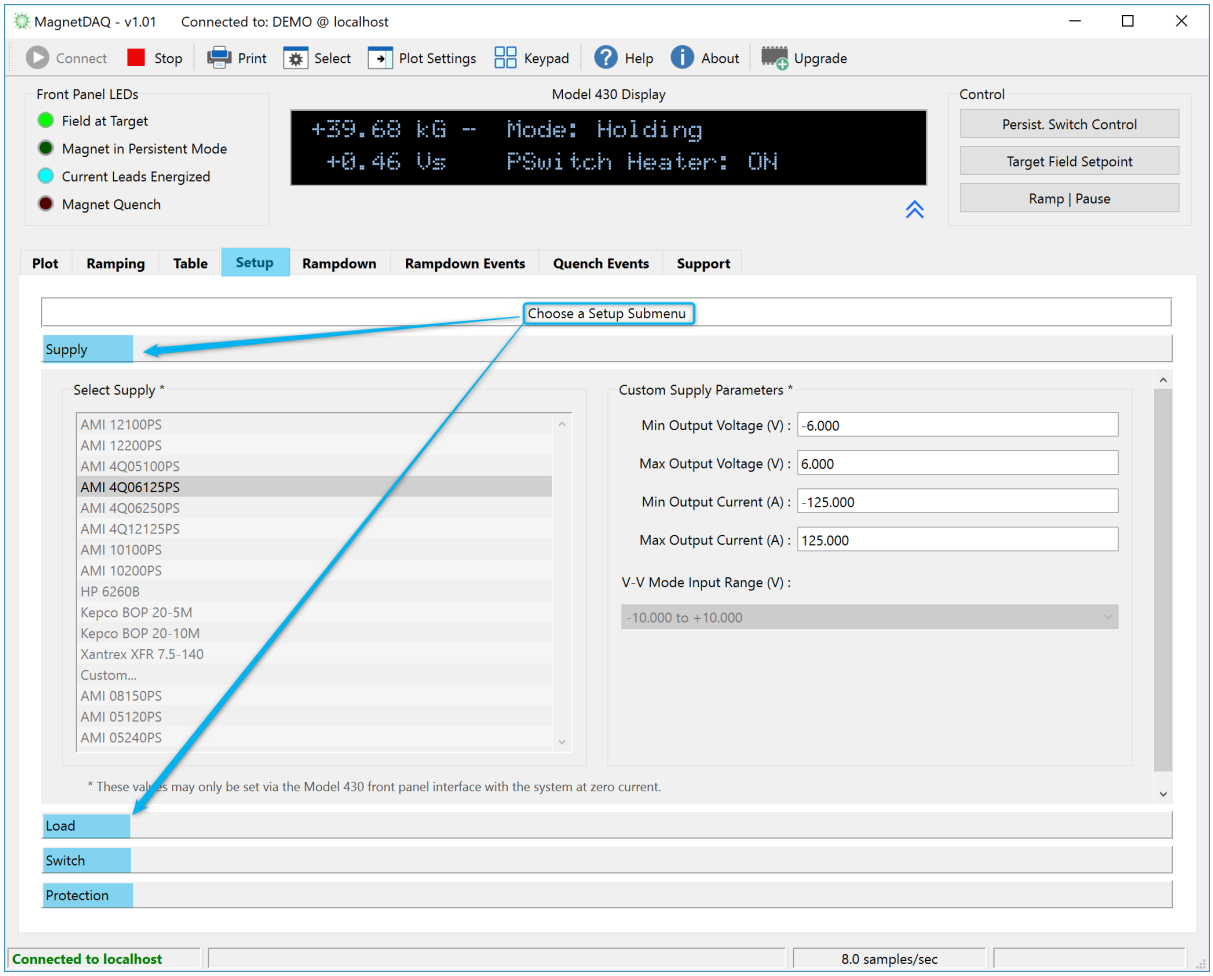
The RampToZero.py script is provided in the Python Examples section of this Help illustrating the use of the special variables as Arguments.

Variable Synonyms	Description
%IPADDR% **$IPADDR**	Inserts the IP address of the presently connected Model 430 device.
%CURR:MAG% **$CURR:MAG**	Inserts the present magnet current in amperes.

%CURR:REF% **$CURR:REF**	Inserts the noiseless 430-internal digital ramp reference in amperes.
%FIELD:MAG% **$FIELD:MAG**	Inserts the present magnet field in the selected field units. The present magnet field and the target magnet field should match when the HOLDING state is reached.
%TARG:CURR% **$TARG:CURR**	Inserts the target setpoint magnet current in amperes. The present magnet current and the target magnet current should match when the HOLDING state is reached.
%TARG:FIELD% **$TARG:FIELD**	Inserts the target setpoint magnet field in the selected field units. The present magnet field and the target magnet field should match when the HOLDING state is reached.

2.6 Setup Tab

The Setup Tab provides a multi-paged interface for viewing and setting numerous parameters for the target Model 430. The view is contains a stacked view with Setup Submenus for the **Supply**, **Load**, **Switch**, and **Protection** settings. These submenus correspond to those of the Model 430 accessible via the front panel keypad. Simply click on the page name to access each.



Supply page

The Supply settings are *read-only* to prevent accidental changes. An incorrect change in the supply setup parameters could easily trigger a magnet quench if not performed with an abundance of caution. Therefore, a design choice was made to not allow remote adjustment of the supply setup parameters at this time.

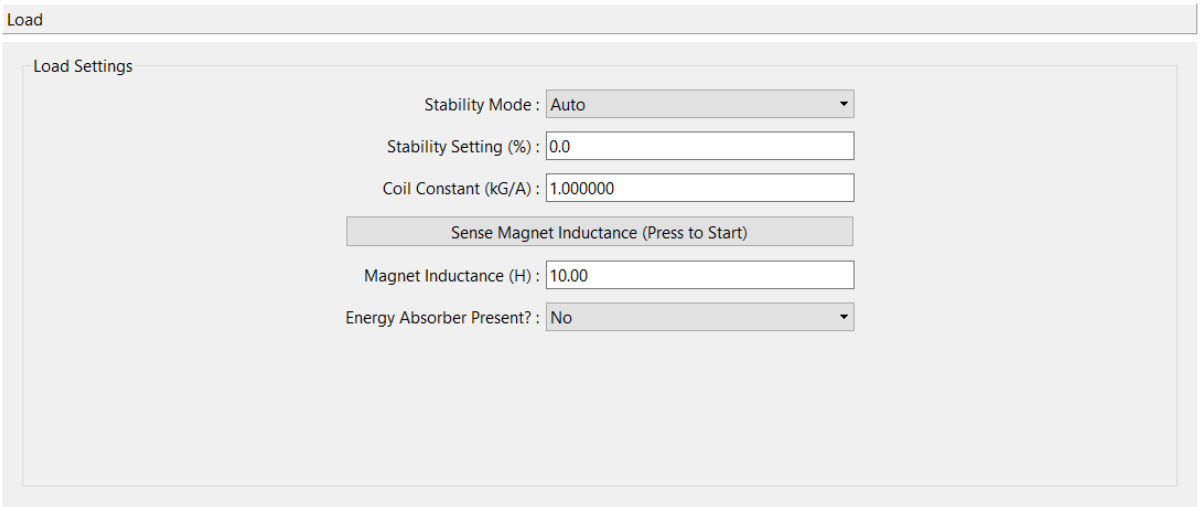
These correspond to the identical settings available in the **Setup > Supply** menu accessible from the Model 430 front panel. Refer to the Model 430 manual for a detailed explanation of each parameter.

Load page

The Load settings include the **Stability Mode**, **Stability Setting**, **Coil Constant**, **Magnet Inductance**, and whether an energy absorber (typically a Model 601) is present and connected to the magnet circuit. These correspond to the identical settings available in the **Setup > Load**

menu accessible from the Model 430 front panel. Refer to the Model 430 manual for a detailed explanation of each parameter.

The Coil Constant units will change (kG/A or T/A) with the selected field units of the Model 430.

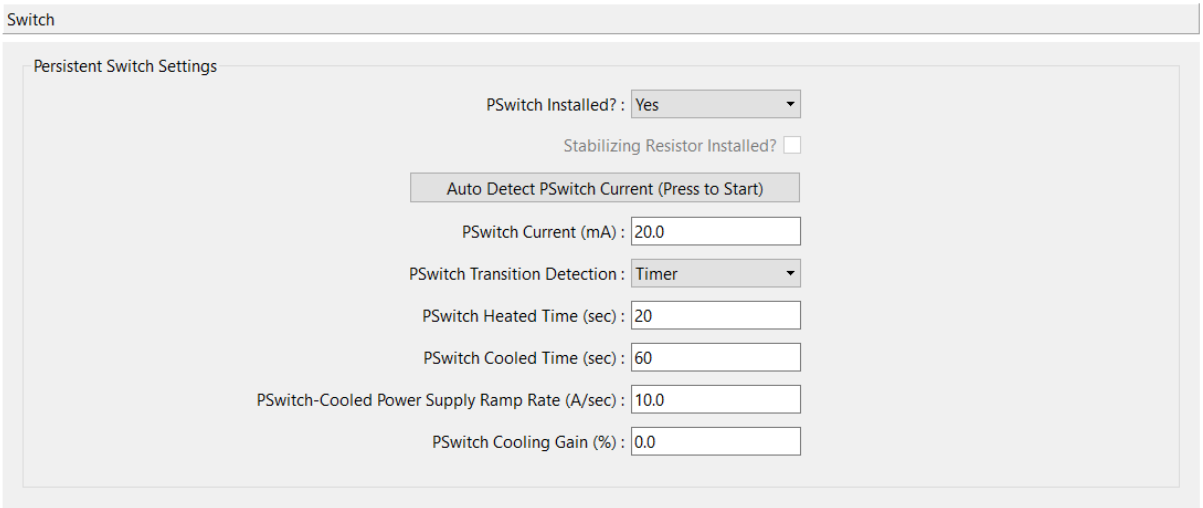


NOTE: The **Sense Magnet Inductance** button will initiate a magnet inductance measurement via the Model 430. Please note that the initiating the sensing function using this button will block all remote I/O with the Model 430 until the inductance sensing process completes. An alternative, non-blocking action is to use the Keypad emulation to initiate the same function via the instrument display.

Switch page

The Switch settings include the whether a switch is installed, **PSwitch Current**, **PSwitch Transition Detection** type, **PSwitch Heated Time**, **PSwitch Cooled Time**, **PSwitch-Cooled Power Supply Ramp Rate**, and **PSwitch Cooling Gain**. These correspond to the identical settings available in the **Setup > Switch** menu accessible from the Model 430 front panel. Refer to the Model 430 manual for a detailed explanation of each parameter.

If a switch is not installed, an optional stabilizing resistor indication can be selected if a stabilizing resistor is present in the magnet circuit.



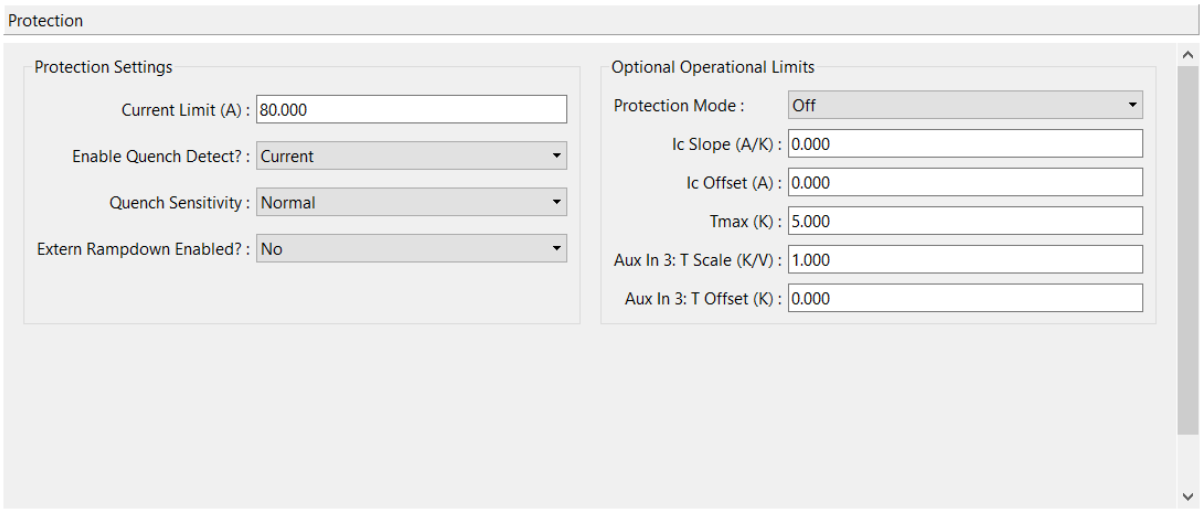
NOTE: The **Auto Detect PSwitch Current** button will initiate the switch heater current detection function via the Model 430. Please note that initiating the sensing function using this button will block all remote I/O with the Model 430 until the sensing process completes. An alternative, non-blocking action is to use the Keypad emulation to initiate the same function via the instrument display.

Protection page

The Protection settings include **Current Limit**, quench detection type selection and enable, **Quench Sensitivity**, and external rampdown enable. These correspond to the identical settings available in the **Setup > Protection** menu accessible from the Model 430 front panel.

In addition, the optional Operational Limits section can be setup with all the associated parameters including **Ic Slope**, **Ic Offset**, **Tmax**, **T Scale**, and **T Offset**.

Refer to the Model 430 manual for a detailed explanation of each parameter.



2.7 Rampdown Tab

The Rampdown Tab provides an interface for viewing and setting optional ramp segments that are used in the event of an *external rampdown event*.

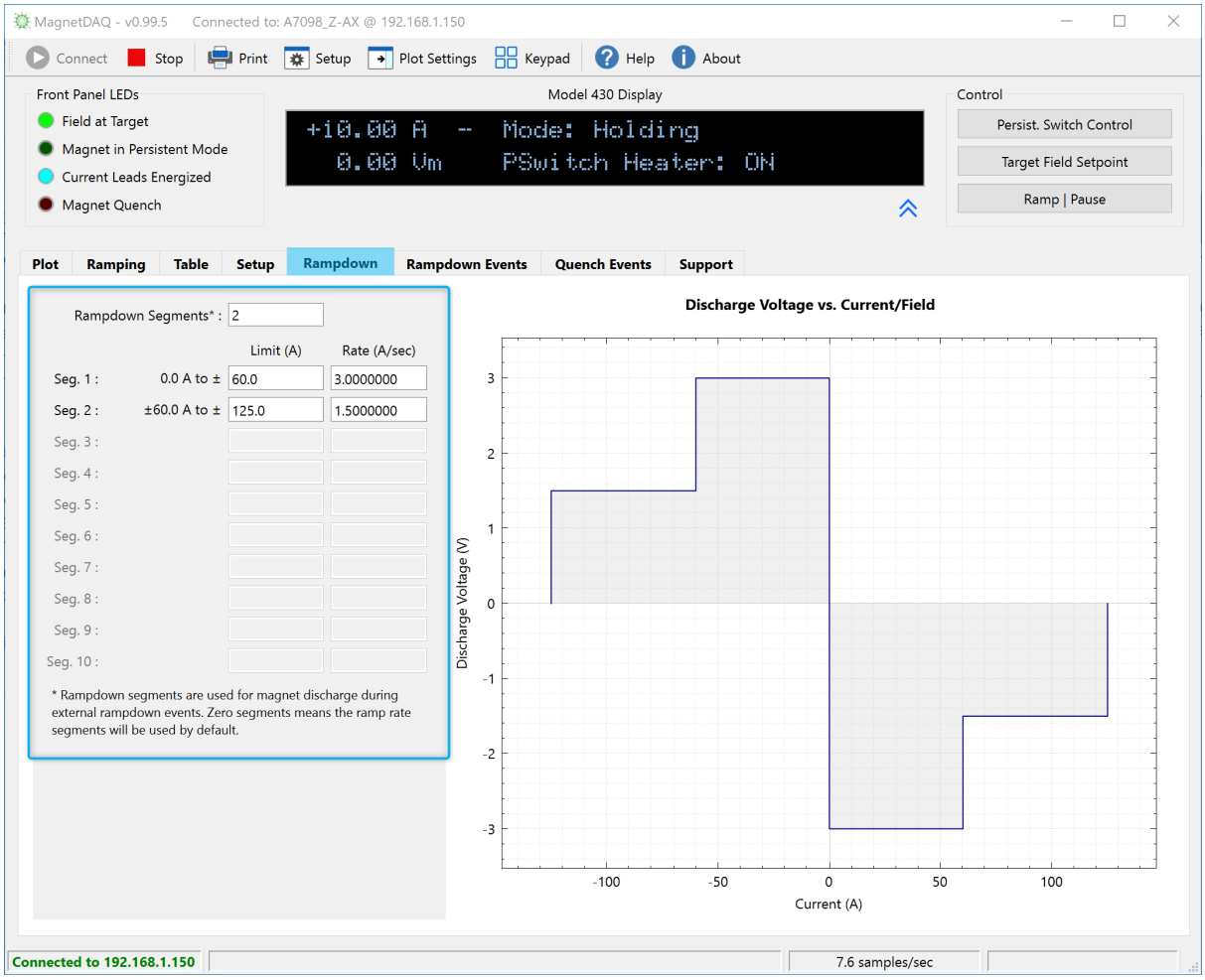
The external rampdown feature uses a rear panel input of the Model 430 (pins 6 and 7 of the Quench I/O connector). The external rampdown discharge ramp segments have no physical interface via the front panel of the Model 430. The rampdown segments may only be specified using the remote interfaces. The Rampdown Tab provides a convenient interface for specifying these segments.

The external rampdown feature is intended to provide a rapid and non-interruptable discharge of the magnet in the event of a situation where the magnet cannot continue operation such as loss of coolant, facility power loss, etc.

As is the case with the normal ramping function, the external rampdown function can accept up to 10 segments. If no segments are specified (i.e. 0 Rampdown Segments), then the values in the Ramping Tab are used during the rampdown process.

See the Model 430 manual for more detailed information regarding the external rampdown feature.

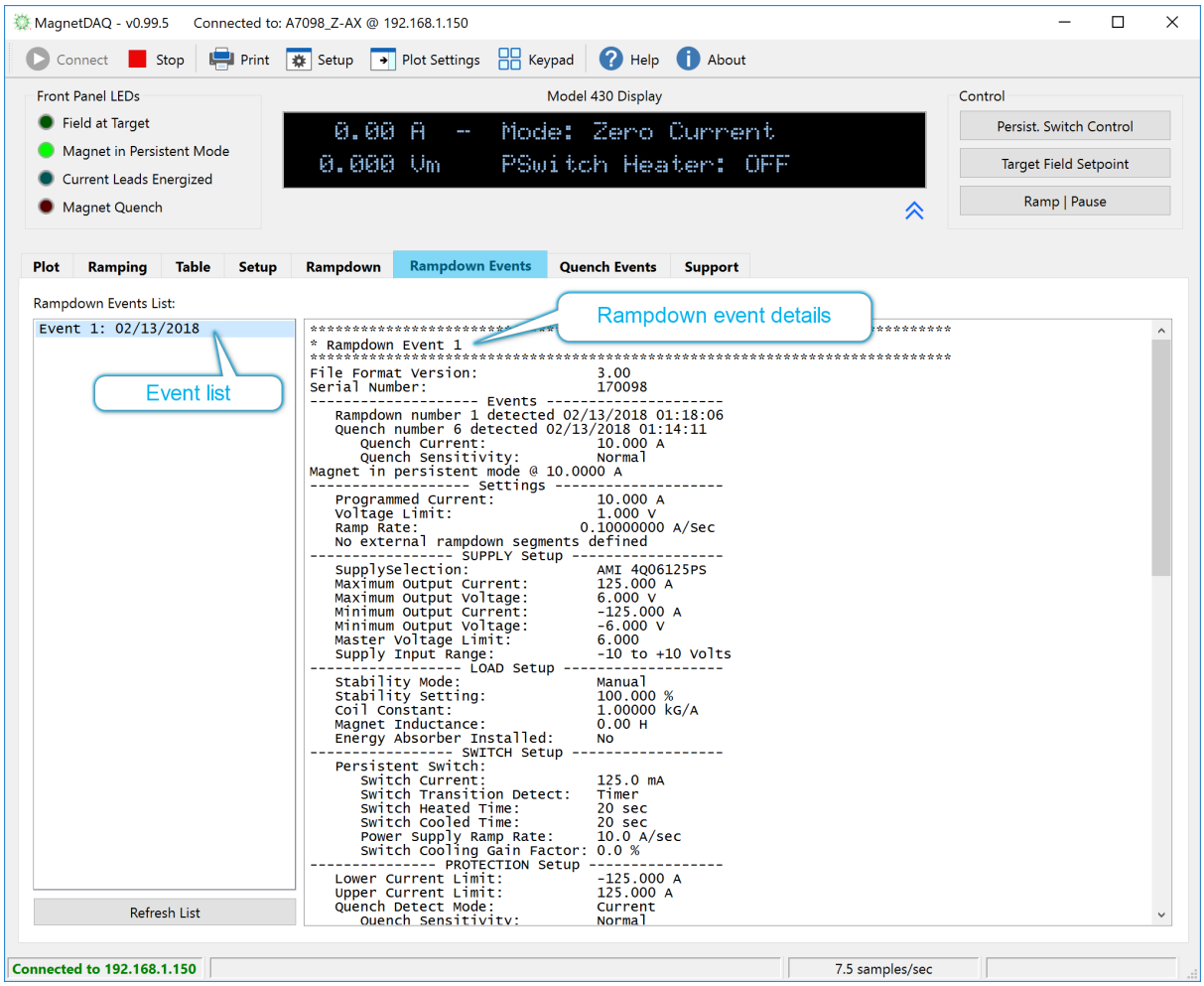
NOTE: The view is split and the space allocated to the settings at left, and the plot at right, can be adjusted by clicking and dragging the split.



2.8 Rampdown Events Tab

The Rampdown Events Tab provides a list of rampdown events recorded by the instrument with a timestamp of the initiation of each event. The complete state of the Model 430 is recorded at the initiation of each event and is provided in the text space to the right upon selection of an event from the list.

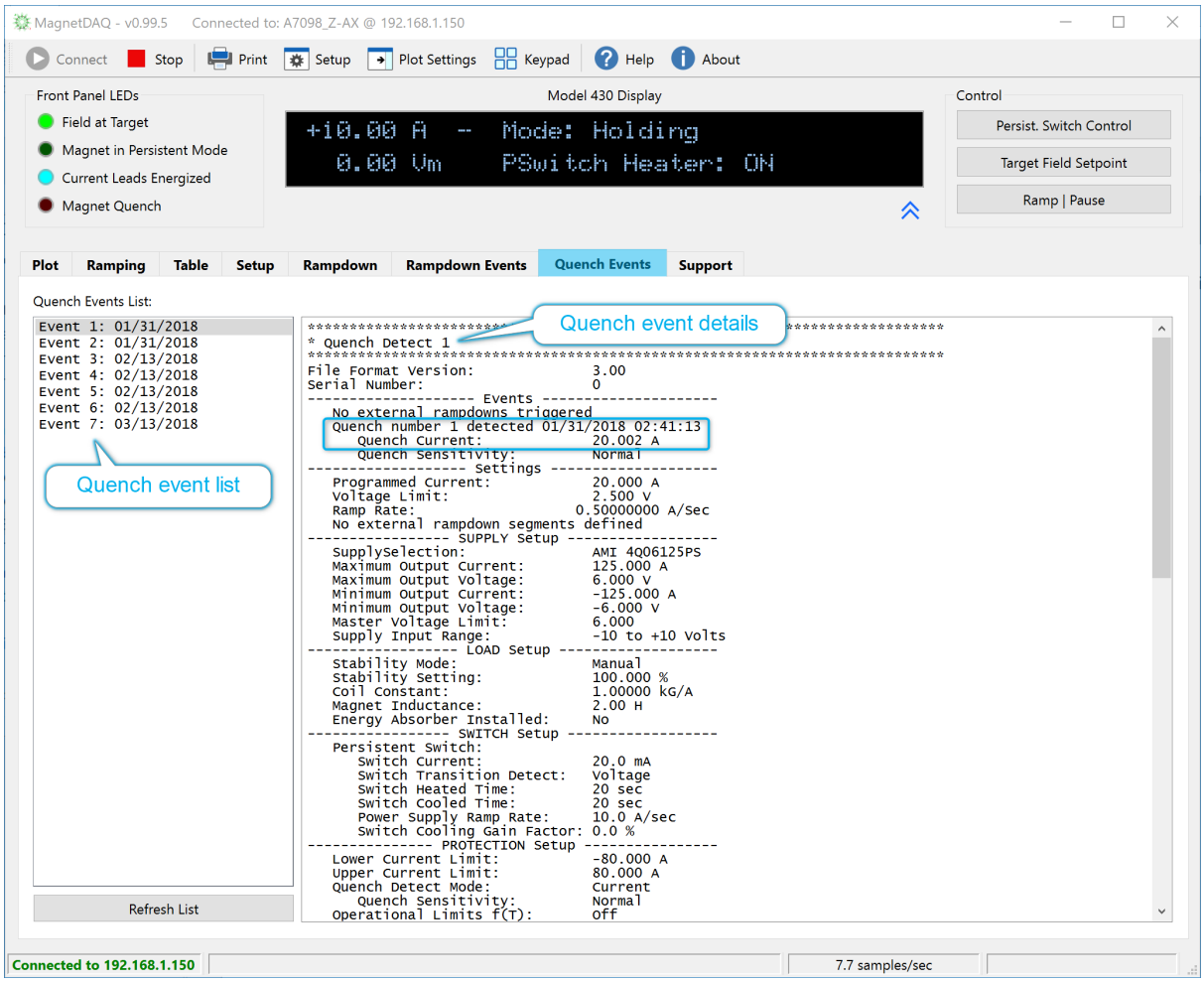
The event list is automatically refreshed each time the Rampdown Events Tab is entered.



2.9 Quench Events Tab

The Quench Events Tab provides a list of quench detection events recorded by the instrument with a timestamp of the initiation of each event. The complete state of the Model 430 is recorded at the initiation of each event and is provided in the text space to the right upon selection of an event from the list.

Up to the last 100 quench events will be fetched from the instrument. The event list is automatically refreshed each time the Quench Events Tab is entered.

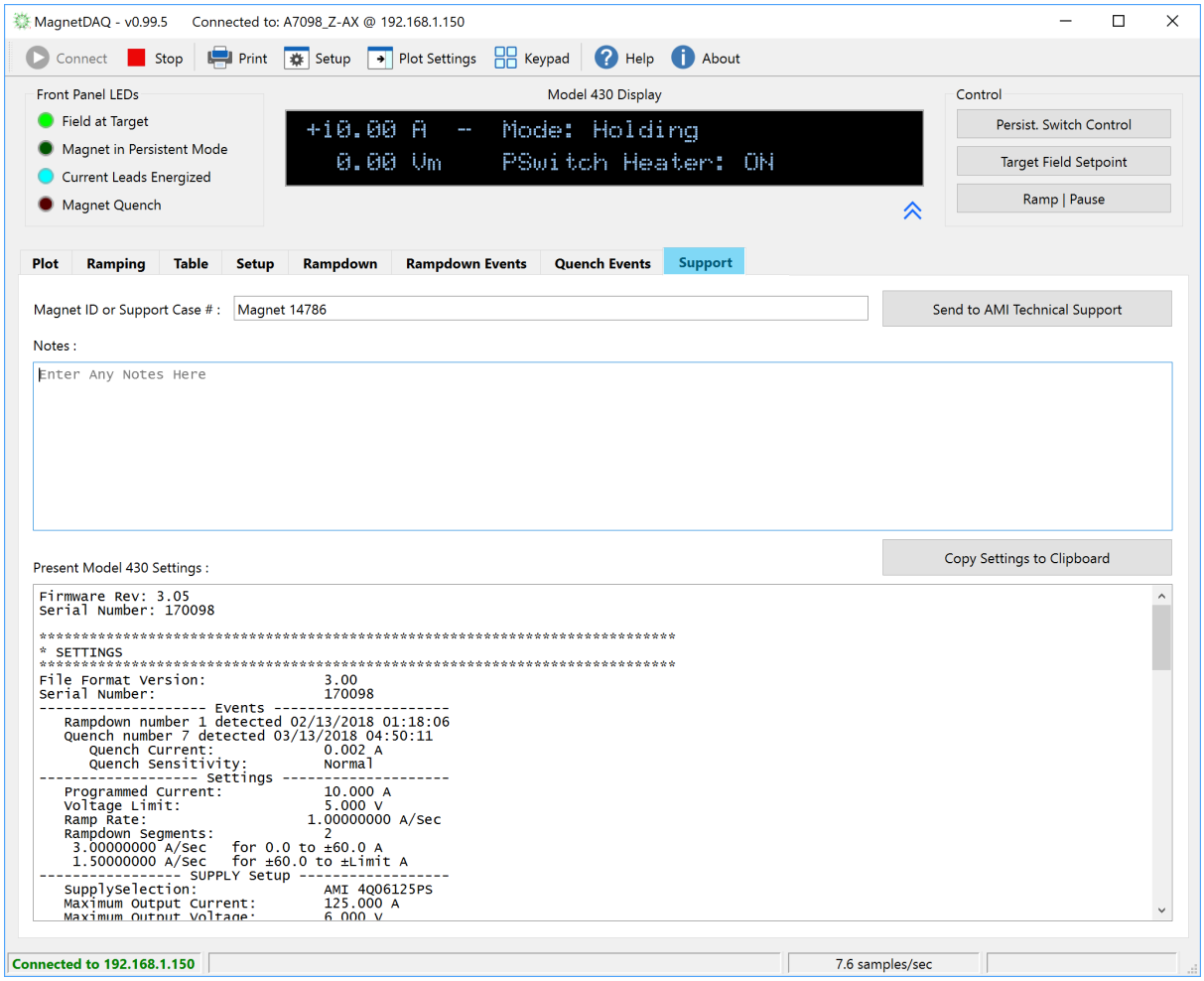


2.10 Support Tab

The Support Tab provides fields for contacting an Authorized AMI Technical Support Representative, including a Magnet ID or Support Case # field (the magnet number is very useful here), a Notes area for the problem description, and the complete settings of the Model 430.

You may choose the "Send to AMI Technical Support" button to compose an email in the default email application as configured on your computer, or you can copy the Model 430 settings to the clipboard and paste it into a message of your own composition.

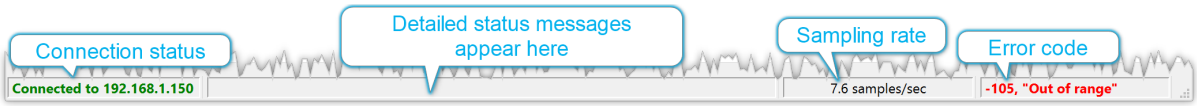
Providing this information to AMI Technical Support can serve to expedite a more detailed response.



2.11 Status Bar

The Status Bar at the bottom of the Main Window consists of four panes of information:

- The leftmost pane indicates the connection status of the remote instrument.
- The next pane to the right provides detailed status or error information. Critical error information will be shown as red text.
- The next pane to the right indicates the present sampling rate of the plotted data.
- The rightmost pane provides the error message codes and short error summary as returned by the instrument.
- Click the Error code pane to open an error history dialog for the present connection.

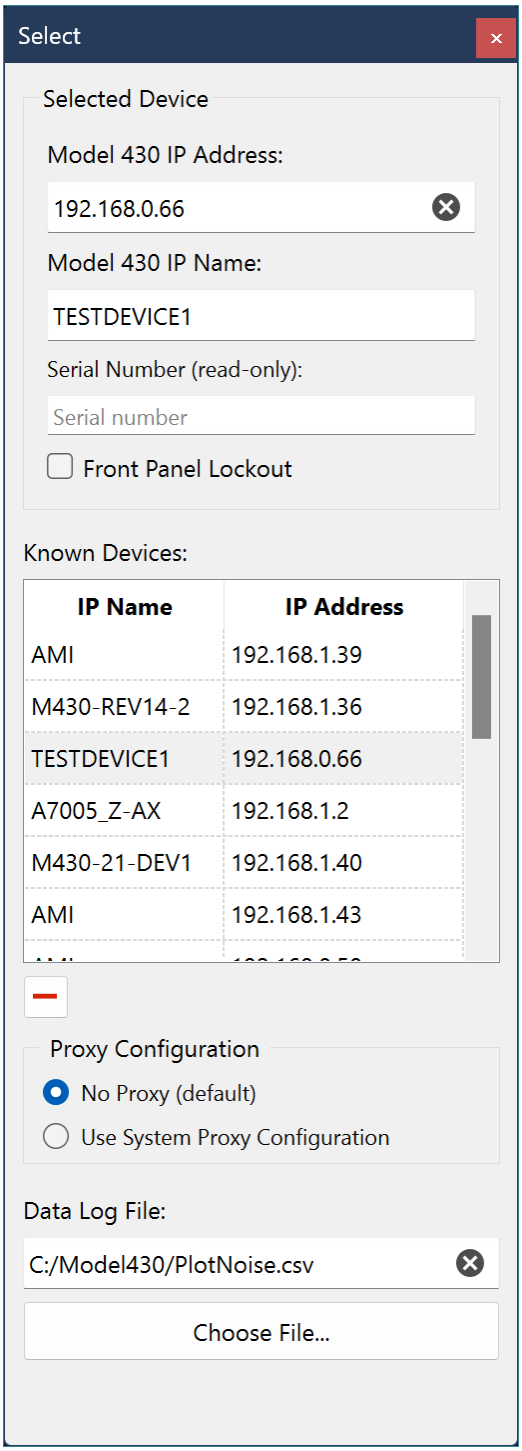


Error History Dialog

Configuration Panels

3 Configuration Panels

3.1 Select

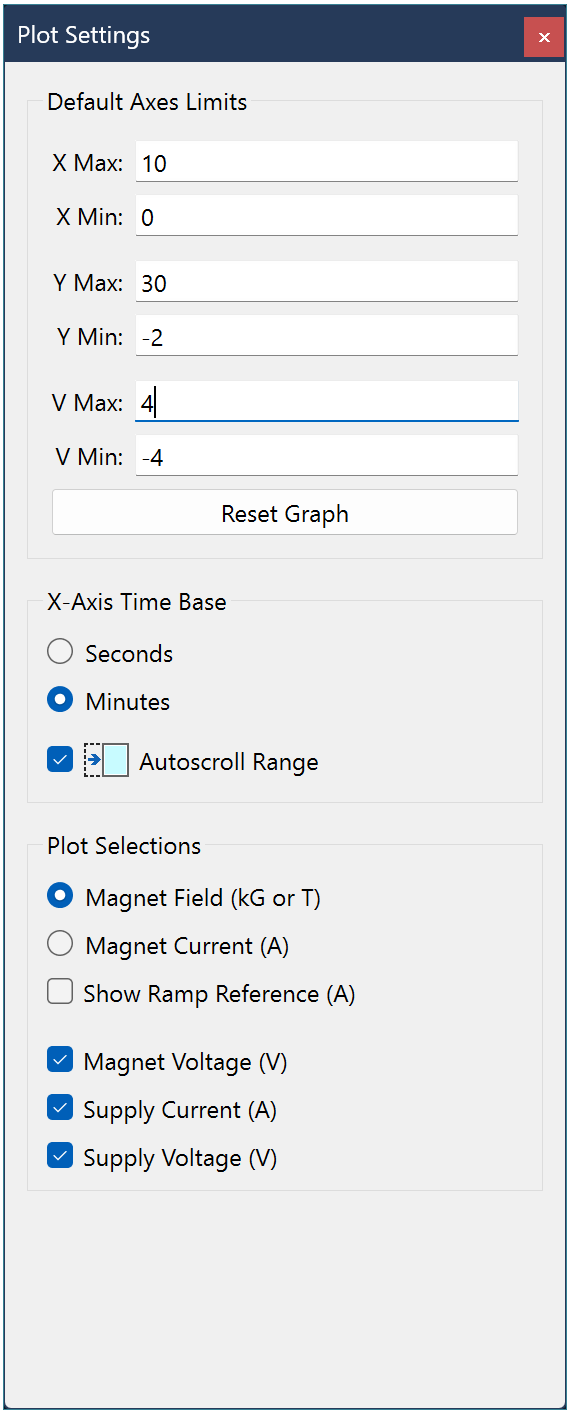


The Select panel is accessible via the Toolbar icon and is the means of selecting a target Model 430 for a connection. The panel can be docked to either the left or right side of the Main Window, or it can be dragged off the Main Window to "float" on the desktop. The fields and interface items are described below:

Model 430 IP Address	The IP address of the target instrument on the local network. This can be manually entered or can be auto-filled with the information from a selection from the "Known Devices" list (see below).
Model 430 IP Name	This is the textual name assigned to the instrument at the IP address. This is read on connection and can be edited once a connection is active.
Serial Number	Read-only display of the instrument's serial number.
Front Panel Lockout	When checked, the local keypad is made inactive on the front panel of the physical instrument. The remote keypad emulation remains functional. This can be used to prevent a user at the instrument from interfering with a remote control session.
Known Devices	A list of previously successfully connected instruments. Select from the list before making a connection to choose from the known devices. Use the button to delete selections from the

	table. Click on a heading to sort the list by name or address.
Proxy Configuration	Allows selection of either *No Proxy* or *System Proxy*. The System Proxy is defined by the operating system. The No Proxy setting is the default and should suffice for most installations, especially for only local network access.
Data Log File	Use the "Choose File..." button to specify a new, or select an existing, data log file. New data will be *appended* to the file at the specified location. The format of the log file is a *comma-separated values* format (.CSV) that is compatible with Microsoft Excel as well as many other spreadsheet or plotting applications. If the field is empty, logging is disabled.

3.2 Plot Settings



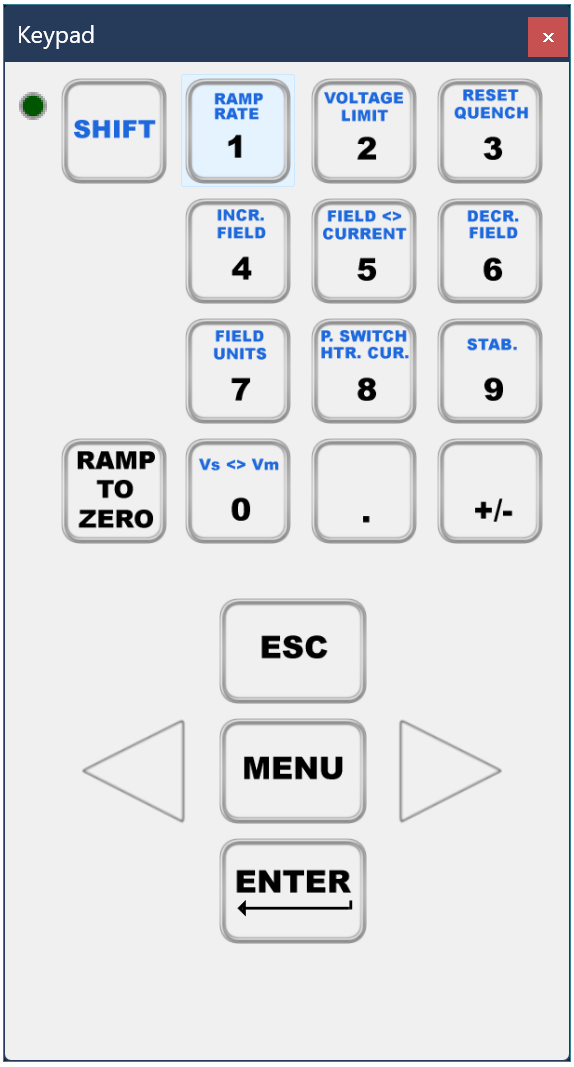
The Plot Settings configuration panel is accessible by using the Toolbar icon. The panel can be docked to either the left or right side of the Main Window, or it can be dragged off the Main Window to "float" on the desktop. The fields and interface items are described below:

X Max	The maximum time value displayed on the horizontal axis of the plot in the selected X-Axis Time Base units.
X Min	The minimum time value displayed on the horizontal axis of the plot in the selected X-Axis Time Base units. The time value starts at zero when the instrument initially enters the "Connected" state.
Y Max	The maximum field and/or current value displayed in the left vertical axis of the plot.
Y Min	The minimum field and/or current value displayed in the left vertical axis of the plot.
V Max	The maximum voltage value displayed in the right vertical axis of the plot.
V Min	The minimum voltage value displayed in the right vertical axis of the plot.
Reset Graph	Pressing this button will reset the plot area to the specified "Default Axes Limits" as described above. However, the horizontal time axis value will continue to increment.

	The time value is only reset to zero when the instrument initially enters the "Connected" state.
X-Axis Time Base	Selected either seconds or minutes for the horizontal plot axis units
Autoscroll Range	If this is selected, then the horizontal axis of the plot is automatically scrolled in time increments set by the value of (X Max - X Min). If you wish to scroll back in time to observe past data, temporarily turn off (i.e. uncheck) Autoscroll Range. A quick-access icon is provided at the bottom left of the plot area as a shortcut to toggling this setting ON/OFF.
Magnet Field (kG or T)	If checked, the magnet field will be plotted in the selected instrument field units.
Magnet Current (A)	If checked, the magnet current will be plotted in amperes.
Show Ramp Reference (A)	If checked, the noiseless, internal digital ramp reference in the Model 430 is plotted in amperes. The value is the current reference to which the Model 430 attempts to control the magnet current.
Magnet Voltage (V)	If checked, the magnet voltage will be plotted in volts. The right vertical axis sets the voltage scale in the plot. This voltage is typically measured by voltage taps across the magnet coil.

Supply Current (A)	If checked, the power supply current is plotted in amperes. Note that the power supply current and magnet current can differ if the magnet is in "persistent mode".
Supply Voltage (V)	If checked, the power supply output voltage is plotted in volts. The right vertical axis sets the voltage scale in the plot. This voltage may differ from the magnet voltage by the additional voltage drops from lead resistance and/or energy absorbers.

3.3 Keypad



The Keypad panel is accessible using the Toolbar icon. The panel can be docked on the left or right of the Main Window, or it can be dragged out of the Main Window to "float" on the desktop. The interface items are identical in function to the physical keypad of the instrument with only a couple of exceptions as described below:

Emulates the SHIFT key function. When pressed, the LED energizes to the left of the button indicating an active SHIFT state, unless the SHIFT state is already active in which case it is canceled and the LED de-energizes.

Emulates the "1" key function. When SHIFT is active, pressing the key displays the RAMP RATE settings.

Emulates the "2" key function. When SHIFT is active, pressing the key displays the VOLTAGE LIMIT setting.

Emulates the "3" key function. When SHIFT is active, pressing the key clears any active QUENCH state.

Emulates the "4" key function. When SHIFT is active, pressing the key causes the magnet field or current to increase in value.

Emulates the "5" key function. When SHIFT is active, pressing the key toggles the display between current and field units.

Emulates the "6" key function. When SHIFT is active, pressing the key causes the magnet field or current to decrease in value.

FIELD UNITS 7	Emulates the "7" key function. When SHIFT is active, pressing the key displays the **Setup > Misc > Field Units** selection menu.
P. SWITCH HTR. CUR. 8	Emulates the "8" key function. When SHIFT is active, pressing the key displays the **Setup > PSwitch > PSwitch Current (mA)** selection menu.
STAB. 9	Emulates the "9" key function. When SHIFT is active, pressing the key displays the **Setup > Load > Stability Mode** selection menu. If the Stability Mode is "Manual", then the arrow keys can be used to move to the **Setup > Load > Stability Setting (%)** entry menu.
Vs <> Vm 0	Emulates the "0" key function. When SHIFT is active, pressing the key toggles the display between supply voltage (Vs) and magnet voltage (Vm) values.
.	Emulates the decimal key function. *No SHIFT function is emulated for this key press.*
+/-	Emulates the sign change key function. *No SHIFT function is emulated for this key press.*
RAMP TO ZERO	Emulates the "Ramp to Zero" key function.
ESC	Emulates the ESC (i.e. escape) key function. The SHIFT state function is available as described in the Model 430 manual.
MENU	Emulates the MENU key function. The SHIFT state function is available as described in the Model 430 manual.

ENTER	Emulates the ENTER key function.
◁	Emulates the left-arrow key function.
▷	Emulates the right-arrow key function.

Advanced Features

4 Advanced Features

4.1 Command Line Options

The application supports several command line options. These can be specified, for example, on the Windows platform by creating a custom shortcut and adding the options in the Target field of the shortcut Properties.

Command line option	Meaning
-h	Hide (minimize) the Magnet-DAQ interface on launch.
-x	Label the Magnet-DAQ window as "X Axis" and superimpose an X on the app icon.
-y	Label the Magnet-DAQ window as "Y Axis" and superimpose a Y on the app icon.
-z	Label the Magnet-DAQ window as "Z Axis" and superimpose a Z on the app icon.
-p	Start the stdin/stdout parser function (for Python or QProcess use). *Firmware upgrades are not allowed in this mode.* If this option is specified, the data rate of the connected Model 430 is fixed at one sample per second.
-a *address*	Start and auto-connect to IP *address*.
--port *portid*	Connect to specified *port number* (for proprietary simulation use only).
--telnet *portid*	Show display echoed to specified *port number* (for proprietary simulation use only).

Example:

"C:\Program Files\American Magnetics, Inc\Magnet-DAQ\Magnet-DAQ.exe" -h -z -p -a 192.168.1.14

This starts the application in minimized mode, labels the Main Window and taskbar icon with the letter Z (for Z-axis), starts the stdin/stout parser, and autoconnects to the device at IP address 192.168.1.14.

NOTE: The --port and --telnet options are designed to support AMI-proprietary superconducting magnet and Model 430 simulation programs that can co-exist on the same host for testing, debugging, and demo purposes. They should not be used by customers in typical applications.

4.2 Python/Remote Scripting Support

The Magnet-DAQ application supports a parsing mode (specified by using the -p command line option on launch) that allows communication with the application using the *stdin* and *stdout* interfaces. This can be utilized by Python-based scripts or the QProcess C++ object that is part of the Qt Toolkit. These are only examples — any method that can utilize *stdin* and *stdout* can be used to communicate.

NOTE: The *Multi-Axis Operation* application distributed by AMI for operating multi-axis superconducting magnet systems uses the parser function of Magnet-DAQ and QProcess objects to operate up to three separate Model 430 units in tandem.

This interface allows reading and writing a subset of the Model 430 settings and state *without* having to deal with TCP/IP sockets or serial port programming. Not all features of the Model 430 are, as of yet, exposed to this parsing interface. The specific commands and queries that are presently supported are shown below.

The lower case characters in commands and queries indicate the *optional* long form of the command/query. The uppercase letters are the short form. All decimal values are returned with 10 significant digits to the right of the decimal. All return values are terminated with a linefeed character, '\n'.

Command parameters shown in braces { } indicate valid arguments (choose *one*). Parameters shown in < > are required decimal arguments, where ( ) indicates value units if applicable. When sending commands, omit all { } < > ( ) characters. Commands do not return a value.

NOTE: Parser errors will be enunciated with a beep by the application. An error queue is also generated as a last-in-first-out (LIFO) list. Use the **`SYSTem:ERRor?`** and **`SYSTem:ERRor:COUNt?`** queries to check the error status. It is recommended to add the error checking as a standard process of sending a command to the parser.

Commands

SYSTEM COMMANDS

`*CLS`

Clears the parser error queue.

`EXIT`

Disconnects from any connected Model 430 and gracefully exits the application.

CONTROL COMMANDS

`RAMP`

Places the Model 430 Programmer in automatic ramping mode. The Model 430 will continue to ramp at the configured ramp rate(s) until the target field/current is achieved.

`PAUSE`

Pauses the Model 430 Programmer at the present operating field/current.

`PSwitch {0|1}`

Turns the persistent switch heater OFF and ON. Sending “0” turns the switch heater OFF. Sending a “1” turns the switch heater ON. The default value is “0”.

`ZERO`

Activates ramping to zero current/field without altering the Target Setpoint value.

CONFIGURATION COMMANDS

`CONFigure:CURRent:LIMit <current (A)>`

Sets the Current Limit in amperes. The Current Limit is the largest magnitude operating current allowed during any ramping mode. For bipolar power supplies, the Current Limit functions as both a positive and negative current limit. This value is typically provided by the magnet manufacturer as the maximum safe limit of magnet operation.

`CONFigure:CURRent:TARGet <current (A)>`

Sets the target setpoint current in amperes.

`CONFigure:COILconst <value (kG/A, T/A)>`

Sets the coil constant (also referred to as the field-to-current ratio) per the selected field units. The coil constant must be set to a non-zero, positive value in order to command or query the MagnetDAQ app in units of field.

CONFigure:FIELD:TARGet <*field (kG, T)*>

Sets the target field in units of kilogauss or tesla, per the selected field units. This command requires that a non-zero coil constant be defined, otherwise the command is ignored and a device error will be generated.

CONFigure:FIELD:UNITS {0|1}

Sets the preferred field units. Sending "0" selects kilogauss. A "1" selects tesla. "0" is the default value. The selected field units are applied to both the MagnetDAQ display and the related parser commands.

CONFigure:INDuctance <*inductance (H)*>

Sets the currently-connected magnet inductance in Henries.

CONFigure:PSwitch {0|1}

"0" indicates that a persistent switch is not installed on the connected superconducting magnet. "1" indicates that a persistent switch is installed. The default value is "1". If a persistent switch is installed, the persistent switch heated current should be specified. Heating/cooling times should also be specified for timer-based switch transitions.

CONFigure:PSwitch:CURRent <*current (mA)*>

Sets the persistent switch heater current in mA.

CONFigure:PSwitch:TRANsition {0|1}

Sending a value of "0" selects the timer-based switch transition detection. Sending "1" selects the magnet voltage-based transition detection. Timer-based transition detection is the default.

CONFigure:PSwitch:HeatTIME <*time (sec)*>

Sets the time required in seconds for the persistent switch to become resistive after the persistent switch heater has been activated.

CONFigure:PSwitch:CoolTIME <*time (sec)*>

Sets the time required in seconds for the persistent switch to become superconducting after the persistent switch heater has been deactivated.

CONFigure:PSwitch:PowerSupplyRampRate <*rate (A/s)*>

Sets the ramp rate that will be used by the power supply to ramp the current during the PERSIST. SWITCH CONTROL operation when the switch is in a cooled state. This ramp rate can

be much higher than when the switch is heated and the magnet is in the circuit. For more information as to how this function operates, refer to the Model 430 manual.

CONFigure:PSwitch:CoolingGAIN <*percent*>

Sets the persistent switch cooling gain in percent.

CONFigure:RAMP:RATE:FIELD <*segment*>,<*rate (kG/s, kG/min, T/s, T/min)*>,<*upper bound (kG, T)*>

Sets the ramp rate for the specified segment (values of 1 through the defined number of ramp segments are valid) in units of kilogauss/second or minute, or tesla/second or minute (per the selected field units and ramp rate units), and defines the field upper bound for that segment in kilogauss or tesla (see the Model 430 manual for details of the use of ramp segments). This command requires that a non-zero coil constant be defined; otherwise, the command is ignored and a device error will be generated.

CONFigure:RAMP:RATE:CURRent <*segment*>,<*rate (A/s, A/min)*>,<*upper bound (A)*>

Sets the ramp rate for the specified segment (values of 1 through the defined number of ramp segments are valid) in units of A/sec or A/min (per the selected ramp rate units), and defines the current upper bound for that segment in amperes (see the Model 430 manual for details of the use of ramp segments).

CONFigure:RAMP:RATE:UNITS {0|1}

Sets the preferred ramp rate time units. Sending “0” selects seconds. A “1” selects minutes. “0” is the default value. The selected units are applied to both the MagnetDAQ display and the related parser commands.

CONFigure:RAMP:RATE:SEGments <*value*>

Sets the number of ramp segments from 1 to 10. 1 is the default. See the Model 430 manual for details of the use of ramp segments.

CONFigure:STABility:MODE {0|1|2}

“0” configures the stability mode as “Auto”, “1” is “Manual”, and “2” is “Test”. If “Auto” mode is selected and an inductance value is not specified (i.e. the inductance entry is zero), the MagnetDAQ app will beep once, generate an error, and revert to “Manual” stability mode. Manual mode is the default value. In “Auto” stability mode, the stability setting is automatically adjusted per the presence or absence of a persistent switch, the presence or absence of a stabilizing resistor, and the estimated or measured magnet inductance. See the Model 430 manual for details.

CONFigure:STABility <*percent*>

Sets the stability setting in percent. Valid range is 0.0 to 100.0%.

```
CONFigure:STABility:RESistor {0|1}
```

An argument of “0” specifies no stabilizing resistor is installed. “1” indicates a stabilizing resistor is installed. “0” is the default value.

```
CONFigure:VOLTage:LIMit <voltage (V)>
```

Sets the ramping Voltage Limit in volts. The limit may not exceed the maximum output voltage of the power supply.

Queries

SYSTEM QUERIES

```
*IDN?
```

Returns the identification string of the Magnet-DAQ application. The identification string contains the app name and revision level of app. Example output: **`MagnetDAQ,1.05`**

```
SYSTem:ERRor?
```

Returns the most recent system error added to the error queue and removes it from the queue. If the queue is empty, the return string is `0,"No errors"`. See the Error Codes section below.

```
SYSTem:ERRor:COUNt?
```

Returns the integer number of errors currently in the system error queue.

STATE/CONFIGURATION QUERIES

```
STATE?
```

Returns an integer value corresponding to the ramping state according to the table below:

Return Values for `STATE?` Query	
Return Value	Meaning
1	RAMPING to target field/current
2	HOLDING at the target field/current
3	PAUSED
4	Ramping in MANUAL UP mode

5	Ramping in MANUAL DOWN mode
6	ZEROING CURRENT (in progress)
7	Quench detected
8	At ZERO current
9	Heating persistent switch
10	Cooling persistent switch
11	External Rampdown active

`CURRent:LIMit?`

Returns the Current Limit in amperes.

`CURRent:MAGnet?`

Returns the current flowing in the magnet in amperes. If the magnet is in persistent mode, the command returns the current that was flowing in the magnet when persistent mode was last entered.

`CURRent:SUPPly?`

Returns the measured power supply current in amperes.

`CURRent:TARGet?`

Returns the target current setting in amperes.

`CURRent:REFerence?`

Returns the noiseless, internal Model 430 ramp reference value in amperes.

`COILconst?`

Returns the coil constant setting in kG/A or T/A per the selected field units.

`FIELD:MAGnet?`

Returns the calculated field in kilogauss or tesla, per the selected field units. This query requires that a non-zero coil constant be defined; otherwise, the query is ignored and an error is generated in the error queue. The field is calculated by multiplying the measured magnet current by the coil constant. If the magnet is in persistent mode, the command returns the field that was present when persistent mode was last entered.

`FIELD:TARGet?`

Returns the target current setting in kilogauss or tesla, per the selected field units. This query requires that a non-zero coil constant be defined; otherwise, the query is ignored and an error is generated in the error queue.

FIELD:UNITS?

Indicates the field units. Returns a value of "0" for kilogauss units or "1" for tesla units.

PERSistent?

Indicates the persistence state of a connected magnet. Returns a value of "0" for not persistent, or "1" for persistent. The switch heater must be in the OFF state for a magnet to become persistent. There may be some delay between the OFF switch heater state and persistence indication, per the switch cooling time parameter.

PSwitch?

Indicates the state of the persistent switch heater. Returns a value of "0" for OFF or "1" for ON.

PSwitch:CURRent?

Returns the persistent switch heater current in mA.

PSwitch:TRANsition?

A return value of “0” indicates the timer-based switch transition detection. A return value of “1” indicates the magnet voltage-based transition detection.

PSwitch:HeatTIME?

Returns the time required in seconds for the persistent switch to become resistive after the persistent switch heater has been activated.

PSwitch:CoolTIME?

Returns the time required in seconds for the persistent switch to become superconducting after the persistent switch heater has been deactivated.

PSwitch:PowerSupplyRampRate?>

Returns the ramp rate that will be used by the power supply to ramp the current during the PERSIST. SWITCH CONTROL operation when the switch is in a cooled state. This ramp rate can be much higher than when the switch is heated and the magnet is in the circuit. For more information as to how this function operates, refer to the Model 430 manual.

PSwitch:CoolingGAIN?

Returns the persistent switch cooling gain in percent.

QUench:CURRent?

Returns the current value captured at the time of most recent quench detection in amperes.

RAMP:RATE:FIELD:<*segment*>?

Returns the ramp rate for the specified segment (values of 1 through the defined number of ramp segments are valid) in units of kilogauss/second or minute, or tesla/second or minute (per the selected field units and ramp rate units), and returns the field upper bound for that segment in kilogauss or tesla (see the Model 430 manual for details of the use of ramp segments). This command requires that a coil constant be defined; otherwise the query is ignored and an error is generated in the error queue.

Example (returns 0.015 kG/s with an upper bound of 10.0 kG for ramp segment #2):

```
RAMP:RATE:FIELD:2?
0.015,10.0
```

RAMP:RATE:CURRent:<*segment*>?

Returns the ramp rate for the specified segment (values of 1 through the defined number of ramp segments are valid) in units of A/sec or A/min (per the selected ramp rate units), and returns the current upper bound for that segment in amperes (see the Model 430 manual for details of the use of ramp segments).

Example (returns 0.136612 A/s with an upper bound of 47.8 A for ramp segment #1):

```
RAMP:RATE:CURR:1?
0.136612,47.8
```

RAMP:RATE:UNITS?

Returns the chosen ramp rate timebase units. A “0” indicates seconds. A “1” indicates minutes.

RAMP:RATE:SEGments?

Returns the number of ramp segments from 1 to 10. See the Model 430 manual for details of the use of ramp segments.

STABility:MODE?

“0” indicates the present stability mode as “Auto”, “1” is “Manual”, and “2” is “Test”. In “Auto” stability mode (the preferred setting), the stability setting is automatically adjusted per the presence or absence of a persistent switch, the presence or absence of a stabilizing resistor, and the estimated or measured magnet inductance. See the Model 430 manual for details.

STABility?

Returns the stability setting in percent. Valid range is 0.0 to 100.0%.

STABility:RESistor?

An return value of “0” specifies no stabilizing resistor is installed. “1” indicates a stabilizing resistor is installed.

`VOLTage:LIMit?`

Returns the Voltage Limit in volts. The Voltage Limit is applied to the power supply output as not every magnet manufacturer/integrator provides magnet voltage taps.

`VOLTage:MAGnet?`

Returns the voltage (V) across the magnet if voltage taps are available and connected to the Model 430.

`VOLTage:SUPPly?`

Returns the presently commanded power supply voltage in volts.

Error Codes

The following are error codes returned by the **`SYSTem:ERRor?`** query. The queue is last-in, first-out (LIFO). In addition to the errors defined for the parser function of the application as shown below, *device errors* generated by the resulting communication with the selected Model 430 device are also accumulated in this error queue. The device error codes are described in detail in the Model 430 manual in the *Remote Interface Reference : Error Messages* section.

At present is it not possible to limit the error queue to those generated directly by the parsing interface and the resulting device communication, therefore the error queue contains *all device errors* generated while connected.

`0,"No error"`

The error queue is empty.

COMMAND ERRORS

`-101,"Unrecognized command"`

The command is unrecognized.

`-102,"Invalid argument"`

An argument required for the command is invalid.

`-103,"Non-boolean argument"`

A non-boolean value is provided to a command requiring a boolean argument.

```
-104,"Missing parameter"
```

A required parameter is missing from the command argument list.

```
-105,"Value out of range"
```

A parameter is out of range.

```
-106,"Undefined coil const"
```

Attempted to command or query in field units with a zero (undefined) coil constant value. Specify a coil constant.

```
-151,"Non-numerical entry"
```

A parameter is in a non-numerical format.

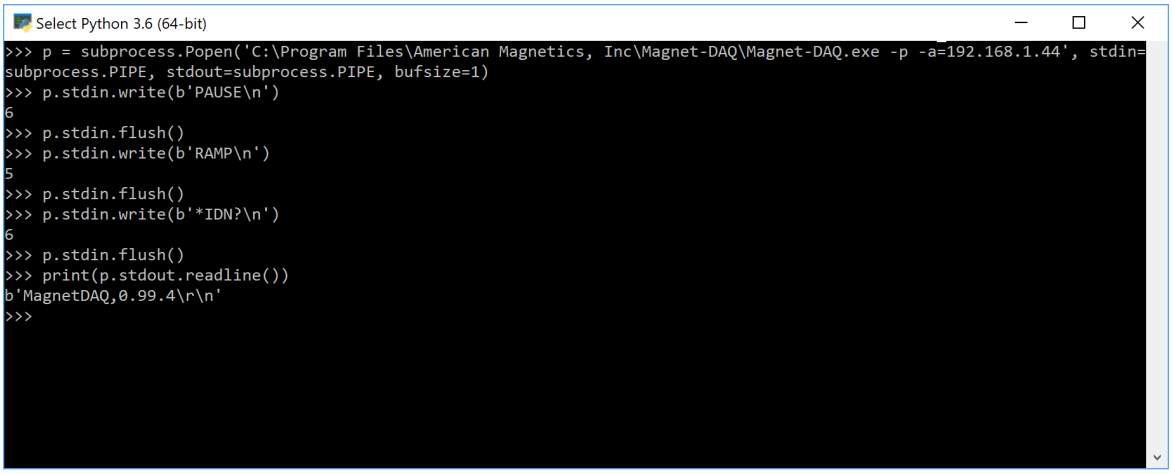
QUERY ERRORS

```
-201,"Unrecognized query"
```

The query is unrecognized.

Python Example

The image below illustrates an interactive Python session from Visual Studio 2017 that launches the Magnet-DAQ application with the parser function enabled, autoconnects to the device at IP address 192.168.1.44, sends the **PAUSE** command, sends the **RAMP** command, and then sends the ***IDN?** query and reads the result.



4.3 Table Import Format

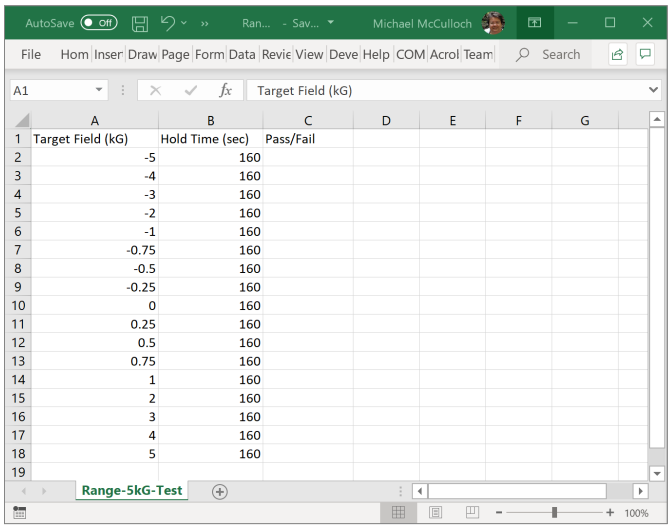
The Table tab format is Comma-Separated Values (CSV) that is compatible with Excel (or other spreadsheet applications) as well as a simple text editor such as Notepad++.

The format is a file with a single-line, four column header and then subsequent rows of target values in current (A) or field (kG or T) units, and optional Hold Time for each in seconds. Omission of the Hold Time value results in a zero Hold Time after the import.

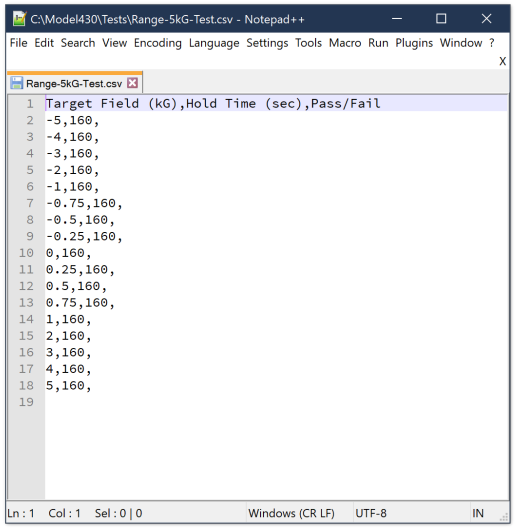
The format is illustrated below with a spreadsheet view on the left (in Microsoft Excel) and a simple text editor view of the *same file* on the right. As can be observed in the illustration, the CSV format is a simple text, comma-separated format.

Example below: The header text should be as shown below with the exception that if you wish to use tesla units for the field magnitude, change (kG) to (T). Specifying the units allows the vector table load function to properly identify (and convert if necessary) the field values.

NOTE: By default, omitting any units (A, kG, or T) in the header assumes Amperes for all target values.



Target Field (kG)	Hold Time (sec)	Pass/Fail
-5	160	
-4	160	
-3	160	
-2	160	
-1	160	
-0.75	160	
-0.5	160	
-0.25	160	
0	160	
0.25	160	
0.5	160	
0.75	160	
1	160	
2	160	
3	160	
4	160	
5	160	



```
Target Field (kG),Hold Time (sec),Pass/Fail
-5,160,
-4,160,
-3,160,
-2,160,
-1,160,
-0.75,160,
-0.5,160,
-0.25,160,
0,160,
0.25,160,
0.5,160,
0.75,160,
1,160,
2,160,
3,160,
4,160,
5,160,
```

Python Examples

5 Python Examples

5.1 Example Python Script

The following is the Example.py Python script as referenced in the Table Tab execution example. This example supports any digital multimeter that is HP/Agilent 34401A compatible, which includes most recent Keysight models.

This simple example script accepts one argument for the IP address of the digital multimeter. It then specifies a file path for saving data, connects to the instrument, and commands the instrument to average 60 voltage samples and return the average value. The return value is then appended to the file and the script exits.

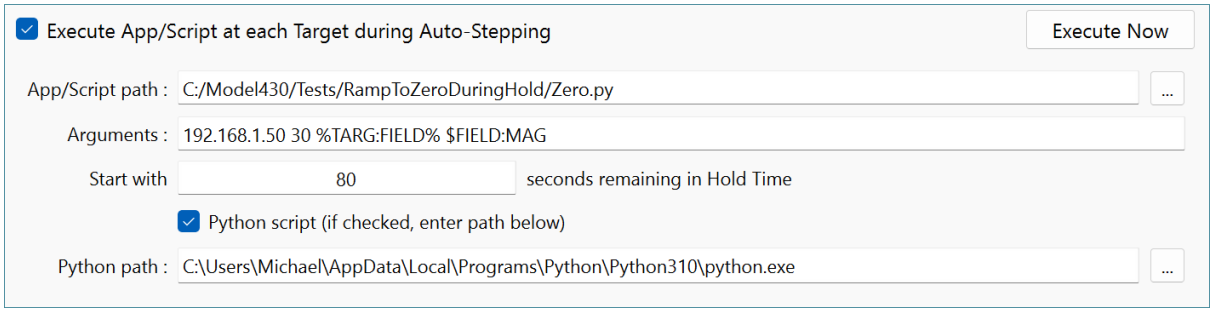
```
# This is an example Python 3.x script showing how to connect
# to a Keysight 34401A compatible DMM and retrieve an average of
# the voltage. The value is written to a file (see "path" below).
# Change the path to a location where your account has file write
# privileges.

import sys
import socket

# open socket to Keysight 34401A compatible DMM
DVM = socket.socket()

# check to see if arguments provided, should be one arg with ip address
if len(sys.argv) > 1:
    DVM.connect((str(sys.argv[1]), 5025))
else:
    DVM.connect(("192.168.1.17", 5025))    # default if not provided

#echo instrument id
DVM.send(b'*IDN?\n')
data = DVM.recv(1024)
print(data.decode('utf-8'))

# append data to a file
path = 'C:/Model430/Tests/Example.csv'
datafile = open(path, 'a')

print((b'Getting 10 second average of voltage...').decode('utf-8'))

# get 60 sample averages (about 10 sec)
DVM.send(b'CONF:VOLT:DC AUTO\n')
DVM.send(b'VOLT:DC:NPLC 10\n')
DVM.send(b'TRIG:SOUR BUS\n')
DVM.send(b'SAMP:COUN 60\n')
DVM.send(b'CALC:AVER:STAT ON\n')
DVM.send(b'INIT\n')
DVM.send(b'*TRG\n')
DVM.send(b'*WAI\n')
```

```
DVM.send(b'CALC:AVER:AVER?\n')
data = DVM.recv(1024)

# write to file
datafile.write(data.decode("utf-8").strip('\n'))
datafile.write('\n');

# close datafile
datafile.close()

# close socket
DVM.close()
```

5.2 Example Python Script with Special Variables

The following is the RampToZero.py Python script using special variables.

This simple example script ramps the power supply system to zero current after the persistent switch is cooled, holds for a specified period (in arg[2]), and then ramps the current back to the target value before the switch is reheated. The special arg values (%TARG:FIELD% and $FIELD:MAG) are output and the script exits. An example Magnet-DAQ Table tab configuration that matches this example is:




```
import socket
import time
import sys

# open socket to Model 430
Model430 = socket.socket()
Model430.connect((sys.argv[1], 7185))

# first check that switch heater is OFF
Model430.send(b'PS?\n')
data = Model430.recv(1024)

if data != b'0\r\n':
```

```
   print("Script aborted: Not in persistent mode")
   sys.exit(0)

# proceed with ramping power supply to zero
Model430.send(b'ZERO\n')

data = b'10\n'

# wait until ramp to zero completes
while data != b'8\r\n':
   time.sleep(1)
   Model430.send(b'STATE?\n')
   data = Model430.recv(1024)

   # check if switch cooling step failed
   if data != b'6\r\n' and data != b'8\r\n':
      print("Script aborted: Switch cooling failed")
      sys.exit(1)

   #check for magnet voltage indicating switch cooling failed
   Model430.send(b'VOLT:MAG?\n')
   Vm = float(Model430.recv(1024))

   if abs(Vm) > 1.0:
      Model430.send(b'PAUSE\n')
      time.sleep(2)
      # turn on switch heater
      Model430.send(b'PS 1\n')
      print("Script aborted: Switch cooling failed")
      sys.exit(1)

# enter paused state
Model430.send(b'PAUSE\n')

# wait argv[2] seconds and RAMP
time.sleep(int(sys.argv[2]))

Model430.send(b'RAMP\n')

# close sockets
Model430.close()

# successful
# print the target field and magnet field passed as args (units of Tesla
print(sys.argv[3] + "T," + sys.argv[4] + "T")

sys.exit(0)
```

Support

6 Support

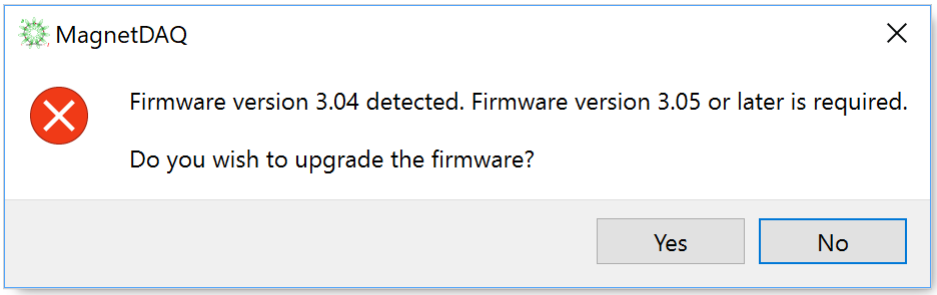
6.1 Firmware Upgrade Wizard

The Magnet-DAQ application contains firmware udpates for the Model 430 Programmer. Each release of Magnet-DAQ may add new features that do not work without a firmware upgrade. Furthermore, firmware upgrades may be recommended due to corrected bugs.

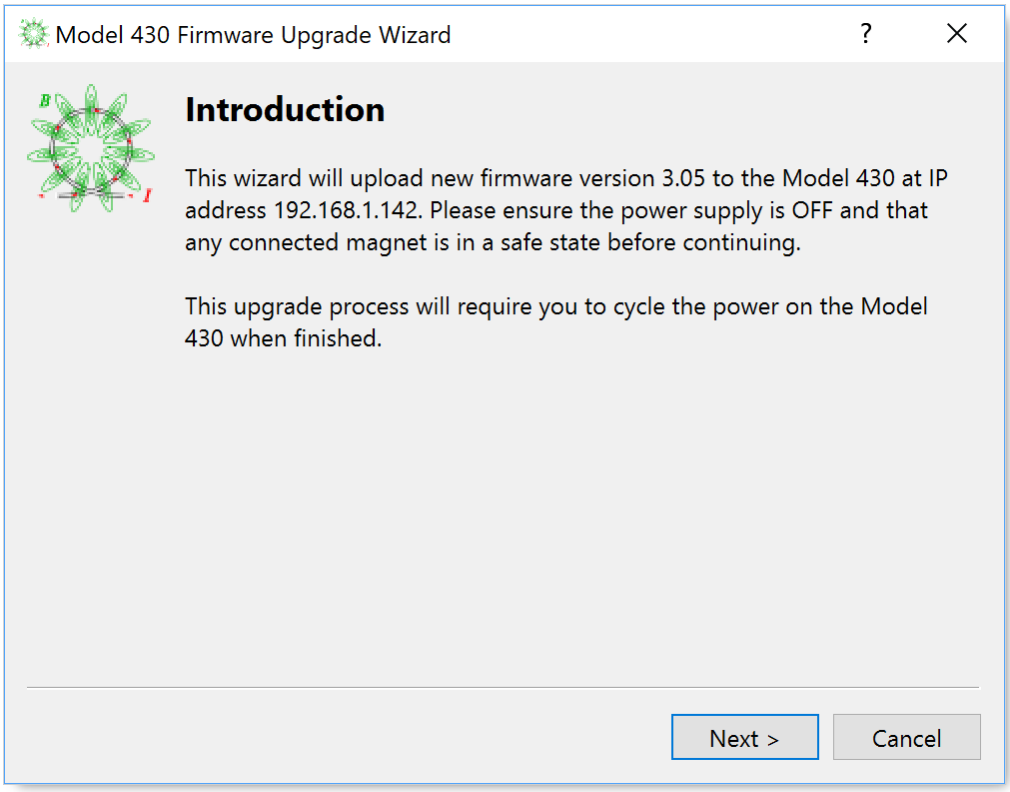
Therefore, Magnet-DAQ may *require* a firmware upgrade of the Model 430 in order to function. The firmware upgrade is entirely *optional*, but Magnet-DAQ will refuse to operate with the target device without the upgrade.

NOTE: If you have any concerns about a firmware upgrade, please feel free to contact AMI Technical Support before attempting the upgrade. At present, the Firmware Upgrade Wizard only supports upgrades for Model 430 Programmers running version 1.62 or later firmware. Earlier versions may be supported in future Magnet-DAQ releases with further regression testing of legacy devices by AMI to ensure compatibility. A manual upgrade process can be detailed for pre-1.62 firmware systems by contacting AMI Technical Support.

If a firmware upgrade is required, Magnet-DAQ will first present the user a notice (the version numbers may be different with your system and each firmware release):



Upon the selection of "Yes", the Firmware Upgrade Wizard will appear as illustrated below (again the version numbers and IP address may change):



NOTE: Please carefully observe the wizard instructions during the upgrade process. Cycling power on the Model 430 will be required in order to complete the upgrade process.

The upgrade process transfers the firmware by standard FTP protocol (ports 20 and 21). If your local network blocks internal FTP traffic, the update will not be accomplished and the wizard will display an error.

6.2 Updates

The Magnet-DAQ is provided as a open-source application subject to the GPL verison 3 or later license.

The latest source code and binaries distributions can be found on the BitBucket Cloud at:

https://bitbucket.org/americanmagneticsinc/magnet-daq

Ready-to-use binaries are provided on the Downloads page for 64-bit versions of Windows 7 or later, Linux (Ubuntu 14.04 or later recommended), and Apple macOS Sierra or later.

Users are encourage to check the site often for updates (check out the "Watchers" feature). Notification lists will not be maintained by AMI.

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Version 3, 29 June 2007

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- C -

- D -

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- G -

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- M -

- N -

- P -

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- R -

- S -

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