4212 DC Load User Manual

Part No. 09-0293

REVISION D

March 29, 2013

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1. DESCRIPTION

The Model 4212 is an electronic programmable DC load targeted to test low voltage AC/DC and DC/DC converters. This load uses a state-of-the-art thermal management system to achieve a power density of 300W per slot, for a maximum of 1800W per 5¼ inch S400 chassis. A unique multi-range design is used to cover test requirements from 0.7V to 120V in three ranges, and current from milliamps to 60A, in three ranges. The power handling capability can be expanded through paralleling additional modules.

The 4212 Load utilize a linear power design for fastest response time and quiet operation. Constant (current, power, resistance, and voltage) operating modes are provided. Transient and short circuit modes are also provided. An advanced Texas Instruments DSP processor is used to tightly synchronize paralleled modules, as well as provide programmable output waveforms with unprecedented accuracy compared with older, more limited analog designs.

A sampling Analog to Digital Converter is used for metering which allows the display of waveforms similar to a Digital Storage Oscilloscope.

1.1 Features

Power	300W continuous, 400W intermittent
Current ranges	0.6A, 6A, 60A
Voltage ranges	6V, 60V, 120V
Voltage @ Current	0.7V @ 60A
Resistance	0.02Ω - 5kΩ
Hardware Modes	CC, CR, CP, CV, Auto, OVR
Software Modes	Slew, Transient
Short-circuit Resistance	0.013Ω @ 60A
Analog Control	Yes, CC only
Current Monitor	Yes
Parallel Modules	Yes
DINs	Trigger In, Ext Logic Level
DOUTs	Trigger Out, Ext Short
Protection	Over voltage, current, power, temperature, Reverse voltage
DC Measurements	Voltage, current, power, resistance
DSO and Timing Measurements	Voltage, Current, Overshoot, Undershoot, Rise Time, Fall Time, Settling Time, Hold Up Time, AC RMS, AC+DC RMS, Trigger In Time, DIN State and Time

2. SPECIFICATIONS

2.1 Configuration

One, isolated DC electronic load in one module

2.2 Size

Single slot of S430, S440 chassis

2.3 Weight

6.6 lbs.

2.4 Communication

Implements and conforms to the S6k.2 command packet protocol.

2.5 Protection

Over-voltage and reverse-voltage protections are provided by the avalanche rated body diode in the power MOSFETs.

Over-temperature protection is provided by a thermal sensor.

Over-current and over-power protection are provided in hardware and limit to the maximum for that range. Over-current and over-power protection are disabled in short mode.

2.6 Isolation

±1000VDC from AC power input to load or chassis ground. ±500VDC from load to chassis ground.

2.7 Calibration

Closed cover, all adjustments are done in software and stored in an on-board FLASH.

Equipment Required:

Multimeter, Hewlett Packard Model 3458A or equivalent

NHR Calibrator

2.8 Self-test

Power-up selftest is implemented in firmware. This will report comprehensive error messages about the status of the input, output, control and protection mechanism.

2.9 Performance Monitoring

Performance monitoring is performed continuously by the 4212 DC Load's controller. In case of measurement ambiguities, over/under range conditions, heat sink temperature limits reached, etc an appropriate error or warning is sent to the controlling device.

2.10 Temperature

Operating from 0 to 25°C at 350W.

Operating from 0 to 35°C at 300W.

Operating from 0 to 45°C at 230W.

Specifications apply at 23°C ±5°C after 10-minute warm-up

Noncondensing humidity < 75% R.H.

2.11 Control power

Operational from 90 to 132 or 180 to 264VAC, 47-63Hz.

2.12 Processor

Texas Instruments TMS320C32 Floating Point DSP is used for all control.

2.13 External Modulation

0 to 10V external input signal is provided which drives 0 to 100% current for that range. This signal is referenced to the load negative input.

Accuracy is ±15%, repeatability is ±1%.

2.14 Current Monitor

0 to 10V external output signal is provided which is 0 to 100% current for that range. This signal is referenced to the load negative input.

Accuracy is ±15%, repeatability is ±1%.

2.15 Digital Input

An external CMOS logic level DIN is provided. The state may be measured. Timing measurements may be made from Trigger In to Digital In or any DSO measurement. This signal is referenced to the load negative input.

2.16 Voltage Sense

The voltage sense will function with a drop of up to 2VDC total between sense voltage and power input voltage. The voltage sense input is fully protected against reverse input and over voltage conditions, up to the full isolation rating of +/-500V from common.

2.17 Programmable Features

Constant Current ***	Range Accuracy Resolution	0 to 0.6A, 0 to 6A, 0 to 60A 0.06% of set + 0.06% of range 0.025% of range		
Constant Voltage	Range Accuracy Resolution	0.7 to 6V, 0.7 to 60V, 0.7 to 120V, 0.05 of set + 0.05% of range 0.025% of range		
Constant Power	Range Accuracy Resolution	Current range times Voltage range, Up to 400W max 1% of set + 1% of range 0.025% of range		
Constant Resistance ***	Range Accuracy	15% to 3000% of Voltage range divided by Current range * 2% of set **		
Short Circuit	Current Resistance	60A < Isc < 100A 0.013Ω max		
Slew Rate	Range Maximum	0.6A 0.03A/μS	6A 0.6A/μS	60A 12A/μS
Transient Mode Only one mode (CC, CR, CP or CV) at a time may be programmed in a transient	Settings Total Period Delay Resolution Accuracy Modes	100 50μSec to 20 Sec 20μSec to 20 Sec 10μSec 1% ± 10μSec Single burst or continuous		
Rise and fall time 10% - 90% of max range	Range Accuracy Resolution	10μSec to 20 Sec 1% ± 10μSec < 10μSec		

* CR Range: Not less than 21milliohms

** CR Accuracy: Set 15% to 500% of range = 2% accuracy

Set 500% to 3000% of range = 10% accuracy

*** SPECIAL FOR LED LOAD(1109342)

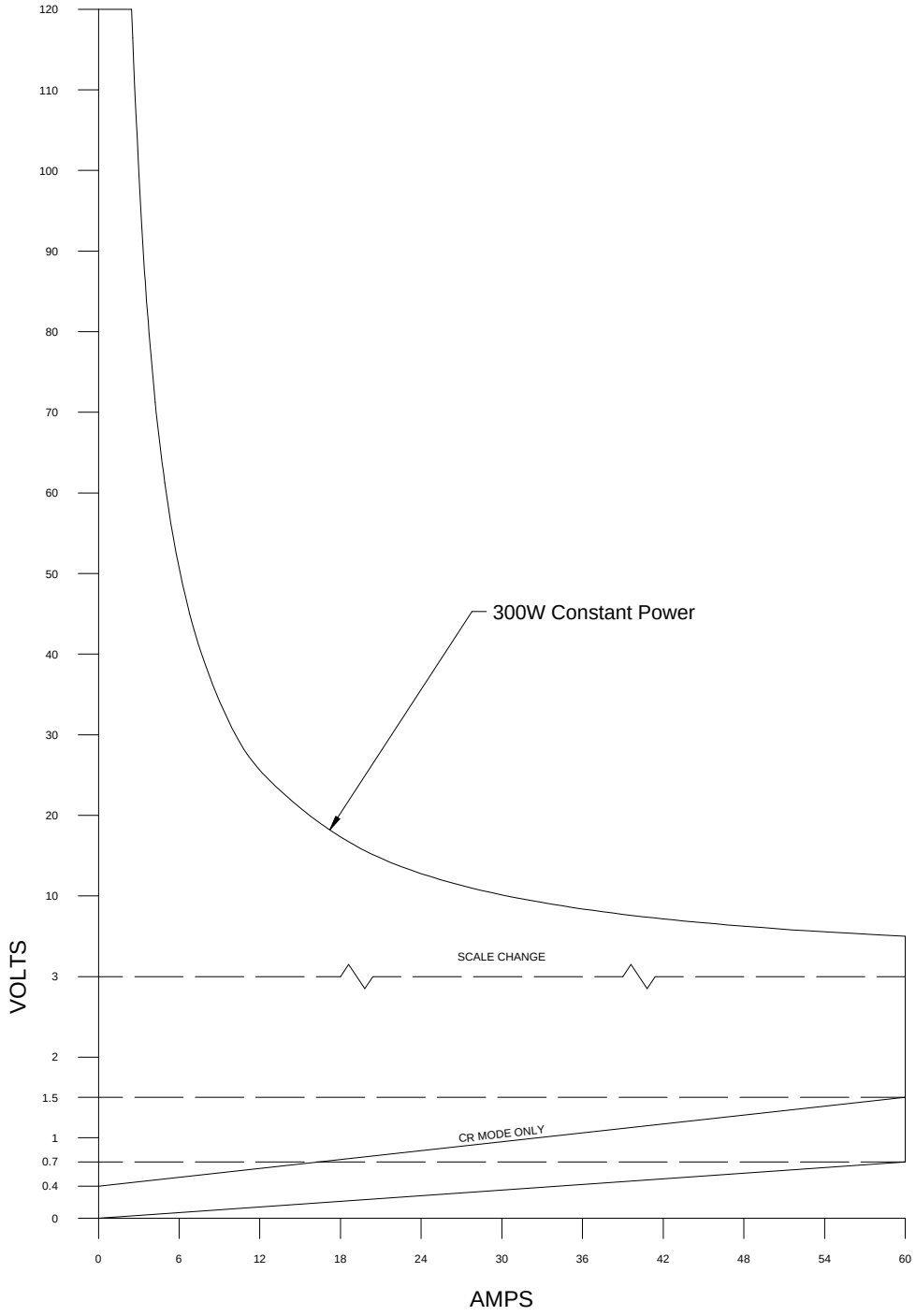
The load simulates a diode. Constant Voltage represents the zener voltage of the diode. The Constant resistance represents the diode resistance.

2.18 Measurements

Current	Range Accuracy Resolution	0 to 0.6A 0 to 6A 0 to 60A 0.05% of reading, + 0.05% of range 0.0015% of range
Voltage	Range Accuracy Resolution	0 to 6V, 0 to 60V, 0 to 120V 0.01% of reading, + 0.02% of range 0.0015% of range
Power	Range Accuracy Resolution	Current range times Voltage range Current Accuracy + Voltage Accuracy 0. 0015% of range
Resistance	Range Accuracy Resolution	(Min Voltage divided by Max Current) to (Max Voltage divided by Min Current) Current Accuracy + Voltage Accuracy 0. 0015% of range
DSO Voltage and current waveform capture two channels muxed	Bandwidth Accuracy Digitizing rate Resolution Triggering	DC to (¼ of sample rate) 1% of range 50 to 50k Samples/Second 0.0015% of range S6K Trigger In
DSO Voltage or current waveform capture one channel only	Bandwidth Accuracy Digitizing rate Resolution Triggering	DC to (¼ of sample rate) 1% of range 100 to 100k Samples/Second 0.0015% of range S6K Trigger In
Din and Trigger Timing	Range Accuracy Resolution	58k years 0.05% of reading, ±100µSeconds 100nanoSeconds

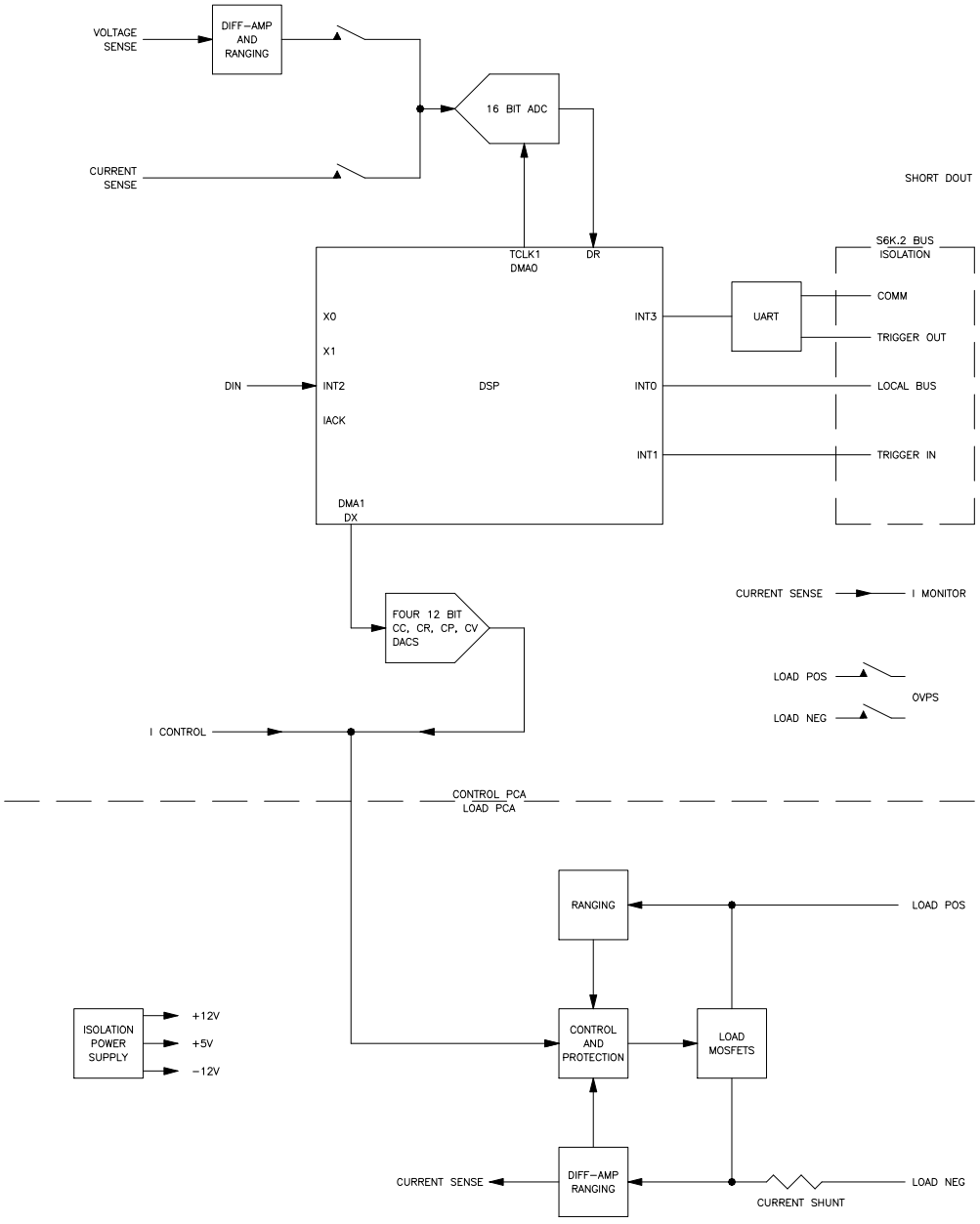
DSO Range is the same as Current or Voltage being measured.

2.19 Operating Envelope



4212 DC Load Operating Envelope

2.20 Block Diagram



4212 Block Diagram

3. INSTALLATION

3.1 Hardware Installation

Unpack the load. Save the packing material if a need arises to return the load.

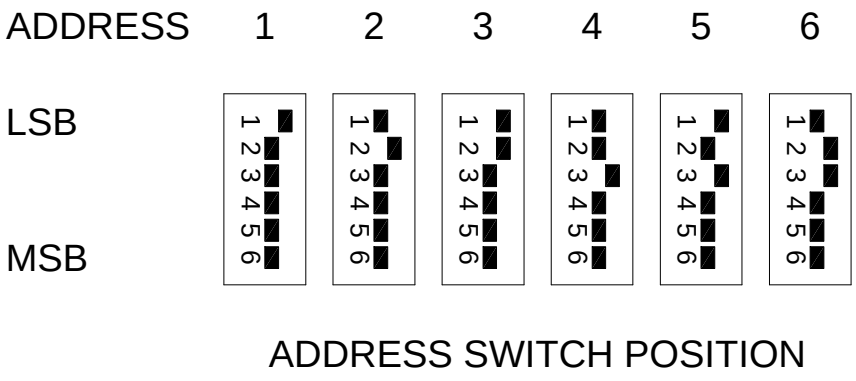
3.2 Communication Port

3.2.1 Baud Rate

A baud rate of 19.2k or 38.4k may be selected. In most cases, 19.2k (factory default) will be used, however, if you may change the baud rate to 38.4k by placing a jumper on W1 of the control PCA.

3.2.2 Address Switch

The 6-bit address switch is used to set a unique communication address for the serial interface. This address switch setting must match the software address. The LSB is labeled 1. The MSB is labeled 6. When a switch bit is moved toward the outside of the module, the bit is set to 0. When a switch bit is moved toward the inside of the module, the bit is set to 1. If all six positions of this switch are off when the load is turned on, it will boot from firmware in EPROM and not from FLASH. This is useful if the firmware in FLASH has been corrupted.



ADDRESS SWITCH POSITION

3.3 Voltage Sense

Voltage sense must be selected for COAX input or Power Connector input. This is accomplished by two mini jumpers at the front of the module. Jumping pins 1 to 2 on J5 and pins 1 to 2 on J6 selects the COAX input. Jumping pins 2 to 3 on J5 and pins 2 to 3 on J6 selects the Power Connector input.

The COAX or Power Connector voltage sense wires must be connected to the power supply output terminals.

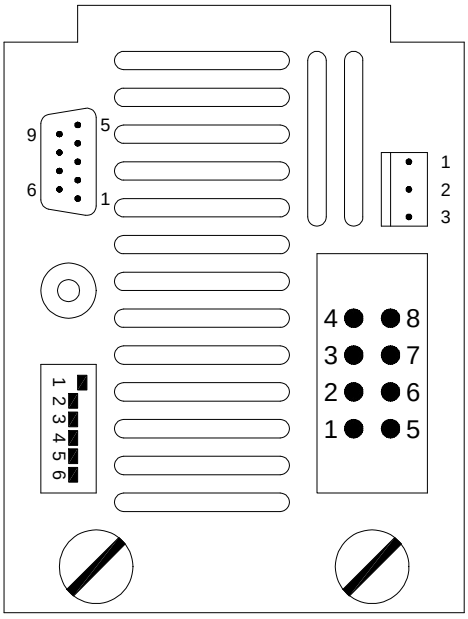
3.4 Connectors

3.4.1 Rear View

AUXILIARY CONNECTOR
PIN DESCRIPTION
1 DIN
2 Return (load-)
3 SHORT
4 Return (load-)
5 I MONITOR
6 Return (load-)
7 I CONTROL
8 Return (load-)

COAX
VOLTAGE
SENSE

MODULE
ADDRESS
SWITCH



OVPS CONNECTOR
PIN DESCRIPTION
1 OVPS+
3 OVPS-

POWER CONNECTOR
PIN DESCRIPTION
1 LOAD+
2 LOAD+
3 LOAD+
4 VSENSE+
5 LOAD-
6 LOAD-
7 LOAD-
8 VSENSE-

REAR VIEW

3.4.2 COAX Voltage Sense

The voltage sense positive is the center conductor. The voltage sense negative is the shield.

COAX Mating Connector

N.H. P/N	DESCRIPTION	QTY	COMMERCIAL PART NUMBER	MANUFACTURER.
6000262	CONN, COAX MINIATURE SMB	1	131-1403-016	JOHNSON

3.4.3 Power

Input power positive is applied to the load on these connector pins 1, 2 and 3. Input power negative is applied to the load on these connector pins 5, 6 and 7. The load may draw up to 60A, this requires six 12gauge wires, one per pin.

The voltage sense positive is pin 4. The voltage sense negative is pin 8.

Power Mating Connector

N.H. P/N	DESCRIPTION	QTY	COMMERCIAL PART NUMBER	MANUFACTURER.
6203129	PWR-LOK 8P FEMALE	1	PLB08F0O5O	POSITRONICS
6203157	PWR-LOK FEMALE CONTACT	8	FS112N2	POSITRONICS
	EXTRACTION TOOL		9081	POSITRONICS
	INSERTION TOOL		9099	POSITRONICS

3.4.4 OVPS

An optional Over Voltage Power Supply may be connected. A relay in the load will connect the OVPS to the load for over voltage testing. 5A fuses limit input current.

The OV positive input is on this connector pin 1. The OV negative input is on this connector pin 3.

OVPS Mating Connector

N.H. P/N	DESCRIPTION	QTY	COMMERCIAL PART NUMBER	MANUFACTURER.
6300379	CONN, 3 PIN HOUSING .156 CTRS	1	09-50-3031	MOLEX
6300107	CONN, TERMINAL 22-18 AWG .156 CTRS	2	08-65-0115	MOLEX

3.4.5 Auxiliary

Pin 1 is CMOS logic digital input used for making timing measurements. An internal 10k pull up to +5 is provided. This input is referenced to common or load negative input and is not isolated.

Pin 3 is an open collector digital output designed to drive an external shorting relay. Maximum current is 100milliamps and maximum voltage is 24V. A voltage source for the external relay is not provided. This output is referenced to common or load negative input and is not isolated.

Pin 5 is a current monitor output. 0 to 10V indicates 0 to 100% of full range current. This output is referenced to common or load negative input and is not isolated.

Pin 7 is a current modulation input. When enabled 0 to 10V will cause 0 to 100% current draw for that range. This input is referenced to common or load negative input and is not isolated.

Auxiliary Mating Connector

N.H. P/N	DESCRIPTION	QTY	COMMERCIAL PART NUMBER	MANUFACTURER.
6202014	CONN, DSUB 9PIN SOCKET	1	DE9-P	ITT CANNON
6201698	CONN, DSUB SHELL "E" SIZE	1	DE24657	ITT CANNON
6201309	CONN, DSUB SCREW LOCK "A,B,C,E" .281	2	D20419-21	ITT CANNON

3.5 Software Installation

3.5.1 Software Installation from DVD

Close all programs that are currently running in windows. Insert the DVD into the drive, if your drive is configured for Autoplay the setup program should start. If Autoplay is not enabled, you will need to view the contents of the disk and double click on ‘Setup’ to start the installation.

Follow the prompts on the screen to install. You will need to reboot during the process.

4. OPERATION

4.1 Status Indicator

This yellow indicator may be seen by looking into the rear of the load. This LED blinks at a one hertz rate during normal operation. This LED blinks at an 8-hertz rate during an error condition. If the LED is not blinking, remains off or on, the CPU is not operating.

4.2 COM Indicator

This green indicator may be seen by looking into the rear of the load. This LED will blink when the computer is communicating with any device on the bus. This LED stays on when the computer is communicating with this load. If it remains off, there is no communication on the bus.

4.3 Ranges

Current ranges are 0.6, 6 and 60A.

Voltage ranges are 6, 60 and 120V.

Power range in the 0.6A current range is 40W.

Power range in the 6 and 60A current ranges is 400W.

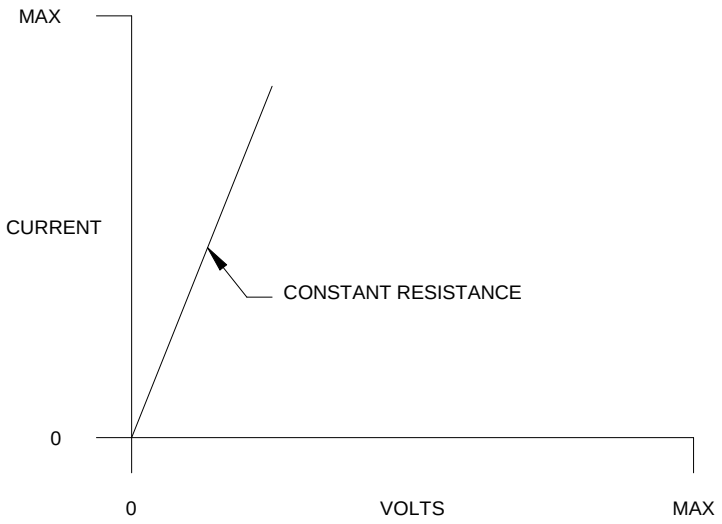
Resistance range is 15% to 3000% of the Voltage range divided by Current range

Enter the maximum voltage and current you need and the software will select the proper voltage and current ranges. Do not enter larger than necessary voltage and current because this will cause higher ranges to be selected with less accuracy.

4.4 Operating Modes

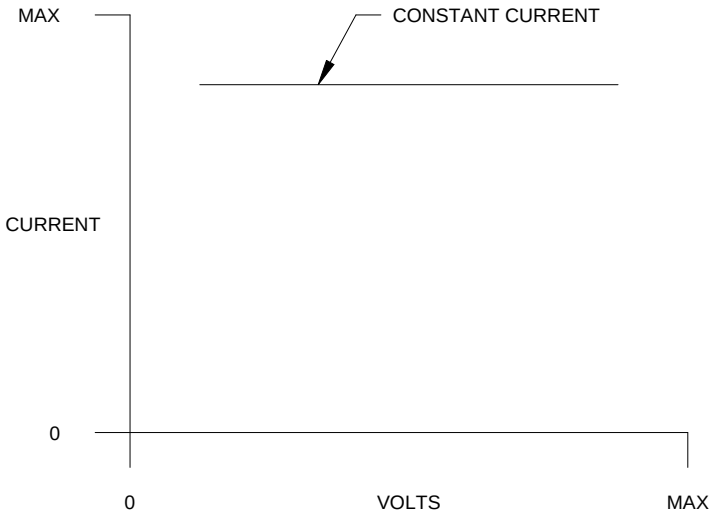
4.4.1 Constant Resistance

In this mode, the load will draw current proportional to voltage as programmed by the resistance.



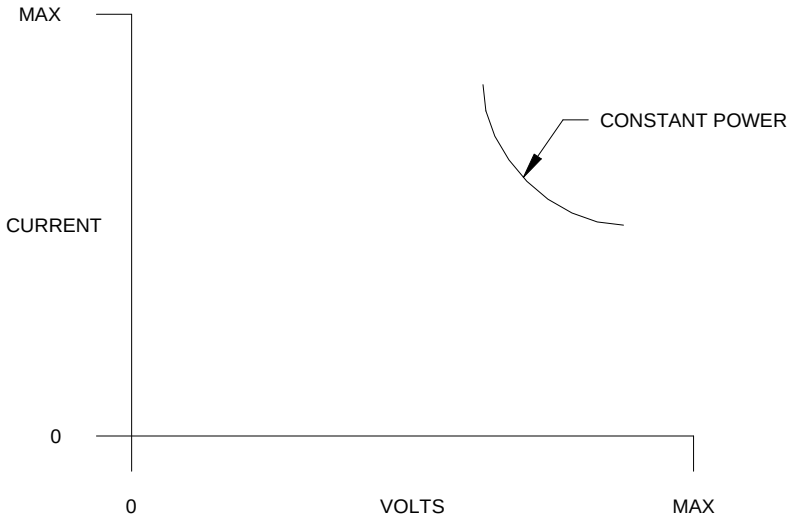
4.4.2 Constant Current

In this mode, the load will draw the current programmed without regard to voltage.



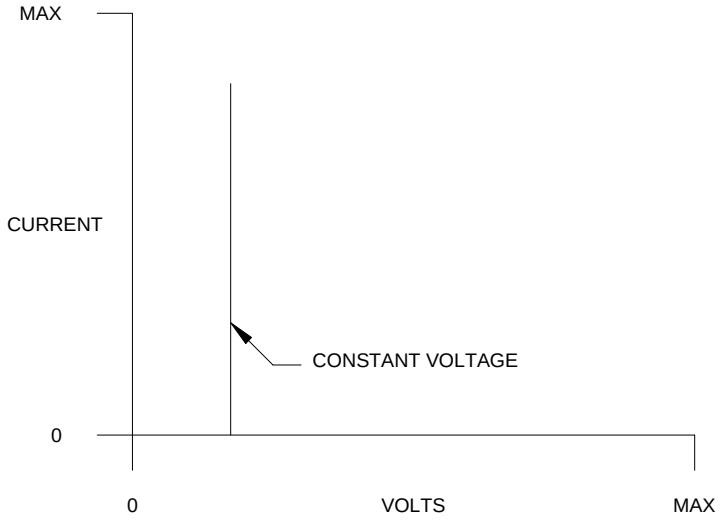
4.4.3 Constant Power

In this mode, the load will draw the current required to maintain the programmed power.



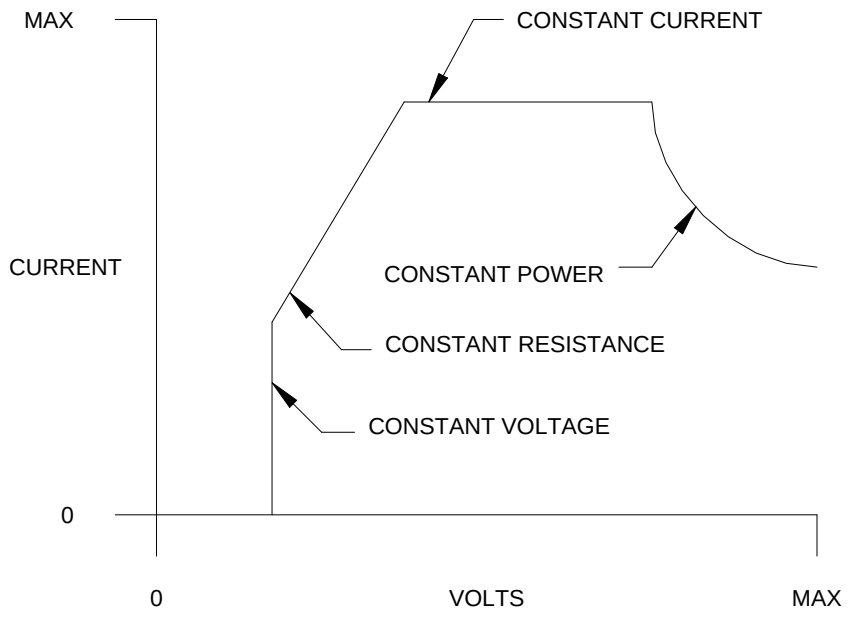
4.4.4 Constant Voltage

In this mode, the load will draw the current required to maintain the programmed voltage.



4.4.5 Auto Mode

When more than one mode is enabled the unit auto switches between the enabled modes, depending on the applied input voltage. This allows smooth, automatic switching between operating modes driven only by the input voltage. To understand this operation, refer to the following drawing:



Each setting (voltage, resistance, current, or power) sets a maximum that the load cannot exceed. However, the load may be operating at a *lower* setting if the input voltage puts it in some other mode. Basically, the mode that draws the least current is in control.

For example, starting from 0V, the load current will stay at 0A until the voltage is increased to the Constant Voltage setting. As the voltage continues to increase, the load goes into Constant Resistance Mode. As the input voltage rises further, up the load will go into Constant Current Mode. As the input voltage is raised further, the load will go into Constant Power Mode. Finally, if the input voltage is raised above the maximum rated voltage, the load will draw current to limit voltage.

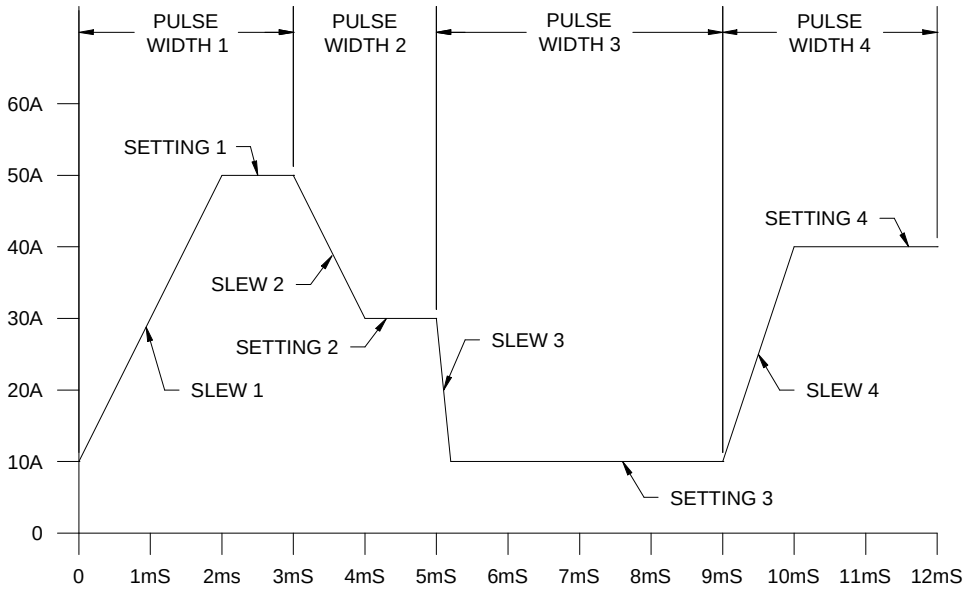
Note that not all of these modes may actually be used, depending on the settings and if they are enabled. For example, if the Resistance setting is too small, or the Voltage setting too large, the load will go directly from Voltage to Current Mode. Alternatively, if the Resistance is high enough and the Power is low enough, the load may go directly from Resistance to Power Mode.

The Voltage Mode may also be used as a programmable under voltage turn off. See the discussion under "Under Voltage" below for more information.

4.4.6 Transient Mode

Transients may be executed in any one and only one (current, resistance, power or voltage) modes. Other modes may also be enabled to form auto mode during a transient. The mode executing the transient may not be changed during the transient.

In transient mode, the load puts out a sequence of up to 100 programmable settings. The time delay between each new setting is independently programmable. This feature, along with the programmable slew rate, allows the user to synthesize a wide range of multi-leveled square, pulse, ramp, or triangle waveforms. The output sequence may be synchronized to other modules for parallel operation. Transients may run a single burst or continuous.



This current waveform is programmed as follows:

Constant current mode is selected at 10A.

Step 1, set pulse width to 3mS, slew rate to 20A/mS (40A/2mS) and current to 50A.

Step 2, set pulse width to 2mS, slew rate to 20A/mS (20A/1mS) and current to 30A.

Step 3, set pulse width to 4mS, slew rate to 200A/mS (20A/0.1mS) and current to 10A.

Step 4, set pulse width to 3mS, slew rate to 30A/mS (30A/1mS) and current to 40A.

4.4.7 Short Mode

In short mode all FETs are saturated on. Current will limit from 60A to 90A. Measured current over 60A may return invalid. Over Power protection is disabled, but if over powered the error will still be set. If Over Power protection is desired, use Constant Voltage fast mode set to 0V.

An open collector output is available on the auxiliary connector. This output is on in short mode and may be used to drive an external short circuit relay.

4.5 Slew Rate

Programmable slew rate may be independently programmed for all modes. One and only one (current, resistance, power or voltage) mode may slew at a time. A slew rate (with a time step greater than 20μS) is implemented digitally with a DSP processor, giving high accuracy and flexibility over a wide range without any calibration.

The default slew rate “0” is not the fastest. The load will slew faster if programmed to a larger slew rate. See Programmable Features for default and maximum slew rates.

4.6 Dynamic Performance

Within a single operating range, changing from one current setting to another, or changing between Constant Current, Voltage, Resistance, or Power Modes, is continuous and glitch free in Auto Mode at all settings within the normal specified operating conditions.

The load is turned off when changing operating ranges, to avoid transients. The user selects an operating range explicitly via a range select command at the beginning of each test. The load does not change ranges under any other conditions, to avoid glitching.

4.7 Under Voltage

If the voltage decreases below 0.7V current may also decrease.

To prevent the UUT from going into a fully on state at 0V, the constant voltage can be set which will turn the load completely off below this voltage. Thus, the exact turn on behavior is fully programmable without any special operating modes.

4.8 External Modulation

The current can be modulated with an external analog signal. This signal is referenced to the output common (the low side), and not isolated. The external modulation is controlled by an enable bit that can be set by a software command.

4.9 Current Monitor

The output current can be monitored. This signal is referenced to the load negative input.

4.10 Digital Input

An external logic level DIN is provided. The state may be measured. Timing measurements may be made from Trigger In to Digital In or any DSO measurement. This signal is referenced to the load negative input.

4.11 Trigger Input

The load includes a trigger input to synchronize a programmed load set step with external devices. The trigger input is available from the chassis and not directly from the load. This may be turned on or off under software control.

4.12 Trigger Output

The load includes a trigger output synchronized to a programmed set step, for triggering external measurement devices, such as an oscilloscope. The trigger output is available from the chassis and not directly from the load. This may be turned on or off under software control.

4.13 OVPS Relay

For compatibility with NH Research Powertest® automated power supply test systems, a DPST relay is included on the load to connect the UUT input leads to an external OVPS. The relay contacts are rated for 5A maximum.

4.14 Parallel Loads

Loads can be paralleled in all operating modes, including Short Circuit Mode. Loads can be software configured into logical loads. Load changes are synchronized via the back plane and the on-board DSP processor. No special hardware connections are necessary for synchronization or current sharing.

4.15 Metering

4.15.1 Remote Voltage Sense Input

Remote voltage sense input lines are provided to avoid errors in voltage measurements due to drops in the main output cables. These sense lines must always be properly connected.

4.15.2 DC Measurements

DC average measurements include voltage, current, power and resistance.

4.15.3 DSO and Timing Measurements

A sampling Analog to Digital Converter is used for metering which allows the display of waveforms similar to a Digital Storage Oscilloscope. The ADC may sample only the voltage or current for the fastest sample rate. The ADC may multiplex between voltage and current for slower simultaneous sampling of both.

The following measurements are available for Voltage and Current: Overshoot, Undershoot, Rise Time, Fall Time, Settling Time, Hold Up Time, AC RMS, AC+DC RMS, Trigger In Time, DIN State and Time

4.16 Protection Circuits

4.16.1 Over Current

In all operating modes, except short mode, current through the output FETs is limited to a maximum level slightly higher than the maximum for that range.

4.16.2 Over Voltage

If voltage greater than maximum, the load will draw current and prevent the voltage from rising. If voltage and power is exceeded, the load will go to short mode.

4.16.3 Over Power

If maximum power is exceeded the current will drop to limit maximum power, except short mode.

4.16.4 Over Temperature

The unit shuts down when the temperature of the heat sink exceeds a preset limit, for maximum safety and reliability.

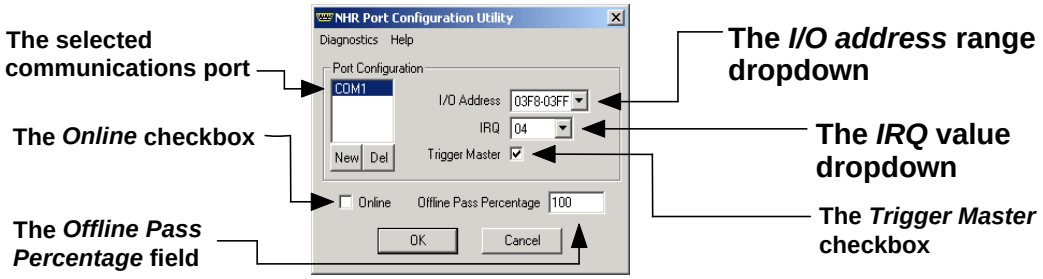
The over temperature function protects the module from exceeding its maximum operating temperature and thus damaging itself.

4.16.5 Reverse Voltage

Each FET has an internal reverse parallel diode to short the output in the presence of a reversed DC voltage input.

4.17 Port Configurator – Serial RS232 COM Interface

In the NHR Port Configuration Utility, you describe/re-describe to the software the serial and Ethernet communication ports it has available for communicating with hardware devices. The NHR Port Configuration Utility can only be used to configure/re-configure the standard serial communications ports.



4.17.1 Toggling the Online/Offline mode.

With this checkbox unchecked, the software will run in the Offline mode, and will not attempt to interact with any hardware devices. When the software is installed, its default mode is Online.

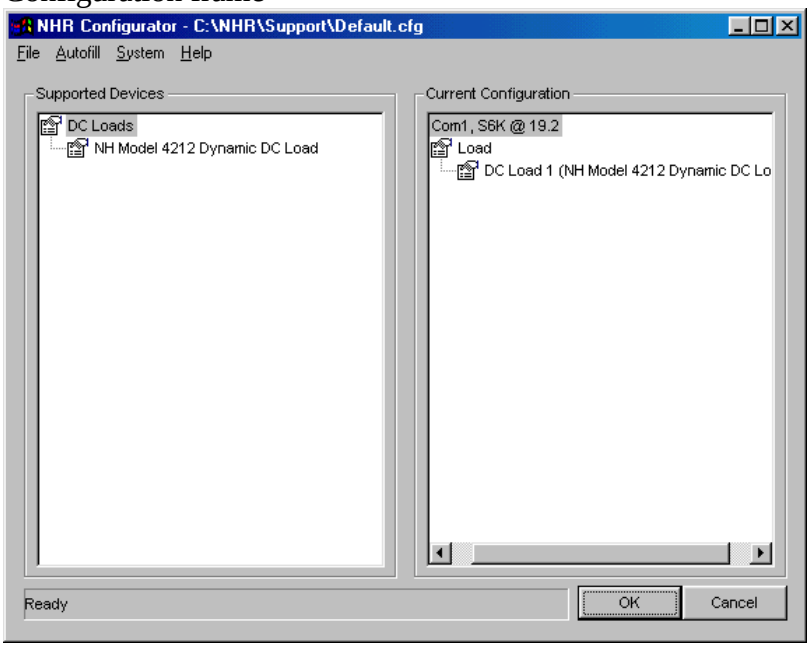
Check or uncheck the online checkbox, as you require.

NOTE: The Offline Pass Percentage field has no effect on stand-alone instruments.

4.18 Configure Hardware

Pressing configure hardware will display a dialog that allows you to modify your hardware configuration.

The NHR Configurator has two frames, the Supported Devices frame, and the Current Configuration frame



The Supported Devices frame contains the list of all NHR supported hardware drivers installed on your PC. This may only list a single device type like the NHR 4212 DC Load or it may include other NHR supported hardware.

The Current Configuration frame shows the list of implemented device drivers in the Current Configuration file, usually named default.cfg. This configuration file can be customized to meet your requirements.

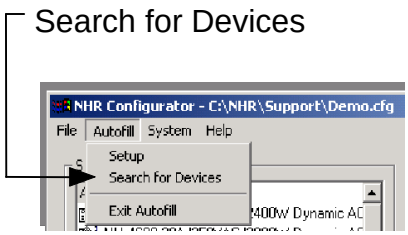
You will notice that the hardware devices listed in the Current Configuration frame are listed by logical names such as DC Load 1, with their more descriptive name in parentheses following it. The logical names are how you will refer to this specific piece of hardware from this point on.

4.18.1 Adding New Devices

If you hook up additional NHR supported hardware to the system (like a second load), the use of the Search for Devices option in the Autofill menu of NHR Configurator is the recommended method for adding new hardware device drivers to the Configuration file.

4.18.2 Autofill – Online mode only

The Search for Devices option **ONLY** works on NHR hardware devices connected to the serial and Ethernet communication ports; and only when in Online mode. Using this method Configurator does most of the work for you; it "autofills" much of the setup information that the software would otherwise ask you to supply. It does this because the configurator can find, and ask the NHR hardware devices about themselves.



Search for Devices in the Autofill menu

4.18.3 Updating Device Firmware

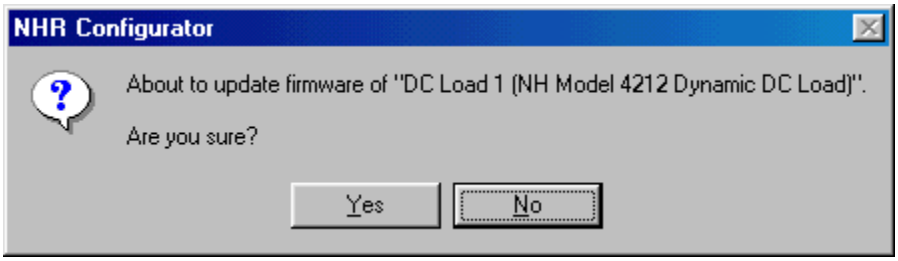
The firmware is really software that "lives" on a computer chip built into an NH Research hardware device. Some of NH Research's hardware devices allow you to update the firmware.

Since updating firmware is an interactive process, you can only update firmware while on-line.

Right-click the name of hardware device you want to update – the hardware device menu opens.

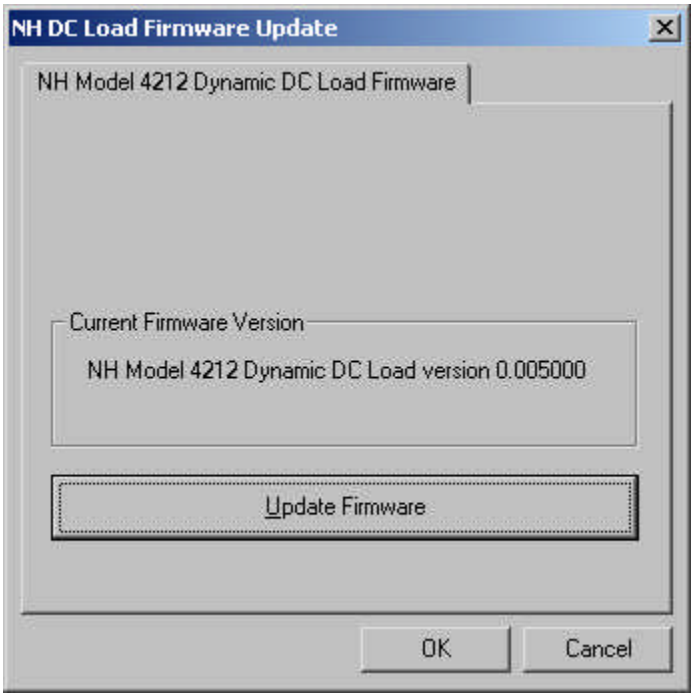
If the menu item Update Firmware is enabled, then the hardware device you right-clicked can have its firmware updated; if the menu item Update Firmware is disabled then the hardware device cannot have its firmware updated.

Select Update Firmware…



Click the Yes button.

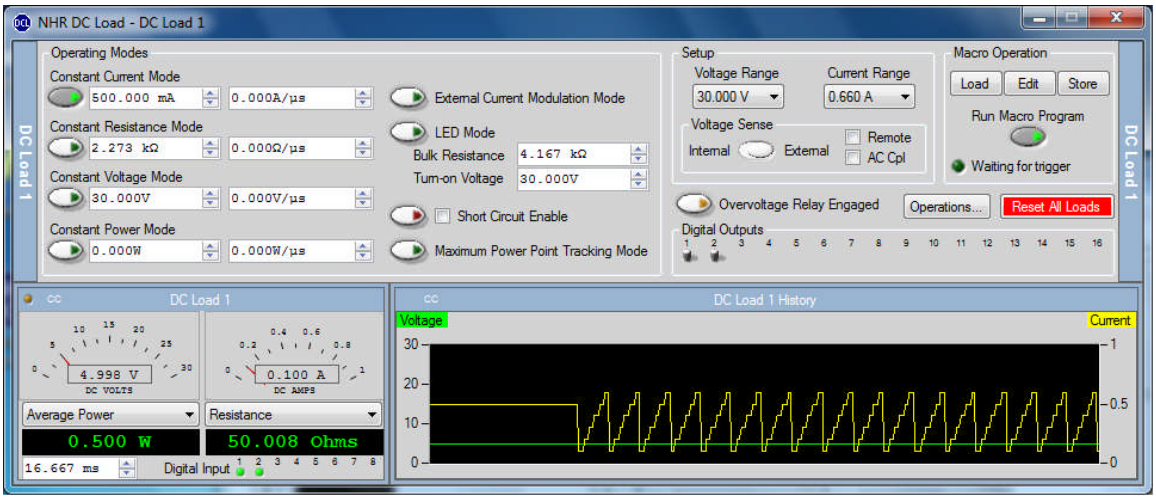
This will take you into a dialog that shows the current firmware version and if you press "Update Firmware", you will be prompted for the new .hex file. Once downloading is begun, do not interrupt the process.



4.19 NHR IVI Instrument Panel

The NHR IVI Instrument Panel (referred to as the softpanel) can be started from the desktop icon or the start menu in the NH Research program group.

The panel should look like this after loading…



Important note: Some of the modes and features presented in screen shots and text within this document may not be available with your particular load.

The soft panel can control many different load models, and the capabilities of each load vary from model to model. If a capability is not supported, the feature will be disabled on the soft panel.

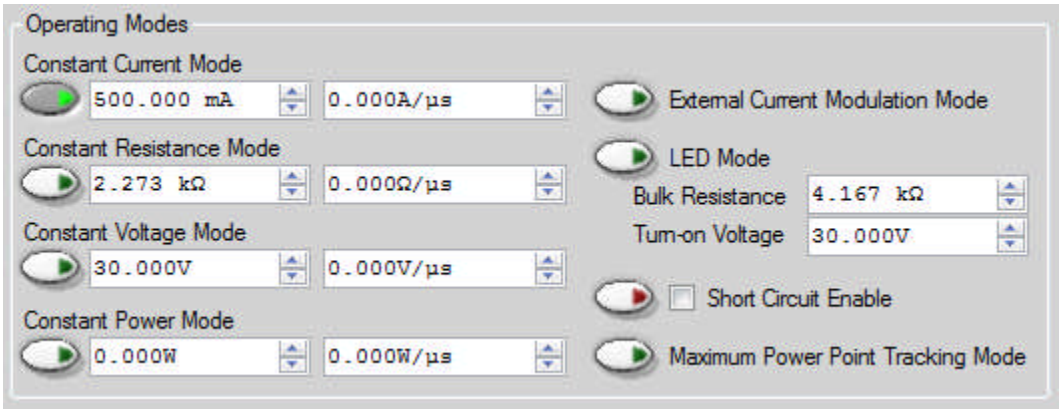
Please refer to the Specification section to determine the capabilities of your load model.

If there is more than one load in your configuration, the softpanel will adjust itself to maximize the number of loads visible at one time. Depending on your configuration and computer monitor, your softpanel may appear slightly different, but the operations remain the same.

The title bar and side bars contain the logical name of the DC Load you are currently controlling. This softpanel can control any number of physical loads, including NHR loads of different types. Use the Control section to set the various features of the selected load. To switch loads, simply click anywhere within the measurement or history window of the desired load. Switching from one load to another does NOT affect the settings. The Control section is automatically updated to reflect the state of the selected load.

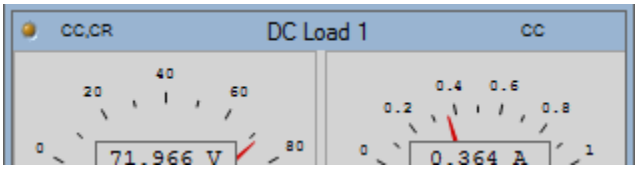
The panel allows full control of the DC load. The panel is divided into 8 sections.

4.19.1 Operating Modes Section



This is the section used to control the principal operating characteristics of the load. This load supports any number of modes enabled at a time. To enable a mode, press the corresponding switch. If all the switches are off, the load is off (high impedance). In the sample above, Constant Current mode is enabled.

The measurement section of each load contains information indicating which modes are enabled for the load, and which of the enabled modes is the active one. The text near the left-hand measurement active LED indicates which modes are enabled: CC for constant current, CR for constant resistance, etc. On the right-hand of the title bar the active mode is indicated (note: not all load models support the reporting of the active mode):



The active mode is the mode that is the most restrictive of the current being drawn. It is dynamic and will change based on the conditions present. For example, suppose you have a 12V 100A source hooked up to the load. The following table shows a few examples of how the various modes would interact.

Enabled Modes	Active Mode	UUT Volts	UUT Amps
CC at 50A	CC	12	50
CR at 1ohm	CR	12	12
CP at 1000W	CP	12	83.33
CV at 10V	CV	10	110
CC at 50A CR at 1ohm	CR	12	12
CC at 50A CR at 1ohm CP at 100W	CR	12	12
CC at 50A CR at 1ohm CP at 1000W CV at 10V	CR	12	12
CC at 50A CP at 1000W CV at 10V	CC	12	50
CP at 1000W CV at 10V	CP	12	83.33
CV at 10V	CV	10	105

When the External Current Modulation Mode is enabled, the load will attempt to draw a constant current proportional to the voltage on the External Current Control Voltage input. When the input is at zero volts, the load will be set to zero amps; 10 volts equals a current draw of 100% of the current range.

Short circuit mode is higher priority than the other modes. If it is enabled the load will go into short circuit mode regardless of the other modes that are enabled. Because of this, activating the short circuit mode requires two actions. First, arm the mode by checking the Short Circuit Enable checkbox. Second, click the button to the left of the enable (the one with the red LED). The short will be applied for as long as the button remains down. Click the button again to release the short circuit mode.

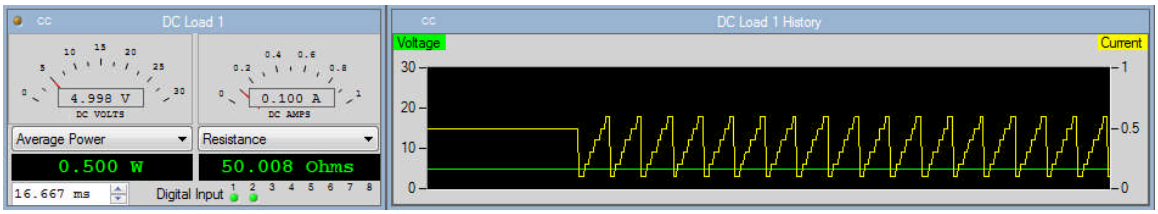
The slew rate for each mode can be set and applies only when a programmed value is changed. For example (assuming a 12V 100A UUT):

1) The load is set in CR mode at 1ohm with a 1ohm/s slew rate; the load will be drawing 12A.
2) Set the load to 2ohms. The load will decrease the current from 12A to 6A linearly over a period of one second.

When the slew rate is set to zero, the load will transition to the new state as fast as possible.

NOTE: Slew rates do NOT apply when the load is reacting to a change in the UUT.

4.19.2 Measurement Section



If enabled, the load will make measurements over a period defined by the aperture. To reduce the effect of noise, increase the aperture; to make faster, less accurate measurements, reduce the aperture. The aperture window is located in the lower-left corner of the measurement section. Each load can define its own aperture size.

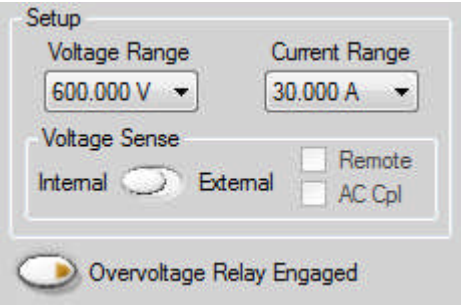
Each time a measurement is taken, the load will display the active voltage and current in the analog gauges. Two additional measurements are available in the digital gauges. Use the dropdown lists above each digital gauge controls to select the desired additional measurements.

The amber LED in the upper-left corner flashes whenever a measurement is active. You can click this light to disable the measurements. Click again to re-enable.

The measurement history chart displays the past voltage and current measurements. It is ONLY updated when measurements are active. Depending on the number of loads in your configuration, there may not be enough screen space to display the history chart all the time. In this situation, the history chart shares screen space with the measurement window and a "+" sign will be visible in the upper-right corner. Pressing the "+" button will toggle between the measurement window and the history chart.

If the load supports Digital Inputs (DINs), the state of each input is displayed via an LED. When the LED is lit, the DIN is high; when off, the DIN is low.

4.19.3 Setup Section



This section sets up the load's operating ranges and controls whether the external sense is enabled and whether the overvoltage relay is engaged.

The voltage and current ranges affect the operating range of the hardware. When either is changed, the load will go to the off state, and the settings and slew go to their default state for that range. Changing the range has the same effect as RESET.

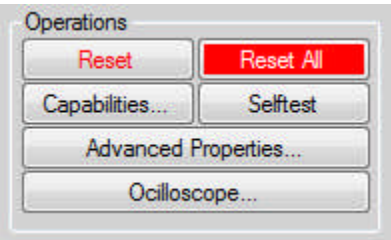
Switching voltage sense to external will cause the load to use the voltage present on the external sense connector for all metering. If the external sense is not connected, you will measure 0V.

Important note: Internal Sense is not available on the 4212 loads. This feature will be disabled on the softpanel. If external sense is not connected, you will measure zero volts. Please refer to the Specification section to determine the capabilities of your load model.

Some load models support AC coupling and "remote" measurements. When remote is selected, the load will disregard all voltage measurements and restrict its operating mode to constant current. This allows external voltages to be monitored by the load measurement circuitry without affecting the behavior of the load itself.

Selecting overvoltage relay engaged will activate the internal relay, which causes the overvoltage input to be connected in parallel with the load. CAUTION: This relay is only rated for 10A. If the load is drawing more than 10A, the panel will prevent you from engaging the relay. However, there is no additional protection and if you try to draw more than 10A damage to the relay may result.

4.19.4 Operations Section



4.19.4.1 Reset

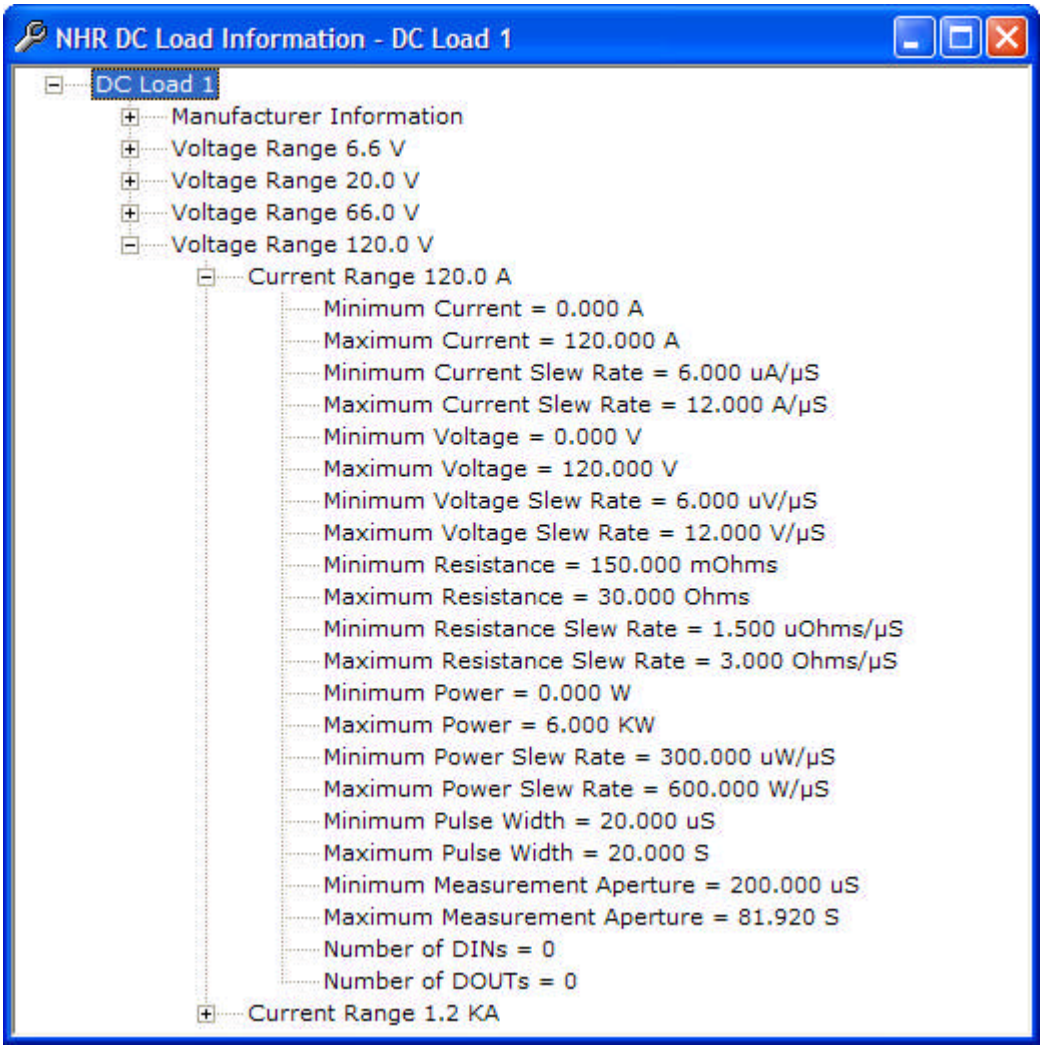
Pressing reset will reset the selected load and set all settings back to default. After reset, the load will be off.

4.19.4.2 Reset All

This button will reset all the modules in the panel to their default settings.

4.19.4.3 Capabilities

Pressing capabilities will display a dialog that allows you to see the minimum and maximum settings for all values of the selected load for any range you choose.



The Manufacturer Information section contains useful data such as the load's serial number, hardware and firmware revision numbers, and date of last calibration.

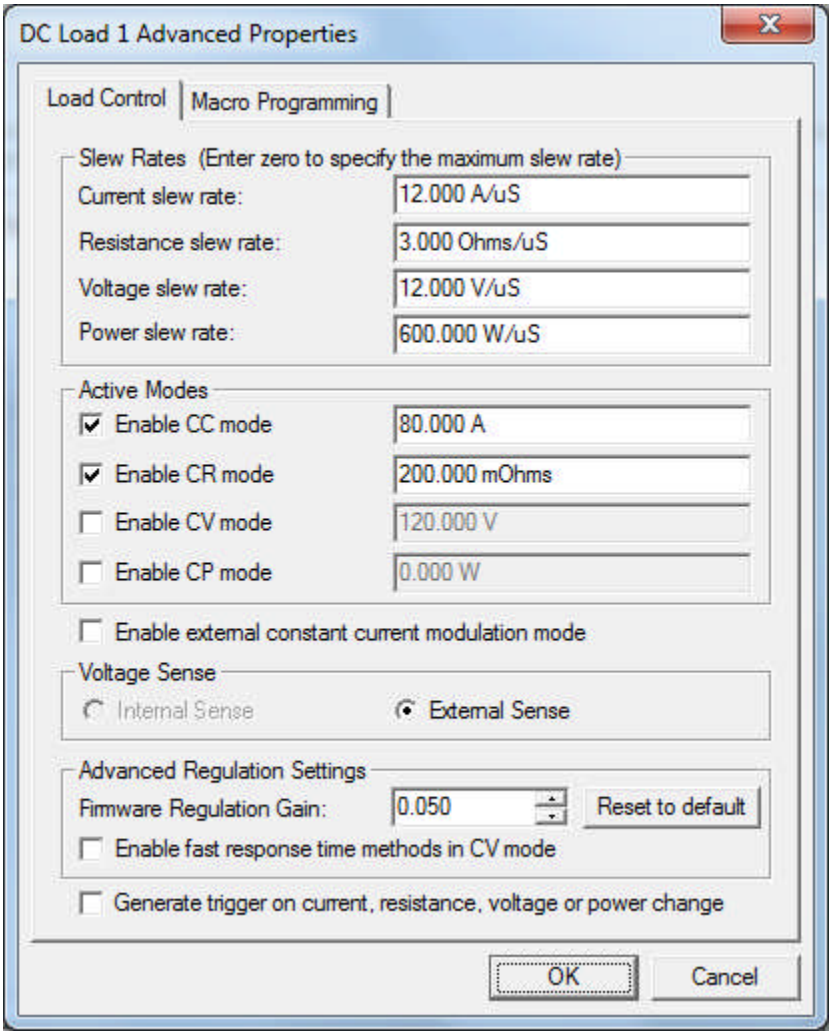
4.19.4.4 Selftest

Pressing self-test will reset the selected load then perform a built-in test. After the test is complete, a pop-up dialog appears informing the results of the test.

4.19.4.5 Advanced Properties

Pressing advanced properties will display a dialog that allows you to set properties that, while rarely used, can be beneficial when operating the load.

From the dialog below, you can see that the advanced property dialog contains fields that duplicate those found on the softpanel itself. When OK is pressed, the softpanel will refresh itself to reflect any changes made within the advanced property dialog.



If an advanced property is disabled, that feature is not available on the selected load hardware. The unique advanced properties are listed below.

4.19.4.5.1 Firmware Regulation Gain

Regulation gain is used to control the rate at which the load attempts to regulate based on the loads measurements.

This value is the percent (expressed as a decimal such that 1.00 = 100%, 0.15 = 15%, etc.) change the load will allow in each measurement sample while attempting to correct an error between the set and measured value. Setting this value higher will make faster corrections at the risk of oscillations.

For example, if the regulation gain is set to 0.30, 30% of the difference between set and measure will be done each sample. Therefore, the correction could look like this:

Programmed set = 10A CC
Sample 1: Internal set = 10.000A, measure 9.980A
Sample 2: Internal set = previous set + 0.3 * (10.000 - 9.980) = 10.006, measure 9.986A
Sample 3: Internal set = previous set + 0.3 * (10.000 - 9.986) = 10.010, measure 9.990A
Sample 4: Internal set = previous set + 0.3 * (10.000 - 9.990) = 10.013, measure 9.993A

4.19.4.5.2 Enable Fast Response Time Methods in CV Mode

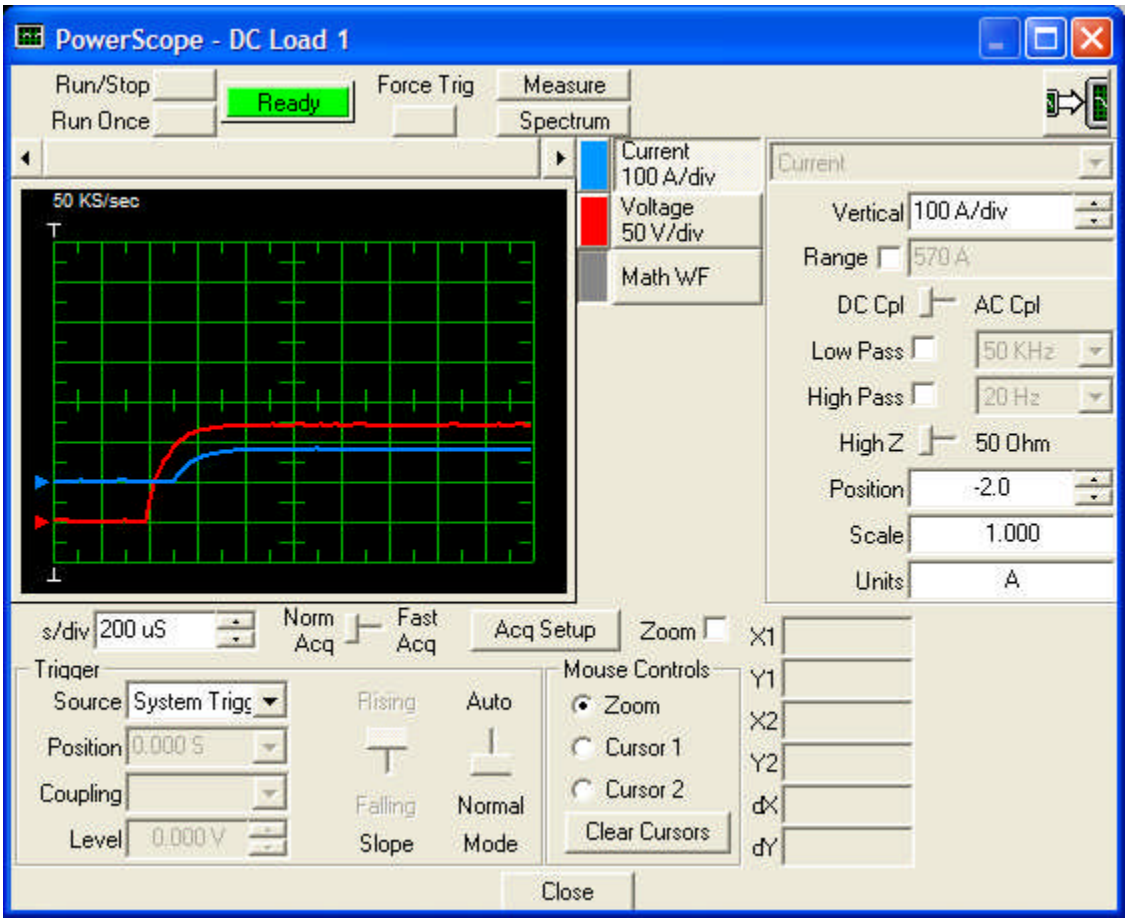
This property Controls the loop response rate of the load when constant voltage is the active mode. When enabled, the load will increase the speed at which it adjusts the voltage level. The fast loop response mode is more susceptible to oscillations.

4.19.4.5.3 Generate Trigger on Current, Resistance, Voltage or Power Change

When enabled, a trigger pulse will be sent on the communications line whenever a current, resistance, voltage or power value is sent to the load. Due to the design of the softpanel, this will generate a continuous trigger pulse stream when enabled. The use of this property is more practical when you are creating your own instrumentation software using the supplied instrument driver.

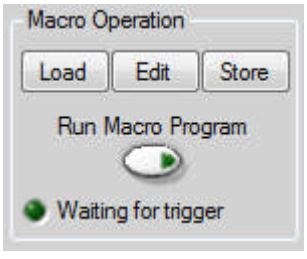
4.19.4.6 Oscilloscope

To display the oscilloscope panel for the selected load, press the Oscilloscope button. When you do, this panel is displayed.

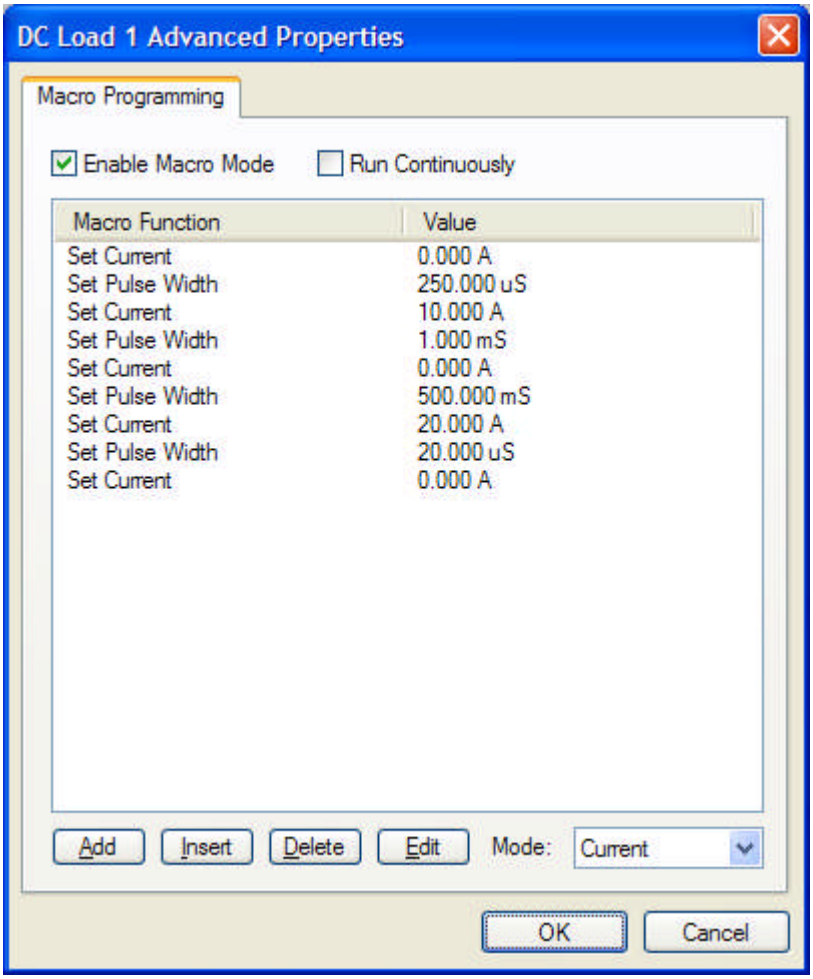


Operation of the oscilloscope panel is similar to a traditional scope. It is, however, limited to the capabilities of the load hardware.

4.19.5 Macro (Transient) Operation Section



Macro programs are sequences of load settings which can be played back to create a sophisticated pattern with precise timing. For example, if you want to create a 0 to 10A pulse 250uS wide then 1mS later a 0 to 20A pulse 500mS wide you would press the Edit button and create a sequence like this…

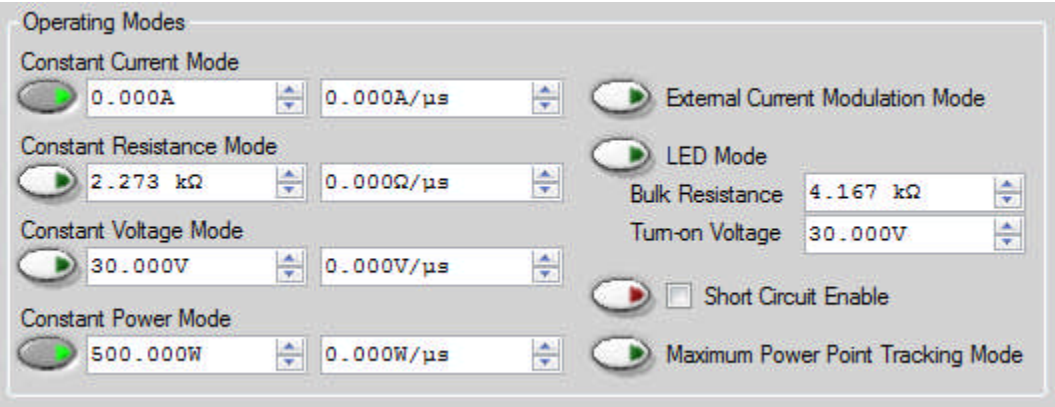


If you want the sequence to repeat continuously, check the “Run Continuously” checkbox and it will continually repeat as long as the “Run Macro Program” button is pressed. If it is not checked, the sequence will run once each time the “Run Macro Program” button is pressed.

If the macro program contains a wait for trigger command, the sequence will pause at that step and wait for a system trigger to occur. The “Waiting for trigger” LED will light and a Force Trigger button will appear so you can manually generate the trigger should the need arise.

The macro program requires the selected mode to be active in order to run. In the above example, we created a Constant Current program. If constant current mode is not enabled, a software fault will inform you that it must be enabled before the program can be run.

When running the macro program, all settings are in effect. In this example, if the settings look like this…

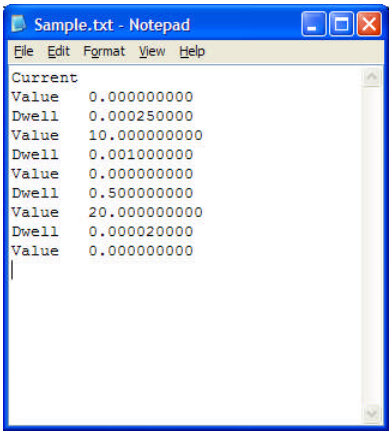


…then the maximum power will be limited to 500W regardless of the current setting in the transient program.

The Load and Store buttons allow you to save macro sequences and recall them for use at a later time. The file format is an ASCII file as follows:

- The first line indicates the active mode ("Current", "Resistance", "Power" or "Voltage"). Only the first letter is required ("C", "R", "P" or "V").
- The following lines indicate the desired commands and associated values. Commands and values are separated by spaces or tabs:
  - "Value", or V, is the "set" value for the active mode
  - "Slew", or S, is the rate of change for the value
  - "Dwell", or D, is the pulse width
  - "Trigger", or T, is used to indicate that the macro should wait for a trigger before continuing execution. There is no "value" associated with a trigger.

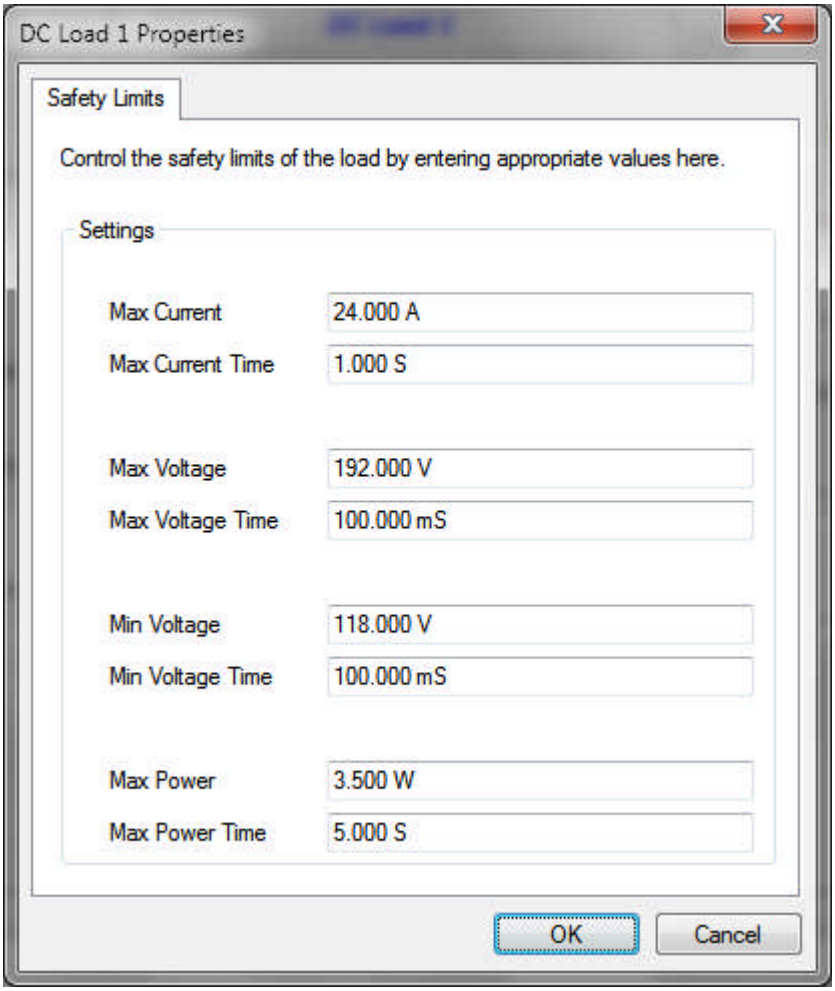
A macro can contain up to 100 command/value pairs. This is the sample defined above:



4.19.6 Safety Section

(Note: depending on your monitor resolution, this section may be part of the Operations pop-up dialog.)

On loads that support Safety Limits, pressing the “Limits” button displays the Safety setup page:

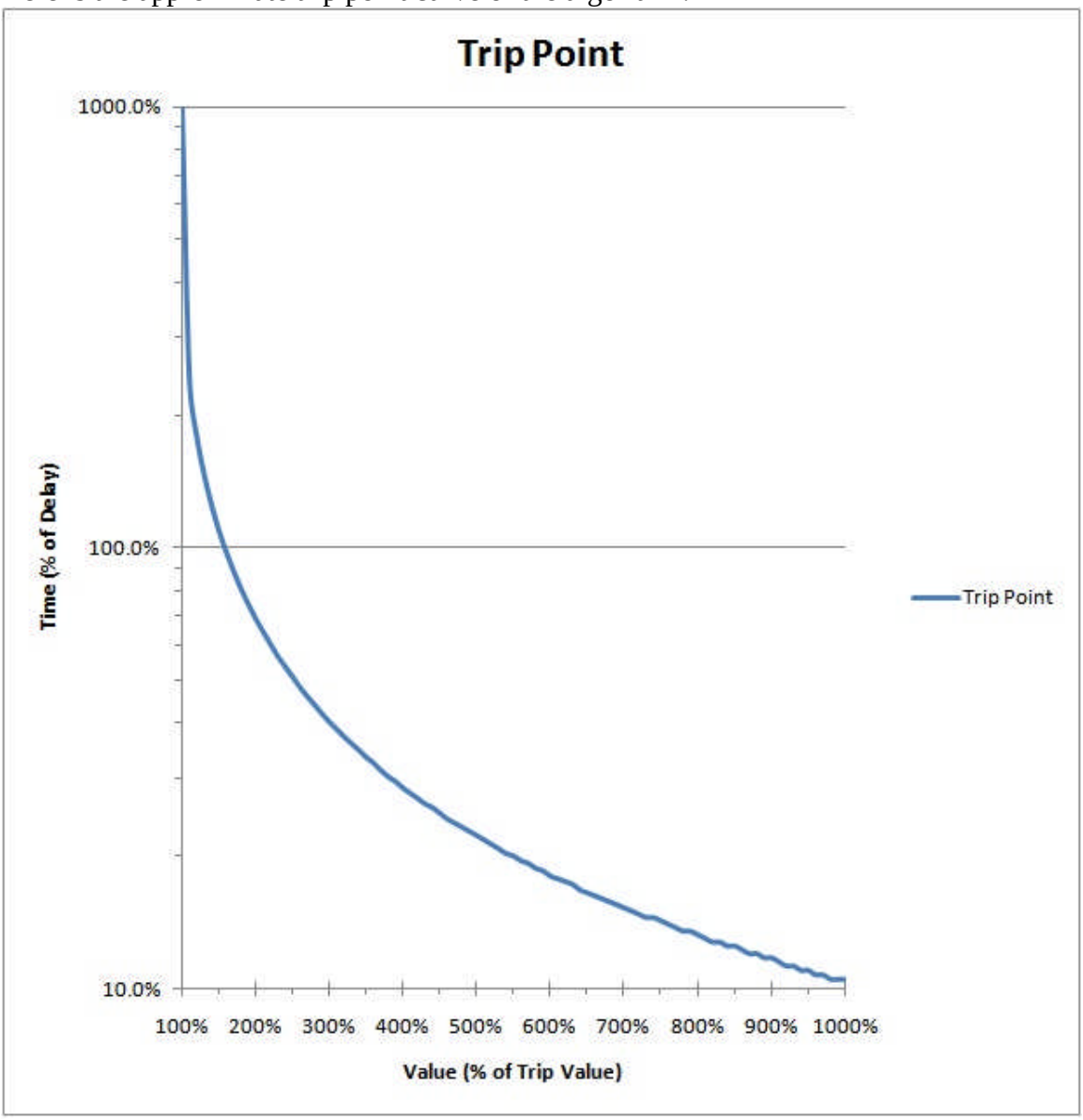


Important note: Safety limits are not available on the 4212 loads. This feature will be disabled on the softpanel Please refer to the Specification section to determine the capabilities of your load model.

The safety setup page allows you to set safety trip points. In essence, you are defining a "programmable circuit breaker" for current, voltage, and power. You will define a value and a time for each characteristic. Note, if you set the time value to zero, it will act as an instantaneous fuse. That is, it will trip off the instant it sees a value that exceeds the programmed setting. This often leads to false trips due to high frequency noise spikes. It is usually better to set a small (non-zero) time to avoid false trips but still provide fast trip response.

The safety trip algorithm mimics the behavior of a circuit breaker. Like a circuit breaker, the algorithm will not be affected by noise and the trip point delay will vary with the amount of overload. That is, the higher the overload, the faster the trip. The parameters that can be set are the trip value and the time value.

Here is the approximate trip point curve of the algorithm.



For example, for a 10A maximum current safety trip point and a time value of 5 seconds:

If the load draws 20A (200% of trip value) it will trip off in about 3 s (65% of time value)
If the load draws 15A (150% of trip value) it will trip off in about 5 s (100% of time value)
If the load draws 12A (120% of trip value) it will trip off in about 9 s (180% of time value)

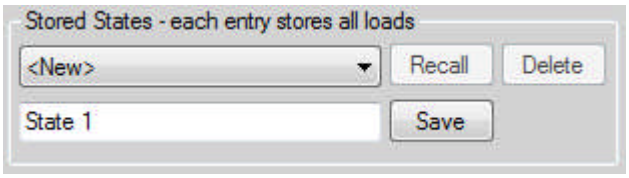
To set the load to default to the programmed safety limits, use the “Save Safety Settings as Default” button in the “Save/Recall Settings” section.

4.19.7 Digital Output Section

Many NHR load models provide general-purpose Digital Outputs, useful for fixture control. The state of the digital output matches that of the corresponding toggle switch. To set the digital high, simply move the switch to its up position (as shown in #2 above); move the switch to its down position for a digital low.

4.19.8 Stored States Section

(Note: depending on your monitor resolution, this section may be part of the Operations pop-up dialog.)



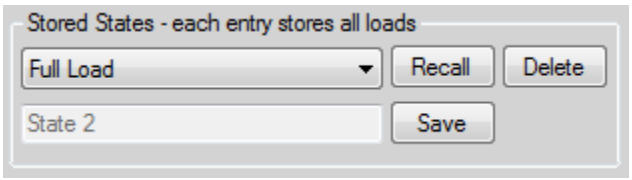
As a convenience, all load settings can be saved to the hard disk for later recall. You can save as many different states as you have room on your hard drive (for all intents and purposes unlimited). All load settings are saved including the transient program. Each state stores the settings for all loads being controlled by the softpanel (one state saves all).

To save the current settings to a new state description

1. Set up all load settings as desired.
2. Select <New> in the "Stored States" selection box.
3. Modify the description if desired (the default will be "State #" which will be a unique name).
4. Press the "Save" button.

To recall a saved state

1. Select the desired state to restore in the "Stored States" selection box. In this example, "Full Load" was chosen.



2. Press the "Recall" button. ***WARNING!*** The saved state will be restored and become active immediately! If the state was stored with short circuit turned on, a short will be applied as soon as you press recall.

5. PROGRAMMING

5.1 General

NH Research provides an IVI-compliant instrument driver with the softpanel, along with support files for various popular development environments. The driver contains functions for selecting, configuring, taking measurements from and controlling the instrument.

Complete, context-sensitive help is provided for every method and property via a compiled HTML help file, `NHRDCLoad.chm`, which is located in `C:\Program Files\IVI Foundation\IVI\Drivers\NHRDCLoad`.

Samples are located in the `C:\NHR\Samples\NHR DC Load` folder.

5.2 Microsoft .NET Languages

You use the IVI-COM instrument driver to control the load in a .NET program. Interop assemblies are used in .NET environments, such as C# and VB.NET, to access COM components. The necessary interop assembly is deployed and registered on the system during software installation. The "Samples" folder contains a C# program that illustrates the use of the load driver in the .NET environment, as well as the source code for the softpanel.

5.3 Microsoft Visual Basic 6.0

You use the IVI-COM instrument driver to control the load in a VB6 program. References to COM drivers are used in VB6 to gain access to the load hardware. The necessary driver is deployed and registered on the system during software installation. The "Samples" folder contains a VB6 program that illustrates the use of the load driver in this environment.

5.4 National Instruments LabVIEW

A palette set providing direct access to each of the instrument driver functions is included with the software installation. NOTE: for LabVIEW to see the palette, you must copy or move the `NHRDCLoad` folder located in `C:\NHR\Samples\NHR DC Load\LabVIEW\instr.lib` into the LabVIEW instrument sub-folder, which is usually located in `C:\Program Files\National Instruments\LabVIEW X.X\instr.lib`.

From a LabVIEW block diagram, traverse the Instrument I/O and Instrument Driver menus to find the NHR DC Load palette. The "Samples" folder contains several LabVIEW samples, along with the source "vi" for the softpanel.

Alternately, a LabVIEW programmer can access the IVI-COM driver directly using LabVIEW's support for ActiveX drivers.

5.5 National Instruments LabWindows/CVI

A function panel providing access to the driver is included with the software installation. The “Samples” folder contains a LabWindows program that illustrates the use of the load driver in this environment. NOTE: depending upon where you install the files, you may have to browse for the instrument function panel (`NHRDCLoad.fp`, usually located in `C:\Program Files\IVI Foundation\IVI\Drivers\NHRDCLoad`) before the sample will compile.