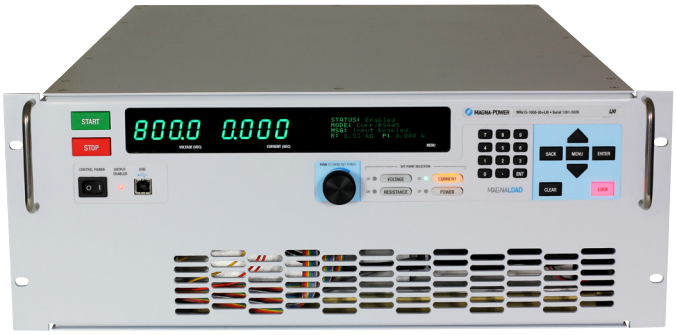
WRx Series

DC Electronic Load • Water cooled, Active Resistance Technology



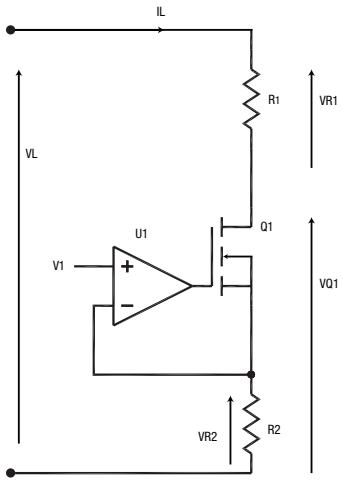
Overview

Utilizing Magna-Power's patented Active Resistance Technology (US Patent 9,429,629) in combination with the company's internally manufactured microchannel water-cooled heatsinks, the WRx Series addresses high power DC applications where exhaust heat control is essential. The WRx Series greatly increases power density compared air-cooled alternatives. An integrated solenoid controls the flow of water to avoid condensation. Full power can be achieved using conventional water, with water inlet temperatures up to 25°C.

Magna-Power's Active Resistance Technology utilizes a switched binary matrix of resistances and MOSFET network, combined with Magna-Power's new MagnaLINK™ distributed DSP architecture, the WRx Series delivers the same features and performance as traditional electronic loads, at a fraction of the price. In addition to the 16-bit precision voltage, current, resistance, power, and shunt regulator control modes, the WRx Series also provides a rheostat control mode, allowing direct control of the product's internal resistance network.

Technology

The WRx Series utilizes Active Resistance Technology to deliver performance consistent with conventional electronic loads, but at a fraction of the price and with the ability to directly switch passive resistors on-the-fly.



In Magna-Power's Active Resistive Technology, switched resistors are placed in series with MOSFETs. High-performance DSPs simultaneously control both dissipation elements in harmony. Assuming the power across the shunt resistor is insignificant, the power dissipated in load resistor R1 is IL x VR1 and the power dissipated in MOSFET Q1 is IL x VQ1. The resistors can be operated at higher temperatures than the MOSFETs, simplifying cooling requirements of the passive elements. Keeping VQ1 small and VR1 large lowers system costs in comparison with purely semiconductor electronic loads. Adjusting the value of resistor R1 is accomplished with a binary switching matrix. Finally, keeping the resistor switching increments small and over a wide range maintains the smallest voltages across the linear modules and over the widest operating range.

The advantage of resistive loads are reliability and cost per watt for dissipating power, while the advantage of MOSFET loads is speed of performance and the ability to dissipate power over a wide operating range. Active Resistive Technology blends switched resistance with MOSFETs to significantly lower the product's cost, add new control modes, while still delivering 16-bit precision and high-accuracy performance.

Key Features

- MagnaLINK™ Distributed DSP Architecture
- 16-bit digital programming and monitoring resolution
- SCPI Remote Programming API
- Many control modes, including: voltage, current, power, resistance, shunt regulator and rheostat
- Multiple operating ranges
- Integrated front and rear full control USB ports, RS485, and dual MagnaLINK™ ports, with LXI TCP/IP Ethernet and IEEE-488 GPIB available.
- Digital plug-and-play master-slaving
- Programmable protection limits
- Configurable external analog-digital user I/O
- Designed and manufactured in the USA

Rheostat Mode

Rheostat Mode, one of six available control modes, bypasses the linear elements to provide direct on-the-fly control of the MagnaLOAD's switched resistor matrix for true step load response. A total of 31 different resistor states are available. Each resistor state has an associated power limit, less than the MagnaLOAD's full scale rated power, which cannot be exceeded. Resistor states can be switched on-the-fly, with the DC input enabled, at the resistor state's maximum power rating. The full scale rated output voltage or full scale rated output current can be achieved at each resistor state, as long as that resistor state's power limit is not exceeded.

The 31 available Rheostat resistance values vary by model. For a single resistor state on a specific model, the resistance value is calculated as:

(Reference Resistor Value) x (Resistor Multiplier)

Refer to the User Manual for each model's resistor parameters.

Models

Model	Maximum Power	Maximum Voltage	Maximum Current	Package Type	Minimum Voltage
WRx12.5-200-130	12.5 kW	200 Vdc	130 Adc	Rack-mount	2.5 Vdc
WRx12.5-500-52	12.5 kW	500 Vdc	52 Adc	Rack-mount	3.0 Vdc
WRx12.5-1000-26	12.5 kW	1000 Vdc	26 Adc	Rack-mount	5.0 Vdc
WRx25-200-260	25 kW	200 Vdc	260 Adc	Floor-standing	2.5 Vdc
WRx25-500-104	25 kW	500 Vdc	104 Adc	Floor-standing	3.0 Vdc
WRx25-1000-52	25 kW	1000 Vdc	52 Adc	Floor-standing	5.0 Vdc
WRx50-200-520	50 kW	200 Vdc	520 Adc	Floor-standing	2.5 Vdc
WRx50-500-208	50 kW	500 Vdc	208 Adc	Floor-standing	3.0 Vdc
WRx50-1000-104	50 kW	1000 Vdc	104 Adc	Floor-standing	5.0 Vdc
WRx75-200-780	75 kW	200 Vdc	780 Adc	Floor-standing	2.5 Vdc
WRx75-500-312	75 kW	500 Vdc	312 Adc	Floor-standing	3.0 Vdc
WRx75-1000-156	75 kW	1000 Vdc	156 Adc	Floor-standing	5.0 Vdc
WRx100-200-1040	100 kW	200 Vdc	1040 Adc	Floor-standing	2.5 Vdc
WRx100-500-416	100 kW	500 Vdc	416 Adc	Floor-standing	3.0 Vdc
WRx100-1000-208	100 kW	1000 Vdc	208 Adc	Floor-standing	5.0 Vdc

Specifications

AC Input Specifications

AC Input Voltage	85-132 Vac or 216-264 Vac 1Φ, 2-wire + ground
AC Input Frequency	45-66 Hz
AC Input Isolation	±1500 Vac, maximum input voltage to ground

Programming Specifications

Resolution (All Modes)	16-bit, 0.0015%
Accuracy	Voltage: ±0.1% of full scale voltage rating Current: ±0.2% of full scale current rating Power: ±0.3% of full scale power rating Resistance: ±0.3% of full scale resistance rating
Rise/Fall Time Maximum	Voltage Mode: 350 ms, 10% to 90% max voltage Current Mode: 700 µs, 10% to 90% max current Power Mode: 40 ms, 10% to 90% max power Resistance Mode: 650 ms, 10% to 90% max res. Rheostat Mode: Instantaneous load step
Trip Settings Range	Over Voltage: 10% to 110% of max voltage rating Under Voltage: 0% to 110% of max voltage rating Over Current: 10% to 110% of max current rating Over Power: 10% to 110% of max power rating

Connectivity Specifications

Communication Interfaces (Standard)	USB Host (Front): Type B USB Host (Rear): Type B RS485 (Rear): RJ-45 MagnaLINK™: RJ-25 x 2 External User I/O: Standard-pin-sub Female
Communication Interfaces (Optional)	LXI TCP/IP Ethernet (Rear): RJ-45 GPIB (Rear): IEEE-488

Water Cooling Specifications

Water Connection Provided 12.5 kW Models	1/2" NPT male inlet and outlet
Water Connection Provided 25 kW to 100 kW Models	1" NPT male inlet and outlet
Maximum Inlet Temperature	25°C
Maximum Inlet Pressure	80 PSI
Minimum Flow Rate	12.5 kW Models: 1.5 GPM 25 kW Models: 3.0 GPM 50 kW Models: 6.0 GPM 75 kW Models: 9.0 GPM 100 kW Models: 12.0 GPM

Environmental Specifications

Ambient Operating Temperature	0°C to 50°C
Storage Temperature	-25°C to +85°C
Humidity	Relative humidity up to 95% non-condensing
Air Flow	Front air inlet, rear exhaust

External User I/O Specifications

Digital Inputs	5 V, 10 kΩ impedance
Digital Monitoring Signals	5 V, 32 mA capacity
Digital Reference Signal	5 V output, 20 mA capacity
Analog Sampling Rate	2 kHz
Analog Programming Input	0-10 V
Analog Programming Impedance	10 kΩ
Analog Programming Resolution	12-bit, 0.025%
Analog Monitoring Signals	0-10 V, 3 mA capacity
Analog Monitoring Impedance	0.005 Ω
Analog Monitoring Accuracy	0.05% of max rating
Analog Reference Signal	10 V, 20 mA capacity

Physical Specifications

Power Level	Rack Units	Size	Weight
12.5 kW	4U	7" H x 24" W x 19" D (17.8 x 60.9 x 48.2 cm)	165 lbs (74.8 kg)
25 kW	12U Cabinet	30.7" H x 24" W x 31.5" D (78.0 x 61.0 x 80.0 cm)	455 lbs (206.4 kg)
50 kW	24U Cabinet	58.25" H x 24" W x 31.5" D (148.0 x 61.0 x 80.0 cm)	785 lbs (356.1 kg)
75 kW	24U Cabinet	58.25" H x 24" W x 31.5" D (148.0 x 61.0 x 80.0 cm)	1115 lbs (505.8 kg)
100 kW	36U Cabinet	74" H x 24" W x 31.5" D (188.0 x 61.0 x 80.0 cm)	1445 lbs (655.4 kg)

Regulatory Compliance

EMC	Complies with European EMC Directive for test and measurement products, 2014/30/EU
Safety	Complies with EN61010-1:2010
CE Mark	Yes
RoHS Compliant	Yes

500 kW WRx Series MagnaLOAD System

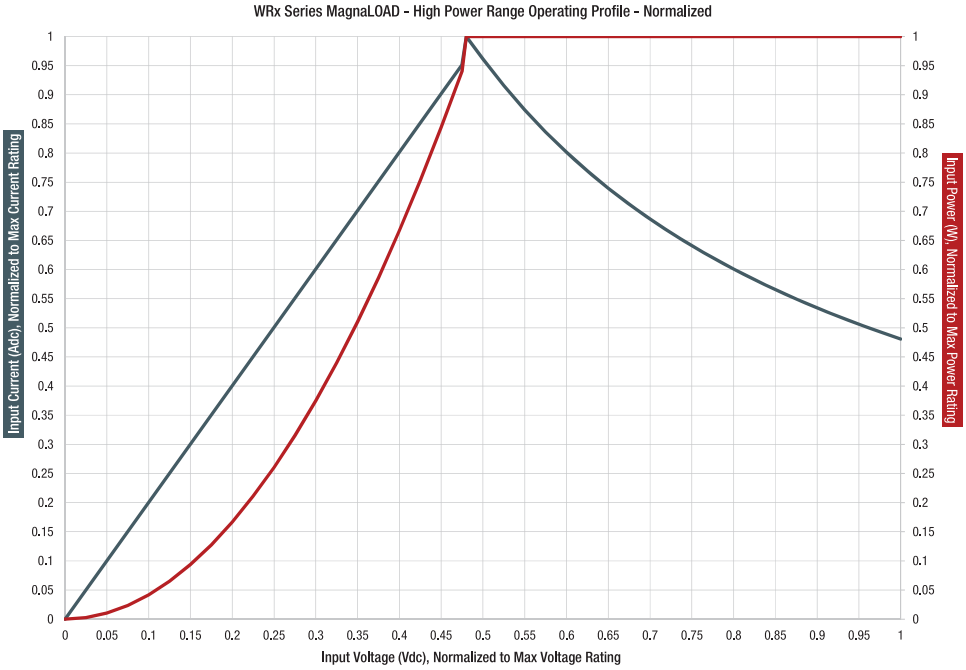
Five 100 kW WRx Series MagnaLOADs in digital master-slave parallel, performing as a single 500 kW system with measurement aggregation

Operating Ranges

With its combination of resistor and linear elements, the WRx Series DC electronic load provides two distinct operating ranges: High Power Range and Low Power Range. The operating range can be selected from the front panel or by computer command.

The operating ranges figures below apply to to all WRx Series models, normalized about the model's maximum voltage, current, and power ratings.

High Power Range

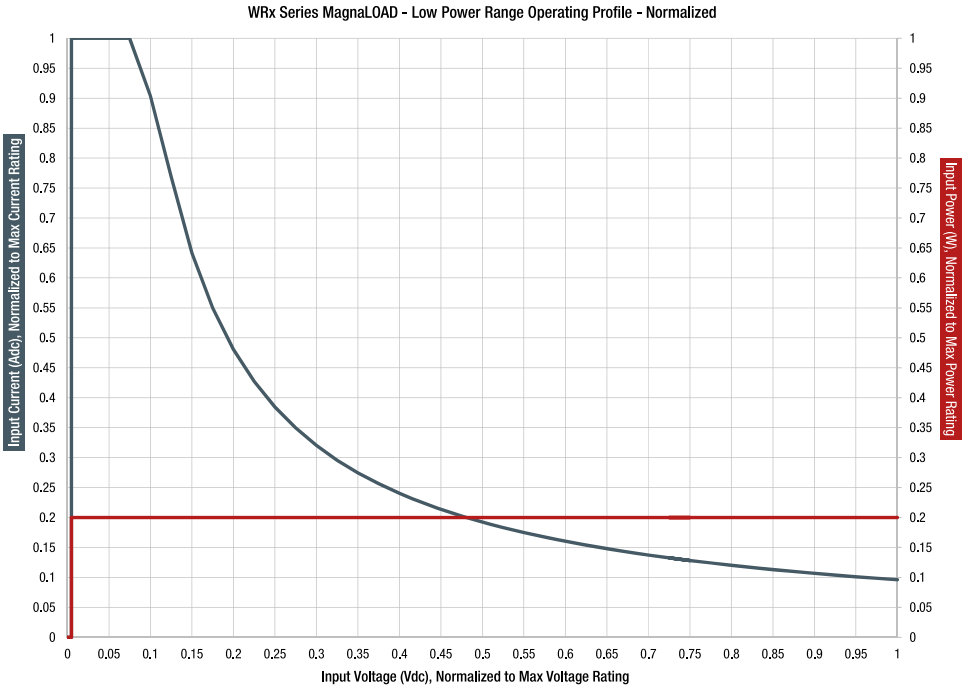


Understanding the High Power Operating Range

The chart on the left normalizes the High Power Operating range about the product's maximum voltage, current and power ratings.

The High Power Range allows the ARx Series MagnaLOAD to operate up to its maximum power rating over the range of 48% to 100% of the product's maximum voltage rating (shown by the light blue series). Below 48% of the product's maximum voltage rating, the current available decays linearly (shown by the dark blue series).

Low Power Range



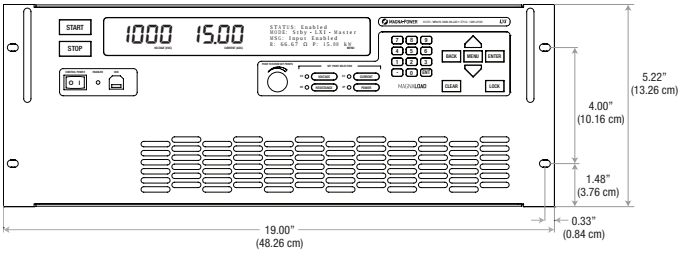
Understanding the Low Power Operating Range

The chart on the left normalizes the Low Power Operating range about the product's maximum voltage, current and power ratings.

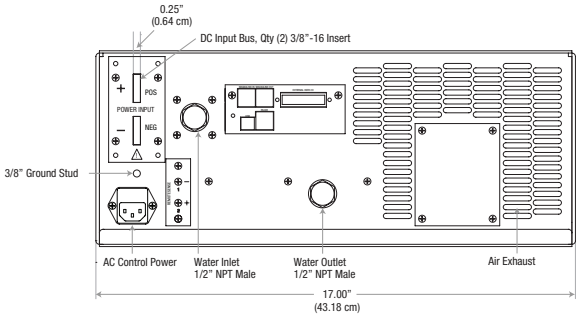
The Low Power Range allows the ARx Series MagnaLOAD to operate at the full current rating from the product's minimum voltage rating to 10% of the product's maximum voltage rating. Above 10% of the maximum voltage rating, the unit is limited to just over 20% of the maximum power rating, so the available current falls as a function of voltage.

Product Diagrams

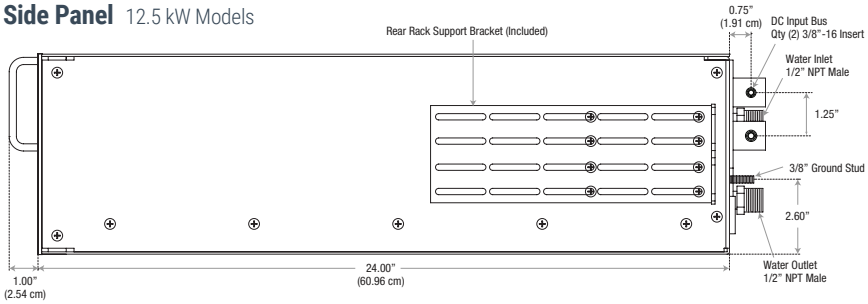
Front Panel 12.5 kW Models



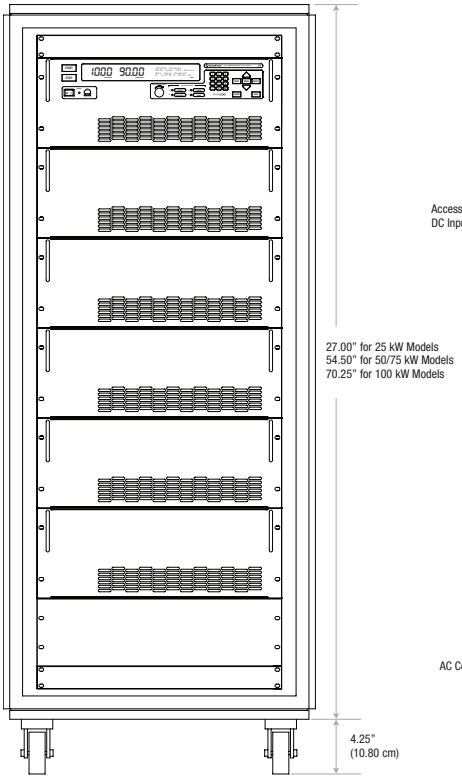
Rear Panel 12.5 kW Models



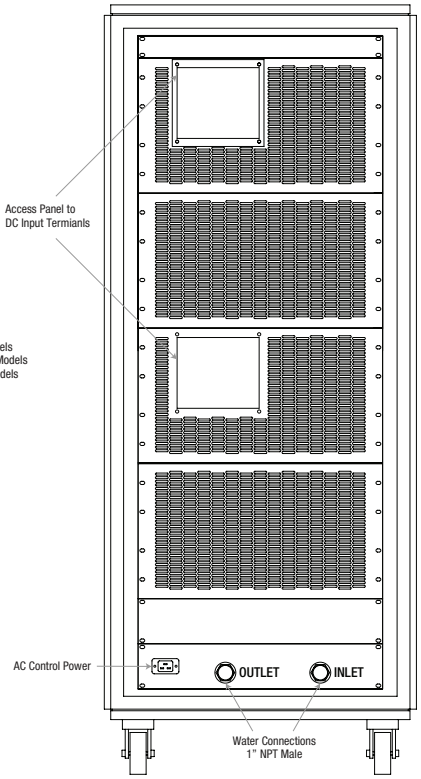
Side Panel 12.5 kW Models



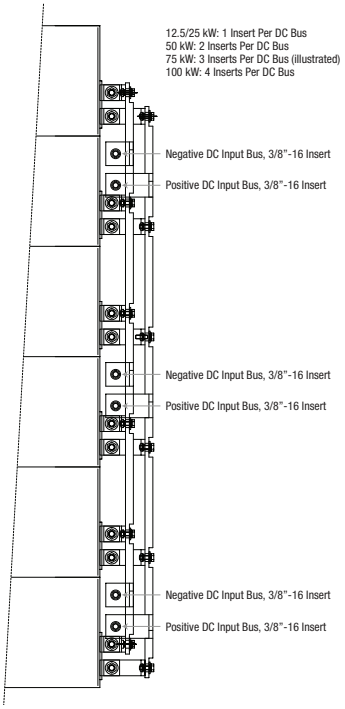
Front Side 25 kW to 100 kW Models



Rear Side 25 kW to 100 kW Models



DC Input Bus 25 kW to 100 kW Models



MagnaLOAD Overview

MagnaLINK™ Distributed Digital Control

Magna-Power's MagnaLINK™ technology provides distributed Texas Instrument DSP control across power processing stages inside the MagnaLOAD DC electronic load. This technology follows a significant internal development cycle from Magna-Power to provide a unified digital control platform across its electronic loads and power supplies, featuring fully digital control loops, adjustable control gains, programmable slew rates, digital master-slaving, and many new advanced control technologies.

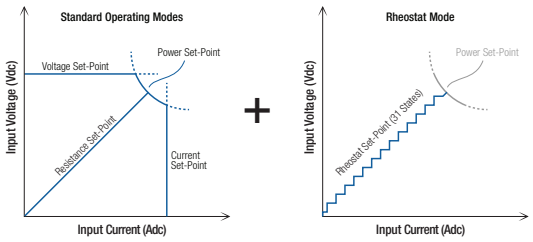
All MagnaLOADs come with the following interfaces:

- Front panel knob, keypad, and menu system
- 25-pin configurable external user I/O, including a high-speed analog input
- Front and rear USB and rear RS-485 or optional Ethernet

When in standby or diagnostic fault, the DC input bus is disconnected via a switching device.

Finally, with a dedicated +5V interlock input pin and included +5V reference on all models, external emergency stop systems can be easily integrated using an external contact.

Flexible Operating Modes



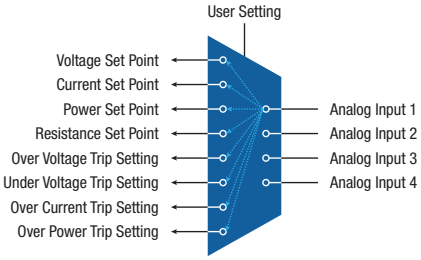
To accommodate a variety of DC sources, all MagnaLOADs come with many configurable control modes, including:

- Voltage Mode
- Current Mode
- Power Mode
- Resistance Mode
- Shunt Regulator Mode
- Rheostat Mode (ARx Series and WRx Series only)

Preference for DC regulation is given to the parameter in the selected mode within the programmed set-points. Using the MagnaLOAD's set-points and trip settings, the product can configured to either trip with a fault when a limit is exceeded or to cross-over into a different regulation state.

Shunt Regulator Mode turns the MagnaLOAD into a high-speed smart braking resistor, engaging the DC input only when a specified voltage and exceeded by a user-defined percentage, while limiting the shunt current to a programmed set-point.

Configurable External User I/O



Beyond the front panel and computer controls, all MagnaLOADs come standard with a 25-pin D-Sub connector designated as the External User I/O. This connector provides:

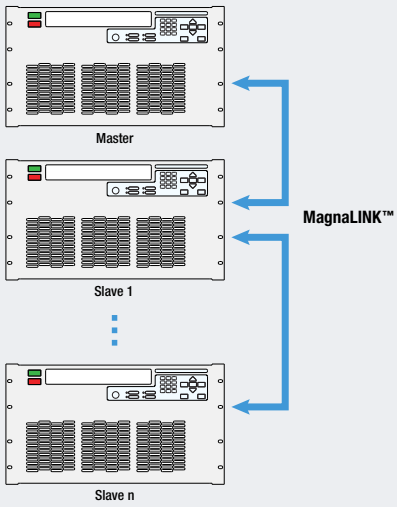
- 8 Digital Outputs
- 4 Digital Inputs
- 4 Analog Outputs
- 4 Analog Inputs

All the analog-digital I/O ports are configurable, allowing the user to select which parameters they want to control and monitor. This configurable I/O scheme reduces complexity, eases PLC integration and allows control parameters from various interfaces simultaneously.

The MagnaLOAD's configurable analog inputs provide 0-10V programming from PLCs and external D/A converters.

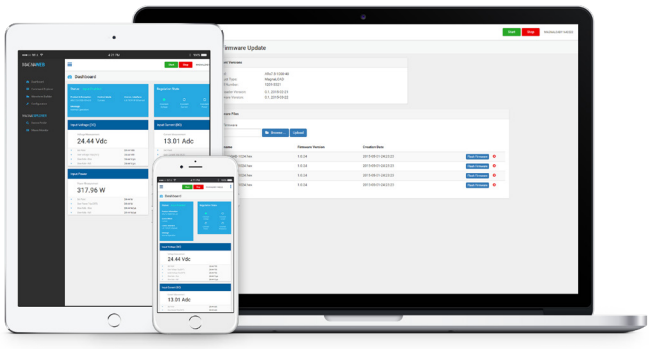
Digital Master-Slaving: Expandibility Without Compromise

All MagnaLOADs come standard with a MagnaLINK™ Input and a MagnaLINK™ Output port, which provides plug and play digital master-slaving. Simply connect the master's MagnaLINK™ Output to the slave's MagnaLINK™ Input and, using the MagnaWEB software, the products will automatically configure themselves for master-slave operation as a higher-power unit based on the populated ports. Buffered digital MagnaLINK™ connections means many MagnaLOADs can be daisy-chained in master-slave operation. Master-slave MagnaLOAD units will aggregate measurements to one display panel.



The internal MagnaLINK™ protocol was developed with expandability at the forefront. When configured for master-slave operation, the master controller takes control of all the slave's digital "targets." With this digital master-slaving strategy, it is completely transparent whether the unit is operating as a stand-alone product or in master-slave.

MagnaWEB Software Interface



Magna-Power's next generation software interface, MagnaWEB, provides intuitive and user-friendly web-browser based controls for programming and measurement read-back of the MagnaLOAD's activity. Virtually all of the MagnaLOAD's available functions can be controlled and monitored from the MagnaWEB software over any of product's installed communication interfaces.

MagnaWEB uses a server-client software model to provide access to the MagnaLOAD from nearly any device and operating system. Install and run the MagnaWEB software locally on Windows then, using a web browser, access the server connected to the MagnaLOAD from a variety of devices including other desktops, tablets or smart-phones.

Extensive Programming Support

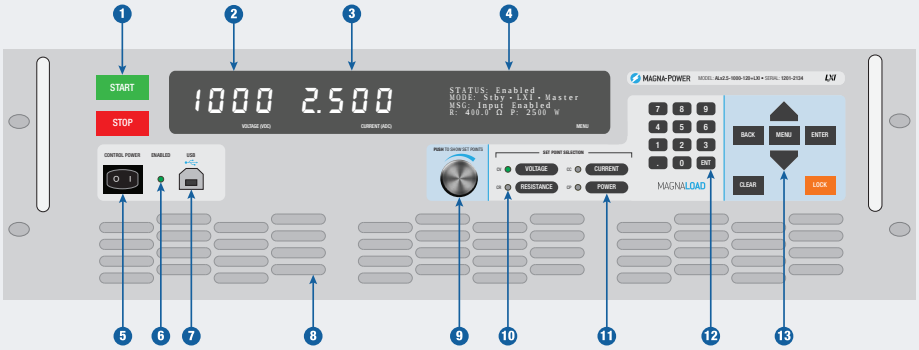
All MagnaLOAD DC electronic loads come with a dedicated National Instruments LabVIEW™ driver, Interchangeable Virtual Instrument (IVI) driver, and support for a wide range of Standard Commands for Programmable Instrumentation (SCPI). These programming interfaces support full control, measurement, and monitoring of the MagnaLOAD. All of the MagnaLOAD's available communication interfaces are supported by these drivers and command sets, including: USB, RS-485, LXI TCP/IP Ethernet, and IEEE-488 GPIB.

Showcased in the following basic code examples, SCPI commands provide the simplest form of communication by using plain ASCII text and parameters sent over a basic socket connection. Over 50 commands are provided, with detailed documentation in the respective product series user manual.

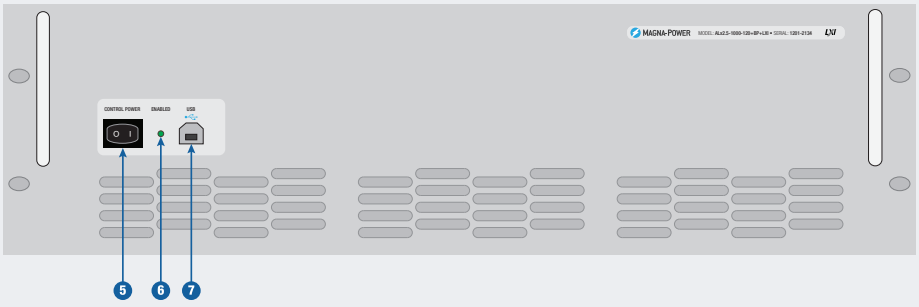
Python programming example using SCPI commands

```
import serial
conn = serial.Serial(port='COM8', baudrate=115200)
conn.write('*IDN?\n')
print conn.readline()
conn.write('VOLT 1000\n')
conn.write('CURR 2.5\n')
conn.write('INP:START\n')
conn.write('MEAS:ALL?\n')
print conn.readline()
```

MagnaLOAD Front Panel - Standard



MagnaLOAD Front Panel - Blank Panel (+BP) Option



1. START: Enables the DC input bus
   STOP: Disable the DC input bus
2. Voltage measurement display
3. Current measurement display
4. 4-line character display featuring a menu system, operating status and modes, product messages with diagnostic codes, resistance measurement display, and power measurement display
5. Control power switch, energizes the control circuits without engaging DC bus
6. LED indicator that the DC input is enabled
7. Full control (host) front panel USB port
8. Clean air intake, with integrated fans
9. Aluminium digital encoder knob for programming set-points
10. LED indicator of the MagnaLOAD's present regulation state, which can include: constant voltage (CV), constant current (CC), constant power (CP), or constant resistance (CR)
11. Illuminated selector buttons to choose which set-point the digital encoder knob and digital keypad buttons will modify.
12. MENU: Enters the menu system on the 4-line display
    BACK: Moves back one level in the menu
    ENTER: Selects the highlighted menu item
    CLEAR: Removes the product from a faulted state
    LOCK: Locks the front panel

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