

Magna-Power Electronics

Programmable DC Power Supplies

Technology and Feature Overview

Innovative and Scalable

Magna-Power Electronics programmable DC power supplies combine the best of DC power processing with microprocessor embedded control. A combination of high and medium frequency power processing technologies improves response, shrinks package size, and reduces cost. All Magna-Power Electronics DC power supplies are current-fed and are more tolerant to abusive loads than conventional switching power supplies. This technology allows the power supply to operate under short-circuit conditions, open-circuit conditions and everything in between.

The programmable DC power supplies offer both master/slave parallel and series operation. This enables two or more power supplies to be placed in parallel for increased output current or in series for increased output voltage, within the unit's isolation limits. With master/slave operation, power supplies operate at near equal voltage and current. The process of master/slaving power supplies is plug & play with the use of Magna-Power Electronics UID47 option, which can be added at any time.

All supplies can operate as a voltage source or current source depending on the control settings and load conditions. If the power supply is operating as a voltage source and the load increases to a point beyond the current command setting, the power supply automatically crosses over to current mode control and operates as a current source at that setting.

Designed for Safety

Magna-Power Electronics programmable DC power supplies have extensive diagnostic functions—all of which, when activated, take command to shut down the system. Diagnostic functions include phase loss, excessive thermal conditions, over voltage trip, over current trip, fuse clearing, and program line. Program line monitors externally applied analog set point signals to insure they are within the specified range. Upon a diagnostic fault condition, main power is disconnected and the diagnostic condition is latched into memory. Pressing the clear key clears the memory. All diagnostic functions can be monitored through the rear connector and software. Furthermore, control functions can also be set through the rear connector to allow simultaneous control of one or more power supplies.

The power supplies have three levels of over voltage/current protection: shutdown of controlling insulated gate bipolar transistors (IGBTs), disconnect of main power and input fuses. After an over voltage/current trip condition, the supply fault must be cleared.

Isolated External I/O for Automation

Using the rear isolated 37-pin I/O connector, the programmable power supplies can be completely controlled and monitored using external signals. The voltage, current, over voltage and over current set points are set by applying a 0-10V analog signal. Each diagnostic condition is given a designated pin, which reads +5V when high. Reference +5V and +10V signals are provided, eliminating the need for external voltage signals and allowing the use of dry contacts. Also, the power supply features a normally closed external interlock, which when enabled, allows the power supply to be tied in with other emergency stop equipment. All these pins are isolated to earth-ground as standard—no additional isolation equipment or options necessary.

Fully Programmable

The Magna-Power Electronics programmable DC power supplies can be programmed and monitored using three possible sources:

- Stepless front panel programming knobs
- External analog/digital signals
- Computer interface through included software, LabVIEW, or other programming environment

The power supply can be programmed to have its control functions accessible from the front panel, rear connector, RS232 (standard), LXI TCP/IP Ethernet (+LXI), IEEE 488 GPIB (+GPIB), USB Edgeport (+USB), or RS485DSS (+RS485) communications. The included IVI driver enables programming in a variety of software environments, including: Visual C++, Visual C#, Visual Basic .NET, Visual Basic 6.0, LabVIEW, LabWindows/CVI, MATLAB, Measure Foundry, and Agilent VEE Pro. Basic programming requirements are satisfied by the instrument's supported Standard Commands for Programmable Instruments (SCPI). Sensing can be established at the output terminal of the power supply or through a rear remote sense terminals for sensing at the load. Even calibration has been simplified with front panel access to digital calibration potentiometers.

Attention to Power Quality

All Magna-Power Electronics power supplies contain circuitry to work harmoniously with other power equipment. Step-start contactors are used to keep inrush current below full scale operating current. Filter components lower current harmonic content emanating from the power supply and increase power factor to levels beyond 90%. Every power supply is tested at 90% to 125% nominal line to insure satisfactory operation even under the worst line voltage conditions.

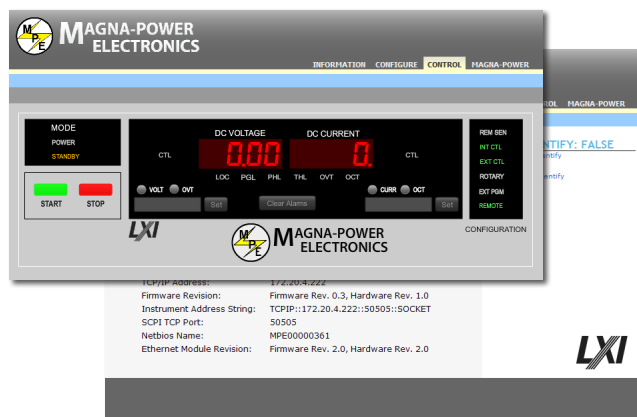
Electronic Output Stage

The novel electronic output stage (XR/TS/MS Series) utilizes near constant power loading under all conditions via an electronic bleed resistance. This electronic bleeder means stability under all operating conditions and faster fall times, without affecting the overall system efficiency.



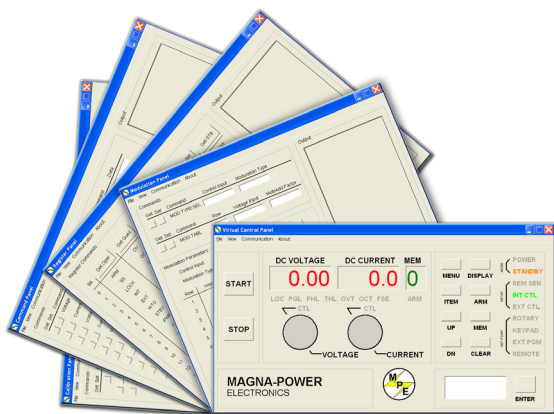
Higher Quality Power Processing

LXI TCP/IP Ethernet Interface Option (+LXI)



LXI is an instrumentation platform based on industry standard Ethernet technology designed to provide modularity, flexibility and performance to small- and medium-sized systems. Certified to the LXI Standard (Class C), Magna-Power Electronics +LXI option includes an embedded web-server, allowing web browser power supply control and monitoring from virtually anywhere and a universal IVI driver.

Remote Interface Software



The Remote Interface Software ships with all power supplies. The software provides the user with an easy and intuitive method to operate a Magna-Power Electronics power supply with computer control. The Remote Interface Software has six windows: Virtual Control Panel, Command Panel, Register Panel, Calibration Panel, Firmware Panel, and Modulation Panel.

Key Product Line Features:

Magna-Power Electronics has designed its products from the ground up to provide synergy across the entire product line. The following are some of the company's programmable DC power supplies key features:

- **Industry leading power density**
Rack-mount space is always at a premium. Magna-Power Electronics power supplies are continuously refined with new technology and devices to drive down size and increase power density.
- **High accuracy programming**
 $\pm 0.075\%$ full scale programming accuracy on all models and programming interfaces.
- **High power factor: > 0.92 on all 3 Φ models:**
Attention to AC power quality and input inductance enables a high power factor, consistent across all 3 Φ input voltages.
- **Standard 37-pin isolated I/O and RS232**
- **Multiple front panel types for flexibility**
- **Extensive programming interface options**
- **CE Mark safety and EMI/EMC certification**
- **Made in USA** 
All products are designed and manufactured at Magna-Power Electronics vertically integrated headquarters in Flemington, NJ USA

Protective Diagnostic Features:

- Over-voltage protection (OVT) (*Programmable*)
- Over-current protection (OCT) (*Programmable*)
- Over-temperature protection (THL)
- Interlock fault (LOC)
- Fuse fault (FUSE)
- Phase loss alarm (PHL)
- Analog programming line voltage fault (PGM LN)
- Remote sense lead detection (REM SEN)

SL Series: 1.5 kW to 4 kW



SL Series 1.5 kW, 2.6 kW, 4.0 kW

Product Name:	SL Series
Number of Models:	70
Power Levels:	1.5 kW, 2.6 kW, and 4.0 kW
Voltage Range:	Models from 0-5 Vdc to 0-1000 Vdc
Current Range:	Models from 0-1.5 Adc to 0-250 Adc
Enclosure	Rack-mount, 1U

Overview

Magna-Power Electronics SL Series was designed for high reliability and to provide market leading 1U (1.75” height) rack-mount power density, with output isolation up to 1000 Vdc. This product series utilizes Magna-Power Electronics signature current-fed power processing, delivering robust power conversion with high efficiency. A wide variety of input voltages are available, from 208 Vac up to 480 Vac. A single-phase universal input (UI) featuring active power factor correction is available for 1.5 kW models. High accuracy programming and monitoring levels allow confidence in power supply measurements, eliminating the need for external power meters.

All SL Series power supplies come standard with isolated 37-pin external I/O, RS232, Remote Interface Software, IVI drivers for integration into a variety of programming environments, and modulation capabilities for non-linear output profile emulation. Two front panel types are available for different application requirements. The standard SL Version front panel (pictured in the image above) provides front panel control and calibration, start and stop buttons, and a digital display for voltage and current. The C Version front panel provides a blank display panel, allowing control only from the computer or isolated 37-pin I/O connection.

Available Options

- Single Phase Universal Input (UI) (1.5 kW Only)
- Cabinet and Integrations (+CAB1, +CAB2, +CAB3)
- High Slew Rate Output (+HS)
- IEEE-488 GPIB Interface (+GPIB)
- LXI TCP/IP Ethernet Interface (+LXI)
- Photovoltaic Power Profile Emulation (+PPPE)
- RS-485DSS Interface (External) (+RS485)
- UID47: Universal Interface Device (+UID)
- USB Edgeport Interface (External) (+USB)



1U Programmable DC Power Supplies

SL Series Specifications

Input Specifications

Nominal Voltage 1 phase, 2 wire + ground	85 - 265 Vac, 1Φ (UI—Universal input) (Available on 1.5 kW Models Only)
Nominal Voltage 3 phase, 3 wire + ground	208 Vac, 3Φ (operating range 187 - 229 Vac) 240 Vac, 3Φ (operating range 216 - 264 Vac) 380 Vac, 3Φ (operating range 342 - 418 Vac) 415 Vac, 3Φ (operating range 373 - 456 Vac) 440 Vac, 3Φ (operating range 396 - 484 Vac) 480 Vac, 3Φ (operating range 432 - 528 Vac)
Frequency	50 Hz - 400 Hz (operating range 45 - 440 Hz)
Power Factor	0.99 at maximum power for 1Φ units > 0.82 at maximum power for 3Φ units

Output Specifications

Ripple	(See Model Charts)
Line Regulation	Voltage Mode: $\pm 0.004\%$ of full scale Current Mode: $\pm 0.02\%$ of full scale
Load Regulation	Voltage Mode: $\pm 0.01\%$ of full scale Current Mode: $\pm 0.04\%$ of full scale
Load Transient Response	2 ms to recover within $\pm 1\%$ of full scale output, with a 50% to 100% or 100% to 50% step load change
Efficiency	$\geq 86\%$ at full load (See Models Chart)
Stability	$\pm 0.10\%$ for 8 hrs. after 30 min. warmup
Isolation	User inputs and outputs: referenced to earth ground Maximum input voltage to ground: ± 2500 Vac Maximum output voltage to ground: ± 1000 Vdc
Maximum Slew Rate	Standard Models: 100 ms for output voltage change from 0 to 63% 100 ms for output current change from 0 to 63% With High Slew Rate Option (+HS): 4 ms for output voltage change from 0 to 63% 8 ms for output current change from 0 to 63%

Physical Specifications

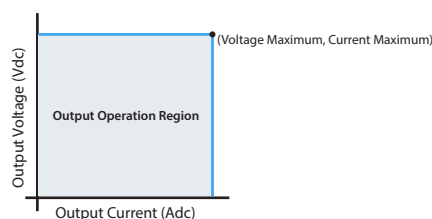
Power	Size (H" x W" x D")	Weight
1.5 kW	1.75 x 19 x 24 in (4.44 x 48.3 x 61.0 cm)	32 lbs (14.52 kg)
2.6 kW	1.75 x 19 x 24 in (4.44 x 48.3 x 61.0 cm)	34 lbs (15.42 kg)
4.0 kW	1.75 x 19 x 24 in (4.44 x 48.3 x 61.0 cm)	35 lbs (15.88 kg)

Control Specifications

Voltage Programming Accuracy	$\pm 0.075\%$ of full scale voltage
OVT Programming Accuracy	$\pm 0.075\%$ of full scale voltage
Current Programming Accuracy	$\pm 0.075\%$ of full scale current
OCT Programming Accuracy	$\pm 0.075\%$ of full scale current
Voltage Readback Accuracy	$\pm 0.2\%$ of full scale voltage
Current Readback Accuracy	$\pm 0.2\%$ of full scale current
External Analog Programming and Monitoring Levels	0 - 10 Vdc
External Analog Output Impedances	Voltage output monitoring: 100 Ω Current output monitoring: 100 Ω +10 Vdc reference: 1 Ω
External Digital Programming and Monitoring Limits	Input: 0 to 5 Vdc, 10k input impedance Output: 0 to 5 Vdc, 5 mA drive capacity
Remote Sense Limits	3% maximum voltage drop from output to load

Environmental Specifications

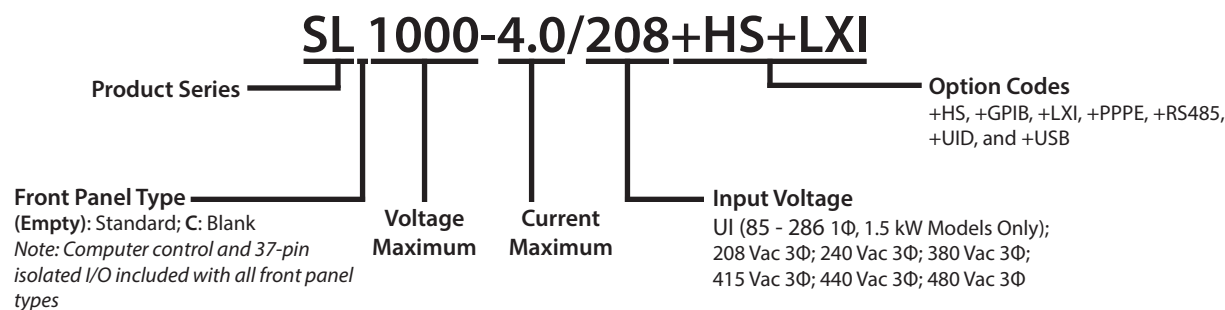
Ambient Operating Temperature	0 °C to 50 °C
Storage Temperature	-25 °C to 85 °C
Humidity	Relative humidity up to 95% non-condensing
Temperature Coefficient	0.04 % / °C of maximum output voltage 0.06 % / °C of maximum output current
Air Flow	Side air inlet, rear exhaust



Note: Specifications are subject to change without notice. For three-phase configurations, input specifications are line-to-line. Unless otherwise noted, input voltages and currents are specified for three-phase configurations.

SL Series Models

Model Ordering Guide



Models Chart

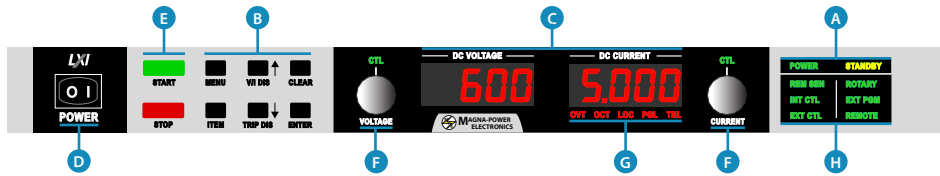
The following chart details the available standard SL Series models. The Current Maximum (A_{dc}) column is separated by the available power levels. To determine the appropriate model, first select your output Voltage Maximum (V_{dc}) to find appropriate row. Next, select one desired Current Maximum from the row that contains your desired Voltage Maximum. Then, construct you model number according to the model ordering guide, above. Non-standard voltage and current configurations are available.

	1.5 kW	2.6 kW	4 kW		
Voltage Maximum (V _{dc})	Current Maximum (A _{dc})			Ripple (mV _{rms})	Efficiency (%)
5	250	N/A	N/A	50	86
10	150	250	N/A	40	86
16	93	162	250	35	86
20	75	130	200	40	86
32	46	81	125	40	86
40	37	65	100	40	87
50	30	52	80	50	87
80	18	32	50	60	87
100	15	26	40	60	87
125	12	20	32	100	87
160	9	16	25	120	87
200	7	13	20	125	87
250	6	10.4	16	130	88
375	4	6.9	10.4	170	88
400	3.7	6.5	10	180	88
500	3	5.2	8	220	88
600	2.5	4.3	6.4	250	88
800	1.8	3.2	4.8	300	88
1000	1.5	2.6	4.0	350	88
	Input Current (A _{ac})				
UI (85 - 265 Vac, 1Φ)	21 - 7	N/A	N/A		
208/240 Vac, 3Φ	6	11	16		
380/415 Vac, 3Φ	5	8	11		
440/480 Vac, 3Φ	4	6	9		

Note: Ripple specified for standard models. For models with the High Slew Rate Output Option (+HS), ripple will be higher.

SL Series Diagrams

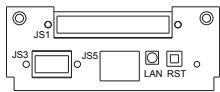
SL Front Panel (Standard)



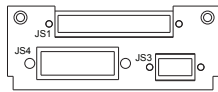
C Version Front Panel



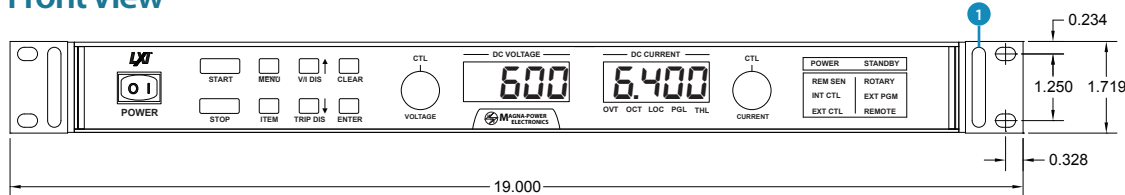
Optional (+LXI) Interface



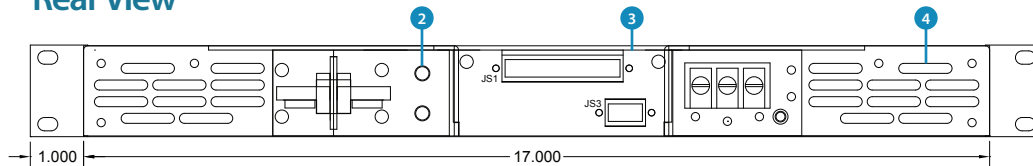
Optional (+GPIB) Interface



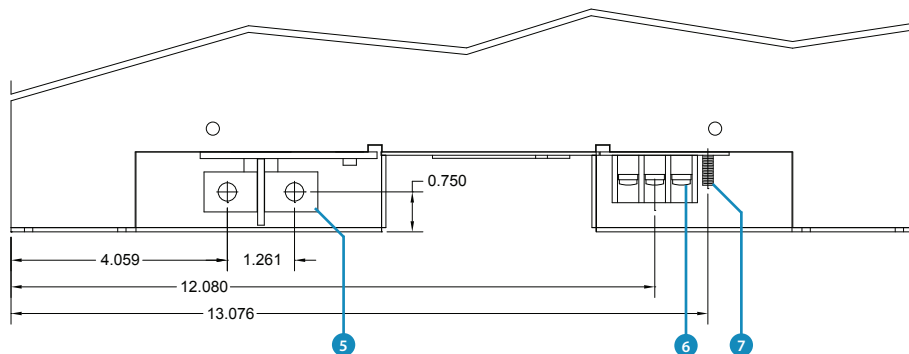
Front View



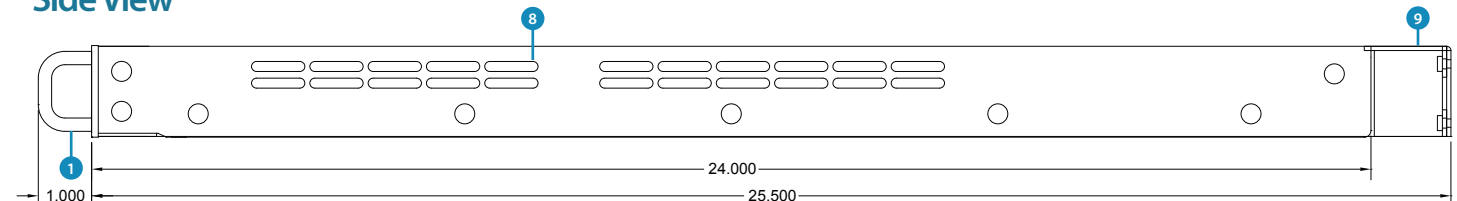
Rear View



Top View (Rear Side)



Side View



- A** MODE
POWER: Indicates power output
STANDBY: Indicates control power only
- B** FUNCTION KEYS
MENU: Selects function
ITEM: Selects item within function
V/I DIS: Displays voltage/current settings
TRIP DIS: Displays OVT and OCT settings
CLEAR: Clears setting or resets fault
ENTER: Selects item
- C** Meters display output voltage, output current, voltage set point, current set point, over voltage trip, and over current trip
- D** Power switch energized control circuits without engaging main power
- E** Engages and disengages main power
- F** Stepless rotary knob to set voltage/current
- G** DIAGNOSTIC ALARMS
LOC: Interlock
PGL: External input voltage beyond limits
THL: Indicates over-temperature condition
OVT: Over-voltage protection has tripped
OCT: Over-current protection has tripped
- H** CONFIGURATION
REM SEN: Remote sense enabled
INT CTL: Front panel start/stop/clear enabled
EXT CTL: External start/stop/clear enabled
ROTARY: Front panel control
EXT PGM: External voltage/current control
REMOTE: Computer control

- 1** Front Panel Handles (Removable)
- 2** Remote Sense Connections
- 3** Computer and External Control Connections
- 4** Rear Air Exhaust
- 5** Output DC Connections
0.25" x 0.75" Tin Plated Copper Bus
Qty (2) 3/8-16 Threaded Insert
- 6** Input AC Connections
38660 Molex Input Connector
- 7** 10-32 Ground Stud
- 8** Side Air Intake
- 9** Qty (2) Rear Metal Covers (Removable)

Product Options

Performance and Packaging Options

Magna-Power Electronics programmable DC power supplies are designed to be as versatile and expandable as possible. A variety of options are available allowing the product to deviate from its standard specifications. This section provides an overview of the available performance and packaging options and products supported.

Cabinet and Integration

Option Code:	+CAB1, +CAB2, +CAB3
Products Supported:	SL Series, XR Series, TS Series

Cabinet and integration services are offered for the rack-mount programmable DC power supply products. Cabinets are supplied with fans rated to installed products. Key features of the cabinet and integration option are as follows:

- Reliable Premier Metal (+CAB1, +CAB2) and Hoffman® (+CAB3) cabinets
- Casters installed, including (2) locking casters
- Special circuitry for product integration with cabinet fans
- Installation and testing as a complete system

Cabinet and Integration Specifications		
Cabinet Option	Dimensions (H" x W" x D")	Rack Units
Cabinet 1 (+CAB1)	38.75" x 22" x 31"	18U
Cabinet 2 (+CAB2)	49.25" x 22" x 31"	24U
Cabinet 3 (+CAB3)	67" x 24" x 31.5"	30U

High Slew Rate Output

Option Code:	+HS
Products Supported:	SL Series, XR Series, TS Series, MS Series, MT Series

The high slew rate option solves several limitations inherent in switching power supply design. Rapid voltage transitions require internal electronics to supply the energy to charge and discharge output capacitors. Peak currents internal to the power supply define slew rate; utilizing less capacitance enables voltage transitions in shorter time periods. Additionally, less capacitance reduces requirements for discharge demands during open circuit conditions.

The standard output stage Magna-Power Electronics power supplies has been designed to provide the lowest possible output ripple voltage within the constraints of available components, size, and cost. Part of the output stage consists of a bank of aluminum electrolytic capacitors which has the desired electrical properties to provide this function. These components require bleed resistors to discharge any voltage when the power supply has no load and is disabled. While the presence of these components and the resulting performance are normally industry accepted, there are applications where lower output capacitance is extremely desirable and higher ripple voltage is acceptable. To meet this need, a high-slew rate option is available which has an output stage consisting of low capacitance film and aluminum electrolytic capacitors. Applications for the high-slew rate option include battery charging, photovoltaic emulation, power waveform generation, and medium speed power pulsing. These applications all benefit from higher bandwidth and in many cases, can tolerate the increased ripple voltage of this option.

Slew Rate Specifications		
	Slew rate standard	Slew rate with +HS option
Voltage	100 ms	4 ms
Current	100 ms	8 ms

High Isolation Output

Option Code:	+ISO
Products Supported:	TS Series, MS Series, MT Series

Certain applications require floating the output voltage to values beyond the power supply's standard isolation rating. Magna-Power Electronics High Isolation Output option (+ISO) enables any TS Series, MS Series, or MT Series model with a peak output voltage rating of 250 Vdc through 1000 Vdc to be rated for a higher voltage output isolation. Improved isolation is achieved by a novel output stage with improved controller isolation. In addition to being able to float the power supply to a higher output voltage, this option also enables lower voltage units to connected series up to the higher isolation rating.

The table below provides the output isolation rating for all available configurations, where V_o is the unit's rated maximum output voltage.

Output Isolation Specifications			
Product	Isolation, models 1000 Vdc and below	Isolation, models 1000 Vdc and below with +ISO option	Isolation, model above 1000 Vdc
SL Series	1000 Vdc	N/A	N/A
XR Series	1000 Vdc	N/A	N/A
TS Series	1000 Vdc	$\pm (2000 \text{ Vdc} + V_o/2)$	$\pm (2000 \text{ Vdc} + V_o/2)$
MS Series	1000 Vdc	$\pm (2000 \text{ Vdc} + V_o/2)$	$\pm (2000 \text{ Vdc} + V_o/2)$
MT Series	1000 Vdc	4000 Vdc	4000 Vdc

UID47: Universal Interface Device

Option Code:	+UID
Products Supported:	SL Series, XR Series, TS Series, MS Series, MT Series

Magna-Power Electronics UID47 is a general purpose device for connection to Magna-Power Electronics' power supplies. The device contains the necessary circuitry for configuring power supplies for master/slave parallel or series operation.

Master/slave parallel operation allows two or more power supplies to equally share output current when connected together. Master/slave series operation allows two or more power supplies to equally share output voltage when connected together. In either operation mode, the master unit will command the slave units to the proper voltage and current. Each unit will display its own individual voltage and current. Installation requires setting jumpers, placing included 37-conductor cables between the UID47 and power supplies, and wiring the power supply outputs in either parallel or series.

The UID47 can be used as an interface for connecting control and monitoring lines to external circuitry. It also contains an area on the printed circuit board for interconnecting wires and placing components for specific user applications.

Key features of the UID47 option are as follows:

- Compatible with all Magna-Power Electronics power supplies
- Interface for series and parallel master/slave operation
- User configurable screw terminal connector
- Pad area for custom circuitry
- (2) 6-foot 37-pin cables included



Water Cooling

Option Code:	+WC
Products Supported:	TS Series, MS Series

Water cooling is available for Magna-Power Electronics TS Series and MS Series power supplies typically for use in corrosive environments, such as electroplating applications or in densely packaged system cabinets, where heat removal by air cooling presents a problem.

Water cooling is accomplished with chill plates and an integrated central heat exchanger. The chill plates provides a thermal conduction path for heat sensitive components and the central heat exchanger removes heat from air internal to the enclosure. Water cooled TS Series models have enclosures without vent holes and are basically sealed the unit from the environment. An internal solenoid valve enables water flow when the chill plate reaches 60 degrees celcius. Operation of the solenoid prevents internal condensation.

Water Cooling Specifications			
	5 kW - 15 kW Models	20 kW to 30 kW Models	45 kW to 75 kW Models
Inlet Coolant Temperature	25°C	25°C max	25°C max
Flow Rate (Min)	1.5 GPM	3.0 GPM	4.5 GPM
Pressure (Max)	80 psi	80 psi	80 psi
Inlet/Outlet Pipe Size	1/4" NPT male	1/2" NPT male	1/2" NPT male

Each 15 kW module has a 1/4" NPT female inlet and outlet for water flow. For models greater than 15 kW, external plumbing interconnects power supply modules. A minimum of 2.50" is recommended behind the enclosure for this hardware and user connections. For systems requiring more than one power supply, plumbing connections must be paralleled; that is, water should not flow from one power supply into another.

Product Options

Communication Interface Options

All Magna-Power Electronics programmable DC power supplies come standard with RS232 serial interface and 37-pin isolated analog/digital I/O. Additional available interface options are available, as detailed in this section.

IEEE-488 GPIB

Option Code:	+GPIB
Products Supported:	SL Series, XR Series, TS Series, MS Series, MT Series

The IEEE-488 interface, sometimes called the General Purpose Interface Bus (GPIB), is a general purpose digital interface system that can be used to transfer data between two or more devices. It is particularly well-suited for interconnecting computers and instruments. Some of its key features are:

- Up to 15 devices may be connected to one bus
- Total bus length may be up to 20 m and the distance between devices may be up to 2 m
- Communication is digital (as opposed to analog) and messages are sent one byte (8 bits) at a time
- Message transactions are hardware handshaked
- Data rates may be up to 1 Mbyte/sec

LXI TCP/IP Ethernet

Option Code:	+LXI
Products Supported:	SL Series, XR Series, TS Series, MS Series, MT Series

Certified to the LXI Standard (Class C), the TCP/IP Ethernet option includes an embedded web-server, allowing web browser power supply control and monitoring from virtually anywhere. LXI is an instrumentation platform based on industry standard Ethernet technology designed to provide modularity, flexibility, and performance to small- and medium-sized systems.

LXI's advantages are exemplified in its compact, flexible package providing high-speed I/O and reliable measurements. The Magna-Power Electronics LXI TCP/IP Ethernet option includes an embedded web-server, allowing web browser power supply control and monitoring from virtually anywhere.

USB Edgeport

Option Code:	+USB
Products Supported:	SL Series, XR Series, TS Series, MS Series, MT Series

Edgeport USB-to-serial converters offer instant I/O expansion for peripheral device connectivity. An out-of-the-box (external) alternative to PCI cards, Edgeport makes it easy to add serial port to a PC, server or thin client in minutes without opening the chassis, reconfiguring or rebooting the system.

The USB Edgeport device plugs directly into the back of the power supply, creating a seamless USB interface. Feature-rich design, reliability and unmatched operating system support make Edgeport USB-to-serial converters ideal for mission-critical enterprise applications. USB cable included along with associated drivers on the Magna-Power Electronics software CD.

RS-485DSS

Option Code:	+RS485
Products Supported:	SL Series, XR Series, TS Series, MS Series, MT Series

The 485DSS allows non-addressable, "dumb" RS-232 devices to be connected on an addressable RS-485 network. The master node controls all communications to connected devices. By distributing the switching intelligence along the RS-485 network, wiring cost savings are substantial compared to a single switched "star" configuration.

Devices can either be polled by the master node or request access to the bus through a RS-232 handshake line. This provides a versatile system for interconnecting devices that are designed for point to point communications. Because the units communicate using standard RS-485 signals, RS-232 devices can form their own network or be added to an existing system. Up to 32 nodes at up to 4000 feet can be on one bus without a repeater, and the 485DSS's addressing scheme allows up to 256 units on a single network with repeaters.