TS Series: 5 kW to 45 kW

TS Series 5 kW, 10 kW, and 15 kW Models (3U)

TS Series 20 kW, 25 kW, and 30 kW Models (6U)

TS Series 45 kW Models (9U)

Available Options

- 208/240 Vac Single-Phase Input (SP) (5 kW Only)
- Cabinet and Integration (CAB1, CAB2, CAB3, CAB4)
- High Isolation Output (+ISO)
- High Slew Rate Output (+HS)
- IEEE-488 GPIB Interface (+GPIB)
- LXI TCP/IP Ethernet Interface (+LXI)
- Photovoltaic Power Profile Emulation (PPPE)
- RS-485 Converter (RS485)
- UID47: Universal Interface Device (UID)
- USB Edgeport Converter (USB)
- Water Cooling (+WC)

Product Name:	TS Series
Number of Models:	80
Power Levels:	5 kW, 10 kW, 15 kW, 20 kW, 25 kW, 30 kW, and 45 kW
Voltage Range:	Models from 0-5 Vdc to 0-4000 Vdc
Current Range:	Models from 0-1.2 Adc to 0-2700 Adc
Enclosure	Rack-mount, 3U to 9U

Overview

Magna-Power Electronics TS Series provides a wide voltage and current range while still maintaining among the highest power density rack-mount packaging. The TS Series covers voltages from 5 Vdc up to 4000 Vdc (floating) and current levels from 1.2 Adc up to 2700 Adc. Models 5 kW to 15 kW are available in a 3U chassis, models 20 kW to 30 kW are available in a 6U chassis, and 45 kW models are available in a 9U chassis. In addition, there are several special low voltage high current models (Page 23), enabling a more cost-effective solution for these requirements.

All TS 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 environment Three front panel types are available (Page 22) for maximum application flexibility. The A Version provides front panel control and calibration, start and stop buttons, and a digital display for voltage and current. The D Version front panel adds a 10-key digital front panel entry, memory sequencing, and modulation capabilities for non-linear output profile emulation.

Mobile TS Series Power Supplies, Part of the F-35 Joint Strike Fighter (JSF) Program

3U to 9U Rack-Mount Power Supplies

TS Series Specifications

Input Specifications

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 - 440 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)
1 phase, 2 wire + ground **(5 kW Models Only)**	208 Vac, 1Φ (operating range 187 - 229 Vac) 240 Vac, 1Φ (operating range 216 - 264 Vac)
Frequency	50 Hz - 400 Hz (operating range 45 - 440 Hz)
Power Factor	> 0.92 at maximum power for 3Φ units > 0.70 at maximum power for 1Φ units

Output Specifications

Ripple	(See Models Chart)
Line Regulation	Voltage Mode: ± 0.004% of full scale Current Mode: ± 0.02% of full scale
Load Regulation	Voltage Mode: ± 0.01% of full scale Current Mode: ± 0.04% of full scale
Load Transient Response	2 ms to recover within ±1% of full scale output, with a 50% to 100% or 100% to 50% step load change
Efficiency	≥ 86% at full load (See Model Charts)
Stability	± 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 for models less than or equal to 1000 Vdc ±(2000 Vdc + Vo/2) for models greater than 1000 Vdc or with High Isolation Option (+ISO) where Vo is the unit's output voltage maximum
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%
Bandwidth	Standard Models: 3 Hz for remote analog voltage programming 2 Hz for remote analog current programming With High Slew Rate Option (+HS): 60 Hz for remote analog voltage programming 45 Hz for remote analog current programming

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.

Physical Specifications

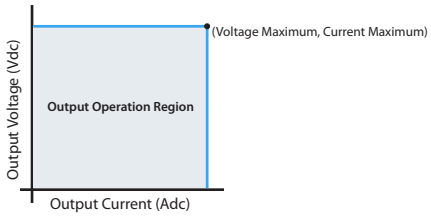
Power	Size (H" x W" x D")	Rack Units	Weight
5 kW	5.25 x 19 x 24 in (13.3 x 48.3 x 61.0 cm)	3U	74 lbs (33.60 kg)
10 kW	5.25 x 19 x 24 in (13.3 x 48.3 x 61.0 cm)	3U	94 lbs (42.64 kg)
15 kW	5.25 x 19 x 24 in (13.3 x 48.3 x 61.0 cm)	3U	114 lbs (51.71 kg)
20 kW	10.25 x 19 x 24 in (26.0 x 48.3 x 61.0 cm)	6U	197 lbs (89.36 kg)
25 kW	10.25 x 19 x 24 in (26.0 x 48.3 x 61.0 cm)	6U	217 lbs (98.43 kg)
30 kW	10.25 x 19 x 24 in (26.0 x 48.3 x 61.0 cm)	6U	237 lbs (107.50 kg)
45 kW	15.75 x 19 x 24 in (40.0 x 48.3 x 61.0 cm)	9U	349 lbs (158.30 kg)

Control Specifications

Voltage Programming Accuracy	± 0.075% of full scale voltage
OVT Programming Accuracy	± 0.075% of full scale voltage
Current Programming Accuracy	± 0.075% of full scale current
OCT Programming Accuracy	± 0.075% of full scale current
Voltage Readback Accuracy	± 0.2% of full scale voltage
Current Readback Accuracy	± 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, 10 kΩ input inpedance 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
Water Cooling (+WC Option) (Diagrams Available)	Inlet temperature: 25°C Flow rate (minimum): 1.5 GPM for 15 kW units 3.0 GPM for 20 to 30 kW units 4.5 GPM for 45 kW units 80 PSI maximum pressure



TS Series Models

Model Ordering Guide

TSD1000-15/208+HS+LXI

Product Series

Front Panel Type
A: Analog; **D**: Digital; **C**: Blank
Note: Computer control and 37-pin isolated I/O included with all front panel types

Voltage Maximum

Current Maximum

Input Voltage
208 Vac 1Φ; 240 Vac 1Φ; 208 Vac 3Φ; 240 Vac 3Φ; 380 Vac 3Φ; 415 Vac 3Φ; 440 Vac 3Φ; 480 Vac 3Φ

Integrated Option Codes
+HS, +GPIB, +ISO, +LXI, and +WC

Models Chart

The following chart details the available standard TS Series models. The Current Maximum (Adc) column is separated by the available power levels. To determine the appropriate model, first select your output Voltage Maximum (Vdc) 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.

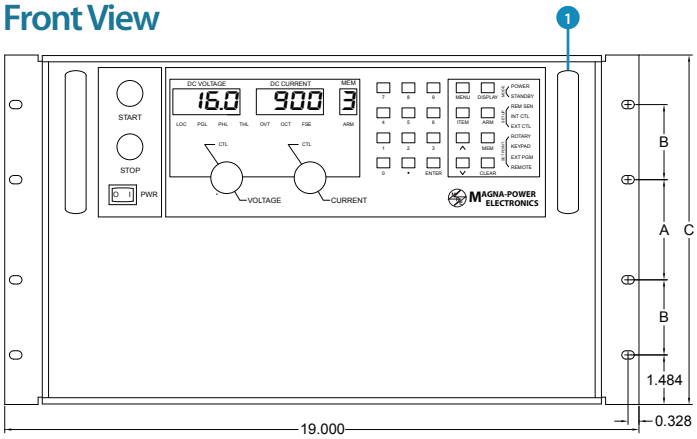
	5 kW	10 kW	15 kW	20 kW	25 kW	30 kW	45 kW		
Voltage Maximum (Vdc)	Current Maximum (Adc)							Ripple (mVrms)	Efficiency (%)
5	900	1800*	2700*	N/A	N/A	N/A	N/A	50	86
8	600	1200*	N/A	N/A	N/A	N/A	N/A	40	86
10	500	900	1800*	N/A	2700*	N/A	N/A	40	86
16	300	600	900	1200	1500	1800	2700	35	86
20	250	500	750	1000	1250	1500	2250	40	86
25	200	400	600	800	1000	1200	1800	40	86
32	150	300	450	600	750	900	1350	40	86
40	125	250	375	500	625	750	1125	40	87
50	100	200	300	400	500	600	900	50	87
60	83	166	249	342	415	498	747	60	87
80	62	124	186	248	310	372	558	60	87
100	50	100	150	200	250	300	450	60	87
125	40	80	120	160	200	240	360	100	87
160	31	62	93	124	155	186	279	120	87
200	25	50	75	100	125	150	225	125	87
250	20	40	60	80	100	120	180	130	88
300	16	32	48	64	80	96	144	160	88
375	13	26	39	52	65	78	117	170	88
400	12	24	36	48	60	72	108	180	88
500	10	20	30	40	50	60	90	220	88
600	8	16	24	32	40	48	72	250	88
800	6	12	18	24	30	36	54	300	88
1000	5	10	15	20	25	30	45	350	88
1250	4	8	12	16	20	24	36	375	88
1500	3.3	6.6	9.9	13.2	16.5	19.8	29.7	400	88
2000	2.5	5.0	7.5	10.0	12.5	15.0	22.5	450	88
3000	1.6	3.2	4.8	6.4	8.0	9.6	14.4	500	88
4000	1.2	2.4	3.6	4.8	6.0	7.2	10.8	550	88
	Input Current Per Phase (Aac)								
208/240 Vac, 1Φ	38	N/A	N/A	N/A	N/A	N/A	N/A		
208/240 Vac, 3Φ	19	36	54	72	90	108	162		
380/415 Vac, 3Φ	10	21	30	40	50	60	90		
440/480 Vac, 3Φ	9	18	27	36	45	54	81		

Ripple specified for standard models. For models with the High Slew Rate Output Option (+HS), ripple will be higher. Models marked with an asterisk (*) are special low-voltage high-current models that may vary in size and input current from the standard TS Series models in the same power envelope.

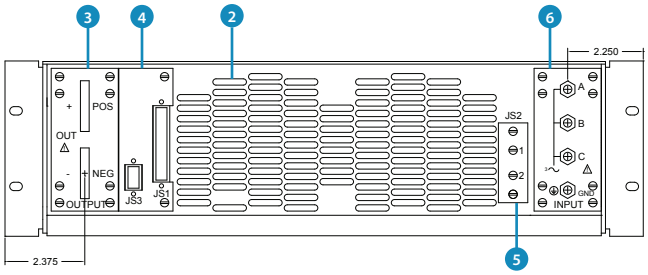
TS Series Diagrams

Physical Specifications			
Power	A (in)	B (in)	C (in)
5 kW	2.250	N/A	5.219
10 kW	2.250	N/A	5.219
15 kW	2.250	N/A	5.219
20 kW	3.000	2.250	10.469
25 kW	3.000	2.250	10.469
30 kW	3.000	2.250	10.469
45 kW	4.750	4.000	15.719

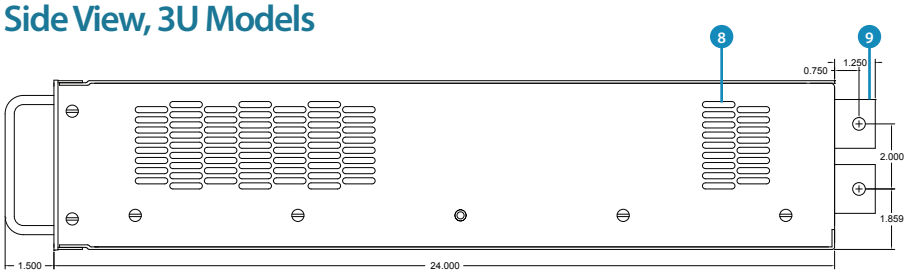
Front View



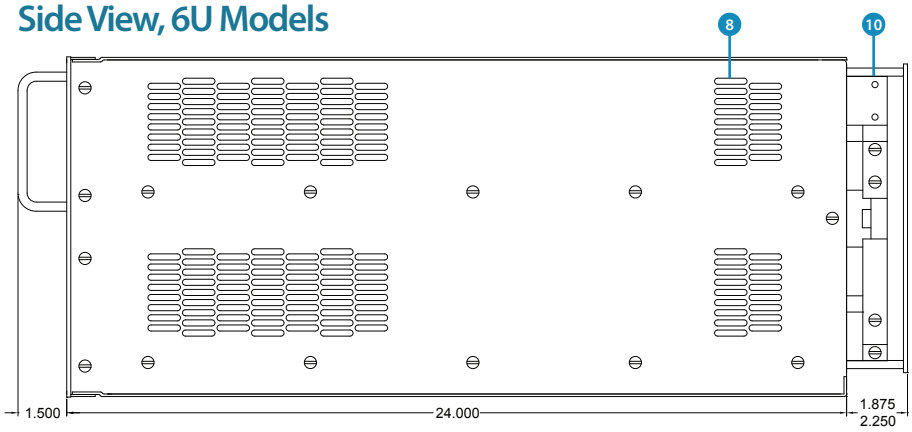
Rear View, 3U Models



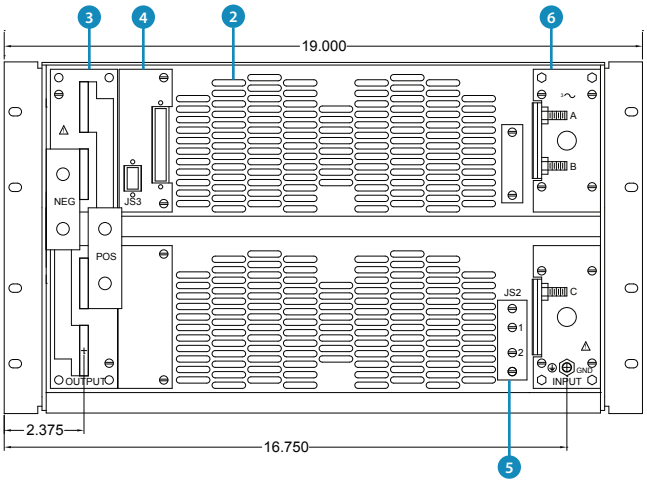
Side View, 3U Models



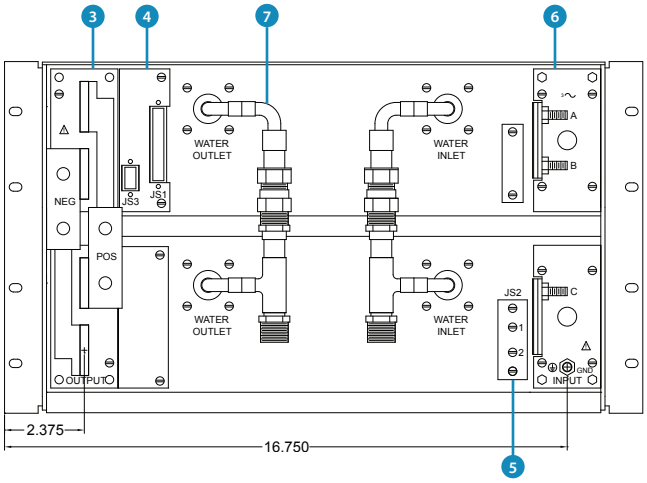
Side View, 6U Models



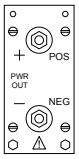
Rear View, 6U Models



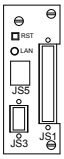
Rear View, 6U Models with Water Cooling (+WC)



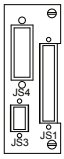
Output Bus for Models Greater Than 1000 Vdc



Optional (+LXI) Interface



Optional (+GPIB) Interface



1. Front Panel Handles
2. Rear Air Exhaust
3. Output DC Connections - 3/8-16 Threaded Insert
   Qty (1) Insert Per Bus Bar, 5 kW to 15 kW Models
   Qty (2) Inserts Per Bus Bar, 20 kW to 30 kW Models
   Qty (4) Inserts Per Bus Bar, 45 kW Models
4. Computer and External Control Connections
5. Remote Sensing Connector
6. Input AC Connections
   1/4-20 Bolt, Qty (4) PLC'S
7. Water Inlet-Outlet for Models with +WC Option
8. Side Air Intake (Air-Cooled Models Only)
9. Output DC Connections, 5 kW - 15 kW (Side View)
10. Output DC Connections, 20 kW - 45 kW (Side View)

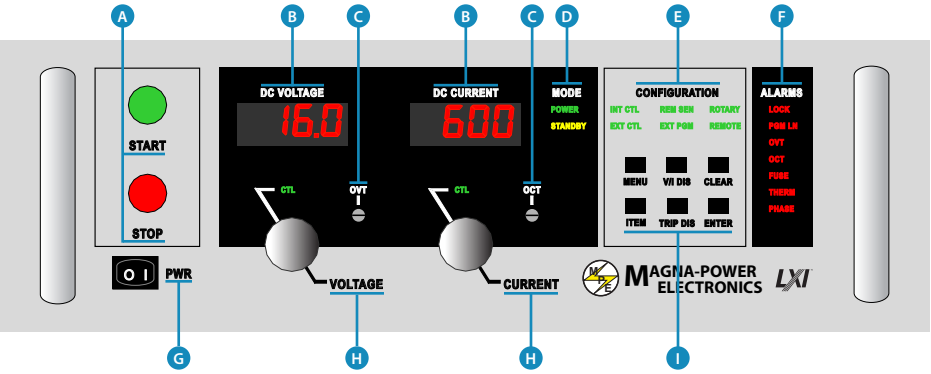
Note: Metal Cover included for rear panel on 5 kW to 15 kW models. Stand-offs included for all other models.

Front Panel Types (TS/MS/MT Series)

This section details the various front panel types available for the TS Series, MS Series, and MT Series power supplies. For the XR Series front panels, refer to its diagram page.

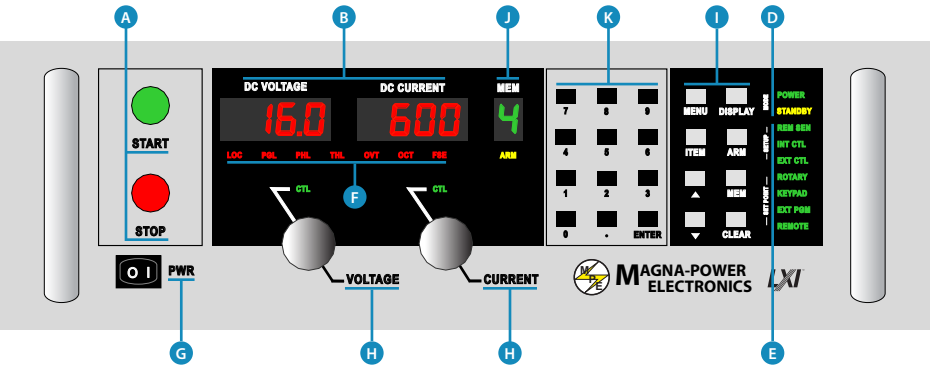
A Version Front Panel

The A Version front panel provides a digital display with rotary front panel input, isolated 37-pin analog/digital I/O, and a RS232 computer interface.



D Version Front Panel

In addition to the features of the A Version front panel, the D Version front panel provides digital 10-key entry, auto-sequencing with memory capability, and modulation for non-linear power profile emulation.



C Version Front Panel

The C Version front panel is blank, providing on a switch to enable control power. All control must be performed by the provided isolated 37-pin analog/digital I/O or through a computer interface.

- **A** Engages and disengages main power
- **B** Meters display output voltage, output current, voltage set point, current set point, over voltage trip, and over current trip
- **C** Over voltage trip and over current trip setting potentiometers
- **D** MODE
  POWER: Indicates power output
  STANDBY: Indicates control power only
- **E** 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
  KEYPAD: 10-digit numeric keypad control
  EXT PGM: External voltage/current control
  REMOTE: Computer control
- **F** DIAGNOSTIC ALARMS
  LOCK: Interlock
  PGM LN: External input voltage beyond limits
  OVT: Over-voltage protection has tripped
  OCT: Over-current protection has tripped
  THERM: Indicates over-temperature condition
  PHASE: Indicates under-voltage AC input
  FSE: Warns that a fuse has cleared
  ARM: Indicates power supply is ready for or operating in auto-sequencing
- **G** Power switch energizes control circuits without engaging main power
- **H** Stepless rotary knob to set voltage/current
- **I** 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
  MEM: Sets the memory location
- **J** Memory location indicator, used for auto-sequencing applications
- **K** Digital input keypad

Low Voltage High Current Units

Magna-Power Electronics offers a range of standard low voltage high current units based on TS Series IV and MS Series IV that do not fit in these series' standard power envelopes. All of the product options are available for these models.

Model	Voltage Maximum (Vdc)	Current Maximum (Adc)	Power (kW)	Ripple (mVrms)	Efficiency (%)	Size	Input Current (Aac)		
							208/240 Vac	380/415 Vac	440/480 Vac
TS5-1800	5	1800	9.0	50	86	6U	38	22	18
TS8-1200	8	1200	9.6	40	86	6U	38	22	18
TS5-2700	5	2700	13.5	50	86	9U	57	33	27
TSA10-1800	10	1800	18.0	40	86	6U	72	42	36
TSA10-2700	10	2700	27.0	40	86	9U	108	63	48
MS5-2700	5	2700	13.5	50	86	18U Cabinet	57	30	27
MS5-3600	5	3600	18.0	50	86	18U Cabinet	76	40	36
MS5-4500	5	4500	22.5	50	86	30U Cabinet	95	50	45
MS10-2700	10	2700	27.0	40	86	18U Cabinet	108	62	54
MS10-3600	10	3600	36.0	40	86	18U Cabinet	144	84	72
MS10-4500	10	4500	45.0	40	86	30U Cabinet	180	106	90

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, CAB4, CAB3x2, CAB4x2
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:

- Hoffman® cabinet frames
- 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 Name	Dimensions (H″ x W″ x D″)	Rack Units
CAB1	32″ x 24″ x 31.5″	12U
CAB2	51.5" x 24" x 31.5"	24U
CAB3	67″ x 24″ x 31.5″	30U
CAB4	75″ x 24″ x 31.5″	36U
CAB3x2	67″ x 48″ x 31.5″	60U
CAB4x2	75″ x 48″ x 31.5″	72U

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 Vo 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	± (2000 Vdc + Vo/2)	± (2000 Vdc + Vo/2)
MS Series	1000 Vdc	± (2000 Vdc + Vo/2)	± (2000 Vdc + Vo/2)
MT Series	1000 Vdc	4000 Vdc	4000 Vdc

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

UID47: Universal Interface Device

Option Code:	UID47
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-uited 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 (Adapter)

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-485 (Adapter)

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

The RS-485 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.