

# TS Series

## 3U to 16U Programmable DC Power Supply • Rugged Current-Fed Power Processing

### Overview

The TS Series offers many models spanning 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 6,000 Vdc (floating) and current levels from 1.2 Adc up to 10,000 Adc. Models 5 kW to 15 kW are available in a 3U chassis, models 20 kW and 25 kW are available in a 4U chassis, models 30 kW are available in a 6U chassis, models 40 kW and 50 kW are available in an 8U chassis with removable casters, models 75 kW models are available in a 12U chassis with removable casters, and 100 kW models are available in a 16U chassis with removable casters. In addition, there are several special low voltage high current models, 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, and LabVIEW drivers for integration into a variety of programming environment.



TS Series 4U Models. Rack-mount kit included.

### Models

	5 kW	10 kW	15 kW	20 kW	25 kW	30 kW	40 kW	50 kW	75 kW	100 kW		
	3U	3U	3U	4U/6U <sup>2</sup>	4U/6U <sup>2</sup>	6U	8U	8U	12U	16U		
Max Voltage (Vdc)	Max Current (Adc)										Ripple <sup>5</sup> (mVrms)	Efficiency
5	900	1800 <sup>1</sup>	2700 <sup>1</sup>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50	84%
8	600	N/A	N/A	2500 <sup>3,4</sup>	N/A	N/A	5000 <sup>4</sup>	N/A	7500 <sup>4</sup>	10000 <sup>4</sup>	40	85%
10	500	900	N/A	2000 <sup>3</sup>	2700 <sup>1</sup>	N/A	4000	N/A	6000	8000	40	87%
16	300	600	900	N/A	N/A	1800	N/A	N/A	N/A	N/A	35	87%
20	250	500	750	1000	1250	1500	2000	2500	3750	5000	40	88%
25	200	400	600	800	1000	1200	1600	2000	3000	4000	40	89%
32	150	300	450	625	781	900	1250	1562	2343	3124	40	89%
40	125	250	375	500	625	750	1000	1250	1875	2500	40	89%
50	100	200	300	400	500	600	800	1000	1500	2000	50	89%
60	83	166	249	333	416	498	666	832	1248	1664	60	90%
80	62	124	186	250	312.5	372	500	625	937.5	1250	60	90%
100	50	100	150	200	250	300	400	500	750	1000	60	90%
125	40	80	120	160	200	240	320	400	600	800	100	90%
160	31	62	93	125	156	186	250	312	468	624	120	90%
200	25	50	75	100	125	150	200	250	375	500	125	91%
250	20	40	60	80	100	120	160	200	300	400	130	91%
300	16	32	48	66.6	83.3	96	133.2	166.6	249.9	333.2	160	91%
375	13	26	39	53.3	66.6	78	106.6	133.2	199.8	266.4	170	92%
400	12	24	36	50	62.4	72	100	125	187.2	249.6	180	92%
500	10	20	30	40	50	60	80	100	150	200	220	92%
600	8	16	24	33.3	41.6	48	66.6	83.2	124.8	166.4	250	92%
800	6	12	18	25	31.2	36	50	62.4	93.6	124.8	300	92%
1000	5	10	15	20	25	30	40	50	75	100	350	92%
1250	4	8	12	16	20	24	32	40	60	80	375	92%
1500	3.3	6.6	9.9	13.3	16.6	19.8	26.6	33.2	49.8	66.4	400	92%
2000	2.5	5	7.5	10	12.5	15	20	25	37.5	50	600	92%
3000	1.6	3.2	4.8	6.6	8.3	9.6	13.2	16.6	24.9	33.2	650	92%
4000	1.2	2.4	3.6	5	6.2	7.2	10	12.4	18.6	24.8	700	92%
5000	1	2	3	4	5	6	8	10	15	20	1500	92%
6000	0.8	1.6	2.5	3.3	4.1	5	6.6	8.3	12.3	16.4	1700	92%
AC Input Voltage (Vac)	Input Current Per Phase (Aac)											
208/240 Vac, 1Φ	41	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
208/240 Vac, 3Φ	18	36	52	69	85	105	N/A	N/A	N/A	N/A		
380/415 Vac, 3Φ	10	20	29	38	47	57	76	94	141	188		
440/480 Vac, 3Φ	9	17	25	33	40	50	66	82	120	160		

<sup>1</sup> 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 within the same power envelope.

<sup>2</sup> 20/25 kW models with 380/415, 3Φ input or 440/480 Vac, 3Φ input come in a 4U chassis. 20/25 kW models with 208/240, 3Φ input come in a 6U chassis.

<sup>3</sup> Available with 380/415, 3Φ input or 440/480 Vac, 3Φ input only, 4U.

<sup>4</sup> 45°C max ambient operating temperature rating for standard air cooled configurations. 50°C max ambient operating temperature rating for configurations with Water Cooling (+WC) option.

<sup>5</sup> Ripple specified for standard models. Ripple will be higher for models with the High Slew Rate Output (+HS). Refer to option page for more details.

# TS Series

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## Key Features

- SCPI Remote Programming API
- High Accuracy Measurements
- Master-Slave Functionality
- Remote Sensing
- 37-Pin External User I/O
- RS232 Interface
- Ethernet and GPIB Available
- 0-10V External Analog Inputs
- Programmable Protection Limits
- Fast Transient Response
- Remote Interface Software
- NI LabVIEW™ and IVI Driver
- Interlock Shutdown Input
- Designed and manufactured in the USA

## Available Options

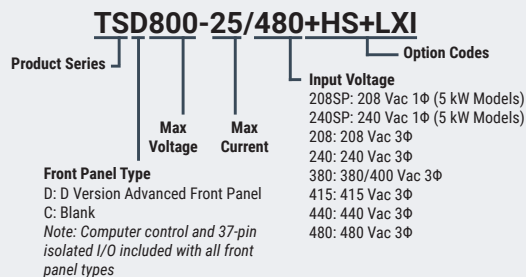
- Blocking Diode (+BD)
- High Isolation Output (+ISO)
- High Slew Rate Output (+HS)
- IEEE-488 GPIB Communications (+GPIB)
- LXI TCP/IP Ethernet Communications (+LXI)
- Water Cooling (+WC)

## TS Series Model Ordering Guide

There are 279 different models in the TS Series spanning power levels: 5 kW, 10 kW, 15 kW, 20 kW, 25 kW, 30 kW, 40 kW, 50 kW, 75 kW and 100 kW.

To determine the appropriate model:

1. Select the desired Max Voltage (Vdc) from the left-most column.
2. Select the desired Max Current (A<sub>dc</sub>) from the same row that contains your desired Max Voltage.
3. Construct your model number according to the model ordering guide.



## Specifications

### Physical Specifications

Power Level	Rack Units	Size	Weight
<b>5 kW</b>	3U	5.25" H x 19" W x 24" D (13.34 x 48.26 x 60.96 cm)	74 lbs (34.57 kg)
<b>10 kW</b>	3U	5.25" H x 19" W x 24" D (13.34 x 48.26 x 60.96 cm)	94 lbs (42.64 kg)
<b>15 kW</b>	3U	5.25" H x 19" W x 24" D (13.34 x 48.26 x 60.96 cm)	125 lbs (56.70 kg)
<b>20 kW</b> 380/415 Vac, 3Φ input 440/480 Vac, 3Φ input	4U	7" H x 19" W x 24" D (17.8 x 48.2 x 60.9 cm)	160 lbs (72.6 kg)
<b>20 kW</b> 208/240 Vac, 3Φ input	6U	10.5" H x 19" W x 24" D (26.67 x 48.26 x 60.96 cm)	185 lbs (83.9 kg)
<b>25 kW</b> 380/415 Vac, 3Φ input 440/480 Vac, 3Φ input	4U	7" H x 19" W x 24" D (17.8 x 48.2 x 60.9 cm)	180 lbs (81.7 kg)
<b>25 kW</b> 208/240 Vac, 3Φ input	6U	10.5" H x 19" W x 24" D (26.67 x 48.26 x 60.96 cm)	220 lbs (99.79 kg)
<b>25 kW</b>	4U	7" H x 19" W x 24" D (17.8 x 48.2 x 60.9 cm)	185 lbs (83.9 kg)
<b>30 kW</b>	6U	10.5" H x 19" W x 24" D (26.67 x 48.26 x 60.96 cm)	245 lbs (111.1 kg)
<b>40 kW</b>	8U	With casters removed: 14" H x 19" W x 24" D (35.6 x 48.2 x 60.9 cm)  With casters attached: 17.75" H x 19" W x 24" D (45.1 x 48.2 x 60.9 cm)	315 lbs (142.9 kg)
<b>50 kW</b>	8U	With casters removed: 14" H x 19" W x 24" D (35.6 x 48.2 x 60.9 cm)  With casters attached: 17.75" H x 19" W x 24" D (45.1 x 48.2 x 60.9 cm)	355 lbs (161.0 kg)
<b>75 kW</b>	12U	With casters removed: 21" H x 19" W x 24" D (53.3 x 48.2 x 60.9 cm)  With casters attached: 24.75" H x 19" W x 24" D (62.9 x 48.2 x 60.9 cm)	540 lbs (244.9 kg)
<b>100 kW</b>	16U	With casters removed: 28" H x 19" W x 24" D (71.1 x 48.2 x 60.9 cm)  With casters attached: 31.75" H x 19" W x 24" D (80.7 x 48.2 x 60.9 cm)	725 lbs (328.9 kg)

### Regulatory Compliance

<b>EMC</b>	Complies with 2014/30/EU (EMC Directive) CISPR 22 / EN 55022 Class A
<b>Safety</b>	Complies with EN61010-1; Complies with 2014/35/EU (Low Voltage Directive)
<b>CE Mark</b>	Yes
<b>RoHS Compliant</b>	Yes

Specifications continued on the next page >

# TS Series

## 3U to 16U Programmable DC Power Supply • Rugged Current-Fed Power Processing

### Specifications (Continued)

#### AC Input Specifications

<b>1Φ AC Input Voltage</b> 1Φ, 2-wire + ground Available on 5 kW models	208 Vac (208SP; operating range 187-229 Vac) 240 Vac (240SP; operating range 216-264 Vac)
<b>3Φ AC Input Voltage</b> 3Φ, 3-wire + ground	208 Vac (operating range 187 to 229 Vac) 240 Vac (operating range 216 to 264 Vac) 380/400 Vac (operating range 342 to 440 Vac) 415 Vac (operating range 373 to 456 Vac) 440 Vac (operating range 396 to 484 Vac) 480 Vac (operating range 432 to 528 Vac)
<b>AC Input Current</b>	Refer to chart of available models
<b>AC Input Frequency</b>	50-400 Hz
<b>Power Factor</b>	>0.92 at max power; models with 3Φ AC input >0.70 at max power; models with 1Φ AC input
<b>AC Input Isolation</b>	±2500 Vac, maximum input voltage to ground

#### Output Specifications

<b>Voltage Ripple</b>	Refer to chart of available models.
<b>Line Regulation</b>	Voltage mode: ± 0.004% of full scale Current mode: ± 0.02% of full scale
<b>Load Regulation</b>	Voltage mode: ± 0.01% of full scale Current mode: ± 0.04% of full scale
<b>Load Transient Response</b>	2 ms to recover within ±1% of regulated output with a 50% to 100% or 100% to 50% step load change
<b>Stability</b>	± 0.10% for 8 hrs. after 30 min. warm-up
<b>Efficiency</b>	84% to 92%; refer to chart of available models
<b>DC Output Isolation</b> Models Rated ≤1000 Vdc	±1000 Vdc, max output voltage to ground
<b>DC Output Isolation</b> Models Rated >1000 Vdc or Models with +ISO Option	±(3000 Vdc + Vo/2), max output voltage to ground, where Vo is the max rated voltage

#### Programming Specifications

<b>Programming Accuracy</b>	Voltage: ±0.075% of max voltage rating Current: ±0.075% of max current rating
<b>Measurement Accuracy</b>	Voltage: ±0.2% of max voltage rating Current: ±0.2% of max current rating
<b>Maximum Slew Rate</b> Standard Models	< 170 ms, output voltage change from 0 to 63% < 200 ms, output current change from 0 to 63%
<b>Maximum Slew Rate</b> Models with High Slew Rate Option (+HS)	< 5 ms, output voltage change from 0 to 63% < 10 ms, output current change from 0 to 63%
<b>Trip Settings Range</b>	Over Voltage: 10% to 110% max voltage rating Over Current: 10% to 110% max current rating
<b>Computer Command Protocol</b>	Standard Commands for Programmable Instruments (SCPI)
<b>Remote Sense Limits</b> Wired; Available on Models Rated ≤1000 Vdc	3% maximum voltage drop from output to load

#### Connectivity Specifications

<b>Communication Interfaces (Standard)</b>	RS232: DB-9, Female External User I/O: DB-37, Female
<b>Communication Interfaces (Optional)</b>	LXI TCP/IP Ethernet: RJ-45 GPIB: IEEE-488

#### External User I/O Specifications

<b>Digital Inputs</b>	5 V, 10 kΩ impedance
<b>Digital Monitoring Signals</b>	5 V, 5 mA capacity
<b>Digital Reference Signal</b>	5 V output, 25 mA capacity
<b>Analog Programming Input</b>	0-10 V
<b>Analog Programming Impedance</b>	10 kΩ
<b>Analog Monitoring Signals</b>	0-10 V, 5 mA capacity
<b>Analog Monitoring Impedance</b>	100 Ω
<b>Analog Monitoring Accuracy</b>	0.2% of max rating
<b>Analog Reference Signal</b>	10 V, 5 mA capacity, 1 Ω impedance

#### Environmental Specifications

<b>Ambient Operating Temperature</b>	-25°C to 50°C
<b>Storage Temperature</b>	-40°C to +85°C
<b>Humidity</b>	Relative humidity up to 95% non-condensing
<b>Temperature Coefficient</b>	0.04%/°C of maximum output voltage 0.06%/°C of maximum output current
<b>Air Cooling</b> 3U and 6U Models	Side air inlet, rear exhaust
<b>Air Cooling</b> 4U, 8U, 12U and 16U Models	Front and side air inlet, rear exhaust
<b>Water Cooling</b> With +WC Option	25°C maximum inlet temperature 1.5 GPM minimum flow rate for 3U/4U units 3.0 GPM minimum flow rate for 6U/8U units 4.5 GPM minimum flow rate for 12U units 6.0 GPM minimum flow rate for 16U units 80 PSI maximum pressure 1/4" NPT male pipe size (3U/4U models) 1/2" NPT male pipe size (6U/8U/12U/16U models) Front air intake, rear exhaust (6U/8U/12U/16U models only)



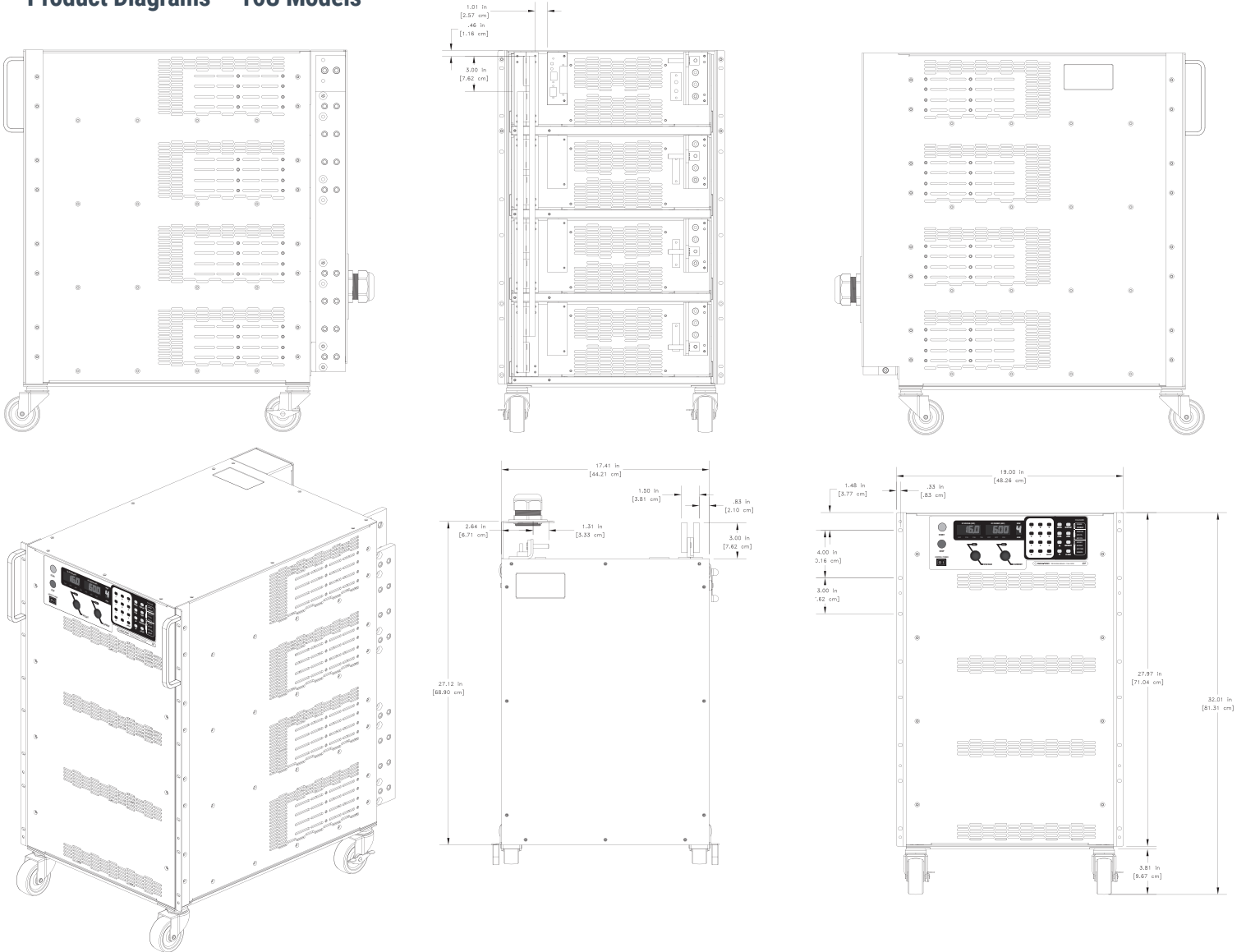
TS Series 16U models with removable casters installed. Rack-mount kit included.

Note: Specifications are subject to change without notice. Input voltage specifications are line-to-line.

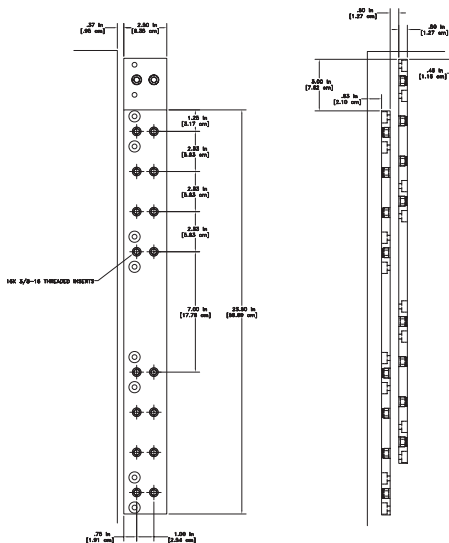
# TS Series

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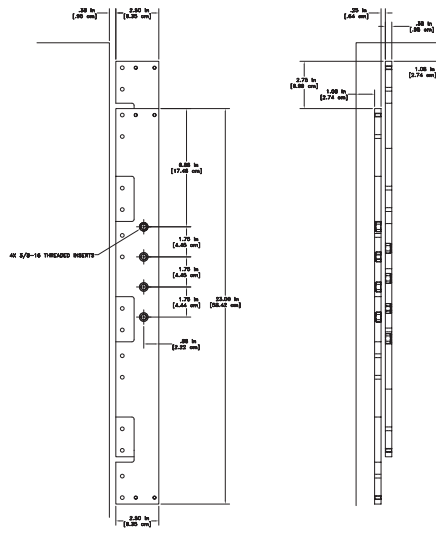
## Product Diagrams – 16U Models



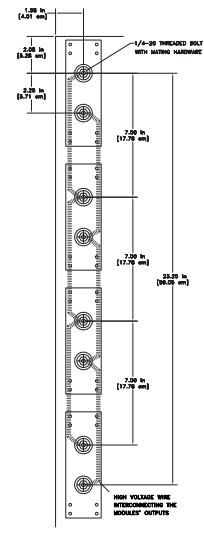
**DC Output Bus**  
16U Models Rated < 125 Vdc



**DC Output Bus**  
16U Models Rated 125 Vdc to 1000 Vdc



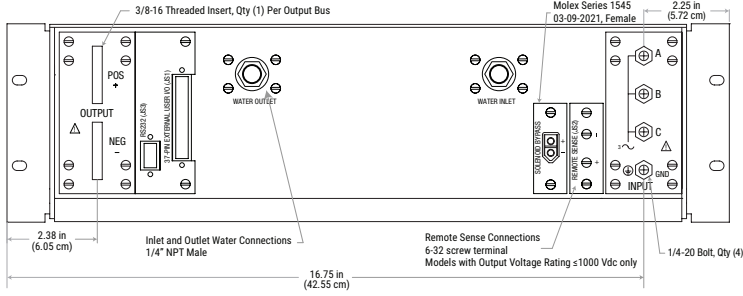
**DC Output Bus**  
16U Models Rated > 1000 Vdc or with +HSO Option



**Product Diagrams – With Water Cooling (+WC) Option**

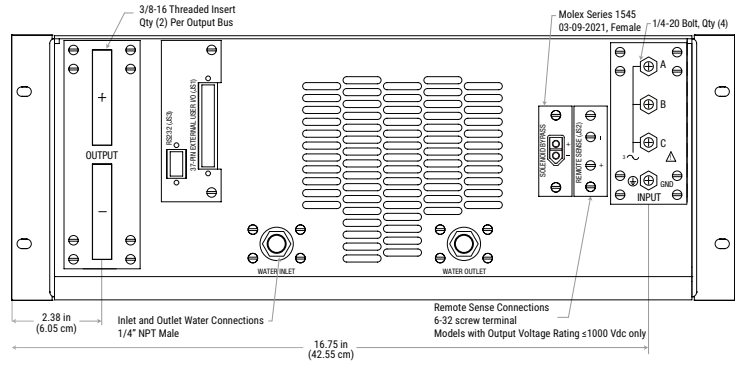
**Rear Panel**

3U Models, With Water Cooling (+WC) Option



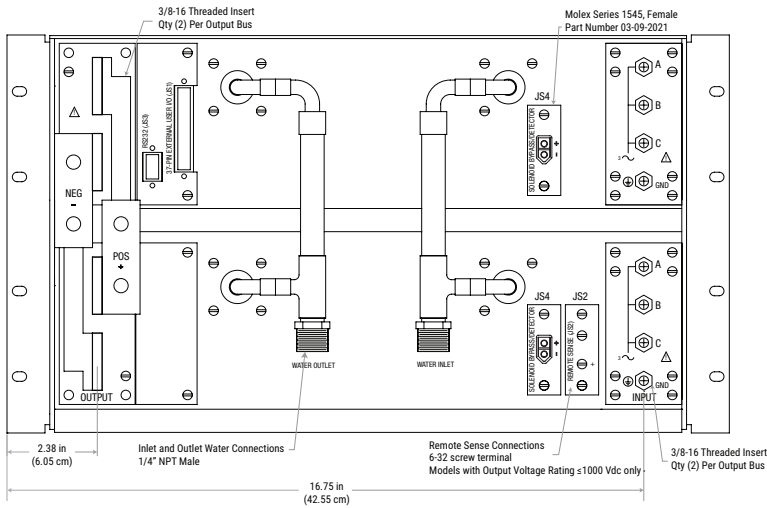
**Rear Panel**

4U Models, With Water Cooling (+WC) Option



**Rear Panel**

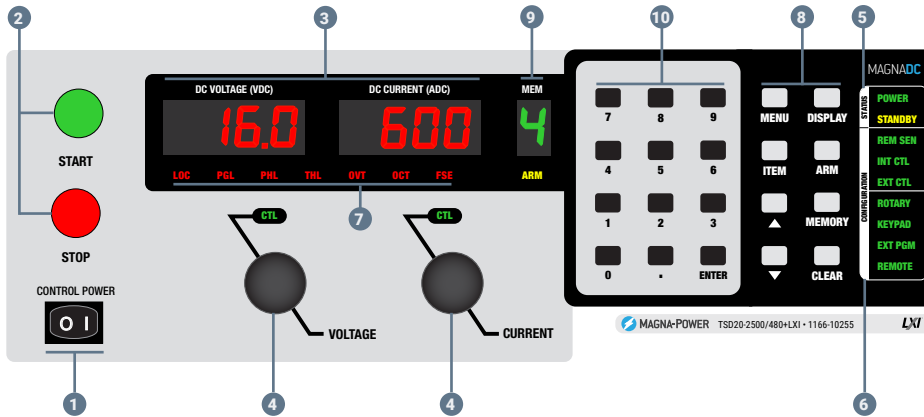
6U Models, With Water Cooling (+WC) Option



### TS Series Front Panel Types

#### D Version Front Panel

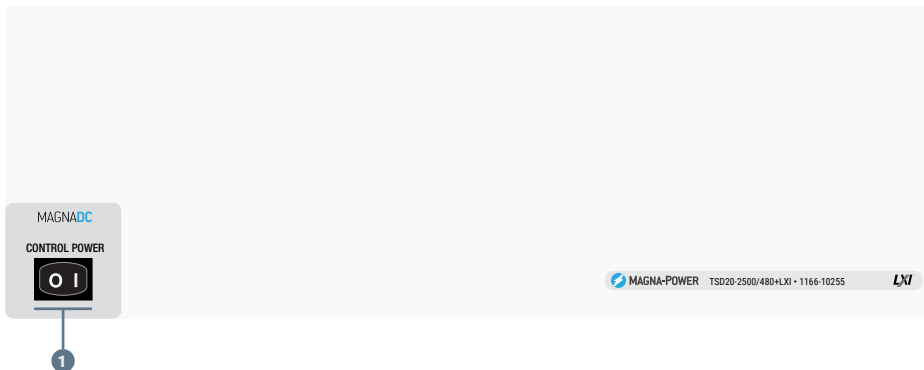
The standard D Version front panel offers front panel provides a digital display with rotary front panel input, isolated 37-pin analog/digital I/O, and a RS232 computer interface. In addition, the D Version front panel provides digital 10-key entry, auto-sequencing with memory capability, and modulation for non-linear power profile emulation.



- 1 Power switch energizes control circuits without engaging main power
- 2 Engages and disengages main power via integrated mechanical contactor
- 3 Meters display output voltage, output current, voltage set point, current set point, over voltage trip and over current trip
- 4 Stepless aluminum rotary knob to set voltage and current
- 5 POWER: Indicates power output  
STANDBY: Indicates control power only
- 6 Configuration  
REM SEN: Remote sense enabled  
INT CTL: Front panel start/stop/clear enabled  
EXT CTL: External start/stop/clear enabled  
ROTARY: Front panel rotary knob input  
EXT PGM: External analog voltage-current control  
REMOTE: Computer control
- 7 Diagnostic Alarms  
LOC/LOCK: Interlock  
PGM LN: External input voltage beyond limits  
THERM: Over-temperature condition  
OVT: Over-voltage protection has tripped  
OCT: Over-current protection has tripped  
FUSE: Indicates a fuse has cleared  
PHASE/PHL: Indicates input AC phase loss
- 8 Function Keys  
MENU: Selects function  
ITEM: Selects item within function  
DISPLAY or V/I DIS: Displays V/I set points  
TRIP DIS: Displays OVT and OCT settings  
CLEAR: Clears setting or resets fault  
ENTER: Selects item  
MEM: Sets the memory location
- 9 Memory location indicator, used for autosequencing applications
- 10 Digital input keypad

#### 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.





TS Series 16U models with included rear covers removed. Rack-mount kit included.



TS Series 16U models with included rear covers added. Rack-mount kit included.



TS Series 16U models with removable casters installed. Rack-mount kit included.



## Innovation in Programmable Power

Magna-Power designs and manufactures robust programmable power products in the USA that set industry standards for quality, size, and control. The company's experience in power electronics is reflected in its 1.25 kW to 2000 kW+ product line, quality service, and reputation for excellence. Today, you will find Magna-Power's standard products at its thousands of customers worldwide, aiding in the manufacture of electric vehicles, simulating solar arrays for development of inverters, steering magnets for particle accelerators, powering radar systems, driving traction controllers for locomotive development, or at a wide range of Universities for cutting-edge energy research.

### Quick Facts

#### Year Founded

1981

#### Total Power Shipped

390+ megawatts

#### Headquarters and Manufacturing Location

Flemington, New Jersey USA

#### Facility Size

73,500 ft<sup>2</sup>

### Vertically Integrated USA Manufacturing

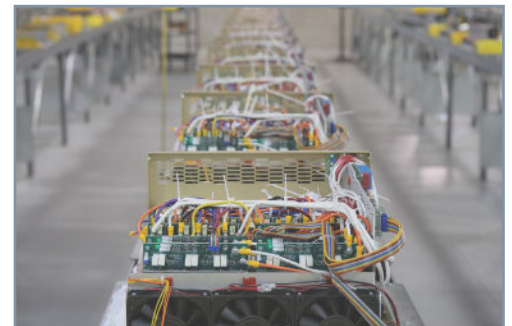
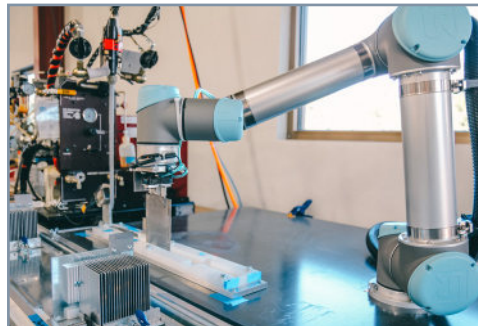
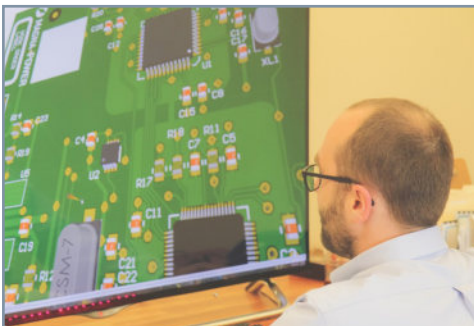
Magna-Power Electronics products are proudly made in the USA at the company's vertically integrated, company designed and owned 73,500 ft<sup>2</sup> headquarters in Flemington, New Jersey. All engineering, manufacturing and North America product servicing is performed at the company's headquarters.

Magna-Power Electronics utilizes vertical integration in its manufacturing process for complete control over quality, cost, and lead-time of its made-to-order products. As the company has grown, more operations have been internalized.

Vertical integration enables Magna-Power to manufacture a very broad line of sophisticated electronic products, while still maintaining industry leading lead-times. Housing engineering and manufacturing teams in the same facility forces strong collaboration between the two teams for continual process and product improvements.

### Internal Company Processes

- Research and development
- Magnetics winding
- Magnetic core punching and cutting
- Full sheet metal operations
- EDM and CNC machining
- Cable harnessing
- Powder coating
- Robotic air- and water-cooled heat-sink fabrication
- Surface-mount and through-hole printed circuit board assembly
- Final assembly, testing, and burn-in



# MagnaDC Overview

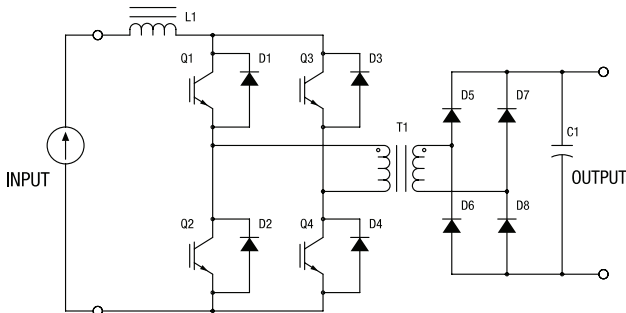
## Fully Programmable DC Power

MagnaDC programmable DC power supplies features programmable voltage, current, and protection settings along with high accuracy measurements. The SL Series functions and features are accessible and configurable from a variety of control methods, including:

- Front panel interface with stepless knobs
- 37-pin isolated analog-digital user I/O
- RS232 Computer interface with software and drivers

Various additional programming interfaces are available, such as LXI TCP/IP Ethernet (+LXI), IEEE-488 GPIB (+GPIB), Edgeport USB Accessory (+USB), RS485 Accessory (+RS485).

## Current-Fed Topology: Robust Power Conversion



All MagnaDC programmable DC power supplies utilize high-frequency IGBT-based power processing in current-fed topology. This topology adds an additional stage over the conventional voltage-fed topology for enhanced control and system protection, ensuring that even under a fault condition, the power supply will self-protect. Due to the self-protecting characteristics of this topology, the possibility of fast rising current spikes and magnetic core saturation is eliminated.

In addition to its robust topology, key performance characteristics of MagnaDC programmable DC power supplies include:

- High-accuracy voltage and current programming accuracy
- Class-leading line and load regulation performance
- High 3 $\Phi$  AC input power factor with in-rush limiting circuitry
- Computer and user I/O isolated from the power supply output

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 ensure satisfactory operation even under the worst line voltage conditions.

## Designed for Safety

MagnaDC programmable DC power supplies have extensive diagnostic functions, including:

- AC Phase Loss
- Excessive Thermal Conditions
- Over Voltage Trip (Programmable)
- Over Current Trip (Programmable)
- Cleared Fuse
- Excessive Program Line Voltage
- Interlock Fault

When in standby or diagnostic fault, the AC mains are mechanically disconnected by an embedded AC contactor, providing confidence that the unit is only processing power when desired.

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.

## Included Software Interface: RIS Panel

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.



## High-Performance Plug and Play Master-Slaving

The MagnaDC programmable DC power supplies' master-slaving strategy helps to ensure no degradation in performance as units are added in parallel or series by providing gate drive signals directly to the slave units from the master. This strategy eliminates the noise susceptibility commonly found when sending analog control references over long distances, in addition to maintaining a single control loop.

The UID47 eases master-slave parallel or series configuration of Magna-Power DC power supplies, enabling near equal current or voltage sharing, depending on the configuration.



## Isolated External I/O For Hardware-in-the-Loop or PLC Control

Using the rear isolated 37-pin I/O connector, the MagnaDC 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 from the output terminals and referenced to earth-ground as standard—no additional isolation equipment or options necessary.

The following list summarizes the available I/O from the power supply:

- 4 analog inputs
- 2 analog outputs
- 5 digital inputs
- 15 digital outputs
- +2.5V, +5V and +10V reference signals

With the High Slew Rate Output (+HS) option equipped, high bandwidth operation is enabled along with fast rise times, allowing the MagnaDC programmable DC power supplies to address requirements for Hardware-in-the-Loop (HIL).

## Extensive Programming Support

All MagnaDC programmable DC power supplies 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 MagnaDC power supply. All of the MagnaDC power supplies are available communication interfaces are supported by these drivers and command sets, including: RS232, LXI TCP/IP Ethernet, IEEE-488 GPIB, USB or RS485.

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 SL Series User Manual.

Python programming example using SCPI commands

```
import serial
conn = serial.Serial(port='COM8', baudrate=19200)
conn.write('*IDN?\n')
print conn.readline()
conn.write('VOLT 1000\n')
conn.write('CURR 5\n')
conn.write('OUTP:START\n')
conn.write('MEAS:CURR?\n')
print conn.readline()
```

## Designed and Manufactured in the USA



For complete control of quality, MagnaDC programmable DC power supplies are designed and manufactured at

Magna-Power's vertically integrated USA manufacturing facility in Flemington, New Jersey. Heat-sinks and chassis are machined from aluminum. All sheet metal is fabricated and powder coated in-house. Magnetics are wound-to-order from validated designs based on a model's voltage and current. An automated surface-mount production line places components on printed circuit boards for control, driver, auxiliary power, and display circuits. And finally after assembly, products undergo comprehensive test and NIST-traceable calibration, followed by an extended burn-in period.

## Tailor Performance with Integrated Options

Magna-Power's MagnaDC programmable power supplies are designed to be flexible, depending on the application's requirements. With its configured-to-order integrated options, including:

- Blocking Diode (+BD)
- IEEE-488 GPIB (+GPIB)
- High Slew Rate Output (+HS)
- High Isolation Output (+ISO)
- LXI TCP/IP Ethernet (+LXI)
- Ruggedized (+RUG)
- Water Cooling (+WC)



## Blocking Diode (+BD)

The integrated **Blocking Diode (+BD)** option provides an internally heat-sunk protection diode on the positive output terminal of a MagnaDC programmable DC power supply. This diode protects the product's output from reverse voltage up to 1200 Vdc. All voltage sensing is performed after the protection diode—at the product's output terminals—making the diode's operation completely transparent to the performance of the power supply.

The +BD option is recommended for applications where there is significant back-emf or the possibility of a DC output voltage that could exceed the power supply's output voltage rating, such as:

- DC motor drives
- Battery and capacitor charging
- Large electromagnets

In these applications, the integrated blocking diode can be used to prevent back-emf from the energy stored in the load into the power supply's output. Furthermore, the integrated blocking diode will prevent the power supply's internal bleed resistance from discharging the energy stored in the load when the power supply is off or in standby.

### Availability

The +BD option is available for models with maximum output voltage rating as specified for the following product series:

- TS Series, models rated from 40 Vdc to 1000 Vdc
- MS Series, models rated from 40 Vdc to 1000 Vdc
- MT Series, models rated from 125 Vdc to 1000 Vdc

The +BD option cannot be combined with the +ISO option.

### Specifications

#### Additional Specifications for Blocking Diode (+BD) Option

##### Reverse Voltage Rating

Models Rated 1200 Vdc  
125 Vdc to 1000 Vdc

##### Reverse Voltage Rating

Models Rated 200 Vdc  
Below 125 Vdc

##### Additional Losses

Models Rated Up to 1.4%  
125 Vdc to 1000 Vdc

##### Additional Losses

Models Rated Up to 2.5%  
Below 125 Vdc

## High Isolation Output (+ISO)

Certain applications require floating the output voltage to values beyond the power supply isolation rating. Magna-Power's **High Isolation Output Option (+ISO)** enables a 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 be tied together in series up to its new higher isolation rating, in accordance with the table in the Specifications section below.

### Availability

The +ISO option is available for models with maximum output voltage rating as specified for the following product series:

- TS Series, models rated from 250 Vdc to 1000 Vdc
- MS Series, models rated from 250 Vdc to 1000 Vdc
- MT Series, models rated from 250 Vdc to 1000 Vdc

The +ISO option cannot be combined with the +BD or +WC options. Addition of the +ISO option will cause the product's wired remote sense feature to be removed.

### Specifications

#### Output Isolation Rating for Various Configurations

Product Series	Output Isolation Standard, No Option	Output Isolation for Models Rated 250-1000 Vdc With +ISO Option	Output Isolation for Models Rated Above 1000 Vdc; Standard, No Option Necessary
<b>SL Series</b>	±1500 Vdc	N/A	N/A
<b>XR Series</b>	±1500 Vdc	N/A	±(1500 Vdc + Vo/2)
<b>TS Series</b>	±1000 Vdc	±(3000 Vdc + Vo/2)	±(3000 Vdc + Vo/2)
<b>MS Series</b>	±1000 Vdc	±(3000 Vdc + Vo/2)	±(3000 Vdc + Vo/2)
<b>MT Series</b>	±1000 Vdc	±6000 Vdc	±6000 Vdc

## High Slew Rate Output (+HS)

The High Slew Rate Output (+HS) 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 and lower loss bleed resistors are 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 and lower loss bleed resistors. 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 increased ripple voltage.

### Key Applications

For battery charger applications, output capacitance and internal bleed resistors present themselves as a load to the connecting batteries. One common practice is to use a series diode to block reverse current flow with the sacrifice of increased cost and lower efficiency. The high slew rate option, with its lower output capacitance and lower loss bleed resistors, enables direct connection to batteries without series blocking diodes.

For photovoltaic emulation applications, higher bandwidth and lower output capacitance enable improved performance with higher speed, maximum power tracker algorithms. Maximum power tracker circuitry deviates the operating point of photovoltaic arrays to determine maximum power output. Slow responding emulation sources can present a problem when the speed of the algorithm exceeds that of the source. Furthermore, with lower output capacitance, changes in the operating point and transients, caused by shorting the solar inverter input, produce lower unwanted input currents.

The high-slew rate option enables the power supply to operate as a low frequency, power pulse generator. With the special capacitors selected for this option, it is possible to superimpose waveforms or produce a medium speed pulse on top of the dc output and expect normal capacitor life. It is important to note that the power supply output is single quadrant; that is, the output voltage or current cannot reverse.

### Availability

The +HS option is available for the following product series:

- SL Series
- XR Series
- TS Series
- MS Series
- MT Series

XR Series models greater than 2000 Vdc already include a high slew rate output stage and no additional +HS option is available for these models.

### Additional Specifications for High Slew Rate Output (+HS) Option

Max Voltage Rating	Output Capacitance SL Series (μF)	Output Capacitance XR Series (μF)	Output Capacitance TS Series MS Series (μF) <sup>1</sup>	Ripple (Vrms)
5	4235	13200	13200	0.5
8	N/A	N/A	9000	0.5
10	1740	4080	9000	0.5
16	1740	4080	4080	0.5
20	775	2340	2340	0.7
25	775	1170	2340	0.7
32	775	1170	1170	1.4
40	760	240	1170	1.5
50	760	240	1170	1.5
60	760	240	300	1.5
80	110	240	300	1.5
100	110	160	200	1.6
125	70	160	200	1.6
160	70	160	200	1.6
200	70	160	200	1.6
250	70	160	200	1.6
300	70	160	200	1.8
375	70	160	200	1.8
400	70	160	200	1.8
500	40	56	200	2.1
600	40	56	120	2.3
800	30	52	70	2.5
1000	30	52	60	3.0
1250	N/A	18	18	3.5
1500	N/A	18	18	3.5
2000	N/A	18	18	3.5
3000	N/A	N/A	9	4
4000	N/A	N/A	9	4
6000-10000	N/A	N/A	N/A	N/A

<sup>1</sup> For 20 to 30 kW models, multiply capacitance by 2  
 For 45 kW models, multiply capacitance by 3  
 For 60 kW models, multiply capacitance by 4  
 For 75 kW models, multiply capacitance by 5  
 For TS Series 4U/8U models and MT Series models, please contact Magna-Power support.

## IEEE-488 GPIB (+GPIB)

The **IEEE-488 GPIB (+GPIB)** option, 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 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

The IEEE-488 GPIB interface is integrated with the power supply's rear communication ports. The IEEE 488 interface offers full compatibility with Magna-Power provided drivers, software and SCPI command set.

### Availability

The +GPIB option is available for the following product series:

- SL Series
- XR Series
- TS Series
- MS Series
- MT Series

## LXI TCP/IP Ethernet (+LXI) *LXI*

Certified to the LXI Standard (Class C), version 1.4, the **LXI TCP/IP Ethernet (+LXI)** allows the product to be fully controlled over an integrated TCP/IP Ethernet interface. LXI is an instrumentation platform based on industry standard Ethernet technology designed to provide modularity, flexibility, and performance to small- and medium-sized systems. All of the product's standard SCPI commands are supported over the +LXI option, along with all provided software and drivers.

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.

### Availability

The +LXI option is available for the following product series:

- SL Series
- XR Series
- TS Series
- MS Series
- MT Series

## Ruggedized (+RUG)

The **Ruggedized Option (+RUG)** provides additional mechanical security for large power components and sub-assemblies within SL Series and XR Series products.

SL Series and XR Series units with the Ruggedized Option have been independently tested to comply with the following MIL-STD-810G shock and vibration specifications:

- MIL-STD-810G CHG1 Method 516.7 Functional Shock, Procedure I; which subjects the product to 40G, 11 ms terminal saw tooth pulse; three shocks in each direction along three mutually perpendicular axes
- MIL-STD-810G CHG1 Method 514.7 Vibration; which subjects the product to two hours of vibration per axis along three mutually perpendicular axes

All products with the Ruggedized Option maintain ambient operating temperatures from 0°C to 50°C and ambient storage temperatures from -25°C to +85°C.

### Availability

The +RUG option is available for the following product series:

- SL Series
- XR Series

## Water Cooling (+WC)

The **Water Cooling (+WC)** option is available for Magna-Power power supplies for use in densely packaged system cabinets, where heat removal by the product's standard air cooling presents a challenge.

Water cooling is accomplished with chill plates and an integrated central heat exchanger. The chill plates provide a thermal conduction path for heat sensitive components and the central heat exchanger removes heat from air internal to the enclosure. An internal solenoid valve enables water flow when the chill plate reaches 60°C. Operation of the solenoid prevents internal condensation.

3U and 4U models have a 1/4" NPT male inlet and outlet for water flow. For 6U, 8U, and floor-standing models, external plumbing interconnects power supply modules to a single 1/2" NPT male connection: one for inlet, one for outlet. A minimum of 2.5" 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.

When water cooled power supplies are ordered in combination with the Cabinet and Integration accessory, Magna-Power will parallel the water inlet connections and parallel the water outlet connections, providing a single inlet and outlet for the rack.

### Availability

The +WC option is available for models with maximum output voltage rating as specified for the following product series:

- TS Series, models rated from 1000 Vdc and below
- MS Series, models rated from 1000 Vdc and below

The +WC option cannot be combined with the +ISO option.

### Specifications

Refer to the individual product series specifications.