



# mPower™ DC 411 Bidirectional

## Regenerative Programmable Autoranging DC Power Supplies



Marway's lab quality mPower DC bi-directional power supplies provide both source and sink functionality. When acting as a load, energy can be transferred back to the power grid with up to 96% efficiency.

### Convenience

- Complete configuration, control, and monitoring from graphical control panel.
- Touchscreen interface with multi-function rotary controls simplify operation, and speed up test settings entry.
- Easy locking of controls to prevent unintended changes.
- Control bus shares data among parallel units providing a true single-point for control and monitoring.

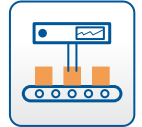
### Control

- Constant voltage, constant current, constant power, and constant resistance modes.
- Protection circuits and alarms for over voltage, current, power, and temperature.
- Output voltage Sense bus monitors voltage at the load, instead of the output terminals, to compensate for minor losses in output cables.
- USB, RS232, Ethernet, CAN, CANopen, Profibus, Profinet, ModbusTCP, EtherCAT, and analog interfaces. Modbus and SCPI command protocols. Windows® application, LabView® VIs, and your own custom scripts for remote control.

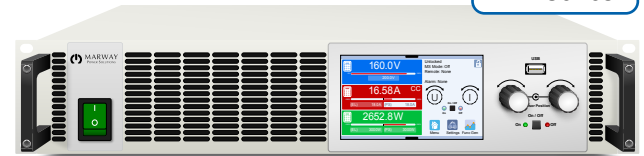
### Power

- Source and sink of the full power capacity.
- Autoranging power control delivers/absorbs 100% power rating over a wide range of voltage and current allowing a wider test range, or a wider set of devices, to be tested with the same unit.
- 1.5, 3, 5, 10, 15, 30 kW capacities.
- Up to 2000 Vdc and up to 1000 amps.
- Parallel operation up to 64 units for up to 1,920 kW.
- Discharge circuit reaches safe Vdc in  $\leq 10$  seconds.

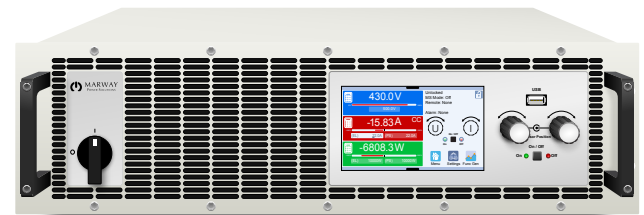
Bidirectional Battery and Fuel Cell Testing  
Solar/Battery Simulations  
Automated Test Suites  
Production Tooling and Testing



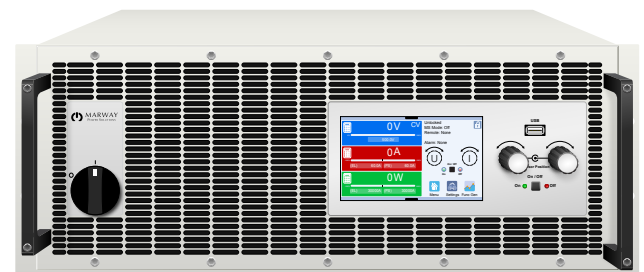
#### 411 Series



2U • 10 to 1500 Volts • 6 to 120 Amps • 1.0 kW, 1.5 kW, 3.0 kW



3U • 10 to 2000 Volts • 20 to 510 Amps • 5 kW, 10 kW, 15 kW



4U • 10 to 2000 Volts • 40 to 1000 Amps • 30 kW

# mPower Bidirectional DC Power Supplies

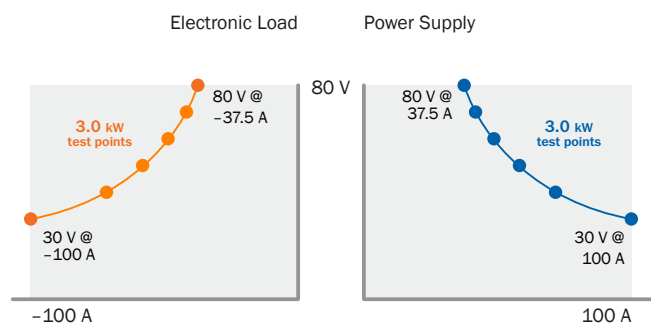
## Autoranging Output Power

Autoranging enables mPower to operate at full power over a wider range than traditional power supplies. Traditional “rectangular envelope” power supplies can provide peak power (watts) at only one specific voltage and current configuration. mPower’s autoranging power envelope can deliver peak power along a curve of voltage and current configuration points.

You’ll notice that any given mPower model’s maximum DC output voltage multiplied by its maximum current is much higher than the power rating of the system. When a system is

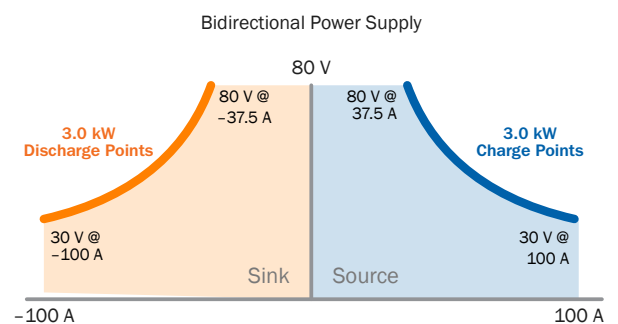
able to run at a lower than maximum current, the voltage can be adjusted higher to still yield the maximum power of the system. Likewise, when running the system at a lower voltage, the current can be increased—again, up to the limit of the full power rating. In fact, running in constant power mode, both voltage and current can change while the unit holds a steady power output. The autoranging envelope maintains a high quality output signal with voltages down to about 30% of the rating, but can be operated as low as 10%.

### Traditional 2 units • 8.0 kW each



Let’s look at an example with multiple test points at a consistent 3000 watts total load. It can take multiple power supplies to meet this 80 Vdc and 100 amp test range example. But often, setups use one large system to meet the maximum voltage and current needs which can be an inefficient option for cost, power, and space. For bi-directional testing, the oversized power supply is matched with an oversized electronic load.

### Marway 1 unit • 3.0 kW

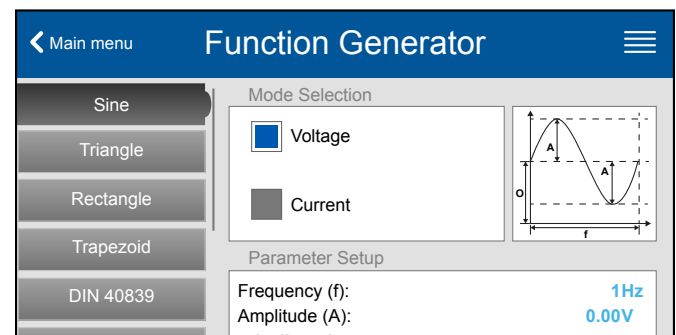
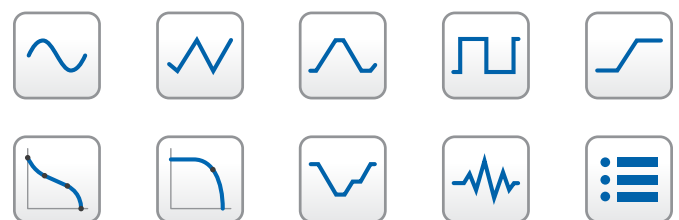


For that same test suite, a single 3 kW mPower DC Bidirectional with autoranging can serve all tests. Both source and sink are in a single unit. Autoranging enables a greater range of voltage and current in lower kW power packages while being able to deliver 100% of a power supply’s capacity in both directions. This means fewer, smaller power supplies — saving space, cost, power consumption, and even installation costs.

## Function Generator

mPower has two foundational function generators to define signal forms, and apply them to either voltage or current. An arbitrary generator allows up to 99 sequences to be repeated up to 999 times or infinitely. An XY table-based generator accepts up to 4,096 UI/IU mapped values. Both generator types are fully customizable with remote control programming, and table data can even be loaded and saved to USB thumb drives.

There are several pre-defined common waveforms which are configured on the control screen through data entry of parameters such as offsets, time, frequency, amplitude, etc. making them very quick to set up and run. Likewise, there are built-in aids for simulations of photovoltaic, fuel cell, and battery power sources to aid in device testing by simply defining a few parameters prior to execution.

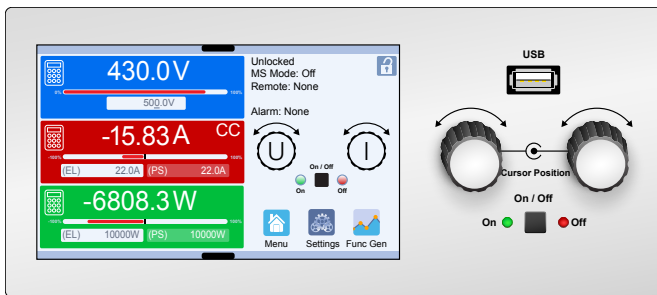


# mPower Bidirectional DC Power Supplies

## Controls & Locking

- Menu driven, multi-parameter display.
- Rotary pushbutton controls for quick data entry.
- 5 settings profiles storage to quickly swap settings.
- Control panel locking prevents accidental changes.
- Remote control lockout protects operators working on the equipment setup between tests.

All system configuration, test parameters, and even function generator details are adjustable from the touch control panel. To avoid accidental changes, the control panel can be quickly locked. A simple press of the lock status button initiates locking. The control lock mode can include or not include the DC output on/off button. Optionally, a 4-digit PIN can be required to unlock the controls. For safety, remote control can be locked out for when an operator must make setup or wiring adjustments.

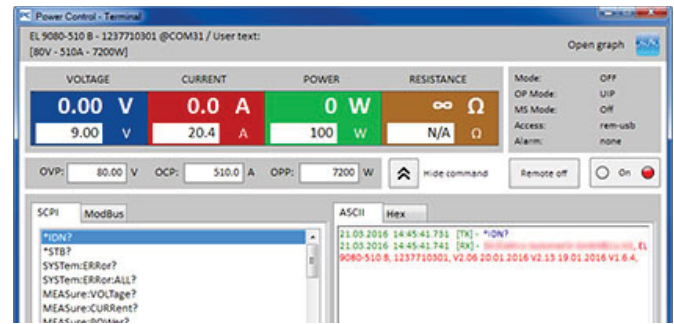


The control panels include a graphical display with a menu-driven interface as well as hardware controls. Power output, settings, and status indicators are visible during operation. The control panel can be locked to prevent accidental changes. All system configuration, test parameters, and even function generator details are adjustable from the control panel.

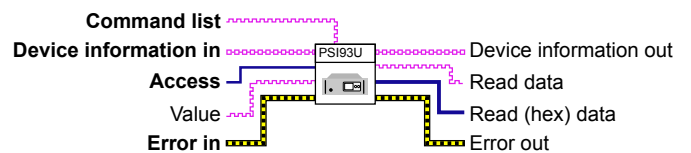
## Protective Features

- Over-voltage, over-current, over-power, and over-temperature shutdown and alerts.
- Alerts available on digital and analog interfaces.

For protecting connected equipment, there are adjustable settings for overvoltage, overcurrent, and overpower. There is also an overtemperature protection for the power supply itself. As soon as one of these thresholds is reached, the DC output is switched off, and a status signal is generated on the display and remote interfaces.



mPower control and configuration, including defining signal function profiles can be done through the on-board control panel, and through a Windows® application. Function definitions can be imported from and exported to the on-board USB port.



LabView VIs provide control for power settings and function generators.

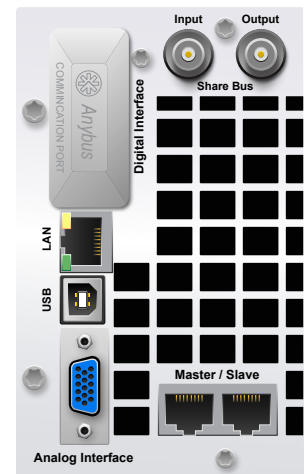
## Remote Control

- Modbus and SCPI command protocols.
- Scriptable control of power and function generator.
- LabView® VIs for power and function generator.
- Windows® application for desktop control.
- USB, Ethernet, CAN, CANopen, Profibus, Profinet, ModbusTCP, EtherCAT, GPIB, RS232, and analog interfaces available—not all on all models.

The 411 Series can be remotely controlled by scripting, by LabView, or with a Windows application.

All models include a USB port, Ethernet port, and analog interface for remote control. The analog interface allows custom hardware or PLCs to switch the DC outlet on/off, adjust setpoints, retrieve measurements, and monitor alarms.

The 411 Series also includes an Anybus digital interface port. This port facilitates a number of optional modules to support additional field buses including CAN, CANopen, EtherCAT, Modbus TCP, Profibus, Profinet, RS232, or additional Ethernet ports. The modules are field exchangeable.



# mPower Bidirectional DC Power Supplies

## Parallel Expansion

- Up to 64 units in parallel (1,920 kW total)

mPower allows for parallel connection of the DC outputs to increase current and power capacity. Control buses are daisy chained to share data even among units with different ratings. This system allows one unit to be configured as the control unit, while other units are configured as expansion units. Once set up, the control unit is aware of the total capacity. The new capacity of the whole system is displayed on the touchscreen, and all settings are relative to that capacity. For example, with six 10 kW systems in parallel, the power setting value can be adjusted from 0–60 kW. The control unit communicates with all units regarding settings and status.

All units must be 411 Series, but the latest production units allow for a mixture of current and power capacities with the overall limits set by the capacity of the smallest unit. (However, it is recommended that all units have the same voltage rating if possible.)

## Series Expansion

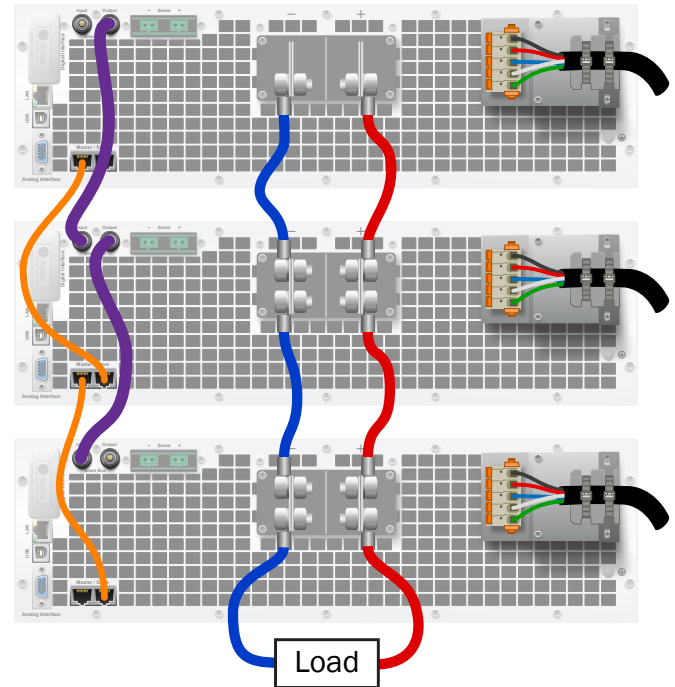
A limited number of units can be combined in serial where the DC output poles are daisy chained plus to minus. This allows a set of smaller units to operate an attached device at higher voltage. Each unit is manually controlled individually (there's no one unit in control of everything).

## Voltage Drop Compensation

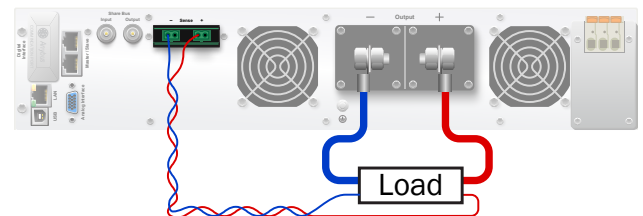
- Up to 5% of the rated voltage in compensation for voltage drops at the load (e.g. 4 V for an 80 Vdc unit).

For more accurate constant-voltage operation at the load, the system can compensate for some voltage loss in the DC cables. A voltage Sense bus connects remote voltage sensing to the load. The system recognizes the remote sensing mode automatically, and regulates the output voltage at the load rather than at its own DC terminals.

Parallel connection of the DC outputs increases current and power capacity. Control buses are daisy chained to share data even among units with different ratings.



The voltage sense bus connects to the load terminals, and adjusts the power supply output to compensate for voltage drops of up to 5% of the rated voltage.



## 411 Series General Configuration

411 Series			
Chassis Size	2U	3U	4U
Power Range <sup>[1]</sup>	1.5, 3.0 kW	5, 10, 15 kW	30 kW
Input Voltages <sup>[2]</sup>	(110/120 Vac) 208–240 Vac 1-phase	380–480 Vac 1-phase 3-phase Δ	380–480 Vac 3-phase Δ
Available DC Output Voltages <sup>[1]</sup>	10, 60, 80, 200, 360, 500, 750, 1000, 1500	10, 60, 80, 200, 360, 500, 750, 1000, 1500, 2000	10, 60, 80, 200, 360, 500, 750, 920, 1000, 1500, 2000
Available DC Output Currents <sup>[1]</sup> (See the following pages)	16 models ranging from 120A to 6A	26 models ranging from 510A to 20A	11 models ranging from 1000A to 40A
Autoranging	Yes		
Bidirectional	Yes		
Expansion for High Power	Parallel up to 64 units		
Function Generator	Sine, Triangle, Rectangle, Trapezoid, Arbitrary, Ramp, XY Table, PV, Fuel Cell, Battery, MPP		
Programmable Impedence	Yes		
Analog	Yes		
USB	Yes		
Ethernet	Yes		
Anybus	Yes		
Operating conditions	0–50 °C, < 80% R.H., < 2000 m altitude		

[1] There are multiple models each with a maximum voltage and current limit determined by the overall power capacity (kW). Not every model is capable of the range of voltages and currents listed. These are intended to indicate the range covered by the entire product line. See the Catalog for exact models.

[2] All units have some flexibilities to use a lower than nominal input voltage with the consequence of automatic derating of DC output capacity. Refer to the mPower DC Product Catalog or the Operating Guides for details as to the allowed voltages and resulting deratings. We do not generally promote the use of the lower voltages, but they are an option when a need arises.

## 411 Series 2U Specification Highlights

### 1.5 kW

10 Vdc	60 Amps <sup>[1]</sup>
60 Vdc	60 Amps
80 Vdc	60 Amps
200 Vdc	25 Amps
360 Vdc	15 Amps
500 Vdc	10 Amps
750 Vdc	6 Amps

### 3.0 kW

10 Vdc	120 Amps <sup>[1]</sup>
60 Vdc	120 Amps
80 Vdc	120 Amps
200 Vdc	50 Amps
360 Vdc	30 Amps
500 Vdc	20 Amps
750 Vdc	12 Amps
1000 Vdc	10 Amps
1500 Vdc	6 Amps

### 208–240 1ph Vac

Nominal input power of 208/220/230/240  $\pm 10\%$  Vac single phase is needed to reach output maximum for 1.5 kW and 3.0 kW models.<sup>[4]</sup>

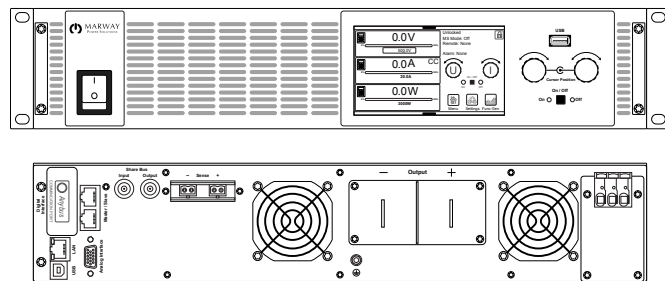
#### Performance Specs<sup>[2]</sup>

Load regulation CV (at 0–100% load)	$\leq 0.05\%$ of rating
Line regulation CV (at $\pm 10\%$ max. $\Delta$ Vac)	$\leq 0.01\%$ of rating
Stability CV	$\leq 0.02\%$ of rating
Load regulation CP (at 0–100% load)	$\leq 0.3\%$ of rating
Stability CC	$\leq 0.02\%$ of rating
Load regulation CR	$\leq 0.3\% + 0.1\%$ current rating
Voltage rise/fall time CV 10–90% $\Delta$ U	$\leq 20$ ms
Current rise/fall time CC 10–90% $\Delta$ I	$\leq 10$ ms
Ripple RMS CV at 300 kHz (model dependent) <sup>[3]</sup>	1 kW 80 V • $\leq 10$ mV 1 kW 500 V • $\leq 40$ mV 3 kW 80 V • $\leq 10$ mV 3 kW 500 V • $\leq 40$ mV
Ripple and noise p-p at 20 MHz (model dependent) <sup>[3]</sup>	1 kW 80 V • $\leq 100$ mV 1 kW 500 V • $\leq 500$ mV 3 kW 80 V • $\leq 100$ mV 3 kW 500 V • $\leq 500$ mV
Efficiency up to	95% model dependent

#### Misc Specs

Alarm Value range	110% of rating
Set Value range	102% of rating
Display accuracy	$\leq 0.05\%$ of V rating $\leq 0.1\%$ of I rating
Analog interface accuracy U/I/P/R	0–10 V $\leq 0.2\%$ 0–5 V $\leq 0.4\%$
Load Sense compensation	up to 5% of rating

#### Layout of 411 Series 2U models



Chassis depth is approximately 18.2" with 1.6" front protrusion and 1.8" rear protrusion not including cable bends.

[1] 10 Vdc Models are rated at 600 watts and 1200 watts.

[2] Performance is generally determined after 30 minutes warmup, and stable AC, load, and environmental conditions.

[3] Selected units shown for examples. Please check the model-specific spec sheets in the Operating Guide for details.

[4] 110/120 Vac single phase can be used, but the 1.5 kW unit derates to 1.2 kW, and the 3 kW unit derates to 1.5 kW. We generally do not promote use of 120 Vac, but it can be used if a need arises.



## 411 Series 3U Specification Highlights

### 5 kW

10 Vdc	170 Amps <sup>[1]</sup>
60 Vdc	170 Amps
80 Vdc	170 Amps
200 Vdc	70 Amps
360 Vdc	40 Amps
500 Vdc	30 Amps
750 Vdc	20 Amps

### 10 kW

10 Vdc	340 Amps <sup>[1]</sup>
60 Vdc	340 Amps
80 Vdc	340 Amps
200 Vdc	140 Amps
360 Vdc	80 Amps
500 Vdc	60 Amps
750 Vdc	40 Amps
1000 Vdc	30 Amps
1500 Vdc	20 Amps

### 15 kW

10 Vdc	510 Amps <sup>[1]</sup>
60 Vdc	510 Amps
80 Vdc	510 Amps
200 Vdc	210 Amps
360 Vdc	120 Amps
500 Vdc	90 Amps
750 Vdc	60 Amps
1000 Vdc	40 Amps
1500 Vdc	30 Amps
2000 Vdc	20 Amps

### 380–480 Vac

All models 380–480 Vac. <sup>[4]</sup>  
5 kW models use two phases, while 10 kW and 15 kW use all three phases.

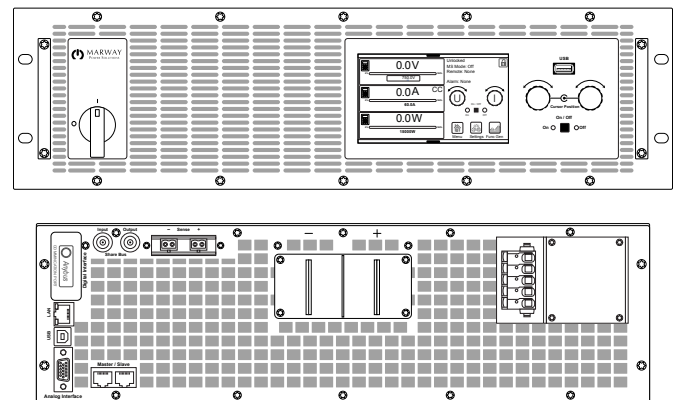
#### Performance Specs <sup>[2]</sup>

Load regulation CV (at 0–100% load)	≤ 0.05% of rating
Line regulation CV (at ±10% max. ΔVac)	≤ 0.01% of rating
Stability CV	≤ 0.02% of rating
Load regulation CP (at 0–100% load)	≤ 0.3% of rating
Stability CC	≤ 0.02% of rating
Load regulation CR	≤ 0.3% + 0.1% current rating
Voltage rise/fall time CV 10–90% ΔU	≤ 20 ms
Current rise/fall time CC 10–90% ΔI	≤ 10 ms
Ripple RMS CV at 300 kHz (model dependent) <sup>[3]</sup>	5 kW 80 V • ≤ 10 mV 5 kW 500 V • ≤ 70 mV 15 kW 80 V • ≤ 10 mV 15 kW 750 V • ≤ 200 mV
Ripple and noise p-p at 20 MHz (model dependent) <sup>[3]</sup>	5 kW 80 V • ≤ 100 mV 5 kW 500 V • ≤ 350 mV 15 kW 80 V • ≤ 100 mV 15 kW 750 V • ≤ 800 mV
Efficiency up to	95.5% model dependent

#### Misc Specs

Alarm Value range	110% of rating
Set Value range	102% of rating
Display accuracy	≤ 0.05% of V rating ≤ 0.1% of I rating
Analog interface accuracy U/I/P/R	0–10 V ≤ 0.2% 0–5 V ≤ 0.4%
Load Sense compensation	up to 5% of rating

#### Layout of 411 Series 3U models



Chassis depth is approximately 26.8" max. with 1.6" front protrusion and 2.5" rear protrusion not including cable bends.

[1] 10 Vdc Models are rated at 1700, 3400, 5100 watts.

[2] Performance is generally determined after 30 minutes warmup, and stable AC, load, and environmental conditions.

[3] Selected units shown for examples. Please check the model-specific spec sheets in the Operating Guide for details.

[4] 208 Vac 3-phase input can be used with significant power derating. 5 kW rating becomes 3 kW, 10 kW becomes 6 kW, and 15 kW becomes 9 kW. We generally do not promote use of 208 Vac, but it can be used if a need arises.

## 411 Series 4U Specification Highlights

### 30kW

10 Vdc	1000 Amps <sup>[1]</sup>	500 Vdc	180 Amps
60 Vdc	1000 Amps	750 Vdc	120 Amps
80 Vdc	1000 Amps	920 Vdc	125 Amps
200 Vdc	420 Amps	1000 Vdc	80 Amps
360 Vdc	240 Amps	1500 Vdc	60 Amps
		2000 Vdc	40 Amps

#### Performance Specs<sup>[2]</sup>

Load regulation CV (at 0–100% load)	≤ 0.05% of rating
Line regulation CV (at ±10% max. ΔVac)	≤ 0.01% of rating
Stability CV	≤ 0.02% of rating
Load regulation CP (at 0–100% load)	≤ 0.3% of rating
Stability CC	≤ 0.02% of rating
Load regulation CR	≤ 0.3% + 0.1% current rating
Voltage rise/fall time CV 10–90% ΔU	≤ 20 ms
Current rise/fall time CC 10–90% ΔI	≤ 10 ms
Ripple RMS CV at 300 kHz (model dependent) <sup>[3]</sup>	30 kW 80 V • ≤ 25 mV 30 kW 1000 V • ≤ 300 mV
Ripple and noise p-p at 20 MHz (model dependent) <sup>[3]</sup>	30 kW 80 V • ≤ 320 mV 30 kW 1000 V • ≤ 1600 mV
Efficiency up to	96.5% model dependent

[1] 10 Vdc Model rated at 10000 watts

[2] Performance is generally determined after 30 minutes warmup, and stable AC, load, and environmental conditions.

[3] Selected units shown for examples. Please check the model-specific spec sheets in the Operating Guide for details.

[4] 208 Vac 3-phase input is possible with significant power derating. 30 kW rating becomes 18 kW. We generally do not promote use of 208 Vac, but it can be used if a need arises.

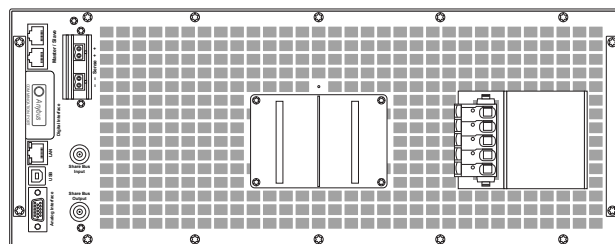
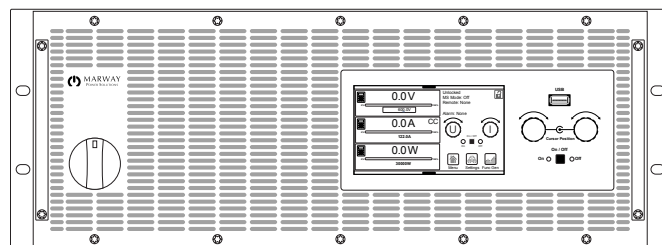
### 380–480 Vac

All model ratings are available with ac input of 380–480 Vac 3-phase only.<sup>[4]</sup>

#### Misc Specs

Alarm Value range	110% of rating
Set Value range	102% of rating
Display accuracy	≤ 0.05% of V rating ≤ 0.1% of I rating
Analog interface accuracy U/I/P/R	0–10 V ≤ 0.2% 0–5 V ≤ 0.4%
Load Sense compensation	up to 5% of rating

#### Layout of 411 Series 4U models



Chassis depth is approximately 26.3" with 1.7" front protrusion and 3.4" rear protrusion not including cable bends.

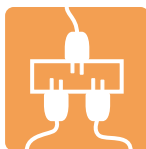




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