IONPURE®

DCR
Power Controller

600 VDC
15 Amps

Operation
&
Maintenance
Manual

IP- MAN-DCR-1019-EN.pdf
Revision 4
October 2019

Manual Covers Model #:

IP-DCR600V15A-M
IP-DCR600V15A-R2

IONPURE®

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DISCLAIMER STATEMENT

The operation and maintenance manual should provide complete and accurate information to meet your operating and/or service requirements based on the information available at the time of publication. The information in this manual may not cover all operating details or variations or provide for all conditions in connection with installation, operation and maintenance. Should questions arise which are not answered specifically in this manual, contact your equipment supplier.

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MANUAL REVISION HISTORY

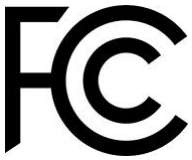
Event	Date	Changes
Revision 0	May 2016	Original publication.
Revision 1	June 2016	Added Section 3.3.4 (24 VDC Input). Updated CE/UL Directives.
Revision 2	July 2017	Updated Appendix A (Isolation Transformer). Clarified language on operating modes. Removed reference to Nexed EDR.
Revision 3	November 2018	3.2.1 - Added clarification on Terminal Resistor. Updated Appendix A.4, Transformer Sizing. Added section on Power Panel Software. Added Alarm Codes.
Revision 4	October 2019	2.2.2 Updated fuse recommendations. 3.2.8 Updated output relay specifications. Revised electrical schematic drawings, Appendix B. Updated Appendix A.4, Transformer Sizing. Updated EU compliance, page 6.

COMPLIANCE

The Digital Communication Rectifier (DCR) for CEDI, IP-DCR600V15A-M and IP-DCR600V15A-R2 conform to the following marks:

Listed 3L32 – Industrial Control Equipment
100 kA Short Circuit Current Rating
File Number E136219

EN60947-4-3
IP 20
See CE Declaration of Conformity



Part 15 Subpart B
Class A Device

See RoHS Certificate of Compliance

We the undersigned manufacturer
Evoqua Water Technologies – 558 Clark Road, Tewksbury, MA, U.S.A.
Phone: 978-863-4600

Certify and declare under our sole responsibility that the products:
W2T827123 (IP-DCR600V15A-M) (Tested as uF1HXDC-15-P3R00)
W2T827122 (IP-DCR600V15A-R2) (Tested as uF1HXDC-15-P3R00)

Conform to the following directives:

2014/35/EU (electrical equipment designed for use within certain voltage limits)

2014/30/EU (electromagnetic compatibility)

The unit conforms to the essential requirements of the above European Directive(s) using the relevant section(s) of the normalized standards and related documents shown below. In addition, it is certified to have been inspected and packaged in accordance to applicable drawings and test specifications per the ISO 9001/14001 standards.

EN 60947 – 4 - 3: 2014 Low-voltage switchgear and controlgear (electrical safety).

EN 60947 – 4 – 1: 2012

- Clause 9.4.2 Immunity referencing EN 60947-1: 2007/A1: 2010/A2: 2014, Clause 8.4.1, Table 23
  - EN 61000- 4 – 2: 2008
  - EN 61000- 4 – 3: 2006/A1: 2007/A2: 2010
  - EN 61000- 4 – 4: 2004/A1:2010
  - EN 61000- 4 – 5: 2005/AC1:2009
  - EN 61000- 4 – 6: 2013
  - EN 61000- 4 – 8: 2009
  - EN 61000- 4 – 11: 2004

EN 60947 – 4 – 1: 2012, Clause 9.4.3 Emission
Referencing EN 60947 – 1: 2007/A1: 2010/A2: 2014, Clause 7.3.3
European Standard EN 55011: 2009 + A1: 2010
FCC Part 15 Subpart B

Note 1: All power terminals must be populated as to keep the controller touch safe to comply with EN 60947-4-3.
Note 2: Controller must be mounted in a shielded enclosure to comply with EMC Directive 2014/30/EU.
Note 3: Controller must have appropriate line and control power filter to comply with EN61000-6-2.

The technical documentation file is located at
Evoqua Water Technologies LLC, 558 Clark Rd, Tewksbury MA, USA

The authorized representative within the community is:
Georgia Tatiana-Bekioti, Evoqua Water Technologies, Sales Representative
Karchidonos Street 12, 16562 Glyfada, Attika, Greece

Name and position of the person binding the manufacturer:
Rahoul Bhagat, Quality Assurance and Document Control

Documentation for the above component can be found on www.ionpure.com.
Should you need further assistance, please e-mail ionpure@evoqua.com. We value you as a customer and will accommodate you in whatever way to provide total satisfaction.

1 INTRODUCTION

1.1 Caution and Warning Messages

WARNING and CAUTION labels are used to attract attention to essential or critical information in this manual. The labels are located to the left of the associated messages. Caution and Warning messages will be located immediately before related text.

⚠WARNING	**Warnings indicate condition, practices, or procedures that must be observed to avoid personal injury or fatalities.**

⚠CAUTION	**Cautions indicate a situation that may cause damage or destruction of equipment or may pose a long-term health hazard.**

Notes are also used to draw attention to information. Notes may be located before or after the related text.

NOTE: Notes are used to add information, state exceptions, and point out areas that may be of greater interest or importance.

1.2 General Description

The Ionpure® Digital Communication Rectifier (DCR) for continuous electrodeionization (CEDI) is an ultra-compact, high-performance microprocessor-based single-phase DC power controller designed to control resistive loads.

The DCR is designed specifically as a component of a DC power supply system used with CEDI modules manufactured by IONPURE. This unit can be used with the MX, LX, and VNX lines of CEDI modules.

The DCR is normally used in constant current mode. In constant current mode, the output current is maintained at the selected value, regardless of the load resistance, while the voltage varies. As the resistance increases, the required voltage also increases.

NOTE: When the required voltage reaches the maximum possible DC voltage (90% of the RMS AC input voltage), it cannot increase further. If the resistance continues to increase, the output current must decrease.

The DCR accepts an input voltage of up to 660 VAC (45 – 65 Hz), has a maximum output voltage of 600 VDC (or 90% of AC input voltage), and a maximum full frame current rating of 15 ADC. A separate 24 VDC (7 watt) power source supplies the control electronics and maintains critical communications to your control system when the mains are absent.

Status LEDs and an LED bar graph make operation and troubleshooting simple. Configuration is through a simple DIP switch and a rotary dial switch.

The controller has five selectable DC output current ranges: 0 – 2.5 A, 0 – 4.0 A, 0 – 6.5 A, 0 – 10.0 A, and 0 – 15 A. One of these current ranges is selected with the on-board DIP switch.

NOTE: For the power controller to operate properly, there must be an appropriate resistive load

connected to the DC output. If the unit is operated without a load, then the unit will remain powered on but there will be no DC output. This fault condition will be indicated by the on-board LEDs as described in Section 6.

There is no energy storage within the unit, such as electrolytic bulk capacitance. Therefore, the output appears as unfiltered DC power with an AC power component, which is acceptable for its intended use in electrodeionization. The unit contains no formal power factor corrector, but it will provide a high power factor at most outputs other than at the lowest power levels, which is a result of the unit's design as a low bandwidth current source looking into a primarily resistive load. The power controller has input over-voltage protection, as well as heat sink over-temperature protection. Output over-current protection occurs automatically as a result of the unit's use as a programmable current source.

The unit's robust design allows for continuous full-frame current up to 50 °C, up to 6,000 feet altitude. Cooling is accomplished through natural convection.

The on-board Modbus RTU fieldbus interface allows monitoring of line voltage, load voltage, load current, and temperature of the unit easily from an external display or PLC; reducing system installation costs.

The DC output current can be adjusted by any one of following methods:

- For IP-DCR600V15A-M models:
    - An optional digital touch panel, Model No. IP-POWERDSP-TP, which can operate *up to sixteen* power controllers.
    - On-board Modbus RTU fieldbus
    - A 4 – 20 mA input signal from a remote process controller, such as a PLC.
- For IP-DCR600V15A-R2 models:
    - An optional digital display board, Model No. IP-POWERDSP-G2, which can operate *up to sixteen* power controllers.
    - A 0 – 5 VDC input signal from a remote process controller, such as a PLC.

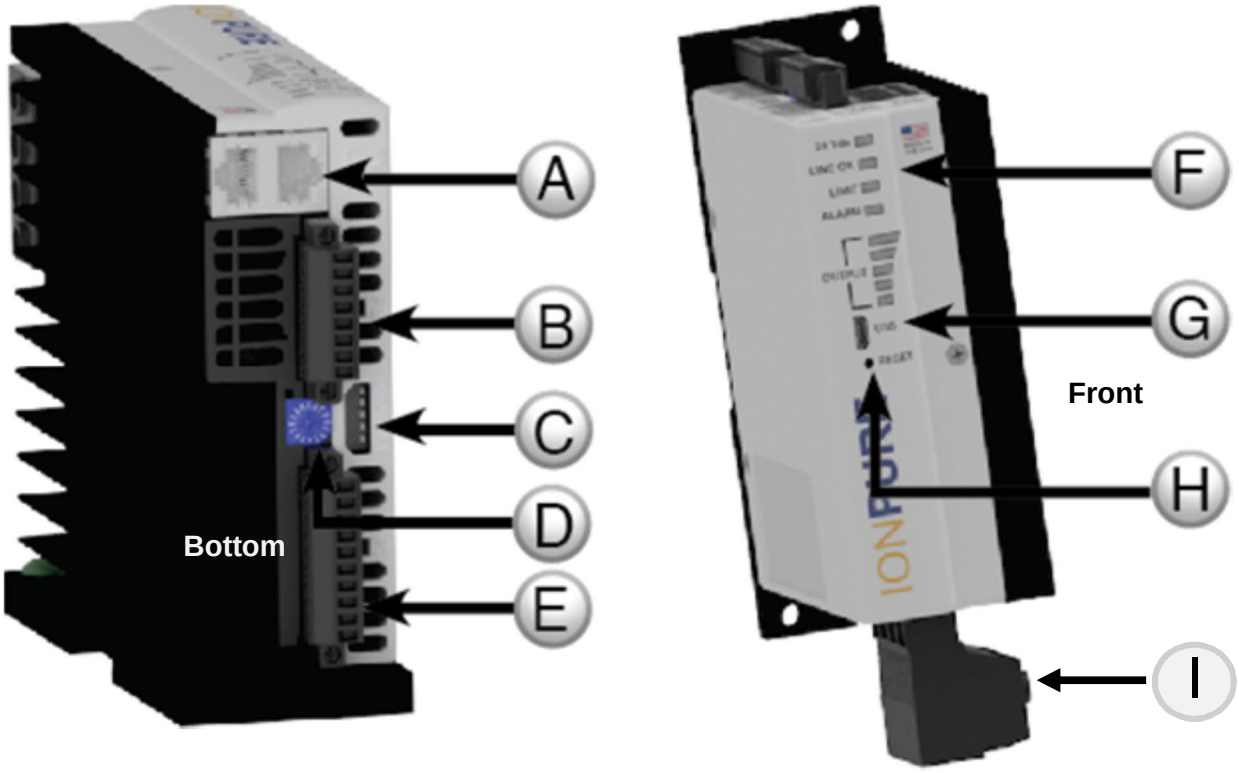
The power controller output can be turned on and off by a signal from a remote set of contacts. This feature allows the use of remote instrumentation, such as a flow switch, for turning off controller output.

The DC power controller is a component of the DC power supply used with IONPURE's CEDI modules. A complete DC power supply **must** include all of the following:

- The DC power controller
- An isolation transformer
- Circuit protection (fuses or circuit breakers)
- Controls and operator interface
- Enclosure with cooling

Full-size dimensional drawings of the DCR Power Controllers for CEDI are included in Appendix B.

1.3 DCR Connection and Configuration points



Label	Name	Description
A	Modbus RTU Interface	A 9600 baud serial interface allows you to digitally interface and daisy chain multiple controllers to either a display or PLC
B	P2 - Retransmit & Relay Connections	Two analog transmits (output) and a form C relay
C	Configuration DIP Switches	Select constant current or constant voltage control, set the current scaling, and enable Modbus RTU terminating resistor
D	Rotary Switch	Sets the Modbus RTU slave address
E	P1 - Command Connections	Analog input, 24 VDC supply, Run/Stop
F	Indicator LEDs	Assist with diagnostics
G	USB Port	Connects PC with Power Panel software
H	Controller Reset	External reset of processor to factory defaults
I	High voltage terminal	AC input and DC output

2 INSTALLATION

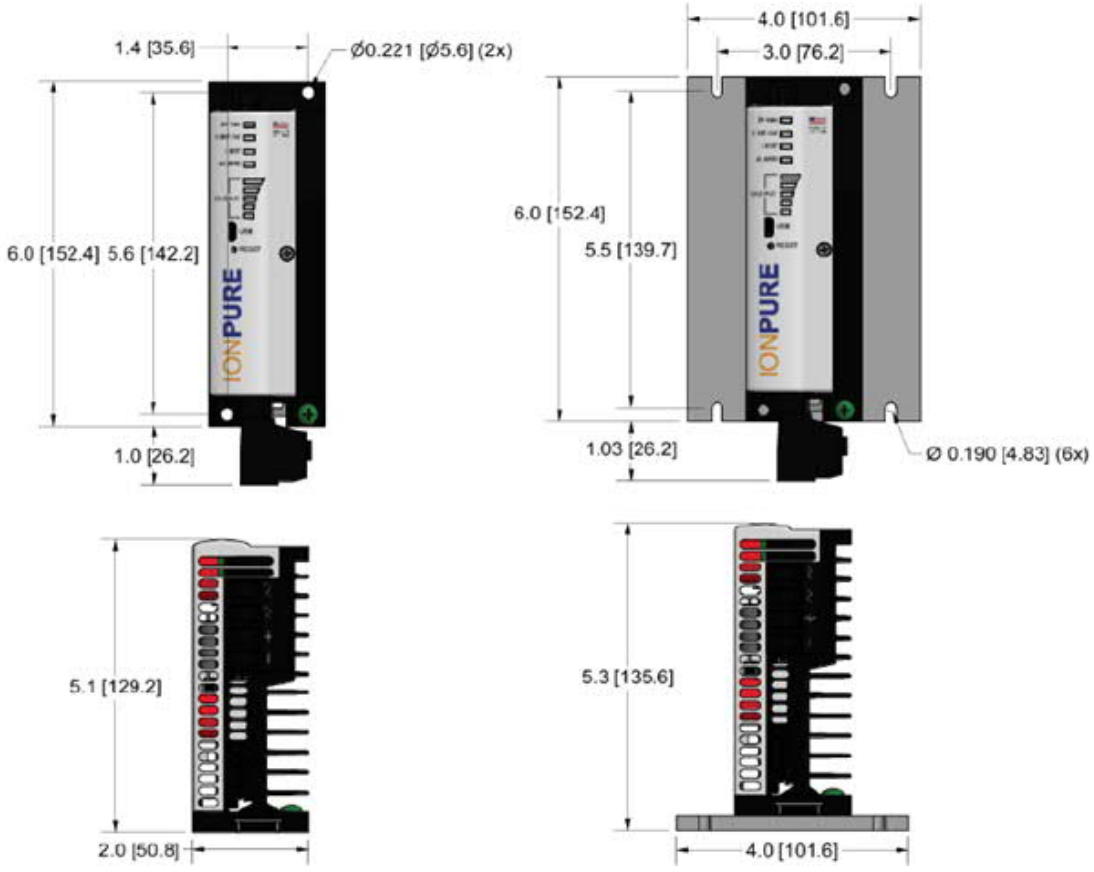
2.1 Mounting

⚠CAUTION **Electrostatic discharge can damage electronic components. Make contact with a grounded conductive pad and/or wear a grounded wrist strap when you handle the power controller.**

The Digital Communication Rectifier is intended for mounting on a sub-panel inside an enclosure.

For IP-DCR600V15A-M, use DIN rail, or M5 or UNC 10-32 screws (not included). The location of the mounting holes is shown below and in Figure B.1, located in Appendix B.

For IP-DCR600V15A-R2, using four screws, either M4 or UNC 8-32 (not included). The location of the mounting slots is shown below and in Figure B.2, located in Appendix B. The base plate can be removed if DIN-rail mounting is preferred.



The environmental limits for operation are 0 to 50 °C, at up to 95% relative humidity (non-condensing). An enclosure with at least an IP52/NEMA 12 rating is recommended. The DCR contains a heatsink for cooling; however, the enclosure should also include a cooling fan that draws through ambient air.

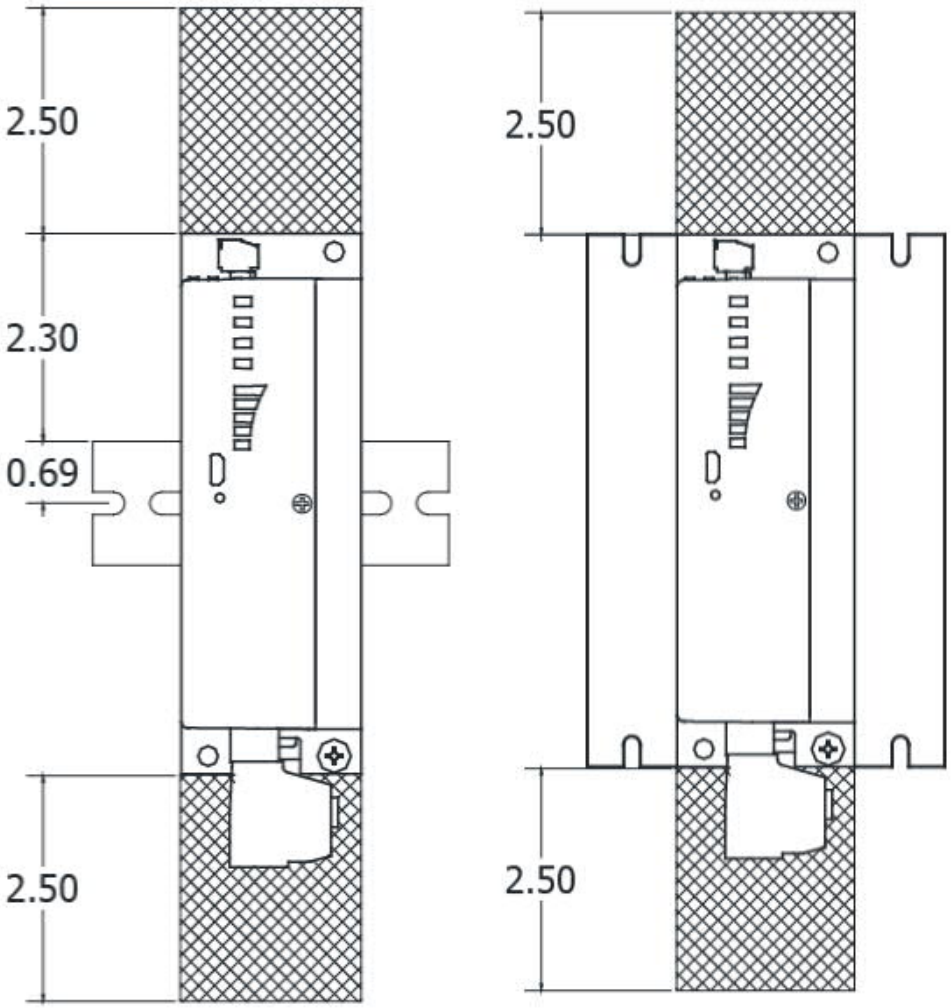
In installations where a water-resistant enclosure (IP56/NEMA 4) is necessary, cooling the interior of the enclosure is more difficult. Typical cooling methods include:

- Sizing the enclosure for a sufficient rate of heat transfer to the environment through the enclosure walls.
- Using an air-to-air or water-to-air heat exchanger.
- Installing an air conditioning unit.
- Using vortex cooling.

The maximum heat generated by each DCR is approximately 50 watts. Additional heat generation is expected from the isolation transformer and other equipment in the enclosure.

2.1.1 Orientation and Spacing

Mount the power controllers vertically. The keep out area on the top and bottom are for air circulation. The top and bottom of the controller must have a minimum of 3.00 inches (76.2 mm) free from obstructions, as measured from the edge of the heatsink fins. Dimensions above are measured from the edge of the heatsink base.



2.2 AC Supply

Electrical schematics for typical installations are shown in Figures B.3, B.4, and B.5 in Appendix B.

2.2.1 Isolation Transformer

The AC input to the power controller **must be** isolated from the AC mains by an isolation transformer that is correctly sized for the maximum power required from the power controller (See Appendix A). The purpose of the transformer is to:

- Provide isolation from the AC mains so that the cathode of the CEDI module can be grounded. This is grounded effectively on the DC negative, internally on the DCR.
- Convert the voltage of the AC mains to an AC input voltage (up to 660 VAC) for optimum operation of the power controller and the CEDI module.
- The transformer shown in Figure B.5, for example, can convert the 480 VAC from AC mains to a 660 VAC input to the DCR.

⚠CAUTION	**The secondary of the transformer MUST NOT be connected to earth ground. Grounding the secondary will damage the DCR.**

2.2.2 Over-Current Protection

⚠CAUTION	**The DCR does not have built-in fuses for the AC input. Over-current protection devices, such as circuit breakers or fuses, must be installed between the isolation transformer and the AC input terminals, for example as shown in Figure B.4.** **SELECT "FAST ACTING" CLASS J or CLASS T FUSES WITH 100KA INTERRUPTING RATING OR A CIRCUIT BREAKER WITH A FAST TRIPPING CURVE.**

If the maximum DC output current of the DCR will be limited to 13.2 amps, a current rating of 20 amps for the over-current protection devices is recommended. If the DCR will be limited to a DC current of less than 13.2 amps, size over-current protection devices according to Isolation Transformer Sizing for a Single Power Controller, located in Appendix A.

Over-current protection devices must also be installed on the primary of the isolation transformer and sized correctly according to applicable local electrical codes.

⚠CAUTION	**Do NOT install fuses, circuit breakers or any type of switching device between the DC output of the DCR and the CEDI module. Doing so might eventually cause damage to the DCR.**

Electrical schematics of typical single and multiple module installations are located in Appendix B.

2.2.3 Electrical Surge Suppression

Inductive elements in a circuit can generate harmful voltage spikes when a switch, contactor or breaker opens and cuts the current flow abruptly. Snubbers are simple energy absorbing circuits used to suppress those spikes.

⚠CAUTION	**Although the power controller's input section is protected by an MOV (metal oxide varistor), a snubber should be considered at sites with poor electric power quality indicated by swells, over-voltages, surges, transients, etc.**

As a preventive measure, snubbers are most effective when installed on the secondary of the transformer, between any switching devices and the power controller. Snubbers are intended to prevent damage caused by transient feed voltage.

IONPURE offers snubber circuits, model numbers IP-SNUBCIRC-1PH and IP-SNUBCIRC-3PH. The 3-phase version is only suitable for installation on the primary side of the isolation transformer, while the single-phase version can be installed on the transformer secondary. Refer to the Voltage Snubber instruction manual (available at www.ionpure.com) for details.

3 WIRING

IONPURE configures and tests each controller before shipping. Once received, the unit is ready to install. The following sections will describe how to properly wire the unit with the recommended fusing.

For line and load connections, use copper conductors rated 75 °C minimum. See torque specifications (3.1.3 and 3.2.9) for proper tightening.

⚠WARNING **This unit ties the DC negative terminal to chassis ground. Therefore, for safe and proper operation, this controller may only be used on the output of an isolation transformer. Do not apply power to this controller without an isolation transformer upstream. Failure to follow this warning may result in injury or death.**

A ground wire is required for proper operation. Use 10 AWG or larger wire.

NOTE: You must wire controllers in conformance with applicable local wiring codes.

3.1 High Voltage Connections

3.1.1 Initial Selection of AC Input Voltage

The AC voltage supplied to the power controller should be at least 1.1 times higher than the maximum DC voltage required by the CEDI module(s). The AC voltage is single-phase, and it can range from 24 VAC to 660 VAC.

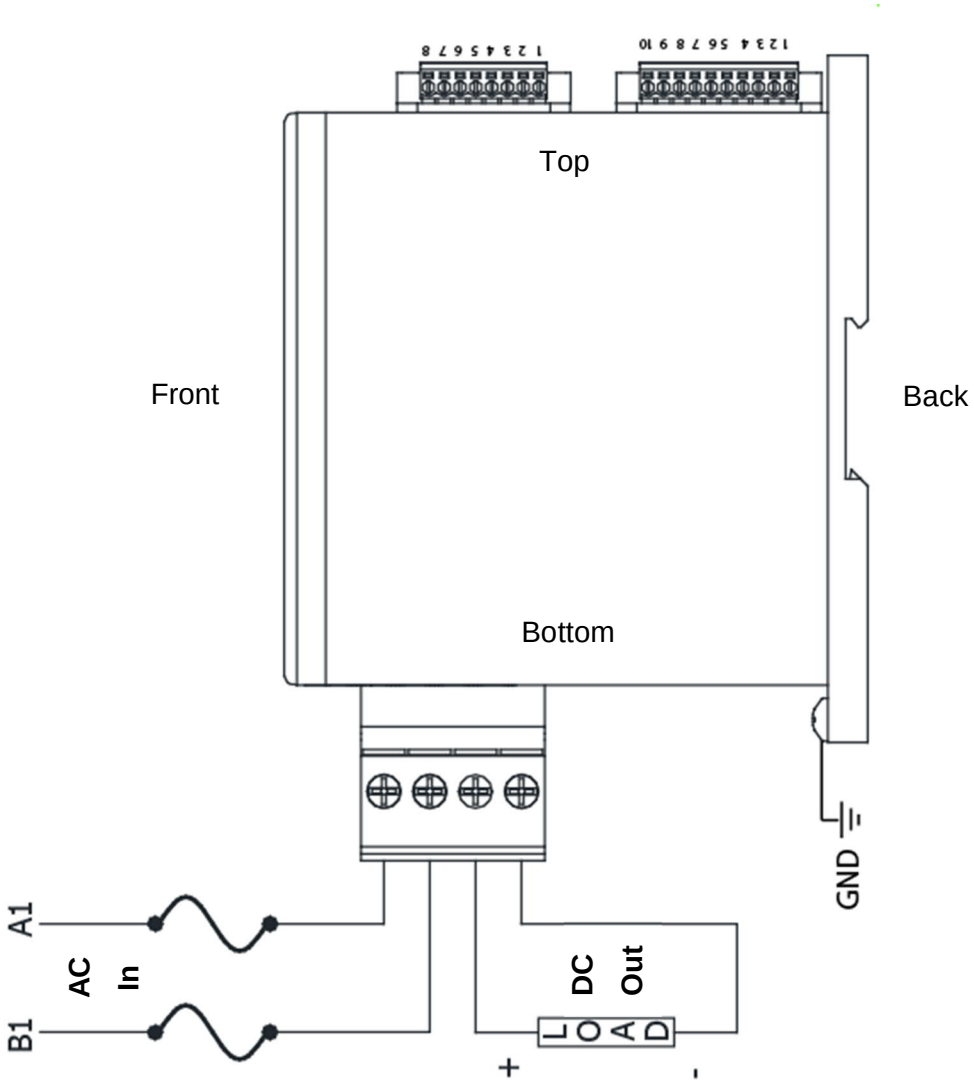
For example: if the maximum DC voltage required by a CEDI module is 300 VDC, then the input to the controller must be at least 330 VAC. The maximum design input voltage is 660 VAC. If the design input voltage is greater than 660 VAC, then typical voltage variations can result in voltages outside the unit's operating conditions which can damage the CEDI unit.

⚠CAUTION **The unit can tolerate short, intermediate input voltage variations of +/- 10% but should NOT exceed the maximum design voltage of 660 VAC.**

3.1.2 High Voltage Connections (AC and DC)

AC and DC power connections must be made as described below. The next page has a basic illustration of these connections.

Terminal	Connection
A1 and B1	AC input from isolation transformer
DC+	DC positive output to anode of CEDI module
DC-	DC negative output to cathode of CEDI module
GND	Earth ground inside panel enclosure



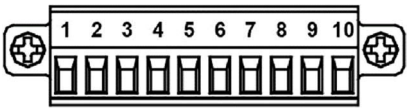
⚠CAUTION	**The GND terminal of the power controller must be connected to earth ground (PE) inside the power supply enclosure. A diode is required on each ground connection when multiple DCRs are sharing a common secondary winding.**
⚠CAUTION	**Do <u>NOT</u> install fuses, circuit breakers or any type of switching device between the DC output of the power controller and the CEDI module. Doing so might eventually cause damage to the power controller.**
⚠CAUTION	**Do <u>NOT</u> install a jumper between terminals DC- and GND of the power controller, nor between the negative and ground terminals of the CEDI module. The DC- is internally grounded inside the DCR. Follow the wiring guidelines illustrated in Figure B.6.**

3.1.3 Torque Specifications for High Voltage Connections

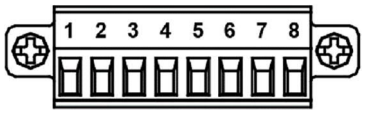
Recommended Tightening Torque for Line/Load Connectors	
Wire Size (AWG)	Torque
4-22	24 IN-LBS [2.70 Nm]

3.2 Low Voltage Connections

3.2.1 P1 Terminal Strip (10-Pin)

Terminal	Connection	Picture
P1-1	**24 VDC Input** – 24V-	
P1-2	**24 VDC Input** – 24V+	
P1-3		
P1-4	**Analog Input** – Ic+	
P1-5	**Analog Input** – Ic-	
P1-6		
P1-7		
P1-8	**Dry Signal** – Common	
P1-9	**Dry Signal** – Run/Stop	
P1-10		

3.2.2 P2 Terminal Strip (8-Pin)

Terminal	Connections	Picture
1	**Analog Output** – Im+	
2	**Analog Output** – Im-	
3	**Analog Output** – Vm+	
4	**Analog Output** – Vm-	
5		
6	**Relay Output** – N.O.	
7	**Relay Output** – Common	
8	**Relay Output** – N.C.	

3.2.3 Signal Wiring Guidelines

Proper grounding and wiring of all electrical equipment are important to help ensure optimum operation of your system and to provide additional electrical noise protection for your application. Please follow these guidelines for your signal wiring:

- The ground connections of the power controller(s) and the analog signal processing equipment (e.g. PLC module, panel meter, etc.) should be connected to the earth ground of the system.
- All ground wires should be as short as possible.
- Always use shielded twisted-pair cables for analog signals.
- Connect only one end of the cable shield to earth ground.
- Keep cable length as short as possible. Recommended length is 100 feet (30.5 meters) or less for current signals (4-20 mA), 15 feet (4.6 meters) or less for voltage signals (0-5 VDC), and 328 feet (100 meters) or less for Ethernet (CAT5 or CAT6) cable.
- Keep signal wires as far away as possible from AC wires and rapidly switched DC wires. Place them in separate wire trays or ducts.
- Follow other grounding and wiring guidelines for your analog signal processing equipment.
- If possible, use analog signal metering devices with differential inputs for improved noise immunity.

3.2.4 24 VDC Input (P1-1, P1-2)

A separate 24 VDC (7 watt) power source supplies the control electronics and maintains critical communications to your control system when the mains are absent.

3.2.5 Control of DC Output Current (P1-4, P1-5)

It is necessary to provide a command signal to control the DC output current to the CEDI module. Use **only one** of the following options to control the DC output current:

- For IP-DCR600V15A-M models:
  1) Modbus RTU fieldbus.
  2) IONPURE Touch Panel, Model No. IP-POWERDSP-TP, which can operate up to sixteen power controllers. Use Cat 5 or Cat 6 cable and special DB9 female to RJ45 female adapter (provided with DSP-TP) to connect DCR-M to the IONPURE Touch Panel. Use standard Cat 5 or 6 cables between DCR units.
  3) A 4 – 20 mA input signal (Ic) from a remote process controller, such as a PLC
- For IP-DCR600V15A-R2 models:
  1) IONPURE G2 Display Board, Model No. IP-POWERDSP-G2, which can operate *up to* sixteen power controllers. Use standard Cat 5 or Cat 6 cables, IONPURE model numbers IP-CABLE50CM-G2 or IP-CABLE2M-G2.
  2) A 0 – 5 VDC input signal (Ic) from a remote process controller, such as a PLC.

The analog signal corresponds to 0 - 100% of the selected DC output current range.

3.2.6 Remote ON / OFF (Enable Signal, P1-8, P1-9)

The DC output is switched on/off by a remote isolated non-powered (dry) contact connected to the terminals 8 and 9 on the P1 connector. A closed contact enables the power controller's DC output; an open contact shuts it off.

A possible implementation: flow switches on the feed, product and/or reject streams of the CEDI module or system, and an auxiliary contact of the motor starter of the RO or CEDI feed pump could be wired in series to the coil of a time-delay relay (to allow the flow signals to stabilize before activating). One of the relay contacts would be wired to the remote ON / OFF input to apply DC power to the module only when there is water flow.

3.2.7 Analog Outputs

The analog outputs for the unit are listed below with associated connection information:

- A 4 – 20 mA (for IP-DCR600V15A-M models) or 0 – 5 VDC (for IP-DCR600V15A-R2 models) output is provided for remote display of output voltage. The signal is calibrated to correspond to 0 – 100% of the DC output voltage range
- A 4 – 20 mA (for IP-DCR600V15A-M models) or 0 – 5 VDC (for IP-DCR600V15A-R2 models) output is provided for remote display of output current. The signal is calibrated to correspond to 0 – 100% of the selected (via DIP switch) DC output current range.

⚠CAUTION **These signals are developed by operational amplifiers and must not be connected to power sources or drive load resistance less than 10 KΩ.**

3.2.8 Output Status Relay

The output relay provides a relay signal that indicates the status of the DC output. This signal can be used for remote status indication (e.g. Run / Standby status light).

Relay Specifications	
Rated load	0.3 A at 125 VAC 1 A at 30 VDC
Rated carry current	2 A
Maximum switching voltage	125 VAC 60 VDC
Maximum switching current	1 A

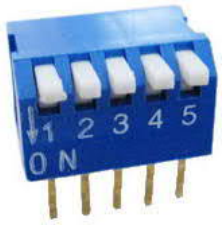
3.2.9 Torque Specifications for Low Voltage Connections

Recommended Tightening Torque for P1/P2 Connectors		
Number of wires	**Wire Size (AWG)**	**Torque**
1	16 – 26	3.0 IN-LBS [0.34 Nm]
2	20	3.0 IN-LBS [0.34 Nm]

3.3 Selector Switches

3.3.1 DIP Switch for Current Range, Feedback, and Modbus Selection

DC output current range, current/voltage feedback, and Modbus termination resistance are selected via a current range DIP switch, as shown below.

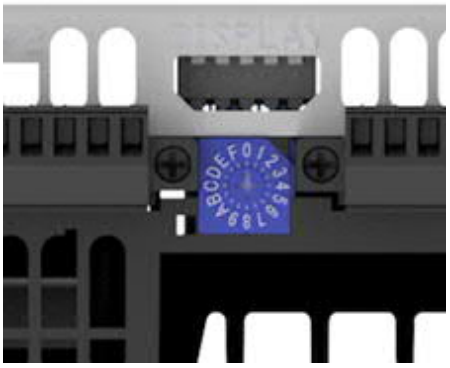
Current Range	Switch 1	Switch 2	Switch 3	Switch 4	Switch 5
0 – 2.5			OFF	OFF	OFF
0 – 4			OFF	OFF	ON
0 – 6.5			OFF	ON	OFF
0 – 10			OFF	ON	ON
0 – 15			ON	OFF	OFF
Terminal Resistor In	OFF				
Terminal Resistor Out	ON				
Constant voltage mode		ON			
Constant current mode		OFF			

Only the last DCR in the daisy chain should be set for Terminal Resistor In.

The default current setting is 0 – 2.5 amperes. Refer to A.4 in Appendix A for correct current range settings (from column “Maximum Required DC Amps”).

3.3.2 Rotary Switch for Modbus RTU Slave Address

The rotary dial switch sets the Modbus RTU Slave address for each controller. The slave address value is the switch position +1. For example, a switch setting of 0 will mean the controller will respond to requests with a slave address of 1.



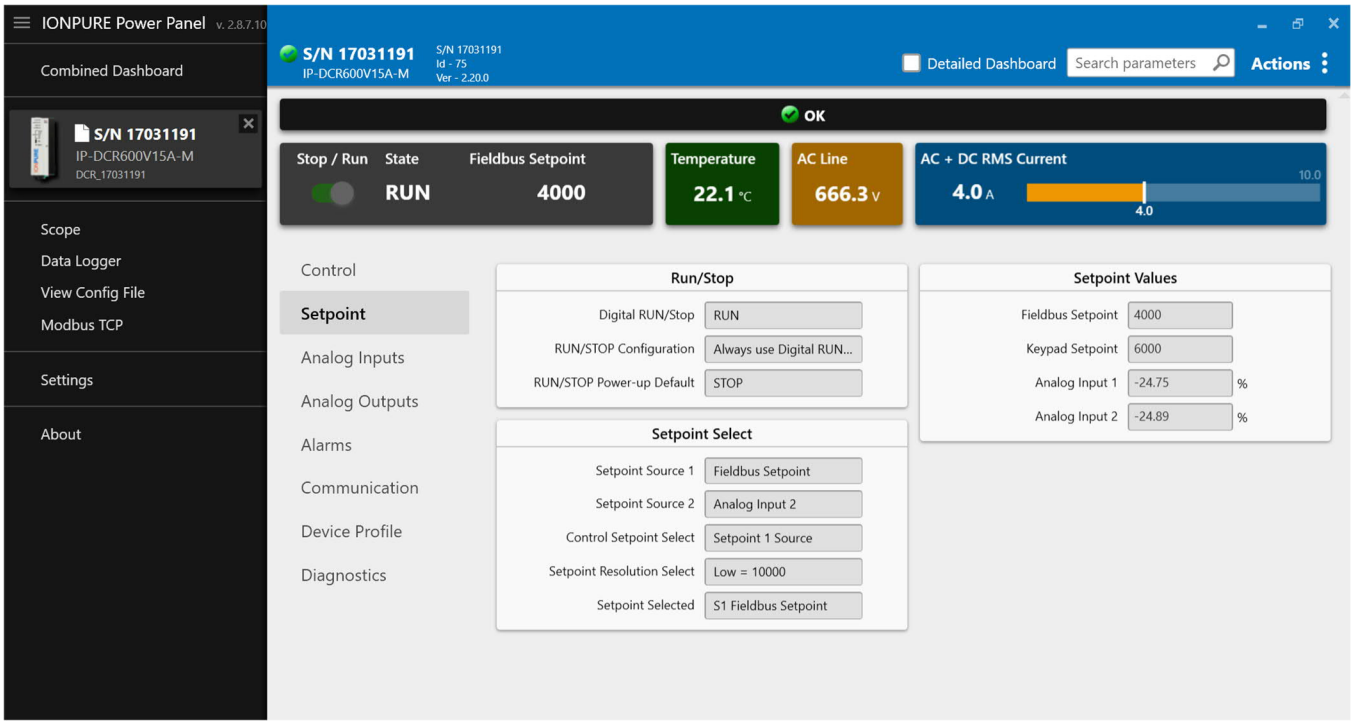
Rotary Switch Address	Modbus RTU Slave Address
0	1
1	2
2	3
3	4
4	5
5	6
6	7
7	8
8	9
9	10
A	11
B	12
C	13
D	14
E	15
F	16

4 USB

4.1 USB Interface and Power Panel Software

A micro-USB interface is standard on all DCR power controllers for connecting the controller to the Ionpure Power Panel software application (available for registered users on www.ionpure.com).

This PC-based utility software assists with the installation, parameter setup, operation and troubleshooting of Ionpure DCR power controllers. Possible uses are for updating device firmware and changing power controller configurations.



4.2 Minimum PC Requirements

Minimum PC requirements for the Ionpure Power Panel Software are as follows:

- 1 GHz Single-Core Processor
- 1 GB RAM
- 100 MB of available hard disk space
- 1280 x 768 x 60 Hz Compatible Display Adapter
- Windows 7® (32/64 bit), Windows 8® (32/64 bit), or Windows 10® (32/64 bit) Operating Systems
- Microsoft®.NET Framework 4.0 – Client Profile

An instruction manual is not yet available for the Ionpure Power Panel software. For assistance, please contact your local Ionpure Technical Support representative.

5 OPERATION

5.1 Initial Startup - Example

The startup sequence depends on the design of the CEDI system. Please consult the Operation Manual for the CEDI system. The following startup procedure is only an example for a typical single module CEDI system with an electrical schematic as shown in Figure B.3.

- Close the main disconnect switch (or circuit breaker) for the CEDI system.
- Open the appropriate valves and start the pretreatment equipment, such as the reverse osmosis (RO) system, upstream of the CEDI system.
- Adjust the flow rates of the dilute and concentrate streams through the module.
- Slowly increase the DC output current to the value calculated by the Ionpure Performance Projection Program (Current Startup Calculator). The power controller will maintain the current at that setting if the required voltage to drive the current is lower than the maximum DC voltage available.
- Verify that the DC output is removed when the CEDI module flow is interrupted.

⚠CAUTION **Operation with DC power on and insufficient water flow can cause irreparable damage to the CEDI module(s) and system.**

During normal operation, no further attention to the power controller should be required.

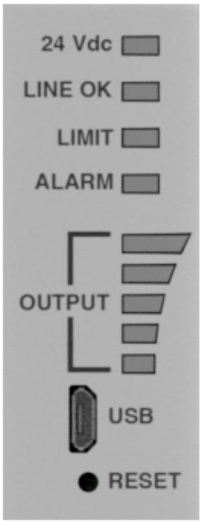
5.2 Output Adjustment

The DC output current may need to be adjusted if there is a change in feed water conditions and/or flow rate.

6 INDICATOR LEDS

The DCR status (normal operation or fault conditions) is indicated by the LEDs on the circuit board. See chart below for LED colors and indicated condition.

24VDC	
Green	+24 VDC Present
Red	+24 VDC Wired Backwards



LINE OK	
Off	No AC Line Voltage
Green	OK, Locked
Orange	Boot Segment
Red	Phase Lock Loss

LIMIT	
Off	OK, No Limits
Orange	Voltage Limited
Red	Current Limited
Flash Between	Power Limit

ALARM	
Off	OK, No Alarms, Not in RUN
Green	OK, No Alarms, in RUN
Orange	Warning Alarm
Red	Inhibit Alarm

OUTPUT	
Green	LEDs turn green in proportion to the output
Top LED Red	Indicates 100% on
All Flashing Green	DIP switches not properly configured

7 TROUBLESHOOTING

WARNING **Troubleshooting should be performed by qualified personnel only. Safety procedures should be reviewed prior to working with the DCR.**

Input Over-Voltage	
Possible Cause	**Action**
AC source too high for power controller	Check AC voltage at isolation transformer primary; ensure that transformer primary is wired to match voltage available at site. Check voltage at isolation transformer secondary with multi-meter; confirm that it is less than or equal to 660 VAC.
Improper transformer design or construction	See transformer design requirements in Appendix A.

Input Under-Voltage or Damaged Unit	
Possible Cause	**Action**
Low or no AC voltage at input to power controller	Check AC voltage at isolation transformer secondary with multi-meter; confirm that it is greater than 24 VAC.
Low or no AC voltage at input to isolation transformer	Check AC voltage at isolation transformer primary with multi-meter, confirm that it meets transformer specification.

Over-Temperature	
Possible Cause	**Action**
Inadequate cooling of enclosure	Check temperature inside enclosure during operation, ensure is less than 50°C.
Fan-cooling insufficient	Check fan sizing, ambient temperature; possible need for air conditioning or vortex cooling.

Open On/Off Input	
Possible Cause	**Action**
Low flow switch activated (open)	Check operation of flow switch. Check availability of feed water. Check upstream and downstream valves.
No jumper at on/off interlock input on power controller (if remote on/off interlock not used)	Install jumper.
Remote on / off interlock activated (open)	Check status of RO system, CEDI feed pump or other remote on/off interlock (system specific).

No Command Signal or No Load	
Possible Cause	**Action**
No communications with display board	Check connections and condition of cable. Verify that it is a standard cable, not crossover.
DC output current set to 0.0 amps on display board	Increase the current set point.
No analog signal from PLC or display board	Check for current/voltage at Ic terminals
CEDI module not connected to DC output (no load) or damaged DC output wires	Check connections and wires between DC output and CEDI module.
External control set incorrectly	Determine if the display or PLC will be the source of control, and change to YES/NO accordingly

Short Circuit	
Possible Cause	**Action**
Incorrect wiring to CEDI module	With power off, disconnect wiring at power controller and check for continuity (trace short).

7.1 DCR Alarm Codes

The DCR alarm code is represented by two numbers, separated by a dash. Together they indicate the alarm state or fault of the power controller. Alarm codes can be seen using the Ionpure Power Panel software or the Ionpure Touch Panel Display. See also Appendix C Modbus RTU Fieldbus Interface and Parameters List.

7.1.1 First position: DCR Inhibit Alarm Status (latch unless noted)

128 = Watchdog timeout
32 = Network timeout (latch depends on selection on Communication page)
16 = I/O Power supply failure
8 = Line Phase Loss (does not latch)
4 = PLL Lock Loss (does not latch)
2 = Heatsink Over-Temp
1 = Over Current Trip (PWM Fault input over current)
0 = No inhibit alarm

7.1.2 Second position: DCR Warning Alarm Status (do not latch)

1024 = Network timeout
512 = Deviation
256 = Output % high
128 = Output % low
64 = Low output
16 = Shorted SCR
8 = Heatsink Temp
4 = Power Limit
2 = Current Limit
1 = Voltage Limit
0 = No Warning Alarm

NOTE: in the case of multiple simultaneous alarms the values will be added.
For example: I/O Power supply failure (16) with Line Phase Loss (8) and PLL Lock Loss (4) = 28, or Deviation (512) with Low Output (64) and Heatsink Temp (8) = 584

APPENDIX A DESIGN CONSIDERATIONS

A.1 Basic Isolation Transformer Design Considerations

- Primary: single or three-phase, selected to match the power available at the site. Three phase primary should be Delta, not Wye.
- Secondary: single-phase, with voltage matched to CEDI module as shown in Table A.4. The maximum AC voltage in the transformer secondary should be 1.1 times higher than the maximum DC voltage required by the CEDI module.
- Number of Secondary Windings: The preferred configuration is a dedicated secondary winding for each DCR power controller.
    - While a single secondary winding can feed multiple DCRs, this requires the installation of a diode on each DCR heatsink ground connection to prevent cross-unit interference through the ground. Contact Ionpure for instructions.
- Frequency: 50 or 60 Hz.
- Duty Cycle: 100%
- The DC power requirements, recommended input voltage to the power controller (VAC), minimum isolation transformer rating (KVA) and fuse size for secondary (amps) for various CEDI single module systems are listed in A.4 in Appendix A.

A.2 Isolation Transformer Temperature Rise and Insulation Class

Transformers with 130 or 150 °C temperature rise with an insulation class of 220 °C are commonly available. Transformers with lower temperature rise are more efficient and have longer service life but are priced higher.

Selection is left up to the user. IEC standards specify the maximum temperature rise of transformers in relation to the insulating material used, for a maximum ambient temperature of 40°C, as listed below.

Insulation Class (°C)	**Max Permitted Temperature Increase in Windings (ºC)**	
(IEC60085)	***(IEC60026)***	***(EN61558)***
105 (A)	60	60
120 (E)	75	75
130 (B)	80	80
155 (F)	100	100
180 (H)	125	125
220	150	---

A.3 Other Isolation Transformer Design Considerations

Construction

Use open frame transformers with copper windings. Copper-wound transformers are usually more efficient and smaller than aluminum-wound units.

Thermal Switch

It is recommended to have a thermal switch embedded in the secondary winding to shut off the AC supply to the transformer if the temperature exceeds a set value, below the insulation class temperature.

Voltage Taps, Primary

Voltage taps in the primary are recommended by most transformer manufacturers. A common tap arrangement is two 2.5% taps above and four 2.5% taps below nominal voltage.

Transformers are shipped with the taps connected for nominal voltage. The installing electrician must change the taps if the supply voltage differs from the nominal voltage rating.

Voltage Taps, Secondary

Voltage Taps in the secondary are recommended to optimize the efficiency (power factor) and reliability of the DCR as well as the salt removal performance of the CEDI module.

Suggested taps are given in column 4 of A.4, and represent 33%, 67% and 100% of the maximum transformer secondary voltage.

The DC output voltage of the DCR will be about 90% of the selected tap (input) voltage.

A.4 Isolation Transformer Sizing for a Single Power Controller (IONPURE CEDI)

Module Type (CEDI)	Maximum Required DC Volts	Maximum Required DC Amps	Input Voltage to DCR (VAC taps)	Minimum Transformer kVA Rating*
MX30	27	2.5	30	0.1
MX60	53	2.5	40 / 60	0.2
MX125	106	2.5	40/80/120	0.4
MX250	213	2.5	80 / 160 / 240	0.8
MX500	426	2.5	160 / 315 / 470	1.6
LX04 X&Z (-4)	27	6	30	0.3
LX10 X&Z (-4)	67	6	25 / 50 / 75	0.6
LX18 X& Z (-4)	120	6	45 / 90 / 135	1.1
LX24 X& Z (-4)	160	6	60 / 120 / 180	1.4
LX30 X& Z (-4)	200	6	75 / 145 / 220	1.8
LX45 X& Z (-4)	300	6	110 / 220 / 330	2.7
LX04HI (-3)	50	10	40 / 60	0.8
LX10HI (-3)	125	10	45 / 95 / 145	1.9
LX18HI (-3)	225	10	80 / 170 / 250	3.4
LX24HI (-3)	300	10	110 / 220 / 330	4.5
LX30HI (-3)	375	10	140 / 280 / 420	5.6
LX45HI (-3)	600	10	220 / 440 / 660	9.0
VNX 28EP (-2)	300	6.6	110 / 220 / 330	3.0
VNX 55E (-2)	300	13.2	110 / 220 / 330	6.0
VNX 55EP (-2)	300	13.2	110 / 220 / 330	6.0
VNX 55EX (-2)	300	13.2	110 / 220 / 330	6.0
VNX15CDIT (-2)	600	6.6	110 / 220 / 330	6.0
VNX30CDIT (-2)	600	13.2	110 / 220 / 330	6.0
VNX55HH (-2)	600	8 **	220 / 440 / 660	7.2
VNX-Max (-1)	600	7	220 / 440 / 660	6.3
VNX-Mini (-1)	480	7	175 / 350 / 530	5.0

*Based on highest secondary voltage tap for specified CEDI module, given in column 4

**For 1.0-2.0 ppm hardness (as $CaCO_3$) in feed.

In most cases, custom designed transformers will be required (e.g. secondary voltage taps and 660 VAC secondary are not standard). The primary windings must be wound for the available AC mains voltage.

A.5 Fuses and Circuit Breakers

- "Fast acting" Class J or Class T fuses or a circuit breaker with a fast tripping curve must be installed between the output of the isolation transformer and the AC input of the power controller.
- 20-amp fuses will protect the DCR, so fuse trip rating is generally dictated by the wire size used to connect the transformer to the DCR. The voltage rating should match or exceed the nominal AC input voltage to the power controller.
- Over-current protection devices must also be installed on the primary of the isolation transformer and sized according to applicable local electrical codes.
- Do NOT install fuses, circuit breakers or any type of switching device between the DC output of the power controller and the CEDI module. Doing so might eventually cause damage to the power controller.

A.6 Snubbers

Snubbers may be desirable for an extra layer of protection against very high energy spikes whenever the power controller is fed with 660 Volts or at sites with poor electric power quality indicated by swells, over-voltages, surges, etc.

Snubbers are most effective when installed on the secondary of the transformer, between any switching devices and the power controller. Schematics showing their ideal location are found in Appendix B.

Ionpure offers voltage snubber circuits, model numbers IP-SNUBCIRC-1PH and IP-SNUBCIRC-3PH. The 3-phase version is only suitable for installation on the primary side of the isolation transformer, while the single-phase version can be installed on the transformer secondary. Refer to the Voltage Snubber instruction manual (available at www.ionpure.com) for details.

A.7 Enclosure

- Sizing: the width and height will depend on size and number of components inside the enclosure. There should be at least two inches of clearance from the top of the power controller to the door of the enclosure to allow proper air flow.
- Cooling: the power controller will dissipate a maximum of 50 watts in the form of heat. The panel enclosure should have proper ventilation to ensure the power controllers operate at a temperature no higher than 50 °C.

A.8 Contactor (Optional)

A contactor can be installed downstream of the over-current protection devices (fuses or breakers) to completely remove AC power to the power controller. This might be desired for emergency stop and/or manual override implementation.

Power to the CEDI module must be enabled / disabled using the Remote ON / OFF input of the power controller, as described in Section 3.3.5.

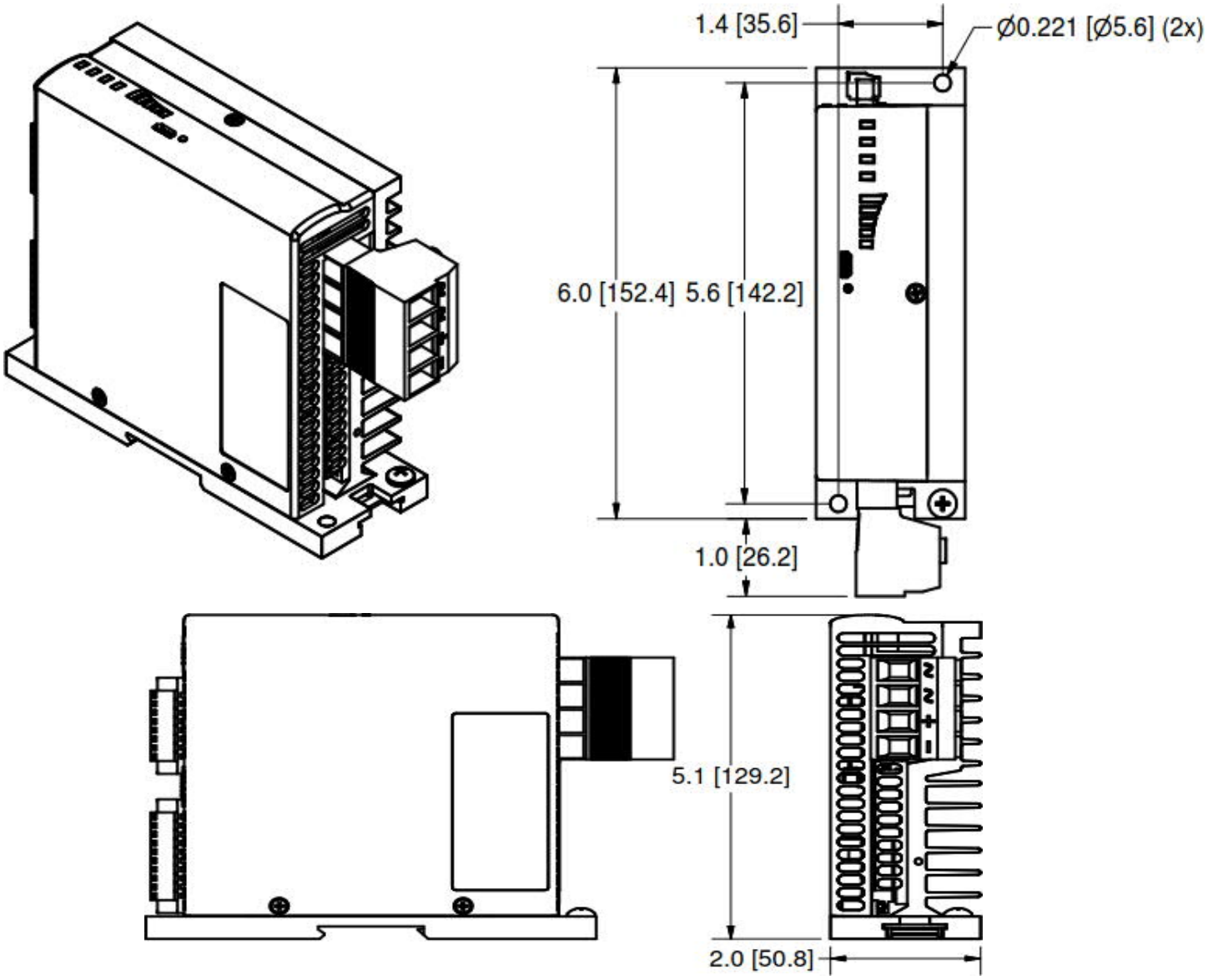
⚠WARNING **Troubleshooting should be performed by qualified personnel only. Safety procedures should be reviewed prior to working with the DCR.**

APPENDIX B ENGINEERING DOCUMENTS AND DRAWINGS

Engineering Drawings included in this section:

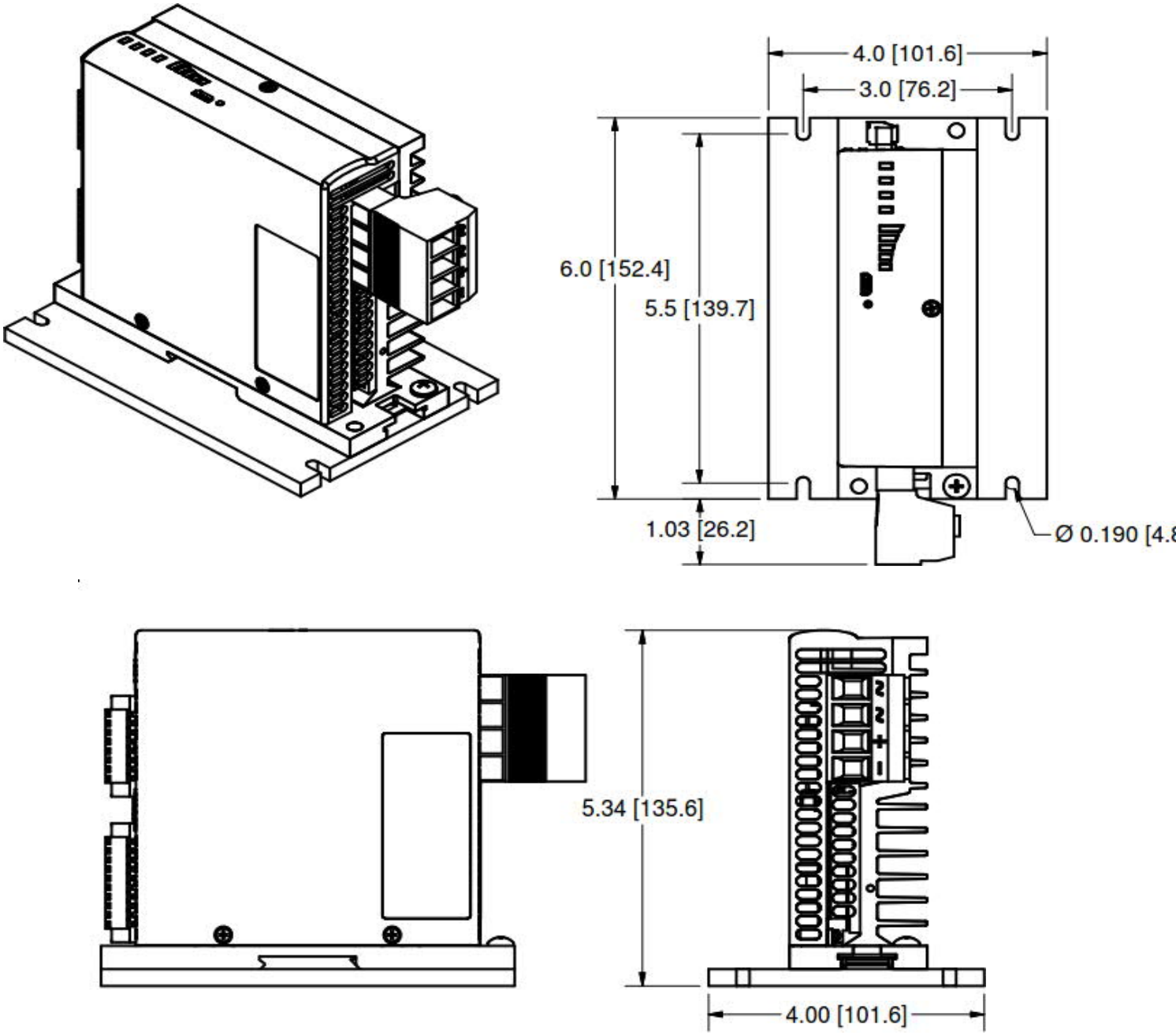
- Figure B.1: Full-Scale Dimensional Drawing for IP-DCR600V15A-M
- Figure B.2: Full-Scale Dimensional Drawing for IP-DCR600V15A-R2
- Figure B.3: Electrical Schematic of a Typical Single-module installation - Single-phase Transformer
- Figure B.4: Electrical Schematic of a Typical Multi-module Installation - Single-phase Transformer with Shared Secondary Winding
- Figure B.5: Electrical Schematic of a Typical Multi-module Installation - Three-phase Transformer with Independent Secondary Windings
- Figure B.6: Electrical Connections

B.1 Full-Scale Dimensional Drawing for IP-DCR600V15A-M

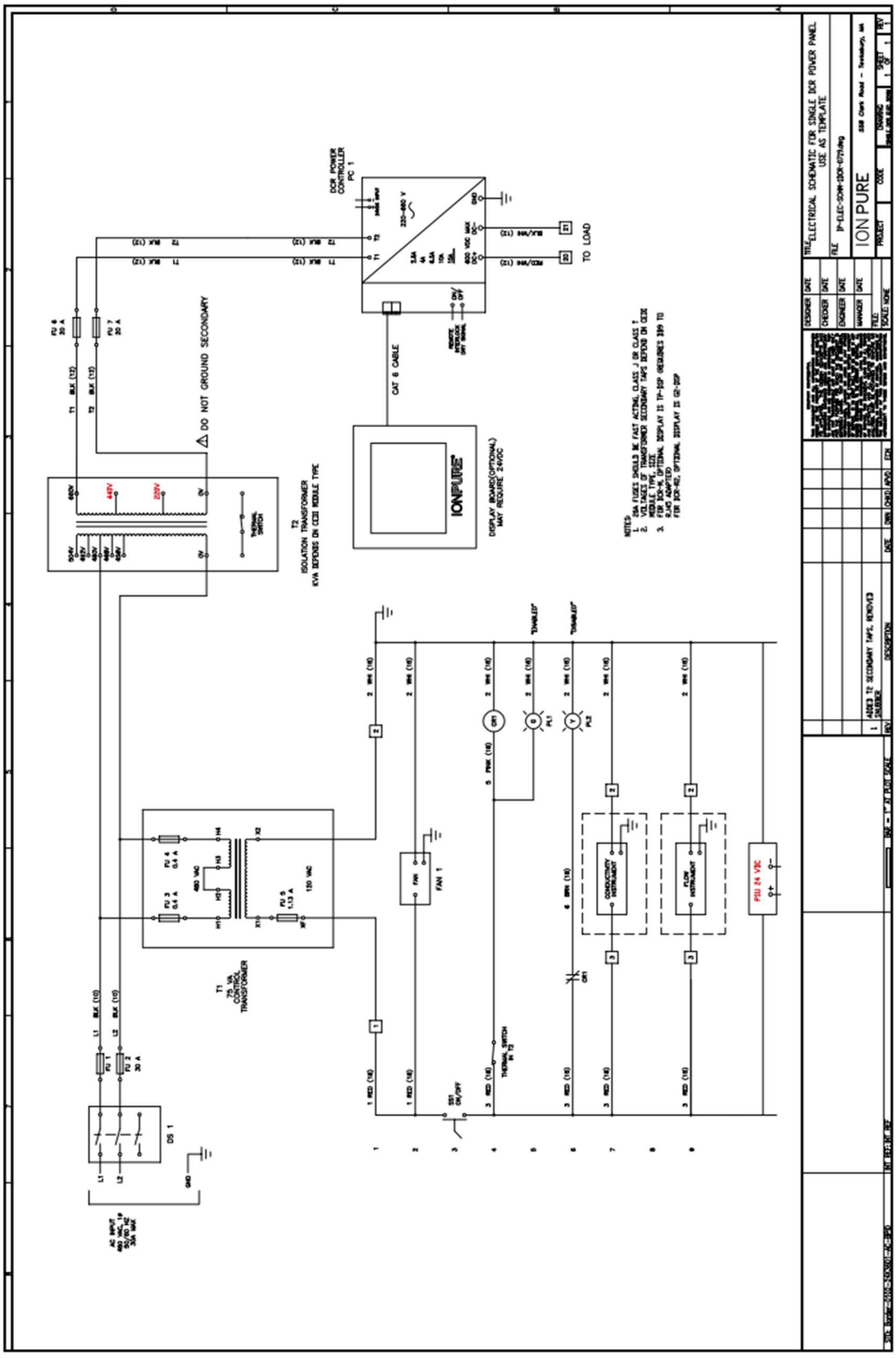


DIN rail mount

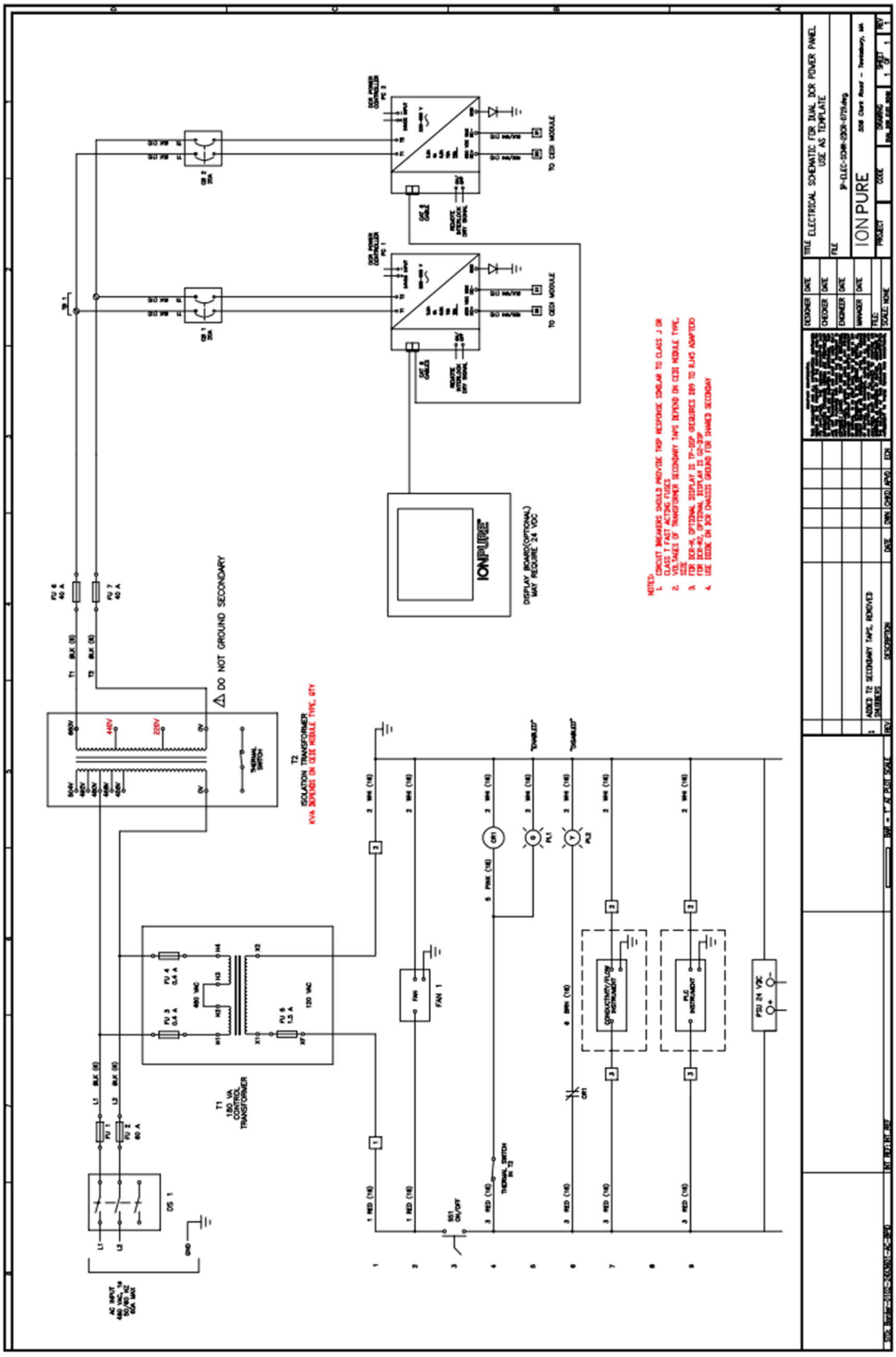
B.2 Full-Scale Dimensional Drawing for IP-DCR600V15A-R2



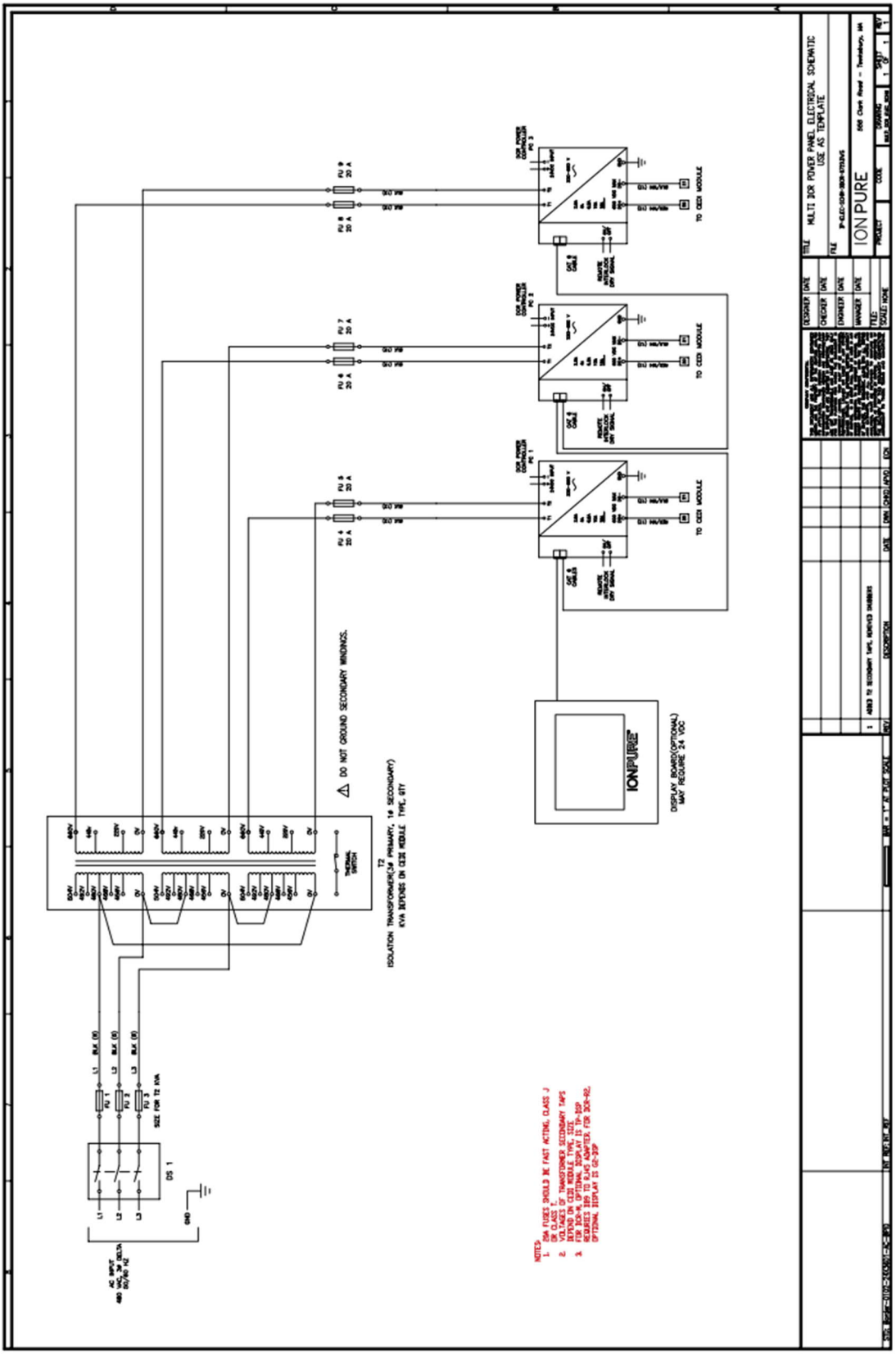
B.3 Electrical Schematic, 1-Module Installation – 1-Ø Transformer



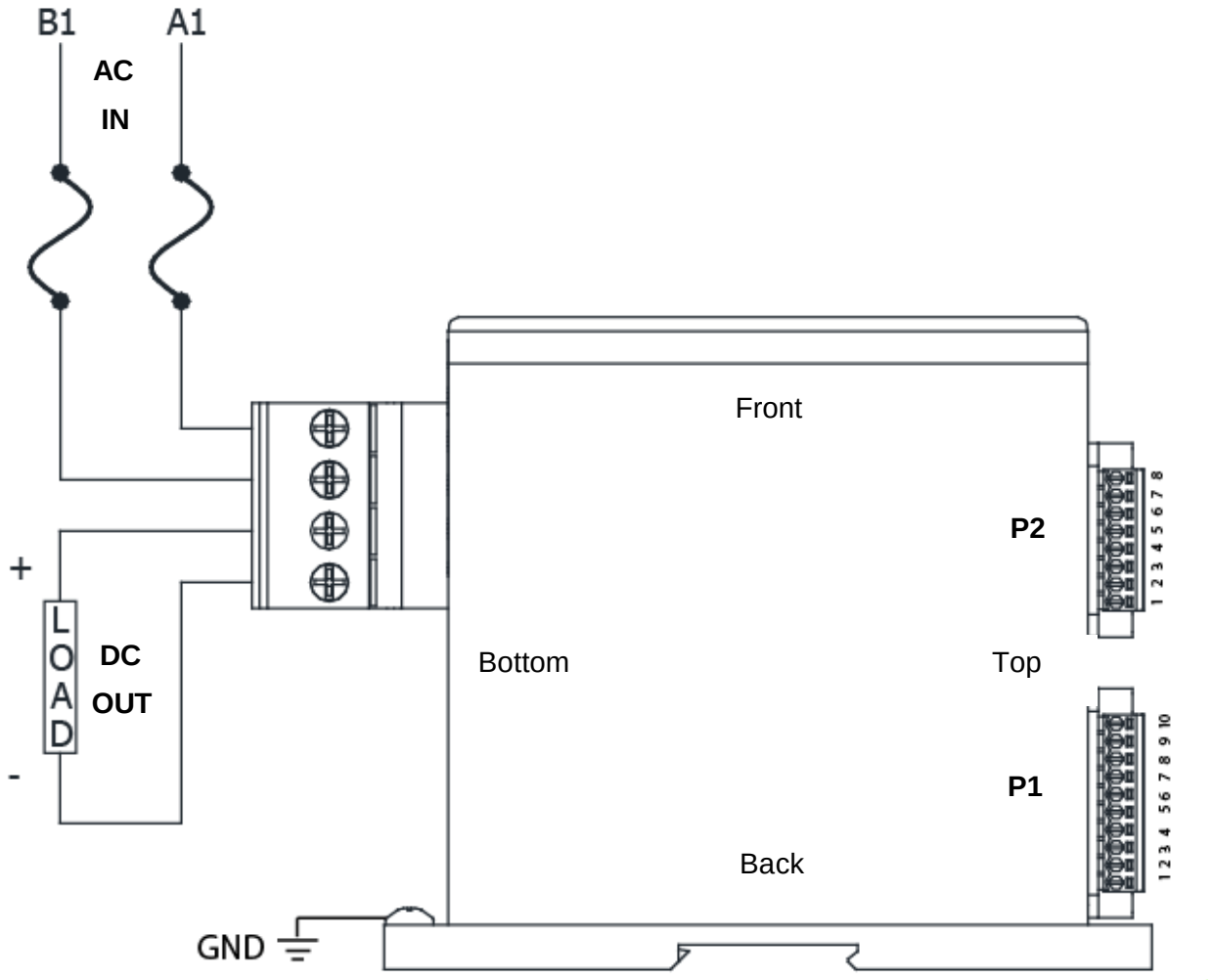
B.4 Electrical Schematic, 2-Module Installation – 1-Ø Transformer, Shared 2° Winding



B.5 Electrical Schematic, 3-Module Installation – 3-Ø Primary, Independent 2° Windings



B.6 Electrical Connections



APPENDIX C MODBUS RTU FIELDBUS INTERFACE & PARAMETER LIST

The following material can be found in resources from Modbus.org. Please consult the following document, “MODBUS over Serial Line: Specification & Implementation Guide”.
http://www.modbus.org/docs/Modbus_over_serial_line_V1.pdf

Use a shielded CAT5 or CAT6 Ethernet cable to daisy chain multiple units together to communicate digitally to either a display or PLC.

The default communication rate is 9600 Baud, N, 8, 1.

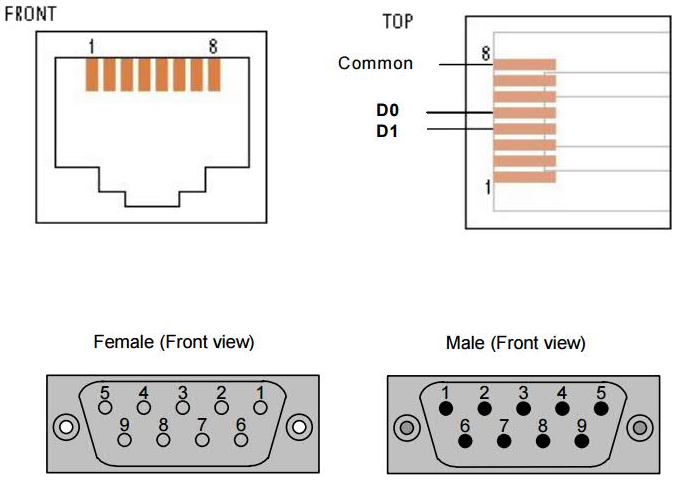
Set the Modbus Slave Address via the rotary dial.

If a RJ45 (or a mini-DIN or a D-Shell) connector is used on an equipment for a MODBUS mechanical interface, a shielded female connector **must** be chosen. Then the cable-end **must** have a shielded male connector.

C.1 Connector Pin-Out for 2W-MODBUS

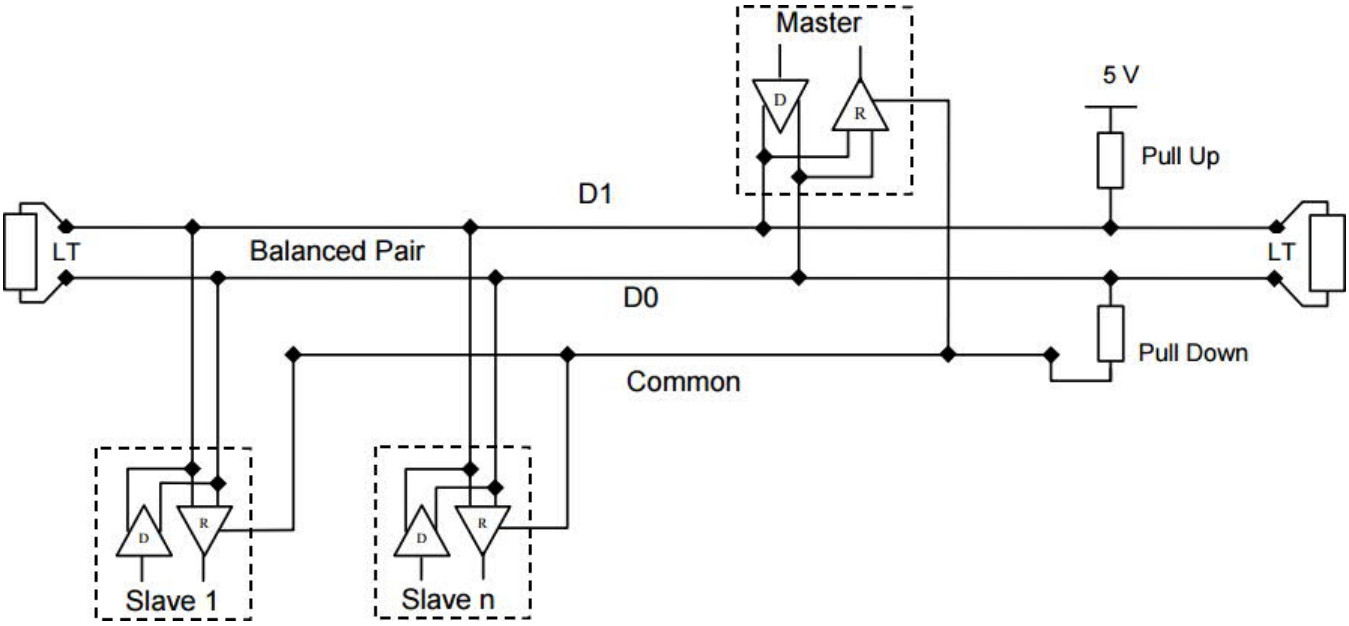
Screw type connectors can also be used.

If an RJ45 or a 9-pin D-shell connector is used for a standard Modbus device, the pinouts hereafter must be respected for every implemented circuit.



C.2 Two-Wire Modbus Definition

A Modbus solution over serial line **should** implement a “Two-Wire” electrical interface in accordance with EIA/TIA-485 standard. On such a 2W-bus, at any time one driver only has the right for transmitting. In fact, a third conductor **must** also interconnect all the devices of the bus: the common.



Required Circuits		For device	Required on device	EIA/TIA-485 name	Description
on ITr	on IDv				
D1	D1	I/O	**X**	B/B’	**Transceiver terminal 1, V1 Voltage** (V1 > V0 for binary 1 [OFF] state)
D0	D0	I/O	**X**	A/A’	**Transceiver terminal 0, V0 Voltage** (V0 > V1 for binary 0 [ON] state)
Common	Common	--	**X**	C/C’	Signal and optional Power Supply Common

C.3 Parameter List

Modbus Protocol

In general, the DCR parameters are all 16-bit integer values. However, there are some parameters such as MP 245 Load Power which use two registers for the value (32-bit value). MP 245 is the HI word, MP 246 is the LO word. These long word situations are clearly documented.

Some values may have digits to the right of the decimal point. The decimal point, or resolution, will not be part of the message. Rather a parameter with one decimal place will be scaled x10, two decimal places scaled x100.

Example: 5.00 must be scaled and sent as 500 and will also need to be scaled when read using a "scale-factor" of 100.

Note: Block reads of up to 24 parameters are recommended with a max polling rate of 4 Hz in order to prevent overloading of the DCR processor.

Parameter Read

Modbus function 0x03 "Read Holding Registers"

Allows reading of multiple parameters

Parameter limit = 24 registers per message (FUSION limit, not Modbus)

"Long Word" (32 bit) parameter values are returned using two (2) consecutive integer slots, MSW first

Parameter Write

Modbus function 0x06 "Preset Single Register"

Limited to one parameter that is integer-only (no larger values)

Parameter Write, Multiple

Modbus Function 0x10 [16] "Preset Multiple Registers"

Allows setting multiple parameters

Parameter limit = 24 registers per message [DCR limit, not Modbus]

Use two consecutive integer slots in the message to send "Long Word" (32 bit) parameter values to the parameters that accept a 32-bit value (MSW first)

Note: DCR controllers contain nonvolatile EEPROMs and writing too frequently to an individual parameter may wear out the EEPROM and cause the controller to fail.

IONPURE recommends allowing an average of five minutes between consecutive writes to an individual parameter within the range of 1-199, with the exception of digital set point commands 100-101 and the digital system command 129. Digital set points and digital system command may be written continually as they are RAM variables.

Read Alarm Status, or Read System Status

Modbus Function 0x07 “Read Exception Status”

Response contains a single byte field that may be used to return 8 status flags to indicate the status of the power controller.

SP 1 Feedback Type (Read Only: Selected by DIP Switch

Units:	N/A
Minimum:	1
Maximum:	7
Selections:	3 = DC AVG Voltage
	5 = DC AVG Current

SP 2-3 Reserved

SP 4 Ramp Time

Units:	Seconds
Decimal Places:	0
Minimum:	0
Maximum:	300
Default:	0

SP 5 Slew Rate (Control Response)

Units:	N/A
Minimum:	1
Maximum:	100
Default:	10

SP 6-7 Reserved

SP 8 Full Scale Voltage

Units:	Volts
Minimum:	5.0

Maximum: 600.0

Default: 480.0

SP 9 Full Scale Current (Read Only: Set by DIP Switch)

Units: Amps

Minimum: 1.0

Maximum: 80.0

Default: 80.0 (Set to Amp size)

SP 10 Full Scale Power

Units: kW

Minimum: 0.1

Maximum: 158.4

Default: 115.2 (Set according to Amp size and default voltage)

SP 11 Voltage Limit

Units: Volts (RMS or AVG)

Minimum: 4.0

Maximum: 660.0

Default: 600.0

SP 12 Current Limit Zone 1 (Read Only – Set by DIP Switch)

Units: Amps (RMS or AVG)

Minimum: 1.0

Maximum: 84.0

Default: 84.0 (Set according to 105% Amp size)

SP 13 Current Limit Type (Read Only – Set by DIP Switch)

Units: N/A

Minimum: 1

Maximum: 2

Default: 1

Selections: 1 = RMS

2 = AVG

SP 14 Current Trip (Read Only – Set by DIP Switch)

Units: Amps RMS

Minimum: 1

Maximum: 360

Default: 140 (Set according to 175% Amp size, 400% for zero cross)

SP 15 Power Limit

Units: kW

Minimum: 0.1

Maximum: 166.4

Default: 76.9 (Set 105% according to Amp size and default voltage)

SP 16 Relay Alarm Mask 1

Units: N/A

Minimum: 0000_0000_0000_0000

Maximum: 1111_1111_1111_1111

Default: 24576 = 6000_{hex} (0110_0000_0000_0000)

Representation:

Bit: 15 = TBD

14 = Heatsink Over Temp

13 = Current Trip

12 = Heatsink High Temp Warning

11 = AC Line Phase Loss

10 = Shorted SCR

9 = Power Limit

8 = Current Limit

7 = Voltage Limit

6 = Digital RUN Enable (RUN State Request)

5 = TBD

4 = 3 Phase Load Imbalance

3 = Low Output

2 = Deviation Alarm

1 = Output% High or Tap Change Up

0 = Output% Low or Tap Change Down

SP 17 Reserved

SP 18 Deviation Band

Units: Percent

Minimum: 0.00

Maximum: 100.00

Default: 100.00

SP 19 Feedback Source

Units: N/A

Minimum: 1

Maximum: 4

Default: 1

Selections: 1 = Internal Feedback Signal (V, I, P)

2 = Analog Setpoint 1

3 = Analog Setpoint 2

4 = Transducer Card

SP 20 Over-Current Trip Retry Setting

Units: Retry count

Minimum: 0

Maximum: 3

Default: 0

SP 21-25 Reserved

SP 84 Reserved

SP 85 System Relay Mask

Units: N/A

Minimum: 0000_0000_0000_0000

Maximum: 1111_1111_1111_1111

Default: 0 (0000_0000_0000_0000)

Representation:

Bit:
- 15 = TBD
- 14 = TBD
- 13 = TBD
- 12 = TBD
- 11 = TBD
- 10 = TBD
- 9 = TBD
- 8 = TBD
- 7 = TBD
- 6 = RUN Enable (Switch terminals OPEN)
- 5 = Controller is in RUN State
- 4 = PLL Lock Loss
- 3 = Watchdog Timeout
- 2 = Memory Error
- 1 = Communications Error
- 0 = Processor Error Trap

SP 86-89 Reserved

SP 90 Analog Setpoint 1 Type

Units: N/A

Minimum: 1

Maximum: 2

Default: 2 (Current)

Selections: 1 = Voltage Input

2 = Current Input

SP 91 Analog Setpoint 1 Lo Command

Units: V, mA

Minimum: -5.00

Maximum: 25.00

Default: 4.00

SP 92 Analog Input 1 Lo Output

Units: % (Based on full scale value)

Minimum: 0.00

Maximum: 100.00

Default: 0.00

SP 93 Analog Input 1 Hi Command

Units: V, mA

Minimum: -5.00

Maximum: 25.00

Default: 20.00

SP 94 Analog Input 1 Hi Output

Units: & (Based on full scale value)

Minimum: 0.00

Maximum: 100.00

Default: 100.00

SP 95 Analog Input 2 Type

Units: N/A

Minimum: 1

Maximum: 2

Default: 1 [Voltage]

Selections: 1 = Voltage Input

2 = Current Input

SP 96 Analog Input 2 Lo Command

Units: V, mA

Minimum: -5.00

Maximum: 25.00

Default: 0.00

SP 97 Analog Input 2 Lo Output

Units: % (Based on full scale value)

Minimum: 0.00

Maximum: 100.00

Default: 0.00

SP 98 Analog Input 2 Hi Command

Units: V, mA

Minimum: -5.00

Maximum: 25.00

Default: 5.00

SP 99 Analog Input 2 Hi Output

Units: % (Based on full scale value)

Minimum: 0.00

Maximum: 100.00

Default: 100.00

SP 100 Fieldbus Setpoint [RAM]

Units: NONE (counts)

Minimum: 0

Maximum: 64000 (see SP-115 Setpoint Resolution Select)

Default: 0

SP 101: Reserved

SP 102 Setpoint 1 Source

Units: N/A

Minimum: 1

Maximum: 5

Default: 1

NOTE: Default = 3 when digital fieldbus option is Modbus TCP, EtherNet/IP, or PROFINET

Selections:
1 = Analog Input 1
2 = Analog Input 2
3 = Fieldbus Setpoint
4 = Keypad Setpoint
5 = PWM Setpoint

SP 103 Setpoint 2 Source

Units: N/A

Minimum: 1

Maximum: 5

Default: 1

NOTE: Default = 1 when digital fieldbus option is Modbus TCP, EtherNet/IP, or PROFINET.

Default = 4 if Analog Setpoint 2 feature is not enabled

Selections:
1 = Analog Input 1
2 = Analog Input 2
3 = Fieldbus Setpoint

4 = Keypad Setpoint

5 = PWM Setpoint

SP 104 Control Setpoint Select

Units: N/A

Minimum: 1

Maximum: 2

Default: 1

Selections: 1 = Setpoint 1 Source

2 = Setpoint 2 Source

SP 105-107 Reserved

SP 108 Network Timeout Setpoint

Units: NONE (counts)

Minimum: 0.00

Maximum: 64000 (see SP-115 Setpoint Resolution Select)

Default: 0

SP 109 Clear Error Latch [RAM]

Units: N/A

Minimum: 0

Maximum: 1

Default: 0

Selections: 0 = Do Not Clear

1 = Clear the Latch Bits to 0

SP 110 Clear Fault [RAM]

Units: N/A

Minimum: 0

Maximum: 1

Default: 0

Selections: 0 = Do Not Clear

1 = Clear the Fault State

SP 111-114: Reserved

SP 115 Setpoint Resolution Select

***NOTE: Locked out during RUN state

Units: N/A

Minimum: 1

Maximum: 2

Default: 1

Selections: 1 = Low = 10000

2 = High = 64000

SP 116-120 Reserved

SP 121 RS-485 Baud Rate

Units: N/A

Minimum: 1

Maximum: 5

Default: 1

Selections: 1 = 9600 bps

2 = 19.2 kbps

3 38.4 kbps

SP 122 RS-485 Byte Format

Units: N/A

Minimum: 1

Maximum: 2

Default: 1

Selections: 1 = N, 8, 1

2 = E, 8, 1

SP 123-124 Reserved

SP 125 Communications Heartbeat Time

Units: Seconds

Minimum: 0

Maximum: 65535

Default: 0

SP 126-127 Reserved

SP 128 Network Timeout Action

Units: N/A

Minimum: 0

Maximum: 2

Default: 0

Selections

0 = NONE, Continue

1 = STOP, Fault Shutdown

2 = Use network timeout setpoint (SP-108)

SP 129 Digital RUN/STOP [RAM]

Units: N/A

Minimum: 0

Maximum: 1

Default: See XP-3401

Selections

0 = STOP

1 = RUN

SP 130 Relay Normal State

Units: N/A

Minimum: 0

Maximum: 1

Default: 0

Selections

0 = OFF (De-energized)

1 = ON (Energized)

SP 131-135 Reserved

SP 136 Analog Input 1 Monitor Full Scale Value

Units: N/A

Minimum: 0.0

Maximum: 3200.0

Default: 1000.0

SP 137 Analog Input 2 Monitor Full Scale Value

Units: N/A

Minimum: 0.0

Maximum: 3200.0

Default: 1000.0

SP 138-139 Reserved

SP 140 Meter 1 Output Type (Read Only – Set by DIP Switch)

Units: N/A

Minimum: 1

Maximum: 2

Default: 1

Selections:
1 = Voltage Output
2 = Current Output

SP 141 Meter 1 Signal Select

Units: N/A

Minimum: 1

Maximum: 12

Default: 1

Selection:
1 = Load Voltage A
2 = Load Current A
3 = Load Voltage B
4 = Load Current B
5 = Load Voltage C
6 = Load Current C
7 = Load Power
8 = 3 Phase Load Power
9 = Direct Out [SP-146]
10 = Load Resistance A
11 = Load Resistance B
12 = Load Resistance C

SP 142 Meter 1 Command Lo Value

Units: %, Based on full scale values

Minimum: 0.00

Maximum: 100.00

Default: 0.00

SP 143 Meter 1 Signal Lo Output

Units: V, mA

Minimum: 0.00

Maximum: 20.00

Default: 0.00

SP 144 Meter 1 Command Hi Value

Units: N/A, Based on Full Scale Values

Minimum: 0.00

Maximum: 100.00

Default: 100.00

SP 145 Meter 1 Signal HI Output

Units: V, mA

Minimum: 0.00

Maximum: 20.00

Default: 5.00

SP 146 Meter 1 Out Direct

Units: V, mA

Minimum: 0.00

Maximum: 20.00

Default: 0.00

SP 147 Meter 2 Output Type

Units: N/A

Minimum: 1

Maximum: 2

Default: 1

Selections: 1 = Voltage Output

2 = Current Output

SP 148 Meter 2 Signal Select

Units: N/A

Minimum: 1

Maximum: 12

Default: 2

Selection: 1 = Load Voltage A

2 = Load Current A

3 = Load Voltage B

4 = Load Current B

5 = Load Voltage C

6 = Load Current C

7 = Load Power

8 = 3 Phase Load Power

9 = Direct Out [SP-153]

10 = Load Resistance A

11 = Load Resistance B

12 = Load Resistance C

SP 149 Meter 2 Command Lo Value

Units: N/A, Based on Full Scale Values

Minimum: 0.00

Maximum: 100.00

Default: 0.00

SP 150 Meter 2 Signal Lo Output

Units: V, mA

Minimum: 0.00

Maximum: 20.00

Default: 0.00

SP 151 Meter 2 Command HI Value

Units: N/A, Based on Full Scale Values

Minimum: 0.00

Maximum: 100.00

Default: 100.00

SP 152 Meter 2 Signal HI Output

Units: V, mA

Minimum: 0.00

Maximum: 20.00

Default: 5.00

SP 153 Meter 2 Out Direct

Units: V, mA

Minimum: 0.00

Maximum: 20.00

Default: 0.00

SP 154 Load Resistance Maximum (for Retransmit scaling)

Units: Ohm

Minimum: 0.00

Maximum: 650.00

Default: 50.00

SP 155-199 Reserved

MP 200 Setpoint Selected

Units: N/A

Minimum: 1

Maximum: 10

Note: S1 = Setpoint 1 source, S2 = Setpoint 2 source

Representation:
1 = S1 Analog Input 1
2 = S1 Analog Input 2
3 = S1 Fieldbus Setpoint
4 = S1 Keypad Setpoint
6 = S2 Analog Input 1
7 = S2 Analog Input 2
8 = S2 Fieldbus Setpoint
9 = S2 Keypad Setpoint

MP 201: Reserved

MP 202 Analog Input 1

Units: %, Based on full scale values

Minimum: -100.00

Maximum: 100.00

MP 203 Analog Input 1 Command Value

Units: N/A

Minimum: -99999.9

Maximum: 99999.9

MP 204 Analog Input 1 Signal

Units: V, mA

Minimum: -99.99

Maximum: 99.99

MP 205 Analog Input 2

Units: %, Based on Full Scale Values

Minimum: -100.00

Maximum: 100.00

MP 206 Analog Input 2 Command Value

Units: N/A

Minimum: -99999.9

Maximum: 99999.9

MP 207 Analog Input 2 Signal

Units: V, mA

Minimum: -99.99

Maximum: 99.99

MP 208 Analog Input 1 Monitor Value

Units: N/A

Minimum: -9999.9

Maximum: 9999.9

MP 209 Analog Input 2 Monitor Value

Units: N/A

Minimum: -9999.9

Maximum: 9999.9

MP 210 Inhibit Alarm Status

Units: N/A

Minimum: 0000_0000

Maximum: 1111_1111

Representation

Bit:

MSB

7 = Watchdog Timeout

6 = Memory Error (Not Active)

5 = Network Timeout

4 = Not Used

3 = Line Phase Loss

2 = PLL Lock Loss

	1	=	Heatsink Over-Temp
LSB	0	=	Current Trip

MP 211 Controller Status

Units: N/A

Minimum: 0

Maximum: 5

Representation:

	0	=	Disabled
	1	=	Enabled
	2	=	Diagnostic
	3	=	Calibration
	4	=	Program Mode
	5	=	Heater Bakeout

MP 212: Reserved

MP 213 Digital I/O Status

Units: N/A

Minimum: 0000_0000

Maximum: 1111_1111

Representation: 0 = open/not active, 1 = closed/active

Bit:

MSB	7	=	Not Used
	6	=	Not Used
	5	=	Not Used
	4	=	Not Used
	3	=	Not Used
	2	=	Not Used
	1	=	Not Used
LSB	0	=	Run/Stop-Reset

MP 214 Reserved

MP 215 Load Current Limit (in use)

** SET ACCORDING TO THE LOAD CURRENT SWITCH AT POWER-UP/INITIALIZATION **

Units: Amps RMS or Average

Minimum: 2.5

Maximum: 15.0

MP 216-218 Reserved

MP 220 Line Voltage A

Units: RMS Volts

Minimum: 0.0

Maximum: 999.9

MP 221 Load Voltage A

Units: Volts RMS or AVG

Minimum: 0.0

Maximum: 999.9

MP 222 Load Current A

Units: Amps RMS or AVG

Minimum: 0.0

Maximum: 9999.9

MP 223 Load Resistance A

Units: Ohm

Minimum: 0.00

Maximum: 999.99

MP 224 Heatsink Temp A

Units: °C

Minimum: 0.0

Maximum: 999.9

MP 225-234 Reserved

MP 235 Load Current A

Units: Amps RMS or Average

Minimum: 0.00

Maximum: 999.99

MP 236-244 Reserved

MP 245 Load Power HI (MSW)

Units: Watts or VA

Minimum: 0

Maximum: 32767

MP 246 Load Power LO (LSW)

Units: Watts or VA

Minimum: 0

Maximum: 65535

MP 247 Line Power Factor

Units: N/A

Minimum: 0.00

Maximum: 9.99

MP 248 Controller State

Units: N/A

Minimum: 0

Maximum: 3

Representation: 0 = STOP

1 = RUN

2 = FAULT

3 = FAULT RESET

MP 249 Output Duty Cycle %

Units: % of Full ON

Minimum: 0.0

Maximum: 999.9

MP 250 Setpoint Reference HI (MSW)

Units: V, A, W

Minimum: -99

Maximum: 99

MP 251 Setpoint Reference LO (LSW)

Units: V, A, W

Minimum: 0

Maximum: 65535

MP 252 Feedback HI (MSW)

Units: V, A, W

Minimum: -99

Maximum: 99

MP 253 Feedback LO (LSW)

Units: V, A, W

Minimum: 0

Maximum: 65535

MP 254 Control Loop Error HI (MSW)

Units: V, A, W

Minimum: -99

Maximum: 99

MP 255 Control Loop Error LO (LSW)

Units: V, A, W

Minimum: 0

Maximum: 65535

MP 256 Warning Alarm Status

Units: N/A

Minimum: 0000000000 = 0

Maximum: 1111111111 = 2047

Representation:

Bit:

MSB	10	=	Network Timeout
	9	=	Deviation
	8	=	Output% High or Tap Change Up
	7	=	Output% Low or Tap Change Down
	6	=	Low Output
	5	=	Load Imbalance
	4	=	Shorted SCR
	3	=	Heatsink Tmp
	2	=	Power Limit
	1	=	Current Limit
LSB	0	=	Voltage Limit

MP 257 Load Power Factor

Units: N/A

Minimum: 0.00

Maximum: 9.99

MP 258-306: Reserved

MP 307 Power-up Count

Units: Counts

Minimum: 0

Maximum: 65535

MP 308 Low Power Count

Units: Counts

Minimum: 0

Maximum: 65535

MP 309 In Service Time HI (MSW)

Units: Hour

Minimum: 0

Maximum: 32767

MP 310 In Service Time LO (LSW)

Units: Hour

Minimum: 0

Maximum: 65535

MP 311-317 Reserved

MP 318 Power-Up Status 1 (Controller)

Units: N/A

Minimum: 0000000000000000 = 0

Maximum: 1111111111111111 = 65535

Representation:

Bit:

MSB 15 = Normal Power-up = OK

14 = Brownout Reset

	13	=	Not used
	12	=	Not used
	11	=	Not used
	10	=	Not used
	9	=	Bootloader version check failure
	8	=	EEPROM checksum failure
	7	=	Firmware checksum failure
	6	=	SRAM check failure
	5	=	Watchdog Timeout Reset
	4	=	DMA memory access conflict trap
	3	=	Math Error trap
	2	=	Stack Error trap
	1	=	Address Error trap
LSB	0	=	Oscillator Failure trap

MP 319 Power-up Status 2 (Microprocessor

Units: N/A

Minimum: 0000000000000000 = 0

Maximum: 1111111111111111 = 65535

Representation:

Bit:

MSB	15	=	A processor Trap conflict occurred prior to reset
	14	=	Illegal opcode execution caused a reset
	13	=	Not used
	12	=	Not used
	11	=	Not used
	10	=	Not used
	9	=	Not used
	8	=	Not used
	7	=	Master Reset (reset switch or power-up)
	6	=	Software Reset (reset command)
	5	=	not used

	4	=	Watchdog Timeout Reset
	3	=	Processor wakeup from sleep mode
	2	=	Processor recover from idle mode
	1	=	Processor Brown-out Reset
LSB	0	=	Power-up Reset

MP 320-321 Reserved

MP 322 USB Status

Units: N/A

Minimum: 0000_0000

Maximum: 1111_1111

Representation

Bit:

MSB	7	=	CRC or LRC Error
	6	=	Not Used
	5	=	Not Used
	4	=	Not Used
	3	=	Parity Error
	2	=	Framing Error
	1	=	Receive Buffer Overrun
LSB	0	=	Address received, Message Error encountered

MP 323 Network Status (CCI Link)

Units: N/A

Minimum: 0000_0000

Maximum: 1111_1111

Representation

Bit:

MSB	7	=	Bus OFF State
	6	=	Bus Passive State

	5	=	Duplicate MAC ID Detected
	4	=	Connection Timeout
	3	=	Cyclic Connection Established
	2	=	Reserved
	1	=	Explicit Connection Established
LSB	0	=	ON Line

MP 324 RS-485 Data Received

Units:	N/A
Minimum:	0
Maximum:	255

MP 325 RS-485 Address (Switch setting)

Units:	N/A
Minimum:	1
Maximum:	15

MP 326 Comm Status (Communications Module)

Units:	N/A
Minimum:	00000000 = 0
Maximum:	11111111 = 255
Representation	
Bit:	

MSB	7	=	Not used
	6	=	Not used
	5	=	Not used
	4	=	Not used
	3	=	Parity error
	2	=	Framing error
	1	=	Buffer Overrun error
LSB	0	=	Not used

MP 327-330 Reserved

MP 331 Firmware ID

Units: N/A

Minimum: 0

Maximum: 32767

MP 332 Firmware Version

Units: N/A

Minimum: 0.00.01

Maximum: 99.99.99

MP 333 Minor Revision (Appended to Firmware Version)

Units: N/A

Minimum: 01

Maximum: 99

MP 334 Reserved

MP 335 Misc Status

Units: N/A

Minimum: 0000_0000_0000_0000

Maximum: 1111_1111_1111_1111

Representation:

Bit:

MSB 15 = Not Used

14 = Not Used

13 = Not Used

12 = Not Used

11 = Not Used

10 = Not Used

9 = Not Used

	8	=	Not Used
	7	=	Load Trace is ON, Collecting Data
	6	=	AC Line Trace is ON, Collecting Data
	5	=	Load Trace is Enabled, Waiting for Trigger
	4	=	AC Line Trace is Enabled, Waiting for Trigger
	3	=	Waiting for the Enter Key during Initialization
	2	=	USER Unlock, Access Code Successfully Entered
	1	=	Not Used
LSB	0	=	MFG Unlock, Access Code Successfully Entered

MP 336 EEPROM Status

Units: N/A

Minimum: 0000_0000_0000_0000

Maximum: 1111_1111_1111_1111

Representation:

Bit:

MSB	15	=	Not Used
	14	=	Not Used
	13	=	EEPROM SP Definition Table update required
	12	=	EEPROM is write-protected
	11	=	Backup User SP V-table checksum failure
	10	=	Not Used
	9	=	Not Used
	8	=	Repair record checksum failure
	7	=	Error Code Record checksum failure
	6	=	MFG Data Table checksum failure
	5	=	Calibration Data Table checksum failure
	4	=	CAL Parameter V-Table checksum failure
	3	=	MFG SP V-Table checksum failure
	2	=	User SP V-Table checksum failure
	1	=	Blank, Initialization required

LSB	0	=	Read/Write failure

MP 337-341 Reserved

MP 342 AC Line Status

Units:	N/A		
Minimum:	0000_0000		
Maximum:	1111_1111		
Representation:			
Bit:			
MSB	7	=	Feedback ADC Timing OK
	6	=	Control Loop Timing OK
			Phase Rotation 3-2-1
	5	=	(0 = Phase Rotation 1-2-3)
	4	=	Phase Rotation Determined (Three Phase)
	3	=	Not Used
	2	=	Line Voltage C Present
	1	=	Line Voltage B Present
LSB	0	=	Line Voltage A Present

MP 343 Load Status

Units:	N/A		
Minimum:	0000_0000		
Maximum:	1111_1111		
Representation:			
Bit:			
MSB	7	=	Not Used
	6	=	Open Load C
	5	=	Open Load B
	4	=	Open Load A
	3	=	Not Used
	2	=	Shorted SCR C

	1	=	Shorted SCR B
LSB	0	=	Shorted SCR A

MP 344 Zone Status

Units: N/A

Minimum: 0000_0000_0000

Maximum: 0000_0001_0000

Representation:

Bit:

MSB	15	=	Not Used
	14	=	Not Used
	13	=	Not Used
	12	=	Not Used
	11	=	Not Used
	10	=	Not Used
	9	=	Not Used
	8	=	Not Used
	7	=	Not Used
	6	=	Not Used
	5	=	Not Used
			Zone 1: (0 = Not at Setpoint,
	4	=	1 = at Setpoint)
	3	=	Not Used
	2	=	Not Used
	1	=	Not Used
LSB	0	=	Zone 1: (0 = Normal, 1 = FAULT)

MP 345 Error Latch

Units: N/A

Minimum: 0000_0000_0000_0000

Maximum: 1111_1111_1111_1111

Representation:

Bit:

MSB	15	=	(0) Reserved
	14	=	(0) Reserved
	13	=	(0) Reserved
	12	=	(0) Reserved
	11	=	(0) Reserved
	10	=	(0) Reserved
	9	=	(0) Reserved
	8	=	(0) Reserved
	7	=	(0) Reserved
	6	=	(0) Reserved
	5	=	(0) Reserved
	4	=	ADC/DMA Feedback “Re-Sync” performed
	3	=	AC Line “Re-Sync” performed
	2	=	AC Line Frequency check failure
	1	=	Phase Loss or Missing AC Line cycle detected
LSB	0	=	AC Line Phase Lock Loss

MP 346 Alarms

Units: N/A

Minimum: 0000_0000_0000_0000

Maximum: 0111_1111_1111_1111 = 32767

Representation:

Bit:

MSB	15	=	Not Used
	14	=	Watchdog Timeout
	13	=	Output% High or Tap Change Up
	12	=	Output% Low or Tap Change Down
	11	=	Line Phase Loss
	10	=	PLL Lock Loss
	9	=	Heatsink Overtemp
	8	=	Current Trip

	7	=	Deviation
	6	=	Low Output (at MAX Output)
	5	=	Load Imbalance
	4	=	Shorted SCR
	3	=	Heatsink Close to Overtemp
	2	=	Power Limiting
	1	=	Current Limiting
LSB	0	=	Voltage Limiting

MP 347-348 Reserved

MP 349 Firmware Update Code

Units: N/A

Minimum: 0

Maximum: 65535

MP 350-369 Reserved

MP 370 Network Heartbeat Timer

Units: Seconds

Minimum: 0

Maximum: 65535

MP 371-377 Reserved

MP 378 EEProm Status 2

Units: N/A

Minimum: 00000000 = 0

Maximum: 11111111 = 255

Representation:

Bit:

MSB	7	=	User Backup XP Table 2 checksum error

	6	=	User Backup XP Table 1 checksum error
	5	=	MFG XP Table 2 checksum error
	4	=	MFG XP Table 1 checksum error
	3	=	XP Table 2 checksum error
	2	=	XP Table 1 checksum error
	1	=	XP Definition table 2 error
LSB	0	=	XP Definition table 1 error

MP 379 Bootloader Version

Units:	N/A
Minimum:	1.00
Maximum:	99.99

MP 380 PGA Gain AC Line

Units:	N/A
Minimum:	1
Maximum:	32

MP 381 PGA Gain Load Voltage

Units:	N/A
Minimum:	1
Maximum:	32

MP 382 Load Voltage Range

Units:	N/A
Minimum:	1
Maximum:	3

MP 383-384 Reserved

MP 385 PGA Gain Load Current

Units:	N/A

Minimum: 1

Maximum: 32

MP 386-388 Reserved

MP 389 PGA Gain Message Count

PGA Gain Update Message Count per AC Line 1/2

Units: Cycle

Minimum: 0

Maximum: 65535

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