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POWER

iHP Owner's Manual





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1 Overview

1.1 General Description

The Intelligent High Power (iHP) series is an addition to Artesyn's existing breadth of configurable AC to DC power supply products. The iHP series offers the highest power and voltage rating in the configurable family and provides the most flexible and universal solutions for medical and industrial applications. The iHP series provides accuracy, resolution, and stability as either a programmable voltage or current source. The basic modular concept consists of an iHP rack into which iHP modules are inserted. The rack is a Power Factor corrected front-end converting worldwide standard AC input voltages into a regulated high voltage DC (HVDC) output. The pluggable modules provide an extended range of voltage and current combinations converting the HVDC input into programmable 3KW increments of output power. iHP output modules are configured into a power system by plugging the modules into one of two different standard 19" AC-HVDC racks. One rack houses up to four modules (12KW) and the other rack up to eight modules (24KW). Provisions are made for up to six racks to be connected and controlled in parallel.

Safety approvals secured by Artesyn eliminate the need for an isolation transformer in medical equipment. The iHP system also has industrial safety approvals, including compliance to the SEMI F47 standard for semiconductor processing equipment.

The iHP series offers developers either an analog or digital interface to their system, supporting standard communications protocols, including CANbus, Ethernet, and RS485. Digital control enables the use of Artesyn's high-level PowerPro software graphical user interface (GUI) to control and monitor all functions on one or multiple iHP systems. The PowerPro GUI also incorporates graphical script creation that allows users to write their own process control routines.

The iHP series offers efficient power factor correction (PFC) and low total harmonic distortion (THD) over a wide range of loads. It uses a multi-phase continuous mode boost PFC architecture, resulting in ripple current cancellation that offers lower EMI and extends the life of electrolytic capacitors.

Users can configure and customize the iHP modules to fit exact applications requirements. A qualified service personnel can configure the iHP rack for single or three phase inputs. The modules can be connected in series or parallel, while achieving accurate voltage and current sharing. Using grouping commands, modules in parallel or series can be controlled as one single output. For specific types of load applications, the iHP system can be programmed to three different compensation configurations including resistive load, capacitive load and LED load. The LED load compensation opens new applications for large horticulture farms that require high voltage for many LED strings tied in series.

1.2 Operational Overview

The iHP system is designed to be configurable to meet varied design requirements. The number of configurable parameters is extensive and access to the parameters is via a computer interface instead of the front panel. Before operating the supply, it is important that communication between a computer and the supply be established and the supply operational parameters be configured for the intended application.

The simplest way to get started is to use the Power Pro Connect Module (PPCM) to establish a link to the supply. The PPCM allows the user to quickly establish a connection with the power supply with a Web based GUI and set up the power supply. The configuration of the supply can be set up to run autonomously when powered on, controlled via rear panel digital and analog input and outputs, or actively controlled via the PPCM.

For more advanced users developing their own software control, the PPCM is not required and the supply can be directly interfaced via the users preferred standard communications protocols, including CANbus, Ethernet and RS485.

1.3 Specification Summary

Tables 1-1 and Table 1-2 below summarize the 24K and 12K input parameters, followed by Table 1-3 outlining the general Module specifications

Table 1-1

iHP24 Electrical Specifications		
Input Parameter	**19" Rack 24 KW strapped as 3-phase 380/480 Vac Nominal (iHP24H3A/L)**	**19" Rack 24 KW strapped as 3-phase 208/240 Vac Nominal (iHP24L3A/L)**
Input range	342 Vac to 528 Vac (Nominal rating 380/480 Vac)	187.5 Vac to 264 Vac (Nominal rating 208/240 Vac)
Number of phases	3-phase (Wye or Delta) 4 wire total (3-phase and 1 protective earth ground)	
Frequency	47-63 Hz	
Phase detection	Loss of phase will inhibit unit off. Housekeeping/comms must continue with phase loss.	
Max current/phase	51 A @ 342 Vac 40 A @ 432 Vac	84 A @ 187.5 Vac
Under voltage detection	Nominal input locked on at turn-on. Under voltage shutdown at 15% below nominal. Turn-on at 12% below nominal. Not to interfere with SEMI F47 specs.	
Current inrush	2.5 x Max input current	
Power factor	> 0.98 @ full load and nominal line	
Harmonic distortion	THD < 13%, PWHD < 22% (refer to EN 61000-3-12)	
Line interruption	Designed to meet SEMI F47-0706, 53, 58, S14 at nominal input voltages	
Input leakage current	< 2.5 mA (Note for fixed condition 3rd edition leakage = 5 mA)	
Power switch	Front panel power switch provided	
Input protection	Internal fuse (not user serviceable)	
Input overvoltage protection	Up to 115% of nominal input shall not damage unit	
Phase imbalance	≤ 5%	
Rack parallel	Up to 6 racks (144 KW)	
Efficiency	> 90% @ 3P 380 Vac full load > 91% @ 3P 480 Vac full load	> 90% @ 3P 208 Vac full load > 91% @ 3P 240 Vac full load
Standby voltage	5 V	
Standby regulation	4.75 - 5.25 V	
Standby max current	1 A	

Table 1-2

iHP12 Electrical Specifications			
Input Parameter	**19" Rack 12 KW strapped as 1-phase 200/220/230/240 Vac Nominal (iHP12L1A)**	**19" Rack 12 KW strapped as 3-phase 200/208/240 Vac Nominal (iHP12L3A)**	**19" Rack 12 KW strapped as 3-phase 380/480 Vac Nominal (iHP12H3A)**
Input range	180 Vac to 264 Vac (Nominal rating 200/220/230/240 Vac)	180 Vac to 264 Vac (Nominal rating 200/208/240 Vac)	342 Vac to 528 Vac (Nominal rating 380/480 Vac)
Number of phases	1-phase 3-wire total (2-phase and 1 protective earth ground)	3-phase (Wye or Delta) 4-wire total (3-phase and 1 protective earth ground)	
Frequency	47-63 Hz		
Phase detection	NA	Loss of phase will inhibit unit off. Housekeeping/comms must continue with phase loss.	
Max current/phase	75 A @ 180 Vac	44 A @ 180 Vac	23 A @ 342 Vac 19 A @ 432 Vac
Under voltage detection	Nominal input locked on at turn-on. Under voltage shutdown at 15% below nominal. Turn-on at 12% below nominal. Not to interfere with SEMI F47 specs.		
Current inrush	2.5 x Max input current		
Power factor	> 0.99 @ full load and nominal line	> 0.98 @ full load and nominal line	
Harmonic distortion	THD < 13%, PWHD < 22% (refer to EN 61000-3-12)		
Line interruption	Designed to meet SEMI F47-0706, 53, 58, S14 at nominal input voltages		
Input leakage current	< 1.25 mA		<2.5 mA
Power switch	Front panel power switch provided		
Input protection	Internal fuse (not user serviceable)		
Input overvoltage protection	Up to 115% of nominal input shall not damage unit		
Phase imbalance	NA	$\leq$ 5%	$\leq$ 5%
Rack parallel	Up to 6 racks (72 KW)		
Efficiency	> 91% @ 1P 240 Vac full load > 90% @ 1P 208 Vac/200 Vac full load	> 91% @ 3P 240 Vac full load > 90% @ 3P 208 Vac/200 Vac full load	> 90% @ 3P 380 Vac full load > 91% @ 3P 480 Vac full load
Standby voltage	5 V		
Standby regulation	4.75 - 5.25 V		
Standby max current	1 A		

Table 1-3

OUTPUT – General Specifications							
	Parameter						
MODULE CODE	SL	SQ	SW	S8	S1	SA	S2
# Outputs	1	1	1	1	1	1	1
Nominal O/P (V)	12.0 V	24.0 V	48.0 V	80.0 V	125.0 V	200.0V	250.0 V
Max Power (W)	2400 W	2880 W	3000 W	3000 W	3000 W	3000 W	3000 W
O/P Current Range (A)	0.0 A - 200 A	0.0 A - 120 A	0.0 A - 62.5 A	0.0 A - 37.5 A	0.0 A -24 A	0.0 A -15 A	0.0 A -12 A
Power Density (W/cu-in)	32.5	39.0	40.6	40.6	40.6	40.6	40.6
Efficiency (%)	93.5	93.5	93.5	93.5	93.5	93.5	93.5
Module Input Voltage	400 V						
Module Operating Temp	-0 °C to +65 °C; Baseplate Temp TBD						
Series Operation	12V, 24V & 48V modules can be connected in series up to 300 V for Medical 12V, 24V & 48V modules can be connected in series up to 400 V for ITE 80V, 125V, 200V & 250 V modules can be connected in series up to 800 V for Medical 80V, 125V, 200V & 250 V modules can be connected in series up to 1000 V for ITE						
Parallel Operation	Up to 8 modules can be paralleled in 1 rack, with up to 6 racks connected in parallel. Single Wire Parallel connection will be provided as part of configuration						

1.3.1 Environmental

Table 1-4 outlines the operating and non-operating environmental requirements.

Table 1-4

Environmental Specifications	
Operating Conditions	**ALL MODELS (Unless Otherwise Specified)**
Operating Temperature	0 °C to +50 °C at 100% rated load.
Storage Temperature	-40 °C to +85 °C. For Liquid Cooled models, liquid must be drained before storage
Operating Humidity	20% - 90% non-condensing
Storage Humidity	10% - 95% non-condensing
Operating Altitude	Up to 9,842 feet above sea level (3,000 meters)
Storage Altitude	Up to 30,000 feet above sea level (9,144 meters)
Vibration	Operating Sinusoidal Vibration MIL-STD-810G Method 528 Procedure I (Type 1): NEBS Office Vibration Environment, Alternate Procedure Operating Random Vibration: IPC-9592B Class 1 Non-Operating Vibration (Packaged): IPC-9592B Class 1; MIL-STD-810G, Method 514.6, Procedure 1, Category 7, Table 514.6C-VII General Exposure
Shock	MIL-STD-810G Method 516.6 Procedures I, II, IV, VI
Shipping and Handling	NSTA for <100 lbs.; MIL-STD-2073-1 >100 lbs.
Cooling and Audible Noise	<65 dBA with 80% load @ 30 °C at nominal input voltage with Smart Fan algorithm to be optimized based on module and rack thermal sensors. When modules are inhibited via software control, the fan speed is reduced to idle and acoustic noise is <46 dBA. With modules off via front panel switch fans are at idle for 1 min, and off for 9 min.
Ingress Protection	Fan Cooled = IP20
Pollution Degree	2
RoHS Compliance	Yes

1.3.2 Electrical Specifications

The electrical specification for each module type is dependent on if the module is operating in voltage mode or current mode. Table 1-5 lists the electrical specifications when operating in voltage mode and Table 1-6 lists the specifications when operating in current mode.

Table 1-5

OUTPUT – Module in Voltage Source Mode							
	Voltage Source						
MODULE CODE	SL	SQ	SW	S8	S1	SA	S2
Nominal Output (V)	12	24	48	80	125	200	250
Setting Range (V)	0.6 V - 14.4 V	1.2 V - 28.8 V	2.4 V - 57.6 V	4.0 V - 96.0 V	6.25 V - 150.0 V	10.0 V – 240.0 V	12.5 V - 300.0 V
Low Frequency RMS Ripple (mV)	24	48	96	160	250	500	500
Line Regulation (mV)	12	24	48	80	125	200	250
Load Regulation (mV)	24	48	96	160	250	400	500
P-P Ripple (mV)	60	120	240	400	625	1250	1250
Drift (Temp Stability)	±0.05% of Iout Rated over 8 hours, after 30-minute warm up, constant Line, Load and Temp						
Temp Coefficient (PPM/°C)	200						
Pgm Accuracy (mV)	Digital: 0.1% of Nominal Output Voltage; Analog: 1.0% of Nominal Output Voltage						
Pgm Resolution (mV)	SL=TBD; SQ=1; SW=2; S8=8; S1=6; SA=21; S2=21						
Meas Accuracy (mV)	0.2% + 0.2% of Nominal Output Voltage						
Meas Resolution	SL=TBD; SQ=1; SW=2; S8=8; S1=6; SA=21; S2=21						
Transient Response	Max 5.0% deviation from current set point must recover within 1mS for a 50% step load.						
Current Sense Method	Internal Shunt; External Shunt can be used for better temperature stability.						

Table 1-6

OUTPUT – Module in Current Source Mode							
	Current Source - Programmable load compensation available for resistive and inductive loads; capacitive load applications; and LED drive applications						
MODULE CODE	SL	SQ	SW	S8	S1	SA	S2
Nominal Output (V)	12	24	48	80	125	200	250
Setting Range (A)	0.0 A - 200 A	0.0 A - 120 A	0.0 A - 62.5 A	0.0 A - 37.5 A	0.0 A - 24 A	0.0 A – 15 A	0.0 A - 12 A
RMS Ripple (mA)	200	120	62.5	37.5	24	40	12
Line Regulation (mA)	200	120	125	93.75	48	50	24
Load Regulation (mA)	800	480	250	150	96	56	48
P-P Ripple (mA)	N/A						
Drift (Temp Stability)	±0.05% of I_{out} Rated over 8 hours, after 30-minute warm up, constant Line, Load and Temp						
Temp Co-efficient (PPM/°C)	SL, SQ = 300 PPM; All other modules are 200 PPM. Temp Co-efficient at rack level is [Temp Co-efficient (module level)] + [4500 PPM of Iout-max]						
Pgm Accuracy (A)	0.7% digital, 1.3% analog of rated output max						
Pgm Resolution (mA)	79.2	26.4	13.2	10	5.2	2.6	2.6
Meas Accuracy	0.7% + 0.7% of Rated Output Max						
Meas Resolution	79.2	26.4	13.2	10	5.2	2.6	2.6
Transient Response	0-63% output current change in 7.5 mSec, residual value 1%, settling time 35 mSec						
Current Sense Method	Internal Shunt / External Shunt						

1.3.3 Mechanical Outline

The external dimensions of the iHP system are shown in Figure 1-1.

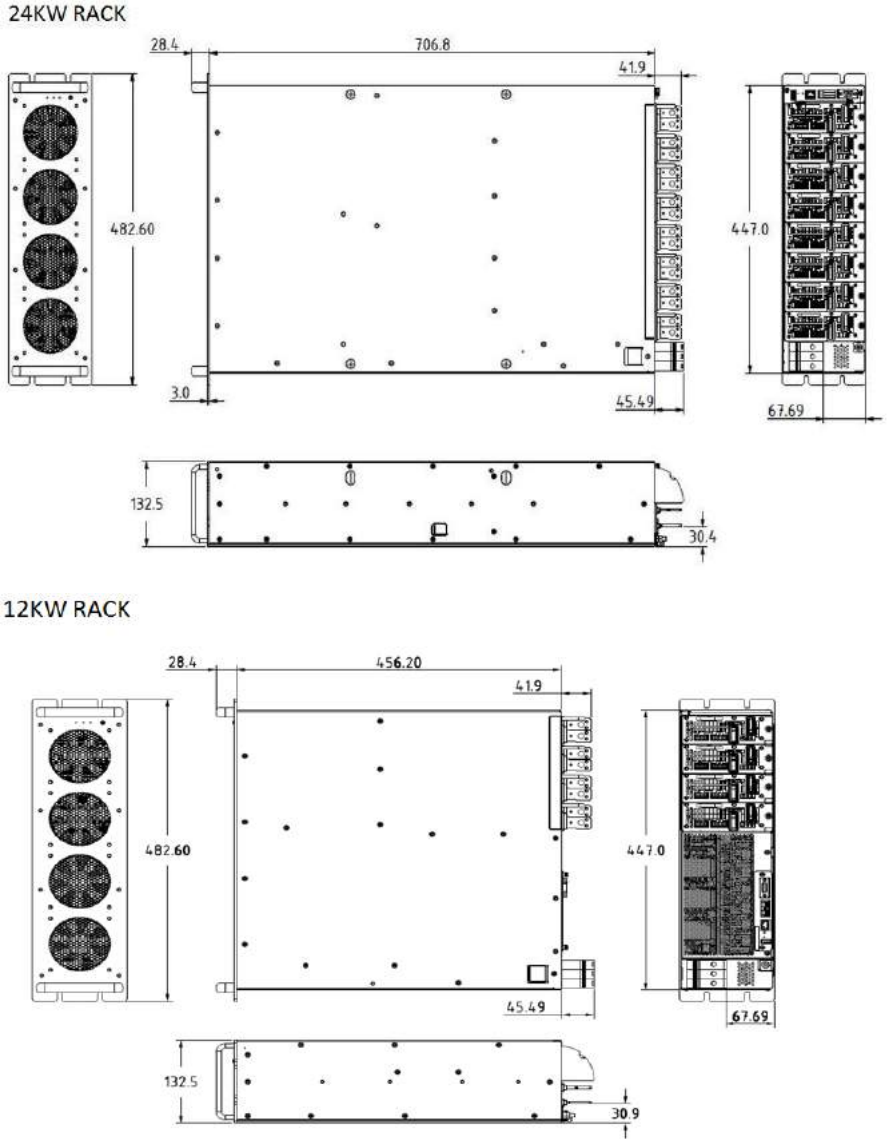


Figure 1-1 External dimensions of iHP system

1.3.4 Front and Rear Panel

Figures 1-2 and 1-3 display the front and rear panels of iHP system. The user interface and connectors are shown.

Note: Please Refer to Appendix A for the Front Panel LED response.

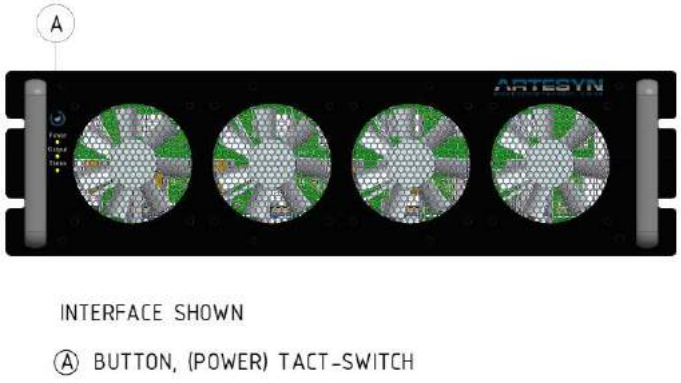


Figure 1-2 Front panel of iHP system

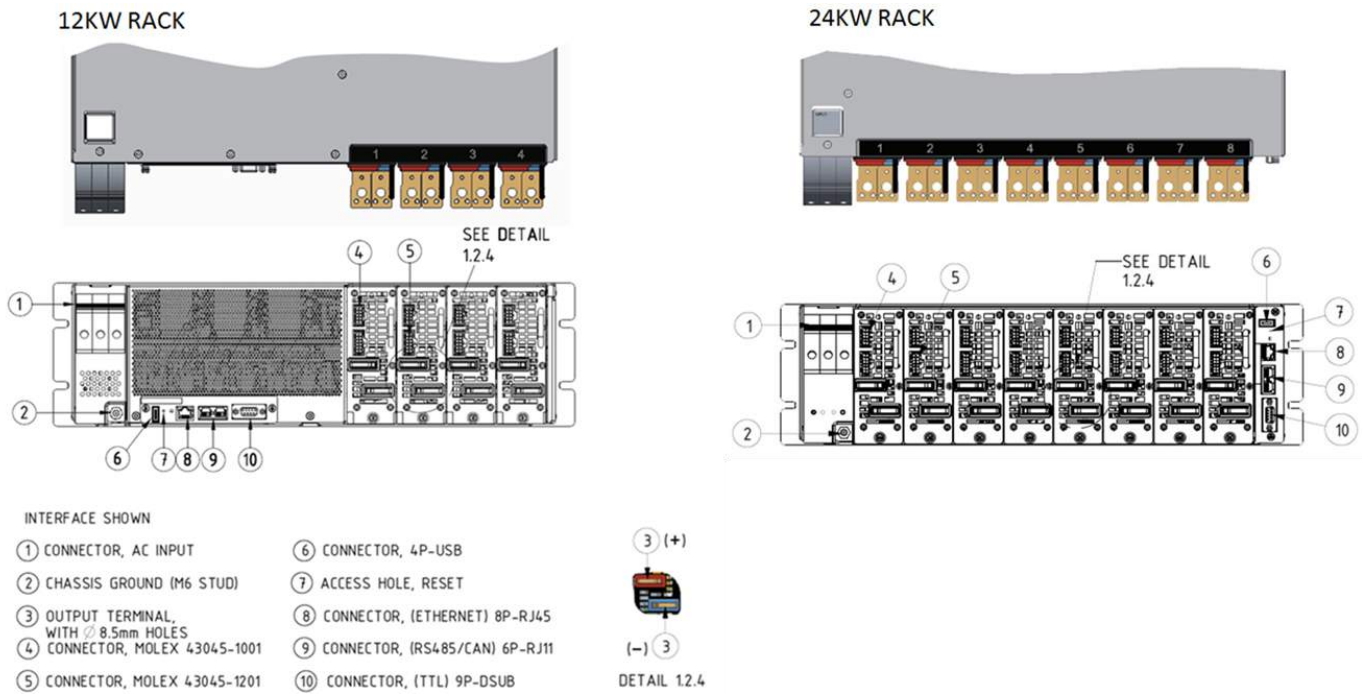


Figure 1-3 Rear Panel of iHP system

2 Installation

2.1 Inspection of Packaging and IHP System

The iHP system is inspected before packaging and is shipped in containers designed to minimize damage during transport. However, damage may still occur during transportation. Inspect the power supply and packaging upon receipt. If damage is observed that indicates the iHP system was dropped or subject to other damage, immediately notify the responsible shipping company.

2.2 Package Contents

Figure 2-1 displays the typical contents of an iHP system.

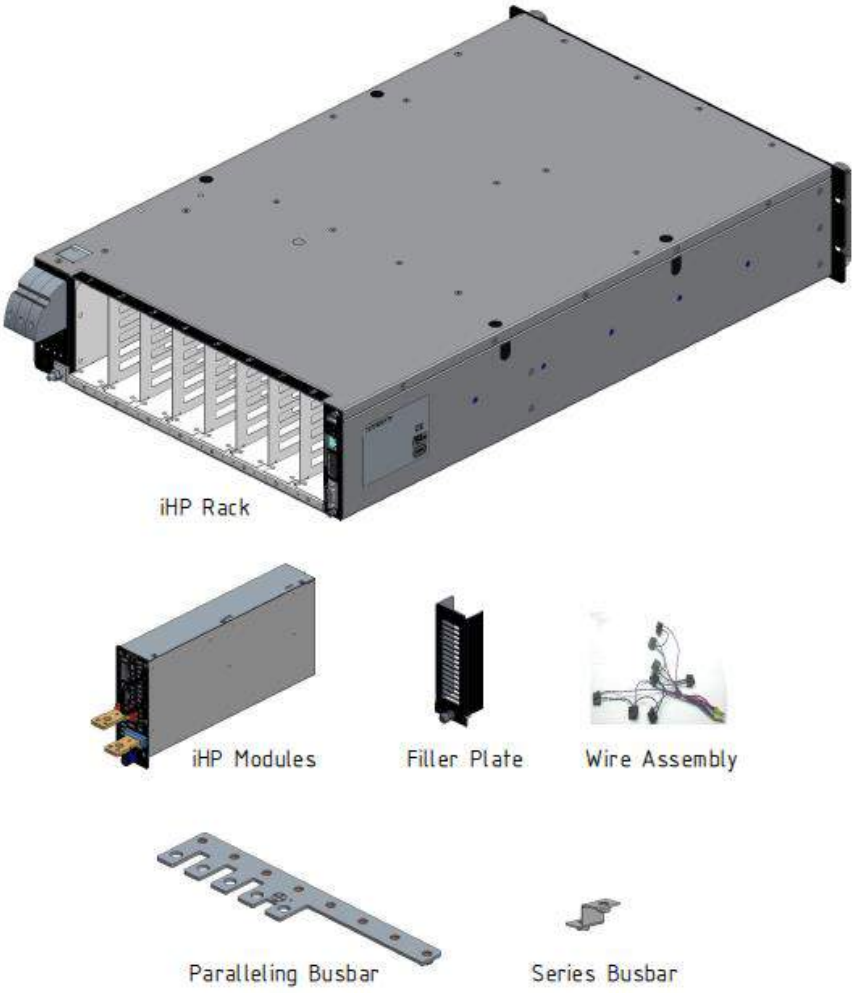


Figure 2-1 Package contents of typical iHP system

The contents of the package may vary depending on the models ordered and configuration. Carefully unpack the containers and confirm contents as per below:

Minimum list of contents:

- iHP Rack
- iHP Modules (quantity and model based on configuration ordered)
- iHP Operating Manual

Optional Accessories

- Filler Plate (for unused Module slots)
- Module J1 Wire Assemblies
- Module J2 Wire Assemblies
- DB9 Cable Kit
- Output Safety Covers
- Paralleling or Series Busbars
- RS485/CAN Bus Terminator

2.3 Installation Requirements

2.3.1 Location Requirements

- The location should be able to support the full weight of the iHP system.
- The iHP system is designed for horizontal mounting. Contact customer service if other mounting orientation is desired.
- iHP air-cooled units should be installed in a protected environment. Exposure to corrosive or conductive material can result to damage.
- iHP air-cooled units should have sufficient ventilation. The front and rear surfaces of the iHP system are recommended to have a minimum clearance of 2” from any airflow blockage.
- The airflow is front to back with cool airflow entering the front panel and exhausting the rear panel. There is no airflow through the top and bottom of supply. No clearance is required above or below the supply and multiple supplies can be stacked without clearance requirements above or below the supply.
- Install in a location that will not exceed 50°C operating ambient temperature. For system enclosures, the front panel (air inlet) should receive fresh air.

2.3.2 Lifting Provision

Warning! - 24KW iHP models require a minimum two-man lift.

The iHP rack has been provided with lifting holes which can accommodate carabiners. Recommended carabiner size and location of lifting holes are shown in Figure 2-2.

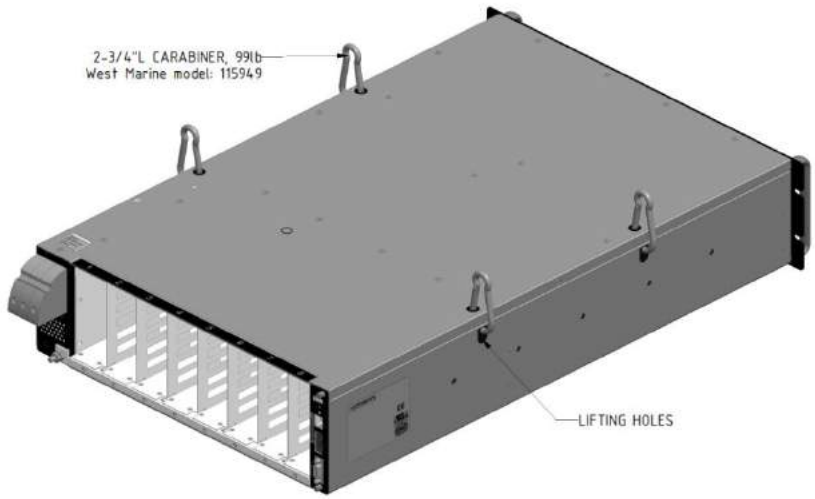


Figure 2-2 Lifting hole location for the power system

Caution! - The front panel handles are not designed to carry the whole weight of iHP.

2.3.3 Mounting

The iHP rack is designed to fit inside a 19-inch rack. Recommended rack depth is at least 33 inches from front panel to back. The front panel cannot support the weight of the supply. Use appropriate L-brackets or an equipment tray, which can support the weight of the iHP system.

The iHP rack also has mounting screw holes on the side panels, which can be used for other mounting configurations. The side panel mounting holes when fully utilized are sufficient to support the weight of the rack and modules. It is designed for metric M5 screws and has 6mm maximum screw penetration. See Section 1.3.3, Figure 1-1 for the location of the mounting holes.

2.4 Inserting Modules

Figure 2-3 shows how to insert the iHP modules into an iHP rack.

Caution! - Observe proper orientation of the module during insertion (output busbars at the bottom) to prevent damage to the module and rack connectors.

Note: The input AC should be turned off for 5 minutes before inserting or removing modules from the rack.

1. Insert, slide, and push the modules until its back panel is flushed to the back of the rack.
2. Tighten the module locking screws.
3. Attach blank fillers to all empty slots as shown in Figure 2-4 of the rack to ensure proper airflow distribution within the rack.

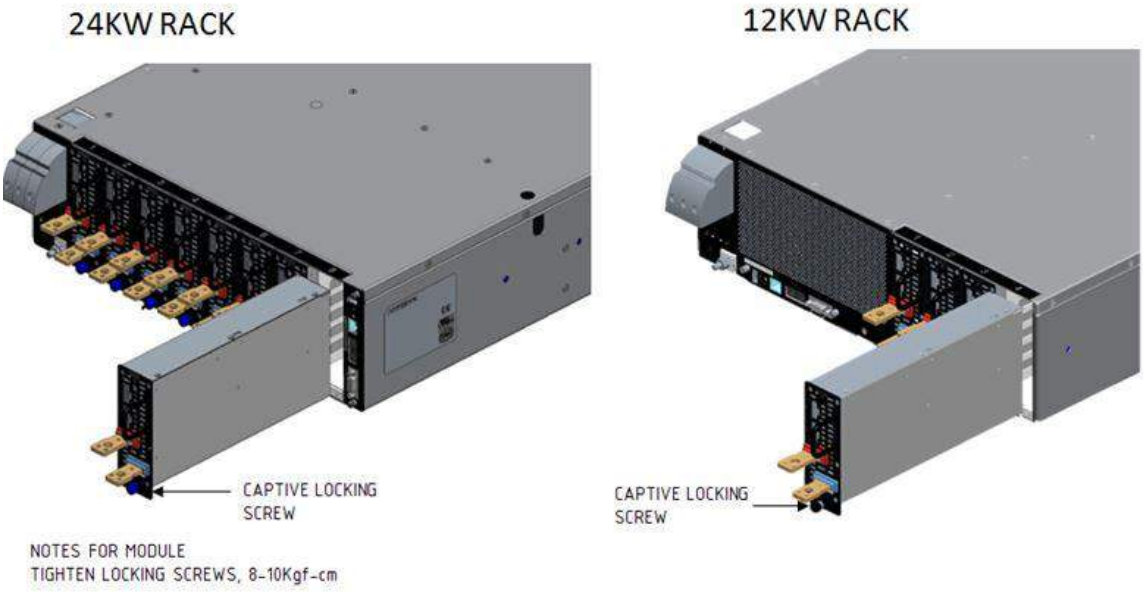


Figure 2-3 Module insertion into system

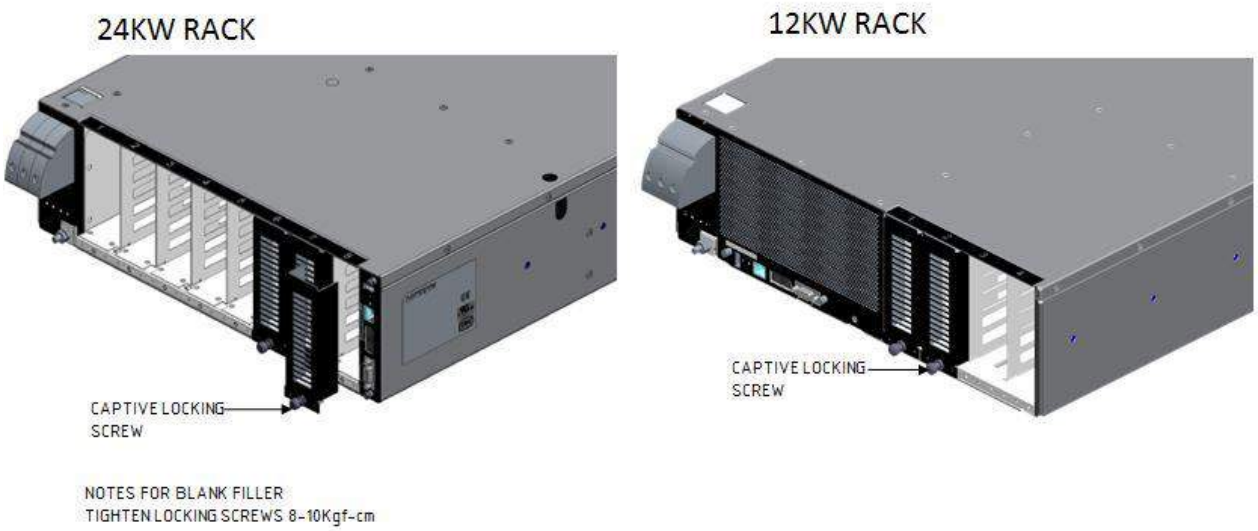


Figure 2-4 Blank panel covering for rear of system

2.5 Input and Output Wiring

Warning! - Disconnect AC power before wiring the iHP system. Due to possible remote operation, it is important to disconnect power at AC breaker before wiring the output connections.

Table 2-1 shows the recommended cable ampacities from the National Electrical Code. Local regulations may differ and should be followed when wiring the system.

Table 2-1

Size	Temperature Rating		
AWG	60°C	75°C	90°C
	Types RUW, T, TW, UF	Types FEPW, RHW, RH, RUH, THW, THWN, XHHW, ZW	Types TA, TBS, SA, AVB, SIS, FEP, FEPB, RHH, THHN, XHHW
14	20	20	25
12	25	25	30
10	30	35	40
8	40	50	55
6	55	65	75
4	70	85	95
3	85	100	110
2	95	115	130
1	110	130	150
1/0	125	150	170
2/0	145	175	195
3/0	165	200	225
4/0	195	230	260

2.5.1 AC Input Wiring

The iHP system is designed for permanent connection to the AC power with a readily accessible safety disconnect device.

Warning! - A safety ground wire must be connected to the unit through the chassis ground stud show in Section 1.2.4. An appropriate ring terminal for M6 stud and the wire gauge must be used.

The input configuration should be confirmed prior to wiring any AC power into iHP system. The figure below shows the location of the label to confirm the AC configuration.

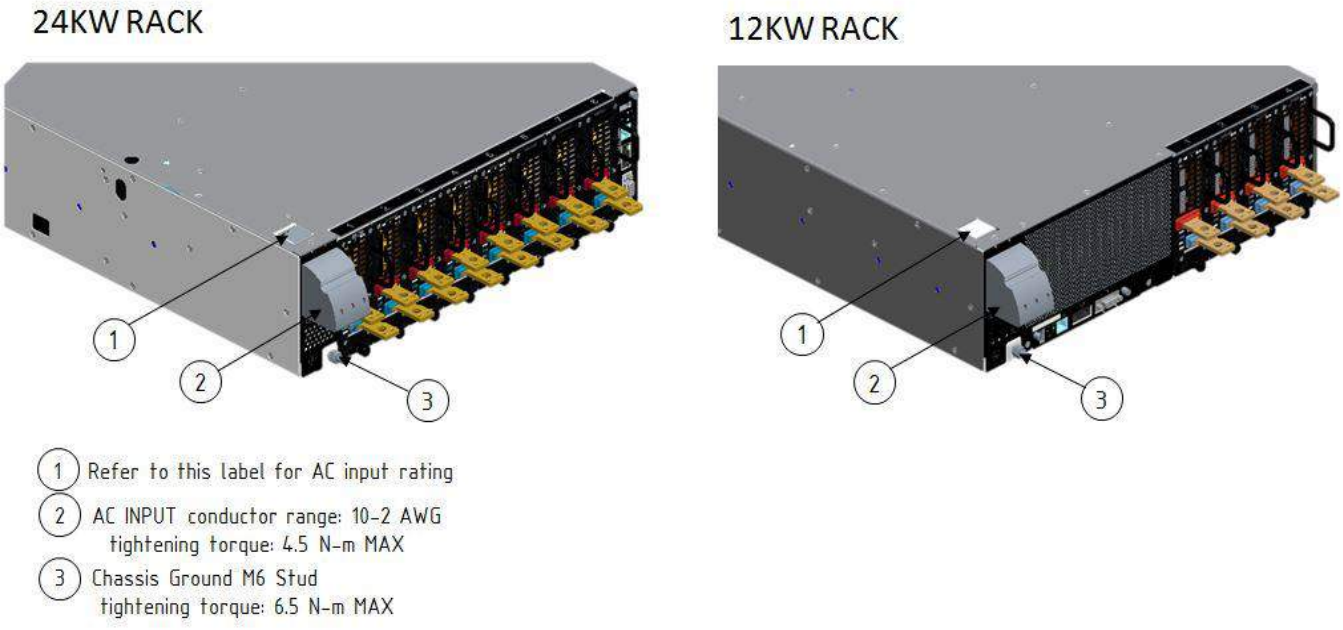


Figure 2-5 Rear panel showing AC wiring and ground terminal

Warning! - Applying a mismatched AC input voltage to what is indicated in the AC input rating label can cause damage to the power supply and voids the warranty.

The rated input current and AC connection varies among different models. Table 2-2 shows the available models and rated input current.

Table 2-2

iHP Rack Model Number	Rated Current	Wires to Connect
73-959-0001	41A	L1, L2, L3 and PE
73-959-0001L	75A	L1, L2, L3 and PE
73-958-0001	21A	L1, L2, L3 and PE
73-958-0001L	40A	L1, L2, L3 and PE
73-958-0001S	68A	L1, L2 and PE

AC power should be wired to L1, L2, and L3 for 3-phase input and L1 & L2 for single phase of the AC Input Terminal show in the Figure 2-5. Follow the torque requirements as per the figure. Wire ferrules as shown in Figure 2-6 can be utilized, but are not required.

Recommended input AC wire ferrule:

- Manufacturer: Panduit, Manufacturer PN: FSD85-16-L
- Manufacturer: Phoenix Contact, Manufacturer PN: 3200577

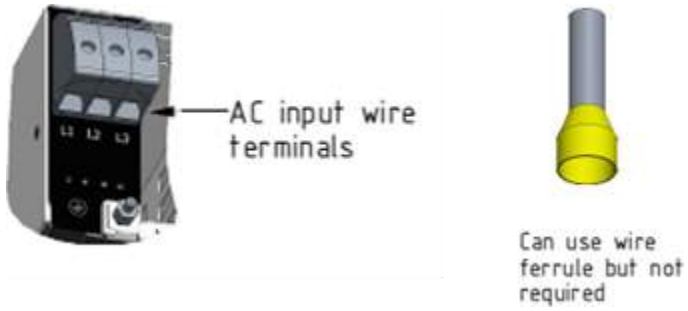


Figure 2-6 AC terminals and ferrule diagram

2.5.2 DC Output Wiring

Wire output cables to each iHP module using M8 ring lugs, bolts, and nuts as shown in the Figure 2-7. The module output busbars are color coded with RED for positive (+) and BLUE for negative (-).

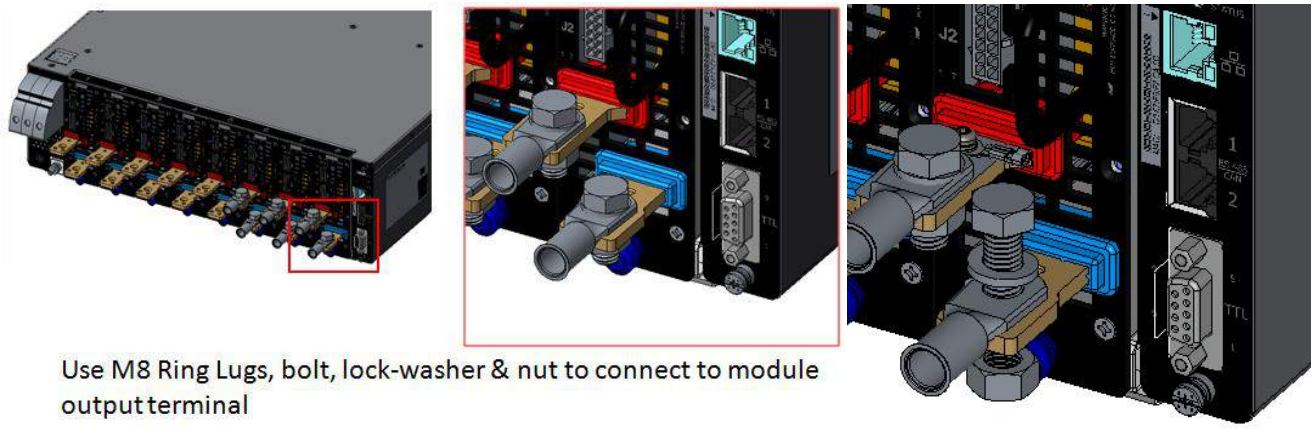


Figure 2-7 DC output wiring diagram

The module types and maximum currents are listed in Table 2-3.

Table 2-3

Model Number	Model Code	Nominal Voltage	Rated Current
73-936-0012	SL	12V	200A
73-936-0024	SQ	24V	120A
73-936-0048	SW	48V	62.5A
73-936-0080	S8	80V	37.5A
73-936-0125	S1	125V	24A
73-936-0200	SA	200V	15A
73-936-0250	S2	250V	12A

2.5.3 Remote Sense Wiring

The iHP system uses remote sense to regulate the voltage drops in the system. The module has a negative (V_SNS-) and a positive (V_SNS+) remote sense to compensate for line drops. Although not needed for operation, the remote sense wires must be connected to the desire regulated point to be able to meet the specification regulation limits. Refer to Section 4.2.1 for the location of the remote sense signals in the module connector J2.

2.5.4 Parallel Module Connection

Same module models can be connected in parallel for higher current applications. A paralleling busbar can be used to parallel the output modules positive (+) and negative (-) terminals as shown in Figure 2-8. M8 bolt and nuts should be used. When ordered as a system, the required busbars will be provided to configure the system as ordered. If reconfiguring a system and a busbar is required for reconfiguration, contact the factory or sales to obtain the needed busbar.

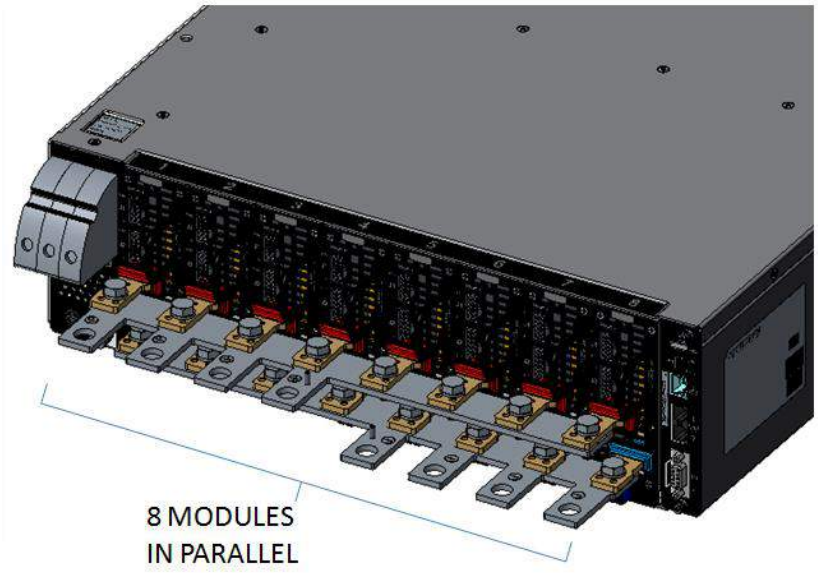


Figure 2-8 Output modules in parallel with busbars

2.5.5 Current Share Signal Wiring

For modules in constant voltage operation mode, the current share signals of all modules connected in parallel should be wired together. All ISHARE and D_RTN should be connected. Refer to Section 4.2.1 for the location of the ISHARE and D_RTN signals in the module connector J2.

2.5.6 Series Modules Connection

Same model modules can be connected in series to achieve higher output voltage. A series connecting busbar can be used with M8 bolts and nuts as show in the Figure 2-9. When ordered as a system, the required busbars will be provided to configure the system as ordered. If reconfiguring a system and a busbar is required for reconfiguration, contact the factory or sales to obtain the needed busbar.

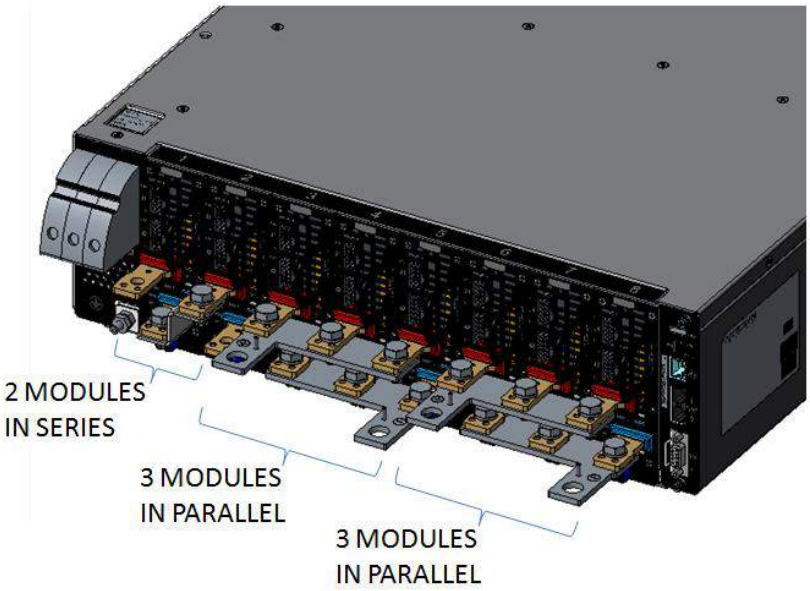


Figure 2-9 Output modules in series and parallel

Please see Table 2-4 as a guide for what modules can be connected in series and combined voltage limitation per safety isolation compliance.

Table 2-4

Model Number	Model Code	Module Nominal Voltage	Safety Compliance	Maximum Total Voltage Allowed
73-936-0012	SL	≤ 48V	Medical 2MOPP*	300V
73-936-0024	SQ		Medical 2MOOP**, ITE	400V
73-936-0048	SW			
73-936-0080	S8	≥ 80V	Medical 2MOPP	600V
73-936-0125	S1		Medical 2MOOP	800V
73-936-0200	SA		Medical 2MOOP	800V
73-936-0250	S2		ITE	1000V

Note: * - 2MOPP or 2 x MOPP (Means of Patient Protection)
** - 2MOOP or 2 x MOOP (Means of Operator Protection)

2.5.7 Output Blocking Diode and Antiparallel Diode Recommendation

The iHP modules can be used in a redundant parallel system by connecting the outputs together via OR-ing diodes. For good regulation the remote sense connections must be made after the OR-ing diode at the same point on the busbar or load. The remote sense leads should be the same length for each power supply and a twisted pair should be used for best noise immunity. The current share lines between the power supplies should be connected as shown in Figure 2-10.

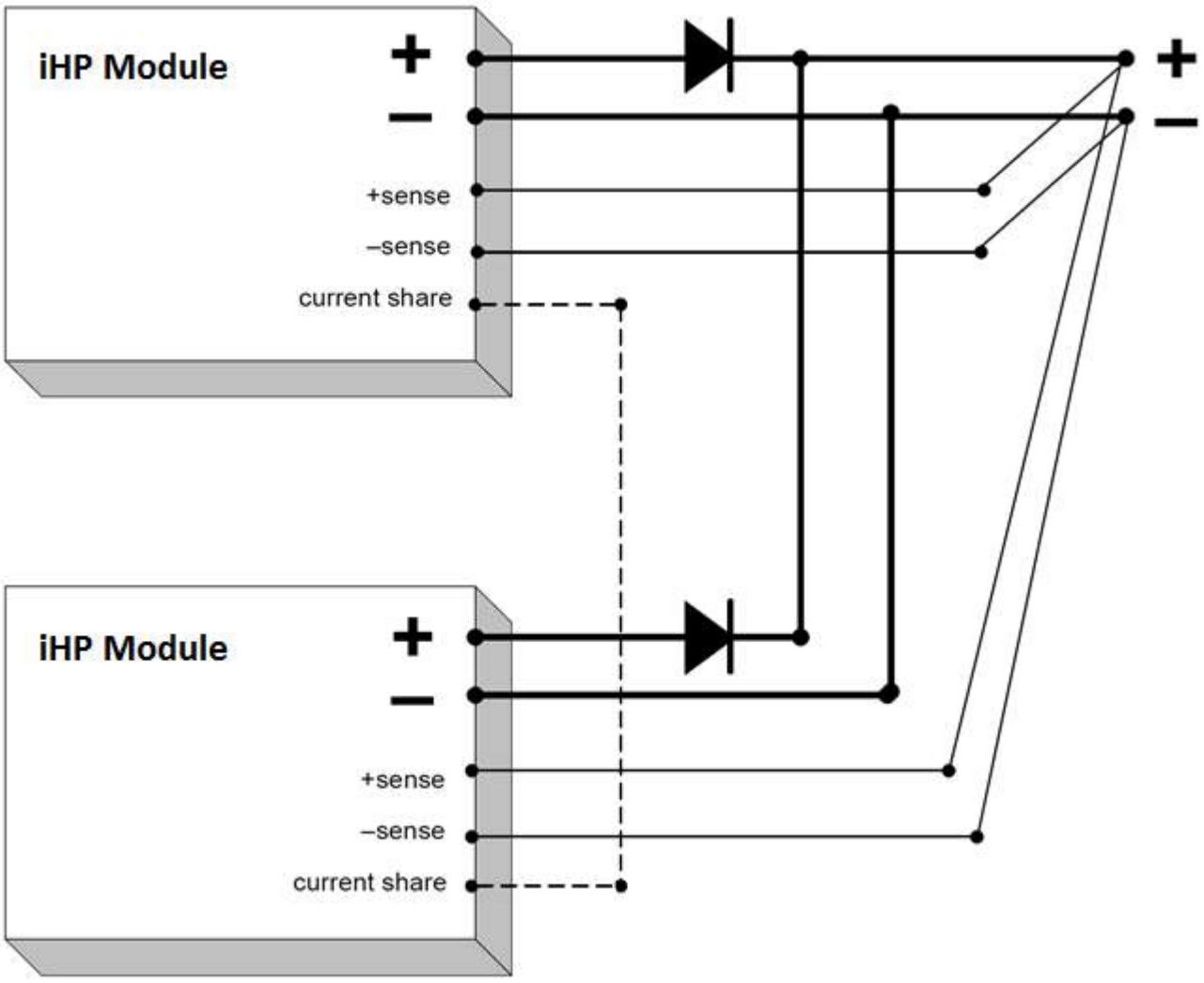


Figure 2-10 Blocking diode for use when connecting modules in parallel

An antiparallel diode should be connected across each module's terminal to prevent sinking of current into one module when it is OFF while the others are ON. The diode should be capable of carrying the maximum current and the forward voltage (Vf) drop should be lower than what is in the table below.

Table 2-5

Model	Min Voltage Rating (V)	Min Current Rating (A)	Maximum Vf	Use below recommended device or its equivalent
12V	45	300	0.9V @ 160A (Tj = 125degC)	IXYS: DSS 2x160-0045A (45V 2x160A)
24V	45	200	0.9V @ 160A (Tj = 125degC)	IXYS: DSS 2x160-0045A (45V 2x160A)
32V	100	120	0.7V @ 80A (Tj = 125degC)	STMicroelecronics: STPS160H100TV (100V 2x80A)
48V	100	120	0.7V @ 80A (Tj = 125degC)	STMicroelecronics: STPS160H100TV (100V 2x80A)
80V	150	80	1.5V @ 50A (Tj = 125degC)	STMicroelecronics: STTH10002TV1 (200V 2x50A)
125V	200	50	1.5V @ 50A (Tj = 125degC)	STMicroelecronics: STTH10002TV1 (200V 2x50A)
200V	400	30	1.5V @ 60A (Tj = 125degC)	STMicroelecronics: STTH120R04TV1 (400V 2x60A)
250V	400	30	1.5V @ 60A (Tj = 125degC)	STMicroelecronics: STTH120R04TV1 (400V 2x60A)

For series connection, the remote sense for each module should be connected to its output busbar instead of the output load.

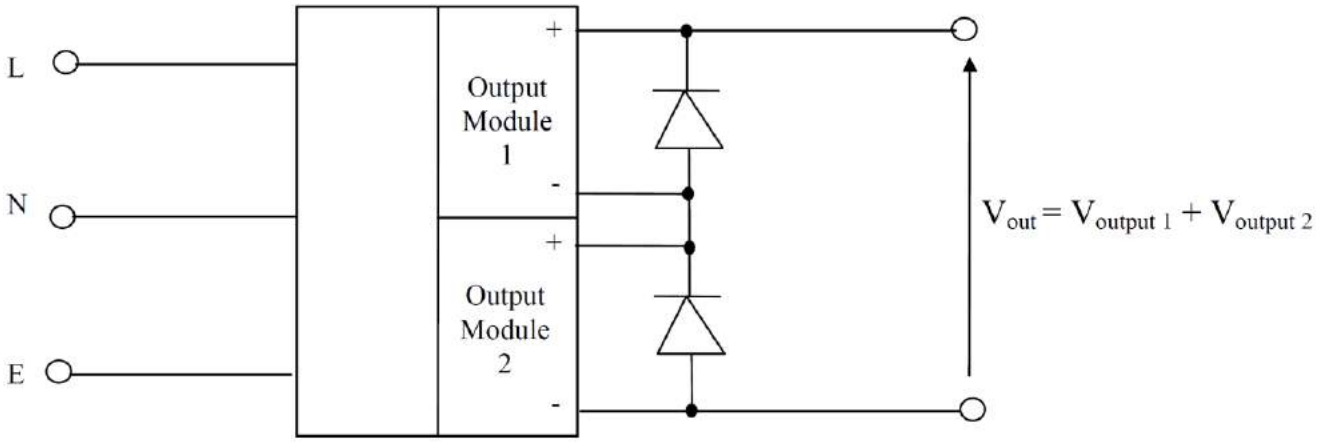


Figure 2-11 Antiparallel diode for use when connecting modules in series

3 Digital Communication

Digital communication is necessary to setup and operate the iHP system. Digital communication will be used to:

- Read the configuration setting of the iHP
- Change the configuration setting of the iHP
- Voltage, current, temperature, and power reporting
- Status reporting
- SW updates for module, PFC, and ISOCOMM

Available user digital communications interfaces for the iHP are CAN, RS485, and Ethernet. The connection ports are shown in Figure 3-1. Ethernet (UDP protocol), RS485 (custom RS485 protocol), and CAN (custom CAN protocol) protocol specifications are in a separate document.

Communication with the iHP system is controlled via the iHP ISOCOMM (**ISO**lated **COMM**unication) section of the supply. All commands are sent to and from the iHP ISOCOMM via the digital communication link. Once a command has been sent to the iHP ISOCOMM, ISOCOMM will handle the sending of the information to the internal PFC section and installed modules. The ISOCOMM functions as a bridge between iHP internal communication and iHP external communication.

Inside the iHP rack, there is an Internal Communication Bus. The installed modules, PFC (Primary Side), and ISOCOMM are all connected to this Internal Communication Bus, but are electrically isolated from each other per safety requirements. ISOCOMM manages the internal communications and external communication of the iHP. Once ISOCOMM receives a command from the user, ISOCOMM will transmit the command to the module or PFC section of the iHP. If the user needs data from a module or PFC device, the module or PFC device will transmit data to the ISOCOMM and ISOCOMM will be the one to send data to the user.

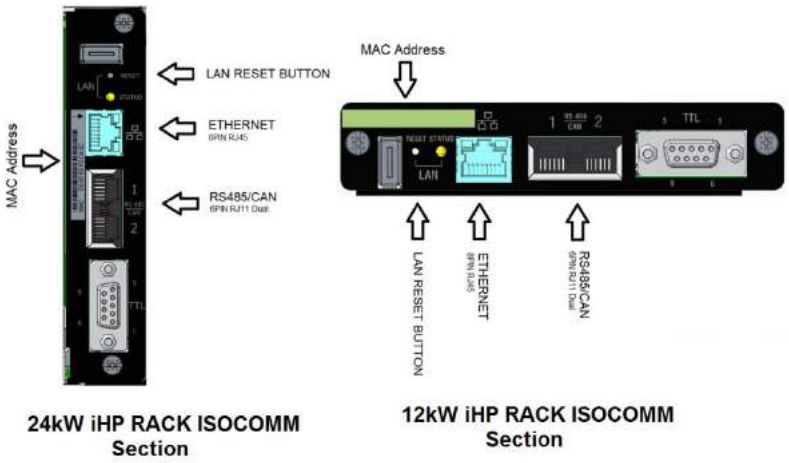


Figure 3-1 12kW and 24kW ISOCOMM Section

3.1 iHP Digital Communication Identifier

To communicate to the iHP, the user needs to know the iHP address and the specific device inside the iHP system in which the user needs to communicate. ISOCOMM, installed modules and PFC devices function independently inside an iHP system and each device has its own device address as shown in Figure 3-2 and 3-3.

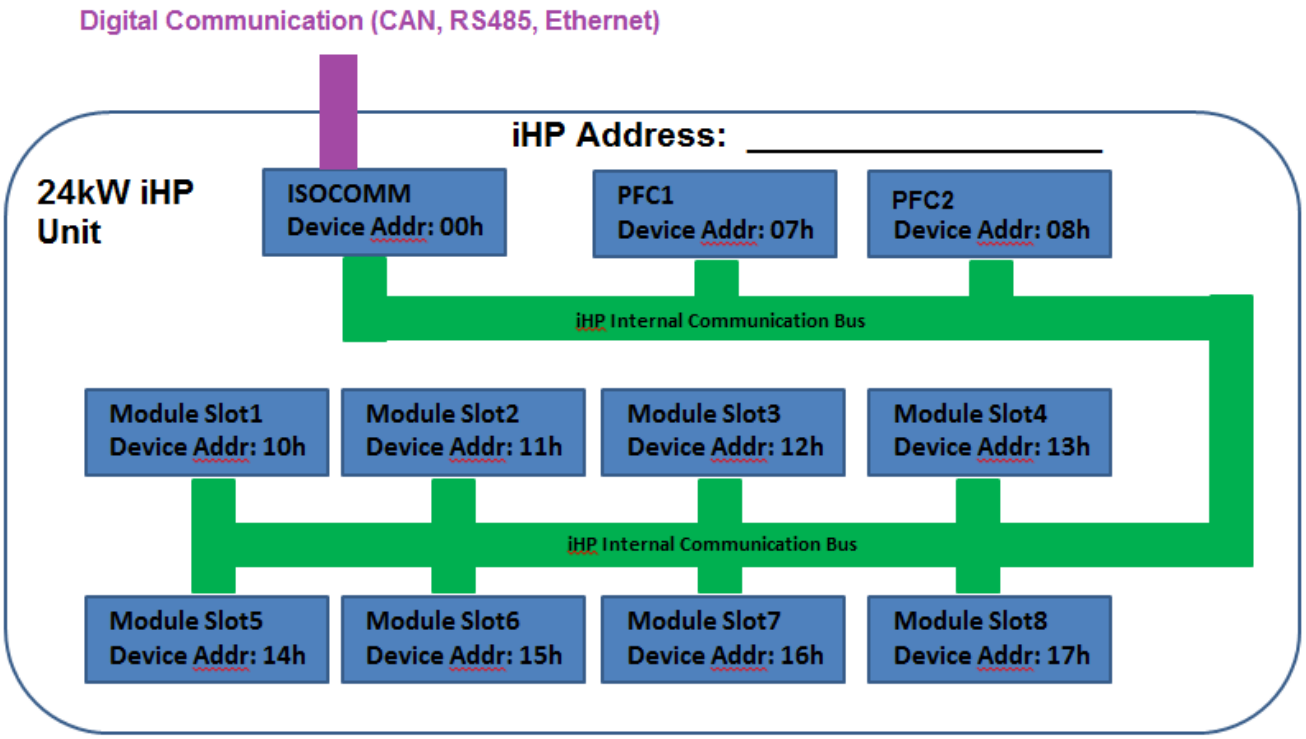


Figure 3-2 24kW iHP rack internal communication architecture

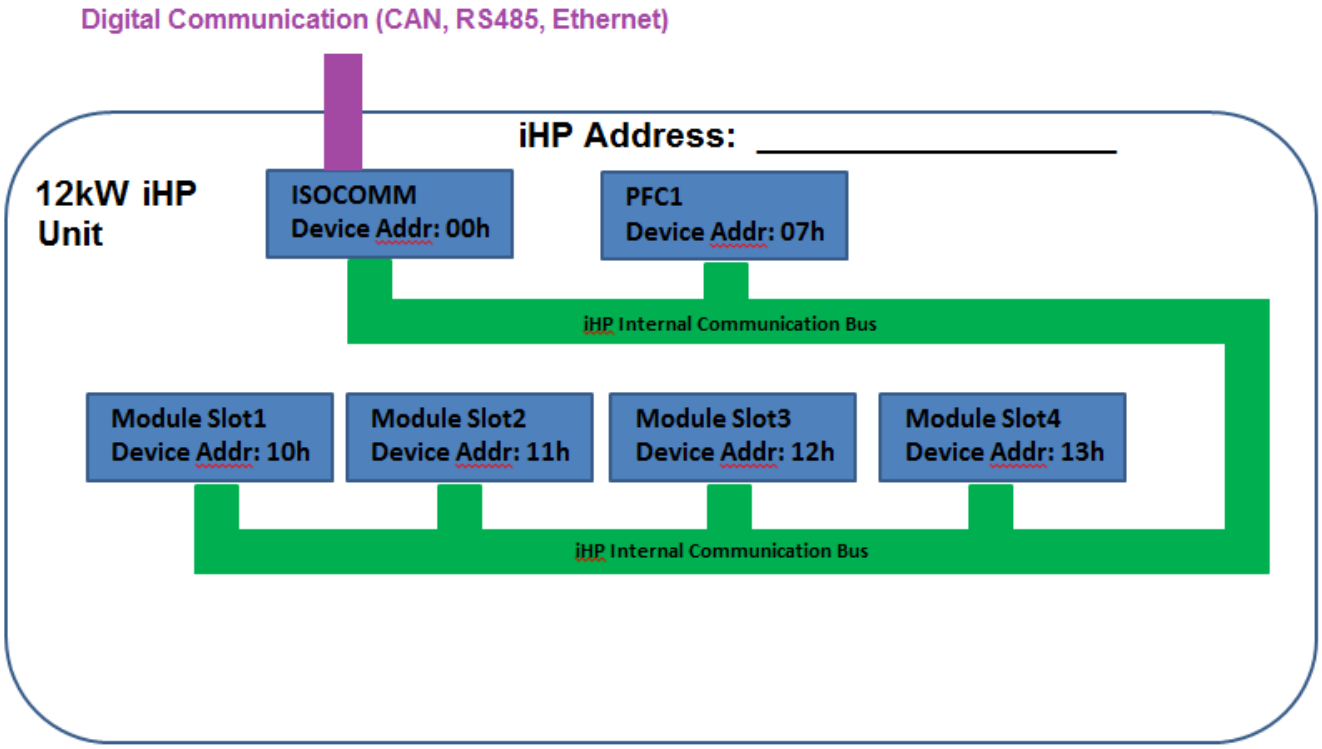


Figure 3-3 12kW iHP rack internal communication architecture

3.1.1 iHP Address

Each iHP system will have a specific address for digital communication. The address will be used to communicate from the PC/Laptop to the iHP system. The iHP address is dependent on the mode of communication.

Ethernet Address – depends on the configuration of iHP. IP setting can be Static or DHCP. For Static IP, this will need to be set to an unassigned IP address by the user before integration into a system. For DHCP, the router will assign an open IP address.

CAN/RS485 – CAN and RS485 communication shares the same address from 0 to 5. When using multiple iHP systems, the address will need to be set before integrating with other iHP systems to avoid address conflicts.

The IP setting and CAN/RS485 address configuration settings are discussed in more detail in Section 5.1.3.

3.1.2 Internal Device Address inside iHP

An iHP system is composed of different independent devices (modules and PFC devices). The internal device address is used to identify the specific device or module group in which user wants to communicate. Please see below table for the Internal Device Address inside the iHP system.

Table 3-1

iHP Internal Device Address	Device/Group iHP RACK 24kW	Device/Group iHP RACK 12kW
0x00	ISOCOMM	ISOCOMM
0x01 – 0x06	*Reserved*	*Reserved*
0x07	PFC1	PFC1
0x08	PFC2	Not Applicable
0x09 – 0x0F	*Reserved*	*Reserved*
0x10	Module 1	Module 1
0x11	Module 2	Module 2
0x12	Module 3	Module 3
0x13	Module 4	Module 4
0x14	Module 5	Not Applicable
0x15	Module 6	Not Applicable
0x16	Module 7	Not Applicable
0x17	Module 8	Not Applicable
0x18	Group 1	Group 1
0x19	Group 2	Group 2
0x1A	Group 3	Group 3
0x1B	Group 4	Group 4
0x1C	Group 5	Group 5
0x1D	Group 6	Group 6
0x1E	Group 7	Group 7

Note: Module group configuration is discussed in Section 5.1.5 and module group functionality is discussed in Section 6.

3.2 iHP Commands

The iHP command set is patterned from PMBus, but uses a proprietary transaction protocol. All PFC devices have a specific set of commands, all module devices have a specific set of commands, and the ISOCOMM device has a specific set of commands. The PFC command list is in Appendix B.1, the module command list is in Appendix B.2, and the ISOCOMM command list is in Appendix B.3.

iHP commands can be classified into four groups:

- **User Configurable Commands** – Commands that can be configured based on the user operation requirements. The user configurable commands are the commands that can be read or written by the user.

  Notes for Module User Configurable Command:

  The user needs to send the save command (Using ISOCOMM command D7h) in order to retain the command on the next power-up. ISOCOMM command is required to change the module's D3h (MODULE_CONFIG), B5h (MODULE_VRISE_TIME), B6h (MODULE_IRISE_TIME). When the user sends these commands, the setting will be AutoSaved to the module and there is no need to send a separate save command.

- **Manufacturer Commands** – Commands used by the manufacturer. The user is not allowed to use these commands.

- **Read-Only commands** – Commands for iHP system reporting and fixed configuration settings. The user can only read these commands.
  - Voltage, current, power, and temperature reporting
  - Status reporting
  - Fixed configuration settings
- **Special Command** – Commands that have special function in the operation of the iHP system.

3.3 Interval Between User Commands

To communicate properly there should be a time interval between user commands.

Table 3-2

iHP Module Mode in an iHP Rack	Time Interval between User Command		
	Ethernet	RS485	CAN
All iHP modules are configured as Digital Mode	20msec	100msec	TBA
At least one iHP module is configured as Analog Mode	50msec	100msec	TBA

3.4 Ethernet Communication

The iHP Ethernet connection can support up to 10/100Mbps link speed. The iHP IP setting can be configured to static IP or Dynamic Host Configuration Protocol (DHCP). By default, the Ethernet communication is set to DHCP, which requires connection with a router to assign an IP address.

If a router is not being used, the iHP will not have an IP address to allow communication, so the user will need to use the LAN RESET button to set the iHP to known state, which is static IP with IP address of 192.168.2.100.

The iHP rack can be connected to a PC directly using the static IP setting. When using the iHP system with static IP mode, the user computer may need to have a static IP as well to communicate. Details on setting the IP configuration is discussed in Section 5.1.3. Figure 3-4 shows an example of connecting directly to the iHP system using a static IP.

If the user has forgotten the Ethernet setting, the user can push the LAN RESET button to reset the Ethernet. The LAN RESET button will reset the Ethernet connection to a known state, which is static IP with the IP address of 192.168.2.100.



Figure 3-4 iHP system connected directly to the PC (static IP)

If the user's PC/Laptop needs to connect to the iHP system and the user's network, the user should use a router (static IP or DHCP) or switch (static IP) as shown in Figure 3-5.



Figure 3-5 IHP system connected using a router or switch

Up to six iHP systems can be used on the same network at the same time. To communicate using a PC with multiple iHP systems, the user can use a router (static or DHCP IP) or switch (static IP) as shown in Figure 3-6.

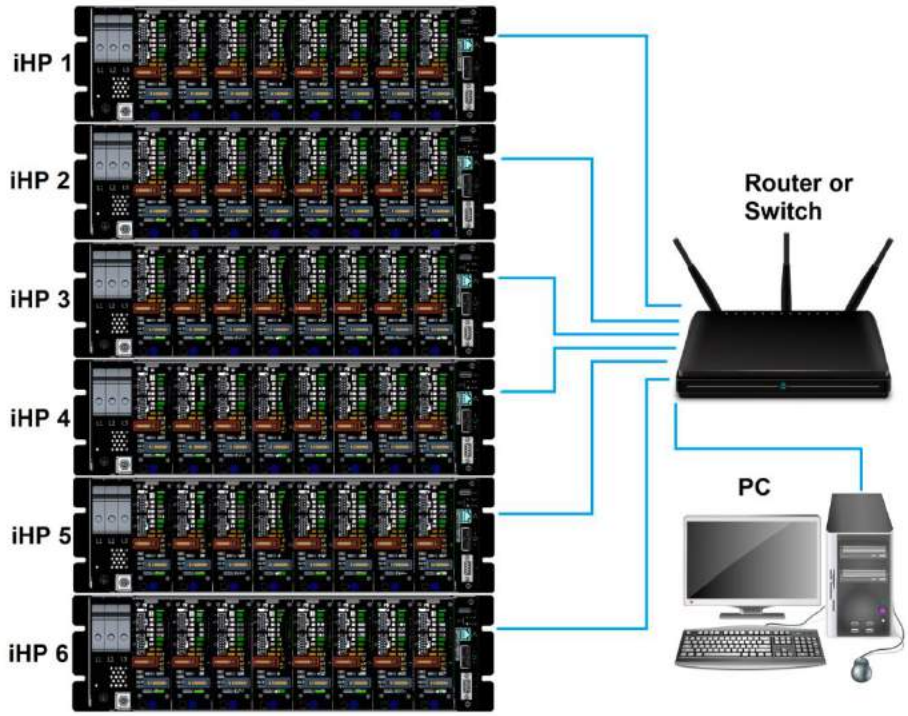


Figure 3-6 Multiple iHP systems connected to PC via a router or switch

The recommended equipment for communicating with the iHP system via the Ethernet are as follows:

- 8-pin RJ45 cable



- Router or Switch



3.5 RS485 Communication

An iHP system can support RS485 communication with below settings:

- Bits per seconds = 115200
- Data bits = 8
- Parity = None
- Stop bits = One
- Flow control = None

RS485/CAN Bus Terminator or 120Ω terminating resistors are required at both end terminals, PC and iHP rack. For multiple RS485 communication, the terminating resistor should be placed on the iHP rack farthest from the PC/Laptop.

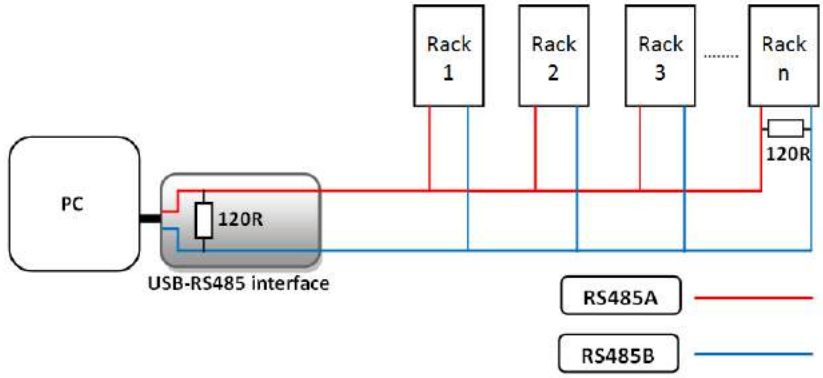


Figure 3-7 Terminating resistors required for RS485 interface

The recommended equipment for communicating with the iHP system via RS485 are as follows:

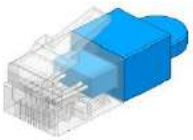
- USB to 2-Wire RS485 Adapter – COMMFRONT USB-485-1 or equivalent



- 6-pin RJ11 Connector with Cable



- RS485/CAN Bus Terminator – RJ11 with 120 ohms resistor (ARTESYN P/N: TBD)



3.6 CAN Communication

iHP systems can support CAN communication with 1Mbps baud rate.

RS485/CAN Bus Terminator or 120Ω terminating resistors are required at both end terminals, PC and iHP rack. For multiple iHP CAN communication, the terminating resistor should be placed on the iHP rack farthest from the PC/Laptop.

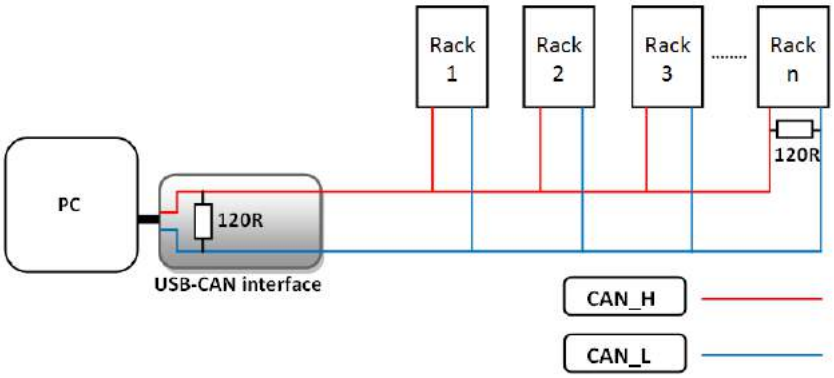


Figure 3-8 Terminating resistors are required for CAN interface

The recommended equipment for communicating with the iHP system via CAN are as follows:

- USB to CAN adapter – GRIDCONNECT IPEH-002022 or equivalent



- 6-pin RJ11 Connector with Cable

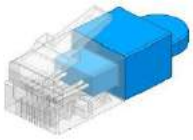


- 9 Way PCB D-sub Connector Socket & D-sub Connector Back shell





- RS485/CAN Bus Terminator – RJ11 with 120 ohms resistor (ARTESYN P/N: TBD)



4 Operation

4.1 iHP System Power-up

This section explains the initial power up of iHP units. It is assumed in this section that this will be the first time the iHP rack and iHP module will be powered up after iHP rack and module was manufactured by Artesyn.

4.1.1 Initial Power-up

Discussed in this section are the iHP rack and iHP module default settings when shipped from Artesyn.

- Configure the input and output connections to the iHP rack and iHP modules based on user requirements. Please follow Section 2 for the installation requirement.
- Apply input AC to the iHP rack.

Note: Please follow the allowable input AC parameters located on the AC input rating label of the iHP rack.

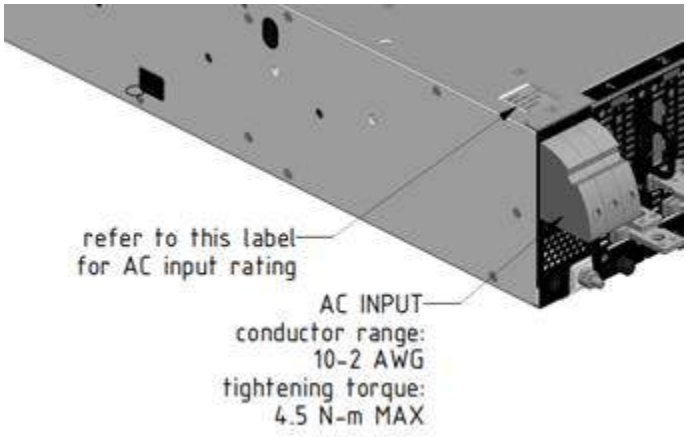


Figure 4-1 AC Input connections and AC input rating label location

Upon the application of input AC, the ISOCOMM will undergo boot-up sequence. The fan will momentarily turn on at full speed and will settle down. The power LED, in the front panel, shown in Figure 4-2, will be blinking GREEN color during the boot-up sequence. After boot-up sequence, the power LED will be either steady RED (AC BAD) or steady GREEN (AC OK) depending on the AC power to the iHP rack. For a full list of LED responses, please refer to Appendix A.

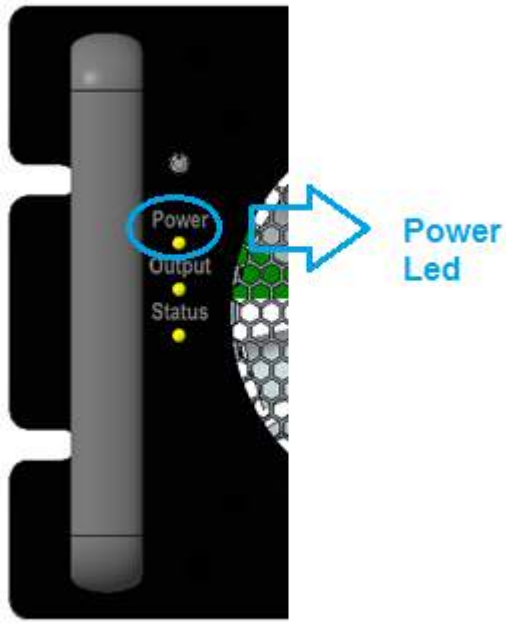


Figure 4-2 Front Panel Power LED

After about 20secs from the application of input AC, the boot-up sequence should be completed. The iHP rack will have detected the slot with installed modules and ISOCOMM will be functional. From the factory, when initially applying input AC, the iHP module outputs will not power-up by default and the user will need to press the front panel switch. The modules are shipped by Artesyn with Digital Voltage Source (DVS) configuration and the output voltage will be set to the module's nominal voltage. The iHP rack and module software configuration when shipped from Artesyn are listed on the next section.

4.1.2 iHP Module Default Settings

Table 4-1 contains iHP module default settings when shipped from Artesyn. The module command definitions are in Appendix B.2 Module Command.

Table 4-1

Command	Parameter	Default Configuration when shipped from Artesyn														User Configurable
		12V Module		24V Module		48V Module		80V Module		125V Module		200V Module		250V Module		
		Data	Process Data	Data	Process Data	Data	Process Data	Data	Process Data	Data	Process Data	Data	Process Data	Data	Process Data	
01h	MODULE_OPERATION	80h	ON	80h	ON	80h	ON	80h	ON	80h	ON	80h	ON	80h	ON	Yes
24h	VOUT_MAX	023280h	14.4V	046500h	28.8V	08CA00h	57.6V	0EA600h	96V	16E360h	150V	249F00h	240V	2DC6C0h	300V	No
31h	POUT_MAX	1258h	2400W	12D0h	2880W	12EEh	3000W	12EEh	3000W	12EEh	3000W	12EEh	3000W	12EEh	3000W	No
41h	VOUT_OV_FAULT_RESPONSE	80h	*	80h	*	80h	*	80h	*	80h	*	80h	*	80h	*	No
45h	VOUT_UV_FAULT_RESPONSE	80h	*	80h	*	80h	*	80h	*	80h	*	80h	*	80h	*	No
48h	OV_FAULT_LIMIT_MULTIPLIER	2EE0h	120%	2EE0h	120%	2EE0h	120%	2EE0h	120%	2EE0h	120%	2EE0h	120%	2EE0h	120%	Yes
49h	OV_WARN_LIMIT_MULTIPLIER	2904h	105%	2904h	105%	2904h	105%	2904h	105%	2904h	105%	2904h	105%	2904h	105%	Yes
4Bh	UV_FAULT_LIMIT_MULTIPLIER	2134h	85%	2134h	85%	2134h	85%	2134h	85%	2134h	85%	2134h	85%	2134h	85%	Yes
4Ch	UV_WARN_LIMIT_MULTIPLIER	2328h	90%	2328h	90%	2328h	90%	2328h	90%	2328h	90%	2328h	90%	2328h	90%	Yes
4Dh	OC_FAULT_LIMIT_MULTIPLIER	2904h	105%	2904h	105%	2904h	105%	2904h	105%	2904h	105%	2904h	105%	2904h	105%	Yes
4Fh	OT_FAULT1_LIMIT	2EE0h	120°C	2EE0h	120°C	3A98h	150°C	30D4h	125°C	2CECh	115°C	2EE0h	120°C	30D4h	125°C	No
50h	OT_FAULT_RESPONSE	B8h	*	B8h	*	B8h	*	B8h	*	B8h	*	B8h	*	B8h	*	No
51h	OT_WARN1_LIMIT	2328h	90°C	2710h	100°C	30D4h	125°C	2710h	100°C	25C1h	96.65°C	251Ch	95°C	251Ch	95°C	No
52h	OC_RESPONSE_TYPE	00h	*	00h	*	00h	*	00h	*	00h	*	00h	*	00h	*	Yes
B5h	SET_VOLTAGE_RISE_SETTING	00 00h	*	00 00h	*	00 00h	*	00 00h	*	00 00h	*	00 00h	*	00 00h	*	Yes
B6h	SET_CURRENT_RISE_SETTING	00 00h	*	00 00h	*	00 00h	*	00 00h	*	00 00h	*	00 00h	*	00 00h	*	Yes
B7h	SET_IO_ACTIVE_LEVEL_LOGIC	00 02h	*	00 02h	*	00 02h	*	00 02h	*	00 02h	*	00 02h	*	00 02h	*	Yes
B8h	SET_MODULE_LOAD TYPE	00 02h	*	00 02h	*	00 02h	*	00 02h	*	00 02h	*	00 02h	*	00 02h	*	Yes
BAh	ANALOG_FILTER_ENABLE	03h	*	03h	*	03h	*	03h	*	03h	*	03h	*	03h	*	Yes
D3h	MODULE_CONFIG	00h	DVS	00h	DVS	00h	DVS	00h	DVS	00h	DVS	00h	DVS	00h	DVS	Yes
B1h	VREF		12V		24V		48V		80V		125V		200V		250V	Yes
B2h	IREF		200A		126A		65.625A		39.375A		25.2A		15A		12.6A	Yes
E9h	CALIBRATION_DATE	Factory Calibration Date														Yes
**	OT_FAULT1_RECOV		90°C		100°C		85°C		85°C		85°C		90°C		85°C	No
**	OT_WARN1_RECOV		90°C		80°C		85°C		85°C		65°C		85°C		85°C	No
**	OT_FAULT3_LIMIT		120°C		120°C		110°C		95°C		92°C		120°C		125°C	No
**	OT_FAULT3_RECOV		90°C		100°C		85°C		75°C		75°C		90°C		85°C	No
**	OT_WARN3_LIMIT		100°C		100°C		100°C		85°C		75°C		95°C		95°C	No
**	OT_WARN3_RECOV		90°C		80°C		85°C		70°C		55°C		85°C		85°C	No
**	Brick Wall OVP		15.63V		31.3V		64.5V		110V		162V		250V		315V	No

Note: * Bitmapped data, please refer to Appendix B.2 Module Command.

** No assigned command. Parameter is hardcoded in the module firmware.

4.1.3 ISOCOMM Default Settings

Table 4.2 contains ISOCOMM default settings of the iHP rack when shipped from Artesyn. The ISOCOMM setting definition is in Section 5.1.

Table 4-2

ISOCOMM WebTool Section	User Configurable Parameter	Default Setting when shipped from Artesyn	User Configurable
NETWORK	DHCP	Disable*	Yes
	Static IP Address	192.168.2.100	Yes
	CAN/RS485 RACK Address	0	Yes
RACK	Internal Ambient Temperature OTP	62°C	Yes
	INH0/EN0 TTL Function	Inhibit	Yes
	INH1/EN1 TTL Function	Inhibit	Yes
	Wait for Power Switch	Enable	Yes
	Disable on 5V_STBY Fault	Disable	Yes
	RACK Synchronized Off	Disable	Yes
	Numbers of Racks Connected	1	Yes
MODULE	Module Synchronized Off	Enable	Yes
	Module Grouping	No Grouping	Yes

Note: * - Model revision AZ or later for 73-958-0001, model revision AH or later for 73-958-0001L & 73-958-0001S are set by default to DHCP.

4.2 Module and Rack Hardware Signals

This section contains a description of module and rack analog and digital hardware signals that the users can use based on their requirements or applications. For module command information, please refer to Appendix B.2 Module Command.

4.2.1 Module Interface Signals

Figure 4-3 shows the location of the J1 and J2 connectors and the pin location of the signals. These signals allow direct interface with the supply to allow direct control and monitoring of the iHP system using analog and digital input and outputs.

J1 Signal

Pin#	Signal	Signal	Pin#
5	Dummy Net	SYS_M_FAULT#	10
4	0-5VEXT_IPROG	SYS_M_ENABLE#	9
3	0-10VEXT_IPROG	SYS_RTN	8
2	0-5VEXT_VPROG	SYS_M_INHIBIT	7
1	0-10VEXT_VPROG	Dummy Net	6

J2 Signal

Pin#	Signal	Signal	Pin#
6	Dummy Net	Dummy Net	12
5	IMON	VMON	11
4	D_RTN	ISHARE	10
3	EXT_ISENSE+	EXT_ISENSE-	9
2	D_RTN	V_SNS-	8
1	V_SNS+	D_RTN	7

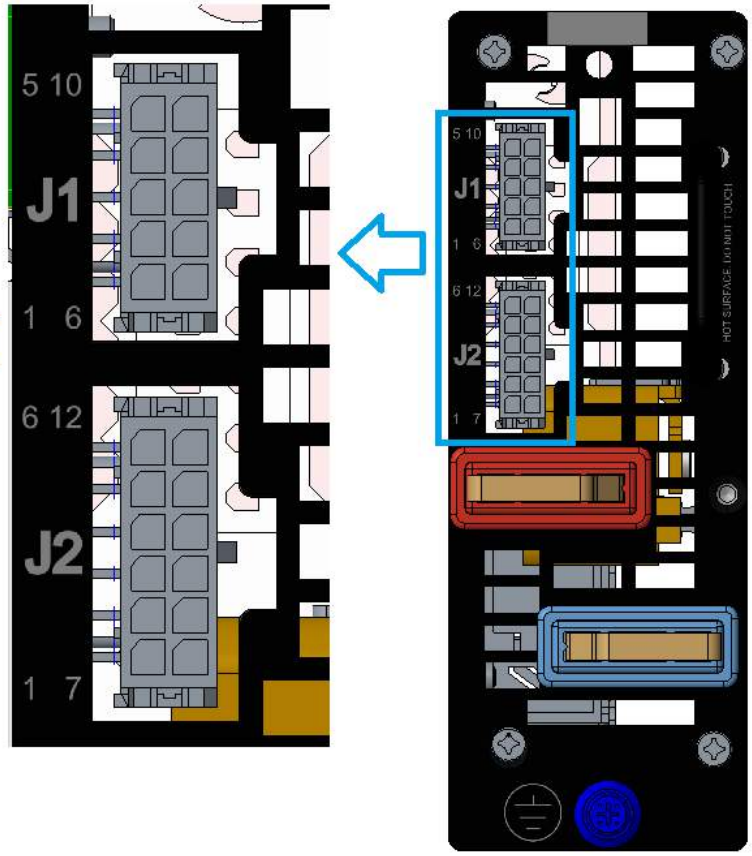


Figure 4-3 Module J1 and J2 signal connections for controlling the modules

4.2.1.1 Module's J1 Signal

Table 4-3 lists the signal information available on connector J1.

Warning! - The module's J2 signals and output voltage are isolated from module's J1 signals. D_RTN and SYS_RTN are completely isolated.

Table 4-3

J1 Pin No.	Signal Name	Signal Type	Functions

1	0-10VEXT_VPROG	Input	Use to control the output voltage by applying 0 to 10V to this pin. This pin will function when the module is configured to Analog Voltage Source.
2	0-5VEXT_VPROG	Input	Use to control the output voltage by applying 0 to 5V to this pin. This pin will function when the module is configured to Analog Voltage Source.
3	0-10VEXT_IPROG	Input	Use to control the output current by applying 0 to 10V to this pin. This pin will function when the module is configured to Analog Current Source.
4	0-5VEXT_IPROG	Input	Use to control the output current by applying 0 to 5V to this pin. This pin will function when the module is configured to Analog Current Source.
5	Dummy Pin		
6	Dummy Pin		
7	SYS_M_INHIBIT	Input	Signal to Inhibit the module
8	SYS_RTN		Ground reference for J1 signals.
9	SYS_M_ENABLE#	Input	Signal to Enable the module
10	SYS_M_FAULT#	Output	Signal to notify user that Fault occurred.

4.2.1.1.1 Analog Voltage Programming

0-10VEXT_VPROG (J1 Pin1) and 0-5VEXT_VPROG (J1 Pin2) are used to program the output voltage by applying external voltages. Analog voltage programming will work if the module configuration is in analog voltage source.

Please note that 0-10VEXT_VPROG and 0-5VEXT_VPROG cannot be used simultaneously:

- If user will use 0-10VEXT_VPROG, 0-5VEXT_VPROG should be floating.
- If user will use 0-5VEXT_VPROG, 0-10VEXT_VPROG should be floating.

When utilizing signal, 0-10VEXT_VPROG, apply 0V to 10V between J1 pin 1 (0-10VEXT_VPROG) and J1 pin 8 (SYS_RTN). Table 4-4 shows the corresponding output voltage when utilizing this signal.

Table 4-4

0-10VEXT_VPROG	Corresponding Output Voltage
0V – 0.42V	5% Nominal Output Voltage

2.5V	30% Nominal Output Voltage
5V	60% Nominal Output Voltage
7.5V	90% Nominal Output Voltage
8.33V	100% Nominal Output Voltage
10V	120% Nominal Output Voltage

When utilizing signal, 0-5VEXT_VPROG, apply 0V to 5V between J1 pin 2 (0-10VEXT_VPROG) and J1 pin 8 (SYS_RTN). Table 4-5 shows the corresponding output voltage when utilizing this signal.

Table 4-5

0-5VEXT_VPROG	Corresponding Output Voltage
0V – 0.21V	5% Nominal Output Voltage
1.25V	30% Nominal Output Voltage
2.5V	60% Nominal Output Voltage
3.75V	90% Nominal Output Voltage
4.166V	100% Nominal Output Voltage
5V	120% Nominal Output Voltage

4.2.1.1.2 Analog Current Programming

0-10VEXT_IPROG (J1 Pin3) and 0-5VEXT_IPROG (J1 Pin4) are used to program the output current by applying external voltages. Analog current programming will work if the module configuration is in analog current source.

Please note that 0-10VEXT_IPROG and 0-5VEXT_IPROG cannot be used simultaneously:

- If user will use 0-10VEXT_IPROG, 0-5VEXT_IPROG should be floating.
- If user will use 0-5VEXT_IPROG, 0-10VEXT_IPROG should be floating.

When utilizing signal, 0-10VEXT_IPROG, apply 0V to 10V between J1 pin 3 (0-10VEXT_IPROG) and J1 pin 8 (SYS_RTN). Table 4-6 shows the corresponding output current when utilizing this signal.

Table 4-6

0-10VEXT_IPROG	Corresponding Output Current
0V	0% Nominal Output Current

2.5V	25% Nominal Output Current
5V	50% Nominal Output Current
7.5V	75% Nominal Output Current
10V	Nominal Output Current

When utilizing signal, 0-5VEXT_IPROG, apply 0V to 5V between J1 pin 4 (0-10VEXT_IPROG) and J1 pin 8 (SYS_RTN). Table 4-7 shows the corresponding output current when utilizing this signal.

Table 4-7

0-5VEXT_IPROG	Corresponding Output Current
0V	0% Nominal Output Current
1.25V	25% Nominal Output Current
2.5V	50% Nominal Output Current
3.75V	75% Nominal Output Current
5V	Nominal Output Current

4.2.1.1.3 SYS_RTN

SYS_RTN (J1 pin 8) is the common ground for J1 signals. SYS_RTN is isolated from Module Negative Output terminal and Module J2 D_RTN.

4.2.1.1.4 Isolated Output Inhibit

The iHP module provides an input signal to inhibit the output. J1 Pin7 SYS_M_INHIBIT functions as the inhibit signal of the module. This inhibit pin is internally connected to an optocoupler's LED side. An external 1kohms pull-up resistor is required. The pull-up resistor is connected to a 5V supply. The maximum pull-up resistor voltage is 5V and the maximum sink current is 5mA.

The logic for this pin is configurable via module command SET_IO_ACTIVE_LEVEL_LOGIC (B7h) and can change the correlation between the output state and the status of the optocoupler's LED.

The default pin configuration is

- Optocoupler LED On = Output is Disabled
- Optocoupler LED Off = Output is Enabled

Figure 4-4 shows recommended external circuits to control the inhibit pin.

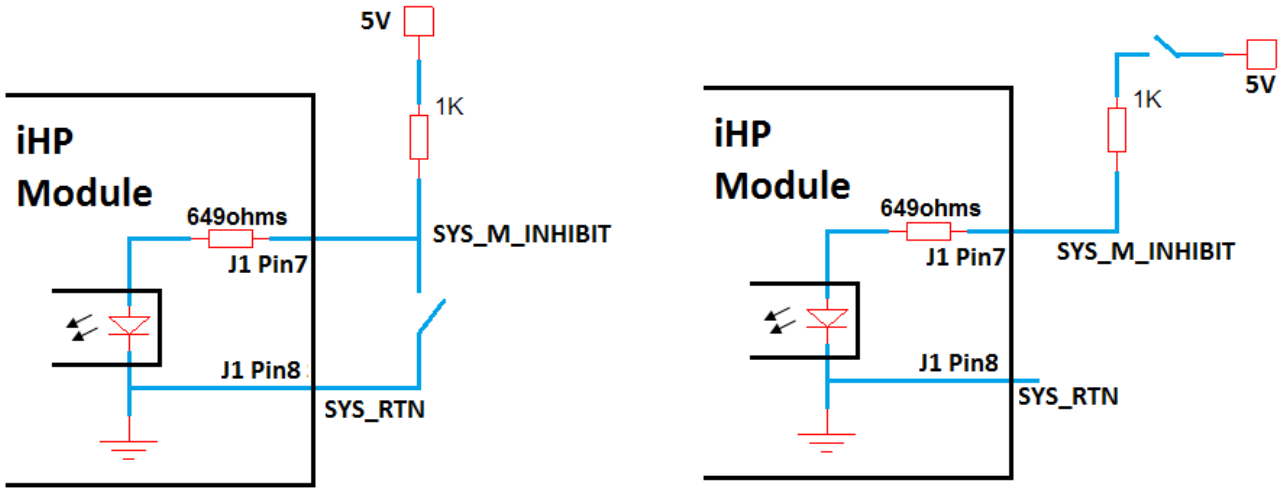


Figure 4-4 Isolated output inhibit circuits to externally inhibit the module.

4.2.1.1.5 Isolated Output Enable

The iHP module provides an input signal to enable output. J1 Pin 9 SYS_M_ENABLE# functions as the enable signal of the module. This pin is internally connected to an optocoupler's LED side. An external 1kohms pull up resistor is required. The pull up resistor is connected to a 5V supply. The maximum pull up resistor voltage is 5V and the maximum sink current is 5mA.

The logic for this pin is configurable via module command SET_IO_ACTIVE_LEVEL_LOGIC (B7h) and can change the correlation between the output state and the status of the optocoupler's LED.

The default pin configuration is

- Optocoupler LED On = Output is Disabled
- Optocoupler LED Off = Output is Enabled

Figure 4-5 shows recommended external circuits to control the enable pin.

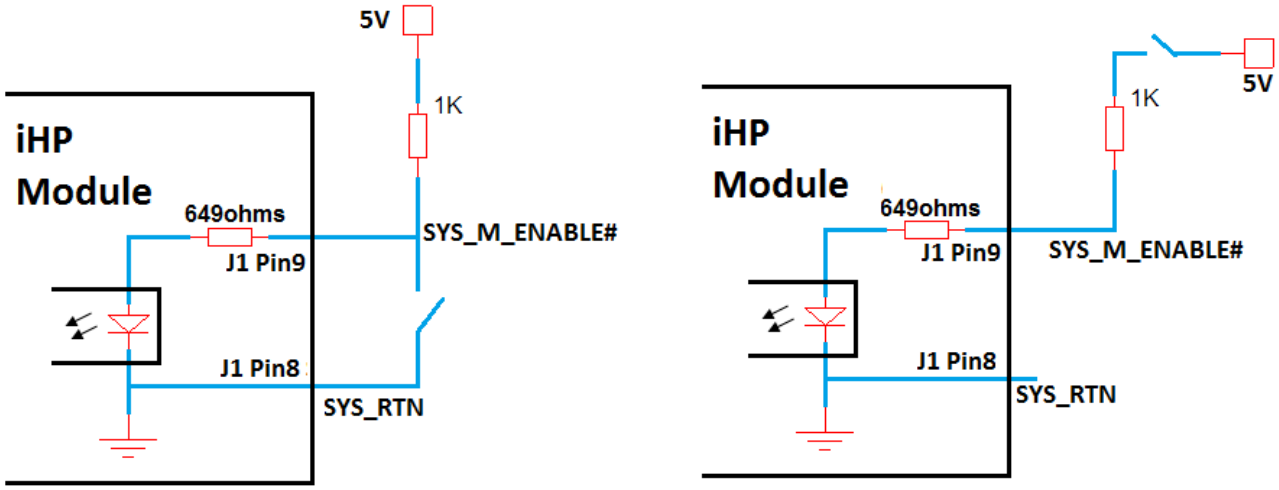


Figure 4-5 Isolated Output Enable to externally Enable module.

4.2.1.1.6 Isolated Fault Signal

During a fault condition, the iHP module provides a fault signal to the system side. J1 Pin 10 SYS_M_FAULT# functions as the fault signal of the module. The signal is internally connected to an open collector output. An external 2kohms pull-up resistor is required. The pull-up resistor should be connected to a 5V supply. The maximum pull-up resistor voltage is 5V and the maximum sink current of 5mA.

The logic for this pin is configurable via module command SET_IO_ACTIVE_LEVEL_LOGIC (B7h) and can change the correlation between the output state and the status of the module.

The default pin configuration is

- SYS_M_FAULT# logic Low = Module is at Fault.
- SYS_M_FAULT# logic High = Module is at normal operating condition.

Figure 4-6 shows recommended external circuits to control the enable pin.

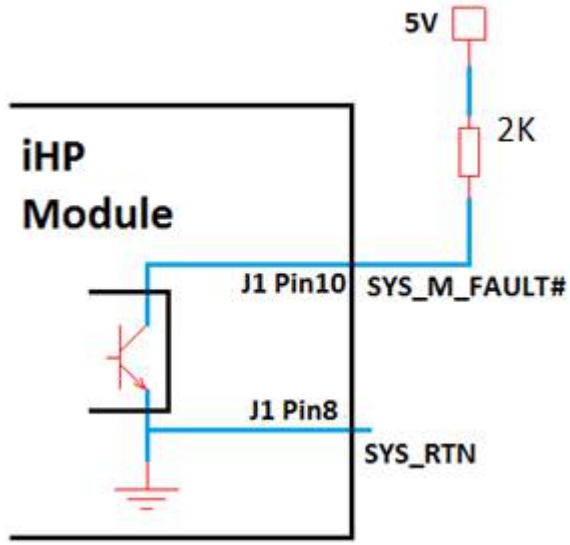


Figure 4-6 Isolated fault signal to signal a module fault condition

4.2.1.2 Module's J2 Signal

Table 4-8 list the signal information available on connector J2. The module analog connector J2 contains non-isolated signals. The signal's circuitry is internally connected and referenced to the module's output negative terminal. The module's J2 signals are isolated from the module's J1 signals.

Table 4-8

J2 Pin No.	Signal Name	Signal Type	Functions
1	V_SNS+	Input	Signal use for module positive remote sense
2	D_RTN		Ground reference for IMON or VMON signals
3	EXT_ISENSE+	Input	Input for external resistor shunt for external current sensing application.
4	D_RTN		Ground reference for ISHARE signal
5	IMON	Output	Analog signal to report the output current in scaled value (0-10V)
6	Dummy Pin		
7	D_RTN		Ground reference for IMON or VMON signals
8	V_SNS-	Input	Signal use for module negative remote sense
9	EXT_ISENSE-	Input	Input for external resistor shunt for external current sensing application
10	ISHARE	Output	Signal for active current sharing
11	VMON	Output	Analog signal to report the output voltage in scaled value (0-10V)
12	Dummy Pin		

4.2.1.2.1 V_SNS+ and V_SNS-

The distance of the load and the module can create a voltage drop on the wires. To compensate for the voltage drops on the wire, remote sense is employed.

The module has a positive return, V_SNS+ J2 Pin 1, and a negative return, V_SNS- J2 Pin 8, remotes sense to compensate for ground drops and line drops respectively. Remote sense will be able to regulate out a maximum of 200mV drop on each sense line. It is recommended for user to connect the remote sense either on the load side or to the output terminals of the modules. The connection of the remote sense signal determines the point at which the voltage will regulate. Remote sense is required to meet the regulation specification of the module. Remote sense is required during voltage source configuration.

The module will protect itself if the polarity is incorrectly connected between the V_SNS+ and V_SNS- to module's output positive and negative terminal. It is recommended to use twisted and equal length wires for V_SNS+ and V_SNS- for noise immunity.

For parallel module output operation, all module V_SNS+ should be star connected and all module V_SNS- should be star connected as shown by examples in Figure 4-7. Star connection is recommended to reduce the introduction of DC offset and noise to the signals.

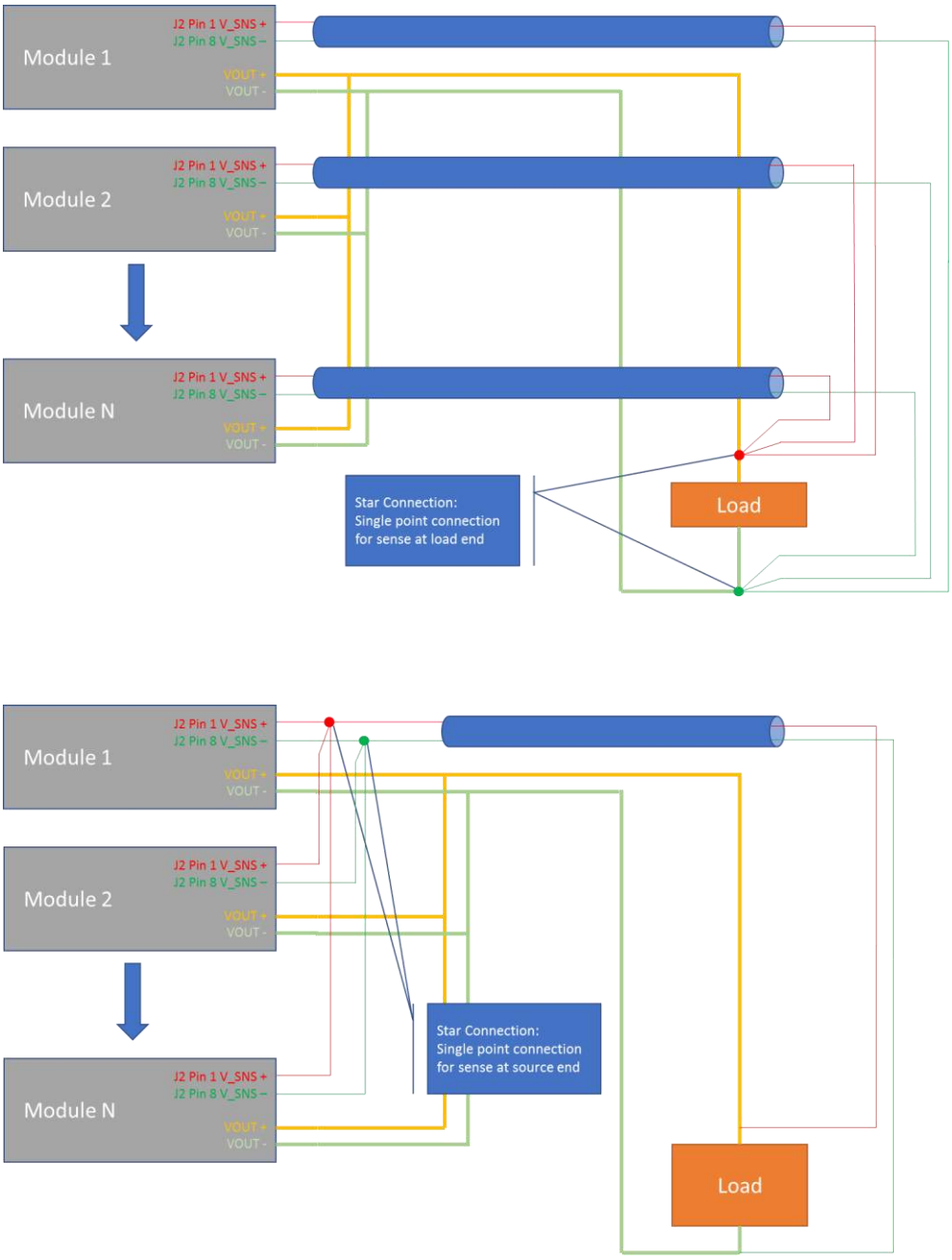


Figure 4-7 **Examples of star connections for remote sensing**

4.2.1.2.2 External Current Sense

An external shunt resistor can be connected to the iHP module. The current sensing will be transferred from the iHP module internal shunt to external shunt. The iHP module's EXT_ISENSE+ J2 Pin 3 and EXT_ISENSE- J2 Pin 9 signals are used for external current sense application.

The module configuration should be changed to enable external current sense operation via ISOCOMM command module MODULE_CONFIG (D3h).

When using external current sense, all output current information used by the iHP module will be taken from the differential voltage across the external shunt. The information collected from external sense connections will be used for output reporting, current protection, and constant current operation.

Connection of the external shunt should only be on the negative output busbar of the iHP module. The EXT_ISENSE- should be connected to the external shunt's negative output busbar side and the EXT_ISENSE+ should be connected to the external shunt's load side as shown in Figure 4-8.

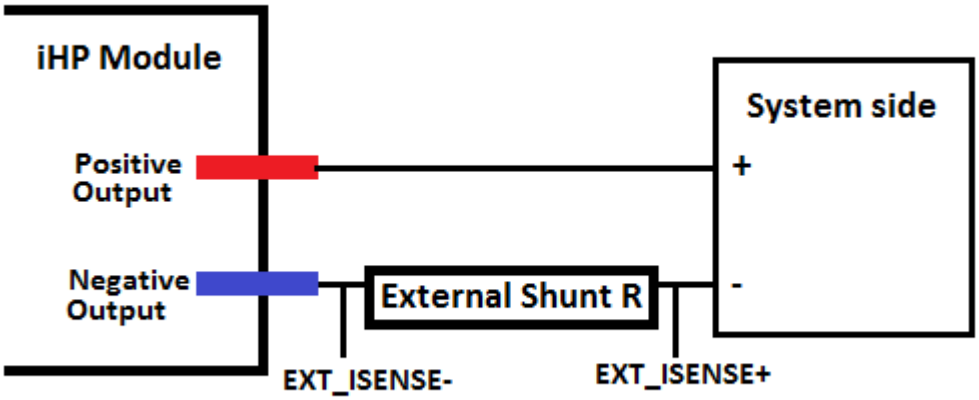


Figure 4-8 Location of external shunt and external shunt sense lines

Table 4-9 list the required shunt resistor per iHP module.

Table 4-9

iHP Module	Module Current Rating (A)	Voltage Drop (mV)	Tolerance Max (%)	TCR max (ppm/degC)
12V	200	10	± 5	25
24V	200	12	± 5	25
48V	62.5	7.8125	± 5	25
80V	37.5	9.375	± 5	25
125V	24	12	± 5	25
200V	15	12	± 5	25
250V	12	12	± 5	25

4.2.1.2.3 Current Monitor (IMON)

IMON J2 Pin 5 is an output signal. IMON functions as the current monitor signal of the module. It reports the sensed output current with a scaled voltage between 0 and 10V according to Table 4-10. D_RTN J2 Pin2 is used for twisted pair cabling with IMON.

Table 4-10

IMON	Output Current
0V	0% Nominal Output Current
2.5V	25% Nominal Output Current
5V	50% Nominal Output Current
7.5V	75% Nominal Output Current
10V	Nominal Output Current

4.2.1.2.4 Voltage Monitor (VMON)

VMON J2 Pin 11 is an output signal. VMON functions as the voltage monitor signal of the module. It reports the sensed output voltage with a scaled voltage between 0 and 0V. D_RTN J2 Pin 7 is used for twisted pair cabling with VMON.

Table 4-11

VMON	Output Voltage
0V – 0.42V	5% Nominal Output Voltage
2.5V	30% Nominal Output Voltage
5V	60% Nominal Output Voltage
7.5V	90% Nominal Output Voltage
8.33V	100% Nominal Output Voltage
10V	120% Nominal Output Voltage

4.2.1.2.5 Current Sharing Signal (ISHARE)

ISHARE J2 Pin 10 signal is used for active current sharing. Interconnecting the ISHARE signal of the modules in a star connection activate the active current sharing circuitry. Active current sharing is required when modules are connected in parallel. The module's ISHARE signal and D_RTN J2 Pin 4 should be star connected. This will reduce the introduction of DC offset and noise to the signals.

4.2.1.2.6 D_RTN

D_RTN (J2 Pin2 and Pin7) is used for twisted pair cabling of IMON and VMON signal to reduce noise pick up.

- D_RTN (J2 Pin2) is used for twisted pair cabling with IMON.
- D_RTN (J2 Pin7) is used for twisted pair cabling with VMON.
- D_RTN (J2 Pin4) is used as return ground for the ISHARE signal.

D_RTN is internally connected to module's negative output and D_RTN is isolated from module's J1 SYS_RTN.

4.2.2 iHP Rack Communications and Interfaces

The following section describes the available communication ports and protocols available on the rack to interface the rack to the user's system. Figure 4-9 shows the back panel of the section and location of the ports and Table 4-12 list the available ports.

Warning! - iHP rack signal in this section are isolated from module's signal (J1 and J2 connector).

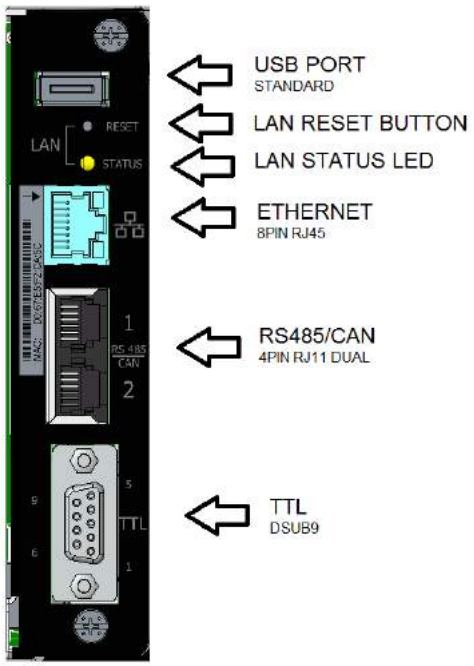


Figure 4-9 Communication ports on back panel of iHP rack

Table 4-12

iHP Rack Port	Connector	Functions
USB Port	Standard USB	Use for Future Expansion.
ETHERNET Port	8Pin RJ45	Use for Ethernet communication.
RS485/CAN Port	6Pin RJ11	Use for RS485 and CAN communication.

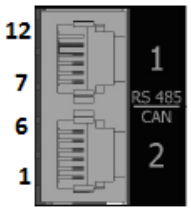
4.2.2.1 USB Port

USB port for future expansion

4.2.2.2 ETHERNET Port

LAN Port for Ethernet communication

4.2.2.3 RS485/CAN Port



6pin RJ11 Dual

CANL	**Pin 1, Pin 7**
CANH	**Pin 2, Pin 8**
GND	**Pin 3, Pin 9**
5V Housekeeping Bias	**Pin 4, Pin 10**
RS485_A	**Pin 5, Pin 11**
RS485_B	**Pin 6, Pin 12**

Figure 4-10 RS485/CAN Port pinout

To communicate via RS485 or CAN communication user will need a 6pin RJ11 connector. There are two identical port for RS485/CAN as shown in Figure 4-10 and the pinout of RS485/CAN port 1 and RS485/CAN port 2 are the same. All signals with the same signal name of RS485/CAN port 1 and RS485/CAN port 2 are internally connected. The two ports functions to provide user easy iHP rack to iHP rack daisy chaining of the RS485 and CAN communication lines.

4.2.2.3.1 CANL and CANH

The CAN communication lines are for communicating via the CAN protocol.

4.2.2.3.2 RS485_A and RS485_B

The RS485 communication lines are used for communicating using the RS485 protocol.

4.2.2.3.3 GND

The GND is used as the common ground for RS485 or CAN communication. The GND signal is internally connected to DSUB9 pin 2 5V Housekeeping Bias Return.

4.2.2.3.4 5V Housekeeping Bias

Supply Bias for CAN and RS485 communication and is internally connected to DSUB9 pin 1 5V Housekeeping Bias.

4.2.2.4 LAN RESET BUTTON

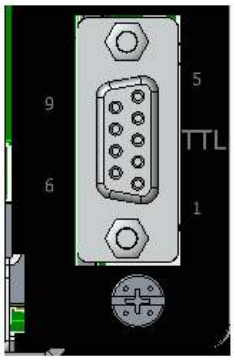
Button to reset the Ethernet setting to STATIC with IP address 192.168.2.100

4.2.2.5 LAN STATUS LED

For future expansion

4.2.2.6 DSUB9 Port

Figure 4-11 shows the DSUB9 signals and pin locations and Figure 4-13 lists the signals and their functions.



DSUB9 Signals

5V Housekeeping Bias	Pin 1
5V Housekeeping Bias Return	Pin 2
Spare (Not Connected)	Pin 3
Global Inhibit/Enable Logic "1"	Pin 4
Global Inhibit/Enable Logic "0"	Pin 5
ACOK - "Emitter"	Pin 6
ACOK+ "Collector"	Pin 7
Global DC OK - "Emitter"	Pin 8
Global DC OK + "Collector"	Pin 9

Figure 4-11 Dsub9 Port pinout

Table 4-13

DSUB9 Pin No.	Signal Name	Signal Type	Functions
1	5V Housekeeping Bias	Output	5V supply to power up system side circuits
2	5V Housekeeping Bias Return	Output	Ground reference of the 5V Housekeeping Bias
3	Dummy		
4	Global Inhibit/Enable Logic "1"	Input	Signal can be configured for either Inhibit logic High or Enable logic High
5	Global Inhibit/Enable Logic "0"	Input	Signal can be configured for either Inhibit logic Low or Enable logic Low
6	ACOK- "Emitter"	Output	Use for ACOK signal
7	ACOK- "Collector"	Output	Use for ACOK signal
8	Global DCOK- "Emitter"	Output	Use for DCOK signal
9	Global DCOK- "Collector"	Output	Use for DCOK signal

4.2.2.6.1 5V Housekeeping Bias

The 5V supply, DSUB9 Pin 1 is for user housekeeping circuits and has a maximum supply capability of 1A. The signal is internally connected to the 6 pin RJ11 5V Housekeeping Bias on pin 4 and pin 10.

4.2.2.6.2 5V Housekeeping Bias Return

Ground for 5V Housekeeping Bias on DSUB9 pin 2

4.2.2.6.3 Global Inhibit/Enable Logic "1"

The Global Inhibit/Enable Logic "1" DSUB9 pin 4 signal functions to turn-off or turn-on all modules simultaneously. This signal can be configured to either Global Inhibit1 or Global Enable1 via the ISOCOMM WebTool.

When this pin is configured as Inhibit1 (INH1),

- A 5V input will activate Inhibit function and will shut down all modules
- A ground connection or no connection will de-activate the inhibit function and all modules will turn-on

When this pin is configured as Enable1 (EN1),

- A 5V input will activate Enable function and all modules will turn-on

- A ground connection or no connection will de-activate Enable function and will shut down all modules

4.2.2.6.4 Global Inhibit/Enable Logic "0"

The Global Inhibit/Enable Logic "0" (DSUB9 Pin5) signal functions to turn-off or turn-on all modules simultaneously. This signal can be configured either Global Inhibit 0 or Global Enable 0 via ISOCOMM WebTool.

When this pin is configured as Inhibit 0 (INH0),

- A 5V input or no connection will de-activate Inhibit function and all modules are enabled
- A ground input will activate Inhibit function and will shut down all modules

When this pin is configured as Enable 0 (EN0),

- A 5V input or no connection will de-activate Enable function and will shut down all modules
- A ground input will activate Enable function and all modules are enabled

Table 4-14 lists the functionality of these Inhibit and Enable signals based on the configuration of the supply.

Table 4-14

Configuration	iHP Rack DSUB9		Module Status
	Input to Global Inhibit/Enable Logic "0"	**Input to Global Inhibit/Enable Logic "1"**	
INH0 & INH1	Shorted to GND	Floating	OFF
	Shorted to GND	5V	OFF
	Floating	Floating	ON
	Floating	5V	OFF
INH0 & EN1	Shorted to GND	Floating	OFF
	Shorted to GND	5V	OFF
	Floating	Floating	OFF
	Floating	5V	ON
EN0 & INH1	Shorted to GND	Floating	ON
	Shorted to GND	5V	OFF
	Floating	Floating	OFF
	Floating	5V	OFF
EN0 & EN1	Shorted to GND	Floating	OFF
	Shorted to GND	5V	ON
	Floating	Floating	OFF
	Floating	5V	OFF

4.2.2.6.5 ACOK Signal "Power Fail" (Uncommitted Transistor)

This signal indicates that the input AC is within operational range of the unit. ACOK- "Emitter" and ACOK+ "Collector" signal functions as an AC OK signal. These signals are connected to an uncommitted transistor.

- AC is Ok when the transistor is On.
- AC is not Ok when the transistor is Off.

The max sink current is 50mA for ACOK transistor and the bias resistor should be chosen to limit current to a maximum of 50mA. The recommended supply voltage is 5V. Possible circuit configuration for AC OK signal is shown in Figure 4-12.

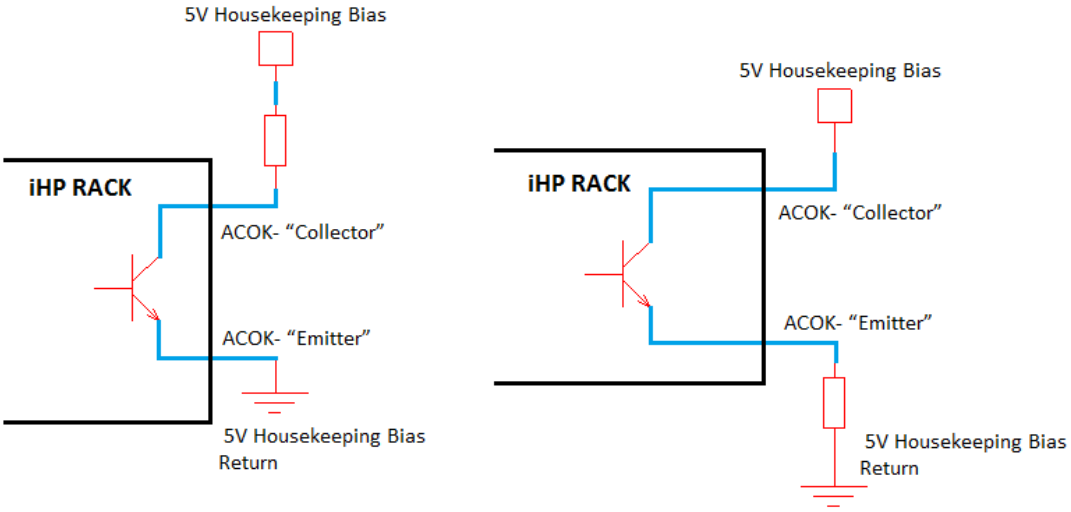


Figure 4-12 Possible circuits configuration for ACOK functionality

4.2.2.6.6 DCOK Signal "Output Fail" (Uncommitted Transistor)

This signal indicates that all modules are on and functioning properly. The signal will be de-asserted when at least one module turns off via fault or inhibited by the system. DCOK- "Emitter" and DCOK+ "Collector" signal functions as DC OK signal. These signals are connected to an uncommitted transistor.

- When all output of module is Ok, the transistor is On.
- When all output of module is not Ok, the transistor is Off.

The max Sink current is 50mA for DCOK transistor and the bias resistor should be chosen to limit current to a maximum of 50mA. The recommended supply voltage is 5V. Possible circuit configuration for DCOK signal is shown in Figure 4-13.

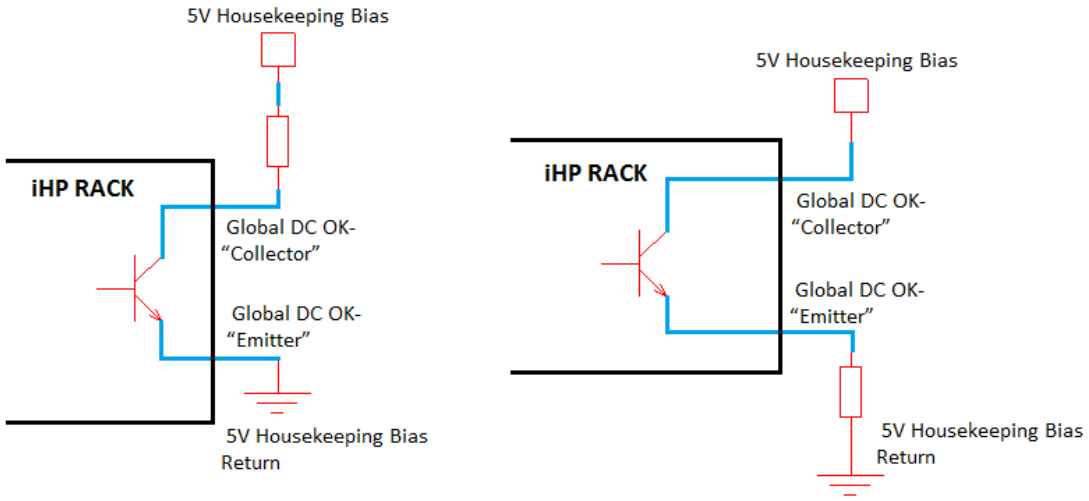


Figure 4-13 Possible circuits configuration for DCOK functionality

At iHP rack start-up, the iHP rack will detect the slots with populated modules. The assertion of hardware DCOK signal will be based on the output status of the modules detected by the iHP rack during start-up. For example:

When seven modules inserted to the iHP rack,

- For the iHP rack DCOK signal to assert, all seven modules should have a power good status.
- If any module has a power bad status, the iHP rack DCOK signal will be de-asserted.

When three modules inserted to iHP rack,

- For the iHP rack DCOK signal to assert, all three modules should have a power good status.
- If any module has a power bad status, the iHP rack DCOK signal will be de-asserted.

4.3 Module Operating Mode

The iHP modules can be operated in several operating modes. The operating mode is set by the ISOCOMM D3h command and once set remains in the mode chosen until changed by a sending a new configuration via the ISOCOMM D3h command.

- **Digital Voltage Source (DVS)** – The module operates as a voltage source. The module output voltage functions can only be controlled by sending a command using a PC or laptop.
- **Digital Current Source (DCS)** – The module operates as a current source. The module output current functions can only be controlled by sending a command using a PC or laptop.
- **Analog Voltage Source (AVS)** – The module operates as a voltage source. The module output voltage can only be controlled by inputting 0V-10V to module's 0-10VEXT_VPROG signal (module J1 connector pin1) or 0V-5V to module's 0-5VEXT_VPROG signal (module J1 connector pin2).

- **Analog Current Source (ACS)** - The module operates as a current source. The module output current can only be controlled by inputting 0V-10V to module's 0-10VEXT_IPROG signal (module J1 connector pin3) or 0V-5V to module's 0-5VEXT_IPROG signal (module J1 connector pin4).

Module operating mode can be change via ISOCOMM Command D3h. Module operating mode can be check via reading Module Command D3h. Table 4-15 lists the module nominal settings and the output range configurability.

Table 4-15

Module Series	Vnominal	Inominal	Pnominal	DVS and AVS Output Voltage Range (5% to 120%)	DCS and ACS Output Current Range (0% to 100%)
12V	12V	200A	2400W	0.6V to 14.4V	0A to 200A
24V	24V	120A	2880W	1.2V to 28.8V	0A to 120A
48V	48V	62.5A	3000W	2.4V to 57.6V	0A to 62.5A
80V	80V	37.5A	3000W	4V to 96V	0A to 37.5A
125V	125V	24A	3000W	6.25V to 150V	0A to 24A
200V	200V	15A	3000W	10V to 240V	0A to 15A
250V	250V	12A	3000W	12.5V to 300V	0A to 12A

4.4 Digital Control

The user can control the module's output voltage or current using a PC or laptop when the module is configured in digital control. A wide range of digital commands is supported. Module commands are specific to an individual module at the module level. ISOCOMM commands are higher-level system commands such as when controlling a group of modules. Many of the commands are fixed but several are user configurable. A list of the user configurable commands specific to the modules and example of the command structure is shown in Section 5.2. Definition of all the Module Commands is in Appendix B.2, Module Command. Definition of ISOCOMM Command is in Appendix B.3, ISOCOMM Command.

4.4.1 Digital Voltage Source (DVS)

In this operating mode, the user has the capability to control the output voltage using digital means. A PC or laptop will be required to change the output voltage. To change to Digital Voltage Source (DVS) mode, the user needs to send below commands to ISOCOMM.

Device Address	ISOCOMM Command	Data1	Data2
00h	D3h	<Module slot or Group #>	00h

*Before writing to the ISOCOMM, please ensure that the ISOCOMM Command Write Protect (10h) is disabled.

Where: Data1 please refer to ISOCOMM Command Table
Data2 "00h" signifies Digital Voltage Source

After sending ISOCOMM Command D3h, the modules will momentarily shutdown, re-initialize, and then restart. The shutdown, re-initialize, and restart process takes approximately 1.5 seconds. Since the module

will re-initialize, the Module Operational Command (01h) and Module Write Protect Command (10h) will be set to enable. The module output will be ON and set to nominal V out.

Table 4-17 lists the status of the module command and the functionality of the commands when configuring the module to DVS mode.

Table 4-16

Module Command	Command Name	Functional in DVS	Upon Change to DVS
B1h	VREF	Yes	Set to the module's nominal output voltage.
B2h	IREF	Yes	IREF is the output current level in which the module will enter to Constant Current Source. During 52h set to Constant Current, value will be set based on Module Command 4Dh and nominal output current. During 52h set to Latch Type, although the Latch level can be adjusted, the IREF value will be fixed to 120% of the nominal output current.
48h	OV_FAULT_LIMIT_MULTIPLIER	Yes	No change from previous value
49h	OV_WARN_LIMIT_MULTIPLIER	Yes	No change from previous value
4Bh	UV_FAULT_LIMIT_MULTIPLIER	Yes	No change from previous value
4Ch	UV_WARN_LIMIT_MULTIPLIER	Yes	No change from previous value
4Dh	OC_FAULT_LIMIT_MULTIPLIER	Yes	No change from previous value
52h	OC_RESPONSE_TYPE	Yes	Set to Constant Current Protection
B5h	SET_VOLTAGE_RISE_SETTING	Yes	No change from previous value
B6h	SET_CURRENT_RISE_SETTING	No	No change from previous value
B7h	SET_IO_ACTIVE_LEVEL_LOGIC	Yes	No change from previous value
B8h	SET_MODULE__LOAD_TYPE	Yes	Default to capacitive load type Data "02h"
BAh	ANALOG_FILTER_ENABLE	No	No change from previous value

*Functional: If Yes, Module Command is operational during the module mode.
If No, Module Command is not operational during the module mode

To change module output voltage, a B1h (VREF) command to the module.

Device Address	Module Command	Data
<Module Slot Address>	B1h	< Data is the Set Voltage in hexadecimal>

*Before writing to the module, please ensure that the Module Command Write Protect (10h) is disabled.
*Please refer to Section 5.2 for Module User Configurable Parameters or Appendix B.2 Module Command

The user can program the module's output voltage within 5% to 120% of the nominal output voltage rating of the module. For example, a 24V module has a nominal voltage of 24V and can be set to operate between 1.2V and 28.8V.

Setting the VREF outside the valid range:

- Setting the VREF value beyond the acceptable range, but not to 0V, the module will trigger a Status CML (Communication Memory Logic) fault and will retain the existing value.
- Setting the VREF value to 0V, the module will enter to standby mode. To re-enable the module, set VREF to an acceptable range.

During a module change of output voltage:

- OVP is temporary disabled until the output voltage level increases to the commanded VREF.
- UVP is temporary disabled until the output voltage level decreases to the commanded VREF.
- IREF will automatically readjust if the voltage request is above the nominal output voltage. This will prevent the module from operating above the rated power.

4.4.1.1 DVS Protection Modes

When the supply is in DVS mode, the output is protected against over current, short circuit, over voltage, and under voltage faults. The behavior of the supply during an over current fault or short circuit fault is dependent on whether IREF is set to constant current behavior or latch behavior. In constant current mode, the module will attempt to operate at a constant current level while reducing the output voltage and in latch mode, the supply shut off. In the event of over voltage and under voltage faults, the supply will shut down. Please refer to Section 8 on how to clear the fault and power up the module after fault.

4.4.1.1.1 DVS Protection Over Current Response

Over current (OC) response mode will be set by Module Command 52h (OC_RESPONSE_TYPE). The two types of response are Constant Current and Latch. The over current level will be based on Module Command 4Dh OC_FAULT_LIMIT_MULTIPLIER setting.

Module command 4Dh OC_FAULT_LIMIT_MULTIPLIER range is 50% to 105%

When 52h is set to **Constant Current Response**, the module will enter constant current mode when load current reaches the IREF value (B2h). The output voltage will decrease to maintain the load current at the current limit. No fault reporting occurs during this condition.

The module will revert to normal operation when load current becomes less than IREF value (B2h).

The constant current setting, IREF, is dependent on the Vout setting (VREF).

When the:

- Vo (VREF) is below or equal to the nominal voltage

  IREF = (Inominal) * (OC_FAULT_LIMIT_MULTIPLIER)

- Vo (VREF) is above the nominal voltage, the IREF, value is automatically reduced to maintain the supply within the maximum peak power of the module

  IREF = [(Pnominal) * (OC_FAULT_LIMIT_MULTIPLIER)] / VREF

Note that the CC setting level, IREF, will be reflected on IREF (Module Command B2h).

When 52h is set to **Latch Type**, the module will shut down when the output current reaches the Latch Level for 500msec and a fault status will be reported. The Latch Current Level setting is dependent on the Vout setting (VREF).

When the:

- Vo (VREF) is below or equal to the nominal voltage

  Latch Current Level = (Inominal) * (OC_FAULT_LIMIT_MULTIPLIER)

- Vo (VREF) is above the nominal voltage, Latch Level value is automatically reduced to maintain the supply within the maximum peak power of the module

  Latch Current Level = [(Pnominal) * (OC_FAULT_LIMIT_MULTIPLIER)] / VREF

Note that latch setting level will NOT be reflected to IREF (Module Command B2h). Latch Level can be determined by computation as stated above.

4.4.1.1.2 DVS Short Circuit Protection

When 52h is set to **Constant Current Response**, the module will shut down when Vo is approximately less than 4% of the nominal for 2 seconds or more. A fault status will be reported.

When 52h set to **Latch Type Response** and an output short circuit occurs, the current level should exceed the latch current level and the module will shut down. A fault status will be reported.

4.4.1.1.3 DVS Protection Over Voltage Protection (OVP)

Over voltage protection will be based on Module Command 48h (OV_FAULT_LIMIT_MULTIPLIER) and B1h (VREF),

OV Level = (48h OV_FAULT_LIMIT_MULTIPLIER) x (B1h VREF)

The module will shut down when the output voltage reaches the OVP level and a Fault status will be reported.

4.4.1.1.4 DVS Protection Under Voltage Protection (UVP)

Under voltage protection will be based on Module Command 4Bh (UV_FAULT_LIMIT_MULTIPLIER) and B1h (VREF),

UV Level = (4Bh UV_FAULT_LIMIT_MULTIPLIER) x (B1h VREF)

The module will shut down when the output voltage is less than UVP level and a fault status will be reported. Note that output UVP will be disabled when the module enters constant current protection.

4.4.2 Digital Current Source (DCS)

In this operating mode, user has the capability to control the output current using digital means. A PC or laptop will be required to change the output current. To change to Digital Current Source (DCS) mode, the user needs to send below commands to ISOCOMM.

Device Address	ISOCOMM Command	Data1	Data2
00h	D3h	<Module slot or Group #>	0x08h

*Before writing to the ISOCOMM, please ensure that the ISOCOMM Command Write Protect (10h) is disabled.

Where: Data1 please refer to ISOCOMM Command Table.
Data2 "08h" signifies Digital Current Source.

After sending ISOCOMM Command D3h, module will momentarily shutdown, re-initialize and restart. The shutdown, re-initialize, and restart process takes approximately 1.5 seconds. Since the module will re-initialize, the Module Operational Command (01h) and Module Write Protect Command (10h) will be set to enable. IREF will automatically be set to 0A. Table 4-17 list the status of the module command and the functionality of the commands when configuring the module to DCS mode.

Table 4-17

Module Command	Command Name	Functional in DCS	Upon Change to DCS
B1h	VREF	Yes	Set to module's nominal output voltage
B2h	IREF	Yes	Set to 0A
48h	OV_FAULT_LIMIT_MULTIPLIER	Yes	Tracking OV Enable will be based on the set VREF OVP multiplier no change from previous value.
49h	OV_WARN_LIMIT_MULTIPLIER	Yes	Tracking OV Warning Enable will be based on the set VREF OVP warning multiplier no change from previous value
4Bh	UV_FAULT_LIMIT_MULTIPLIER	No	Disable. No change from previous value
4Ch	UV_WARN_LIMIT_MULTIPLIER	No	Disable. No change from previous value
4Dh	OC_FAULT_LIMIT_MULTIPLIER	Yes	No change from previous value.
52h	OC_RESPONSE_TYPE	No	Fix to Latch type
B5h	SET_VOLTAGE_RISE_SETTING	No	No change from previous value
B6h	SET_CURRENT_RISE_SETTING	Yes	No change from previous value
B7h	SET_IO_ACTIVE_LEVEL_LOGIC	Yes	No change from previous value
B8h	SET_MODULE__LOAD_TYPE	Yes	Last setting of B8h during DCS Factory setting of B8h during ACS is Resistive (01h)
BAh	ANALOG_FILTER_ENABLE	No	No change from previous value

*Functional: If Yes, Module Command is operational during the module mode.
If No, Module Command is not operational during the module mode

To change module output current, user needs to send below B2h (IREF) command to the module.

Device Address	Module Command	Data
<Module Slot Address>	B2h	< Data is the Set Current>

*Before writing to the module, please ensure that the Module Command Write Protect (10h) is disabled.
* Please refer to Section 5.2 for Module User Configurable Parameters or Appendix B.2 Module Command

The user can program the module's output current within 0% to 100% of the nominal output current. Setting the IREF value beyond the acceptable range, but not to 0A, the module will trigger a Status CML fault and will retain the existing value. Setting the IREF value to 0A will cause the module to enter to standby mode. To enable again the module, set IREF to an acceptable range.

4.4.2.1 DCS Protection Modes

When the supply is in DCS mode, the supply limits the current to the IREF value and the voltage is limited by the VREF value. Secondary output protection is provided in rare load conditions by the OC Fault Level and the OV Fault Level.

4.4.2.1.1 DCS Protection: Constant Voltage Clamp

There are conditions that can exist when the output voltage will be greater than the VREF level (B1h)

- Fixed load resistance and the user increases the IREF setting
- Fixed IREF setting and load resistance increases.

When module output voltage reaches the VREF level, the module will enter constant voltage mode. This will protect the module from continuous increase in output voltage. There will be no fault reporting during this condition. To enter again to DCS, the user needs to decrease the IREF setting or decrease the load resistance.

For module software v04.10.00 and above, user can update the Constant Voltage Clamp from nominal voltage down to 5% of the nominal voltage of the module via Module Command B1h. For module software below v04.10.00, constant voltage clamp is fixed to the nominal output voltage.

4.4.2.1.2 DCS Protection: Over Current Response and Short Circuit Protection

During DCS, over current response will be fix to "Latch type" (52h). OC level will be based on Module Command 4Dh OC_FAULT_LIMIT_MULTIPLIER setting.

Module Command 4Dh OC_FAULT_LIMIT_MULTIPLIER range is 50% to 105%

The module will shut down when the output current reaches the OC level and a fault status will be reported. With Vo (VREF) below or equal to the nominal voltage, the latch level setting value is

Latch Current Level = (Inominal) * (OC_FAULT_LIMIT_MULTIPLIER)

Note that the latch setting level will NOT be reflected to IREF (Module command B2h). Latch level can be determined by computation as stated above.

4.4.2.1.3 DCS Protection: Over Voltage Protection (OVP)

Over voltage protection level during DCS will be based on the OV Fault Limit Multiplier (48h) and VREF (B1h) setting.

OV Level = (48h OV_FAULT_LIMIT_MULTIPLIER) x (B1h VREF)

The module will shut down when the output voltage reaches the OVP level and a fault status will be reported.

4.4.2.1.4 DCS Protection: Under Voltage Protection (UVP)

During DCS operating mode, under voltage protection is not functional.

4.4.3 Module Grouping for Series or Parallel Connection Digital Operation

Modules can be operated in Series or Parallel connection during Digital Mode. Below are list of possible series or parallel connections.

- DVS parallel connection
- DVS series connection
- DCS parallel connection

To work properly, the modules must be connected in parallel or series. Only modules of the same model can be connected in series or in parallel. When a certain module will be included in the group, there are restrictions in place to protect the user and system. Please refer to Section 5.1.5.2 for Module Grouping configuration and Section 6 for Module Grouping details.

4.4.3.1 DVS Parallel Connection

All modules connected in parallel should:

- be grouped as one using ISOCOMM WebTool.
- have the same module configuration.
- have positive terminals connected in parallel.
- have negative terminals connected in parallel.
- have “ISHARE” signals (Module’s J2 pin 10) star connected.
- have “D_RTN” signals (Module’s J2 pin 4) star connected.
- have “REMOTE_SENSE_+” star connected and connected to the desired point of regulation.
- have “REMOTE_SENSE_-” star connected and connected to the desired point of regulation.

To change Group Module output voltage, the user needs to send below B1h (VREF) command to the group.

Device Address	Module Command	Data
<Group Number>	B1h	< Data is the Set Voltage>

*Before writing to this command, please ensure that the Group Address Write Protect (10h) is disabled.

The group output voltage can be programmed within 5% to 120% of the nominal output voltage. Setting the VREF value beyond the acceptable range, but not to 0V, the module will trigger a Status CML fault and will

retain the existing value. Setting the VREF value to 0V, the module will enter to standby mode. To enable again the module, set VREF to an acceptable range.

During group module change of output voltage:

- All modules in the group will adjust based on the commanded output voltage.
- OVP is temporarily disabled until the output voltage level reaches the commanded VREF.
- UVP is temporarily disabled until the output voltage level reaches the commanded VREF.
- IREF will automatically readjust if the voltage request is above the nominal output voltage. This will prevent module to operate above the rated power.

4.4.3.1.1 DVS Parallel Connection Protection

Each individual module in a group will protect independently. Each individual module in a group will protect as stated on section 4.4.1.1.

4.4.3.2 DVS Series Connection

All modules connected in series should:

- be grouped as one using ISOCOMM WebTool.
- have the same module configuration.
- have the terminals connected in series.
- have each module's "REMOTE_SENSE_+" connected to its own positive output terminal.
- have each module's "REMOTE_SENSE_-" connected to its own negative output terminal.
- connect external reverse biased anti-parallel diode to each module output.

Table 4-18 list recommend diodes for each module.

Table 4-18

Model	Min Voltage Rating (V)	Min Current Rating (A)	Maximum Vf	Use Below Recommended Device or its Equivalent
12V	45	300	0.9V @ 160A (Tj = 125degC)	IXYS: DSS 2x160-0045A (45V 2x160A)
24V	45	200	0.9V @ 160A (Tj = 125degC)	IXYS: DSS 2x160-0045A (45V 2x160A)
48V	100	120	0.7V @ 80A (Tj = 125degC)	STMicroelecronics: STPS160H100TV (100V 2x80A)
80V	150	80	1.5V @ 50A (Tj = 125degC)	STMicroelecronics: STTH10002TV1 (200V 2x50A)
125V	200	50	1.5V @ 50A (Tj = 125degC)	STMicroelecronics: STTH10002TV1 (200V 2x50A)
200V	400	30	1.5V @ 60A (Tj = 125degC)	STMicroelecronics: STTH120R04TV1 (400V 2x60A)
250V	400	30	1.5V @ 60A (Tj = 125degC)	STMicroelecronics: STTH120R04TV1 (400V 2x60A)

To change Group Module output voltage, the user needs to send below B1h (VREF) command using Group Device address.

Device Address	Module Command	Data
<Group Number>	B1h	< Data is the Set Voltage>

*Before writing to this command, please ensure that the Group Address Write Protect (10h) is disabled.

The desired output voltage setting should be set to the desired output voltage at the load.

Series Operation DVS “Data” = Total Output Voltage of the Series Module connection.

For example, when setting four modules in series to obtain an output voltage of 80V, the group command B1h should be set to 80V. Internally ISOCOMM will divide the set voltage by the number of modules and will set each module to an output voltage of 20V.

The module’s output voltage can be programmed within 5% to 120% of the nominal output voltage. Setting the VREF beyond the acceptable range, but not to 0V, the module will trigger a Status CML fault and will retain the existing value. Setting the VREF value to 0V, the module will enter standby mode. To enable the module again, set VREF to an acceptable range.

During group module change of output voltage:

- All modules in the group will adjust based on the computed output voltage for each module.
- OVP is temporary disabled until the output voltage level increases to the commanded VREF.
- UVP is temporary disabled until the output voltage level decreases to the commanded VREF.

- IREF will automatically readjust if the voltage request is above the nominal output voltage. This will prevent module to operate above the rated power.

4.4.3.2.1 DVS Series Connection Protection

Each individual module in a group will protect independently, as stated in Section 4.4.1.

4.4.3.3 DCS Parallel Connection

All modules connected in parallel should:

- be grouped as one using ISOCOMM WebTool
- have the same module configuration.
- have output positive terminals connected in parallel.
- have output negative terminals connected in parallel.

The module will clamp into constant voltage source if the requested IREF or load resistance increases enough to cause the output voltage to be greater than the VREF. To operate the group in this condition:

- All Module REMOTE_SENSE_+ should be star connected and connected to the desired point of regulation.
- All Module REMOTE_SENSE_- should be star connected and connected to the desired point of regulation.
- All Module ISHARE signal (Module's J2 pin 10) should be star connected.
- All Module D_RTN signal (Module's J2 pin 4) should be start connected.

To change module output current, send below B2h (IREF) command using Group Device Address.

Device Address	Module Command	Data
<Module Slot Address>	B2h	< Data is the Set Current>

*Before writing to this command, please ensure that the Group Address Write Protect (10h) is disabled.

The desired output current setting should be set to the desired output current at the load.

Parallel Operation DCS "Data" = Total Output Current of the Parallel Module connection.

For example, when setting four modules in parallel to obtain an output current of 100A, the group command B1h should be set to 100A. Internally ISOCOMM will divide the set current by the number of module and will set each module output current to 25A.

The module's output current can be programmed within 0% to 100% of the nominal output current. Setting the IREF outside the valid range will cause the modules to trigger an INVALID PGM RANGE fault (STAUS_MFR_SPECIFIC) and turn the output of the modules off. Set the command within valid range to recover.

4.4.3.3.1 DCS Parallel Connection Protection

Each individual module in a group will protect independently and will protect as stated in Section 4.4.2.

4.5 Analog Control

The module's output (output voltage or current) can be controlled using an external supply connected to the modules' IPROG (0-10VEXT_IPROG or 0-5VEXT_IPROG) or VPROG (0-10VEXT_VPROG or 0-5VEXT_VPROG) signal. Definition of module is in Appendix B.2 Module Command. Definition of ISOCOMM Command is in Appendix B.3 ISOCOMM Command.

4.5.1 Analog Voltage Source (AVS)

In this operating mode, the user has the capability to control the output voltage using analog means. For AVS, user can control the output using the 0-5VEXT_VPROG or 0-10VEXT_VPROG input.

To change to Analog Voltage Source (AVS) mode, the user needs to send the below commands to ISOCOMM.

Device Address	Command	Data1	Data2
00h	D3h	<Module slot or Group #>	02h

*Before writing to the ISOCOMM, please ensure that the ISOCOMM Command Write Protect (01h) is disabled.

Where: Data1 please refer to ISOCOMM Command Table.
Data2 "0x02h" signifies Analog Programmed Voltage Source.

After sending ISOCOMM Command D3h, the module will momentarily shutdown, re-initialize and restart. This will happen for 1.5 seconds. Since the module will re-initialize, the Module Operational Command (01h) and Module Write Protect Command (10h) will be set to enable. The module output voltage will be based on the VPROG signal. Table 4-19 lists the status of the module command and the functionality of the commands when configuring the module to DCS mode.

Table 4-19

Module Command	Command Name	Functional in AVS	Upon Change to AVS
B1h	VREF	No	Fix to Module's Nominal Output Voltage
B2h	IREF	Yes	During 52h set to Constant Current, value will be set based on Module Command 4Dh and nominal output current. During 52h set to Latch Type, value will be fixed to 120% of the nominal output current.
48h	OV_FAULT_LIMIT_MULTIPLIER	No	No change from previous value
49h	OV_WARN_LIMIT_MULTIPLIER	No	No change from previous value
4Bh	UV_FAULT_LIMIT_MULTIPLIER	No	No change from previous value
4Ch	UV_WARN_LIMIT_MULTIPLIER	No	No change from previous value
4Dh	OC_FAULT_LIMIT_MULTIPLIER	Yes	No change from previous value
52h	OC_RESPONSE_TYPE	Yes	No change from previous value
B5h	SET_VOLTAGE_RISE_SETTING	No	No change from previous value
B6h	SET_CURRENT_RISE_SETTING	No	No change from previous value
B7h	SET_IO_ACTIVE_LEVEL_LOGIC	Yes	No change from previous value
B8h	SET_MODULE__LOAD_TYPE	Yes	Default to capacitive load type Data “02h”
BAh	ANALOG_FILTER_ENABLE	Yes	No change from previous value

*Functional: If Yes, command register is operational during the module mode.
If No, command register is not operational during the module mode

To change the output voltage using 0-10VEXT_VPROG, apply 0-10V across the connector J1’s pin 1 (0-10VEXT_VPROG) and pin 8 (SYS_RTN) to get a corresponding output voltage from 5% to 120% of the nominal output voltage. Applied voltage 0V – 0.42V yields 5% nominal output voltage.

To change the output voltage using 0-5VEXT_VPROG, apply 0-5V across the connector J1’s pin 2 (0-5VEXT_VPROG) and pin 8 (SYS_RTN) to get a corresponding output voltage from 5% to 120% of the nominal output voltage. Applied voltage 0V – 0.21V yields 5% nominal output voltage.

Note: IREF will automatically readjust if the voltage request is above the nominal output voltage.

Please note that 0-10VEXT_IPROG and 0-5VEXT_IPROG cannot be used simultaneously:

- If the user will use 0-10VEXT_VPROG, 0-5VEXT_VPROG should be floating.
- If the user will use 0-5VEXT_VPROG, 0-10VEXT_VPROG should be floating.

4.5.1.1 AVS Protection Modes

When the supply is in AVS mode, the output is protected against over current, short circuit, over voltage, and under voltage faults. The behavior of the supply during an over current fault or short circuit fault is dependent on whether IREF is set to constant current behavior or latch behavior. In constant current mode, the module will attempt to operate at a constant current level while reducing the output voltage and in latch mode the supply shut off. In the event of an overvoltage and under voltage faults the supply will shut down. Please refer to Section 8 on how to clear the fault and power up the module after fault.

4.5.1.1.1 AVS Protection Over Current Response

Over current response mode will be set by Module Command 52h (OC_RESPONSE_TYPE). The two types of response are Constant Current and Latch. The over current level will be based on Module Command 4Dh OC_FAULT_LIMIT_MULTIPLIER setting.

Module Command 4Dh OC_FAULT_LIMIT_MULTIPLIER range is 50% to 105%

When 52h set to **Constant Current Response**, the module will enter constant current mode when load current reaches the IREF value (B2h). The output voltage will decrease to maintain the load current at the current limit. No fault reporting occurs during this condition.

The module will revert to normal operation when load current becomes less than IREF value (B2h).

The constant current setting, IREF, is dependent on the Vout setting (VREF).

When the:

- Vo (VREF) is below or equal to the nominal voltage

  IREF = (Inominal) * (OC_FAULT_LIMIT_MULTIPLIER)

- Vo (VREF) is above the nominal voltage, the IREF, value is automatically reduced to maintain the supply within the maximum peak power of the module

  IREF = [(Pnominal) * (OC_FAULT_LIMIT_MULTIPLIER)] / VREF

Note that the CC setting level, IREF, will be reflected on IREF (Module Command B2h).

When 52h set to **Latch Type**, the module will shut down when the output current reaches the latch level for 500msec and a fault status will be reported.

The Latch Current Level setting is dependent on the Vout setting (VREF).

When the:

- Vo (VREF) is below or equal to the nominal voltage

  Latch Current Level = (Inominal) * (OC_FAULT_LIMIT_MULTIPLIER)

- Vo (VREF) is above the nominal voltage, Latch Level value is automatically reduced to maintain the supply within the maximum peak power of the module

  Latch Current Level = [(Pnominal) * (OC_FAULT_LIMIT_MULTIPLIER)] / VREF

Note that the latch setting level will NOT be reflected to IREF (Module Command B2h). Latch level can be determined by computation as stated above.

4.5.1.1.2 AVS Short Circuit Protection

When 52h is set to **Constant Current Response**, the module will shut down when Vo is approximately less than 4% of the nominal for 2 seconds or more. A fault status will be reported.

When 52h set to **Latch Type** and an output short circuit occurs, the current level should exceed the latch current level and the module will shut down. A fault status will be reported.

4.5.1.1.3 AVS Protection Over Voltage Protection (OVP)

Tracking over voltage protection Module Command 48h (OV_FAULT_LIMIT_MULTIPLIER) is not operational during AVS. A Brick Wall OVP is operational during this mode. In Brick Wall OVP mode the limit is hard coded in module firmware at the factory and cannot be changed. The module will shut down when the output voltage reaches the Brick Wall OVP level. Brick Wall OVP level is specified in Section 4.1.2 and a fault status will be reported.

4.5.1.1.4 AVS Protection Under Voltage Protection (UVP)

During ACS operating mode, under voltage protection is not functional.

4.5.2 Analog Current Source (ACS)

In this operating mode, the user has the capability to control the output current using analog means. For ACS, the user can control the output using 0-5VEXT_IPROG or 0-10VEXT_IPROG

To change to Analog Current Source (ACS) mode, the user needs to send below commands to ISOCOMM.

Device Address	Command	Data1	Data2
00h	0xD3h	<Module slot or Group #>	0x0Ah

*Before writing to the ISOCOMM, please ensure that the ISOCOMM Command Write Protect (01h) is disabled.

Where: Data1 please refer to ISOCOMM Command Table.
Data2 “0x0Ah” signifies Analog Programmed Voltage Source.

After sending ISOCOMM Command D3h, the module will momentarily shutdown, re-initialize and restart. The shutdown, re-initialize and restart process takes approximately 1.5 seconds. Since the module will re-initialize, the Module Operational Command (01h) and Module Write Protect Command (10h) will be set to enable. The module output current will be based on the IPROG signal.

Table 4-20 lists the status of the module command and the functionality of the commands when configuring the module to ACS mode.

Table 4-20

Module Command	Command Name	Functional in ACS	Upon Change to ACS
B1h	VREF	Yes	Fix to nominal
B2h	IREF	No	Fix to 0A
48h	OV_FAULT_LIMIT_MULTIPLIER	Yes	OVP will be based on the set VREF. OVP multiplier no change from previous value.
49h	OV_WARN_LIMIT_MULTIPLIER	Yes	OV Warning will be based on the set VREF. OVP warning multiplier no change from previous value.
4Bh	UV_FAULT_LIMIT_MULTIPLIER	No	No change from previous value
4Ch	UV_WARN_LIMIT_MULTIPLIER	No	No change from previous value
4Dh	OC_FAULT_LIMIT_MULTIPLIER	Yes	No change from previous value
52h	OC_RESPONSE_TYPE	Yes	Fix to Latch type
B5h	SET_VOLTAGE_RISE_SETTING	No	No change from previous value
B6h	SET_CURRENT_RISE_SETTING	No	No change from previous value
B7h	SET_IO_ACTIVE_LEVEL_LOGIC	Yes	No change from previous value
B8h	SET_MODULE__LOAD_TYPE	Yes	Last user B8h command. Artesyn Factory setting of DCS is Resistive (01h).
Bah	ANALOG_FILTER_ENABLE	No	No change from previous value

*Functional: If Yes, command register is operational during the module mode.
If No, command register is not operational during the module mode

To change the output current using 0-10VEXT_IPROG, apply 0-10V across connector J1's pin 3 (0-10VEXT_IPROG) and pin 8 (SYS_RTN) to get a corresponding output current from 0% to 100% of the rated output current.

To change the output current using 0-5VEXT_IPROG, apply 0-5V across connector J1's pin 4 (0-5VEXT_IPROG) and pin 8 (SYS_RTN) to get a corresponding output current from 0% to 100% of the rated output current.

Please note that 0-10VEXT_IPROG and 0-5VEXT_IPROG cannot be used simultaneously:

- If the user will use 0-10VEXT_VPROG, 0-5VEXT_VPROG should be floating.
- If the user will use 0-5VEXT_VPROG, 0-10VEXT_VPROG should be floating.

4.5.2.1 ACS Protection Modes

When the supply is in ACS mode, the supply limits the current to the IREF value and the voltage is limited by the VREF value. Secondary output protection is provided in rare load conditions by the OC fault level and the OV fault level. Please refer to Section 8 on how to clear the fault and power up the module after fault.

4.5.2.1.1 ACS Protection: Constant Voltage Clamp

There are conditions that can exist when the output voltage will be greater than the VREF level (B1h):

- Fix load resistance and user increases the IPROG input.
- Fix IPROG input setting and load resistance increases.

When module output voltage reaches the VREF level, the module will enter constant voltage clamp. This will protect the system from continuous increase in output voltage. There will be no fault reporting during this condition. To enter again to ACS, the user needs to decrease the IPROG input or decrease the load resistance.

For module software v04.10.00 and above, the user can update the Constant Voltage Clamp from nominal voltage down to 5% of the nominal voltage of the module via Module Command B1h. For module software below v04.10.00, Constant Voltage Clamp cannot be changed and is set to the nominal output voltage.

4.5.2.1.2 ACS Protection: Over Current Protection and Short Circuit Protection

During ACS, over current protection will be fix to “latch type” (52h). OC level will be based on Module Command 4Dh OC_FAULT_LIMIT_MULTIPLIER setting.

Module Command 4Dh OC_FAULT_LIMIT_MULTIPLIER range is 50% to 105%

The module will shut down when the output current reaches the OC level and a fault status will be reported. With Vo (VREF) below or equal to the nominal voltage, the latch level setting value is

Latch Level = (Inominal) * (OC_FAULT_LIMIT_MULTIPLIER)

Note that the latch setting level will NOT be reflected to IREF (Module Command B2h). Latch Level can be determined by computation as stated above.

4.5.2.1.3 ACS Protection: Over Voltage Protection (OVP)

Over voltage protection level during ACS will be based on the OV Fault Limit Multiplier (48h) and VREF (B1h) setting.

OV Level = (48h OV_FAULT_LIMIT_MULTIPLIER) x (B1h VREF)

4.5.2.1.4 ACS Protection: Under Voltage Protection (UVP)

During ACS operating mode, under voltage protection is not functional

4.5.3 Module Grouping for Series or Parallel Connection Analog Operation

Modules can be operated in Series or Parallel connection during analog mode. Below are list of possible series or parallel connections:

- AVS parallel connection
- AVS series connection
- ACS parallel connection

To work properly, user needs to group the modules connected in parallel or series. To work properly, the modules must be connected in parallel or series. Only modules of the same model can be connected in series or in parallel. When a certain module will be included in the group, there are restrictions in place to protect the user and system. Please refer to Section 5.1.5.2 for Module Grouping configuration and Section 6 for Module Grouping details.

4.5.3.1 AVS Parallel Connection

All modules connected in parallel should:

- be grouped as one using ISOCOMM WebTool.
- have the same module configuration.
- have positive terminals connected in parallel.
- have negative terminals connected in parallel.
- have "ISHARE" signals (Module's J2 pin 10) star connected.
- have "A_RTN" signals (Module's J2 pin 4) star connected.
- have "REMOTE_SENSE_+" signals star connected and connected to the desired point of regulation.
- have "REMOTE_SENSE_-" signals star connected and connected to the desired point of regulation.
- have "SYS_RTN" signals (Module's J1 pin 8) star connected
- have "0-10VEXT_VPROG" signals (Module's J1 pin 1) star connected if system will be operating using 0-10VEXT_VPROG.
- have "0-5VEXT_VPROG" signal (Module's J1 pin 2) signals star connected if system will be operating using 0-5VEXT_VPROG.

Warning! - Module's J2 signals and output voltage are isolated from module's J1 signals.

4.5.3.1.1 AVS Parallel Connection Protection

Each individual module in a group will protect independently and will protect as stated in Section 4.5.1.

4.5.3.2 AVS Series Connection

All modules connected in series should:

- be group as one using ISOCOMM WebTool
- have the same module configuration.
- have output terminals connected in series.
- have each module's "REMOTE_SENSE_+" connected to its own positive output terminal.
- have each module's "REMOTE_SENSE_-" connected to its own negative output terminal.

- have “0-10VEXT_VPROG” signals (Module’s J1 pin 1) star connected If user will operate using 0-10VEXT_VPROG.
- have “0-5VEXT_VPROG” signals (Module’s J1 pin 2) star connected if user will operate using 0-5VEXT_VPROG.
- connect external reverse biased (anti-parallel) diode to each module output.

Table 4-21 list recommend diodes for each module.

Table 4-21

Model	Min Voltage Rating (V)	Min Current Rating (A)	Maximum Vf	Use Below Recommended Device or its Equivalent
12V	45	300	0.9V @ 160A (Tj = 125degC)	IXYS: DSS 2x160-0045A (45V 2x160A)
24V	45	200	0.9V @ 160A (Tj = 125degC)	IXYS: DSS 2x160-0045A (45V 2x160A)
48V	100	120	0.7V @ 80A (Tj = 125degC)	STMicroelecronics: STPS160H100TV (100V 2x80A)
80V	150	80	1.5V @ 50A (Tj = 125degC)	STMicroelecronics: STTH10002TV1 (200V 2x50A)
125V	200	50	1.5V @ 50A (Tj = 125degC)	STMicroelecronics: STTH10002TV1 (200V 2x50A)
200V	400	30	1.5V @ 60A (Tj = 125degC)	STMicroelecronics: STTH120R04TV1 (400V 2x60A)
250V	400	30	1.5V @ 60A (Tj = 125degC)	STMicroelecronics: STTH120R04TV1 (400V 2x60A)

Warning! - Module’s J2 signals and output voltage are isolated from module’s J1 signals.

4.5.3.2.1 AVS Parallel Connection Protection

Each individual module in a group will protect independently and will protect as stated in Section 4.5.1.

4.5.3.3 ACS Parallel Connection

All Modules connected in parallel should:

- be grouped as one using ISOCOMM WebTool
- have the same module configuration.

- have positive terminals connected in parallel.
- have negative terminals connected in parallel.
- have “SYS_RTN” signals (Module’s J1 Pin8) star connected.
- have “0-10VEXT_VPROG” signals (Module’s J1 Pin1) star connected if system will be operating using 0-10VEXT_VPROG.
- have “0-5VEXT_VPROG” signals (Module’s J1 Pin2) star connected if system will be operating using 0-5VEXT_VPROG.

The module will clamp into constant voltage if the requested output current or load resistance increases and causes the output voltage to be greater than the VREF. If operating from this condition connect:

- All Module “REMOTE_SENSE_+” should be star connected and connected to the desired point of regulation.
- All Module “REMOTE_SENSE_-” should be star connected and connected to the desired point of regulation.
- All Module “ISHARE” signal (Module’s J2 pin 10) should be star connected.
- All Module “A_RTN” signal (Module’s J2 pin 4) should be start connected.

Warning! - Module’s J2 signals and output voltage are isolated from module’s J1 signals.

4.5.3.3.1 AVS Series Connection Protection

Each individual module in a group will protect independently and will protect as stated in Section 4.5.2.

5 Configuration

This section discusses user configurable parameters of iHP rack (ISOCOMM configuration) and iHP module. Configuration settings can be accomplished using a computer to connect to the iHP unit.

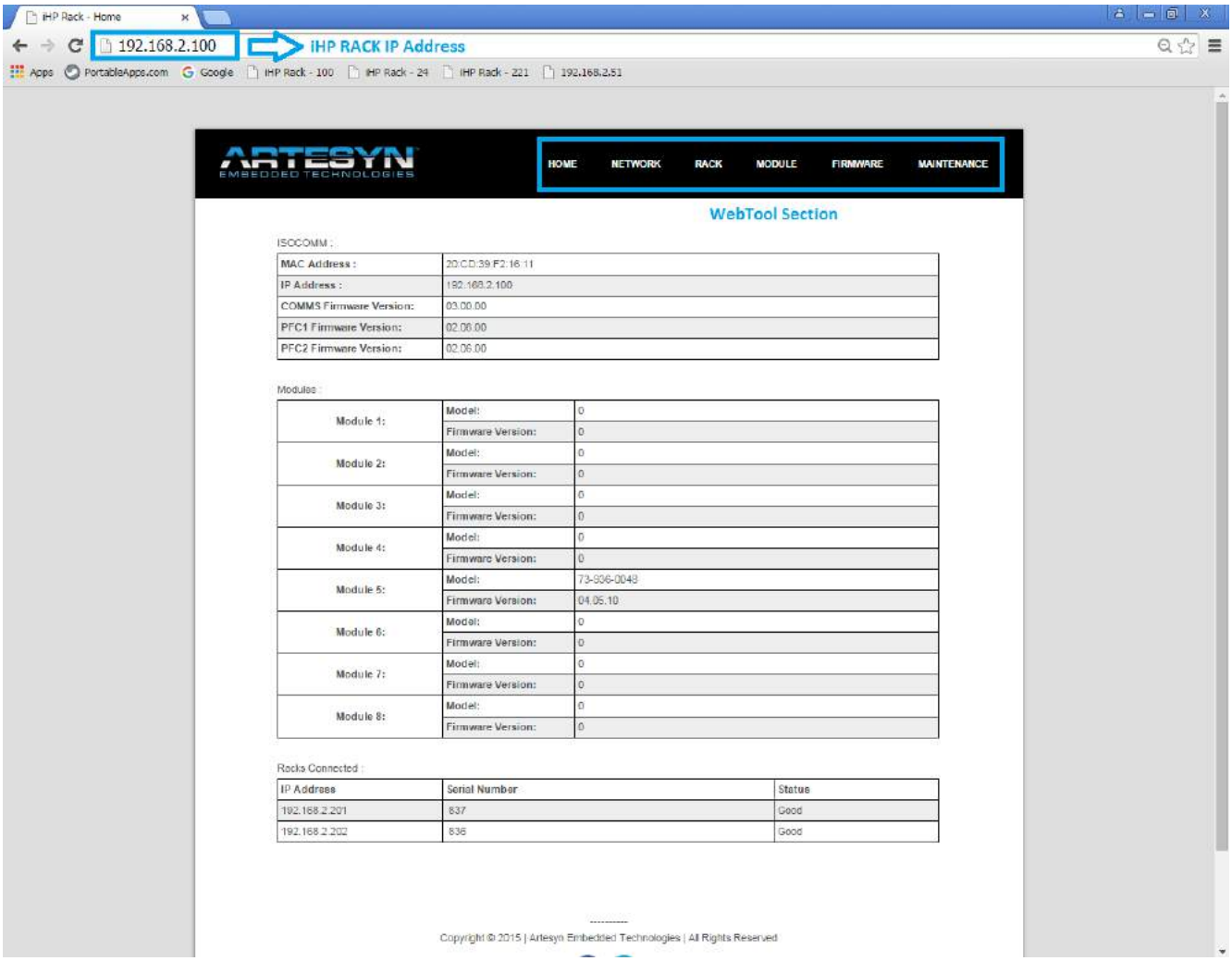
5.1 ISOCOMM User Configurable Parameters

iHP rack configuration can be updated using Ethernet communication only. iHP racks have a built-in WebTool to edit ISOCOMM configuration. The configuration can be changed using an internet browser. Recommended internet browser is Google Chrome.

ISOCOMM WebTool is composed of different section. Each section will be discussed on succeeding pages.

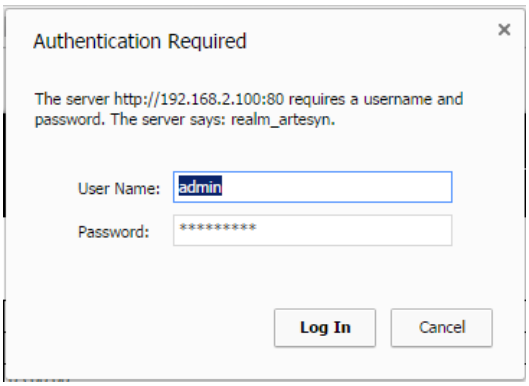
- Home section contains summary of the iHP rack's network setting and the rack's firmware versions, and the iHP modules connected to the iHP rack with the module's respective firmware version.
- Network section contains communication and network configuration.
- Rack section contains iHP rack configuration.
- Module section contains commands necessary for grouping modules.
- Firmware section contains information to perform a firmware update.
- Maintenance section contains information to initiate System Reset.

To access the ISOCOMM WebTool, open the web browser and type the iHP rack IP address to access the WebTool. The home page will be displayed.



User needs to enter USERNAME and PASSWORD when accessing below section (applicable to ISOCOMM SW v03.00.00)

- Rack section
- Module section
- Firmware section
- Maintenance section



Default setting when shipped from Artesyn:

User Name: **admin**

Password: **rtsn1234!**

When the user changes a setting, press “Save” button and perform System Reset. “Save” button is applicable only on the specific WebTool section. Meaning if user changes a parameter in a WebTool section, the “Save” button must be pressed before going to another WebTool section.

System Reset is needed for the “Save” changes to take effect. System reset can be done by:

- Recycling Input AC. Turning Off input AC for 10 seconds then turn-on.
- Initiating “Reset System”. This button is in the Maintenance Section. Please refer to Section 5.1.7.

When user needs to perform changes in different WebTool section, user can change configuration then save before going to another section. System Reset will be required to implement all changes in each WebTool section.

The “Restore Previous Values” button will revert the change configuration value to the setting during the last system initialization. This button is also applicable only on the specific WebTool section. Please take note that this function restores ISOCOMM configuration only. After pressing “Restore Previous Values” button, the user needs to press “Save” button and perform System Reset to ensure that the restore previous value will take into effect.

5.1.1 Home Section

The Home Section contains a general summary of the iHP unit.



ISOCOMM :

MAC Address :	20:CD:39:F2:16:11
IP Address :	192.168.2.100
COMMS Firmware Version:	03.00.00
PFC1 Firmware Version:	02.06.00
PFC2 Firmware Version:	02.06.00

Modules :

Module 1:	Model:	0
	Firmware Version:	0
Module 2:	Model:	0
	Firmware Version:	0
Module 3:	Model:	0
	Firmware Version:	0
Module 4:	Model:	0
	Firmware Version:	0
Module 5:	Model:	73-936-0048
	Firmware Version:	04.05.10
Module 6:	Model:	0
	Firmware Version:	0
Module 7:	Model:	0
	Firmware Version:	0
Module 8:	Model:	0
	Firmware Version:	0

Racks Connected :

IP Address	Serial Number	Status
192.168.2.201	837	Good
192.168.2.202	836	Good

WebTool Home section will display the following information

- ISOCOMM MAC Address
- IP Address
- Comms Firmware version
- PFC1 and PFC2 Firmware version

5.1.1.1 Home Page ISOCOMM Section

ISOCOMM :

MAC Address :	20:CD:39:F2:16:11
IP Address :	192.168.2.100
COMMS Firmware Version:	03.00.00
PFC1 Firmware Version:	02.06.00
PFC2 Firmware Version:	02.06.00

5.1.1.2 Home Page Module Section

- Each iHP rack slot's module model number
- Each iHP rack slot's module firmware version

Modules :

Module 1:	Model:	0
	Firmware Version:	0
Module 2:	Model:	0
	Firmware Version:	0
Module 3:	Model:	0
	Firmware Version:	0
Module 4:	Model:	0
	Firmware Version:	0
Module 5:	Model:	73-936-0048
	Firmware Version:	04.05.10
Module 6:	Model:	0
	Firmware Version:	0
Module 7:	Model:	0
	Firmware Version:	0
Module 8:	Model:	0
	Firmware Version:	0

5.1.1.3 Home Page Racks Section

- Racks connected (applicable to ISOCOMM SW v03.00.00)
  - This section will be active when Rack Synchronize OFF is enabled in WebTool Rack Configuration.
  - This function is needed during multi-rack operation. Multi-rack operation is discussed in Section 7.
  - This field contains:
    - IP address of the racks connected in multi-rack operation
    - Serial Number of the racks connected in multi-rack operation
    - Status of each rack connected in multi-rack operation (Good or Fault/Standby)

In below screen shot, there are three iHP rack in multi-rack operation. The WebTool will display the IP address of the other two racks connected.

Racks Connected :

IP Address	Serial Number	Status
192.168.2.201	837	Good
192.168.2.202	836	Good

5.1.2 Network Section

Network configuration can be done using this section in the WebTool. The Network Section contains the following information:

- Ethernet Settings
  - MAC Address
  - Current IP Address
  - Broadcast Address
  - DHCP Setting
  - Static IP Address (when DHCP is disable)
- CAN/RS485 Settings

In the Network Section user can configure the following:

- Enable/Disable DHCP
- Static IP Address
- CAN/RS485 Rack Address



Network Configuration

Ethernet Settings:

MAC Address :	20:CD:39:F2:10:F2
Current IP Address :	10.162.140.221
Broadcast Address :	10.162.141.255
DHCP :	Enabled
Static IP Address :	192 . 168 . 2 . 100

CAN/RS485 Settings:

Rack Address:	0

Changes to this page will be reflected after reboot.

If you change the IP Address, remember to change the WEB URL when accessing this page.

Restore previous values | Save Changes

5.1.2.1 DHCP

This will allow user to enable or disable Dynamic Host Configuration Protocol.

Setting	Remarks
Enable	The router will automatically assign the IP address to the iHP rack. Once the setting is activated, user will need to search for the IP address assigned by the router.
Disable	IP address will be set to Static IP. User can update IP address in the “Static IP Address” field.

5.1.2.2 Static IP Address

This field will be used to enter user static IP address. This is applicable when the DHCP setting is disabled.

5.1.2.3 CAN/RS485 Setting

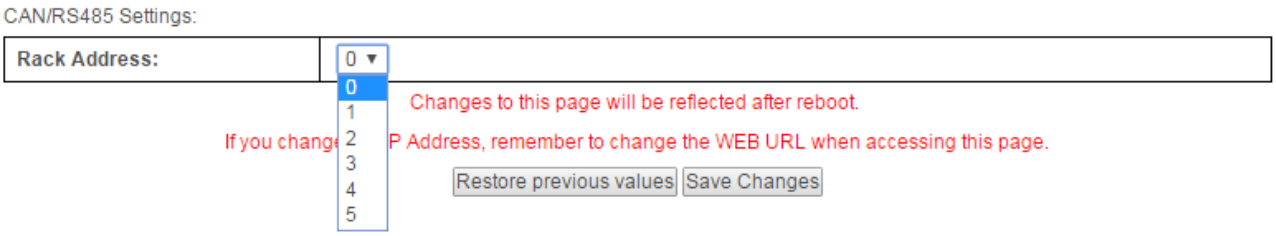
This field will be used to configure CAN / RS485 address.

A dropdown list will be available. Possible CAN / RS485 addresses are:

- Address 0
- Address 1

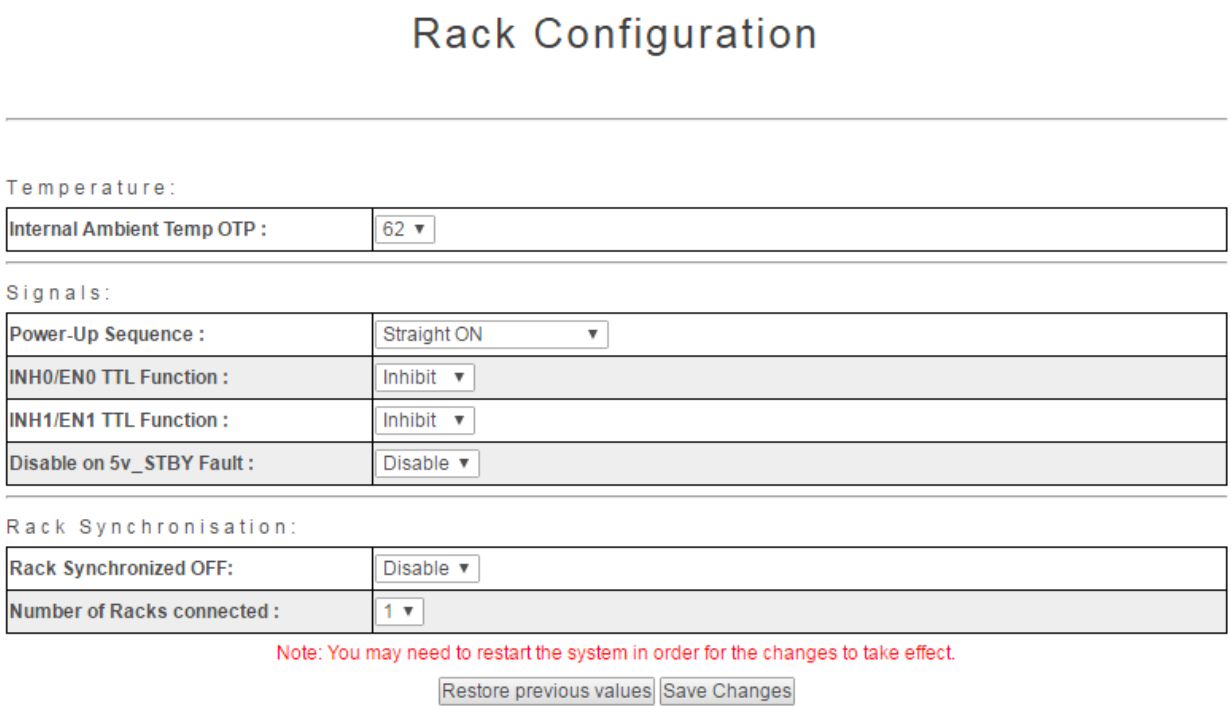
- Address 2
- Address 3
- Address 4
- Address 5

CAN broadcast address is set to address seven. RS485 does not have any broadcast address.



5.1.3 Rack Section

Configuration of rack-related parameters can be updated in this WebTool section.



5.1.3.1 Internal Ambient Temperature OTP

This configuration allows the user to set for the desired rack's internal ambient temperature in which the rack will trigger the OTP.

- The user can set the Ambient OTP from ***0-70 degrees Celsius***.
- OT warning will be flagged when the temperature reaches Ambient OTP less 4°C.

- Ambient temperature monitoring is located on the front panel of iHP rack.

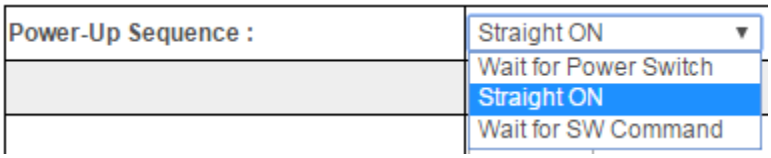
Once Ambient OTP is triggered, status will be reflected on the ISOCOMM command 7Dh (STATUS_TEMPERATURE).

5.1.3.2 Power-Up Sequence

This configuration discusses the output status (on or off) during iHP power-up.

Power-up sequence can be configured as:

- Wait for Power Switch
- Straight ON
- Wait for SW Command



Wait for Power Switch

- Power Switch is located on the front panel of the iHP unit.
- After turning-on the Input AC and ISOCOMM finishes its bootload process, modules will not turn-on. Module will turn-on after pressing the Power Switch.
- Power Switch will be operational after 20 seconds from the application of input AC.

Straight ON

- After turning-on the Input AC and ISOCOMM finishes its bootload process, modules will turn-on automatically.

Wait for SW Command

- After turning-on the Input AC and ISOCOMM finishes its bootload process, modules will not turn-on.
- User needs to send turn-on command via SW.
    - Send ISOCOMM Command: 10h Write_Protect Command; Data: 00h Command to disable ISOCOMM write protect.
    - Send ISOCOMM Command: 01h Operational Command; Data: 80h Command to turn on the module.

Note: Module turn-on will still be dependent on hardware inhibit or enable signals of iHP rack or iHP module.

5.1.3.3 INH0/EN0 TTL and INH1/EN1 TTL Function

This configuration allows the user to configure:

- INH0/EN0 TTL signal (iHP Rack DSUB9 pin 5) as Inhibit Low or Enable Low function.
- INH1/EN1 TTL signal (iHP Rack DSUB9 pin 4) as Inhibit High or Enable High function.

Configuration	iHP Rack DSUB9		Module Status
	Input to INH0/EN0 Pin	Input to INH1/EN1 Pin	
INH0 & INH1	Shorted to GND	Floating	OFF
	Shorted to GND	5V	OFF
	Floating	Floating	ON
	Floating	5V	OFF
INH0 & EN1	Shorted to GND	Floating	OFF
	Shorted to GND	5V	OFF
	Floating	Floating	OFF
	Floating	5V	ON
EN0 & INH1	Shorted to GND	Floating	ON
	Shorted to GND	5V	OFF
	Floating	Floating	OFF
	Floating	5V	OFF
EN0 & EN1	Shorted to GND	Floating	OFF
	Shorted to GND	5V	ON
	Floating	Floating	OFF
	Floating	5V	OFF

5.1.3.4 Disable on 5V_STBY Fault

User can configure the iHP rack to disable the modules if 5V_Stby fault occurred.

Setting	Remarks
Enable	Once the 5V_Stby fault occurred, modules will be disabled.
Disable	Once the 5V_Stby fault occurred, modules are still enabled.

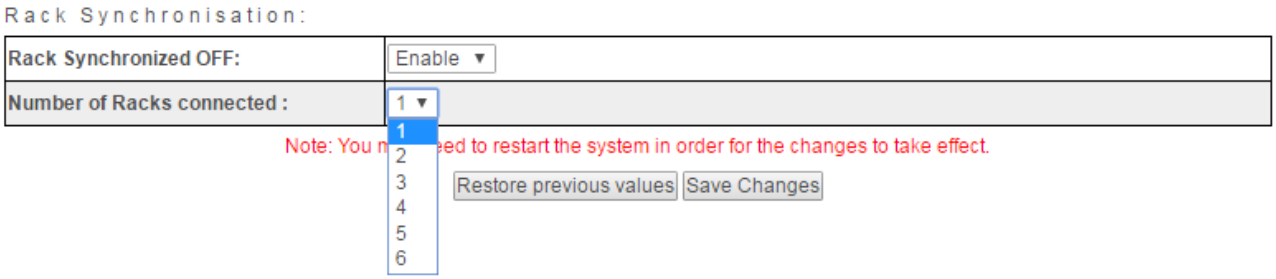
5V_Stby Faults

- Out of regulation
- Over Current / Short Circuit

5.1.3.5 Rack Synchronized Off

This function is needed during multi-rack operation. Multi-rack operation is discussed in Section 7.

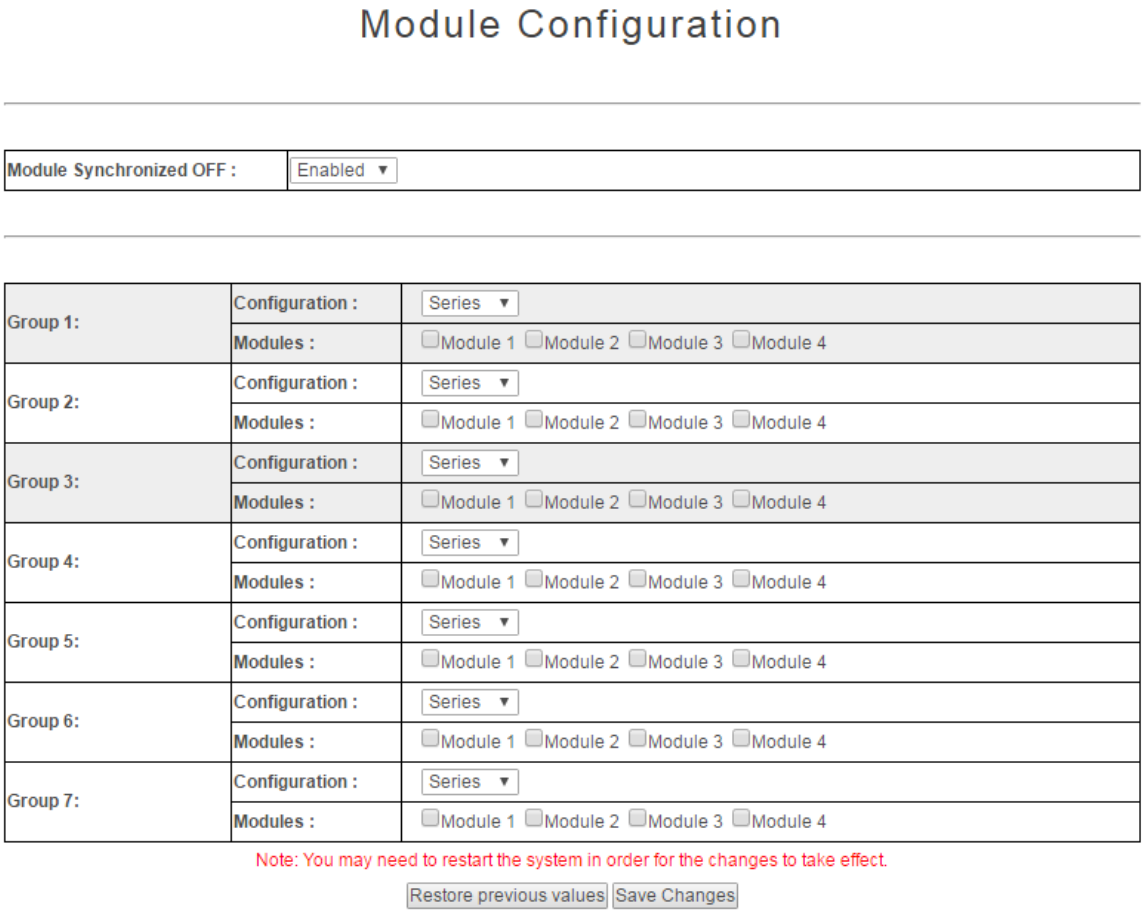
RACK Synchronized Off Setting	Remarks
Enable	Rack synchronize off is activated
Disable	Rack synchronize off is de-activated



Number of racks connected will be activated when the Rack Synchronized OFF is enabled. This parameter will indicate how many racks should be synchronized. Allowable racks to be synchronized is up to six racks.

5.1.4 Module Section

In this section, user can configure multiple modules installed in the iHP rack as one.



5.1.4.1 Module Synchronized OFF

This function will shut down all modules installed in an iHP rack when any module is at fault or in standby mode.

User can configure this function.

Setting	Remarks
Enable	All modules installed in the iHP rack will shut down when any module is at fault or in standby mode.
Disable	When at least one module is at fault or in standby mode, the remaining modules will still be operational.

It is required to enable the “Module Synchronized OFF” functionality when module is connected in parallel or series.

5.1.4.2 Module Group

Modules need to be group as one during parallel or series connections. This function will treat all modules as one.

Once grouped, the system will have the below added functions:

- Single command for all modules in a group (limited command)
- Single Register Status reporting for all modules in a group
- Single Reporting of Vo, Io, and Po for all modules in a group

User will need to configure in the ISOCOMM WebTool, the group number, if the modules in the group are connected in parallel or series, and which group the module should be included.

Note: Modules will be allowed to be included in one group only. Module grouping function is discussed in Section 6.

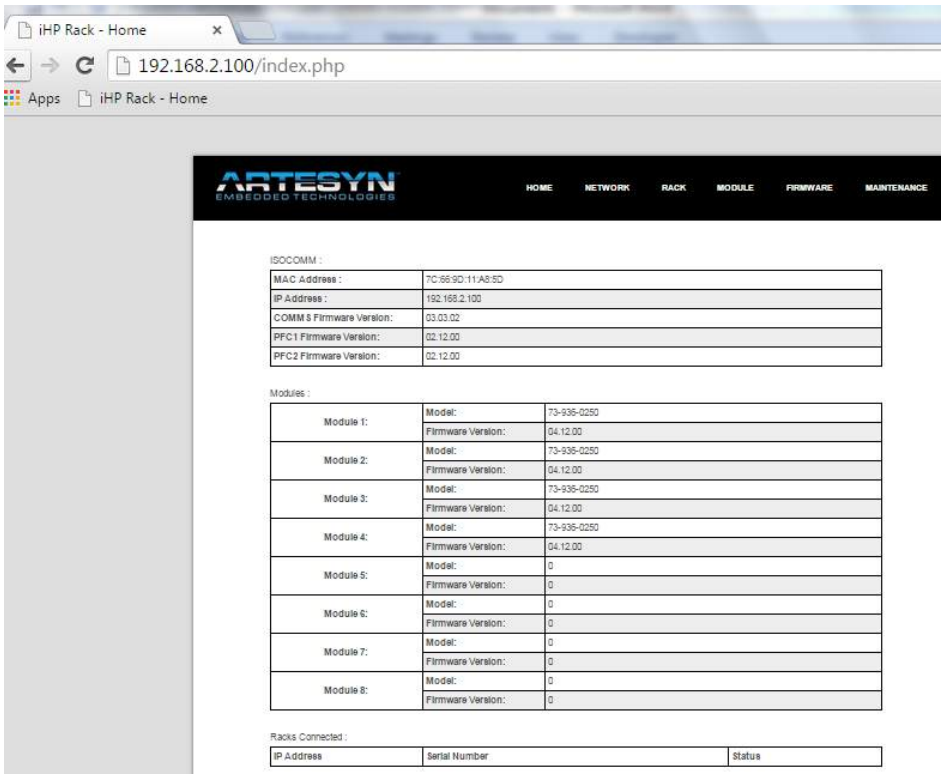
5.1.5 Firmware Section

This section provides instruction for firmware upgrade of PFC and module devices.

Before upgrading the firmware, **module outputs should be disconnected to system load.** PFC can be bootloaded with or without modules inserted to the iHP rack.

Procedure for firmware upgrade (PFC and Module):

- Power on AC source based on the input configuration of the unit.
- Unit will be operational after 20 seconds boot-up.
- Open Google Chrome Browser.
- Type the IP address of the iHP to proceed with the iHP WebTool page.

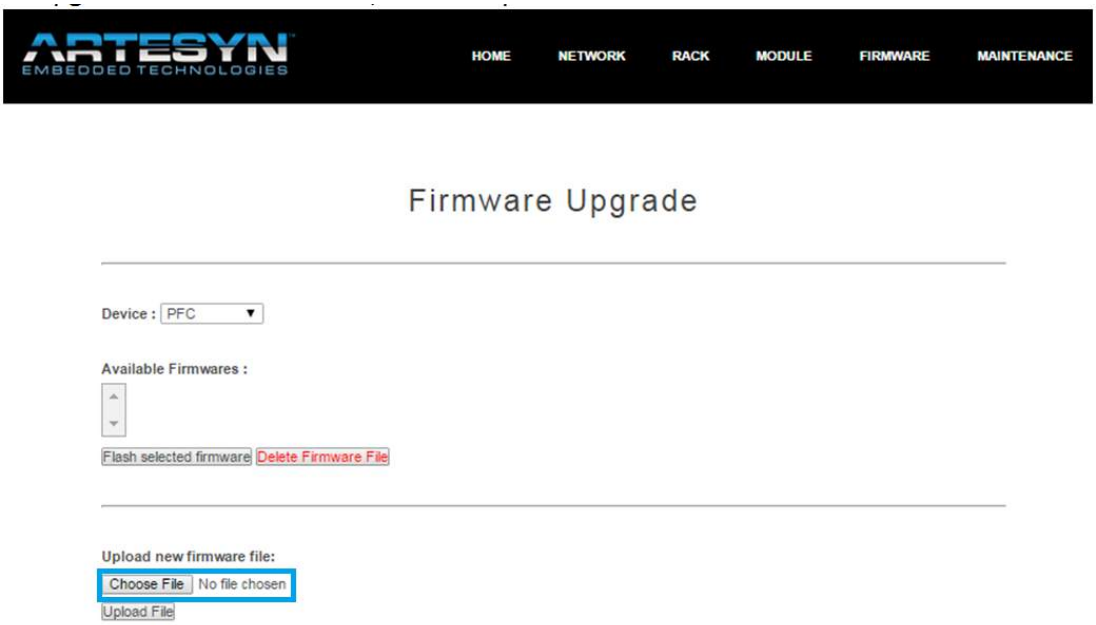


1. Click “FIRMWARE” tab.

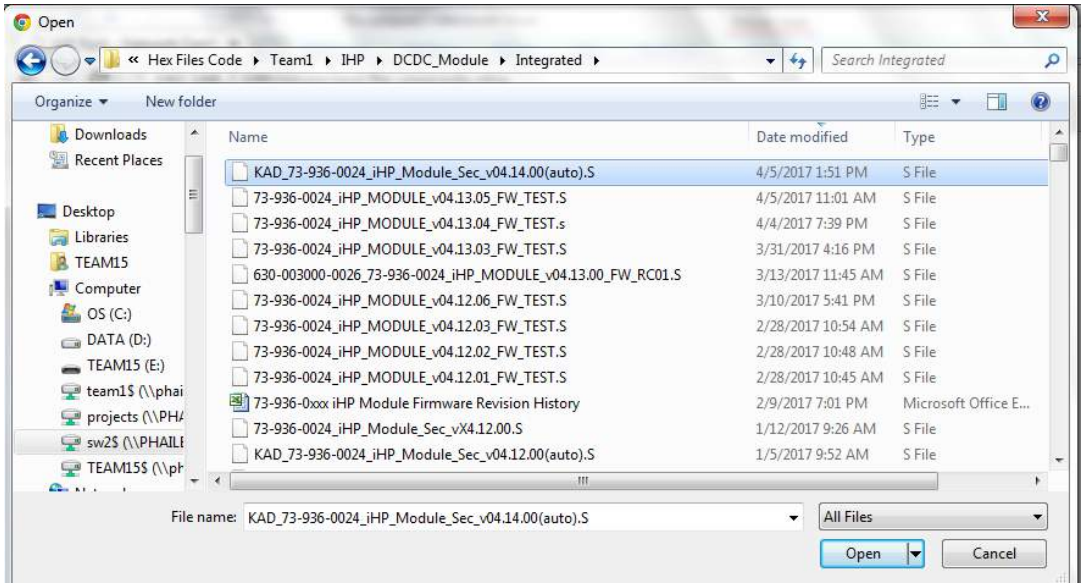


2. If asked for username and password, type below:
   User Name: **admin**
   Password: **rtsn1234!**

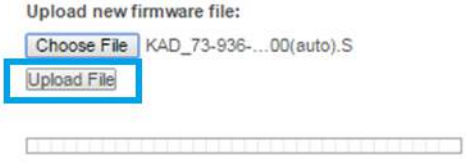
3. Upload the desired FW file. Click “**Choose File.”**



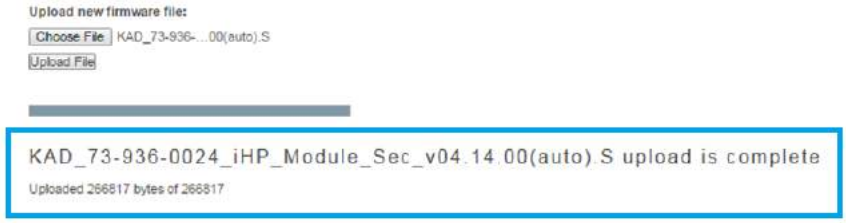
4. Select firmware file then click “Open”. Firmware file extension name is “.S”



5. Click “Upload File”



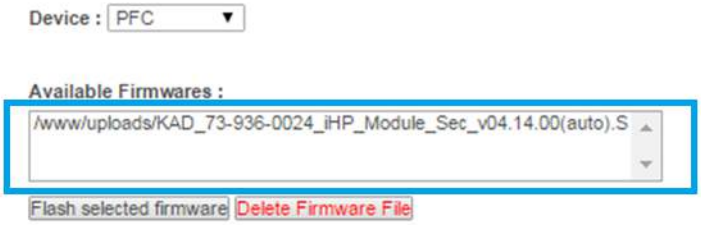
6. Once uploaded successfully, confirmation will be display as below.



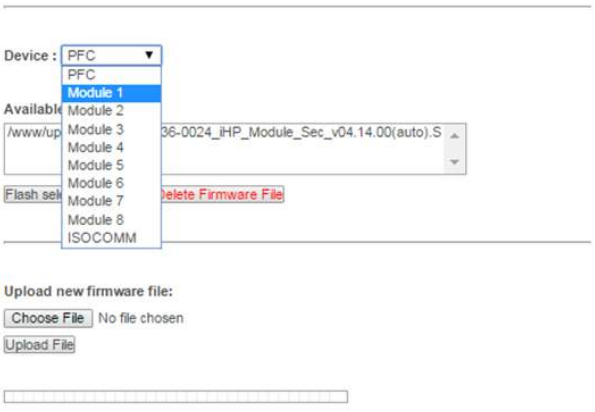
7. Refresh WebTool.



8. The uploaded file should now be visible in the Available Firmware box.



9. Select the preferred device (i.e., PFC or Module 1 or Module 2, … or Module 8) to upgrade. Module bootloading should be done per module, so you can only select one module at a time.



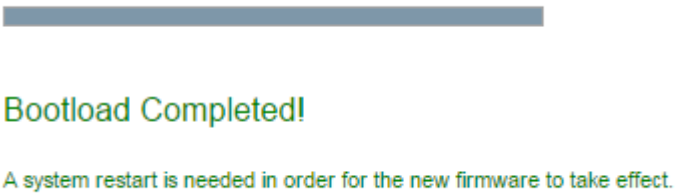
10. Select the desired firmware to be bootloaded at the Available Firmware box. It should be highlighted as below.



11. Click **"Flash selected firmware"** to start the bootloading. Bootloading progress will be displayed.



12. The WebTool will notify the user once the bootloading is completed.



13. To perform FW updates for other modules,
    a. If FW file is present in the "Available Firmware" box section, repeat instructions 13-16.
    b. If FW file is not yet present in the "Available Firmware" box section, repeat instructions 7-16.

    When user completes the bootload, proceed to instruction 18.

14. Turn-off Input AC for 10 seconds.

15. FW update finished.

16. Power-up Input AC again to check FW version.

17. Go to WebTool Home page to check the FW version.



ISOCOMM :

MAC Address :	7C:66:9D:12:B9:94
IP Address :	192.168.2.100
Serial Number :	K835RW0001CCP
Firmware Version:	03.05.01

PFC :

PFC1 Firmware Version:	02.16.00
PFC2 Firmware Version:	02.16.00

Modules :

Module 1:	Model:	73-936-0250
	Firmware Version:	04.14.00
Module 2:	Model:	73-936-0250
	Firmware Version:	04.12.00
Module 3:	Model:	73-936-0250
	Firmware Version:	04.12.00
Module 4:	Model:	73-936-0250
	Firmware Version:	04.12.00

18. Turn-off Input AC. Firmware version checking is now complete.

Note: ISOCOMM WebTool will prevent module firmware from programming PFC devices.

ISOCOMM WebTool will prevent PFC firmware from programming module devices.

PFC and module configuration will not change after firmware upgrade.

5.1.6 Maintenance Section

This section contains provisions to reset the ISOCOMM.



All changes in the configuration in the WebTool will take into effect after

- AC recycles for 10 seconds.
- Reset via pressing the “Reset System” button in the WebTool Maintenance Section

Once user presses the “Reset System” button:

- All modules will shut down.
- ISOCOMM will re-boot. ISOCOMM boot time is about 20 seconds.
- System LED and Output LED will be off.
- Power LED will be blinking green.
- After 20 seconds, ISOCOMM is now configured to the new setting and operational.

Note: When “Reset System” is initiated, this will only reset the ISOCOMM.

5.2 iHP Module User Configurable Parameters

Definition of Module Command is located on Appendix B.2 Module Command.

Command	Description
01h	MODULE_OPERATION
48h	OV_FAULT_LIMIT_MULTIPLIER
49h	OV_WARN_LIMIT_MULTIPLIER
4Bh	UV_FAULT_LIMIT_MULTIPLIER
4Ch	UV_WARN_LIMIT_MULTIPLIER
4Dh	OC_FAULT_LIMIT_MULTIPLIER
52h	OC_RESPONSE_TYPE
B5h	SET_VOLTAGE_RISE_SETTING
B6h	SET_CURRENT_RISE_SETTING
B7h	SET_IO_ACTIVE_LEVEL_LOGIC
B8h	SET_MODULE_LOAD TYPE
BAh	ANALOG_FILTER_ENABLE
B1h	VREF
B2h	IREF
D3h	MODULE_CONFIG
D8h	VPROG_LOW_LIMIT

D9h	IPROG_LOW_LIMIT
DAh	VREF_MAX_LIMIT
DBh	IREF_MAX_LIMIT

5.2.1 Module Command 01h: MODULE_OPERATION

Command to turn-off or turn-on the module.

Module Command 01h Data 80 – Module turn-on
Module Command 01h Data 00 – Module turn-off

5.2.2 Module Command 48h: OV_FAULT_LIMIT_MULTIPLIER

Command to configure the output over voltage level protection in percentage. Data settable between 120% to 130% of the set VREF.

The OV_FAULT_LIMIT_MULTIPLIER function is dependent on the module mode. Please refer to Section 4.3 for the function of OV_FAULT_LIMIT_MULTIPLIER with respect to module mode.

OVP Level = VREF + (Nominal Voltage * (OV_FAULT_LIMIT_MULTIPLIER – 1))

Example

Module = 48V iHP Module
Module Nominal Voltage = 48V
Set VREF = 35V
OV_FAULT_LIMIT_MULTIPLIER = 125%

OVP Level = VREF + (Nominal Voltage * (OV_FAULT_LIMIT_MULTIPLIER – 1))
OVP Level = 35 + (48 * (1.25 – 1))
OVP Level = 47

5.2.3 Module Command 4Bh: UV_FAULT_LIMIT_MULTIPLIER

Command to configure the output under voltage level protection in percentage. Data settable between 80% to 90% of the set VREF. The UV_FAULT_LIMIT_MULTIPLIER function is dependent on the module mode. Please refer to Section 4.3 for the function of UV_FAULT_LIMIT_MULTIPLIER with respect to module mode.

UVP Level = VREF - (Nominal Voltage * (1- UV_FAULT_LIMIT_MULTIPLIER))

Ex.

Module = 48V iHP Module
Module Nominal Voltage = 48V
Set VREF = 35V
OV_FAULT_LIMIT_MULTIPLIER = 85%

UVP Level = VREF - (Nominal Voltage * (1- UV_FAULT_LIMIT_MULTIPLIER))
UVP Level = 35 - (48 * (1 - 0.85))

UVP Level = 27.8V

5.2.4 Module Command 4Dh: OC_FAULT_LIMIT_MULTIPLIER

Command to configure the output over current level protection in percentage. Data settable between 50% to 105% of the set IREF. The OC_FAULT_LIMIT_MULTIPLIER function is dependent on the module mode. Please refer to Section 4.3 for the function of OC_FAULT_LIMIT_MULTIPLIER with respect to module mode.

Set Vo (VREF) is below or equal to the nominal voltage

OC Level = (Inominal) * (OC_FAULT_LIMIT_MULTIPLIER)

OC response will be

Ex.

Module = 48V iHP Module
Module Nominal Current = 62.5A
VREF = 48V
OC_FAULT_LIMIT_MULTIPLIER = 75%

OC Level = (Inominal) * (OC_FAULT_LIMIT_MULTIPLIER)
OC Level = (62.5) * (0.75)
OC Level = 46.875A
Latch or Constant Current over current response will be take into effect when output current reaches 46.875A.

Set Vo (VREF) is above the nominal voltage

OC level = [(Pnominal) * (OC_FAULT_LIMIT_MULTIPLIER)] / VREF

OC response will be

Ex.

Module = 48V iHP Module
Module Nominal Current = 62.5A
VREF = 50V (VREF is above the nominal voltage 48V)
OC_FAULT_LIMIT_MULTIPLIER = 75%

OC level = [(Pnominal) * (OC_FAULT_LIMIT_MULTIPLIER)] / VREF
OC level = [(3000) * (0.75)] / 50
OC Level = 45A
Latch or Constant Current over current response will take into effect when output current reaches 46.875A.

5.2.5 Module Command 52h: OC_RESPONSE_TYPE

Command to configure over current response.

Data 00h – Constant current over current response
Data 01h - Latch Type over current response

The OC_RESPONSE_TYPE function is dependent on the module mode. Please refer to Section 4.3 for the function of OC_RESPONSE_TYPE with respect to module mode.

5.2.6 Module Command B7h: SET_IO_ACTIVE_LEVEL_LOGIC

Command used to set the logic of SYS_M_FAULT#, SYS_M_ENABLE#, and SYS_M_INHIBIT signals.

Bit	Data	Function
7	n/a	Reserved
6	n/a	Reserved
5	n/a	Reserved
4	n/a	Reserved
3	n/a	Reserved
2	1	SYS_M_FAULT# Logic High means module is at fault.
	0	SYS_M_FAULT# Logic Low means module is at fault.
1	1	Module output will turn-off if SYS_M_INHIBIT is logic high.
	0	Module output will turn-off if SYS_M_INHIBIT is logic low.
0	1	Module output will turn-on if SYS_M_ENABLE# is logic high.
	0	Module output will turn-on if SYS_M_ENABLE# is logic low.

Please refer to Section 4.2.1.1 Module's J1 Signal for the signal description and recommended external circuitry for SYS_M_ENABLE#, SYS_M_FAULT#, and SYS_M_INHIBIT hardware signal.

5.2.7 Module Command B1h: VREF

This command has different function with respect to module mode.

Module Mode	Module Command B1h Function
Digital Voltage Source	Output voltage of the module can be change using this command.
Digital Current Source	Functions as output voltage clamp level during current source operation.
Analog Voltage Source	Module below SW v04.15: Fix to nominal voltage. Cannot be changed. Module SW v04.15 and above: Scaling
Analog Current Source	Functions as output voltage clamp level during current source operation.

The VREF function is dependent on the module mode. Please refer to Section 4.3 for the function of VREF with respect to module mode.

6 Module Group

Module Group function was designed to treat multiple modules in a rack as one.

The main function of module grouping is to provide a:

1. Single command for all modules in a group (limited command).
2. Single status reporting for all modules in a group.
3. Single reporting of Vo, Io, and Po for all modules in a group.

Modules are REQUIRED to be grouped as one during parallel or series connections.

Using a group address, the modules included in the group will receive the write command simultaneously. Individual write command to a module is not allowed when a module belongs to a group. This is needed during parallel or series operation in which the module should react simultaneously.

Ex.

Changing VREF to change the output voltage.

Changing IREF to change the output current.

User will need to configure in the ISOCOMM WebTool. Please refer to Section 5.1.5. Modules will be allowed to be included in one group only.

6.1 Group Device Address

ISOCOMM SWv02.08.00 and below have four module groupings.

ISOCOMM SW v03.00.00 and onwards have seven module groupings.

Instead of using ISOCOMM or module device address to send WRITE or READ command, Group device addresses are available. There are seven groupings available. Each group has a specific, unique device address.

Group Device Address	Group Number
18h	Group 1
19h	Group 2
1Ah	Group 3
1Bh	Group 4
1Ch	Group 5
1Dh	Group 6
1Eh	Group 7

The group address will be used to send READ or WRITE commands to all modules included in the group. Only one READ or WRITE command sent is needed to simultaneous command all modules in a group.

6.2 Group Initialization at Start up

Group initialization will take place after ISOCOMM boot sequence. If the grouping function is activated, ISOCOMM will check the configuration of each module. Each specific configuration should be the same in each module that belongs to a group. If there are discrepancies in the module configurations, all iHP modules in the iHP rack will not be allowed to turn-on. ISOCOMM command 80h (MFR Status) low byte bit 4 will be asserted (Group Mismatch Fault).

ISOCOMM will check if below configuration are the same for each module that belongs to a group.

Command	Command Name
01h	MODULE OPERATION
48h	OV_FAULT_LIMIT_MULTIPLIER
4Bh	UV_FAULT_LIMIT_MULTIPLIER
4Dh	OC_FAULT_LIMIT_MULTIPLIER
52h	OC_RESPONSE_TYPE
9Ah	MANUFACTURING MODEL
B1h	VREF
B2h	IREF
B5h	SET_VOLTAGE_RISE_SETTING
B6h	SET_CURRENT_RISE_SETTING
B7h	SET_IO_ACTIVE_LEVEL_LOGIC
B8h	SET_MODULE__LOAD_TYPE
BAh	ANALOG_FILTER_ENABLE
D3h	MODULE CONFIGURATION

6.3 Module within a Group Read/Write Command

User is ALLOWED to Read a specific module's register when the module belongs to a group. User is NOT ALLOWED to Write in any registers of a module when the module belongs to a group. If user needs to WRITE to module's register that belongs to a group, the user needs to ungroup that module.

6.4 Group Write Command

Please refer to Appendix B.2 for Module Command and Appendix B.3 for ISOCOMM Command.

6.5 Accepted Group Commands using Group Device Address

Command	Command Name
01h	OPERATION
03h	CLEAR_FAULTS
10h	WRITE_PROTECT
48h	OV_FAULT_LIMIT_MULTIPLIER
4Bh	UV_FAULT_LIMIT_MULTIPLIER
4Dh	OC_FAULT_LIMIT_MULTIPLIER
52h	OC_RESPONSE_TYPE
B1h	VREF
B2h	IREF
B7h	SET_IO_ACTIVE_LEVEL_LOGIC
BAh	ANALOG_FILTER_ENABLE

Above commands have the same function as specified in Appendix B.2 Module Command. When users send above WRITE command with Group address, all modules included in that Group will receive the WRITE command at the same time.

6.6 Accepted Group Commands using ISOCOMM Device Address

Command	Command Name
D3h	MODULE_CONFIG
B5h	V Rise time
B6h	I Rise time
B8h	SET_MODULE__LOAD_TYPE

Above command functions are specified in Appendix B.3 ISOCOMM Command.

6.7 Group Status and Reporting

When reading STATUS and Reporting, device address of the group should be used.

Command	Command Name	Remarks
0x78h	STATUS_BYTE	ISOCOMM will read each module STATUS_BYTE reporting. ISOCOMM will perform OR operation of STATUS_BYTE of all modules belonging to the group.
0x79h	STATUS_WORD	ISOCOMM will read each module STATUS_WORD reporting. ISOCOMM will perform OR operation of STATUS_WORD of all modules belonging to the group.

Command	Command Name	Remarks
0x7Ah	STATUS_VOUT	ISOCOMM will read each module STATUS_VOUT reporting. ISOCOMM will perform OR operation of STATUS_VOUT of all modules belonging to the group.
0x7Bh	STATUS_IOUT	ISOCOMM will read each module STATUS_IOUT reporting. ISOCOMM will perform OR operation of STATUS_IOUT of all modules belonging to the group.
0x7Ch	STATUS_INPUT	ISOCOMM will read each module STATUS_INPUT reporting. ISOCOMM will perform OR operation of STATUS_INPUT of all modules belonging to the group.
0x7Dh	STATUS_TEMPERATURE	ISOCOMM will read each module STATUS_TEMPERATURE reporting. ISOCOMM will perform OR operation of STATUS_TEMPERATURE of all modules belonging to the group.
0x7Eh	STATUS_CML	ISOCOMM will read each module STATUS_CML reporting. ISOCOMM will perform OR operation of STATUS_CML of all modules belonging to the group.
0x80h	STATUS_MFR_SPECIFIC	ISOCOMM will read each module STATUS_MFR_SPECIFIC reporting. ISOCOMM will perform OR operation of STATUS_MFR_SPECIFIC of all modules belonging to the group.
0x8Bh	READ_VOUT	Group configured connection - Parallel: ISOCOMM will read each module output voltage reporting. ISOCOMM will average the reported output voltage of the modules in the group. Group configured connection - Series: ISOCOMM will read each module output voltage reporting. ISOCOMM will sum up each reported output voltage of the modules in the group.
0x8Bh	READ_IOUT	Modules connected in Parallel: ISOCOMM will read each module output current reporting. ISOCOMM will sum each reported output current of the modules in the group. Modules connected in Series:

Command	Command Name	Remarks
		ISOCOMM will read each module output current reporting. ISOCOMM will average the reported output current of the modules in the group.
0x8Dh	READ_TEMPERATURE_1	ISOCOMM will read each module temperature reporting. ISOCOMM will report the highest temperature reading of the modules in the group.
0x96h	READ_POUT	ISOCOMM will read each module output power reporting. ISOCOMM will sum up each module reported output power in a group.
0x9Ah	MANUFACTURING MODEL	ISOCOMM will report the modules Manufacturing Model.

7 Multi-Rack Operation

Multi-rack operation is functional on ISOCOMM SW v03.00.00

Multi-rack operation connection is:

- When the modules are inserted in different iHP rack and connected in series or parallel.
- When the modules are inserted in different iHP rack and there is a need to synchronize turn-on or turn-off of the modules.

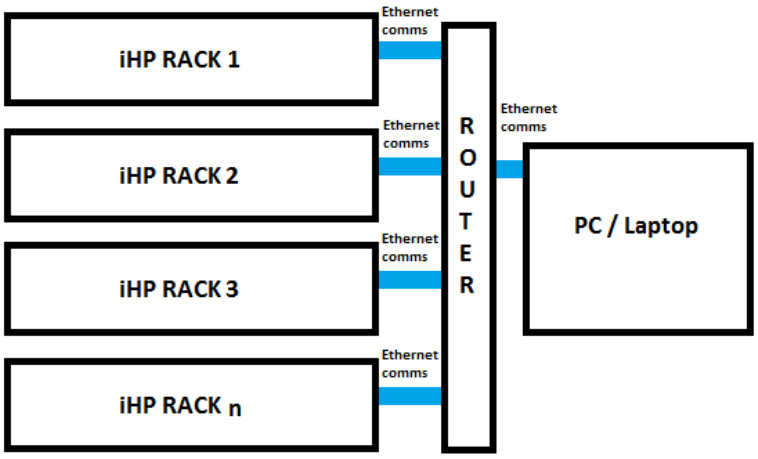
During multi-rack operation, Rack Synchronization Off should be enabled. This function can be configured in the ISOCOMM WebTool Rack section. The number of racks included in the multi-rack operation should be selected. Rack Synchronization OFF is REQUIRED when modules in parallel or series are connected to different iHP racks.

The main purpose of Rack Synchronization Off is to ensure that all modules in the multi-rack operation:

- Turn-on simultaneously
- Turn-off when there is at least one module at fault.
- Turn-off when there is at least one module commanded to turn-off via hardware or software.

When Rack Synchronization Off Operation is enabled, Module Synchronization Off will be automatically enabled, but requires each rack be connected via Ethernet communication as it uses Ethernet communication to perform this function. All IP addresses of the iHP rack, router and PC should be the same except for the last octet. For example, each IP address will start at 192.168.2.xxx and each iHP rack, router and PC will have a unique value for xxx (except for 0 and 255)

The following diagram shows the system configuration for Rack Synchronization OFF Ethernet communication.



Maximum number of iHP RACK for RACK Synchronization is 6.

Each rack will send status via the communication lines. Rack status during multi-rack operation can be either:

- GOOD
- FAULT/STANDBY

To have an iHP rack status “GOOD”, all of these conditions are met:

- All modules included in the rack do not have any Latching Fault or Auto-recoverable Fault
- iHP rack does not have any Latching Fault or Auto-recoverable Fault
- All modules included in the rack are NOT in standby mode via
    - Using software Operational command.
    - Using module hardware signal (Module Enable or Module Inhibit signal).
    - Using iHP rack hardware signal (Global Enable/Inhibit signal).

If any below scenario occurred, the status “FAULT/STANDBY” will be reported by the iHP rack.

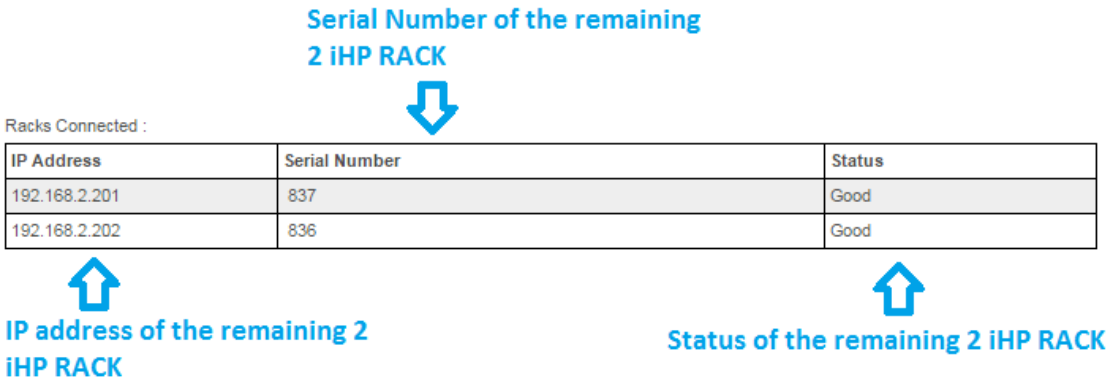
- At least one module included in the rack has a Latching Fault or Auto-recoverable Fault
- iHP rack has any Latching Fault or Auto-recoverable Fault
- At least one module included in the rack is in standby mode via
    - Using software Operational command.
    - Using module hardware signal (Module Enable or Module Inhibit signal).
    - Using iHP rack hardware signal (Global Enable/Inhibit signal).
    - Using Power SW button located in the front panel.

7.1 During Turn-On

iHP rack with Rack Synchronization OFF enabled will communicate to each other via Ethernet. Each iHP rack will get all the IP addresses (for Ethernet) of all rack with enabled Rack Synchronization OFF. This will be recorded in the ISOCOMM WebTool. Aside from the communication address, the rack serial number will also be recorded and shown in the ISOCOMM WebTool.

Ex. iHP rack with IP address: 192.168.2.100

- Rack Synchronization OFF is ENABLED
- Number of racks connected is three.
- 192.168.2.100 is included in the three iHP rack.
- The remaining two will be reflected on 192.168.2.100 WebTool Home page.



Each rack with enable Rack Synchronization Off will send its status via Ethernet communication. When the status of all racks are “GOOD”, all module outputs will turn-on.

7.2 During Turn-off

- iHP rack with fault or standby will send a “FAULT/STANDBY” status via Ethernet. Once the iHP rack receives the “FAULT/STANDBY” status, each iHP rack will shut down all modules. After this, the iHP rack with Fault or Standby status will continue to broadcast the “FAULT/STANDBY” from time to time until the fault is clear or standby mode is deactivated.

7.3 From Module Standby Activated to Module Standby De-activated.

When the module standby is de-activated, the iHP rack will send a status “GOOD” via Ethernet. When all iHP racks in the multi-rack system have a status “GOOD”, all modules will turn-on.

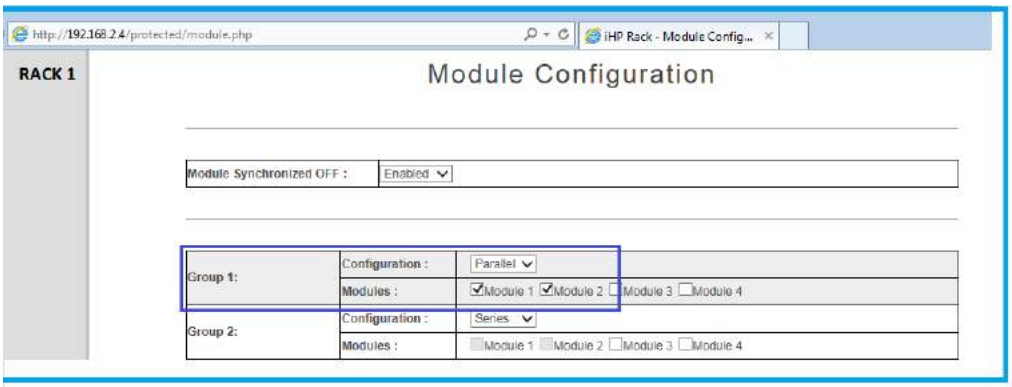
7.4 From Fault to Fault Clear.

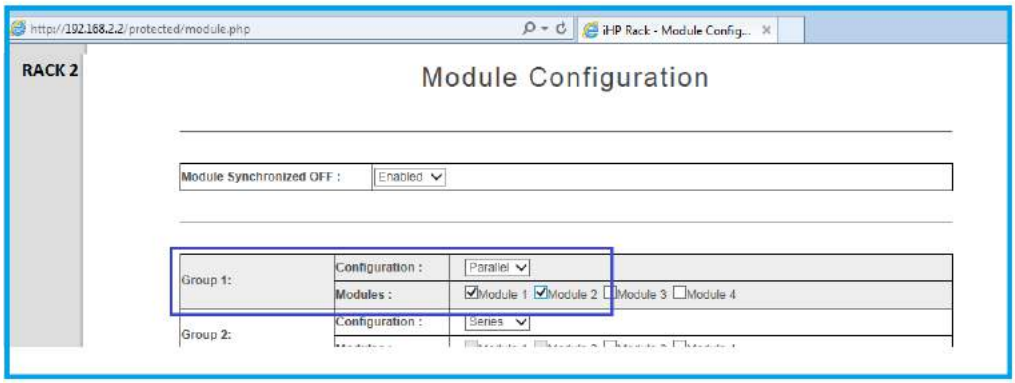
When the module recovers from fault condition latch condition, the iHP rack will send a status “GOOD” via Ethernet. When all iHP racks in the multi-rack system have a status “GOOD”, all modules will turn-on.

7.5 Broadcast Command on Multi Rack Operation

Broadcast command is recommended when modules in each iHP Rack in Multi Rack operation are grouped; see Section 6 on how to group modules.

Group address on each Rack should be the same in order to do broadcast command.





Above sample Multi Rack operation is using 2 units of iHP 12KW Rack with two modules each inserted per Rack.

The 2 modules, Module 1 & Module 2 are group in Group 1.

Broadcast address is set at 192.168.2.255.

Using Group 1 address, the modules included in the group will receive the write or read command simultaneously.

8 Faults and Output Recovery.

8.1 Module Fault

Fault	Description
Output Voltage Over Voltage Fault.	This fault will be trigger when module output increases beyond or equal to the set Over Voltage Fault level. Over Voltage Fault level will be based on Module Command 48h. Module will shut down. Please refer to Section 8.2 for Module Clear Fault and Output Recovery.
Output Voltage Over Voltage Warning.	This warning will be trigger when module output increases beyond or equal to the set Over Voltage Warning level. Over Voltage Warning level will be based on Module Command 49h. Module will NOT shutdown. Over Voltage Warning Status will be auto-clear when output voltage is below the Over Voltage Warning level.
Output Voltage Under Voltage Fault.	This fault will be trigger when module output decreases beyond or equal to the set Under Voltage Fault level. Under Voltage Fault level will be based on Module Command 4Bh. Module will shut down. Please refer to Section 8.2 for Module Clear Fault and Output Recovery.
Output Voltage Under Voltage Warning	This fault will be trigger when module output decreases beyond or equal to the set Under Voltage Warning level. Under Voltage Warning level will be based on Module Command 4Bh. Module will NOT shutdown. Under Voltage Warning Status will be auto-clear when output voltage is above the Under Voltage Warning level.
Iout Output Current Fault	Occurrence of module output short circuit, Latch type over current protection and Primary side over current. Module will shut down. Please refer to Section 8.2 for Module Clear Fault and Output Recovery.
Iout Output Current Warning	Asserted whenever the Iout Output Current Fault is triggered. Warning will be cleared when Iout Output Current Fault is cleared.
IIN Overcurrent Fault	Occurrence of IIN over current Fault in the module input side. Module will shut down. Please refer to Section 8.2 for Module Clear Fault and Output Recovery.
IIN Overcurrent Warning	Asserted when IIN Over Current fault is triggered. Warning will be cleared when IIN Output Current Fault is cleared.
Module Over Temperature Fault	Occurrence of high temperature in the module. Unit will shut down once the module internal device reaches the over temperature level. Over Temperature Fault will be auto-cleared and module output will recover once the temperature is below the temperature recovery level.

Fault	Description
	Please refer to Section 3.1.2 for iHP Module Configuration Default Settings for the over temperature level and recovery.
Module Over Temperature Warning	Occurrence of over temperature warning in the module. Unit will NOT shutdown once the module internal device reaches the over temperature warning level. Warning will be cleared once the temperature reaches below the warning level recovery. Please refer to Section 3.1.2 for iHP Module Configuration Default Settings for the over temperature warning level and recovery.
Invalid or Unsupported Command Received	Module receives invalid or unsupported Command. Module will NOT shutdown. User needs to send Clear Fault command to module in order to remove the fault.
Invalid or Unsupported Data Received	Module receives invalid or unsupported data. Module will NOT shutdown. User needs to send Clear Fault command to module in order to remove the fault.
Packet Error Check Failed	Module-ISOCOMM communication data error. Module will NOT shutdown. User needs to send Clear Fault command to module in order to remove the fault.
Memory Error occur	Invalid module configuration setting. Module will not power-up. Contact Customer Service.
DSP supply goes below regulation	Module DSP supply is below the regulation level. Module will shut down. Please refer to Section 8.2 for Module Clear Fault and Output Recovery.
Internal COMMs Fault	Module Communication failure to ISOCOMMM. Module will shut down. Fault will be auto-clear and module output will recover once communication between module and ISOCOMMM is established again.
Rail Imbalance Fault	Fault occurrence in the module primary side.

Protections are dependent on the module mode. Please refer to section 3.

8.2 Module Clear Fault and output Recovery

Methods of Module Clear Fault and Output Recovery are as follows:

1. Command 03h “CLEAR_FAULT”

When this command is received by the module, the module clear all Faults in the Status Register. Take note that this will just clear the fault in the status register. But, module will not power up when the module shuts down due to fault.

2. Module HW signal “SYS_M_INHIBIT” and “SYS_M_ENABLE#”

   Module Faults will be clear and module will re-start to power up again once user

   - Turn-off then turn-on the Module via Module “SYS_M_INHIBIT”
   - Turn-off then turn-on the Module via Module “SYS_M_ENABLE”

3. Module Operational Command

   Module Faults will be clear and module will re-start to power up again once user send a Module Command 01h to turn-off module then Module Command 01h to turn-on.

4. iHP Rack Inhibit or Enable

   Module Faults will be clear and module will re-start to power up again once user

   - Turn-off then turn-on the module via iHP rack “Global Inhibit/Enable Logic 1” signal
   - Turn-off then turn-on the module via iHP rack “Global Inhibit/Enable Logic 0” signal

5. ISOCOMM Operational Command

   Module Faults will be clear and module will re-start to power up again once user send an ISOCOMM Command 01h to turn-off module then ISOCOMM Command 01h to turn-on command.

8.3 PFC Fault

Fault	Description
AC UV Fault	AC is below the operating range of the unit. Unit will not turn-on. Fault will be auto clear and unit will start up properly when the input AC is within the operating range of the unit.
AC OV Fault	AC is above the operating range of the unit. Unit will not turn-on. Fault will be auto clear and unit will start up properly when the input AC is within the operating range of the unit.
PFC Over Temperature Fault	Occurrence of high temperature in the PFC. Unit will shut down once the PFC internal device reaches the over temperature level (110°C). Over Temperature Fault will be auto-cleared and module output will recover once the temperature is below the temperature recovery level (80°C).
PFC Over Temperature Warning	Asserted whenever the PFC Over Temperature Fault is triggered. Warning will be cleared when PFC Over Temperature Fault is cleared.
Invalid or Unsupported Command Received	PFC receives invalid or unsupported Command. PFC will NOT shutdown. User needs to send Clear Fault command to PFC in order to remove the fault.

Fault	Description
Invalid or Unsupported Data Received	PFC receives invalid or unsupported Data. PFC will NOT shutdown. User needs to send Clear Fault command to PFC in order to remove the fault.
Packet Error Check Failed	PFC-ISOCOMM communication data error. PFC will NOT shutdown. User needs to send Clear Fault command to PFC in order to remove the fault.
PFC Section 3 Fault	Occurrence of either AC OV, AC UV, Vbus OV, or Vbus UV Fault on PFC Section 3. PFC Section 3 fault will be cleared when AC OV, AC UV, Vbus OV, or Vbus UV Fault on PFC Section 3 are cleared.
PFC Section 2Fault	Occurrence of either AC OV, AC UV, Vbus OV, or Vbus UV Fault on PFC Section 2. PFC Section 2 fault will be cleared when AC OV, AC UV, Vbus OV, or Vbus UV Fault on PFC RAIL2 are cleared.
PFC Section 1Fault	Occurrence of either AC OV, AC UV, Vbus OV, or Vbus UV Fault on PFC Section 1. PFC Section 1 fault will be cleared when AC OV, AC UV, Vbus OV, or Vbus UV Fault on PFC Section 1 are cleared.
Differential Voltage Protection	Occurrence of Voltage Differential between PFC Vbus. Once trigger, the PFC will shut down after 3 seconds the PFC will restart again. When the PFC re-starts and the voltage differential is gone, the Differential Voltage Protection fault flag will be auto clear.
Vbus OVP	PFC has two levels of VBus OVP, 1st level and 2nd level OVP. 1st level OVP is latch mode if Vbus voltage hits the first level OVP for five consecutive times. If the 1st level OVP is hit for not more than four consecutive times, OVP counter will reset and OVP fault will auto-clear. 2ndlevel OVP is a latch-type fault which means PFC will shut down upon hitting the 2nd OVP level. Please refer to Section 8.4 for the clear fault and output recovery.
Vbus UVP	This fault will be trigger when PFC Output Vbus level hits the Vbus UV level. Unit will shut down. Please refer to Section 8.4 for the clear fault and output recovery.

8.4 PFC Clear Fault and Output Recovery

Methods of PFC Clear Fault and Output Recovery are as follows

1. PFC Command 03h “CLEAR_FAULT”

   When this command is received by the PFC, the PFC will clear all faults in the PFC Command Status. Take note that this will just clear the fault in the PFC status register. PFC will not power unless the cause of fault/s were removed and input AC recycling is done.

2. Recycling of Input AC. Turning off input AC for 10 seconds then turn-on.

   PFC Fault can be cleared and output will recover after recycling of input AC.

8.5 ISOCOMM Fault

Fault	Description
Ambient Over Temperature Fault	Occurrence of high ambient temperature in the iHP rack. All modules in the iHP rack will shut down once the ambient temperature reaches the over temperature level. Over Temperature Fault will be auto-cleared and module output will recover once the temperature is below the set ambient over temperature less 5°C. Please refer to Section 5.1.4.1 for the ambient over temperature level setting and configuration.
Ambient Over Temperature Warning	Occurrence of ambient over temperature warning in the iHP rack. Unit will Not shutdown once the ambient over temperature warning level reach. Ambient Over Temperature Warning level is 5°C below Ambient Over Temperature Fault level and it is auto-recoverable fault.
Invalid or Unsupported Command Received	ISOCOMM receives invalid or unsupported Command for the ISOCOMM and Modules. Module/s will NOT shutdown. User needs to send Clear Fault command in order to remove the fault.
Invalid or Unsupported Data Received	Module receives invalid or unsupported Data for the ISOCOMM. Module/s will NOT shutdown. User needs to send Clear Fault command in order to remove the fault.
GROUP mismatched	One or more modules in a group do not have the same configuration. Please refer to Section 6 for the list of module critical configurations that are being checked by ISOCOMMM.
Module Communication Error	ISOCOMM to Module Communication failure. Module/s will NOT shutdown. Please refer to Section 8.6 for the clear fault and output recovery.
PFC Communication Error	ISOCOMM to PFC Communication failure. Module will shut down. Fault is auto-recoverable. Please refer to Section 8.6 for the clear fault and output recovery.

Fault	Description
Module Synchronize Off	Occurrence of any fault in a module when user configurable parameter "Module Synchronize OFF" is enabled. Module/s will shut down. Please refer to Section 8.6 for the clear fault and output recovery.
5V Standby Error	Occurrence of undervoltage & overvoltage on 5V Standby. Module/s will shut down if user configurable parameter "Disable on 5v_STBY Fault" is enabled else modules will continue to power up. Please refer to Section 8.6 for the clear fault and output recovery.
Fan 1 Fault	Occurrence of Fan1 Failure. Module/s will shutdown Please refer to Section 8.6 for the clear fault and output recovery.
Fan 2 Fault	Occurrence of Fan2 Failure. Module/s will shutdown Please refer to Section 8.6 for the clear fault and output recovery.
Fan 3 Fault	Occurrence of Fan3 Failure. Module/s will shutdown Please refer to Section 8.6 for the clear fault and output recovery.
Fan 4 Fault	Occurrence of Fan4 Failure. Module/s will shutdown Please refer to Section 8.6 for the clear fault and output recovery.

8.6 ISOCOMM Clear Fault and Output Recovery

Methods of Module Clear Fault and Output Recovery are as follows:

1. ISOCOMM Command 03h "CLEAR_FAULT"

   When this command received by the ISOCOMM, the ISOCOMM clears all faults in the ISOCOMM Command Status. The ISOCOMM will re-start to power-up after the fault is clear.

2. ISOCOMM Fault can be cleared and output will recover after initiating System Reset using the ISOCOMM WebTool. (Please refer to Section 5.1.6)

3. ISOCOMM Fault can be cleared and output will recover after turn-off, then turn-on the iHP unit using Front Panel STBY Switch.

9 Accepted iHP Configuration

iHP power system is a configurable power supply. Modules can be configured in series or in parallel operation. There are safety considerations to observe when modules are configured. Modules can be categorized into Safety Extra Low Voltage (SELV) or Non–Safety Extra Low Voltage (non-SELV).

Module categories based on maximum voltage being offered:

- Safety Extra Low Voltage (SELV)
  - 73-936-0012
  - 73-936-0024
  - 73-936-0048
- Non –Safety Extra Low Voltage (Non-SELV)
  - 73-936-0080
  - 73-936-0125
  - 73-936-0200
  - 73-936-0250

9.1 Module Stand-Alone Configuration

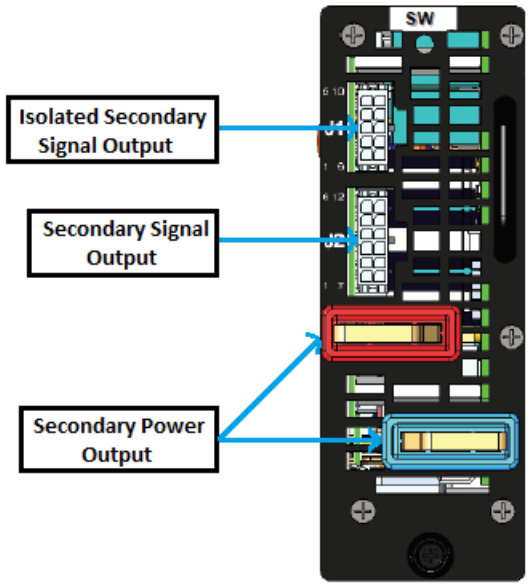
Modules can be used independently in the iHP rack. SELV and Non-SELV modules can be co-located in a single iHP rack to meet Means of Operator Protection (MOOP) medical safety spacing provided that co-located module series connected should have a total output voltage of equal or less than 800V.

Module	Module Maximum Vo	Meets Safety Spacing
73-936-0012	14.4V	Medical MOOP
73-936-0024	28.8V	Medical MOOP
73-936-0048	57.6V	Medical MOOP
73-936-0080	96V	Medical MOOP
73-936-0125	150V	Medical MOOP
73-936-0200	240V	Medical MOOP
73-936-0250	300V	Medical MOOP

SELV modules cannot be co-located with above 800V output (series connected module).

Stand-alone Operation Safety Accessibility Restrictions

Section	SELV Modules		Non-SELV Modules
	All Modules in a Single is non-SELV	**With Series Modules that as a Total Output Voltage of 60V**	
Isolated Secondary Signal Output	Safe to Access	Safe to Access	Safe to Access
Secondary Signal Output	Safe to Access	Not Safe to Access	Not Safe to Access
		Requires Enclosure for safety protections	Requires Enclosure for safety protections
Secondary Power Output	Safe to Access	Not Safe to Access	Not Safe to Access
		Requires Enclosure for safety protections	Requires Enclosure for safety protections



9.2 Parallel Configuration

Inter Rack Module parallel operation is acceptable (up to 6 iHP racks) and only same type of modules can be connected in parallel. SELV and Non-SELV modules can be co-located in a single iHP rack to meet Medical MOOP safety spacing provided that co-located module series connected should have a total output voltage of equal or less than 800V.

Module	Module Maximum Vo	Meets Safety Spacing
73-936-0012	14.4V	Medical MOOP
73-936-0024	28.8V	Medical MOOP

73-936-0048	57.6V	Medical MOOP
73-936-0080	96V	Medical MOOP
73-936-0125	150V	Medical MOOP
73-936-0200	240V	Medical MOOP
73-936-0250	300V	Medical MOOP

SELV Module cannot be co-located with above 800V output (series connected module).

iHP rack setting during Inter Rack Parallel Operation.

- MODULE SYNCRONIZED Off should be enable
- Module Grouping should be the same in each rack
- RACK SYNCRONIZED OFF should be enable

Parallel Operation Safety Accessibility Restrictions

Section	SELV Modules		Non-SELV Modules
	All Modules in a Single is non-SELV	**With Series Modules that as a Total Output Voltage of 60V**	
Isolated Secondary Signal Output	Safe to Access	Safe to Access	Safe to Access
Secondary Signal Output	Safe to Access	Not Safe to Access	Not Safe to Access
		Requires Enclosure for safety protections	Requires Enclosure for safety protections
Secondary Power Output	Safe to Access	Not Safe to Access	Not Safe to Access
		Requires Enclosure for safety protections	Requires Enclosure for safety protections

9.3 Series Configuration

Inter Rack Module series operation is acceptable. SELV modules cannot be co-located from series connected module with greater than 800V output. Same type of modules can be series connected with below restriction.

Module	Module can be Series up to	Meets Safety Spacing
SELV Modules	300Vdc (max)	Medical MOPP
SELV Modules	400Vdc (max)	Medical MOOP and ITE
Non-SELV Modules	600Vdc (max)	Medical MOPP
Non-SELV Modules	800Vdc (max)	Medical MOOP
Non-SELV Modules	1000Vdc (max)	ITE

iHP rack setting during Inter Rack Series Operation.

- MODULE SYNCRONIZED Off should be enable

- Module Grouping should be the same in each rack
- RACK SYNCRONIZED OFF should be enable

Series Operation Safety Accessibility Restrictions

Secondary Signal and Power Output

Section	Series up to 300Vdc (MOPP)	Series up to 400Vdc (MOOP & ITE)	Series up to 600Vdc (MOPP)	Series up to 800Vdc (MOOP)	Series up to 1000Vdc (ITE)
Secondary Signal Output	Safe to access if the total output voltage is equal or less than 60V Not safe to access if the total output voltage is more than 60V. • Requires Enclosure for safety protections				
Secondary Power Output	Safe to access if the total output voltage is equal or less than 60V Not safe to access if the total output voltage is more than 60V. • Requires Enclosure for safety protections				

Isolated Secondary Signal Output

Series Configuration	ISOLATED SECONDARY Signal Output			
	Safe to Access		Not Safe to Access Requires Enclosure	
	Maximum Vo of Series Connected Module	Co-located Module Maximum Vo of Series Connected Module	Maximum Vo of Series Connected Module	Co-located Module Maximum Vo of Series Connected Module
SELV Module 300V Medical MOPP	<= 300V	<= 300V	> 300V	> 300V
SELV Module 400V Medical MOOP & ITE	<= 400V	<= 400V	> 400V	> 400V
Non-SELV Module 600V Medical MOPP	<= 600V	<= 600V	> 600V	> 600V
Non-SELV Module 800V Medical MOOP	<= 800V	<= 800V	> 800V	> 800V
Non-SELV Module 1000V ITE	N/A	N/A	Not Safe to Access	

10 Troubleshooting

Use below table as an aid in troubleshooting iHP system.

Symptom	Check	Action
No Output. **All front panel LEDs are OFF.**	Is the input wire defective?	Check continuity or measure input voltage on the iHP input terminal block. Replace if necessary.
No Output. **Front panel POWER LED is Solid Red; two other LEDs are OFF.**	Is the AC input voltage within range?	Refer to iHP datasheet for correct input voltage. Connect to appropriate input voltage.
No Output. **Front panel POWER LED is Amber; two other LEDs are OFF.**	Have you press the front panel STBY switch?	Press front panel STBY switch.
No Output. **Modules are grouped.**	Do all modules have the same configurations (discussed on Section 6)?	Adjust the configurations so as all modules in each group have the same settings.
No Output. **All front panel LEDs are GREEN.**	What is the module operating mode?	Read the Module operating mode by issuing command D3h on modules. Digital current source (08h) operating mode by default has a 0A output.
No Output. **Front panel POWER LED is Solid Green; OUTPUT LED is Blinking Green & SYSTEM STATUS LED is OFF.**	Is INH0 pulled to ground or INH1 is pulled to 5V?	Toggle the INH switch.
Fail to communicate with the Unit via Ethernet.	Is the unit set in Static IP Mode?	Correct default static address of iHP system is 192.168.2.100.
	Is your PC used for communicating with iHP system is set to Static?	Set your PC to static IP.
	Is the unit set in DHCP IP Mode?	Find the correct IP address of your unit by accessing the Router settings. If you fail to find the DHCP IP address of the unit, you have an option to go back to Static IP default address by pressing the LAN reset.
Fail to change the Module Operating Mode of Module from one mode to another.	Have you send the correct commands to change the Mode of Operation?	Refer to Section 4.4 and Appendix B.3. ISOCOMM command D3h.
	Have you send command to disable the "Write_Protect" 10h of ISOCOMM?	Refer to Section 4.4 and Appendix B.3. ISOCOMM command D3h.

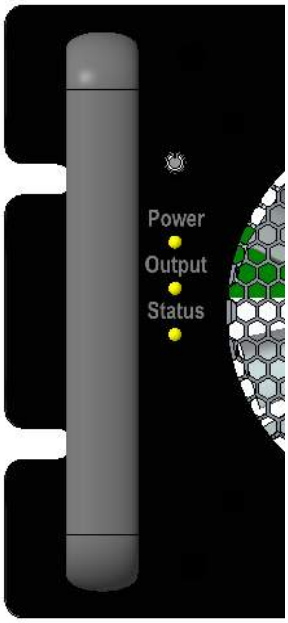
Symptom	Check	Action
Module output out of regulation during DVS mode, no faults reported except Module Power_Good# (79h 0008h reading)	Have you check reported current or output loading?	Adjust output loading as module may have entered current limit.
Module output voltage stuck at around 5% level during AVS mode, no faults reported	Have you check if connector on location J1 is properly connected?	Measure voltage right at the pin of J1 connector and address connection issue if necessary.
	Have you check 0-10VEXT_VPROG or 0-5VEXT_VPROG input voltage	
Module output current stuck at low level (near 0) during ACS mode, no faults reported	Have you check if connector on location J1 is properly connected?	Measure voltage right at the pin of J1 connector and address connection issue if necessary.
	Have you check 0-10VEXT_IPROG or 0-5VEXT_IPROG input voltage?	

Appendix A – LED

iHP Front Panel LED

iHP front panel LEDs are composed of

- Power LED
- Output LED
- Status LED



Please see below front panel LED response

Condition	POWER LED	OUTPUT LED	SYSTEM STATUS LED
No AC	OFF	OFF	OFF
ISOCOMM Start-Up Boot Load	BLINKING GREEN	OFF	OFF
SLEEP Mode (ON/OFF switch)	AMBER	OFF	OFF
Global Inhibit	SOLID GREEN	BLINKING GREEN	OFF
AC GOOD	SOLID GREEN	X	X
AC FAULT (OV, UV)	SOLID RED	OFF	SOLID RED
Output GOOD	SOLID GREEN	SOLID GREEN	SOLID GREEN
Auto-recoverable Fault (OTP)	SOLID GREEN	OFF	SOLID AMBER
Latching Fault (OVP, UVP) or Internal Fault	SOLID GREEN	OFF	SOLID RED
FAN FAIL	SOLID GREEN	OFF	BLINKING RED
BOOTLOADING	X	OFF	BLINKING AMBER

Appendix B –COMMAND

B.1 PFC Command

To convert Linear Data Format to “real world value”, please refer to Appendix B.4

To convert Direct Data Format to “real world value”, please refer to Appendix B.5

PFC Command Definition

Command Code	Command Name	Definition
03h	CLEAR_FAULTS	Same as standard PMBUS CLEAR_FAULT Register. To remove the warning or fault bits set in the status register, User need to send CLEAR_FAULT command.
10h	WRITE_PROTECT	Same as standard PMBUS_WRITE_PROTECT Register. Command used to Enable or Disable writing to the module registers. This will prevent accidental writing to the module. Data: 80h – Disable all write except to the WRITE_PROTECT command. Data: 00h – Enable writes to all commands.
78h	STATUS_BYTE	Same as standard PMBUS_STATUS_BYTE Register. Returns one byte of information with the summary of the most critical faults. Please see below Listing of STATUS_BYTE supported bits: Bit # – Status Bit Name – Supported 7 – BUSY – No 6 – OFF – Yes 5 – VOUT_OV_FAULT – Yes 4 – IOUT_OC_FAULT – No 3 – VIN_UV_FAULT – Yes 2 – TEMPERATURE – Yes 1 – CML – Yes 0 – NONE OF THE ABOVE – No
79h	STATUS_WORD	Same as standard PMBUS_STATUS_WORD Register. Returns two bytes of information with the summary of the unit’s faults condition. Based on the information, user can get more information by reading the appropriate status registers. The low byte of the STATUS_WORD is the same register as the STATUS_BYTE command. Please see below Listing of STATUS_WORD supported bits: LOW BYTE Please refer to Command Code 0x78h STATUS_BYTE HIGH BYTE

Command Code	Command Name	Definition
		Bit # / Status Bit Name / Supported 7 VOUT Yes 6 IOUT/POUT Yes 5 INPUT Yes 4 MFR_SPECIFIC Yes 3 POWER_GOOD# Yes 2 FANS No 1 OTHER No 0 UNKNOWN No
7Ah	STATUS_VOUT	Same as standard PMBUS_STATUS_VOUT Register. Command returns one data byte with contents as follows: Bit # / Status Bit Name / Supported 7 VOUT Overvoltage Fault Yes 6 VOUT Overvoltage Warning Yes 5 VOUT Undervoltage Warning Yes 4 VOUT Undervoltage Fault Yes 3 VOUT Max Warning No 2 TON Max Fault No 1 TON Max Warning No 0 VOUT Tracking Error No
7Ch	STATUS_INPUT	Same as standard PMBUS_STATUS_INPUT Register. Command returns one data byte with contents as follows: Bit # / Status Bit Name / Supported 7 VIN Overvoltage Fault Yes 6 VIN Overvoltage Warning Yes 5 VIN Undervoltage Warning Yes 4 VIN Undervoltage Fault Yes 3 Unit is Off for Insufficient Input Voltage No 2 IIN Overcurrent Fault No 1 IIN Overcurrent Warning No 0 PIN Overpower Warning No
7Dh	STATUS_TEMPERATURE	Same as standard PMBUS_STATUS_TEMPERATURE Register. Command returns one data byte with contents as follows: Bit # / Status Bit Name / Supported 7 OT_FAULT Yes 6 OT_WARNING Yes 5 UT_WARNING No 4 UT_FAULT No

Command Code	Command Name	Definition
		3 Reserved No 2 Reserved No 1 Reserved No 0 Reserved No
7Eh	STATUS_CML	Same as standard PMBUS_STATUS_CML Register. Command returns one data byte with contents as follows: Bit # Status Bit Name Supported 7 Invalid or Unsupported Command Received Yes 6 Invalid or Unsupported Data Received Yes 5 Packet Error Check Failed Yes 4 Memory Fault Detected Yes 3 Processor Fault Detected No 2 Reserved No 1 A communication fault other than the ones listed in this table has occurred No 0 Other Memory or Logic Fault has occurred. No
80h	STATUS_MFR_SPECIFIC	Same as standard PMBUS_STATUS_MFR_SPECIFIC Register. Command returns one data byte with contents as follows: Bit # Status Bit Name Supported 7 RAIL3 Fault Yes 6 RAIL2 Fault Yes 5 RAIL1 Fault Yes 4 Reserved No 3 Reserved No 2 Reserved No 1 Reserved No 0 BULK OVP/DVP Yes
99h	MFR_ID	Same as standard PMBUS_MFR_ID Register. Command to return back the manufacturer's name.
9Ah	MFR_MODEL	Same as standard PMBUS_MFR_MODEL Register. Command to return back the manufacturer's model number
E0h	FW_PRI_VERSION	Manufacture specific command. Command to return back the SW version of the device.
E9h	MFR_STATUS_01	PFC Command for Summary of PFC present status. This PMBUS command has 3 indexes. Each index contains 2 bytes of data. Index 00 "Input Status" Bit Bit Name Bit15 Reserved Bit14 Reserved

Command Code	Command Name	Definition	
		Bit13	Reserved
		Bit12	Reserved
		Bit11	Vin3OVP
		Bit10	Vin2OVP
		Bit9	Vin1OVP
		Bit8	Vin3UVP
		Bit7	Vin2UVP
		Bit6	Vin1UVP
		Bit5	AUX
		Bit4	Relay
		Bit3	Supply
		Bit2	PSON
		Bit1	Address
		Bit0	BulkOK
		Index 01 “PFC Status”	
		Bit	Bit Name
		Bit15	Reserved
		Bit14	Reserved
		Bit13	Reserved
		Bit12	Reserved
		Bit11	Reserved
		Bit10	Reserved
		Bit9	Reserved
		Bit8	OPW
		Bit7	OCW
		Bit6	OVW
		Bit5	Other
		Bit4	SCKT
		Bit3	OCP
		Bit2	UVP
		Bit1	OVP
		Bit0	OutOK
		Index 02 “VBUS Status”	
		Bit	Bit Name
		Bit15	Reserved
		Bit14	Reserved
		Bit13	Reserved
		Bit12	Reserved
		Bit11	Differential Voltage Protection Rail3
		Bit10	Differential Voltage Protection Rail2
		Bit9	Differential Voltage Protection Rail1

Command Code	Command Name	Definition	
		Bit8	Bulk Short Circuit3
		Bit7	Bulk Short Circuit2
		Bit6	Bulk Short Circuit1
		Bit5	Bulk Under Voltage Protection Rail3
		Bit4	Bulk Under Voltage Protection Rail2
		Bit3	Bulk Under Voltage Protection Rail1
		Bit2	Bulk Over Voltage Protection Rail3
		Bit1	Bulk Over Voltage Protection Rail2
		Bit0	Bulk Over Voltage Protection Rail1

PFC Command Data Classifications

Command Code	Command Name	Transaction Type	# of Bytes	Data Format	Write Protection
03h	CLEAR_FAULTS	Send Byte	0	N/A	Basic
10h	WRITE_PROTECT	Read/Write Byte	1	Bitmapped	N/A
78h	STATUS_BYTE	Read Byte	1	Bitmapped	N/A
79h	STATUS_WORD	Read Word	2	Bitmapped	N/A
7Ah	STATUS_VOUT	Read Byte	1	Bitmapped	Basic
7Ch	STATUS_INPUT	Read Byte	1	Bitmapped	Basic
7Dh	STATUS_TEMPERATURE	Read Byte	1	Bitmapped	Basic
7Eh	STATUS_CML	Read Byte	1	Bitmapped	Basic
80h	STATUS_MFR_SPECIFIC	Read Byte	1	Bitmapped	Basic
99h	MFR_ID	Block Read	7	ASCII	N/A
9Ah	MFR_MODEL	Block Read	15	ASCII	N/A
E0h	FW_PRI_VERSION	Block Read	8	ASCII	N/A
E9h	MFR_STATUS_01	Block Read	2 bytes per index	Bitmapped	N/A

Note: 24kW iHP rack is composed of two boards of 12kW PFC.

In PFC PMBUS Commands,

- IOUT refers to the Output current of the PFC in which the command is addressed.
- VOUT refers to the Output voltage of the PFC in which the command is addressed.
- VIN refers to the Input Voltage of the PFC in which the command is addressed.
- IIN refers to the Input Current of the PFC in which the command is addressed.

B.2 MODULE Command

To convert Linear Data Format to “real world value”, please refer to appendix B.4

To convert Direct Data Format to “real world value”, please refer to appendix B.5

MODULE Command Definition

Command Code	Command Name	Definition
01h	OPERATION	Same as standard PMBUS_OPERATION Register. Command used to Turn-off or Turn-on the module. Bit6 = 0 and Bit 7 = 1: Module is ON Bit6 = 0 and Bit 7 = 0: Module is OFF Bit 0 to Bit 5: Don’t Care User Configurable.
03h	CLEAR_FAULTS	Same as standard PMBUS_CLEAR_FAULT Register. To remove the warning or fault bits set in the status register, User need to send CLEAR_FAULT command. This command will only clear the status registers fault.
10h	WRITE_PROTECT	Same as standard PMBUS_WRITE_PROTECT Register. Command used to Enable or Disable writing to the Module Registers. This will prevent accidental writing to the Module. Data: 80h – Disable all write except to the WRITE_PROTECT command. Data: 40h – Disable all write except to the WRITE_PROTECT and OPERATION command. Data: 00h – Enable writes to all commands.
24h	VOUT_MAX	Read maximum output voltage of the Module. Automatically Set to 120% of Nominal Rating. Refer to Module Command data classification for Data Format

Command Code	Command Name	Definition
31h	POUT_MAX	Read Module's rated power Refer to Module Command data classification for Data Format
40h	MFR_REG	Manufacturer register. Do not access.
41h	VOUT_OV_FAULT_RESPONSE	Same as standard PMBUS_VOUT_OV_FAULT_RESPONSE Register. Read Module Response during over-voltage fault condition Fix Data: 80h – Device Latch.
42h	MFR_REG	Manufacturer register. Do not access.
43h	MFR_REG	Manufacturer register. Do not access.
44h	MFR_REG	Manufacturer register. Do not access.
45h	VOUT_UV_FAULT_RESPONSE	Same as standard PMBUS_VOUT_UV_FAULT_RESPONSE Register. Read Module Response during under-voltage fault condition Fix Data: 80h – Device Latch
46h	MFR_REG	Manufacturer register. Do not access.
47h	MFR_REG	Manufacturer register. Do not access.

Command Code	Command Name	Definition
48h	OV_FAULT_LIMIT_MULTIPLIER	Data is used to compute for the tracking over voltage protection (OVP) of the module Refer to Module Command data classification for Data Format. During Digital Voltage Source (DVS), Analog Current Source (ACS), and Digital Current Source (DCS). OVP Level = VREF + (Nominal Voltage * (OVP Multiplier-1)) During AVS, this PMBUS Register is not functional. Data Range: 120% to 130% If user commands outside the set range, 0x7Eh STATUS_CML will be asserted with invalid data fault. User Configurable. This parameter will be override by BRICK OVP Level if target TRACKING OVP Level is higher than BRICK OVP Level
49h	OV_WARN_LIMIT_MULTIPLIER	Data is used to compute for the over voltage warning (OVW) level of the module Refer to Module Command data classification for Data Format. During Digital Voltage Source (DVS), Analog Current Source (ACS), and Digital Current Source (DCS). OVW Level = VREF + (Nominal Voltage * (OVP Multiplier-1)) During Analog Voltage Source (AVS), Analog Current Source (ACS), and Digital Current Source (DCS), this Register is not functional. Data Range: 105% to 125% If user command outside the set range, 0x7Eh STATUS_CML will be asserted with invalid data fault User Configurable.
4Ah	MFR_REG	Manufacturer register. Do not access.

Command Code	Command Name	Definition
4Bh	UV_FAULT_LIMIT_MULTIPLIER	Data is used to compute for the under voltage protection (UVP) level of the module Refer to Module Command data classification for Data Format. Under Voltage Protection is functional during Digital Programming Voltage Source (DVS) UVP Level = VREF – (Nominal Voltage * (1-UVP Multiplier)) Data Range: 80% to 90% This function will be disabled when the VREF is set to less than or equal to 10% of the nominal. If user command outside the set range, 0x7Eh STATUS_CML will be asserted with invalid data fault User Configurable.
4Ch	UV_WARN_LIMIT_MULTIPLIER	Data is used to compute for the under voltage warning (UVW) level of the module Refer to Module Command data classification for Data Format. Under Voltage Warning is functional during Digital Voltage Source (DVS) UVW Level = VREF – (Nominal Voltage *(1- UVP Multiplier)) Data Range: 85% to 95% This function will be disabled when the VREF is set to less than or equal to 10% of the nominal. If user command outside the set range, 0x7Eh STATUS_CML will be asserted with invalid data fault User Configurable.

Command Code	Command Name	Definition
4Dh	OC_FAULT_LIMIT_MULTIPLIER	Data is used to compute for the Over Current Protection (OCP) level of the module Refer to Module Command data classification for Data Format. Digital Voltage Source and Analog Voltage Source Latch type OC level = (Io nominal)*(OC_FAULT_LIMIT_MULTIPLIER) CC type OC level = (Io nominal)*(OC_FAULT_LIMIT_MULTIPLIER) Data Range: 50% to 105% Digital Current Source and Analog Current Source OC_FAULT_LIMIT_MULTIPLIER is not functional during this operation.
4Eh	MFR_REG	Manufacturer register. Do not access.
4Fh	OT_FAULT_LIMIT	Over Temperature Protection level of the Module for TEMP1. Refer to Module Command data classification for Data Format. Fix data varies per module series.
50h	OT_FAULT_RESPONSE	Same as standard PMBUS_OT_FAULT_RESPONSE Register. Read Module Response during over temperature fault condition Fix Data: B8h – Device Shuts down Unit attempt to restart continuously, when required condition is met, until commanded OFF, bias power is removed, or another fault condition shuts the module down.

Command Code	Command Name	Definition
51h	OT_WARN_LIMIT	Over Temperature Warning level of the Module for TEMP1. Refer to Module Command data classification for Data Format. Fix data varies per module series.
52h	OC_RESPONSE_TYPE	Command to read/write Over-current Protection Type Applicable only during Voltage Source configuration. Data 00h - CC Type Protection Data 01h - Latch Type Protection User Configurable.
53h	MFR_REG	Manufacturer register. Do not access.
54h	MFR_REG	Manufacturer register. Do not access.
5Eh	POWER_GOOD_ON	Command to read the output voltage level (DVS) where POWER_GOOD signal is asserted. Refer to Module Command data classification for Data Format. During Digital Programming Voltage Source, Vo @ Power Good ON = VREF * POWER_GOOD_ON This PMBUS command is not functional during DCS, AVS and ACS.
5Fh	POWER_GOOD_OFF	Command to read the output voltage level (DVS) where POWER_GOOD signal is de-asserted. Refer to Module Command data classification for Data Format. During Digital Voltage Source, Vo @ Power Good OFF = VREF * POWER_GOOD_OFF This PMBUS command is not functional during APVS and APCS.

Command Code	Command Name	Definition
61h	MFR_REG	Manufacturer register. Do not access.
62h	MFR_REG	Manufacturer register. Do not access.
63h	MFR_REG	Manufacturer register. Do not access.
6Ah	MFR_REG	Manufacturer register. Do not access.
78h	STATUS_BYTE	Standard PMBUS STATUS Register. Returns one byte of information with the summary of the most critical Module faults. Please see below Listing of STATUS_BYTE supported Bits: Bit # Status Bit Name Supported 7 BUSY No 6 OFF Yes 5 VOUT_OV_FAULT Yes 4 IOUT_OC_FAULT Yes 3 VIN_UV_FAULT No 2 TEMPERATURE Yes 1 CML Yes 0 NONE OF THE ABOVE Yes

<table>
<tr><th>Command Code</th><th>Command Name</th><th>Definition</th></tr>
<tr><td>79h</td><td>STATUS_WORD</td><td>
Same as standard PMBUS_STATUS_WORD Register.

Returns two byte of information with the summary of the Module’s faults condition. Based on the information, User can get more information by reading the appropriate status registers.

The low byte of the STATUS_WORD is the same register as the STATUS_BYTE command.

Please see below Listing of STATUS_WORD supported Bits:

LOW BYTE

Please refer to Module Command Code 0x78h STATUS_BYTE

HIGH BYTE
<table>
<tr><th>Bit #</th><th>Status Bit Name</th><th>Supported</th></tr>
<tr><td>7</td><td>VOUT</td><td>Yes</td></tr>
<tr><td>6</td><td>IOUT/POUT</td><td>Yes</td></tr>
<tr><td>5</td><td>INPUT</td><td>Yes</td></tr>
<tr><td>4</td><td>MFR_SPECIFIC</td><td>Yes</td></tr>
<tr><td>3</td><td>POWER_GOOD#</td><td>Yes</td></tr>
<tr><td>2</td><td>FANS</td><td>No</td></tr>
<tr><td>1</td><td>OTHER</td><td>No</td></tr>
<tr><td>0</td><td>UNKNOWN</td><td>No</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Command Code</th><th>Command Name</th><th>Definition</th></tr>
<tr><td>7Ah</td><td>STATUS_VOUT</td><td>Same as standard PMBUS_STATUS_CML Register.

Command returns one data byte with contents as follows:

<table>
<tr><th>Bit #</th><th>Status Bit Name</th><th>Supported</th></tr>
<tr><td>7</td><td>VOUT Overvoltage Fault</td><td>Yes</td></tr>
<tr><td>6</td><td>VOUT Overvoltage Warning</td><td>Yes</td></tr>
<tr><td>5</td><td>VOUT Undervoltage Warning</td><td>Yes</td></tr>
<tr><td>4</td><td>VOUT Undervoltage Fault</td><td>Yes</td></tr>
<tr><td>3</td><td>VOUT Max Warning</td><td>No</td></tr>
<tr><td>2</td><td>TON Max Fault</td><td>No</td></tr>
<tr><td>1</td><td>TON Max Warning</td><td>No</td></tr>
<tr><td>0</td><td>VOUT Tracking Error</td><td>No</td></tr>
</table>
</td></tr>
<tr><td>7Bh</td><td>STATUS_IOUT</td><td>Same as standard PMBUS_STATUS_IOUT Register.

Command returns one data byte with contents as follows:

<table>
<tr><th>Bit #</th><th>Status Bit Name</th><th>Supported</th></tr>
<tr><td>7</td><td>IOUT Overcurrent Fault</td><td>Yes</td></tr>
<tr><td>6</td><td>IOUT Overcurrent and Low Voltage Shutdown Fault</td><td>No</td></tr>
<tr><td>5</td><td>IOUT_OC_WARNING</td><td>Yes</td></tr>
<tr><td>4</td><td>IOUT_UC_FAULT</td><td>No</td></tr>
<tr><td>3</td><td>Current Share Fault</td><td>No</td></tr>
<tr><td>2</td><td>In Power Limiting Mode</td><td>No</td></tr>
<tr><td>1</td><td>POUT_OP_FAULT</td><td>No</td></tr>
<tr><td>0</td><td>POUT_OP_WARNING</td><td>No</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Command Code</th><th>Command Name</th><th>Definition</th></tr>
<tr><td>7Ch</td><td>STATUS_INPUT</td><td>Same as standard PMBUS_STATUS_INPUT Register.

Command returns one data byte with contents as follows:

<table>
<tr><th>Bit #</th><th>Status Bit Name</th><th>Supported</th></tr>
<tr><td>7</td><td>VIN Overvoltage Fault</td><td>No</td></tr>
<tr><td>6</td><td>VIN Overvoltage Warning</td><td>No</td></tr>
<tr><td>5</td><td>VIN Undervoltage Warning</td><td>No</td></tr>
<tr><td>4</td><td>VIN Undervoltage Fault</td><td>No</td></tr>
<tr><td>3</td><td>Unit is Off for Insufficient Input Voltage</td><td>No</td></tr>
<tr><td>2</td><td>IIN Overcurrent Fault</td><td>Yes</td></tr>
<tr><td>1</td><td>IIN Overcurrent Warning</td><td>Yes</td></tr>
<tr><td>0</td><td>PIN Overpower Warning</td><td>No</td></tr>
</table>

Bit 1 and 2 will be asserted when Module Primary Over Current fault is triggered.</td></tr>
<tr><td>7Dh</td><td>STATUS_TEMPERATURE</td><td>Same as standard PMBUS_STATUS_TEMPERATURE Register.

Command returns one data byte with contents as follows:

<table>
<tr><th>Bit #</th><th>Status Bit Name</th><th>Supported</th></tr>
<tr><td>7</td><td>OT_FAULT</td><td>Yes</td></tr>
<tr><td>6</td><td>OT_WARNING</td><td>Yes</td></tr>
<tr><td>5</td><td>UT_WARNING</td><td>No</td></tr>
<tr><td>4</td><td>UT_FAULT</td><td>No</td></tr>
<tr><td>3</td><td>Reserved</td><td>No</td></tr>
<tr><td>2</td><td>Reserved</td><td>No</td></tr>
<tr><td>1</td><td>Reserved</td><td>No</td></tr>
<tr><td>0</td><td>Reserved</td><td>No</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Command Code</th><th>Command Name</th><th>Definition</th></tr>
<tr><td>7Eh</td><td>STATUS_CML</td><td>Same as standard PMBUS_STATUS_CML Register.

Command returns one data byte with contents as follows:

<table>
<tr><th>Bit #</th><th>Status Bit Name</th><th>Supported</th></tr>
<tr><td>7</td><td>Invalid or Unsupported Command Received</td><td>Yes</td></tr>
<tr><td>6</td><td>Invalid or Unsupported Data Received</td><td>Yes</td></tr>
<tr><td>5</td><td>Packet Error Check Failed</td><td>Yes</td></tr>
<tr><td>4</td><td>Memory Fault Detected</td><td>Yes</td></tr>
<tr><td>3</td><td>Processor Fault Detected</td><td>No</td></tr>
<tr><td>2</td><td>Reserved</td><td>No</td></tr>
<tr><td>1</td><td>A communication fault other than the ones listed in this table has occurred</td><td>No</td></tr>
<tr><td>0</td><td>Other Memory or Logic Fault has occurred.</td><td>No</td></tr>
</table>
</td></tr>
</table>

Command Code	Command Name	Definition
80h	STATUS_MFR_SPECIFIC	Same as standard PMBUS_STATUS_MFR_SPECIFIC Register. Command returns one data byte with contents as follows: Bitmap: Bit7: MFR Specific Fault Bit6: Reserved Bit5: Asserted when DSP supply goes below regulation Bit4: Reserved Bit3: Asserted when module primary current imbalance occurs Bit2: Asserted when module primary over current occurs Bit1: Reserved Bit0: Asserted when internal CAN communication fault occur.
8Bh	READ_VOUT	Module Output Voltage reporting Refer to Module Command data classification for Data Format.
8Ch	READ_IOUT	Module Output Current reporting Refer to Module Command data classification for Data Format.
8Dh	READ_TEMPERATURE_1	Module power device temperature reporting Refer to Module Command data classification for Data Format.
8Eh	MFR_REG	Manufacturer register. Do not access.
8Fh	READ_TEMPERATURE_3	Module Transformer temperature reporting Refer to Module Command data classification for Data Format.
96h	Read_POUT	Module Output Power reporting Refer to Module Command data classification for Data Format. .

Command Code	Command Name	Definition
99h	MFR_ID	Same as standard PMBUS_MFR_ID Register. Command to indicate the manufacturer's Identification. Fix data: "ARTESYN"
9Ah	MFR_MODEL	Same as standard PMBUS_MFR_MODEL Register. Command to indicate the manufacturer's model number. Data : Varies per module series
9Bh	MFR_REVISION	Same as standard PMBUS_MFR_REVISION Register. Command to indicate the module revision number Data : Varies per module series
9Ch	MFR_LOCATION	Same as standard PMBUS_MFR_LOCATION Register. Command to indicate the manufacturer's location. Fix data: "PHILIPPINES"
9Dh	MFR_DATE	Same as standard PMBUS_MFR_DATE Register. Command to indicate the Module's Manufacturing Date. Data format: "YYMMDD"
9Eh	MFR_SERIAL	Same as standard PMBUS_MFR_SERIAL Register. Module's serial number. Command to indicate the
A4h	MFR_VOUT_MIN	Same as standard PMBUS_MFR_VOUT_MIN Register. Minimum Output voltage that can be set in the Module. Refer to Module Command data classification for Data Format.

Command Code	Command Name	Definition
A5h	MFR_VOUT_MAX	Same as standard PMBUS_MFR_VOUT_MAX Register. Maximum Output voltage that can be set in the Module. Refer to Module Command data classification for Data Format.
A6h	MFR_IOUT_MAX	Same as standard PMBUS_MFR_IOUT_MAX Register. Maximum Output current that can be set in the Module. Refer to Module Command data classification for Data Format.
A7h	MFR_POUT_MAX	Same as standard PMBUS_MFR_POUT_MAX Register. Maximum Output Power that can be delivery by the Module the Module. Refer to Module Command data classification for Data Format.
B0h	FRU_DATA	Command to return FRU data of the Module.

Command Code	Command Name	Definition
B1h	VREF	Module voltage reference. Refer to Module Command data classification for Data Format. Command have different function in each Module operation (D3h) Digital Voltage Source ○ User Configurable. User can change output voltage using this command from 5% of nominal Vout to 120% of nominal Vout. ○ The Module will enter to standby mode when user writes 0V to this register. Analog Voltage Source ○ Read Only ○ Automatically set to Module Nominal Output Voltage ○ Not functional during this operation. Digital/Analog Current Source ○ User Configurable. User can change output voltage using this command from 5% of nominal Vout to 100% of nominal Vout. ○ Clamp Voltage during Current Source operation

Command Code	Command Name	Definition
B2h	IREF	Module current reference. Refer to Module Command data classification for Data Format. Digital Current Source ○ User Configurable. User can change output current using this command from 0A to Nominal output current. ○ The Module will enter to standby mode when user writes 0A to this register. Analog Current Source ○ Read Only ○ Automatically set to 0A. ○ Not functional during this operation. Digital/Analog Voltage Source ○ Read only. ○ Latch type Fault: Fix to 120% of nominal output current. Not functional. ○ CC Type Fault: IREF= (Io nominal)*(OC_FAULT_LIMIT_MULTIPLIER) PMBUS command 4Dh OC_FAULT_LIMIT_MULTIPLIER
B3h	MFR_REG	Manufacturer register. Do not access.

Command Code	Command Name	Definition
B5h	SET_VOLTAGE_RISE_SETTING	Command used to read the voltage rise time during Module's Digital Voltage Source (DVS) operation. Data Range: 00h – 0Fh Data 0x00h: 10ms (+/- 5msec) Data 0x01h: 20ms (+/- 5msec) Data 0x02h: 50ms (+/- 5ms) Data 0x03h: 70ms (+/- 5ms) Data 0x04h: 80ms (+/- 5ms) Data 0x05h: 90ms (+/- 5ms) Data 0x06h: 100ms (+/- 5ms) Data 0x07h: 110ms (+/- 5ms) Data 0x08h: 120ms (+/- 5ms) Data 0x09h: 130ms (+/- 5ms) Data 0x0Ah: 140ms (+/- 5ms) Data 0x0Bh: 150ms (+/- 5ms) Data 0x0Ch: 175ms (+/- 10ms) Data 0x0Dh: 200ms (+/- 10ms) Data 0x0Eh: 225ms (+/- 10ms) Data 0x0Fh: 250ms (+/- 20ms) Send Command to Module Read only. User Configurable To configure use ISOCOMM PMBUS Command B5h to change Module B5h.

Command Code	Command Name	Definition
B6h	SET_CURRENT_RISE_ SETTING	Command used to read the current rise time during Module's Digital Current Source (DCS) operation. Data Range: 00h – 0Fh Data 0x00h: 7.2ms Data 0x01h: 100ms (+/- 10ms) Data 0x02h: 125ms (+/- 10ms) Data 0x03h: 150ms (+/- 10ms) Data 0x04h: 175ms (+/- 10ms) Data 0x05h: 200ms (+/- 10ms) Data 0x06h: 225ms (+/- 10ms) Data 0x07h: 250ms (+/- 10ms) Data 0x08h: 300ms (+/- 10ms) Data 0x09h: 350ms (+/- 10ms) Data 0x0Ah: 400ms (+/- 10ms) Data 0x0Bh: 450ms (+/- 10ms) Data 0x0Ch: 500ms (+/- 10ms) Data 0x0Dh: 700ms (+/- 50ms) Data 0x0Eh: 900ms (+/- 50ms) Data 0x0Fh: 1250ms (+/- 50ms) Send Command to Module Read only. User Configurable To configure use ISOCOMM PMBUS Command B6h to change Module B6h.

Command Code	Command Name	Definition
B7h	SET_IO_ACTIVE_LEVEL_LOGIC	Command used to set the logic of SYS_M_FAULT#, SYS_M_ENABLE#, and SYS_M_INHIBIT signals. Bitmap: Bit7: Reserved Bit6: Reserved Bit5: Reserved Bit4: Reserved Bit3: Reserved Bit2: Data: 1 – SYS_M_FAULT# Logic High means Module is at Fault. Data: 0 – SYS_M_FAULT# Logic Low means Module is at Fault. Bit1: Data: 1 – Module will turn-off if SYS_M_INHIBIT is Logic High Data: 0 –Module will turn-off if SYS_M_INHIBIT is Logic Low. Bit0: Data: 1 – Module will turn-on if SYS_M_ENABLE# is Logic High Data: 0 –Module will turn-on if SYS_M_ENABLE# is Logic Low. Please refer to Section 3.2.1.1 Module's J1 Signal for the recommended external circuitry for SYS_M_ENABLE#, SYS_M_FAULT#, and SYS_M_INHIBIT signal User Configurable
B8h	SET_MODULE_LOAD_TYPE	Command to read Module compensation Data: 01h – Resistive load compensation Data: 02h - Capacitive load compensation Data: 04h - LED load compensation User Configurable To configure use ISOCOMM PMBUS Command B8h to change Module B8h.
B9h	MFR_REG	Manufacturer register. Do not access.

Command Code	Command Name	Definition
BAh	ANALOG_FILTER_ENABLE	To enable or disable heavy filtering of IPROG signal during ACS or VPROG signal during AVS. Bit2 to7: Reserved/Unused Bit1: Data “1” ACS Heavy Filter Enabled Data “0” ACS Heavy Filter Disabled Bit0: Data”1” AVS operation and modules in parallel. Sharing enable Data”0” AVS operation and modules stand-alone Waveshape enable.
BBh	MFR_REG	Manufacturer register. Do not access.

Command Code	Command Name	Definition
D0h	SHUTDOWN_CAUSE	Status that indicate the cause of Module shutdown Bitmap: Bit 4-6: Reserved/Unused Bit3: Config Inhibit Status : Module inhibit status during Module Configuration change. Bit 2: Module is ON (1), Module is OFF (0) Bit 1: Module Auto Recoverable Fault Assert Bit Due to: 1) OT Fault, 2) COMM Fault, 3) Invalid Programming (PGM) Range and 4) Output Short Circuit Bit 0: Module Latch Type Fault Assert Bit Due to: 1) Over-voltage Fault, 2) Under-voltage Fault, 3) Over-current Fault, 4) Primary Over-current Fault, 5) Rail Imbalance Fault, and 6) Supply_MON Fault

Command Code	Command Name	Definition
D3h	MODULE_CONFIG	Command to Read Module Configuration Mode Bitmap: Bit 7-4: Reserved/Unused Bit 6: Reserved Bit 5: Reserved Bit 4: Reserved/Unused Bit 3: Source Selection Data 1: Current Source Mode Data 0: Voltage Source Mode Bit 2: Reserved/Unused Bit 1: Select Analog or Digital Control Data 1: Analog Control Data 0: Digital Control Bit 0: Current Sensing Data 1: External Shunt Data 0: Internal Shunt Bit 5 data should be data 0 all the time. Send Command to Module Read only. User Configurable To configure use ISOCOMM PMBUS Command D3h to change Module configuration D3h.
D4h	MFR_REG	Manufacturer register. Do not access.
D5h	MFR_REG	Manufacturer register. Do not access.
D7h	MFR_REG	Manufacturer register. Do not access.
E1h	FW_SEC_VERSION	Command to read Module Software version
E2h	MFR_REG	Manufacturer register. Do not access.

Command Code	Command Name	Definition
E3h	MFR_REG	Manufacturer register. Do not access.
E4h	MFR_REG	Manufacturer register. Do not access.
E5h	OPTN_TIME_TOTAL	Command to read the total time when the Module is turn-on and the output is operational. This will reset when the iHP Rack is turn-off.
E6h	OPTN_TIME_PRESENT	Command to read the total time when the Module is turn-on and the output is operational. This will reset when the module enters to standby mode.
E7h	HISTORY_DATA	Command to read the Module History Data.
E8h	HISTORY_CLEAR	Command to clear History Data
E9h	CALIBRATION_DATE	Command to read the last calibration date. Data representation: YYMMDD YY – Year MM - Month DD – Day
EDh	MFR_REG	Manufacturer register. Do not access.
F6h	MFR_REG	Manufacturer register. Do not access.
F7h	MFR_REG	Manufacturer register. Do not access.
F9H	MFR_REG	Manufacturer register. Do not access.
FAh	MFR_REG	Manufacturer register. Do not access.
FBh	MFR_REG	Manufacturer register. Do not access.

Module Command Data Classifications

Command	Command Name	Transaction Type	# of Bytes	Data Format	Multiplier	Data Unit	Write Protection
01h	OPERATION	Read/Write Byte	1	Bitmapped	N/A	N/A	Basic
03h	CLEAR_FAULTS	Send Byte	0	N/A	N/A	N/A	Basic
10h	WRITE_PROTECT	Read/Write Byte	1	Bitmapped	N/A	N/A	None
24h	VOUT_MAX	Read Word	3	DIRECT	10000	V	N/A
31h	POUT_MAX	Read Word	2	Linear	N/A	W	N/A
41h	VOUT_OV_FAULT_RESPONSE	Read Byte	1	Bitmapped	N/A	N/A	N/A
45h	VOUT_UV_FAULT_RESPONSE	Read Byte	1	Bitmapped	N/A	N/A	N/A
48h	OV_FAULT_LIMIT_MULTIPLIER	Block Read/Write Word	2	DIRECT	100	%	Basic
49h	OV_WARN_LIMIT_MULTIPLIER	Block Read/Write Word	2	DIRECT	100	%	Basic
4Bh	UV_FAULT_LIMIT_MULTIPLIER	Block Read/Write Word	2	DIRECT	100	%	Basic
4Ch	UV_WARN_LIMIT_MULTIPLIER	Block Read/Write Word	2	DIRECT	100	%	Basic
4Dh	OC_FAULT_LIMIT_MULTIPLIER	Block Read/Write	2	DIRECT	100	%	Basic
4Fh	OT_FAULT_LIMIT	Read Word	2	Linear	N/A	^{0}C	N/A
50h	OT_FAULT_RESPONSE	Read Byte	1	Bitmapped	N/A	N/A	N/A
51h	OT_WARN_LIMIT	Read Word	2	Linear	N/A	^{0}C	N/A
52h	OC_RESPONSE_TYPE	Read/Write Byte	1	Bitmapped	N/A	N/A	Basic
5Eh	POWER_GOOD_ON	Read Word	3	DIRECT	10000	V	N/A
5Fh	POWER_GOOD_OFF	Read Word	3	DIRECT	10000	V	N/A
78h	STATUS_BYTE	Read Byte	1	Bitmapped	N/A	N/A	N/A

Command	Command Name	Transaction Type	# of Bytes	Data Format	Multiplier	Data Unit	Write Protection
79h	STATUS_WORD	Read Word	2	Bitmapped	N/A	N/A	N/A
7Ah	STATUS_VOUT	Read Byte	1	Bitmapped	N/A	N/A	N/A
7Bh	STATUS_IOUT	Read Byte	1	Bitmapped	N/A	N/A	N/A
7Ch	STATUS_INPUT	Read Byte	1	Bitmapped	N/A	N/A	N/A
7Dh	STATUS_TEMPERATURE	Read Byte	1	Bitmapped	N/A	N/A	N/A
7Eh	STATUS_CML	Read Byte	1	Bitmapped	N/A	N/A	N/A
80h	STATUS_MFR_SPECIFIC	Read Byte	1	Bitmapped	N/A	N/A	N/A
8Bh	READ_VOUT	Read Word	3	DIRECT	10000	V	N/A
8Ch	READ_IOUT	Read Word	3	DIRECT	10000	A	N/A
8Dh	READ_TEMPERATURE_1	Read Word	2	Linear	N/A	^{0}C	N/A
8Fh	READ_TEMPERATURE_3	Read Word	2	Linear	N/A	^{0}C	N/A
96h	READ_POUT	Read Word	2	Linear	N/A	W	N/A
99h	MFR_ID	Block Read	7	ASCII	N/A	N/A	N/A
9Ah	MFR_MODEL	Block Read	15	ASCII	N/A	N/A	N/A
9Bh	MFR_REVISION	Block Read	2	ASCII	N/A	N/A	N/A
9Ch	MFR_LOCATION	Block Read	6	ASCII	N/A	N/A	N/A
9Dh	MFR_DATE	Block Read	2	ASCII	N/A	N/A	N/A
9Eh	MFR_SERIAL	Block Read	13	ASCII	N/A	N/A	N/A
A4h	MFR_VOUT_MIN	Read Word	3	Direct	10000	V	N/A
A5h	MFR_VOUT_MAX	Read Word	3	Direct	10000	V	N/A
A6h	MFR_IOUT_MAX	Read Word	3	Direct	10000	A	N/A
A7h	MFR_POUT_MAX	Read Word	2	Linear	N/A	W	N/A
B0h	FRU_DATA	Block Read	Varies	ASCII	N/A		User Configuration
B1h	VREF	Read/Write Word	3	Direct	10000	V	Basic
B2h	IREF	Read/Write Word	3	Direct	10000	A	Basic

Command	Command Name	Transaction Type	# of Bytes	Data Format	Multiplier	Data Unit	Write Protection
B5h	SET_VOLTAGE_RISE_SETTING	Block Read Word	2	Direct	1	N/A	N/A
B6h	SET_CURRENT_RISE_SETTING	Block Read Word	2	Direct	1	N/A	N/A
B7h	SET_IO_ACTIVE_LEVEL_LOGIC	Block Read/Write	2	Bitmapped	N/A	N/A	Basic
B8h	SET_MODULE_LOAD TYPE	Block Read Word	2	Bitmapped	N/A	N/A	N/A
BAh	ANALOG_FILTER_ENABLE	Read/Write Byte	1	Bitmapped	N/A	N/A	Basic
D0h	FAULT_CONFIG	Read Byte	1	Bitmapped	N/A	N/A	N/A
D3h	MODULE_CONFIG	Read Byte	1	Bitmapped	N/A	N/A	N/A
E1h	FW_SEC_VERSION	Block Read	8	ASCII	N/A	N/A	N/A
E5h	OPTN_TIME_TOTAL	Block Read	4	DIRECT	1	sec	N/A
E6h	OPTN_TIME_PRESENT	Block Read	4	DIRECT	1	sec	N/A
E7h	HISTORY_DATA	Block Read	4	varies	N/A	N/A	N/A
E8h	HISTORY_CLEAR	Send Byte	0	N/A	N/A	N/A	Factory Configuration
E9h	CALIBRATION_DATE	Block Read	6	ASCII	N/A	N/A	N/A

B.3 ISOCOMM Command

To convert Linear Data Format to “real world value”, please refer to appendix B.4

To convert Direct Data Format to “real world value”, please refer to appendix B.5

ISOCOMM Command Definition

Command Code	Command Name	Definition
01h	OPERATION	Command used to Turn-off or Turn-on ALL modules. Bit 7 = 1 : Module is ON Bit 7 = 0 : Module is OFF Bit 0 to Bit 6 : Don't Care User Configurable.
03h	CLEAR_FAULTS	Standard PMBUS command To remove the warning or fault bits set in the status register, User need to send CLEAR_FAULT command
10h	WRITE_PROTECT	Same as standard PMBUS_WRITE_PROTECT Register. Command used to Enable or Disable writing to the ISOCOMM Registers. This will prevent accidental writing to the Module. Data: 80h – Disable all write except to the WRITE_PROTECT command. Data: 00h – Enable writes to all commands.
3Ah	FAN_CONFIG_1_2	Same as standard PMBUS_FAN_CONFIG_1_2 Register. Command returns one data byte with contents as follows: Bit # — Status Bit Name — Fixed data 7 — Data 1: Fan 1 is present. Data 0: Fan 1 is not present. — 1 6 — Data 1: Fan 1 commanded in RPM Data 0: Fan 1 commanded Duty Cycle — 0 5 — Fan 1 Tachometer pulses per revolution 00b – 1 pulse per revolution — 0 4 — 01b – 2 pulse per revolution 10b – 3 pulse per revolution 11b - 4 pulse per revolution — 1 3 — Data 1: Fan 2 is present. Data 0: Fan 2 is not present. — 1 2 — Data 1: Fan 2 commanded in RPM Data 0: Fan 2 commanded Duty Cycle — 0 1 — Fan 2 Tachometer pulses per revolution 00b – 1 pulse per revolution — 0 0 — 01b – 2 pulse per revolution 10b – 3 pulse per revolution 11b - 4 pulse per revolution — 1

<table>
<tr><th>Command Code</th><th>Command Name</th><th>Definition</th></tr>
<tr><td>3Dh</td><td>FAN_CONFIG_3_4</td><td>Same as standard PMBUS_FAN_CONFIG_3_4 Register.
Command returns one data byte with contents as follows:
<table>
<tr><th>Bit #</th><th>Status Bit Name</th><th>Fixed data</th><th>Supported</th></tr>
<tr><td>7</td><td>Data 1: Fan 3 is present.
Data 0: Fan 3 is not present.</td><td>1</td><td>No</td></tr>
<tr><td>6</td><td>Data 1: Fan 3 commanded in RPM
Data 0: Fan 3 commanded Duty Cycle</td><td>0</td><td>No</td></tr>
<tr><td>5</td><td>Fan 3 Tachometer pulses per revolution
00b – 1 pulse per revolution
01b – 2 pulse per revolution
10b – 3 pulse per revolution
11b - 4 pulse per revolution</td><td>0
1</td><td>No
No</td></tr>
<tr><td>3</td><td>Data 1: Fan 4 is present.
Data 0: Fan 4 is not present.</td><td>1</td><td>No</td></tr>
<tr><td>2</td><td>Data 1: Fan 4 commanded in RPM
Data 0: Fan 4 commanded Duty Cycle</td><td>0</td><td>Yes</td></tr>
<tr><td>1</td><td>Fan 4 Tachometer pulses per revolution
00b – 1 pulse per revolution
01b – 2 pulse per revolution
10b – 3 pulse per revolution
11b - 4 pulse per revolution</td><td>0
1</td><td>Yes
Yes</td></tr>
</table>
</td></tr>
<tr><td>78h</td><td>STATUS_BYTE</td><td>Same as standard PMBUS_STATUS_BYTE Register.
Returns one byte of information with the summary of the most critical ISOCOMM faults.
Please see below Listing of STATUS_BYTE supported Bits:
<table>
<tr><th>Bit #</th><th>Status Bit Name</th><th>Supported</th></tr>
<tr><td>7</td><td>BUSY</td><td>No</td></tr>
<tr><td>6</td><td>OFF</td><td>No</td></tr>
<tr><td>5</td><td>VOUT_OV_FAULT</td><td>No</td></tr>
<tr><td>4</td><td>IOUT_OC_FAULT</td><td>No</td></tr>
<tr><td>3</td><td>VIN_UV_FAULT</td><td>No</td></tr>
<tr><td>2</td><td>TEMPERATURE</td><td>Yes</td></tr>
<tr><td>1</td><td>CML</td><td>Yes</td></tr>
<tr><td>0</td><td>NONE OF THE ABOVE</td><td>Yes</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Command Code</th><th>Command Name</th><th>Definition</th></tr>
<tr><td>79h</td><td>STATUS_WORD</td><td>Same as standard PMBUS_STATUS_WORD Register.
Returns two bytes of information with the summary of the ISOCOMM’s faults condition. Based on the information, User can get more information by reading the appropriate status registers.
The low byte of the STATUS_WORD is the same register as the STATUS_BYTE command.
Please see below Listing of STATUS_WORD supported Bits:
LOW BYTE
Please refer to ISOCOMM Command Code 0x78h STATUS_BYTE
HIGH BYTE
<table>
<tr><th>Bit #</th><th>Status Bit Name</th><th>Supported</th></tr>
<tr><td>7</td><td>VOUT</td><td>No</td></tr>
<tr><td>6</td><td>IOUT/POUT</td><td>No</td></tr>
<tr><td>5</td><td>INPUT</td><td>No</td></tr>
<tr><td>4</td><td>MFR_SPECIFIC</td><td>Yes</td></tr>
<tr><td>3</td><td>POWER_GOOD#</td><td>No</td></tr>
<tr><td>2</td><td>FANS</td><td>Yes</td></tr>
<tr><td>1</td><td>OTHER</td><td>No</td></tr>
<tr><td>0</td><td>UNKNOWN</td><td>No</td></tr>
</table></td></tr>
<tr><td>7Dh</td><td>STATUS_TEMPERATURE</td><td>Same as standard PMBUS_STATUS_TEMPERATURE Register.
Command returns one data byte with contents as follows:
<table>
<tr><th>Bit #</th><th>Status Bit Name</th><th>Supported</th></tr>
<tr><td>7</td><td>OT_FAULT</td><td>Yes</td></tr>
<tr><td>6</td><td>OT_WARNING</td><td>Yes</td></tr>
<tr><td>5</td><td>UT_WARNING</td><td>No</td></tr>
<tr><td>4</td><td>UT_FAULT</td><td>No</td></tr>
<tr><td>3</td><td>Reserved</td><td>No</td></tr>
<tr><td>2</td><td>Reserved</td><td>No</td></tr>
<tr><td>1</td><td>Reserved</td><td>No</td></tr>
<tr><td>0</td><td>Reserved</td><td>No</td></tr>
</table>ISOCOMM OTP protection is with reference to the ambient temperature of the iHP RACK (Front Panel Ambient Temperature).</td></tr>
</table>

Command Code	Command Name	Definition
7Eh	STATUS_CML	Same as standard PMBUS_STATUS_CML Register. Command returns one data byte with contents as follows: Bit # — Status Bit Name — Supported 7 — Invalid or Unsupported Command Received — Yes 6 — Invalid or Unsupported Data Received — Yes 5 — Packet Error Check Failed — Yes 4 — Memory Fault Detected — Yes 3 — Processor Fault Detected — No 2 — Reserved — No 1 — A communication fault other than the ones listed in this table has occurred — No 0 — Other Memory or Logic Fault has occurred. — No
80h	STATUS_MFR	Same as standard PMBUS_STATUS_MFR Register. Command returns a word data where the high byte is a copy of PFC's STATUS_MFR and the low byte is defined as follows: Bit # — Status Bit Name — Supported 7 — Reserved — No 6 — Reserved — No 5 — Rack SYNC Off — No 4 — GROUP mismatched — YES 3 — Module Communication Error — YES 2 — PFC Communication Error — YES 1 — Module Synchronize Off — YES 0 — 5V Standby Error — YES
81h	STATUS_FAN_1_2	Same as standard PMBUS_STATUS_FAN_1_2 Register. Command returns one data byte with contents as follows: Bit # — Status Bit Name — Supported 7 — Fan 1 Fault — YES 6 — Fan 2 Fault — YES 5 — Fan 1 Warning — No 4 — Fan 2 Warning — No 3 — Fan 1 Speed Override — No 2 — Fan 2 Speed Override — No 1 — Air Flow Fault — No 0 — Air Flow Warning — No

Command Code	Command Name	Definition
82h	STATUS_FAN_3_4	Same as standard PMBUS_STATUS_FAN_3_4 Register. Command returns one data byte with contents as follows: Bit # — Status Bit Name — Supported 7 — Fan 3 Fault — YES 6 — Fan 4 Fault — YES 5 — Fan 3 Warning — No 4 — Fan 4 Warning — No 3 — Fan 3 Speed Override — No 2 — Fan 4 Speed Override — No 1 — Reserved — No 0 — Reserved — No
8Dh	READ_TEMPERATURE_1	This command returns the highest temperature between PFC1 and PFC2. Refer to ISOCOMM Command data classification for Data Format
8Fh	READ_TEMPERATURE_2	This command returns the Ambient Temperature of the iHP Rack. Temperature sensor of the Ambient temperature is located on the Front panel. Refer to ISOCOMM Command data classification for Data Format
90h	READ_FAN1_SPEED	iHP RACK fan speed reporting in RPM for FAN1. Refer to ISOCOMM Command data classification for Data Format
91h	READ_FAN2_SPEED	iHP RACK fan speed reporting in RPM for FAN2. Refer to ISOCOMM Command data classification for Data Format
92h	READ_FAN3_SPEED	iHP RACK fan speed reporting in RPM for FAN3. Refer to ISOCOMM Command data classification for Data Format
93h	READ_FAN4_SPEED	iHP RACK fan speed reporting in RPM for FAN4. Refer to ISOCOMM Command data classification for Data Format
99h	MFR_ID	Standard PMBUS command Command to indicate the iHP RACK's manufacturer's Identification. Fix data: "ARTESYN"
9Ah	MFR_MODEL	Same as standard PMBUS_MFR_MODEL Register. Command to indicate the iHP RACK's model number. Data : Varies per module series
9Bh	MFR_REVISION	Same as standard PMBUS_MFR_REVISION Register. Command to indicate the iHP RACK's revision number Data : Varies per module series
9Ch	MFR_LOCATION	Same as standard PMBUS_MFR_LOCATION Register. Command to indicate the iHP RACK's manufacturer's location. Fix data: "PHILIPPINES"
9Dh	MFR_DATE	Same as standard PMBUS MFR_DATE Register. Command to indicate the iHP RACK's Manufacturing Date. Data format: "YYMMDD"
9Eh	MFR_SERIAL	Same as standard PMBUS_MFR_SERIAL Register. Command to indicate the iHP RACK's serial number.
B0h	FRU_DATA	Command to return FRU data of the ISOCOMM

Command Code	Command Name	Definition
B5h	MODULE_VRISE_TIME	Command used to set the voltage rise time of the module during Module's Digital Programming Voltage Source (DPVS) operation. This command has 3 bytes of data to write <DATA1> <DATA2> <DATA3> Data1 indicates the module slot or Group number in which the setting will be implemented <data1> = "00" = Slot 1 module <data1> = "01" = Slot 2 module <data1> = "02" = Slot 3 module <data1> = "03" = Slot 4 module <data1> = "04" = Slot 5 module <data1> = "05" = Slot 6 module <data1> = "06" = Slot 7 module <data1> = "07" = Slot 8 module <data1> = "08" = GROUP1 module <data1> = "09" = GROUP2 module <data1> = "0A" = GROUP3 module <data1> = "0B" = GROUP4 module <data1> = "0C" = GROUP5 module <data1> = "0D" = GROUP6 module <data1> = "0E" = GROUP7 module Data2 and Data3 indicate the module rise time setting. Data "00 00" : 10ms (+/- 5ms) Data "00 01" : 20ms (+/- 5ms) Data "00 02" : 50ms (+/- 5ms) Data "00 03" : 70ms (+/- 5ms) Data "00 04" : 80ms (+/- 5ms) Data "00 05" : 90ms (+/- 5ms) Data "00 06" : 100ms (+/- 5ms) Data "00 07" : 110ms (+/- 5ms) Data "00 08" : 120ms (+/- 5ms) Data "00 09" : 130ms (+/- 5ms) Data "00 0A" : 140ms (+/- 5ms) Data "00 0B" : 150ms (+/- 5ms) Data "00 0C" : 175ms (+/- 10ms) Data "00 0D" : 200ms (+/- 10ms) Data "00 0E" : 225ms (+/- 10ms) Data "00 0F" : 250ms (+/- 20ms) After sending this PMBUS command, All modules will shut down and restart again.

Command Code	Command Name	Definition
B6h	MODULE_IRISE_TIME	Command used to set the current rise time of the module during Module's Digital Programming Current Source (DPCS) operation. This command has 3 bytes of data to write <DATA1> <DATA2> <DATA3> Data1 indicates the module slot or Group number in which the setting will be implemented <data1> = "00" = Slot 1 module <data1> = "01" = Slot 2 module <data1> = "02" = Slot 3 module <data1> = "03" = Slot 4 module <data1> = "04" = Slot 5 module <data1> = "05" = Slot 6 module <data1> = "06" = Slot 7 module <data1> = "07" = Slot 8 module <data1> = "08" = GROUP1 module <data1> = "09" = GROUP2 module <data1> = "0A" = GROUP3 module <data1> = "0B" = GROUP4 module <data1> = "0C" = GROUP5 module <data1> = "0D" = GROUP6 module <data1> = "0E" = GROUP7 module Data2 and Data3 indicate the module rise time setting. Data "00 00" : 7.2ms Data "00 01" : 100ms (+/- 10ms) Data "00 02" : 125ms (+/- 10ms) Data "00 03" : 150ms (+/- 10ms) Data "00 04" : 175ms (+/- 10ms) Data "00 05" : 200ms (+/- 10ms) Data "00 06" : 225ms (+/- 10ms) Data "00 07" : 250ms (+/- 10ms) Data "00 08" : 300ms (+/- 10ms) Data "00 09" : 350ms (+/- 10ms) Data "00 0A" : 400ms (+/- 10ms) Data "00 0B" : 450ms (+/- 10ms) Data "00 0C" : 500ms (+/- 10ms) Data "00 0D" : 700ms (+/- 50ms) Data "00 0E" : 900ms (+/- 50ms) Data "00 0F" : 1250ms (+/- 50ms) ending this PMBUS command, All modules will shut down and restart again.
CAh	READ_VIN1	iHP RACK Input Voltage reporting (Vac) for Line1 Refer to ISOCOMM Command data classification for Data Format
CBh	READ_VIN2	iHP RACK Input Voltage reporting (Vac) for Line2 Refer to ISOCOMM Command data classification for Data Format
CCh	READ_VIN3	iHP RACK Input Voltage reporting (Vac) for Line3 Refer to ISOCOMM Command data classification for Data Format

Command Code	Command Name	Definition
CDh	READ_IIN1	iHP RACK Input Current reporting (Vac) for Line1 Refer to ISOCOMM Command data classification for Data Format
CEh	READ_IIN2	iHP RACK Input Current reporting (Vac) for Line2 Refer to ISOCOMM Command data classification for Data Format
CFh	READ_IIN3	iHP RACK Input Voltage reporting (Vac) for Line3 Refer to ISOCOMM Command data classification for Data Format
D3h	MODULE_CONFIG	Command used to set the configuration of the module. This command has 2 bytes of data to write <DATA1> <DATA2> Data1 indicates the module slot or Group number in which the setting will be implemented <data1> = “00” = Slot 1 module <data1> = “01” = Slot 2 module <data1> = “02” = Slot 3 module <data1> = “03” = Slot 4 module <data1> = “04” = Slot 5 module <data1> = “05” = Slot 6 module <data1> = “06” = Slot 7 module <data1> = “07” = Slot 8 module <data1> = “08” = GROUP1 module <data1> = “09” = GROUP2 module <data1> = “0A” = GROUP3 module <data1> = “0B” = GROUP4 module <data1> = “0C” = GROUP5 module <data1> = “0D” = GROUP6 module <data1> = “0E” = GROUP7 module Data2 indicate the module configuration setting. Bitmap: Bit 7-4: Reserved/Unused Bit 6: Reserved/Unused Bit 5: Reserved/Unused Bit 4: Reserved/Unused Bit 3: Source Selection Data 1: Current Source Mode Data 0: Voltage Source Mode Bit 2: Reserved/Unused Bit 1: Select Analog or Digital Control Data 1: Analog Control Data 0: Digital Control Bit 0: Current Sensing Data 1: External Shunt Data 0: Internal Shunt Bit 5 data should be data 0 all the time. After sending this PMBUS command, All modules will shut down and restart again.

Command Code	Command Name	Definition
D6h	MODULE_DETECTION	Command to indicate module present in the iHP RACK Data Bit0 : Asserted when module is present in slot1 Data Bit1 : Asserted when module is present in slot2 Data Bit2 : Asserted when module is present in slot3 Data Bit3 : Asserted when module is present in slot4 Data Bit4 : Asserted when module is present in slot5 Data Bit5 : Asserted when module is present in slot6 Data Bit6 : Asserted when module is present in slot7 Data Bit7 : Asserted when module is present in slot8
D7h	MODULE_SAVE	Command used to Save below Module Configuration. 48h, 49h, 4Bh, 4Ch, 4Dh, 4Eh, 52h, 53h, 54h, B4h B5h, B6h, B7h, B8h, B9h, Bah, D3h, F9h, FAh This command have indicates the module slot or Group number in which the setting will be implemented data = “00” = Slot 1 module data = “01” = Slot 2 module data = “02” = Slot 3 module data = “03” = Slot 4 module data = “04” = Slot 5 module data = “05” = Slot 6 module data = “06” = Slot 7 module data = “07” = Slot 8 module data = “08” = GROUP1 module data = “09” = GROUP2 module data = “0A” = GROUP3 module data = “0B” = GROUP4 module data = “0C” = GROUP5 module data = “0D” = GROUP6 module data = “0E” = GROUP7 module After sending this PMBUS command, All modules will shut down and restart again.
E1h	FW_VERSION	Command to indicate the software version of the ISOCOMM

ISOCOMM Command Data Classifications

Command	Command Name	Transaction Type	# of Bytes	Data Format	Multiplier	Data Unit	Write Protection
01h	OPERATION	Read/Write Byte	1	Bitmapped	N/A	N/A	Basic
03h	CLEAR_FAULTS	Send Byte	0	N/A	N/A	N/A	Basic
10h	WRITE_PROTECT	Read/Write Byte	1	Bitmapped	N/A	N/A	N/A
3Ah	FAN_CONFIG_1_2	Read Byte	1	Bitmapped	N/A	N/A	N/A
3Dh	FAN_CONFIG_3_4	Read Byte	1	Bitmapped	N/A	N/A	N/A
78h	STATUS_BYTE	Read Byte	1	Bitmapped	N/A	N/A	N/A

Command	Command Name	Transaction Type	# of Bytes	Data Format	Multiplier	Data Unit	Write Protection
79h	STATUS_WORD	Read Byte	2	Bitmapped	N/A	N/A	N/A
7Dh	STATUS_TEMPERATURE	Read Byte	1	Bitmapped	N/A	N/A	N/A
7Eh	STATUS_CML	Read Byte	1	Bitmapped	N/A	N/A	N/A
80h	STATUS_MFR	Read Byte	2	Bitmapped	N/A	N/A	N/A
81h	STATUS_FAN_1_2	Read Byte	1	Bitmapped	N/A	N/A	N/A
82h	STATUS_FAN_3_4	Read Byte	1	Bitmapped	N/A	N/A	N/A
8Dh	READ_TEMPERATURE_1	Read Byte	2	Linear	N/A	^{0}C	N/A
8Fh	READ_TEMPERATURE_2	Read Byte	2	Linear	N/A	^{0}C	N/A
90h	READ_FAN1_SPEED	Read Byte	2	Linear	N/A	RPM	N/A
91h	READ_FAN2_SPEED	Read Byte	2	Linear	N/A	RPM	N/A
92h	READ_FAN3_SPEED	Read Byte	2	Linear	N/A	RPM	N/A
93h	READ_FAN4_SPEED	Read Byte	2	Linear	N/A	RPM	N/A
99h	MFR_ID	Block Read	7	ASCII	N/A	N/A	N/A
9Ah	MFR_MODEL	Block Read	12	ASCII	N/A	N/A	N/A
9Bh	MFR_REVISION	Block Read	2	ASCII	N/A	N/A	N/A
9Ch	MFR_LOCATION	Block Read	1	ASCII	N/A	N/A	Factory Config
9Dh	MFR_DATE	Block Read	2	ASCII	N/A	N/A	Factory Config
9Eh	MFR_SERIAL	Block Read	13	ASCII	N/A	N/A	Factory Config
B0h	FRU_DATA	Block Read	256	ASCII	N/A	N/A	Factory Config
B5h	MODULE_VRISE_TIME	Block Write	3	Bitmapped	N/A	N/A	Basic
B6h	MODULE_IRISE_TIME	Block Write	3	Bitmapped	N/A	N/A	Basic
CAh	READ_VIN1	Read Word	2	Direct	10	V	N/A
CBh	READ_VIN2	Read Word	2	Direct	10	V	N/A
CCh	READ_VIN3	Read Word	2	Direct	10	V	N/A
CDh	READ_IIN1	Read Word	2	Direct	100	A	N/A
CEh	READ_IIN2	Read Word	2	Direct	100	A	N/A
CFh	READ_IIN3	Read Word	2	Direct	100	A	N/A
D3h	MODULE_CONFIG	Write Word	2	Bitmapped	N/A	N/A	Basic
D6h	MODULE_DETECTION	Read Byte	1	Bitmapped	N/A	N/A	Basic
D7h	MODULE_SAVE	Write Byte	1	Bitmapped	N/A	N/A	Basic
E1h	FW_VERSION	Read Byte	8	ASCII	N/A	N/A	N/A

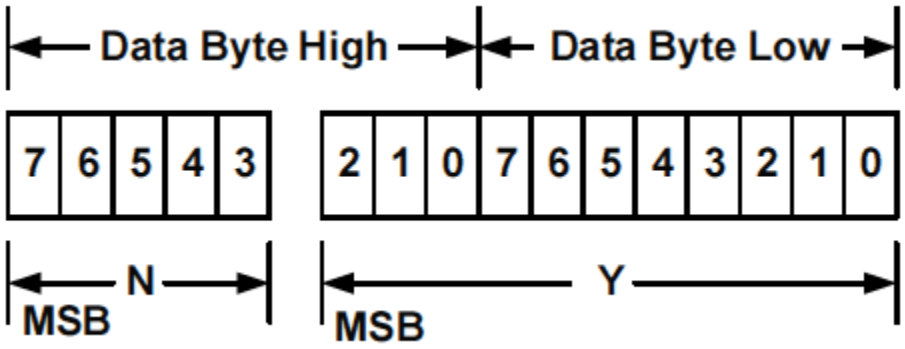
B.4 Data Format: Linear

Data Format Linear is one of the PMBUS Data Format used in iHP units. Please refer to Appendix B.1, B.2, and B.3 for the PMBUS Commands that uses Linear Data Format.

The Linear Data Format is a two byte value with:

- An 11bit, two's complement mantissa.
- An 5bit, two's complement exponent (scaling factor)

The format of the two data bytes is illustrated below



The relationship between Y, N, and the "real word" value is:

$$X = Y * 2^N$$

Where:

X is the "real word" value

Y is an 11bit, two's complement integer

N is a 5 bit, two's complement integer

Example:

Module PMBUS Command 8Dh

Data return: EAC0h

- High Byte: EAh = 1110 1010b
- Low Byte: C0h = 1100 0000b

Interpretation:

N = 11101b = -3

Y = 01011000000 = 704

Computation

$X= Y * 2^N$

$X= (704) * 2^{(-3)}$

$X= 88\ ^oC$

B.5 Data Format: Direct

One of the Data Format used in iHP units. Please refer to Appendix B.1, B.2, and B.3 for the Commands that uses Direct Data Format.

In order to convert the data in to “real word” value, user needs to determine the # of bytes and the multiplier.

The relationship between Y, N, and the “real word” value is:

Y = X * N

Where:

X is the “real word” value

Y is the data read from the device in decimal.

N is a the multiplier

Example 1:

Module Command 8Bh (READ_VOUT)

# of byte = 3 Byte

Multiplier = N = 10000

COMMAND 8Bh returns a data of 0757B0h

Convert 0757B0h to decimal = 481200

Y = X * N

481200 = X * 10000

X = 48.12 V

Example 2

Module Command 8Ch (READ_IOUT)

# of byte = 3 Byte

Multiplier = N = 10000

COMMAND 8Bh returns a data of 098968h

Convert 098968h to decimal = 625000

Y = X * N

625000 = X * 10000

X = 62.5A

Example 3

Module Command 48h (OV_FAULT_LIMIT_MULTIPLIER)

# of byte = 2 Byte

Multiplier = N = 100

COMMAND 48h returns a data of 2EE0h

Convert 2EE0h to decimal = 12000

Y = X * N

12000 = X * 100

X = 120%

Appendix C – MODULE REGISTER MFR_REG (FAE and VAR only)

MODULE Command Definition for MFR_REG

Command Code	Command Name	Definition
40h	VOUT_OV_FAULT_LIMIT	Command to Read the Voltage level of the Module OVP. Based on Module Command 48h.
42h	VOUT_OV_WARN_LIMIT	Command to Read the Voltage level of the Module OVP Warn. Based on Module Command 49h.
43h	VOUT_UV_WARN_LIMIT	Command to Read the Voltage level of the Module UVP. Based on Module Command 44h.
44h	VOUT_UV_FAULT_LIMIT	Command to Read the Voltage level of the Module UVP Warn. Based on Module Command 43h.
46h	IOUT_OC_FAULT_LIMIT	Command to Read the Voltage level of the Module OCP. Based on Module Command 4Dh. This is only applicable when over current protection is set to latch protection (Module command 52h).
47h	IOUT_OC_FAULT_RESPONSE	Same as standard PMBUS_IOUT_OC_FAULT_RESPONSE Register. Read Module Response during over-current fault condition Fix Data: C0h – Device Shuts down
4Ah	IOUT_OC_WARN_LIMIT	Command to Read the Voltage level of the Module OCP Warn. Based on Module Command 4Eh. This is only applicable when over current protection is set to latch protection (Module command 52h).

Command Code	Command Name	Definition
4Eh	OC_WARN_LIMIT_MULTIPLIER	Data is used to compute for the Over Current Warning (OCP) level of the module Refer to Module Command data classification for Data Format. Digital Voltage Source and Analog Voltage Source Latch OCW level = (Io nominal)*(OC_WARN_LIMIT_MULTIPLIER) CC OC level = (Io nominal)*(OC_WARN_LIMIT_MULTIPLIER) Data Range: 105% to 120% Digital Programming Current Source and Analog Programming Current Source OC_FAULT_LIMIT_MULTIPLIER is not functional during this operation.
53h	VoutLow_Sckt_Level	During Voltage Source Mode, when module enters CC mode operation due to current overload, the module latches off when the output voltage level goes less than or equal to VoutLow_SCKT_Level for the validation period of 2s. To read Command 53h o Read Command 53h To change Command 53h ○ Disable Write Protect via Module command 10h ○ Send Admin access via Module command E2h ○ Write to 53h ○ Data written to 53h will be immediately updated User can implement save command using ISOCOMM Command D6h.

Command Code	Command Name	Definition
54h	IoutHigh_Sckt_Level	During Current Source Mode, when the module's output current goes greater than or equal to IoutHigh_Sckt_Level, the module latches off when the output voltage level goes less than or equal to the VoutLow_SCKT_Level (53h) setting for the validation period (default: 2s). To read Command 54h o Read Command 54h To change Command 54h o Disable Write Protect via Module command 10h o Send Admin access via Module command E2h o Write to 54h o Data written to 53h will be immediately updated User can implement save command using ISOCOMM Command D6h.
61h	TON_RISE	Maximum allowable Output voltage rise time. Please refer to Command 0xB5h to change the output voltage rise time Refer to Module Command data classification for Data Format. Fix Value of 250msec.
62h	TON_MAX_FAULT_LIMIT	Same as standard PMBUS TON_MAX_FAULT_LIMIT Register. Read maximum rise time before fault. Fix Data: 350msecs.
63h	TON_MAX_FAULT_RESPONSE	Same as standard PMBUS TON_MAX_FAULT_RESPONSE Register. Read response of unit when rise time is greater than TON_MAX_FAULT_LIMIT Fix Data: 00h (Latch)
6Ah	POUT_OP_WARN_LIMIT	Module Over Power Warning level. Refer to Module Command data classification for Data Format.

Command Code	Command Name	Definition
8Eh	READ_TEMPERATURE_2	Read Module Cool Temp setting used by ISOCOMM Fan Control.
B3h	PCSI	Contains the active values for CONTROL LOOP settings. Be cautious in changing values. Can be written but values will not be saved. User can Read the PCSI configuration Read B3h (Offset) User can write the PCSI configuration. Write Procedure -Write Protect Disable via Module Command 10h -Enter Admin Password via Module Command E2h -Write all the required data using command B3h. Write B3h <Offset> <Data> One Offset per B3h command. - Need to have an On to Off transition before the changes will take into effect If unit is already off when the write B3h command is sent, user needs to ON then OFF before the changes will take into effect. -Turn-off the module either • Module Operational Command • ISOCOMM Operational Command • Module HW signal (SYS_M_INHIBIT and SYS_M_ENABLE#) • RACK HW signal (Global Inhibit/Enable Logic “0” and Global Inhibit/Enable Logic “1”) To Lock again the B3h after write. -User needs to send Lock command via E2h Write E2h <Lock code> -Enable Module Write Protect via Module Command 10h.
B9h	SET_WIRE_IMPEDANCE	Defines the wire impedance during Droop Operation in mohms.

Command Code	Command Name	Definition
BBh	DSP_SOFTWARE RESET	Command to re-initialize the Module DSP. ○ Disable Write Protect via Module command 10h ○ Send Admin access via Module command E2h ○ Turn-off the module either • Module Operational Command • ISOCOMM Operational Command • Module HW signal (SYS_M_INHIBIT and SYS_M_ENABLE#) • RACK HW signal (Global Inhibit/Enable Logic “0” and Global Inhibit/Enable Logic “1”) ○ Send Module command BBh. ○ After sending BBh, module will re-initialize for less than 1sec. ○ Users can now turn-on the module.
D4h	MODULE_OPERATION	Module command to authorize any change of configuration. These include changes in Module PMBUSCommand D3h, F9h, and FAh. Data “00” means disable write to D3h, F9h, and FAh. Data “01” means enable write to D3h, F9h, and FAh.

D5h	PCSI_DATA_CMD	Contains the control settings for different load types. The corresponding settings from this register are loaded to B3h PCSI register during DSP initialization. Difference between B3h and D5h. B3h changes will be active during unit is power-on. When the unit shutdown and restart again the setting will revert back to the original. D5h changes will be save to DSP and will retain the save values every power-up. User can Read the PCSI configuration Read D5h (Offset) User can write the PCSI configuration. Write Procedure -Turn-off the module either ○ Module Operational Command ○ ISOCOMM Operational Command ○ Module HW signal (SYS_M_INHIBIT and SYS_M_ENABLE#) ○ RACK HW signal (Global Inhibit/Enable Logic “0” and Global Inhibit/Enable Logic “1”) -Write Protect Disable via Module 10h -Enter Admin Password via Module E2h -Send Unlock register via Module Command E3h data “01” -Write all the required data using command D5h. Write D5h <Offset> <Data> One Offset per D5h command. -Send queue save command via Module Command E3h data “05” - Send save command via Module Command E3h data “00” -Module will automatically save the new settings -Module command D5h and 10h will automatically lock. -Module command E2h will be reset. -Module can now be turn-on.
D7h	MEMORY_ERROR	Asserted Bits means that there is an invalid checksum

Command Code	Command Name	Definition
		Bit 15- 5: Reserved/ Unused Bit 4: Memory Error Fault Auto Bit Bit4 Assertion due to User Settings Applied. Updated only in Initialization Bit 4 Deassertion: Writing in 0xF9 and 0xFA Command Bit 3: Memory Error Fault Bit Bit3 Assertion/De-assertion due Bitwise OR from Bit0 to Bit2 Bit 2: Reference Memory Page Error Bit. Bit 1: Config Memory Page Error Bit. Bit 0: User Calibration Memory Page Error Bit.
E2h	CONFIG_UNLOCK_CODE	Command for entering password ○ Lock: 20h 20h 20h 20h ○ User access password: 55h 73h 65h 72h ○ Admin access password: 43h 6Fh 6Eh 66h User Access ○ Module command F9h, and FAh. Admin Access ○ Module command E4h, F7h, B0h, B3h, B4h, and D5h.
E3h	CONFIG_CTRL	Command for modifying and saving sensitive registers. ○ Used for registers B0h, D5h, E4h, F7h Write data is as follows: 00h = Save & Lock Registers 01h = Unlock Registers 02h = Queue E4h Saving 03h = Queue F7h Saving 05h = Queue D5h Saving 06h = Queue B0h Saving

Command Code	Command Name	Definition
E4h	CONFIG_DATA	Contains the Module Housekeeping Configuration. User can Read the Module Housekeeping Configuration Read E4h (Offset) User can write the Housekeeping Configuration. Write Procedure -Turn-off the module either ○ Module Operational Command ○ ISOCOMM Operational Command ○ Module HW signal (SYS_M_INHIBIT and SYS_M_ENABLE#) ○ RACK HW signal (Global Inhibit/Enable Logic "0" and Global Inhibit/Enable Logic "1") -Write Protect Disable via Module command10h -Enter Admin Password via Module command E2h -Send Unlock register via Module Command E3h data "01" -Write all the required data using command E4h. Write E4h <Offset> <Data> One Offset per E4h command. -Send queue save command via Module Command E3h data "02" - Send save command via Module Command E3h data "00" -Module will automatically save the new settings -Module command D5h and 10h will automatically lock. -Module command E2h will be reset. -Module can now be turn-on.
EDh	READ_VOR	Command used to read VOR reported value
F6h	CAL_RAW_READ	Command to read the raw data of various parameters used for Module Calibration (Vout, Vor, Internal Shunt, External Shunt, IMON, TEMP3 and TEMP1). Used by Calibration GUI

Command Code	Command Name	Definition
F7h	CAL_COEF_DATA	Register used to Read/Write Module Calibration Parameters ○ VPROG, IPROG IMON, TEMP1, and TEMP2 coefficient. ○ Voltage and Current programming reporting Factory default coefficient ○ Calibrated nominal setting VREF and IREF factory default setting. ○ Factory calibration date. Used by Calibration GUI
F9h	USER_SETTINGS	Register used to Read/Write Module Calibration Parameters ○ Voltage and Current programming reporting active coefficient ○ User calibration date. Used by Calibration GUI
FAh	RESTORE_FACTORY_CAL	Command which restores the Factory Calibration Settings for digital programming & reporting parameters Procedure: User can restore factory cal for digital programming and reporting parameters. Write Procedure -Write Protect Disable via Module command 10h -Enter USER Password via Module command E2h - Write Command D4h data “01h” -Send byte to FAh -Write Command D4h data “01h” -User can implement save command using ISOCOMM Command D6h.
FBh	READCONVREF_FILT	Command to read the raw data of various parameters used for Module Calibration (VPROG and IPROG). Used by Calibration GUI

Module Command Data Classifications for MFR_REG

Command	Command Name	Transaction Type	# of Bytes	Data Format	Multiplier	Data Unit	Write Prtotection
40h	VOUT_OV_FAULT_LIMIT	Read Word	3	Direct	10000	V	N/A
42h	VOUT_OV_WARN_LIMIT	Read Word	3	Direct	10000	V	N/A
43h	VOUT_UV_WARN_LIMIT	Read Word	3	Direct	10000	V	N/A
44h	VOUT_UV_FAULT_LIMIT	Read Word	3	Direct	10000	V	N/A
46h	IOUT_OC_FAULT_LIMIT	Read Word	3	Direct	10000	A	N/A
47h	IOUT_OC_FAULT_RESPONSE	Read Byte	1	Bitmapped	N/A	N/A	N/A
4Ah	IOUT_OC_WARN_LIMIT	Read Word	3	Direct	10000	A	N/A
4Eh	OC_WARN_LIMIT_MULTIPLIER	Block Read / Write Word	2	Direct	100	%	Basic
53h	VoutLow_Sckt_Level	Read/Write Word	3	Direct	10000	V	Basic
54h	IoutHigh_Sckt_Level	Read/Write Word	3	Direct	10000	A	Basic
61h	TON_RISE	Read Word	2	Linear	N/A	ms	N/A
62h	TON_MAX_FAULT_LIMIT	Read Word	2	Linear	N/A	ms	N/A
63h	TON_MAX_FAULT_RESPONSE	Read Byte	1	Bitmapped	N/A	N/A	N/A
6Ah	POUT_OP_WARN_LIMIT	Read Word	2	Linear	N/A	W	N/A
8Eh	READ_TEMPERATURE_2	Read Word	2	Linear	N/A	^{0}C	N/A
B3h	PCSI	Block Read/Write	Varies	Direct	N/A	N/A	Factory Config*
B9h	SET_WIRE_IMPEDANCE	Block Read/Write	2	DIRECT	1	Mohm	Basic
BBh	DSP_SOFTWARE RESET	Send Byte	0	N/A	N/A	N/A	Factory Config*
D4h	MODULE_OPERATION	Read/Write Byte	1	Bitmapped	N/A	N/A	Basic
D5h	PCSI_DATA_CMD	Block Read/Write	Varies	Direct	N/A	N/A	Factory Config*
D7h	MEMORY_ERROR	Read Word	1	Bitmapped	N/A	N/A	N/A

Command	Command Name	Transaction Type	# of Bytes	Data Format	Multiplier	Data Unit	Write Prtotection
E2h	CONFIG_UNLOCK_CODE	Read/Write Byte	4	N/A	N/A	N/A	Basic
E3h	CONFIG_CTRL	WRITE Byte	1	MFR	N/A	N/A	Basic
E4h	CONFIG_DATA	Block Read/Write	4	Direct	N/A	N/A	Factory Config*
EDh	READ_VOR	Block Read	3	Direct	10000	V	N/A
F6h	CAL_RAW_READ	Block Read	4	Direct	N/A	N/A	N/A
F7h	CAL_COEF_DATA	Block Read/Write	4	Direct	N/A	N/A	Factory Config*
F9h	USER_SETTINGS	Block Read/Write	4	Direct	N/A	N/A	User Config**
FAh	RESTORE_FACTORY_CAL	Write Byte	1	N/A	N/A	N/A	User Config**
FBh	READCONVREF_FILT	Block Read	8	Direct	N/A	N/A	N/A

Note: * - Factory Config requires Factory Password
** - User Config requires User Password

For ISOCOMM B8h

B8h	SET_MODULE_LOAD_TYPE	Command to read Module compensation data: 01h – Resistive load compensation Data: 02h - Capacitive load compensation Data: 04h - LED load compensation Module will not accept any data aside from the above listing. If set outside the accepted data, ○ Module will revert to the previous setting. ○ STATUS_CML will be asserted. ○ Module is still operational. Voltage Source: ○ Every change to Voltage Source, B8h will automatically be set to data 02h ○ In order for Module to work properly, B8h should be set to data 02h during Voltage Source. Current Source, ○ B8h can be configured to 01h, 02h, or 03h. Depending on user application. ○ When changing to Current Source, last setting of B8h during Current Source operation will be set to the Module.

Here are the settings of each module based on latest config (ini) file:

	24V	48V	80V	125V	250V
VOR Clamp	1.087V	2.174V	3.6233V	6.0388V	11.4421V
Brick Wall OVP	31.3V	64.5V	110V	162V	315V

- VOR clamp level based on actual module read back
- Brick Wall OVP calculated based on DSP pin voltage
- Values may vary between units due to effects of calibration since both settings are based on DSP pin voltages

Appendix D – FAE and VAR Only

Input Config Change

iHP Rack can operate on 3P Low Line (3P 187.5Vac to 264Vac) and 3P High Line (3P 342Vac to 528Vac). At any instance, the iHP RACK can operate only in one input line either 3P Low Line or 3P High Line.

The Input line operation of an iHP RACK can be change from 3P High Line to 3P Low Line or vice-versa. The input configuration is dependent on the Input Config Board. This board is internal to the iHP RACK.

There are two types of Input Configuration board. These are the 3P Low Line Config Board and 3P High Line Config Board.

Warning! - Unit will be DAMAGE: if a high line input voltage is applied to a iHP RACK unit with 3P Low Line *config.*

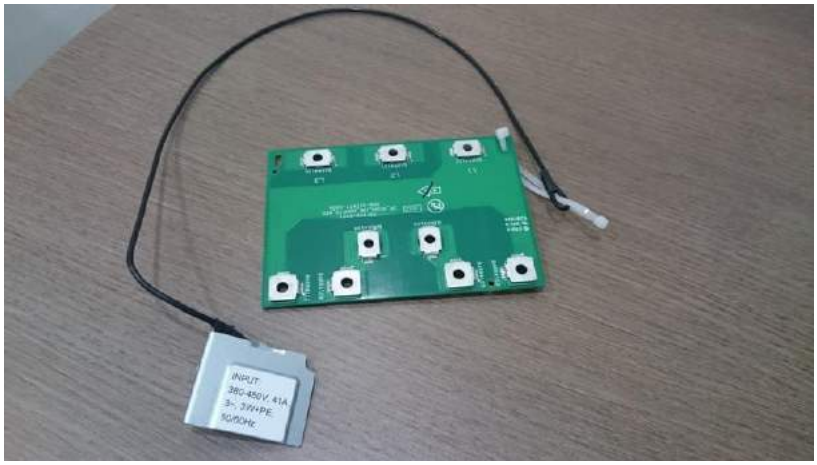
The Value Added Resellers (VARs) are authorized to change the Input Config board. Users are not allowed to do the hardware change.

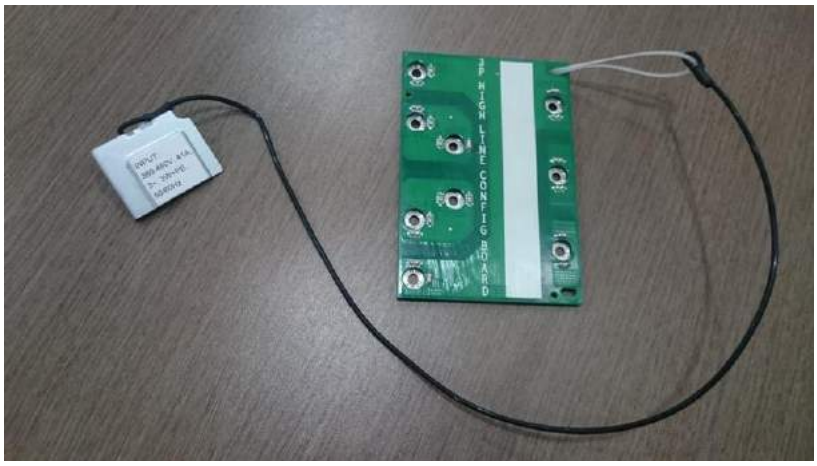
Each type of Input Configuration Board has a label printed on the board.

3P High Line Board label is “3P HIGH LINE CONFIG BOARD” in white color.

3P Low Line Board label is “3P LOW LINE CONFIG BOARD” in Black color.

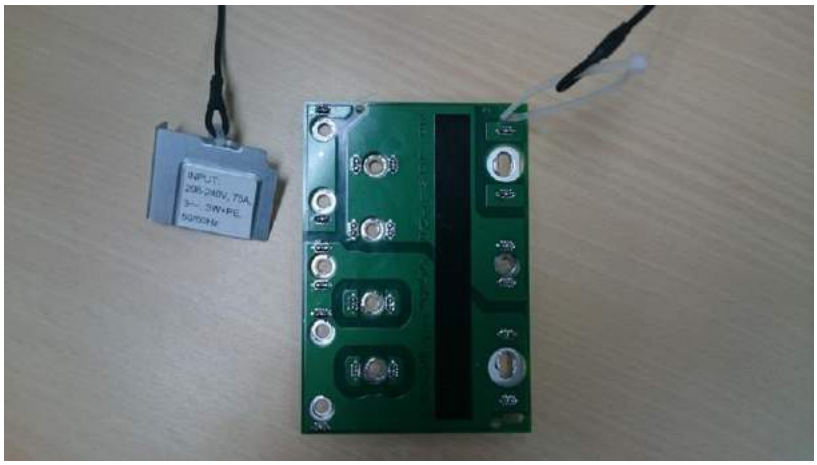
3P High Line Config Board



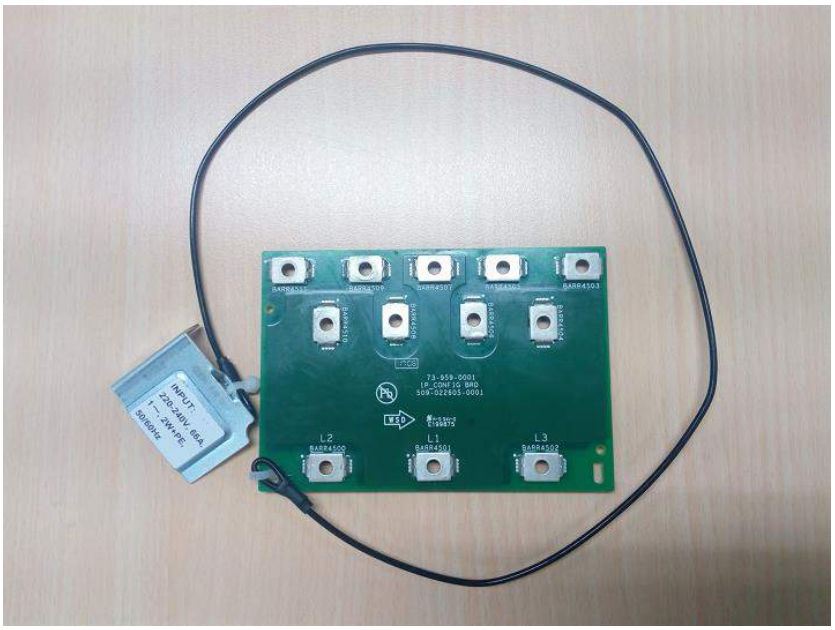


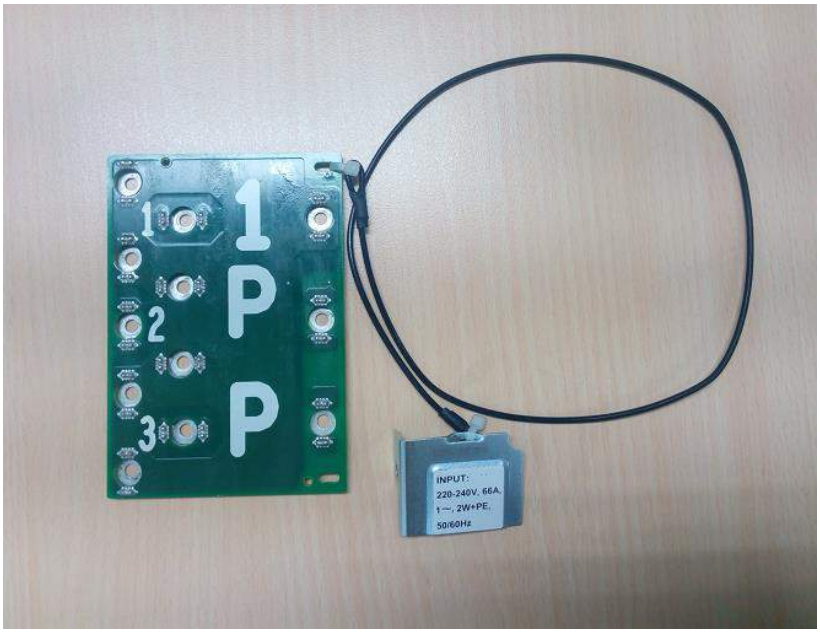
3P Low Line Config Board





1P Config Board





Required Tools for the Input Configuration Board Change.

- Torx screwdriver #15
- Torx screwdriver #20

Input Configuration Board Screw

Input Configuration Board screw is an M4 screw with 8mm length.

Recommended screw for the Input Configuration Board

Manufacturer	Manufacturer Part Number
BOSSARD	6166428
NISSHI METAL SCREW	G-A01-B1589

Input Configuration Board	Number of M4 Screw
3P Low Line Configuration	12pcs
3P High Line Configuration	9pcs

Procedure to change the Input Configuration Board.

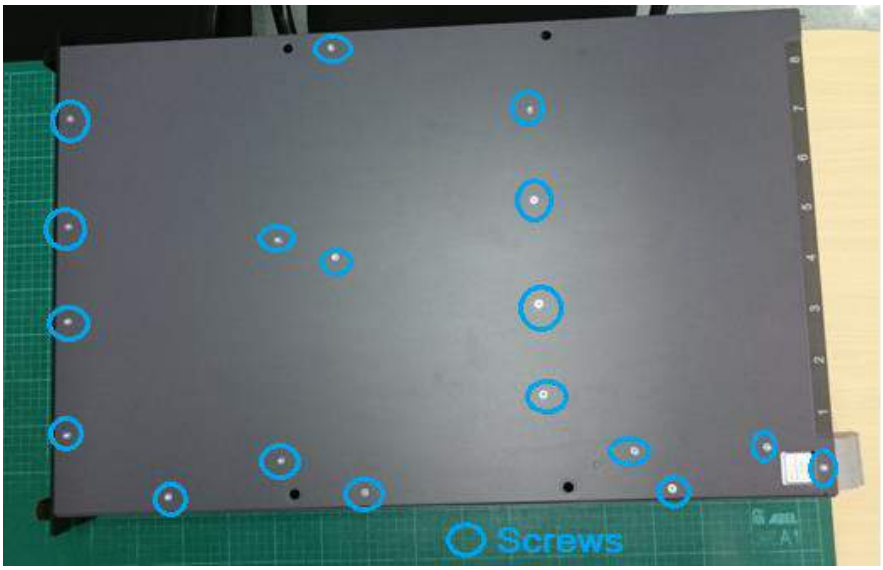
Notes:

- Be sure that the unit is not connected to the input AC.
- In this procedure, the Input Config Board was change from 3P High Line to 3P Low Line.
- Below procedure is also applicable in changing 3P Low Line to 3P High Line Input Config Board.

1. Remove Top Cover screws.

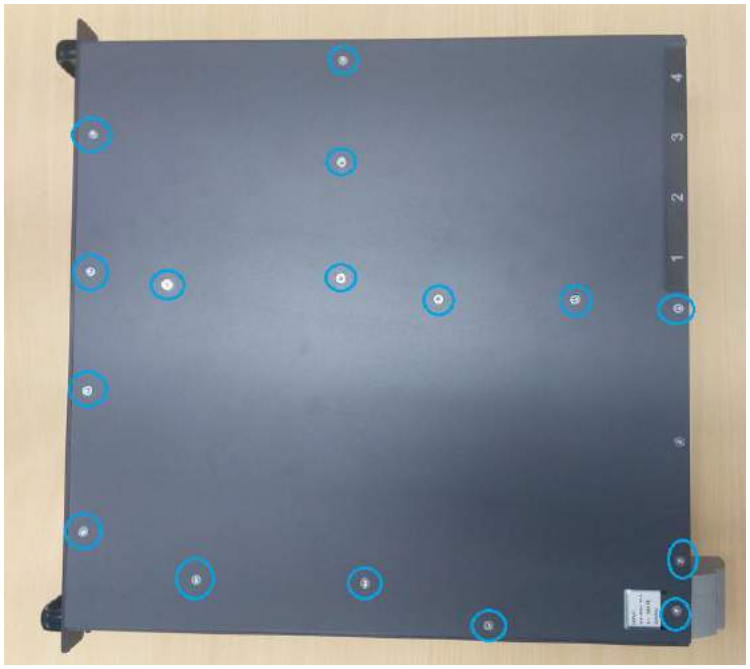
   Tool: Torx screwdriver #15

   24KW RACK





12KW RACK





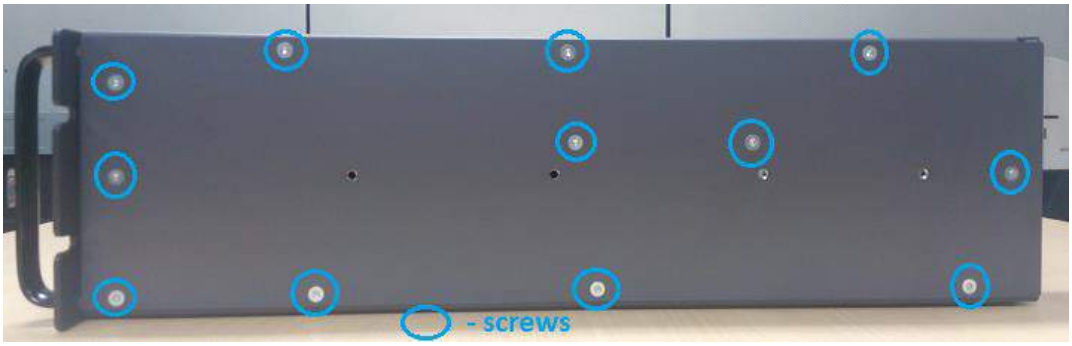
2. Remove Side Cover Screws

   Tool: Torx screwdriver #15

24KW RACK



12KW RACK



3. Push the Side cover upward then remove from the iHP RACK

24KW RACK





12KW RACK



4. Remove screw of the Config Label.

   Tool: Torx screwdriver #15

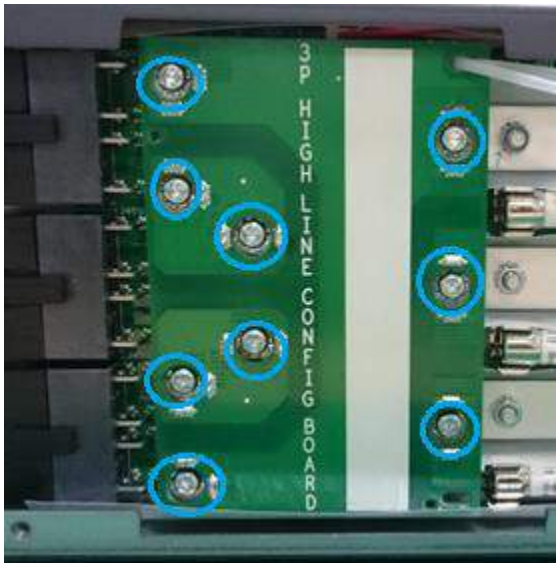


5. Push the Top cover near the Config Label upward. This will remove the Config Label.



6. Remove the screws in the Config Board. This will detach the config board from the iHP RACK.

   Tool: Torx screwdriver #20



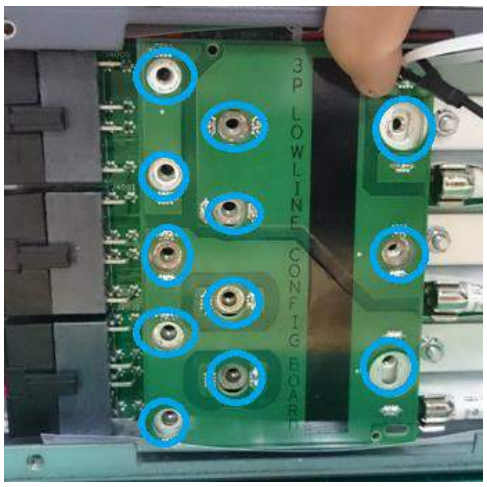
   Note: Number of screws for 3P Low Line Config Board and 3P High Line Config Board are not the same.

7. Prepare the Config Board to be installed in the iHP RACK



8. Install the Config Board in the AC Interconnect Board using screw.

   Tool: Torx screwdriver #20



Note: Number of screws for 3P Low Line Config Board and 3P High Line Config Board are not the same

9. Push the Top cover near the Config Label upward. Then, insert the Config Label.

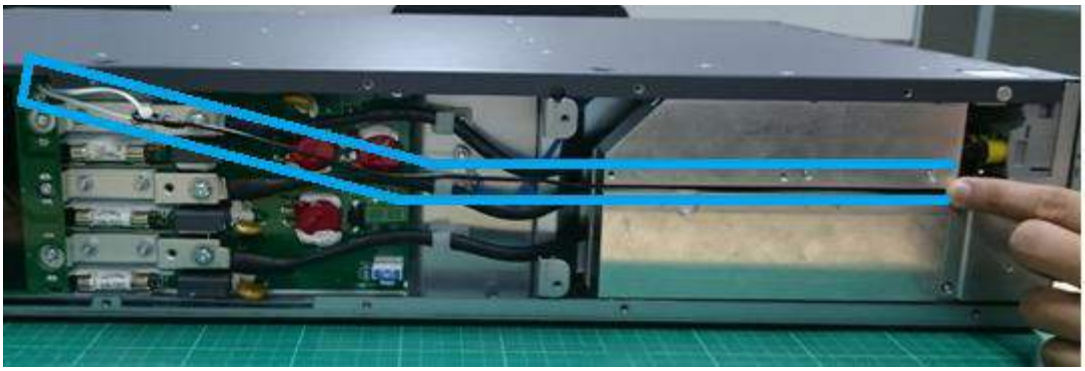


10. Fix the Config Label via screw.

    Tool: Torx screwdriver #15



11. Config Label cabling harnessing.

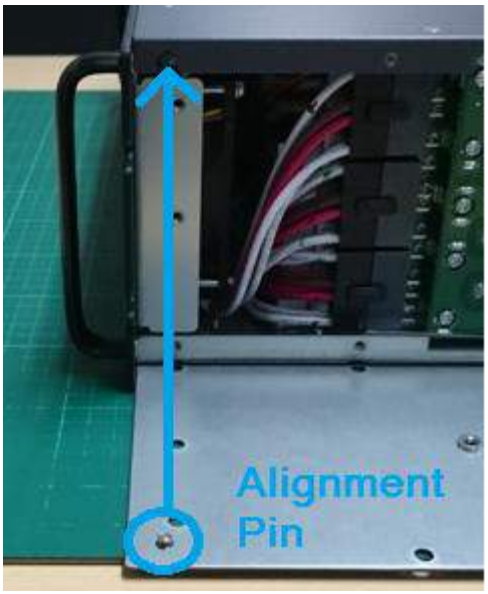


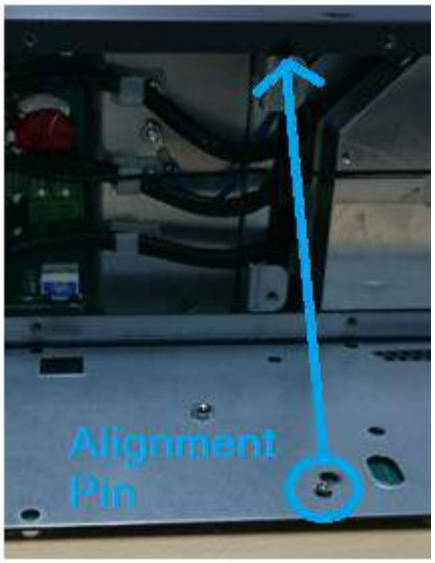
12. Install the Side cover to the iHP RACK using screw.

    Tool: Torx screwdriver #15

    Please take note the Alignment pin of the Side Panel to the iHP RACK.

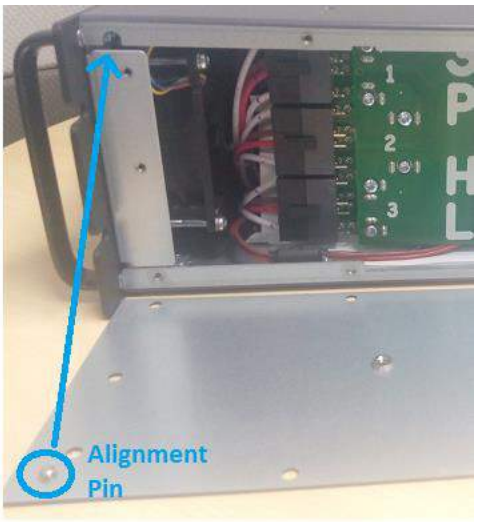
24KW RACK

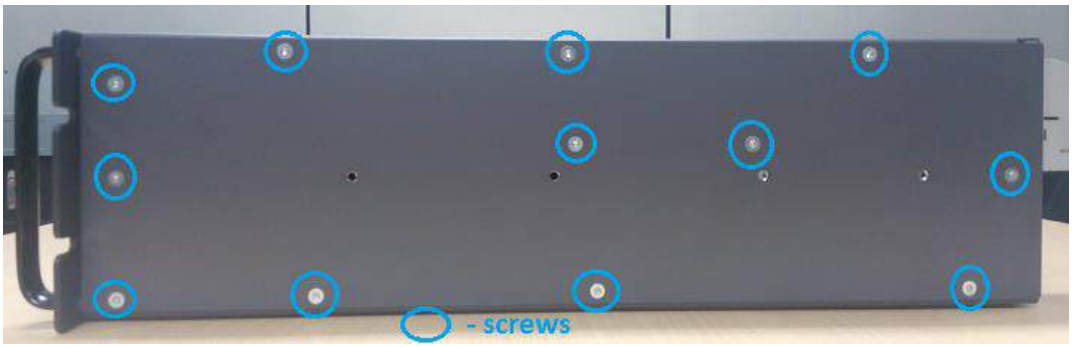






12KW RACK





13. Config Board Change Done.

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