Eaton© PowerPak Power Distribution Unit 50 – 300 kVA

Installation and Operation Manual

Powering Business Worldwide

p/n: 164001125
Revision 03

IMPORTANT SAFETY INSTRUCTIONS - SAVE THESE INSTRUCTIONS

This manual contains important instructions that you should follow during installation and maintenance of the equipment. Please read all instructions before operating the equipment and save this manual for future reference.

CONSIGNES DE SÉCURITÉ IMPORTANTES – CONSERVER CES INSTRUCTIONS

Ce manuel contient des instructions importantes que vous devez suivre lors de l'installation et de la maintenance de l'équipement. Veuillez consulter entièrement ces instructions avant de faire fonctionner l'équipement et conserver ce manuel afin de pouvoir vous y reporter ultérieurement.

⚠WARNING

This is a product for restricted sales distribution to informed partners (EN/IEC 62040-2). Installation restrictions or additional measures may be needed to prevent electromagnetic disturbances.

Dear Customer,

On behalf of everyone at Eaton, we thank you for partnering with us, for trusting us to maintain your business continuity and for preventing downtime at your facility.

Our suite of backup power, power distribution and power management products are designed to protect you from a host of threats including power outages, surges, and lighting strikes, and enable you to monitor and control your power infrastructure.

We trust that our products will deliver high quality, reliable power for your business, and we are committed to your success.

Please read this manual, which details the installation and operation processes for your new Eaton product.

Thank you for choosing Eaton!

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Chapter 1 Introduction

1.1 PowerPak PDU Summary

The WaveStar® PowerPak Power Distribution Unit (PDU) is a versatile and highly configurable 50- 300 kVA PDU. Features and options include the following:

- 50-300 kVA DOE transformer with a choice of transformer sizes, vectors, taps, and options, including the option of non-DOE efficiency standards for exempt and non-US customers.
- Wide variety of electrical, panelboard, and circuit breaker configurations.
- Top, bottom rear, and bottom front cable entry/exit.
- Manual dual PDU configuration with Kirk Key lockouts and choice of different permissive signals.
- Oversized neutrals.
- Optional Surge Protective Devices (SPDs) (or Transient Voltage Surge Suppressor (TVSS)) on input and output.
- Front- and side-facing Side Cars:
  - Up to (10) panelboards or (420) 1P branch circuits can be installed with Side Cars.
  - Up to (12) 250A subfeeds can be installed with Side Cars.
  - Square D I-Line subfeed panelboards (800A, 1000A, and 1200A) can be installed in specially designed Side Cars or Main Cabinet Extensions.
- Physically configurable for service access as front-only, front-and-rear, or front-rear-side(s).
- Can be integrated with WaveStar® Static Transfer Switches in Primary or Secondary Systems.
- Extensive monitoring capabilities:
  - WaveStar® Color Monitor as local PDU display.
  - Monitoring for transformer, main power feeds, subfeeds, panelboards, and other PDU functions.
  - Integration with the Eaton PDI family of Branch Circuit Monitoring System (BCMS) monitoring products.
  - Support for Modbus RTU, Modbus TCP/IP, and SNMP protocols through the Color Monitor, providing communications with Building Management Systems and Data Center Infrastructure Management (DCIM) Systems.
  - Extensive dry contact network.

You should consult with your Eaton sales representative and with Eaton PDI Applications Engineering to select a PDU package that meets your application needs.

1.2 Standards

The PowerPak PDU is certified through ETL for the following standards:

- UL 60950-1
- CS 22.2

In addition, the PowerPak PDU is designed, manufactured, tested, and installed in compliance with the following standards:

- UL67 UL50
- UL489

- UL 891
- UL1561
- IEEE 519-1991
- ANSI C33.4
- NEMA ST-20
- NEMA AB-1
- NEMA-PB-1
- NEC
- ISO 9001
- CS57.12.91

The PowerPak PDU complies with the latest FCC Part 15 EMI emission standard for Class A computing devices.

1.3 Environmental Requirements

1.3.1 Operating Limits

- Operating ambient temperature range: 0ºC to 40ºC (32ºF to 104ºF).
- Relative humidity range from 0% to 95% non-condensing.
- Maximum altitude 6,600 ft. For installation above 6,600 ft., consult with the factory for de-rating information.

1.3.2 Storage Conditions

If the PDU is not to be immediately installed and energized, it should be carefully stored in a warm, dry environment, preferably a heated building with a uniform temperature and air circulation to prevent condensation. It is especially important that the transformer be free of condensation and protected from contamination. The transformer and PDU should be stored in their factory protective coverings.

Storage temperature range must be within these limits: -36º C to +70º C (-33º F to 158º F).

If the transformer has been exposed to moisture, it should be dried out before being energized. Consult Eaton Service if the PDU or transformer have been exposed to moisture or contamination.

1.4 Using This Manual

Read this manual thoroughly and make sure you understand the procedures before you attempt to install, set up, operate or carry out any maintenance work on this Eaton product.

Read through each procedure before beginning the procedure. Perform only those procedures that apply to the unit being installed or operated.

1.5 Conventions Used in This Manual

This manual uses these type conventions:

NOTE Some conventions only apply to display screens (if installed).

- **Bold type** highlights important concepts in discussions, key terms in procedures, and menu options, or represents a command or option that you type or enter at a prompt.
- *Italic type* highlights notes and new terms where they are defined.

- `Screen type` represents information that appears on the screen or LCD.

Icon	Description
	Information notes call attention to important features or instructions.
[Keys]	Brackets are used when referring to a specific key, such as [Enter] or [Ctrl].

1.6 Symbols, Controls, and Indicators

The following are examples of symbols used on the PDU or accessories to alert you to important information:

RISK OF ELECTRIC SHOCK - Observe the warning associated with the risk of electric shock symbol.

CAUTION: REFER TO OPERATOR'S MANUAL - Refer to your operator's manual for additional information, such as important operating and maintenance instructions.

This symbol indicates that you should not discard waste electrical or electronic equipment (WEEE) in the trash. For proper disposal, contact your local recycling/reuse or hazardous waste center.

1.7 Getting Help

NOTE References to PDI (Power Distribution, Inc.) may appear in this manual. Service, warranties and support for these components are obtained from Eaton.

If help is needed with any of the following:

- Scheduling initial startup
- Regional locations and telephone numbers
- A question about any of the information in this manual
- A question this manual does not answer

Please call the Eaton Help Desk at:

United States:**1-800-843-9433** or **1-919-870-3028**

Canada:**1-800-461-9166 ext 260**

All other countries:**Call your local service representative**

Please use the following e-mail for manual comments, suggestions, or to report a technical error in this manual.

E-ESSDocumentation@eaton.com

Eaton PDI PowerPak Power Distribution Unit website:Eaton PDI PowerPak PDU

1.8 Warranty and End User License Agreement

To view the warranty please click on the link or copy the address to download from the Eaton website:

Eaton Product Warranty

https://www.eaton.com/content/dam/eaton/products/backup-power-ups-surge-it-power-distribution/backup-power-ups/portfolio/eaton-three-phase-ups-warranty.pdf

https://www.eaton.com/content/dam/eaton/products/backup-power-ups-surge-it-power-distribution/backuppower-ups/portfolio/eaton-three-phase-ups-warranty.pdf

To view the End User License Agreement please click on the link or copy the address to download from the Eaton website:

Eaton End User License Agreement

https://www.eaton.com/content/dam/eaton/products/support-systems/software-and-cad-registration-form/eaton-end-user-software-license-agreement.pdf

Chapter 2 Safety

⚠WARNING

Follow safe electrical work practices:

- Severe or fatal injury can result from electrical shock during contact with high voltage conductors, monitoring PCBs, or similar equipment.
- Disconnect and lock-out all power supplying equipment before working on or installing components.
- Use a properly rated voltage sensing device to confirm power is OFF.
- Use Lock Out/Tag Out procedures.
- Wear suitable personal protective clothing and use protective equipment for performing mechanical and electrical installations.
- Install equipment in an appropriate electrical environment per local regulations.
- ESD sensitive equipment. Ground yourself, discharge any static charge and ensure that the device is effectively grounded before handling the unit.ESD sensitive equipment. Ground yourself, discharge any static charge and ensure that the device is effectively grounded before handling the unit.

Chapter 3 Installation Planning: PDU Layouts

3.1 PDU Enclosure

The PDU has a NEMA 1 enclosure with removable front, side, and rear panels. A NEMA 3R enclosure is optional. Advanced door catches ensure positive door closure.

3.1.1 PDU Dimensions

Table 1 below gives dimensions for the various PDU frames. Because frames are combined in different configurations, your actual PDU dimensions will vary by side car options and transformer size. Your submittal package will include drawings for your PDU's layout. To determine your PDU's footprint, you must also account for clearances (see below, 3.4 *Clearances*).

Table 1. PDU Dimensions

Main Cabinet (with ˂ 200 kVA transformer)	36.5"Wx 32.75"D x 74.75"H*
Main Cabinet (with 200–300 kVA transformer)	36.5"Wx 39.00"D x 74.75"H*
21" Front-Facing/Side-Facing Side Car add-on	21.00"W x 32.75"D x 74.75"H*
9"Side-Facing Side Caradd-on	9.00"Wx32.75"D x 74.75"H*
12"Side-Facing Side Car (I-Line Panelboards)add-on	12.00"W x 32.75"D x 74.75"H*
Main Cabinet extension for 1200A I-Line Panelboards	46.75"W x 32.75"D x 74.75"H*
*Includes height of PDU with casters.	

NOTE See sample PDU layout drawings (Figure 2 to Figure 6) for dimensions on several PDU configurations.

12" side cars and the Main Cabinet extension can also be used for larger 400A panelboards.

3.1.2 Spacers

In some cases, spacers are used to extend the PDU enclosure:

- A 6.25" rear spacer is added for larger transformers, 200-300 kVA (see above, Table 1).
- A 3" side spacer is used for monitoring components when a dense PDU configuration leaves no room inside the Main Cabinet (Figure 1).

Your submittal drawings will show dimensions for your specific PDU.

Figure 1. Main Cabinet with 3-in Side Spacer

3.2 PDU Weights

PDU weight varies by configuration, especially by transformer size.

PDU Configuration	Transformer	Approximate Weight (LBS)
Main Cabinet, no side cars, 2 panelboards	75 kVA	1300
Main Cabinet, 1 x 9" side car, 2 panelboards	125 kVA	1610
Main Cabinet, no side cars, 4 subfeeds	150 kVA	1705
Main Cabinet, 1 x 9" side car, 4 panelboards	150 kVA	1785
Main Cabinet, no side cars, 6 subfeeds,	225 kVA	2010
Main Cabinet, 1 x 9" side car, 2 panelboards	225 kVA	2205
Main Cabinet, 1 x 21" side car, 6 subfeeds	300 kVA	2470
Main Cabinet, 1 x 21" side car, 6 subfeeds	300 kVA	2695
Main Cabinet, 1 x 21" side car, 4 subfeeds	300 kVA	2840
Note 1: Weights are from actual shipments. Weights vary by the PDU's component characteristics.		
Note 2: Floor stands are not included in the PDU weight. Floor stand weights in the above examples are about 200-400 lbs.		

PDU shipping weight is given on the bill of lading.

3.3 Mounting Options

The PDU can be installed on both fixed floor or on a floor stand in a raised floor environment. The PDU alone or the PDU with floor stand conforms to seismic zone four requirements, California standard, per IBC 2010. The following mounting options are available:

- Heavy duty casters and leveling feet are standard on the Main Cabinet. Casters can support the weight of the PDU.

- An optional universal floor stand is available with heights from 11-76" H to match raised floor height. See 5.5 *Placing PDU on Optional Floor Stand*. Fixed height floor stands are also available for 8-11" heights.
- An optional skirt provides air closure around the PDU.

3.4 Clearances

Ventilation clearance: recommended 6" minimum ventilation clearance on rear and both sides; 18" overhead clearance also recommended.

Service clearance: 36" required front access; 36" required side clearance for Side Cars with side access. 36" service clearance is also required in PDU rear to access transformer taps and infrared scanning unless the transformer is rotated.

Cabling: 12" under floor cabling clearance is recommended for raised floor.

3.5 PDU Layouts

The PDU has many possible configurations as Main Cabinet only or Main Cabinet plus Side Cars on either side or with a Main Cabinet Extension. (Figure 2 to Figure 6) show selected layouts.

Figure 2. PDU 50-150 kVA Main Cabinet with Panelboards (Example)

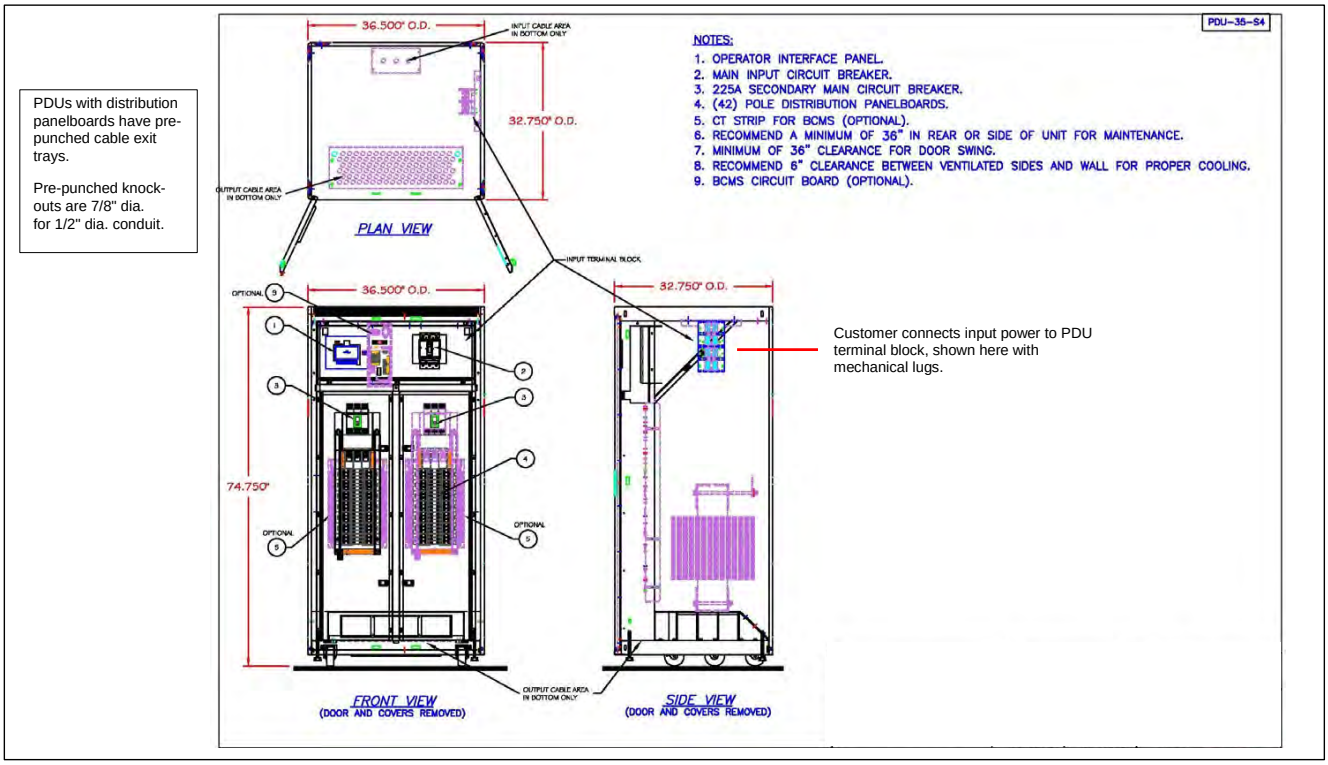


Figure 3. PDU 200-300 kVA with 9-in Side Car and Four Panelboards (Example)

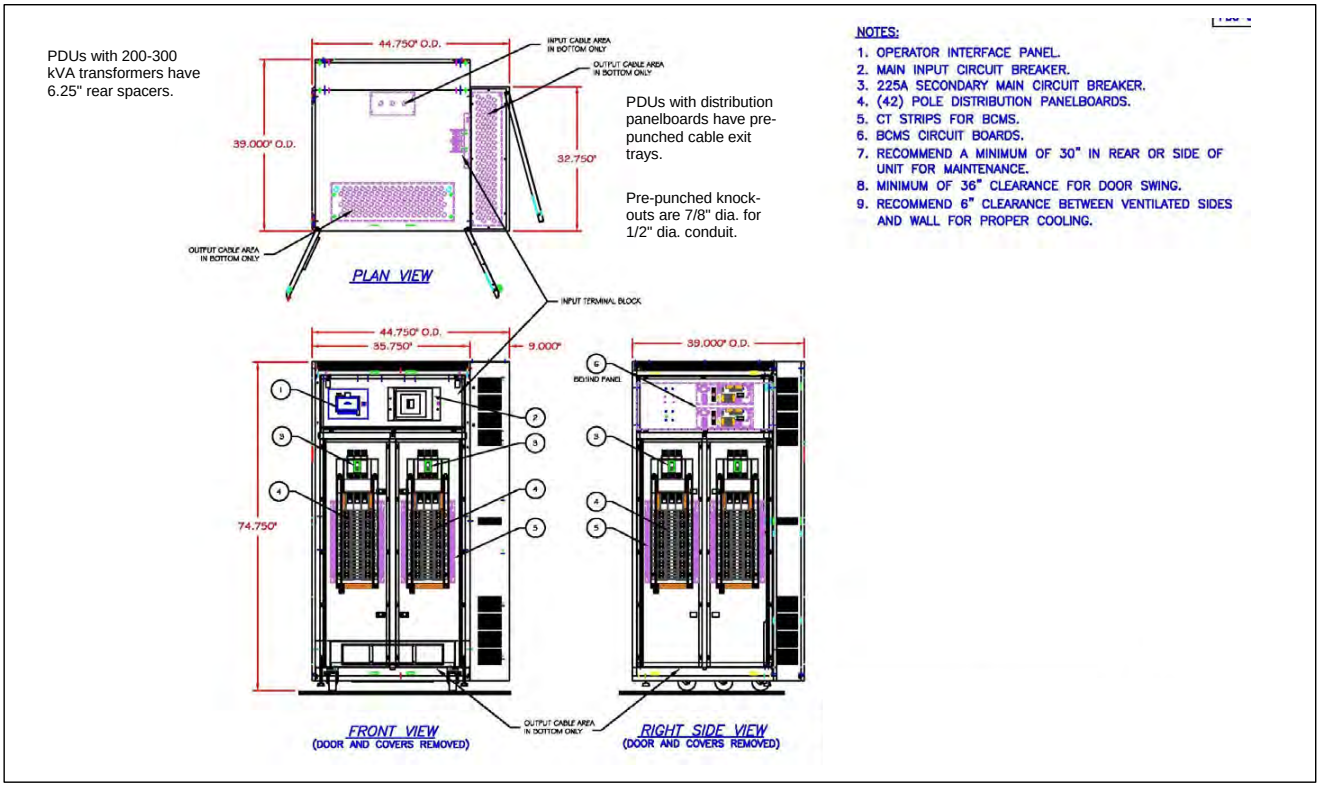


Figure 4. PDU 200-300 kVA with 21-in Side Car and Front-Facing Transformer Taps (Example)

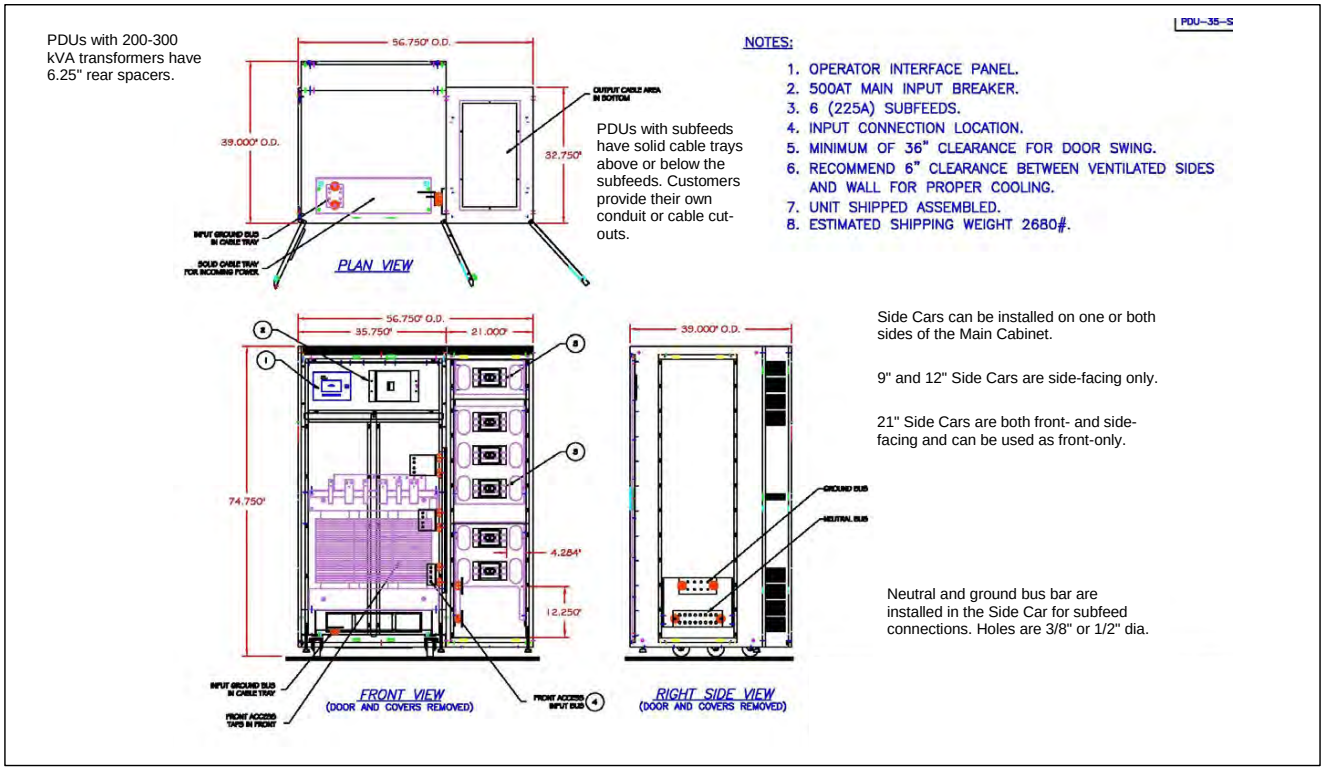


Figure 5. Main Cabinet and 12-in Side Car with 1000A I-Line Panelboard (Example)

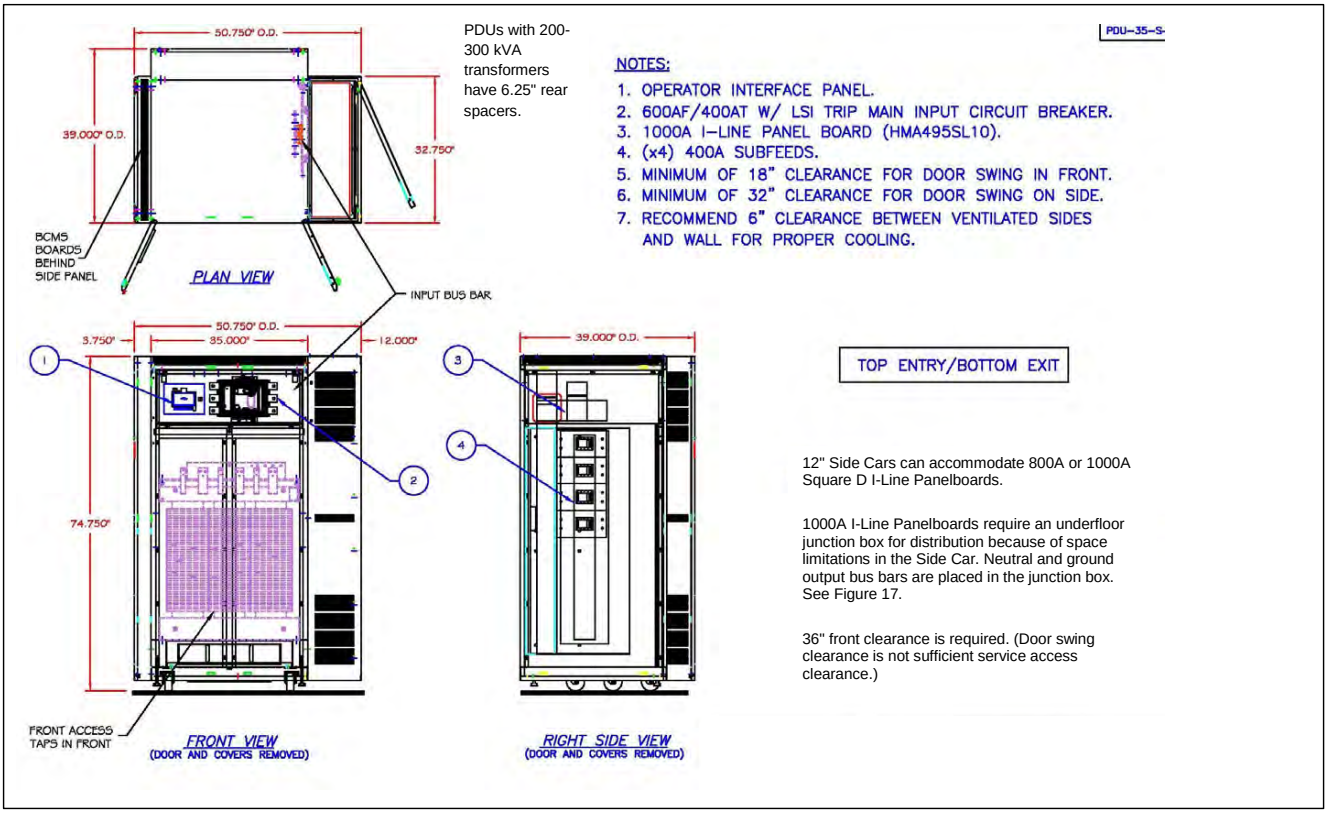
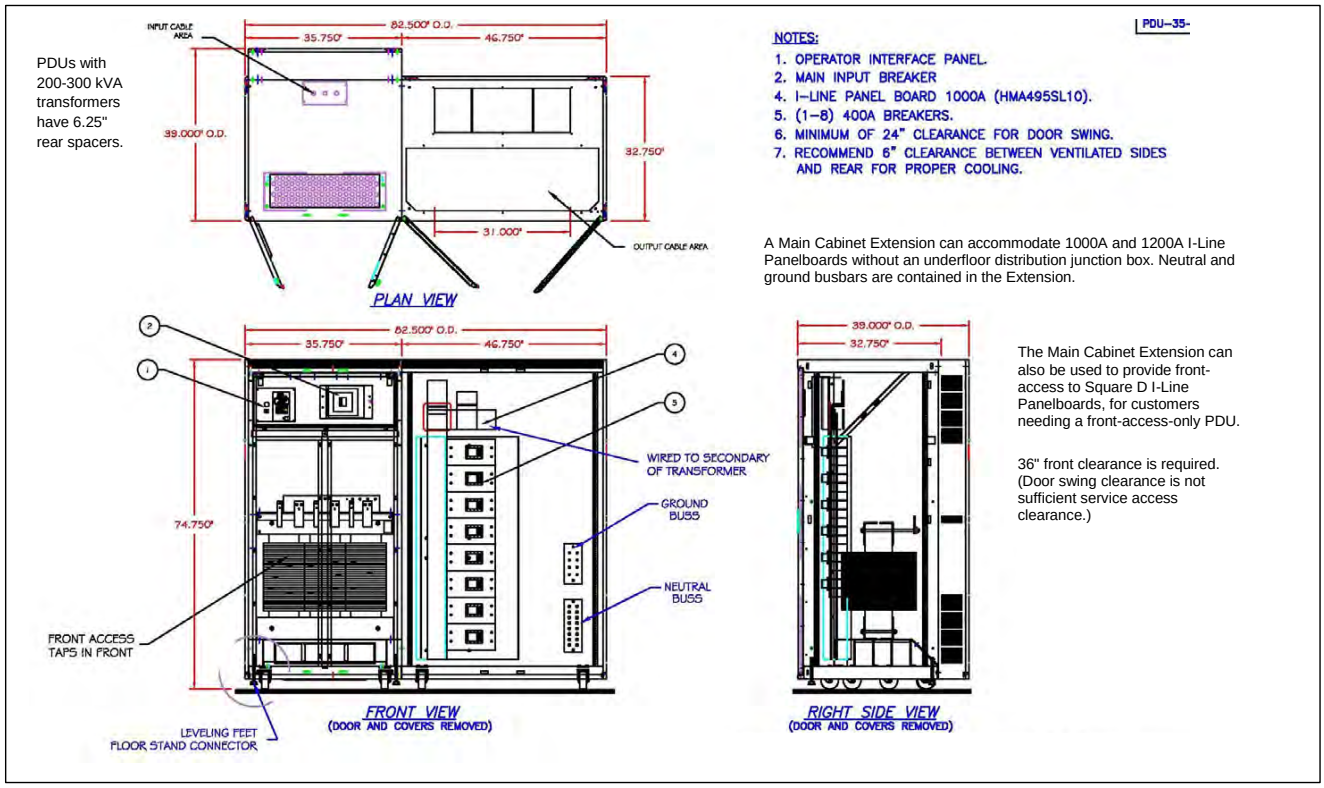


Figure 6. Front-Access PDU: Main Cabinet and Extension with 1000A I-Line Panelboard (Example)



3.6 PDU Service Access Configurations

The PDU can be flexibly configured for different service access requirements:

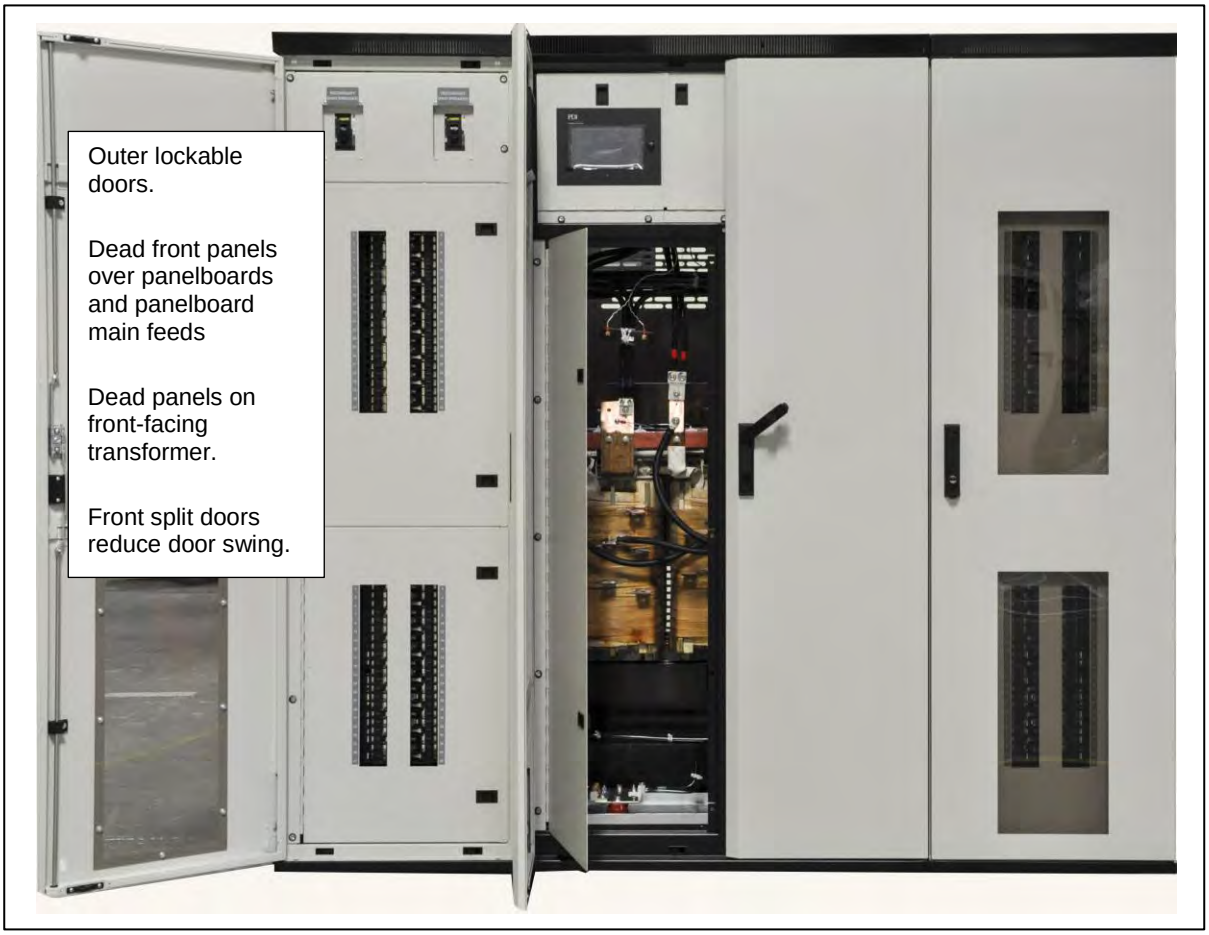
- Front access only PDU
- Front and side access only (one or both sides)
- Front and rear access only
- Front, side, and rear access PDU (one or both sides)

3.6.1 Front Access Only

The PDU can be made front-access for routine maintenance, including easy circuit breaker replacement, and extension of circuit breaker capacity.

The transformer can as an option be turned 180º making transformer taps and infrared scanning front-accessible. Distribution should be in the Side Cars. Rear service access is not required; only 6" ventilation clearance is required at the rear or sides.

Figure 7. PowerPak Front-Access PDU with Two 21-in Side Cars



Front access PDUs can have the following:

- Main Cabinet should have front-facing transformer for front access to taps and infrared scanning.
- 21″ front- and side-facing Side Cars, using front access only to Side Cars.
- (Optional) Main Cabinet Extension for 1000A or 1200A Square D I-Line panelboards.

3.6.2 Front and Side Access Only

Front and side-access PDUs (one or both sides) can have the following:

- Main Cabinet with front-facing transformer.
- 21″ front- and side-facing Side Cars, requiring 36" side service clearance if side access is used.
- 9" side-facing Side Car(s), requiring 36" service clearance on sides with this Side Car.
- 12" side-facing Side Car for I-Line panelboards.

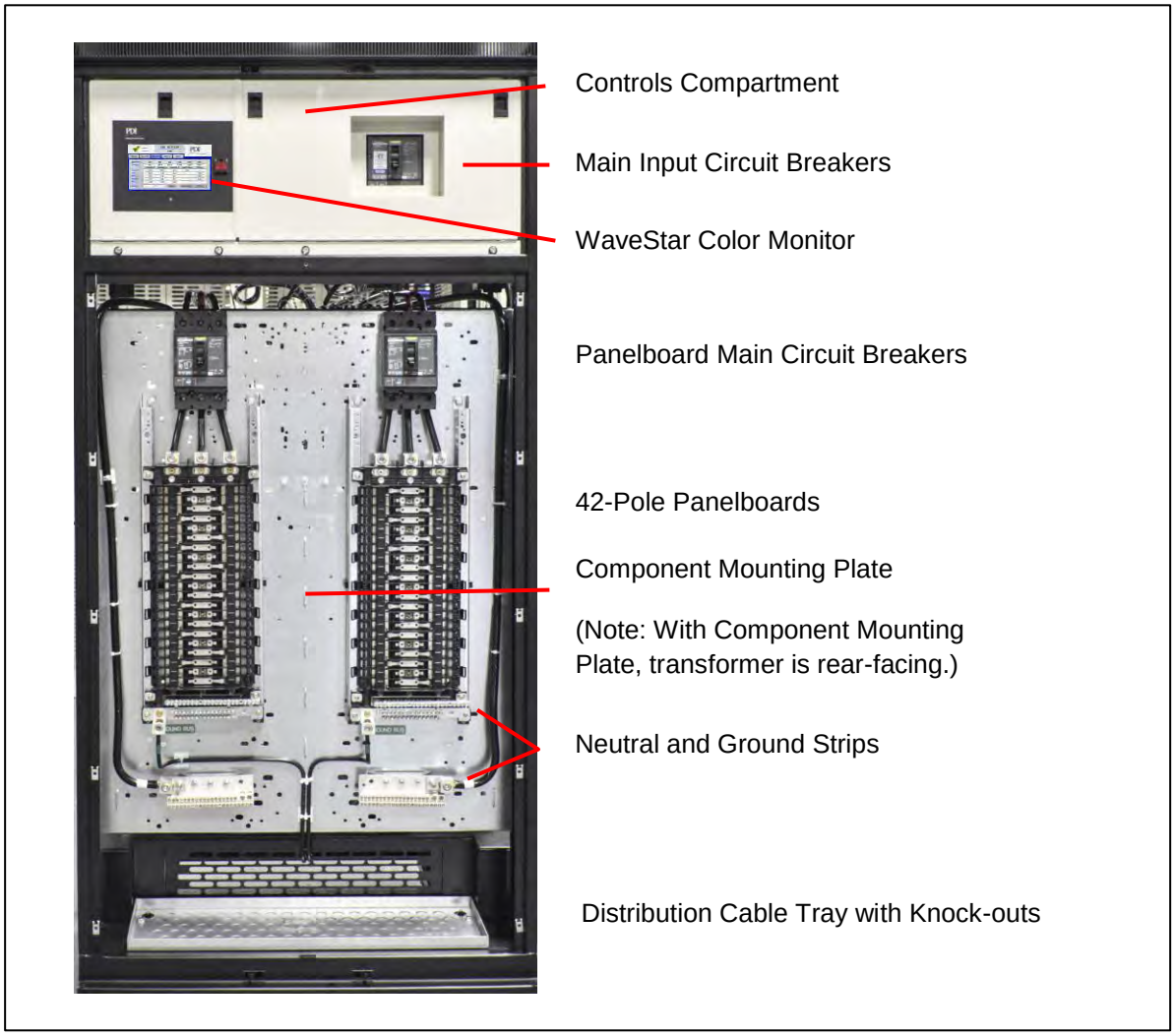
3.6.3 Front and Rear Access Only

Front and rear access PDUs can have the following:

- Main Cabinet with rear-facing transformer taps
- 21" Side Car(s), if side access is not used.

9" and 12" Side Cars are not allowed.

Figure 8. PowerPak PDU, Front and Rear Access, Main Cabinet with Two Panelboards, Doors Off



3.6.4 Front, Rear, and Side Access

Front, side (one or both sides), and rear access PDUs:

- Main Cabinet with rear-facing transformer
- All Side Car configurations and Main Cabinet Extension configurations are allowed.

Chapter 4 Installation Planning: Electrical

4.1 PDU Electrical Specification

- Input: 3-phase, 3 wire plus ground

  Input Voltage

  – @ 50 Hz: 415VAC or 380VAC

  – @ 60 Hz: 600, 480 or 208V

- Output: 3-phase, 4 wire plus ground
- Output Voltage

  – @ 50 Hz: 575, 415/240, or 380/220V

  – @ 60 Hz: 600, 575, 480, or 208/120V

  Output:

  – Neutral: computer grade neutrals for subfeeds and panelboards

    ○ 200%-rated neutral busbars

    ○ 173%-rated panelboard neutrals

  – Ground: Computer-grade single point safety ground

  – Isolated ground available as option

- Emergency Power Off (EPO) button on front-mounted Color Monitor bezel

4.2 Transformer

4.2.1 Transformer Parameters and Options

The PDU is fed from an integral 3-phase, copper or aluminum, high isolation transformer. The transformer is specifically designed for the PDU and its applications, providing voltage transformation, voltage adjustment, high isolation, conditioning, and shielding. Each transformer is complete with electrostatic shielding and uses a universal footing template inside the PDU to secure the transformer to its base.

Each transformer is tested to the C57.121.91 standard.

Standard transformers with DOE2016 efficiency and K-Factor K13 are offered at 150, 225, and 300 kVA. Table 3 lists transformer parameters.

- Standard transformer parameters are applicable to all standard transformers at 150, 225, and 300kVA.
- Non-DOE2106 transformer efficiency standards are offered for customers outside the US and for certain exempt categories in the US.

Table 2. Transformer Parameters

Parameter	Standard Transformer	Options
Input Voltage	480V Delta	400 – 600V
Output Voltage	208 /120V Wye	208 – 600V
Frequency	60 Hz	50 Hz
Impedance	2.5 – 5%	Up to 6%

Table 2. Transformer Parameters (Continued)

Parameter	Standard Transformer	Options
Efficiency	DOE2016	Non-DOE2016 or non-TP1 offered for certain exempt categories, CEC, CSA, NEMA Premium, or customer-requested efficiency values.
K-Factor	K13	K4, K9, K20
Conductor Material	Copper (CU)	Aluminum (AL)
Inrush	8 – 10x	5x
Taps (150-300 kVA)	+2, -4 x 2.5%	±2 x 2.5%, custom taps or no taps designs also available
Temperature Rise	150ºC	115ºC, 130ºC
Vector	Delta-Wye	Delta Zig-Zag Delta Quad-Wye
Average sound level	NEMA ST-20	NEMA ST-20
Applicable Standard	DOE2016, UL-1561 IEEE Standard C57.12.01	IEC 60076, CSA22.2 No 66, CEC 400
Insulation	240ºC Class S	

4.2.2 Transformer BTUs

Transformers generate heat, which should be considered in placing the PDU. The following table shows transformer BTU output at the kVA values offered for standard K13-rated transformers:

Table 3. Standard Transformer BTU Values by kVA

kVA	BTUs/Hour
100	9,284
150	14,296
225	20,536
300	22,483
400	34,825

4.2.3 Transformer Voltage Compensation Taps

The PDU has six (6) transformer voltage compensation taps (4FCBN, 2FCAN). 8.5 *Changing Transformer Taps* Transformer Taps has the procedure for changing taps.

4.2.4 Transformer Temperature Alarms

A standard transformer has six (6) thermal overload devices to monitor core temperature in each winding.

- **180ºF warning**: The first set of thermal devices is calibrated to 180ºF, the warning threshold. If any winding reaches 180ºC core temperature, the thermal overload protection device closes a set of contacts for annunciation of a potential over-temperature condition.

- **195ºF shutdown**: The second set of thermal devices is calibrated to 195ºF, the shutdown threshold. If any winding reaches 195ºF core temperature, the thermal overload protection device closes a set of contacts for annunciation of an over-temperature condition and initiates an automatic PDU shutdown.
- **Settings adjustment**: Temperature warning and alarm levels can be adjusted by Eaton at customer request.

4.2.5 Infrared Scan Windows

Optional 3" infrared scan windows are available for side or rear transformer thermal scanning.

4.2.6 Front-Facing Transformer

The transformer can be rotated 180º to make transformer taps and transformer infrared scanning accessible from the front of the PDU. Only 6" rear ventilation clearance is required instead of 36" service clearance. Because the main cabinet's Component Mounting Plate is removed, distribution must be placed in side cars. Alternatively, a half-height Component Mounting Plate can be provided, allowing (1) 250A panelboard or up to (3) 250A subfeeds in the Main Cabinet.

4.3 One-Line Overview

Figure 9 is a general one-line diagram showing the most common electrical layout with optional SPD/TVSS devices and input wire specifications.

One-line diagram for manual dual PDUs showing permissive signal connections for the Solenoid Key Release Unit (SKRU) is in (Figure 46).

4.4 Main Input Circuit Breaker

The standard Main Input Circuit Breaker is as follows:

- <225kVA: thermal magnetic circuit rated 80% at 480VAC with 35 kAIC and matched to thetransformer size.
- 225kVA – 3000 kVA: fixed (non-adjustable) electronic trip circuit breaker rated 80% at 480VAC with 35 kAIC and matched to the transformer size. The PDU has many Main Input Circuit Breaker options with different

  PDU voltages, amperages, kAIC ratings, and trip settings. Consult with your sales representative or Eaton Engineering for options.

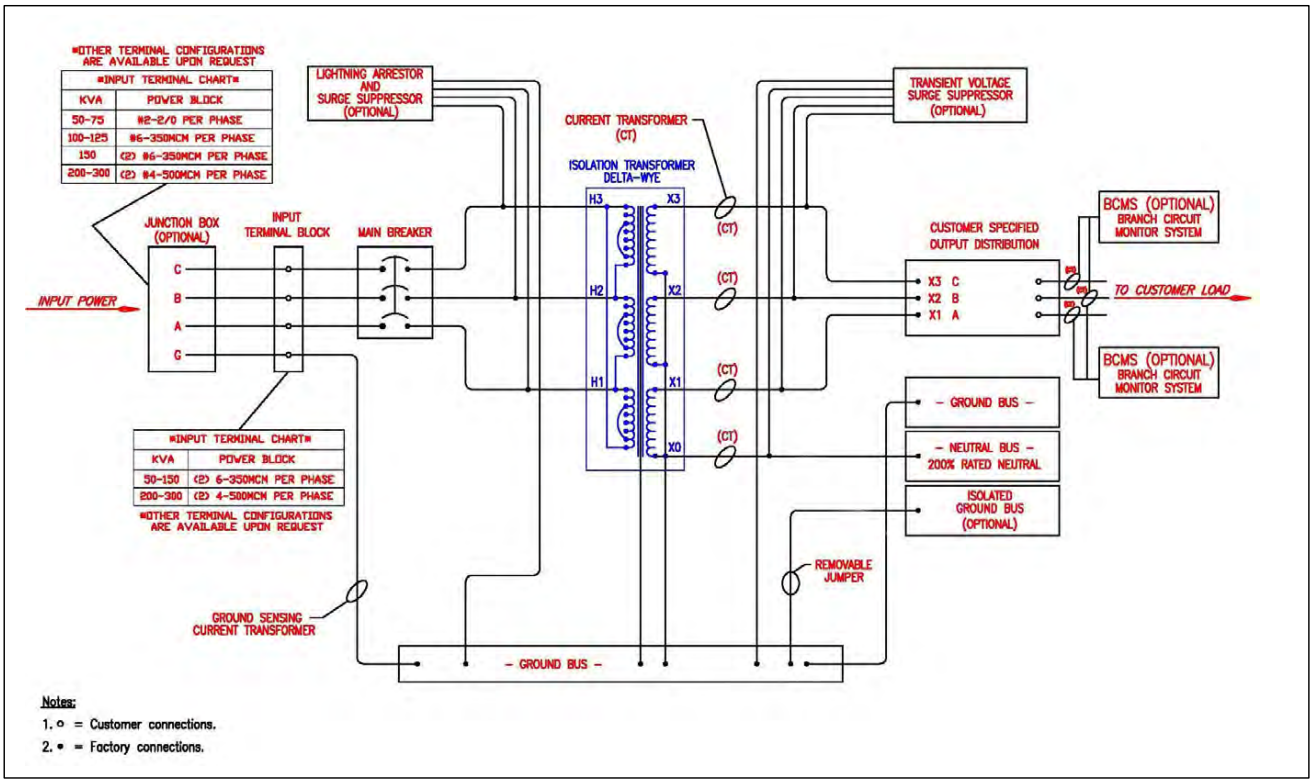
4.5 Surge Protective Devices

SPD/TVSS devices can optionally be installed on the primary and/or secondary sides of the transformer. SPDs are listed to UL 1449 3rd Edition and have the following ratings:

- LEA SP100 providing 100,000 Amps maximum surge current dissipation per phase.
- LEA SP200 providing 200,000 Amps maximum surge current dissipation per phase.

See SPD/TVSS locations in Figure 9

Figure 9. One-Line for PDU with Single Main Input Circuit Breaker



4.6 Subfeed and Panelboard Capacity

The following tables provide general guidance on PDU physical configuration possibilities. PDU capacity depends both on physical configurability and on the electrical limits of the transformer.

Table 4. PDU Subfeed Capacities by Amperage

	250A Subfeeds	400A Subfeeds
Main cabinet	6	4
9" Side-facing side car	6	4
21" Front-and-side facing side car	9	4
Maximum total PDU capacity	12	8

NOTE Subfeed circuit breakers are all 600V rated.

Table 5. PDU Panelboard Capacities at 208VAC

	225A Panelboards at 208VAC	400A Panelboards at 208VAC 400A Subfeeds
Main cabinet	2	2
9" Side-facing side car	2	2
21" Front-and-side facing side car	4	2
Maximum total PDU capacity	8	6

NOTE Each panelboard is protected by a 3-pole secondary main circuit breaker.

Table 6. PDU Panelboard Capacities at 480VAC

	225A Panelboards at 208VAC	400A Panelboards at 208VAC 400A Subfeeds
Main cabinet	1	1
9" Side-facing side car	1	1
21" Front-and-side facing side car	0	0
Maximum total PDU capacity	3	3

NOTE Each panelboard is protected by a 3-pole secondary main circuit breaker.

Table 7. Square D I-Line Subfeed Circuit Breaker Capacities

	225A Frame Circuit Breakers	400A Frame Circuit Breakers
800A MLO (12" side-facing side car)	10	N/A
1000A MLO (12" side-facing side car) (includes underfloor power junction box)	11	8
1200A MLO (requires 46.7"W main cabinet front-facing extension frame)	11	8

Chapter 5 Installation: Placing the PDU

5.1 Receiving and Unpacking the PDU

PowerPak PDUs are shipped as fully assembled units with optional side cars attached and internal cabling completed. Units are strapped to shipping pallets, but not bolted to pallets, and are protected by two layers of external plastic covering. The PDU is first covered by a large plastic bag and then shrink-wrapped.

1. Upon receiving a PowerPak PDU pallet and before removing packaging, inspect the packaging for visible damage that could affect the PDU. If damage is evident notify Eaton and the shipping company (see below).
2. Carefully remove the outer layer of protective shrink wrap from the unit, but leave the interior plastic covering intact. Use care to not puncture or scratch the PDU cabinets with cutting tools.

NOTE Do not cut the retaining bands until the PDU has been moved on its pallet close to its installation location.

3. After removing the outer external packaging, check the unit's exterior panels and doors for any visible damage such as scratches dents, cracks. If any damage is noted, please call Eaton Service (1-800-843-9433).
4. If any damage is evident during unpacking, notify the shipping company and Eaton:
   - File a claim with the shipping company at the time of delivery. Damage must be noted on the bill of lading. Failure to properly document all damage may result in the unit's warranty being voided.
   - Notify the Eaton Service Department.

5.2 Placing the PDU

⚠WARNING

- Do not remove the retaining bands securing the PDU to its pallet until the PDU is near its final position and you are ready to remove the PDU from its pallet.
- Retaining bands are under tension; cut them carefully. Wear eye protection and protective clothing when cutting bands.

1. Move the PDU, still secured to its pallet, to as near its operating position as is practicable with a forklift truck or pallet jack.
2. Carefully cut the safety bands, making sure that they do not scrape the exterior of the unit or scratch the paint. Use eye, face, and hand protections to guard against injury when bands are cut.
3. Remove the PDU from its pallet using a forklift truck. Take care that the unit is properly centered on the forks.
4. Once the unit is completely off the pallet, carefully remove the plastic under layer (protective bag). The unit is now ready to be placed in its final position and prepared for installation.

If you have questions or need further assistance, call the Eaton Service at 1-800-843-9433.

5.3 Pre-Placement Inspection

The installer or installing contractor should perform a complete internal inspection of the PDU after the PDU has been placed in its approximate operating position and before electrical hookup. The following items must be included in the inspection checklist:

1. Transformers: Inspect the transformers for any loose connections or displacement during shipment. Check to make sure all terminal lugs are tight and secure.
2. Internal feeders: Ensure all lug connections are tight and secure.
3. Main input feeder:
    a. Check the main input feeder connections at the main breaker to be sure vibration has not loosened the terminal screws.
    b. Check the feeders from the load side of the main breaker to the primary side of both transformers.
4. Check all other lugs (i.e. neutral bus, ground bus, terminal blocks, etc.).

5.4 Placing Directly on Floor or Raised Floor

The PDU can be moved on a fork lift or pallet jack and placed directly on a floor or raised floor. The floor must be capable of supporting the PDU's weight. See Section 3.2 *PDU Weights* for approximate weights. PDUs are weighed when shipped and actual PDU weight is given on the bill of lading.

Check that required clearances are met when the PDU is placed in its operating position (see 3.4 *Clearances*).

5.5 Placing PDU on Optional Floor Stand

The PDU can be placed on an optional floor stand that will support the PDU's weight. Floor stands are available in several heights to match the height of your installation's raised floor, ranging from 11" to 76".

Each floor stand provides a height range and is adjustable within that range. Center supports are provided on the larger floor stands (48", 60", and 72" height). (See Figure 10 to Figure 11.) Fixed-height floor stand are also available in 8-11" heights. At time of order, select the floor stand that matches your raised floor height.

To install, follow these steps:

1. Remove floor tiles and/or make floor tile cutouts to match the width and depth of the floor stand (Figure 10).
2. Place the floor stand within the raised floor opening and bolt feet securely to the subfloor. See leg detail in Figure 11.
3. To adjust the floor stand height, adjust the bottom height-adjustment screws. To prevent air flow escaping around the base of the PDU, choose one of these options:
    a. Option 1: Reduce the height of the floor stand so that the top of the floor stand is about 1½" below the top of the raised floor. When the PDU is placed on the floor stand, the PDU base should be even with the floor.
    b. Option 2: Match the floor stand to your raised floor height. Install an optional PDU skirt to minimize loss of air flow.
4. The floor stand has removable front and rear cover plates for cable entry/exit and air flow. To provide adequate air flow, remove cover plates before placing the PDU on the floor stand. (See Figure 11")
5. To stabilize the PDU on the floor stand, there are two options:
    a. Option 1: Remove the PDU leveling feet, allowing the PDU to rest on its casters. (The casters rotate 360º but do not lock.) Bolt the PDU to the floor stand using 1/2" all thread (Figure 11). Some customers invert the removed leveling feet and use them to attach the PDU to the floor stand.
    b. Option 2: Adjust the main cabinet leveling feet so that they all rest firmly on the floor stand (Figure 12).
6. With a fork lift or pallet jack, carefully position the PDU over the floor stand. The main cabinet should be centered directly over the floor stand. If you are using the main cabinet leveling feet, they should all be positioned within the borders of the floor stand's top plate.

Figure 10. PDU Floor Stand with Height Options

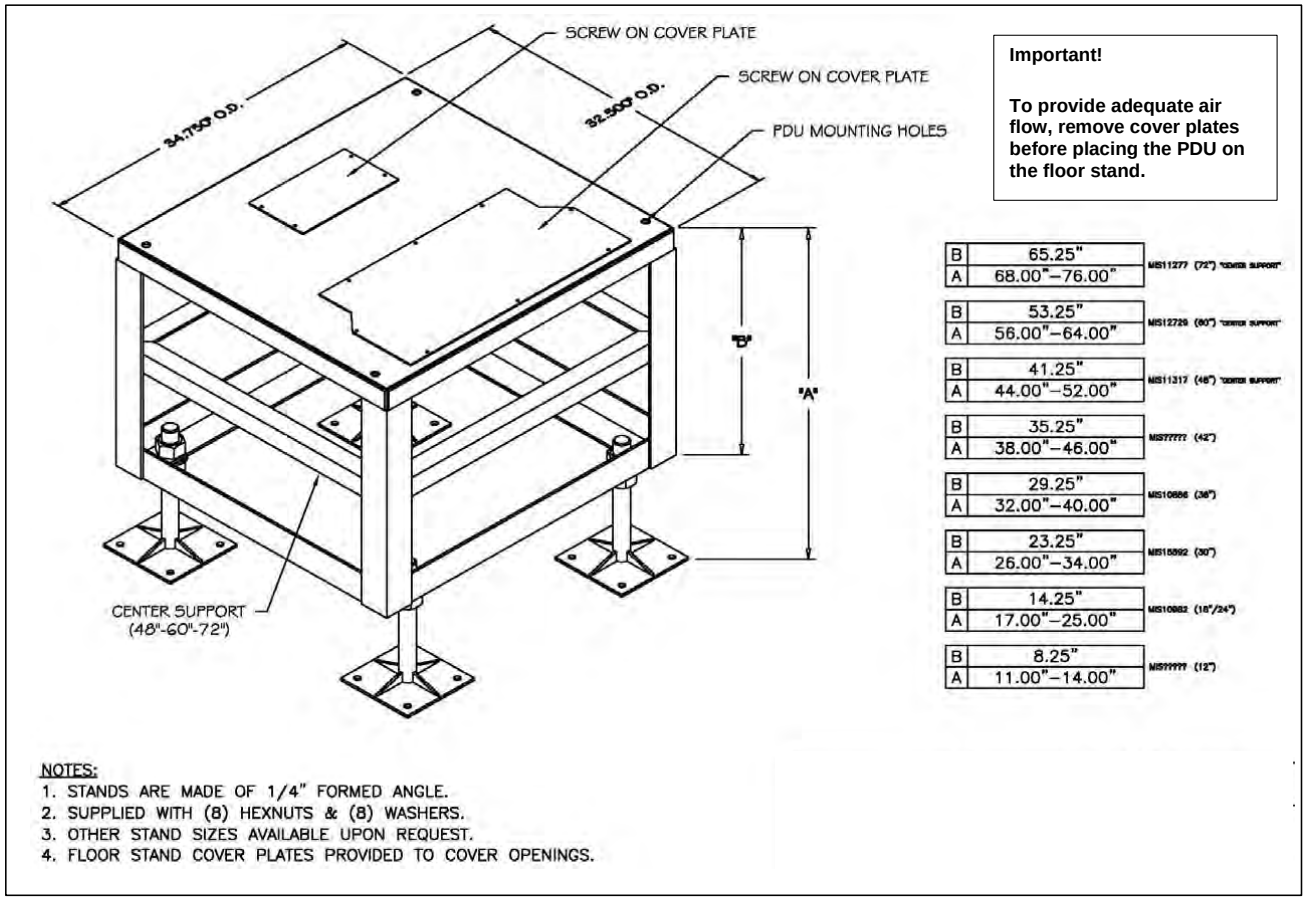
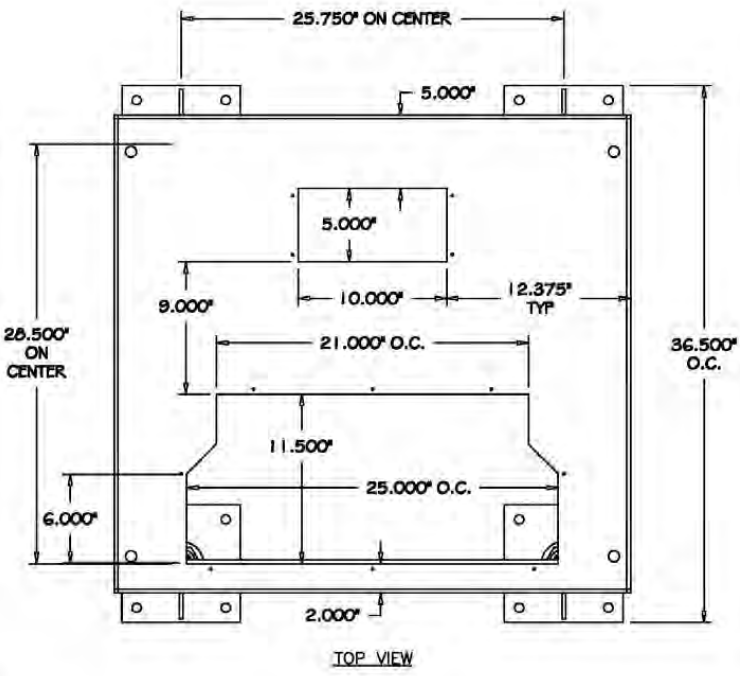
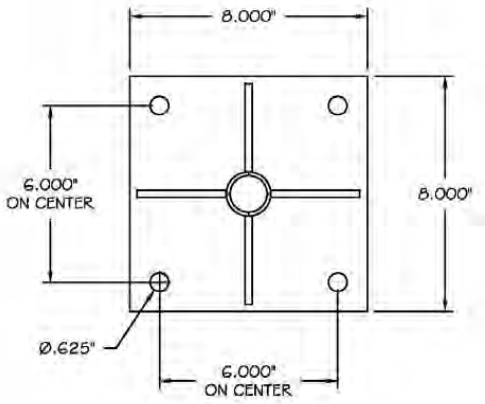


Figure 11. PDU Floor Stand Detail



TOP VIEW



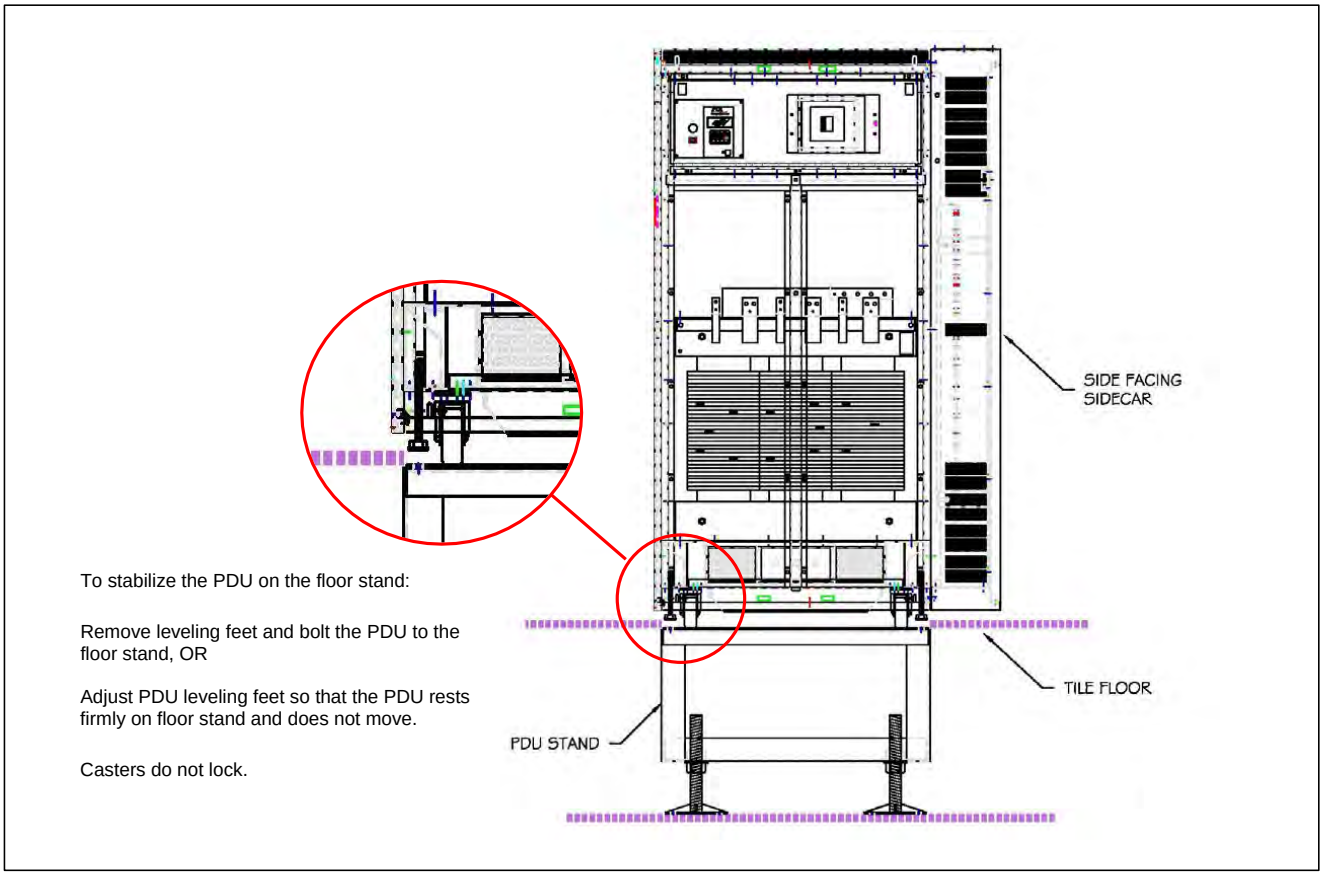
LEG DETAIL

Important!

To provide adequate air flow, remove cover plates before placing the PDU on the floor stand.

NOTES:
1. STANDS ARE MADE OF 1/4" FORMED ANGLE.
2. SUPPLIED WITH (8) HEXNUTS & (8) WASHERS.
3. OTHER STAND SIZES AVAILABLE UPON REQUEST.
4. FLOOR STAND COVER PLATES PROVIDED TO COVER OPENINGS.

Figure 12. Mounting PDU on Floor Stand



To stabilize the PDU on the floor stand:

Remove leveling feet and bolt the PDU to the floor stand, OR

Adjust PDU leveling feet so that the PDU rests firmly on floor stand and does not move.

Casters do not lock.

Chapter 6 Installation: Power Cabling

DANGER

- Severe or fatal injury can result from electrical shock during contact with high voltage conductors, monitoring PCBs, or similar equipment.
- A licensed electrician must install each unit.
- Wear suitable personal protective clothing and use protective equipment for performing mechanical and electrical installations.
- Disconnect power before drilling holes, attaching cables or conduit, or connecting PDUs to other power distribution equipment.
- Use Lock Out/Tag Out procedures.
- Leave ample space for attaching and routing wires.

IMPORTANT

Power wiring must comply with NEC and applicable local codes and should be wired by licensed electricians.

Reference your submittal package for 1-line drawings specific to your PDU configuration.

IMPORTANT

Grounding for this equipment must comply with NEC and local building and electrical codes.

6.1 Input Power Cabling

Input cable entry to the PDU can be from the bottom rear, bottom front, or top.

Input power cables can be landed in several ways:

- To a terminal block in the top right of the Main Cabinet. Input cables are terminated to mechanical lugs or optionally to compression lugs.
- To staggered busbars, for front bottom cable entry.
- For manual dual PDUs, directly to the main input circuit breakers.
- To an optional J-Box (junction box) that can be up to 6' from the PDU. The J-Box is in turn cabled to the PDU's input terminal block or input busbars.

Table 8. Input Cable Entry Options

Cable Entry Location in PDU	Cable/Conduit Entry Holes	Cable Landing	Comments
Bottom Rear	Three (3) pilot holes provided in bottom rear. Customer can enlarge pilot holes to match conduit size.	Terminal Block in top right of PDU: • Compression lugs or • Mechanical Lugs	Typically used when main cabinet has panelboards and bottom front cable tray has pre-punched holes for distribution.
Top	Solid plate provided in top of PDU. Customer makes own cut-outs for cable/conduit entry.	Terminal Block in top right of PDU: • Compression lugs or • Mechanical Lugs	
Bottom Front	Solid plate provided in bottom of PDU. Customer makes own cut-outs for cable/conduit.	Staggered bus bar with mechanical or compression lugs on right front of PDU.	Commonly used with front-facing transformers.
Manual Dual PDU, choose from these options: • Bottom Rear • Top	Choose from above according to cable entry location.	Directly to Main Circuit Breakers	

For wire recommendations, see Figure 9.

Figure 13. Bottom Rear Cable Entry to Terminal Block with Compression Lugs

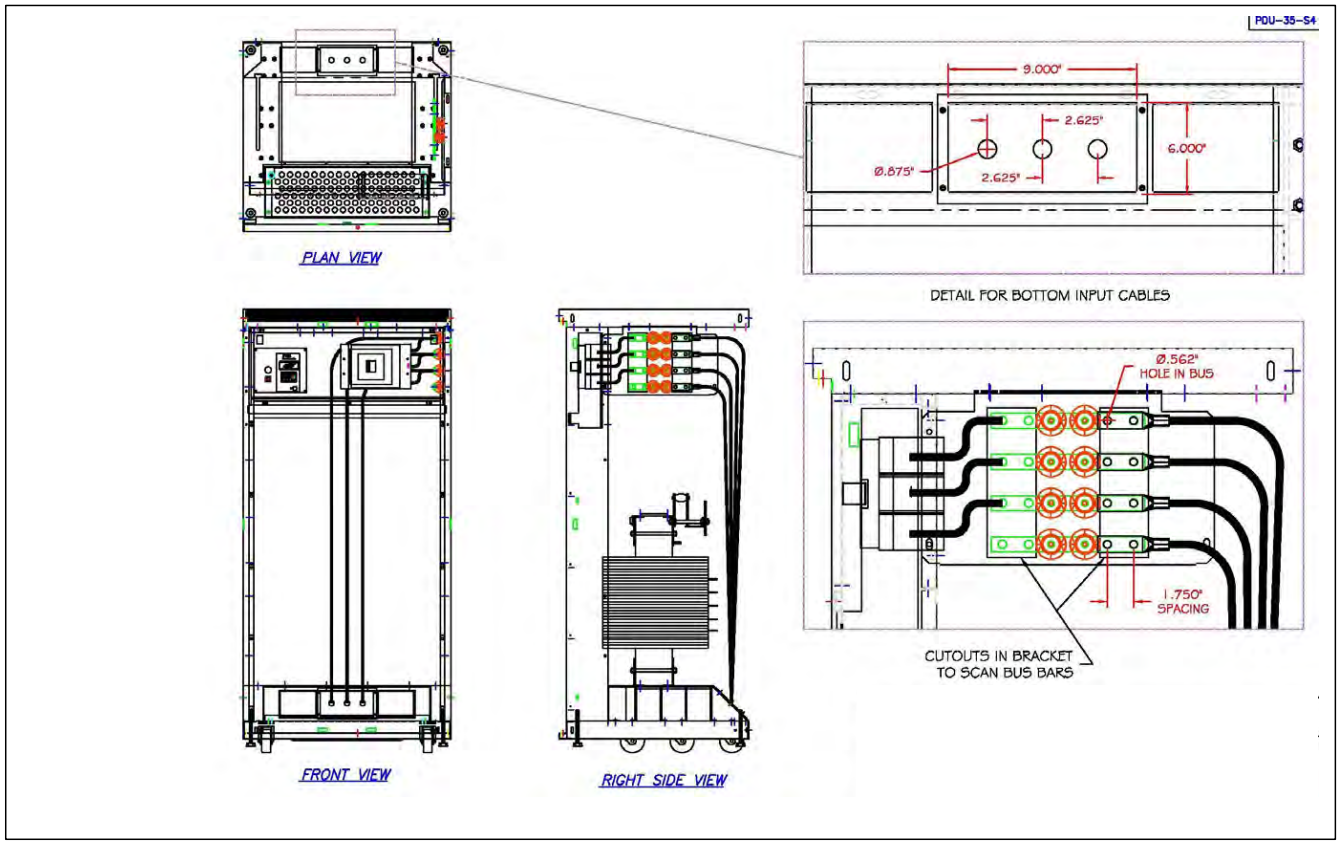


Figure 14. Bottom Rear Cable Entry to Terminal Block with Mechanical Lugs

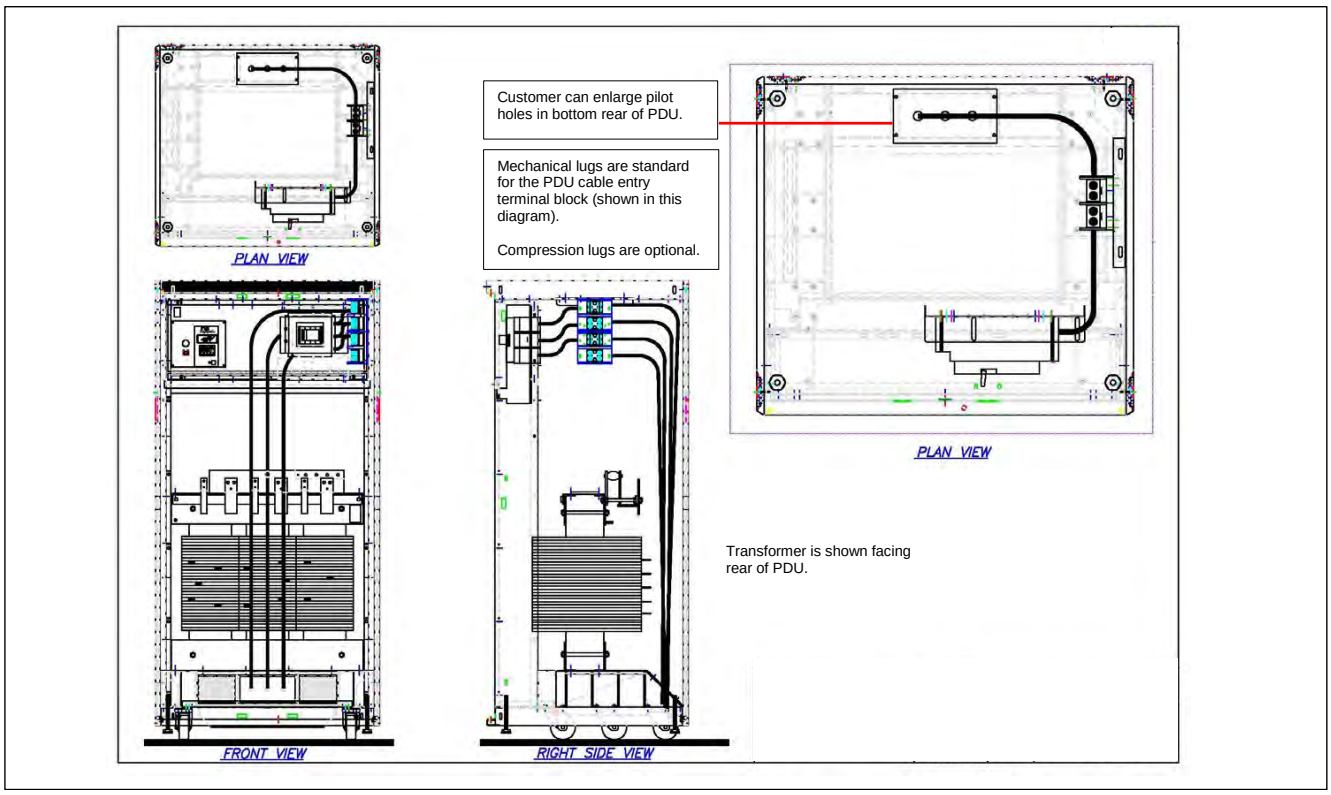
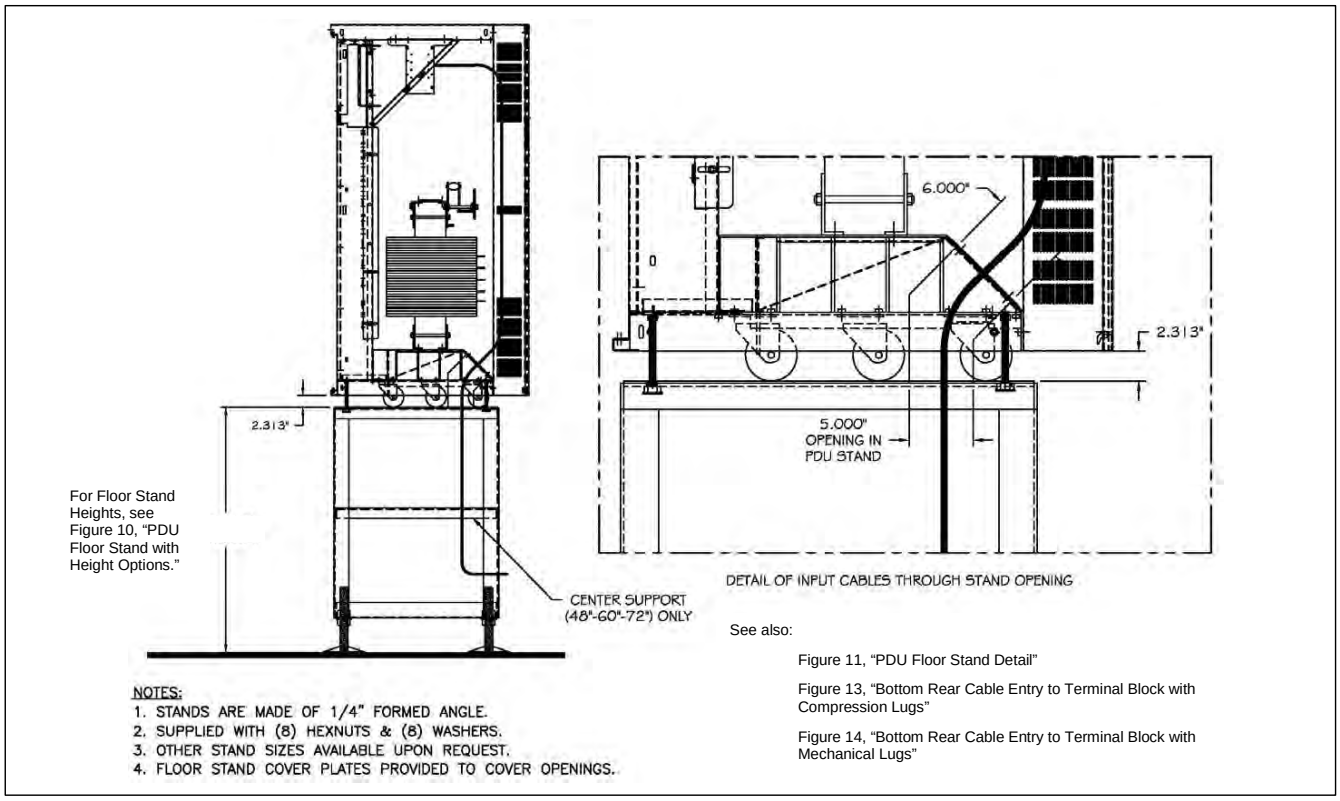


Figure 15. Bottom Rear Cable Entry through Floor Stand



For Floor Stand Heights, see Figure 10, "PDU Floor Stand with Height Options."

See also:

Figure 11, "PDU Floor Stand Detail"

Figure 13, "Bottom Rear Cable Entry to Terminal Block with Compression Lugs"

Figure 14, "Bottom Rear Cable Entry to Terminal Block with Mechanical Lugs"

Figure 16. Bottom Front Cable Entry to Staggered Busbars

For front bottom access, phase cables are landed to staggered busbars allowing 2-hole compression or mechanical lugs.

Front bottom access is most often used with forward-facing transformer taps (shown).

Customer makes own cable entry cutouts in bottom front solid plate.

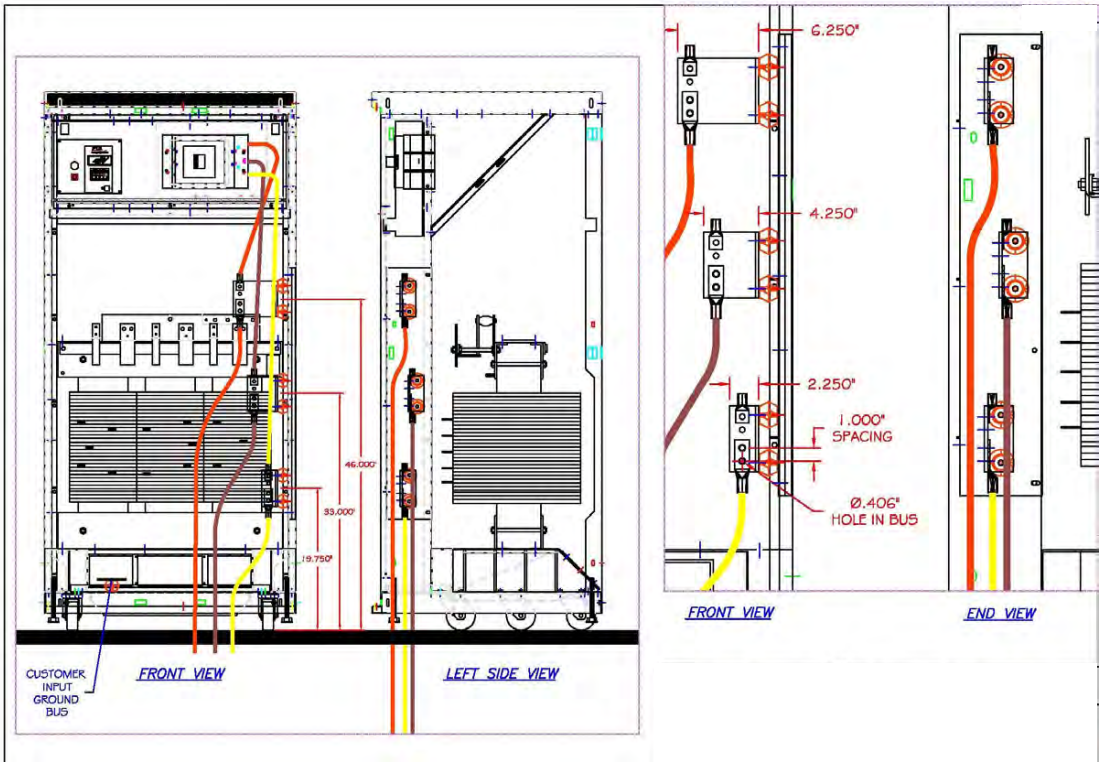
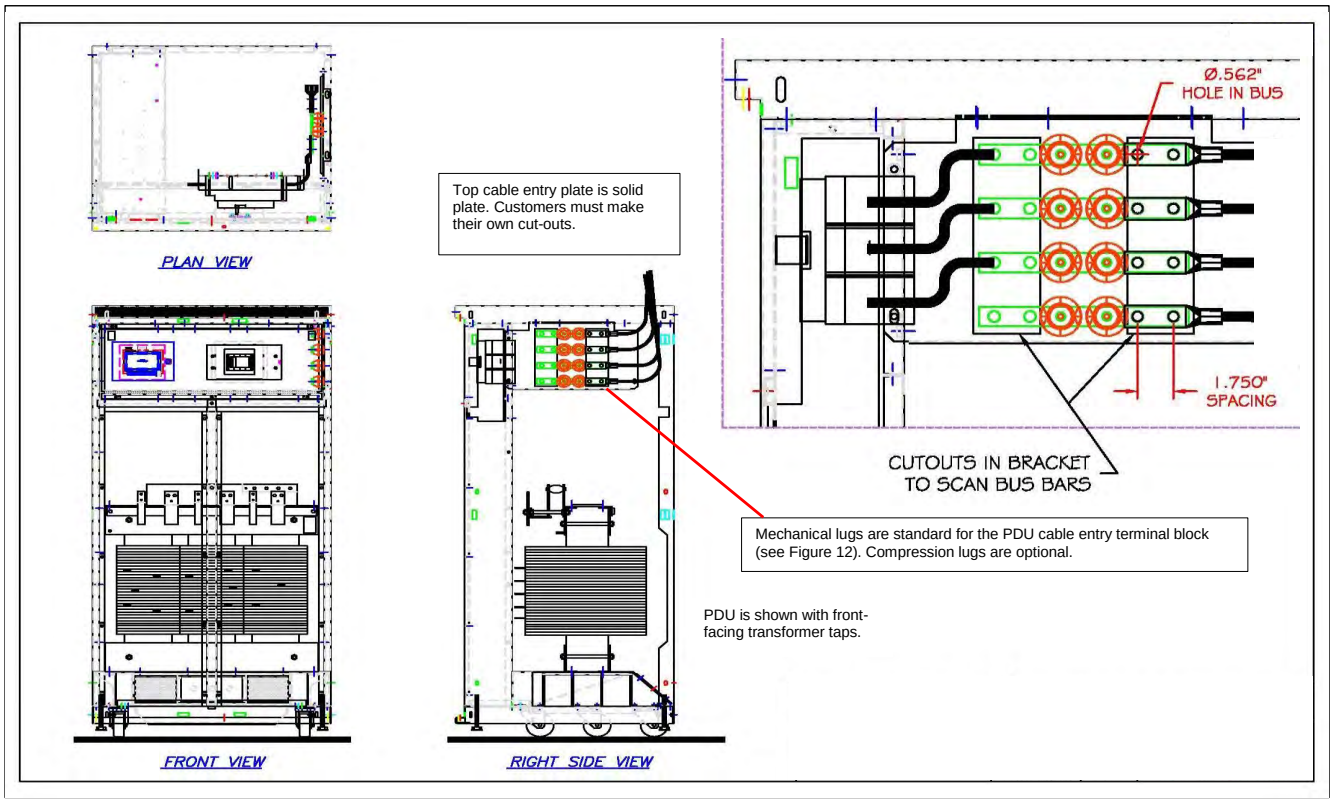


Figure 17. Top Cable Entry



6.2 Input Power Junction Box Option

Eaton PDI offers an input power junction box (J-Box) as an option (Figure 18). The J-Box provides an intermediate connection point between building power and the PDU. Customers may wish to connect building power to the J-Box before the PDU is installed, possibly shortening installation time.

DANGER

A power J-Box and power cable assembly must be installed in accordance with all applicable NEC and local electric al codes.

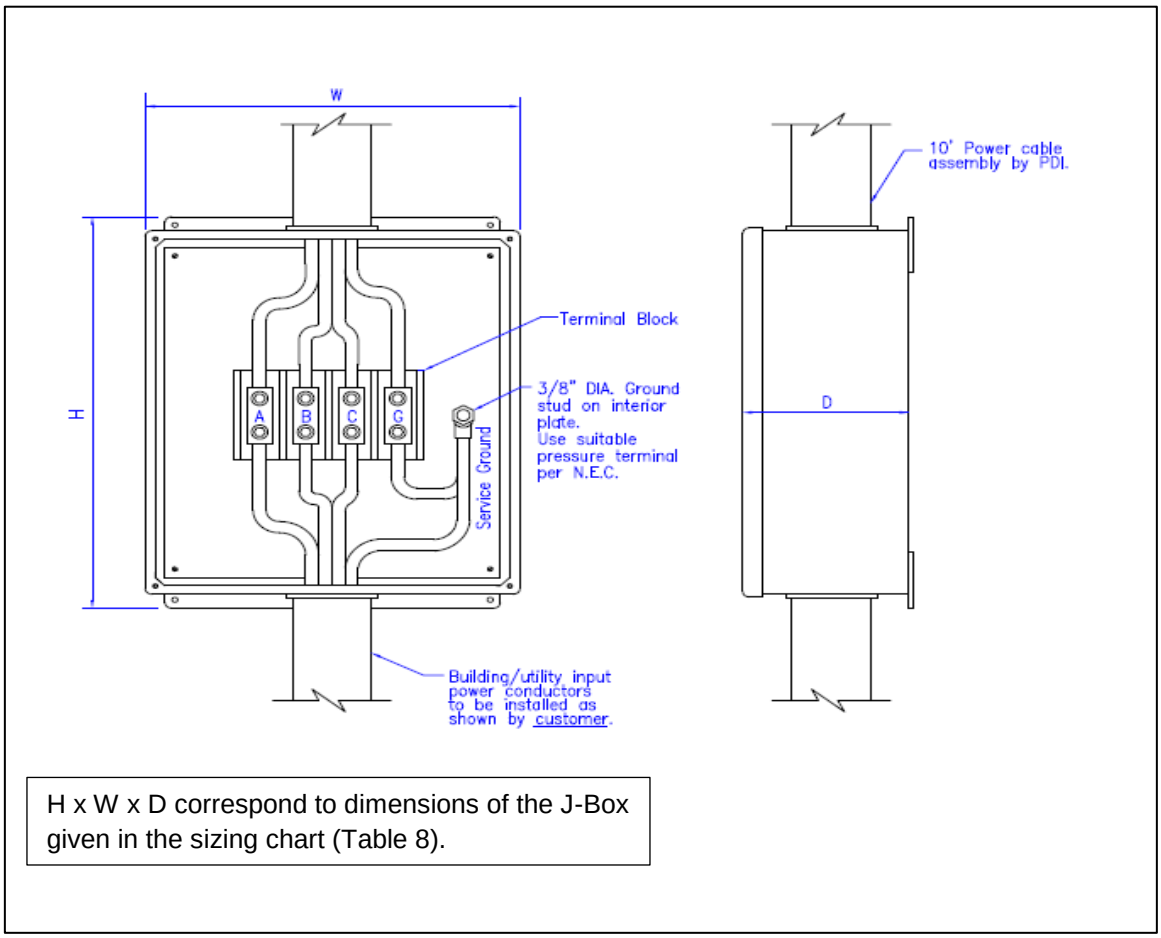
The power J-Box must be installed by a qualified electrician.

Disconnect power before drilling holes, attaching conduit, or attaching the J-Box to a PDU , building power, or to other power distribution

Use Lock Out/Tag Out procedures.

Wear suitable personal protective clothing and use protective equipment for performing mechanical and electrical installations.

Figure 18. Power J-Box



The power J-Box must be located within six (6) feet of the PDU and should remain accessible after the PDU has been installed. If the PDU has its rear panel against a wall, the power J-Box must be installed at least 36" away from the wall and must allow future accessibility.

The J-Box should not restrict the positioning of any power cabling and should not obstruct the floor tiles located directly above the power J box.

Eaton PDI recommends that power cables from the power J-Box enter the PDU through the floor tile cutouts. If cable entry to the PDU uses bottom rear cable entry, the one or more pilot holes are enlarged for conduit coming from the J-Box.

J-Boxes come in three sizes. Wire size must be matched to Main Input Circuit Breaker amperage and conduit to wire size as given in Table 9.

Table 9. Power J-Box and Power Cable Sizing Chart

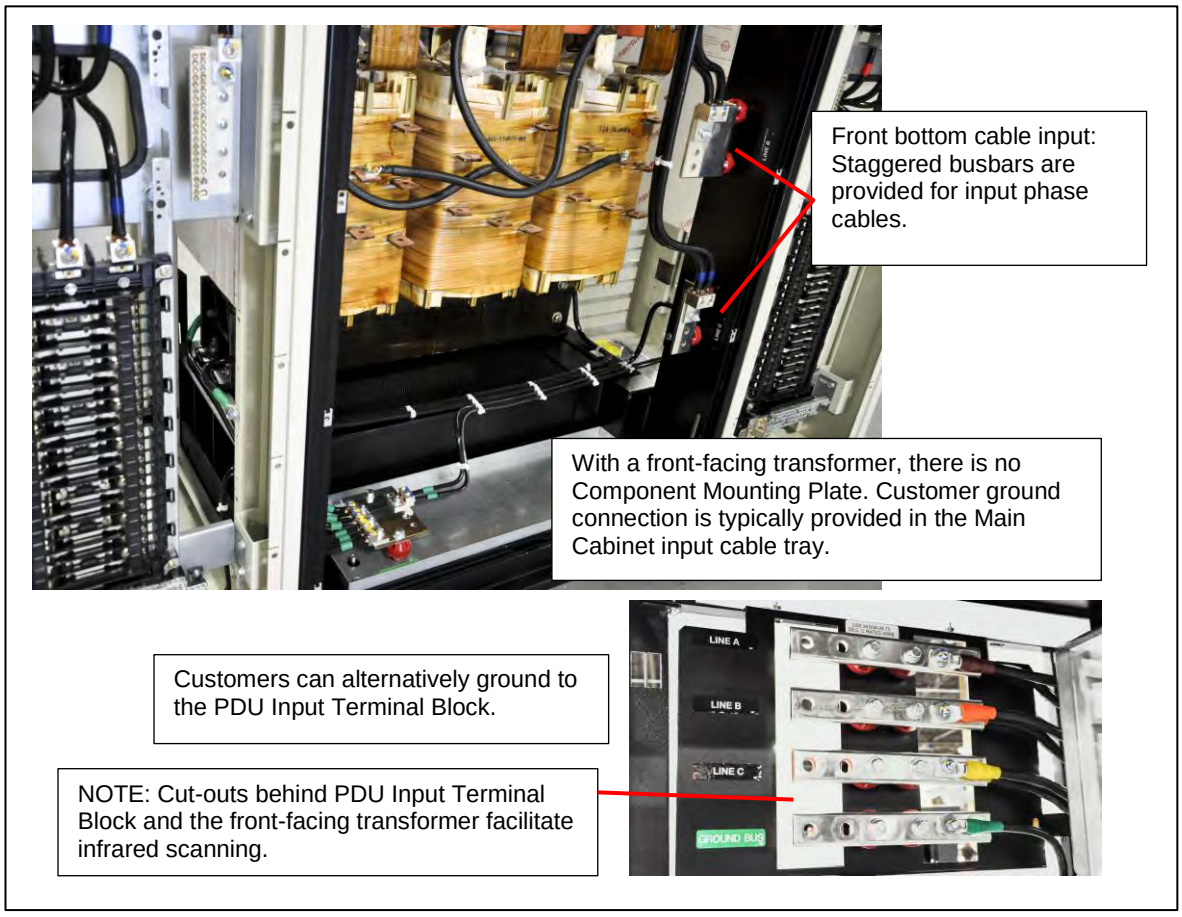
Main Input Circuit Breaker Size (Amps)	Input Power Cable Wire Size Phase & Ground (# - Size)	Input Power Cable Conduit Size (# - Size)	Junction Box Size (H x W x D)	Input Junction Box Terminal Block Size (# Poles - Wire Range)
25	1 x 8 AWG	1 x 1″	12" x 10" x 5″	4 Pole - # 12 x 2/0
30	1 x 6 AWG	1 x 1″	12" x 10" x 5″	4 Pole - # 12 x 2/0
40	1 x 6 AWG	1 x 1″	12" x 10" x 5″	4 Pole - # 12 x 2/0
50	1 x 6 AWG	1 x 1″	12" x 10" x 5″	4 Pole - # 12 x 2/0
60	1 x 6 AWG	1 x 1″	12" x 10" x 5″	4 Pole - # 12 x 2/0
70	1 x 4 AWG	1 x 1 1/4″	12" x 10" x 5″	4 Pole - # 12 x 2/0
80	1 x 4 AWG	1 x 1 1/4″	12" x 10" x 5″	4 Pole - # 12 x 2/0
90	1 x 3 AWG	1 x 1 1/4″	12" x 10" x 5″	4 Pole - # 12 x 2/0
100	1 x 3 AWG	1 x 1 1/4″	12" x 10" x 5″	4 Pole - # 12 x 2/0
110	1 x 2 AWG	1 x 1 1/4″	12" x 10" x 5″	4 Pole - # 12 x 2/0
125	1 x 1 AWG	1 x 1 1/2″	12" x 10" x 5″	4 Pole - # 12 x 2/0
150	1 x 1/0 AWG	1 x 1 1/2″	12" x 10" x 5″	4 Pole - # 12 x 2/0
175	1 x 2/0 AWG	1 x 2"	16" x 14" x 6″	4 Pole - # 6 x 350 MCM
200	1 x 3/0 AWG	1 x 2"	16" x 14" x 6″	4 Pole - # 6 x 350 MCM
225	1 x 4/0 AWG	1 x 2"	16" x 14" x 6″	4 Pole - # 6 x 350 MCM
250	1 x 250 MCM AWG	1 x 2 1/2″	24" x 18" x 6″	4 Pole - # 6 x 350 MCM
300	2 x 3/0 AWG	1 x 3"	24" x 18" x 6″	4 Pole - # 6 x 350 MCM
350	2 x 4/0 AWG	2 x 2"	24" x 18" x 6″	4 Pole - # 4 x 500 MCM
400	2 x 4/0 AWG	2 x 2"	24" x 18" x 6″	4 Pole - #4 x 500 MCM
500	2 x 250 MCM AWG	2 x 2 1/2″	24" x 18" x 6″	4 Pole - #4 x 500 MCM
600	2 x 350 MCM AWG,	2 x 3"	24" x 18" x 6″,	4 Pole - #4 x 500 MCM,
700	2 x 500 MCM AWG,	2 x 3"	24" x 18" x 6″,	4 Pole - #4 x 500 MCM,
800	3 x 300 MCM AWG,	3 x 2 1/2″	Special	Special

6.3 Input Power Wiring

Customers must make their own cut-outs for input cable and conduit. Pull input power conduit through cut-outs. Connect input phase and ground cables to the PDU input terminal block or, for Manual Dual PDUs, directly to main input circuit breaker lugs. Torque lugs to the circuit breaker manufacturer's specification, which are typically given on the circuit breaker.

For top cable entry, input and output share the same plate, which for input may have solid plate and for output solid plate or panelboard knockouts (KOs).

Figure 19. Ground Connections for Front-Access Only PDU



The customer safety ground is typically connected to the Component Mounting Plate in the Main Cabinet with mechanical lugs. Busbar ground connections can be optionally specified.

For front-access transformers, the Component Mounting Plate is removed. A ground connection is typically provided in the input cable tray. Alternatively, ground connection can be made to the PDU Input Terminal Block (Figure 19).

6.4 Distribution Cabling

6.4.1 Subfeeds

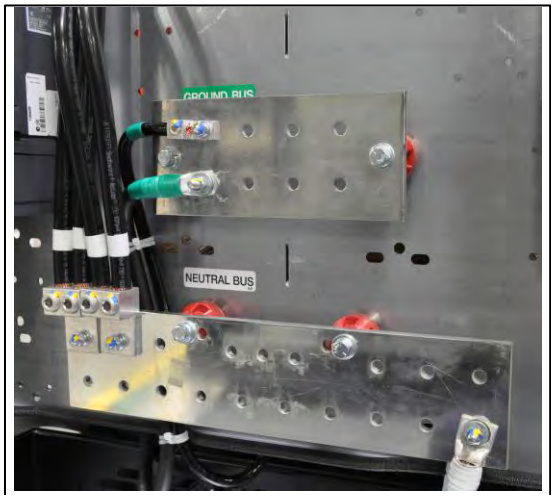
Neutral busbars are rated 200%.

Neutral wires must be twice the size of phase cables. Neutral and ground busbars have two-hole compression lug connections. Holes can be 3/8" dia. or 1/2" dia. (Figure 20).

Location of busbars depends on customer's top or bottom cable exit.

Solid plate is provided at the bottom or top of the main cabinet or side car for cable exit. Customers must execute their own cut-outs for solid plate cable exit trays.

Figure 20. Distribution Ground and Neutral Busbars



6.4.2 Distribution Panelboards

Standard panelboards are Square D or GE bolt-on or snap-on circuit breaker panels.

Square D and GE 225A panelboards for 208VAC or 480VAC are protected by a 3-pole 225A secondary main circuit breaker. 400A panelboards for 208VAC or 480VAC are protected by a 3-pole 400A secondary main circuit breaker.

Panelboards have 173%-rated neutrals.

42-position ground and neutral strips are provided for each multiple of a 42-circuit panelboard. Optional 42-position isolated ground strips are available. Pre-punched cable exit trays are provided at the top or bottom of the main cabinet or side car housing the panelboard(s).

Pre-punched distribution cable exit holes are 7/8" dia. for 1/2" dia. conduit.

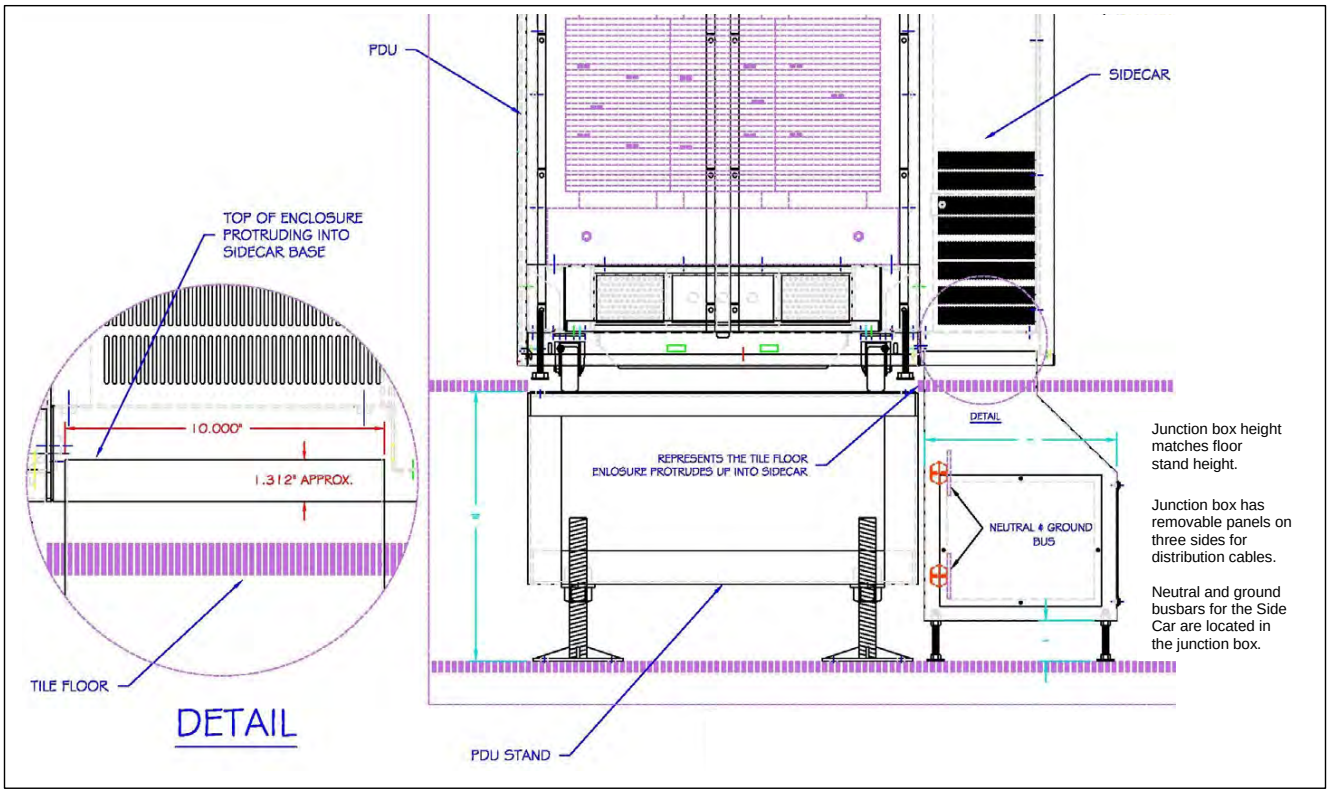
6.4.3 Square D I-Line Subfeed Panelboard

Square D I-Line subfeed panelboards are also available, requiring at minimum their own 12" side cars.

800A and 1000A I-Line panelboards can be installed in 12" side cars. 1000A I-Line panelboards require an under floor junction box for distribution cabling. The junction box has the neutral and ground busbars for the Side Car and cable exit panels on three sides (Figure 21).

1000A and 1200A I-Line panelboards can be installed in a Main Cabinet Extension (Figure 6). Neutral and ground busbars are in the Extension and no under floor junction box is required.

Figure 21. Under Floor Junction Box for 1000A I-Line Panelboard in 12-in Side Car



6.4.4 Installing Current Transformers for I-Line Subfeeds

CTs for I-Line subfeeds cannot be factory installed because the internal (line) side of each I-Line CB is connected to a bus bar rather than to cables. Consequently, CTs must be installed over the load cables when the customer's installer attaches them to the I-Line circuit breakers.

CT sets for I-Line subfeeds are shipped unattached in the I-Line Side Car or Main Cabinet Extension.

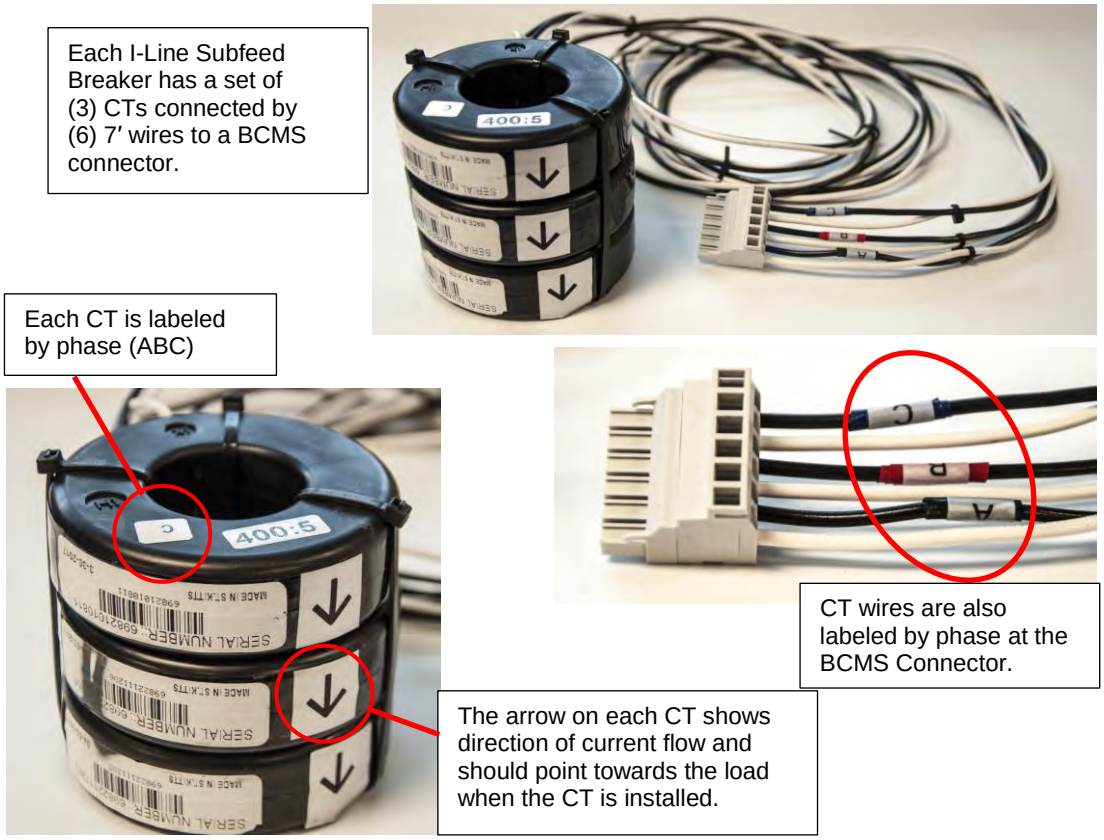
Current Transformer Sets

CTs for I-Line subfeeds are packaged together in sets of three (3), one (1) set for each subfeed breaker (Figure 22).

Each CT is labeled by phase (ABC) with an arrow indicating direction of current flow. The arrow should point in the direction of the load when the CT is installed.

Each of the (3) CTs in a set has (2) 7' wires which are wired together to a 6-pin connector for connection to the BCMS monitoring system. The wires at the BCMS Connector end are also labeled by phase.

Figure 22. I-Line Subfeed CT Sets and Labeling



For each load cable into a circuit breaker, install the CT matching that phase over the cable with the arrow pointing towards the load.

NOTE The ordering of I-Line CBs (CB1, CB2, etc.) is determined by the customer.

The BCMS Connector must be connected to the corresponding breaker socket on a "Resistor Board" (Figure 23). A label in the I-Line section shows the Resistor Board connector positions for each breaker (Figure 24).

Usually the Resistor Board cannot be placed in the I-Line section itself because of space limitations. However, the Resistor Board will be placed as close as possible to the I-Line section although the exact position depends on the layout of the PDU.

Figure 23. Resistor Board

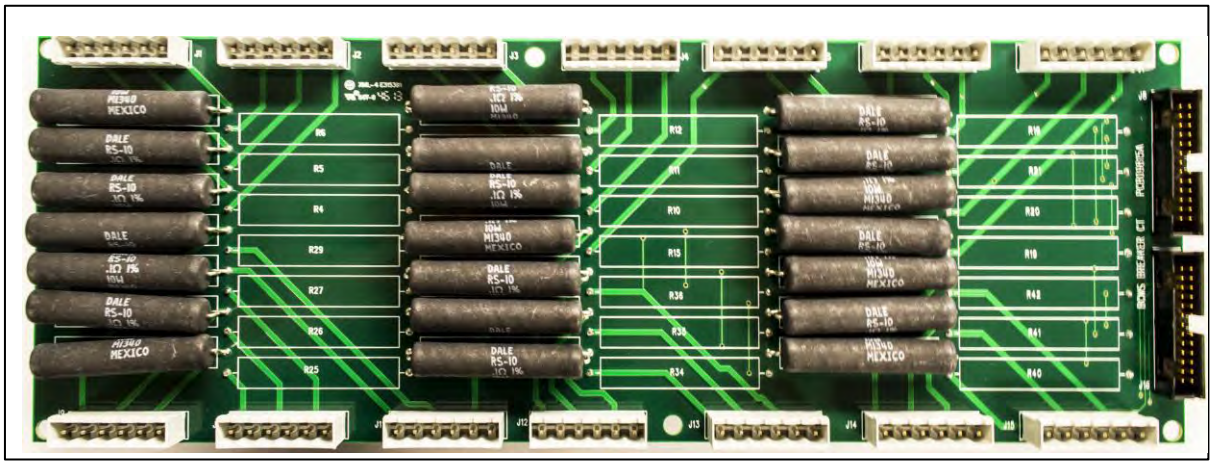
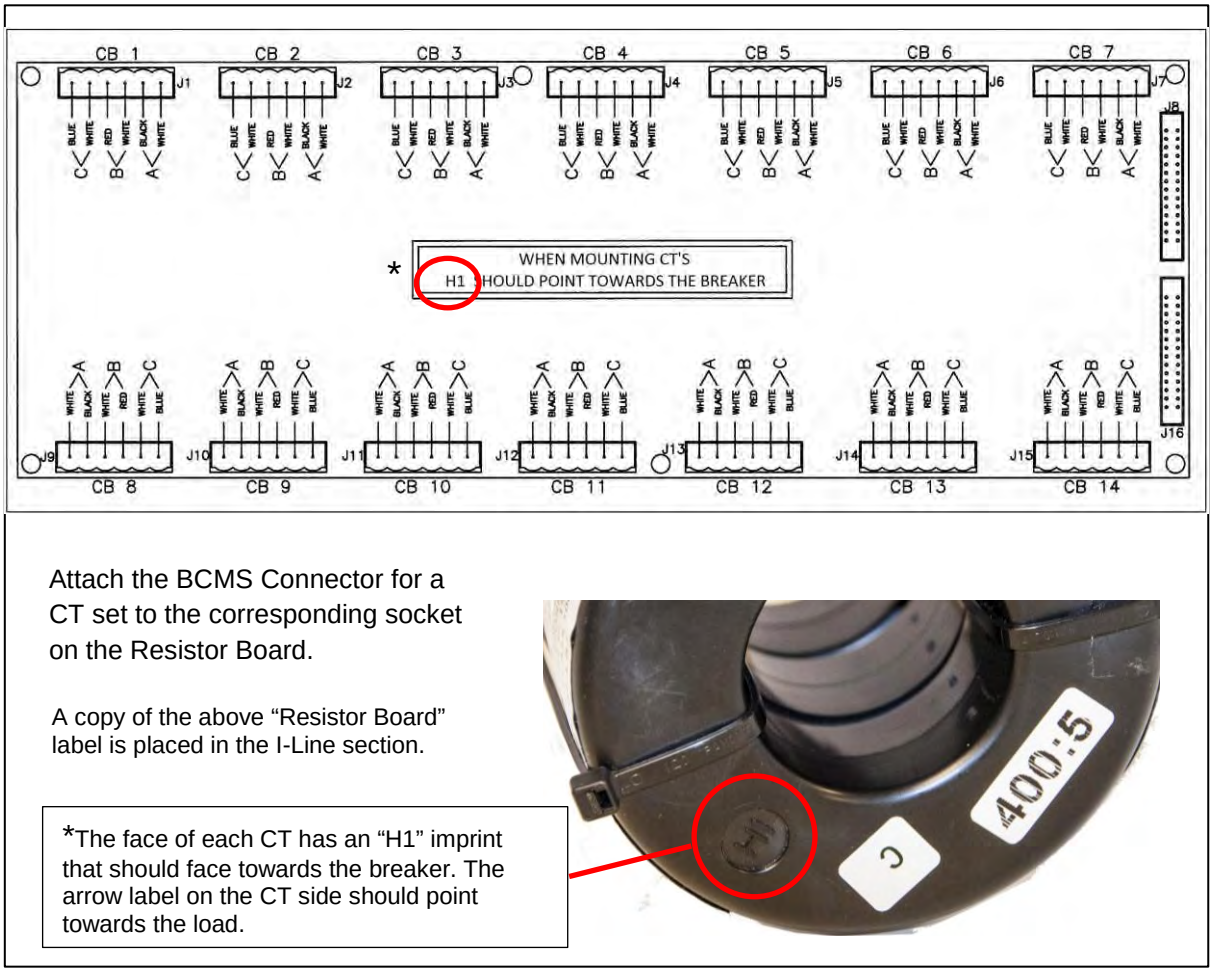


Figure 24. Resistor Board Layout Label



Attach the BCMS Connector for a CT set to the corresponding socket on the Resistor Board.

A copy of the above “Resistor Board” label is placed in the I-Line section.

*The face of each CT has an “H1” imprint that should face towards the breaker. The arrow label on the CT side should point towards the load.

Chapter 7 PDU Initial Start-Up

IMPORTANT

At the initial startup of the PDU, an Eaton factory factory-authorized technician must validate correct operation of the PDU. The product warranty may be voided if the correct start start-up procedures are not followed.

When applying utility power to the PDU for the first time, a Eaton factory-authorized technician must validate correct operation of the PDU. PDU start-up typically includes the following procedures.

7.1 PDU Post-Installation Inspection

After placing the PDU and attaching cables, re-inspect the PDU, as follows:

1. Visually inspect for and remove any debris that may have fallen into the PDU during installation.
2. Transformer: Inspect the transformer for any loose connections or displacement during shipment. Check to make sure all terminal lugs are tight and secure.
3. Internal feeders: Ensure all lug connections are tight and secure.
4. Main input feeder:
   a. Check the main input feeder connections at the main breaker to be sure vibration has not loosened the terminal screws.
   b. Check the feeders from the load side of the main breaker to the primary side of the transformer.
5. Check all other lugs (i.e. neutral bus, ground bus, terminal blocks, etc.).

7.2 Initial Start-Up Procedure

WARNING

Steps 1-4 below must be executed before applying incoming power to the PDU.

Energizing the PDU can create inrush. Verify that the up stream UPS is in bypass mode or can handle inrush from the PDU.

1. Confirm that the PDU's main input circuit breaker (or both breakers for Manual Dual PDU) isin the OFF position.
2. Ensure that all of the PDU's output circuit breakers are in the OFF position.
3. Verify that the input voltage to the unit matches the input voltage rating of the unit as identified on the PDU nameplate found on the outside of the front door.
4. Ensure that the input voltage has proper phase rotation and safe grounding practices.
5. Apply building power to the unit.
6. Measure for correct PDU input voltage, which should match the unit's rating within + 5% to -10% of nominal rating.
7. \Check for correct phase rotation (clockwise) and voltage.
8. Energize the PDU by setting the Main Input Circuit Breaker to the ON position. Note:

NOTE If the main breaker trips when energized, it may indicate a fault in the unit. Contact Eaton Service at 1-800-843-9433 for diagnostic assistance.

9. Perform an EPO check: Depress the external EPO button and verify that the Main Input Circuit Breaker shunt trips.
10. Manually reset the Main Input Circuit Breaker to the ON position. You may have to first manually trip the lever all the way to the OFF position.
11. Verify that the output voltages are correct for the PDU.
12. Sequentially turn ON the distribution circuit breakers.

NOTE Equipment energized by the PDU may require special start-up procedures. Consult the equipment manufacturer's instructions for start-up procedures.

Chapter 8 PDU Procedures

8.1 Normal Start-Up

After initial PDU startup, you can use the following abbreviated procedure to start up the PDU and its downstream equipment:

1. Confirm that the PDU's main input circuit breaker is in the OFF position.
2. Confirm that all of the PDU's output circuit breakers are in the OFF position.
3. Apply power to the unit.
4. Set the Main Input Circuit Breaker to the ON position. You may have to first manually trip the lever all the way to the OFF position.
5. Sequentially energize the distribution output circuit breakers, following any special procedures required by equipment attached to the PDU. Consult the individual manufacturer's instructions for these requirements.

8.2 Normal Shutdown Procedure

1. Shutdown equipment connected to the PDU's distribution output circuits, following any special procedures that the equipment manufacturer has specified.
2. Turn off the Distribution Output Circuit Breakers feeding the load equipment.
3. When ALL output circuit breakers have been turned OFF, turn the Main Input Circuit Breaker to the OFF position.

8.3 7.3 Automatic Shutdown Signals

The PDU can be shut down by the PDU M4G Board with a signal to trip the Main Input Circuit Breaker. The trip signal is sent using either the 170VDC or 24VDC output connections.

The PDU board will shunt-trip the main breaker if it receives any of the following signals (refer to Figure 27 for connections):

- Local EPO signal to the PDU board from the front panel EPO button.
- Remote EPO (REPO) signal from the Contractor Board to the PDU Board. The customer REPO signal is terminated at the Contractor Board.
- Thermal wires registering a temperature in the PDU transformer core that exceeds the transformer temperature limit specified.
- Optional shutdown signals: the customer can elect to shut down the PDU on the following conditions. These optional shutdown conditions are programmed into the PDU M4G Board in manufacturing and should be selected at time of order:
  - Output over-voltage or under-voltage on pre-programmed limits.
  - Improper phase rotation.
  - Ground fault interrupt: ground fault current rises above programmed levels.
  - Building alarm. A 10-second time delay for shutting down the PDU can also be set.

8.4 Manual or Automatic Restart

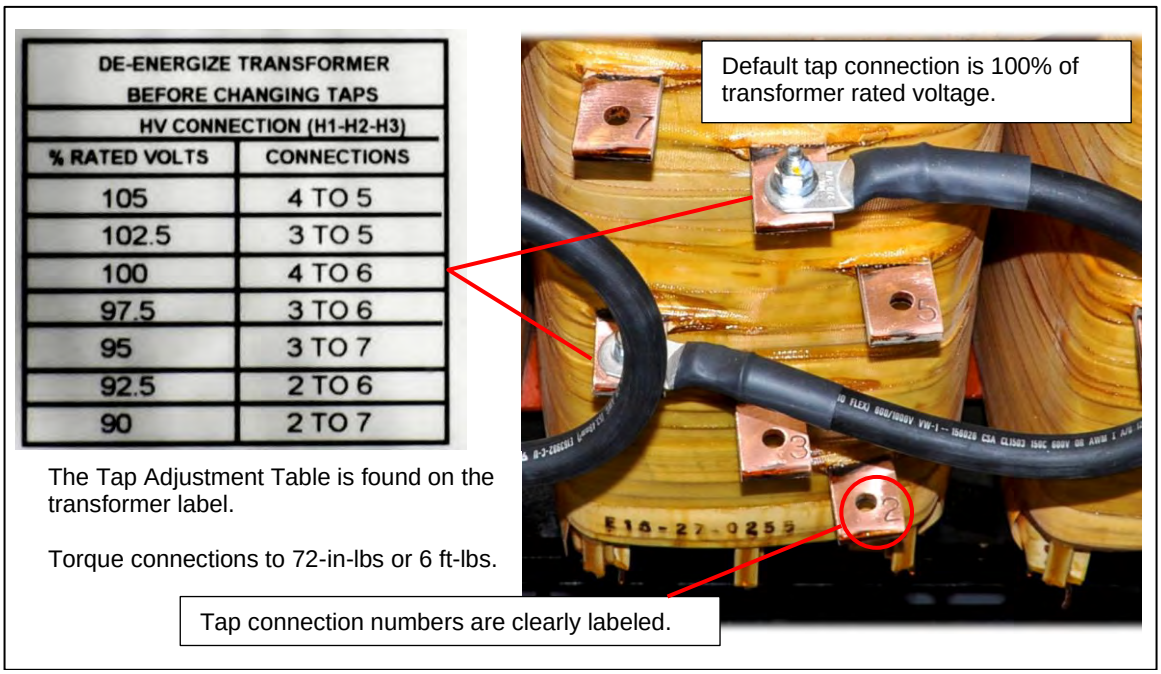
The **Restart Switch** on the PDU board determines if restart is automatic after a voltage loss. The **170VDC** output connection on the PDU M4G Board must be connected to the main breaker trip unit for the Restart Switch to function —the Restart Switch does not work with the 24VDC voltage connection.

- If the Restart Switch is set to **Manual** (**down** or away from the PDU Board transformer), the main breaker is tripped when the PDU loses voltage. When the PDU receives voltage again, the main breaker must then be manually reset and closed to power up the PDU and resume operation.
- If the Restart Switch is set to **Automatic** (**up** or towards the PDU Board transformer), the main breaker is not tripped on a voltage loss. The PDU resumes operation if voltage is in the correct range. This is the default position: the PDU is shipped with the Restart Switch set to **Automatic**.
- See 9.3.1 *PDU M4G Board* PDU M4G Board and associated illustration for location of the Restart Switch.

8.5 Changing Transformer Taps

Transformers have jumper cables on each phase connecting one tap position to another. Changing the tap jumper cable connection changes the transformer voltage output by a predefined percentage. Each transformer has a label showing the voltage adjustment provided by a specific tap connection. Default connection is 100% of the transformer rating.

Figure 25. Transformer Taps



To change transformer taps on the PDU follow these steps (To change transformer taps on PDU with front-facing taps, the procedure is the same except that the customer need only open front panel doors.):

1. Make sure that the PDU is powered off.
2. Lock out power to the PDU at main circuit breaker(s).
3. Remove rear panels or, if transformer is front-accessible, open PDU front doors.
4. Read label on transformer and select the voltage adjustment that is closest to the adjustment you require.
5. Disconnect one or both jumper ends as needed to match tap jumper numbers, retaining bolts and nuts.
6. Reconnect jumpers to correct numbered positions. Jumpers use 1/4-20 x 1" hex head bolts. Torque bolts to 72 inch-pounds or 6 foot-pounds. Apply torque seal. The bolt size and torque specifications are the same for all standard transformers.

7. Replace panels or close doors.

Chapter 9 Monitoring: Components

9.1 Monitoring Component Summary

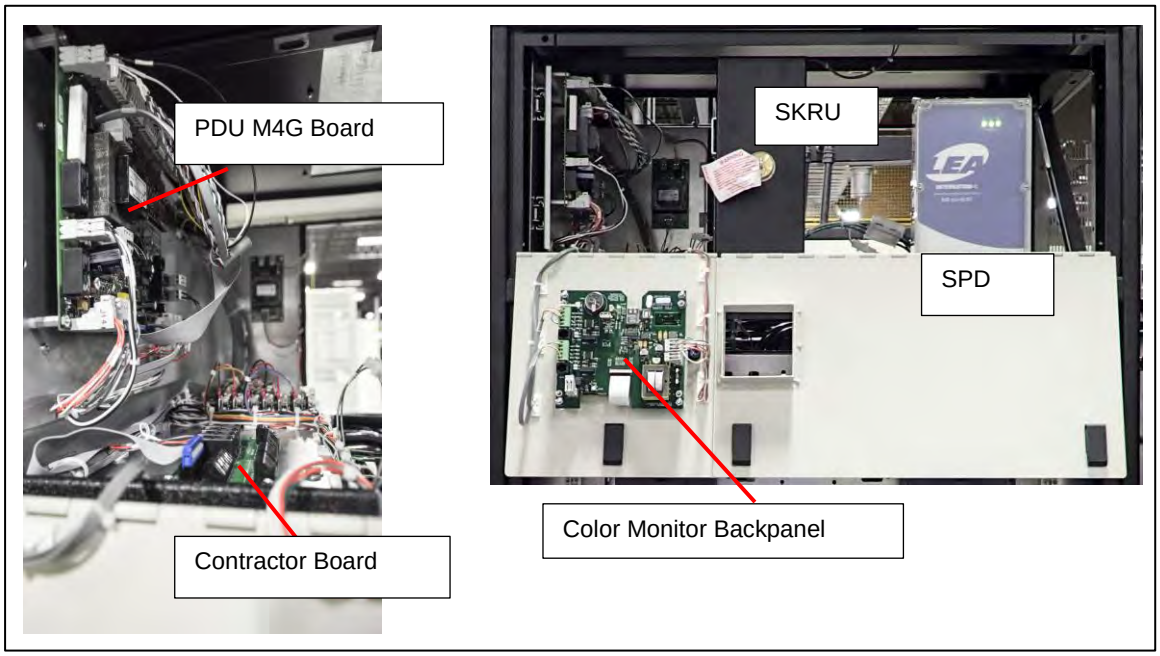
WaveStar monitoring components include the following:

- PDU M4G Board sets PDU parameters and monitors the transformer. Each PDU has a Contractor Board which is an extension of the PDU Board.
- Branch Circuit Monitoring System (BCMS) PCBs collect readings from CT strips on panelboard current transformer (CT) strips and subfeed CTs and voltage measurements.
- A Resistor Board is intermediate between subfeed CTs and a BCMS PCB. It is used only with subfeeds.
- The WaveStar® Color Monitor displays power information about monitored PDU devices and passes their points list information to upstream Modbus master devices, such as a Building Management System or Data Center Infrastructure Management (DCIM).

Monitoring components are mostly located in the Controls Compartment at the top of the Main Cabinet. BCMS PCBs are also placed in Side Cars for monitoring panelboards or subfeeds in the Side Car.

The PDU also has an extensive dry contact network. See Table 10.

Figure 26. Open Controls Compartment



9.2 Customer Connections

Customer connections are made only to the following:

- A Contractor Board, for Modbus RTU network connections, REPO, and remote relays. (See 9.3.2 *Basic Contractor Board*, and 9.3.3 *Enhanced Contractor Board* .)
- Color Monitor back panel for Ethernet cable connection (see Figure 32.
- Other dry contact connections (see Table 10).

- External permissive signals (see 12.3 *Customer Wiring for Permissive Signals*.)

Customers can also specify specific values, such as Digital Inputs or Alarms, which are programmed by Eaton PDI in manufacturing.

Other information in this chapter is provided for reference.

9.3 PDU Board and Contractor Boards

The PDU (M4G) Board sets PDU parameters and monitors the PDU's transformer.

Every PDU also has a **Contractor Board**, which functions as a terminal block to the PDU Board and is directly connected by a ribbon cable to the PDU Board. The customer has a choice of two (2) Contractor Boards, which act as an extension of the PDU M4G Board for making customer connections for remote control and monitoring:

- Basic Contractor Board
- Enhanced Contractor Board, which can connect twice as many output relays and building alarms

Internal PDU signaling, such as the four Digital Inputs, is terminated to the PDU (M4G) Board.

External signaling, such as the customer's REPO signal, is terminated to the Contractor Board: Setup of the PDU and Contractor Boards is performed during manufacturing. These boards can be programmed through a USB programming board the PDU Board. The PDU Board's points list values are also accessible through the customer's BMS, but most points cannot and should not be set by the customer, as incorrect settings can cause PDU malfunctions. Measurements values in the points list can also be viewed on the Color Monitor.

9.3.1 PDU M4G Board

For the following connections, reference Figure 27".

Transformer CT (current) and voltage connections (top edge of Figure 27):

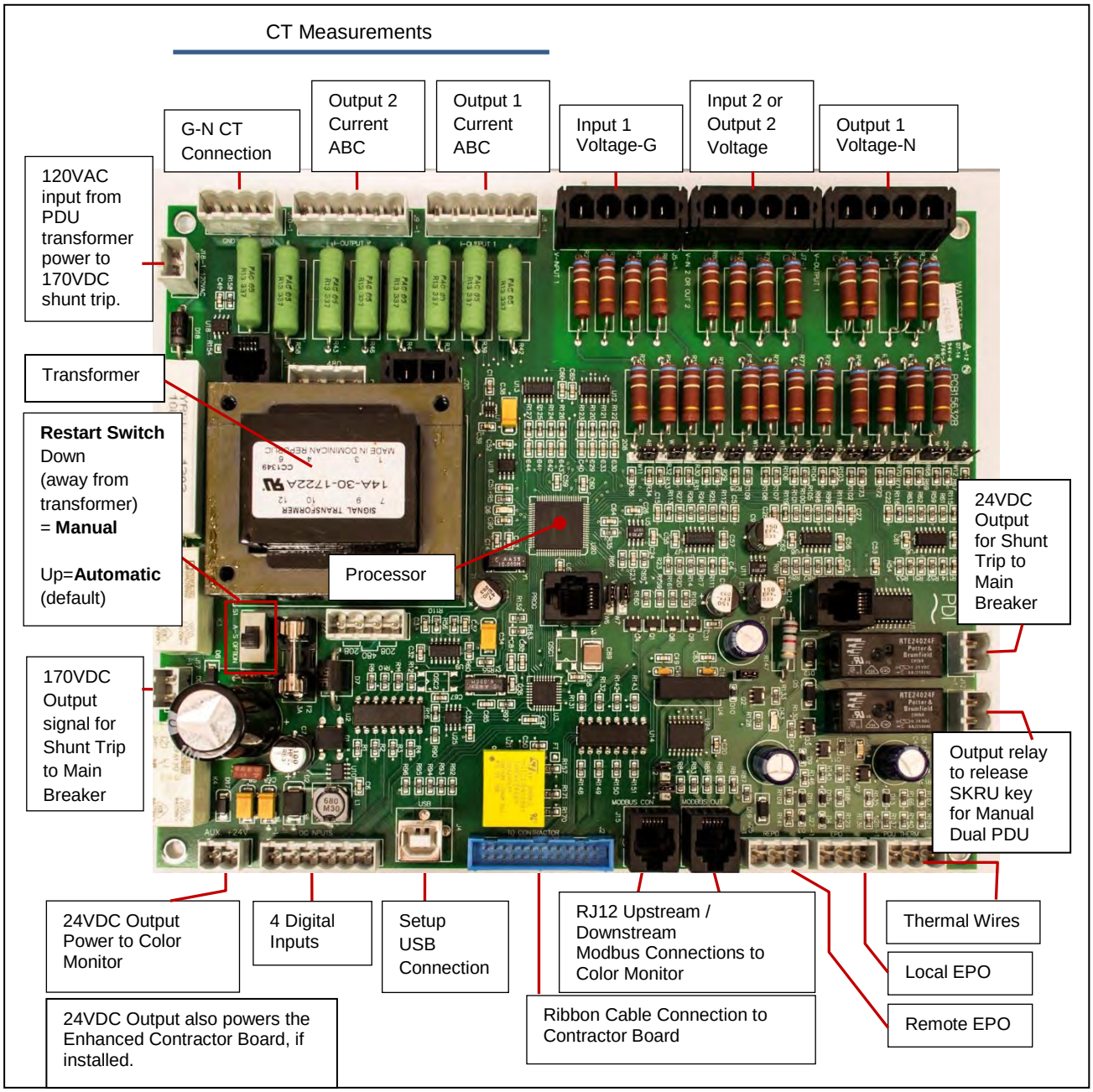
- CT connections, output current (ABC), Output 1 and Output 2
- CT Connection G-N:
  - Pins 1-2: Ground CT connection
  - Pins 3-4: Neutral CT connection
- Input 1 Voltage-G connection: Input Delta connection is 3-wire plus ground (no neutral).
- Output 1 Voltage-N connection: Output Wye connection is 4-wire plus ground.
- Input 2 or Output 2 Voltage provides a configurable second input or output voltage, used with dual input or output PDUs.

Power and Power Signals

- 120VAC Input Power connection provides power to the PDU M4G Board.
- 24VDC Output Power connection provides power to WaveStar Color Monitor
- Power Off Controls:
  - Remote EPO connection from the Contractor REPO Connection (J6), see . Customer REPO dry contact connection is to the Contractor Board.
  - Local EPO connection
  - Thermal wires for transformer temperature measurements, which can cause PDU shutdown.
- Shunt Trip: The board outputs two voltages for tripping the Main Breaker Shunt Trip:

- 170VDC: 170 VDC is rectified from 120VAC input power; 170VDC must be used for Restart Switch to function.
- 24VDC

Figure 27. PDU (M4G) Board



- The **Restart Switch** determines whether restart is automatic or manual after a voltage loss.

- **Manual:** Switch down (away from on-board transformer): PDU restart must be done manually after voltage is restored.
- **Automatic:** Switch up (towards on-board transformer): PDU restart is automatic after power is restored. Automatic Restart is the default setting.
- See section 8.4 *Manual or Automatic Restart* for additional information.

NOTE The Restart Switch requires 170VDC input to the main breaker shunt trip to function. It is not operable with the 24VDC input to the main breaker shunt trip.

Other Input and Output Signals

Four Digital Inputs or Alarms: Digital Inputs or Alarms are used for signalling internal to the PDU, such as a Door Open condition. Digital Inputs can be assigned by Eaton PDI during PDU M4G Board setup, when names can also be assigned to the inputs. These inputs turn on bits in PDU M4G Board Points List, Modbus Registers 90-91.

- Default assignments for single input PDU are as follows:
  - Digital Input 1: Unassigned
  - Digital Input 2: SPD Primary Device 1 not operational (if installed)
  - Digital Input 3: SPD Secondary Device 2 not operational (if installed)
  - Digital Input 4: Door Open
- Default assignments for Manual Dual PDU are as follows:
  - Digital Input 1: Main Input Circuit Breaker 1 is closed.
  - Digital Input 2: Main Input Circuit Breaker 2 is closed.
  - Digital Input 3: SPD Secondary Device 1 or 2 not operational (if installed)
  - Digital Input 4: Door Open

- **Output Relay**: On a Manual Dual PDU, this relay is triggered when prerequisite conditions for a transfer are met and the operator presses the **KEY RELEASE** button on the Color Monitor's Sync screen. The relay signal is transmitted to the Solenoid Key Release Unit (SKRU). A phase synchronization check is performed before enabling the relay. (See 12.5 *Dual Input Source Transfer Procedures* Dual Input Source Transfer Procedures and .)

Setup/USB Connection: Used by Eaton PDI representatives to program set points, contractor board relays, etc., in the PDU M4G and Contractor Boards. PDU board set points cannot be altered through normal Modbus register access to prevent registers being accidentally altered. See PDU M4G Board points list for further information. (See for information on downloading points lists.)

RJ12 Modbus Connections on the PDU M4G board are to/from the Color Monitor.

Replaceable Parts

Battery:

⚠WARNING

The battery used in this device may present a risk of fire or a chemical burn hazard if mistreated. Do not recharge, disassemble, heat above 100°C (212°F) or incinerate. To be carried out by authorized trained personnel only.

Use of another battery may present a risk of fire or explosion. Dispose of battery properly.

There are two battery options on the board and only one will be present:

- Designator U21: Yellow Tophat
  - Replace with STMicroelectronics M4T32-BR12SH1 only.
- Alternate Designator BH1: Coin Cell
  - Replace with Murata CR2032, 3V, 220mAh or any equivalent UL1642 BBCV2 recognized/listed make with same voltage and current rating only.

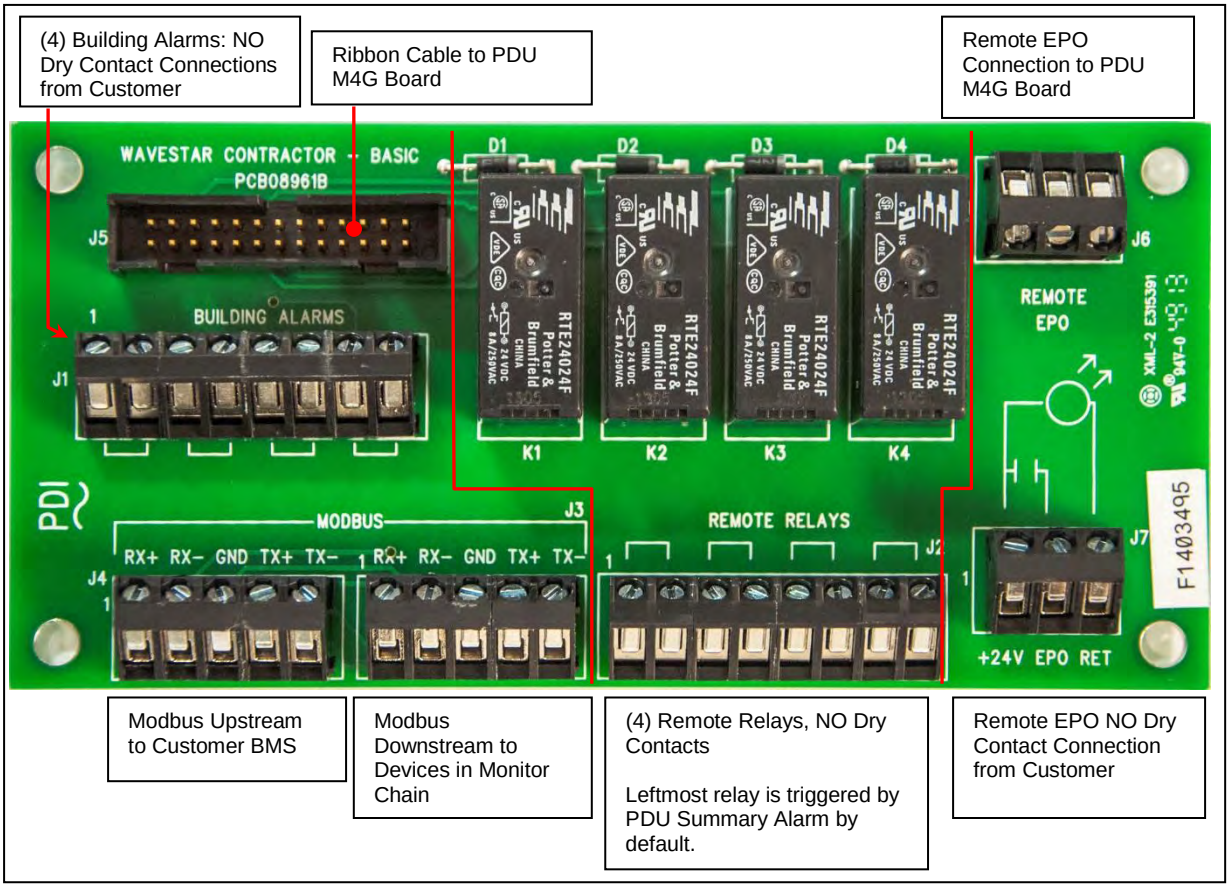
Fuses:

To be carried out by authorized trained personnel only.

- Designator F1:
  - Replace with 2A, 125V Littelfuse 39512000440 or UL recognized, IEC compliant fuse of the same type only.
- Designator F2:
  - Replace with 2A, 250V Bel Fuse 5TT 3-R or UL recognized, IEC compliant fuse of the same type only.

9.3.2 Basic Contractor Board

Figure 28. Basic Contractor Board



The Basic Contractor Board has these connections (Figure 28):

Inputs:

- Remote EPO: Customer dry contact connection point for input of an REPO signal. Connect external dry contacts to terminals marked **+24V EPO RET** (Figure 28). The external REPO signal is passed to the PDU Board via the **REMOTE EPO** connection, which is not a customer connection point. A small indicator light can be powered from the +24V and the return.

⚠CAUTION

Connecting a voltage to the +24V EPO RET dry contact connection can cause damage to the unit.

- Four (4) Building Alarms (Figure 28). Alarm names can be specified by Eaton PDI in PDU Board setup. Building alarms turn on alarm bits in the PDU M4G Board points list (Modbus registers 88-89), but do not shut down the PDU. However, the customer can specify that a specific building alarm shuts down the PDU. The shut-down option must be programmed into the PDU M4G Board in manufacturing. (See 8.3 *7.3 Automatic Shutdown Signals*.)

Outputs:

- Four (4) remote relays that output dry contact (NO) signals (Figure 28).
  - Relays are programmable using the USB setup connection on the PDU M4G Board. Eaton PDI programs the relay inputs, usually in in manufacturing. So, for example, a relay can be programmed to turn on when a specific Building Alarm, such as a fire alarm, is received. The building management system or other control system receives the relay input and can cause PDU shutdown with an REPO signal.
  - By default, the first, left-most relay is programmed to close when the PDU Summary Alarm, PDU Board points list, Modbus Register 70, is in alarm (Figure 28).

Modbus Connections: The board has customer connections for upstream and downstream 4-wire Modbus (Figure 28, J3 and J4). 2-wire Modbus can be set with jumpers on the Color Monitor and other boards in the Modbus RTU chain.

9.3.3 Enhanced Contractor Board

The Enhanced Contractor Board (Figure 29) provides twice as many relays and building alarms as the Basic Contractor Board. The Enhanced Contractor Board is used in other Eaton PDI products and many of the connectors are not used on PDUs.

24VDC Power Input: Unlike the Basic Contractor Board, the Enhanced Contractor Board has a processor and uses 24VDC power from the PDU M4G Board.

Inputs:

- Remote EPO: Dry contact connection point for input of a REPO signal to system. Connection of voltage to this point can cause damage to the unit. Connect external dry contacts to terminals marked **+24V EPO RET** (Figure 29). The REPO signal is sent to the PDU Board via the REMOTE EPO connection, which is not a customer connection point. A small indicator light can be powered from the +24V and the return.

⚠CAUTION

Connecting a voltage to the +24V EPO RET dry contact connection can cause damage to the unit.

- Eight (8) Building Alarms (Figure 29). Alarm names can be specified by PDI in PDU Board setup. Building Alarms turn on alarm bits in the PDU M4G Board points list (Modbus registers 88-89), but do not shut down the PDU. However, the customer can specify that a specific building alarm shuts down the PDU.

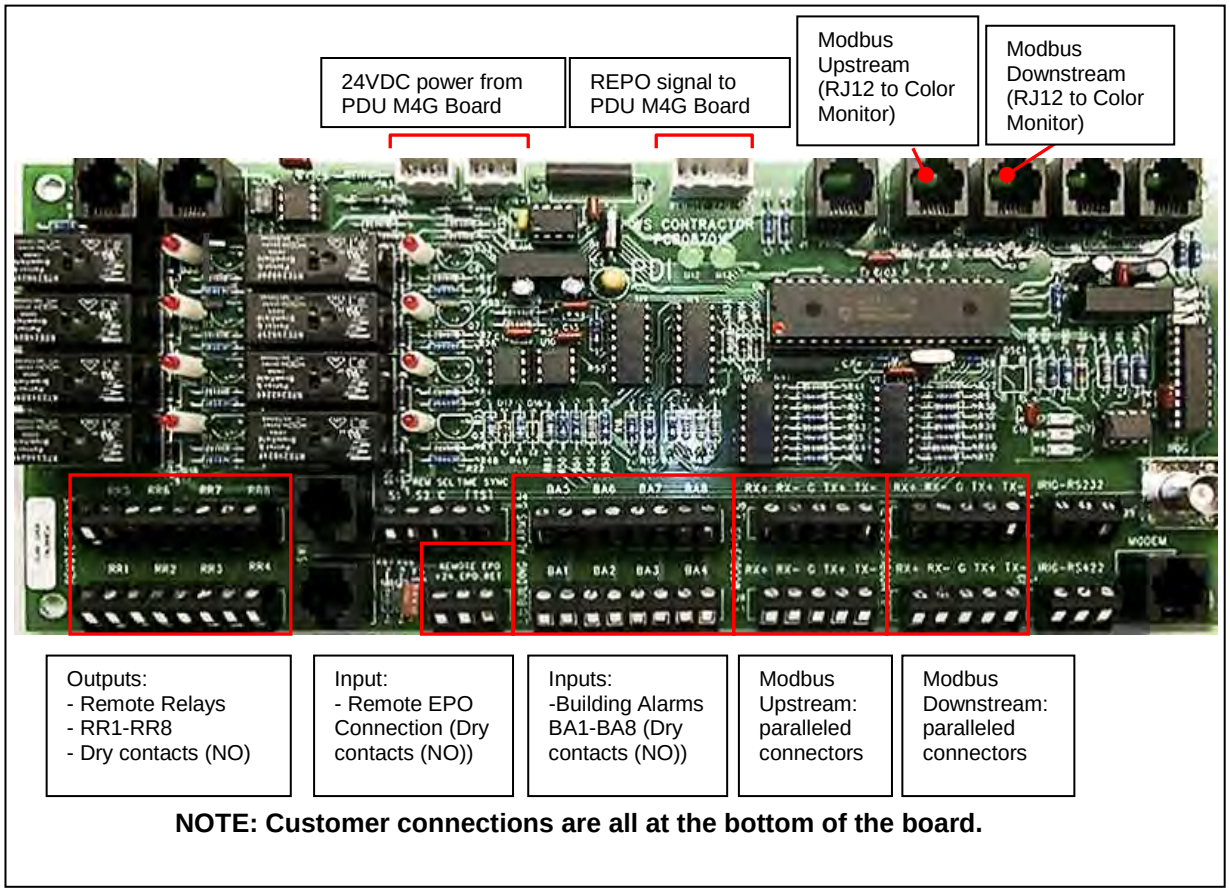
The shut-down option must be programmed into the PDU M4G Board in manufacturing. (See 8.3 *7.3 Automatic Shutdown Signals*.)

Outputs:

- Eight (8) remote relays that output dry contact (NO) signals ().
  - Relays are programmable using the USB setup connection on the PDU M4G Board. Eaton PDI programs the relay inputs, usually in manufacturing. So, for example, a relay can be programmed to turn on when a specific Building Alarm, such as a fire alarm, is received. The building management system (BMS) or other control system receives the relay input, receives the signal and can cause PDU shutdown with an REPO signal.
  - By default, the first relay RR1 is programmed to close when the PDU Summary Alarm, PDU Board points list, Modbus Register 70, is in alarm.

Modbus Connection: 4-wire configuration connection is located on the customer connection terminal block.

Figure 29. Enhanced Contractor Board



9.3.4 PDU M4G Board Points List

The PDU M4G Points List contains measurements and set points for the PDU M4G Acquisition Board and its associated Contractor Board. It has two groups of data:

- Measurements and Alarms

  - Current and voltages measurements from the critical load transformer
  - Alarms from PDU M4G Board and Contractor Board
- set points for
  - Alarm thresholds
  - Contractor board setup, such as enabling building alarms and specifying names

Eaton PDI representatives must specify Modbus register set points or Contractor Board setup options using a special setup program connected to the M4G USB port.

The PDU M4G Board points list can be downloaded from the Eaton website (see 1.7 *Getting Help*.

9.4 Branch Circuit Monitoring System (BCMS)

9.4.1 Panelboard and Subfeed Monitoring

A single BCMS PCB can monitor

- (2) x 42-pole panelboards, or
- (1) x 84-pole panelboard, plus
- The main feed(s) associated with each panelboard.
- Two sets of up to (14) subfeeds (or up to (10) subfeeds if neutrals are monitored).

Panelboards must have CT strips covering each panelboard circuit. Subfeeds must have CTs connected to an intermediate Resistor Board.

Layout of a BCMS HV board (BCMS PCB) is shown in.

9.4.2 BCMS Points Lists

Points lists are loaded onto BCMS PCBs at the factory. Only one kind of points list can be loaded into a BCMS PCB at the same time, but the PCB can monitor more than device that uses that points list.

A 42-pole panelboard is represented by a single panelboard points list. An 84-pole panelboard is represented by two (2) panelboard points lists. Panelboard points lists include the following:

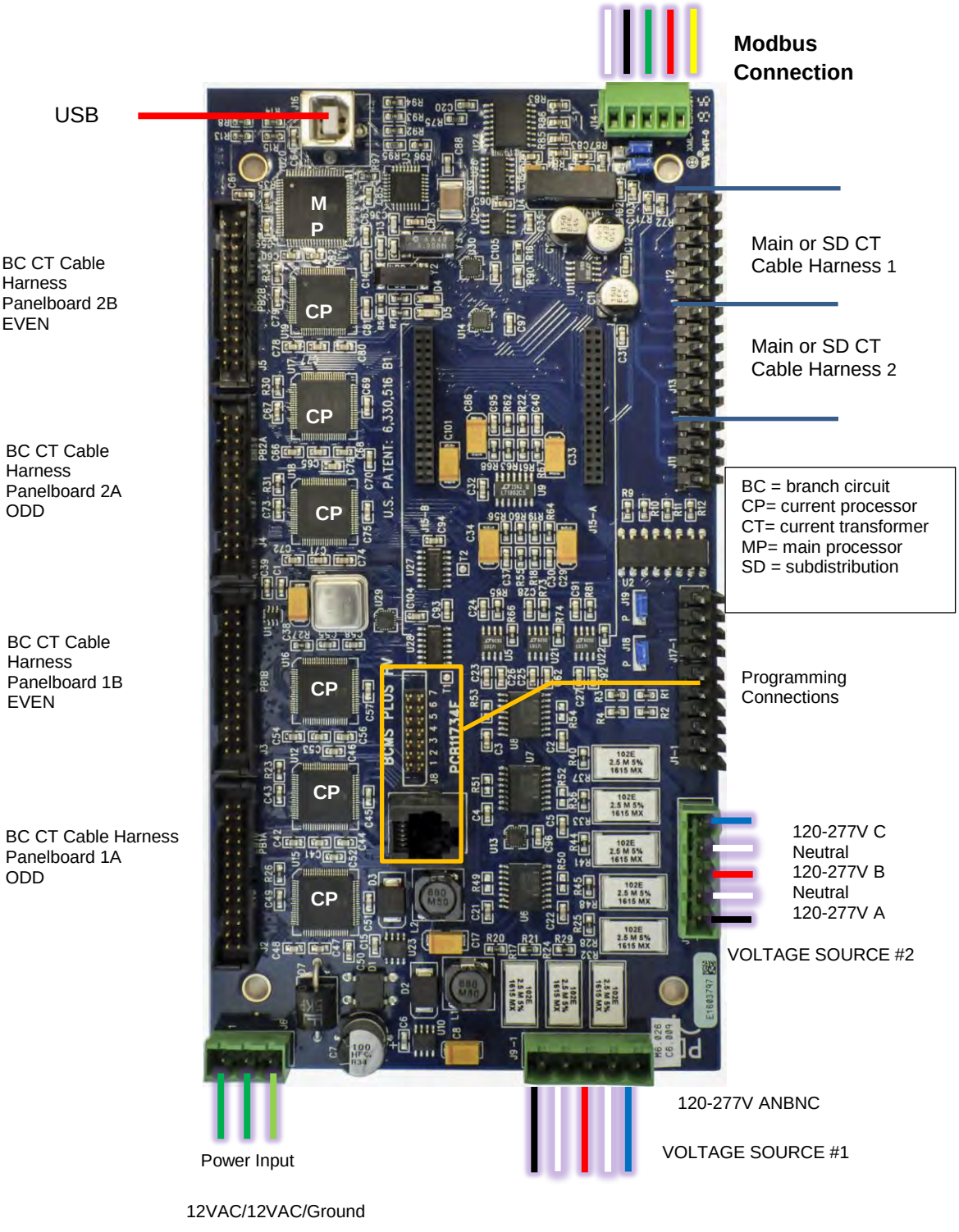
- **BCMS Normal** panelboard points list allows customization of circuit breaker alarms and warnings for each panelboard circuit.
- **BCMS KWH** points list provides accumulated KWH measurements and other detailed power information for each panelboard circuit.
- **BCMS IEC** panelboard points list is for IEC format panelboards with 36 or 72 1P circuits.

Subfeeds (including I-Line subfeeds) use this points list:

- **BCMS Enhanced Subfeeds (ESF)** points list for subfeeds.

Contact Eaton Service for information on downloading points lists from the Eaton website (see 1.7 *Getting Help*).

Figure 30. BCMS HV Board



9.5 Dry Contact Network

In addition to the internal Modbus RTU network, the PDU has a network of dry contacts providing input signals and alarm and status annunciation. Dry contact connections to the Color Monitor, PDU M4G Board, and Contractor Board(s) are standard. Optional dry contacts for subfeed circuit breaker (trip, trip alarm, and aux status) and SPD/TVSS status are also available.

Table 10 lists available dry contact input and output signals

9.5.1 Dry Contacts for Subfeed Circuit Breakers (optional)

Subfeeds can have optional dry contacts to

- present a trip alarm, or
- present circuit breaker status.

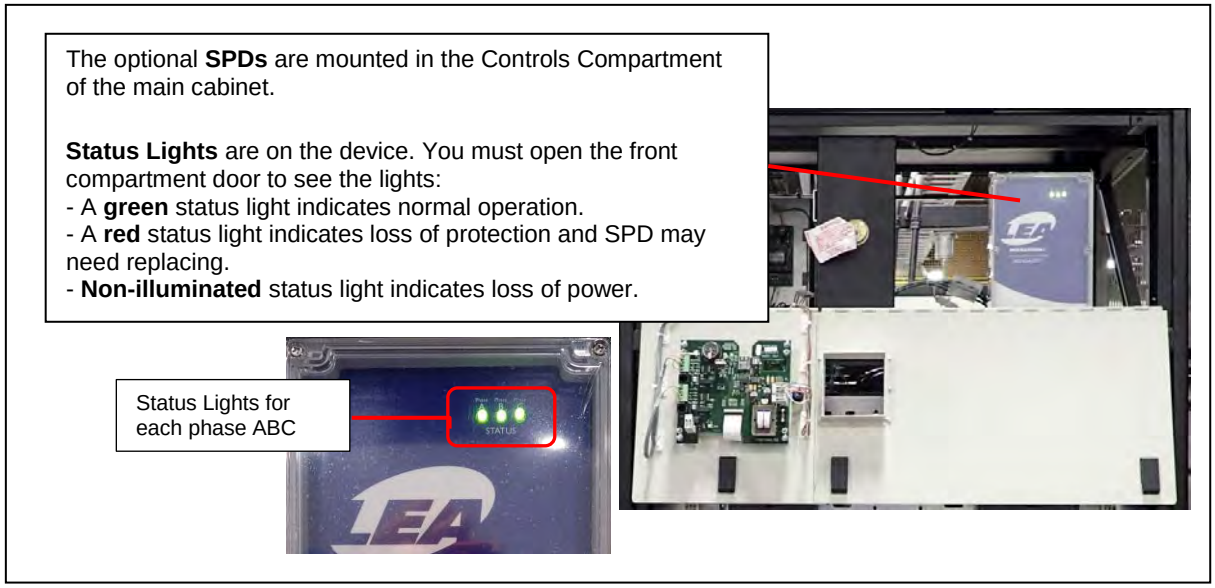
A set of terminal blocks can be installed in the monitoring compartment providing an intermediate connection point between the circuit breakers and the customer's dry contact network.

9.5.2 Surge Protective Device Status

The PDU allows optional SPD/TVSS devices on input and/or output. Each SPD/TVSS incorporates a remote signaling dry contact and visual status lights.

The dry contact is closed when the SPD is powered and functional. (See Table 10), The dry contact is typically wired at the factory to a PDU M4G Board Digital Input.

Figure 31. SPD/TVSS Status Lights



9.6 Subfeed Circuit Breaker Trip

A subfeed circuit breaker can optionally be tripped using an applied voltage, 120VDC or 24VDC. 24VDC is recommended.

Table 10. Dry Contact Signals

Device	Input Signals	Output Signals	Signal Meaning	Dry Contact Spec NA=Not Applicable
Color Monitor		Summary Alarm	An alarm is present on a device in the Monitor's device chain.	0.5A @ 120VAC 0.5A @ 30VDC
PDU board	4 Digital Inputs		Signals internal to PDU with assignable meanings. Digital Input 4 = PDU door open (default assignment).	NA
Contractor Board	Remote Emergency Power Off (REPO)		Signal to immediately power down PDU.	NA
Contractor Board	4-8 Building Alarms		Assignable meanings. Customer can elect to shut down the PDU on a specific building alarm. See Section 8.3 *7.3 Automatic Shutdown Signals*	NA
Contractor Board		4-8 Remote Relays	Assignable meanings Relay 1 = Summary Alarm for PDU by default	Up to 2A/250V
Subfeed breaker(s) (optional)		Breaker trip alarm	Subfeed circuit breaker has tripped or has been reset	Max 5A/600V 24VDC recommended
Subfeed breaker(s) (optional)		Auxiliary contacts	Subfeed circuit breaker contacts have changed state (open or closed)	Max 5A/600V 24VDC recommended
Surge Protective Device (SPD) (optional)		OK/not OK signal	NC contact is closed when SPD is functional and powered. SPD dry contact is usually wired to a Digital Input on the PDU M4G Board. See "Digital Inputs" in 9.3.1 *PDU M4G Board*.	600V wire required. Contact ratings: 0.3 A @ 125VDC 0.3 A @ 110 VDC 1.0 A @ 30 VDC
Manual Dual PDU External Dry Contact Signal	External signal; may be issued from UPS		Enable the Color Monitor's internal permissive signal.	

Chapter 10 Monitoring: PDU Network

The PDU's network is centered on the Color Monitor, which stands at the dividing point between the PDU's internal or downstream network and the network upstream or external to the PDU.

10.1 Color Monitor and Protocols

The Color Monitor is the Modbus master device to all devices in the PDU that use WaveStar monitoring. All of these devices are downstream of the Monitor. Upstream Modbus master devices, such as the Building Management System (BMS), request data from the PDU's monitored components only through the Color Monitor. The Monitor communicates to these upstream Modbus requesters using any of the following protocols, which can all be used simultaneously.

Downstream Protocol The downstream PDU device network has fixed parameters of Modbus RTU, 9600 baud, EVEN parity.

Upstream Protocols The Monitor has separate upstream ports for Modbus RTU and Ethernet, supporting these protocols:

- Modbus RTU
- Ethernet port
  - TCP/IP, used by the Color Monitor's web page server
  - Modbus TCP/IP
  - SNMP Version 1

For in-depth information on the Color Monitor, including setup, networking, commands and replies, screens, and web pages, see *WaveStar® Color Monitor, Setup and Operation, P-164001109*.

10.2 Customer Network Connections

Customer Modbus RTU network connections are made to the Contractor Board. See 9.3.2 *Basic Contractor Board* Basic Contractor Board and 9.3.3 *Enhanced Contractor Board* Enhanced Contractor Board. The Customer Ethernet connection is made to the Color Monitor backpanel. See Chapter 10 *Monitoring: PDU Network*.

10.3 Modbus Addressing

Refer to Figure 33, with the following bullet points:

- The internal PDU network uses Modbus RTU protocol to connect the PDU board and BCMS PCBs to the Color Monitor.
- The Color Monitor is the **Modbus master** to its downstream devices. The upstream Modbus master (such as the BMS) cannot directly address these devices, but rather addresses them through the Monitor. Upstream and downstream from the Monitor are separate Modbus segments.
- The Monitor's upstream address can be set to from 1 to 247, but you must leave enough addressing capacity for downstream devices. The monitor will not respond to a command sent to address 0. The address is set during Monitor Setup.
- The Monitor's downstream devices must be assigned consecutive addresses starting at address1 for the PDU Board. Modbus addresses must be assigned in BCMS setup and will be done initially at the factory. Modbus addresses cannot be assigned by, for example, the BMS.
- For upstream addressing these device addresses are remapped as successor addresses to the Monitor. (This is often confusing, but it is important to understand.) If the Monitor has upstream address 30, the downstream addresses 1, 2, 3, 4, 5, 6, 7 are remapped to 31, 32, 33, 34, 35, 36,37 as seen from the BMS or other Modbus Master.

- Modbus addressing is the same for Modbus RTU and Modbus TCP/IP.

10.4 Color Monitor Network Connections

The Color Monitor's backpanel has Modbus RTU and Ethernet ports (Figure 32). Modbus RTU backpanel connections are typically made in manufacturing. (Customer Modbus RTU connections are made to a Contractor Board.) However, the customer's Ethernet cable is connected directly to the Monitor's Ethernet port.

Figure 32. Color Monitor Network Connections

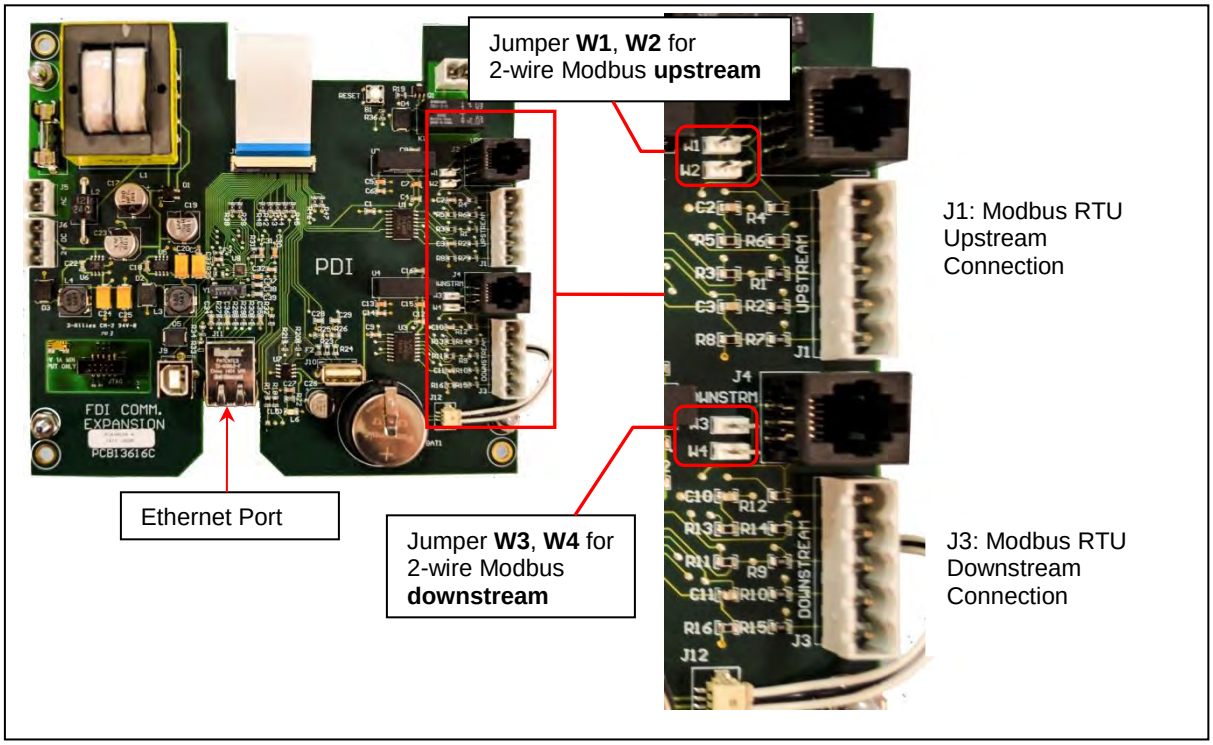
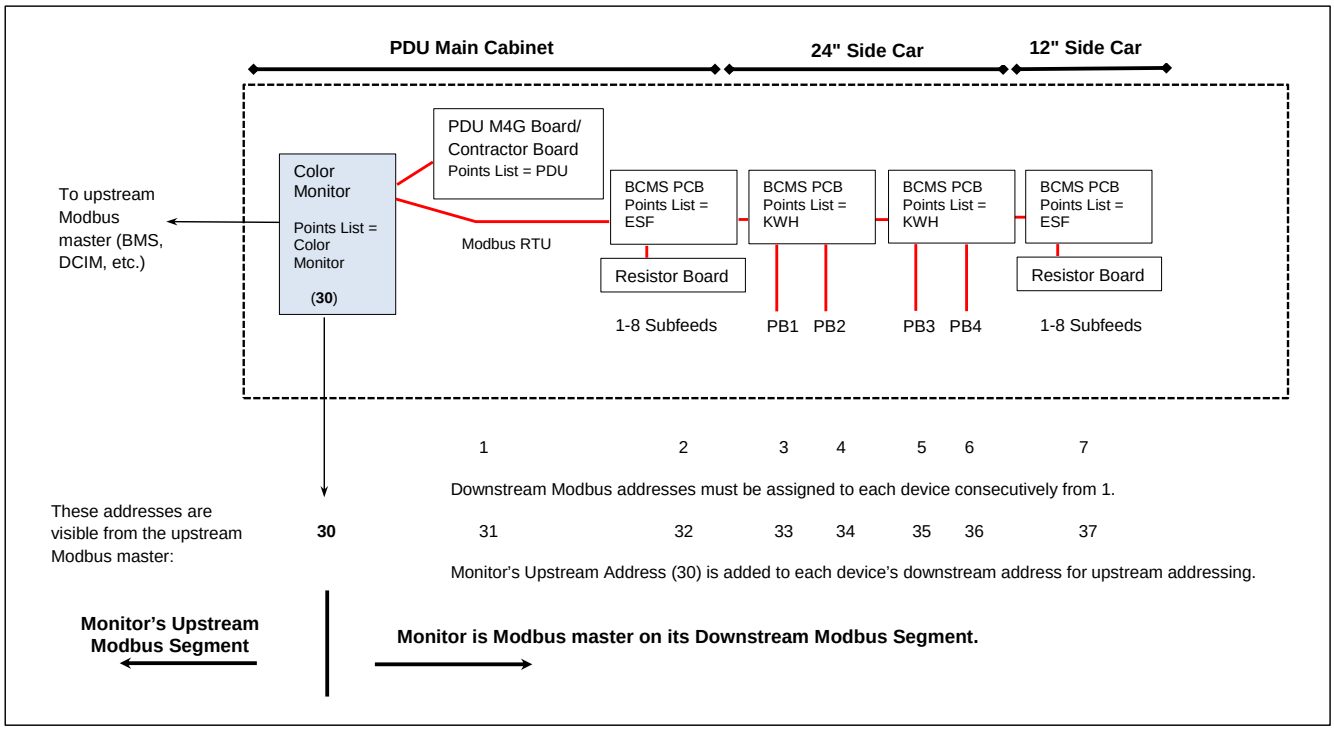


Figure 33. Internal PDU Network, Modbus Addressing, Example



10.4.1 Modbus RTU Ports

Table 11. Pin-Out for Modbus Headers

Pin	J1, J3
1	Ground
2	RX-
3	RX+
4	TX-
5	TX+

The Color Monitor has two (2) paralleled Modbus ports:

- J1 and J3 are header/plug connections for connecting to most devices.
  - J1 is the upstream port.
  - J3 is the downstream port.

The Modbus RTU interface is isolated, and pin designations are given in Table 11.

10.4.2 Modbus RTU 2-Wire vs. 4-Wire Configuration

Eaton PDI devices have two (2) jumpers near their Modbus ports for configuring 2-wire vs. 4-wire Modbus RTU (see Figure 32). The Monitor's 2-wire configuration jumpers are W1 and W2 (upstream) and W3 and W4 (downstream). Upstream and downstream chains can be differently configured.

For 2-wire configuration:

- At least one device in a device chain must have both jumpers jumped on its Modbus connection. If any device in the chain has jumpers installed for 2-wire, all of the device chain is 2-wire. To avoid confusion when troubleshooting, all of the devices in the chain should be jumped in the same way.
- TX+ or RX+ on the Monitor (either one, because the on-board 2-wire jumpers short them together) wires to TX+ or RX+ on downstream devices.
- TX- or RX- on the Monitor wires to TX- or RX- on downstream devices.
- The + and - signal wires should comprise of a (twisted) wire pair residing in the same shield.

For 4-wire configuration:

- All of these jumpers must be removed from every device in the chain.
- TX+ on the Monitor's PCB or on the customer Building Management System (BMS) wires to RX+ on a device PCB (Figure 32).
- TX- from the Monitor or BMS wires to RX- on device PCB ((Figure 32)).
- A second pair of wires connects the other pair of TX+ / RX+ & TX- / RX-.
- The TX+ & TX- going to the RX+ & RX- should be in the same shield. Do not run the +'s in one shield and the -'s in another. Doing so may lead to sporadic communication.
- Run a dedicated ground wire with the signal wires and only ground the shield at one end.

10.5 Modbus RTU Cables

10.5.1 Cable Specification

RS485/RS422 cable length can be up to 4000 ft. if you use the proper cable:

- The cable resistance should be ≤ 27 ohms/1000ft @ 1 kHz and the mutual capacitance should be ≤ 14pf/ft. @ 1 kHz.
- 4-wire cabling:
  - RS422 is typically 4-wire. oUse a shielded cable with two (2) twisted pairs and a shield/ground wire.
  - The two transmit lines must be in one twisted pair and the two receive lines in the other twisted pair.
- 2-wire cabling:
  - RS485 is typically 2-wire and is slower than RS422.
  - Use a shielded cable with one (1) twisted pair and a shield/ground wire.

10.5.2 Cable Biasing and Termination

Eaton PDI devices have soft biasing (27K pull-up and pull-down resistors) on the + and – transmit and receive lines. Therefore, if the customer's Master device allows for control, Eaton PDI recommends that the user turn on biasing and turn off termination, which may "fight" the biasing. Biasing the Master device's lines is not critical because the Color Monitor is already biasing the lines. If termination is needed because of an extremely long cable run, Eaton PDI recommends that a small capacitor be put in series with the terminating resistor.

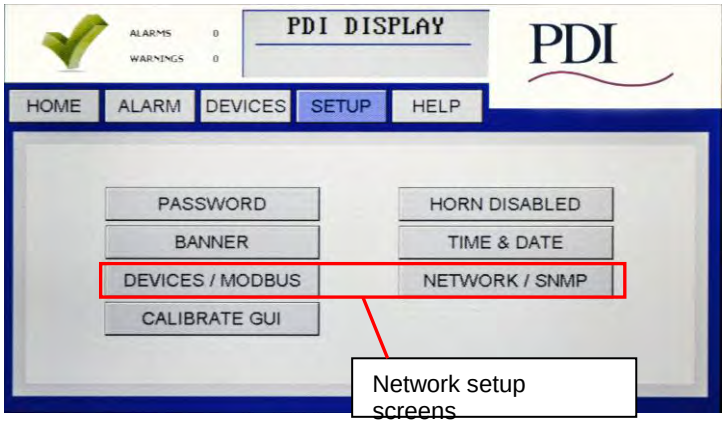
10.6 Ethernet Cables

The maximum length of Ethernet cable depends upon the customer's choice of Ethernet cable.

10.7 Setting Color Monitor Network Parameters

The Color Monitor must be set up to match the customer's physical network. Touch **SETUP** on the Color Monitor **HOME** screen to display buttons for network setup (Figure 34).

Figure 34. Color Monitor SETUP Screen



Touch buttons in the initial **SETUP** screen to link to miscellaneous setup functions:
PASSWORD: Keyboard appears, enter password, then type new password.
HORN DISABLED: Toggle Monitor's audible alarm to ENABLED/DISABLED.
BANNER: Banner setup (here shown as "PDI DISPLAY") is on same screen as Modbus setup (Figure 7).
TIME & DATE: Set time and date; used on HOME screen and alarm timestamps.
CALIBRATE GUI: See next figure.

A password is required to access and change setup parameters. Enter the password (default is "PDI"). The user can navigate through any of the screens and come back to **SETUP** without having to re-enter the password for 10 minutes. Touch **PASSWORD** to change to a new password.

⚠CAUTION

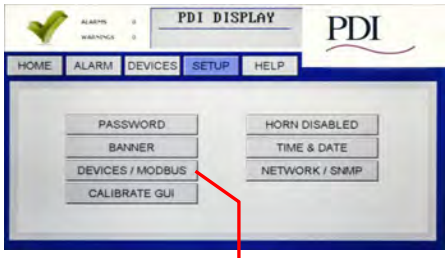
Improper configuration of a WaveStar Color Monitor may conflict with other monitors or devices on the network.

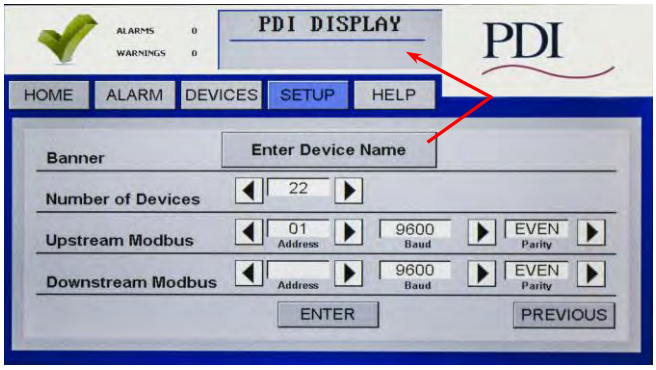
10.7.1 Downstream Modbus Device Chain Setup

To set Modbus device chain parameters, touch DEVICES/MODBUS (Figure 35):

- **Number of Devices** should equal the number of devices in the Monitor's device chain. Up to twenty (20) devices are allowed. The Monitor uses this number to determine how many devices to search for in its downstream chain.
- When you add new devices, increment this counter, then press "ENTER". The Monitor will automatically start a new search and find all of the downstream devices. The devices will then be listed in the **DEVICES** Screen, where the added devices will initially show up as generic device names.
- For each new device the user should then enter a unique device name. Unique device names are needed to isolate alarms and measurements to specific devices.

Figure 35. Modbus RTU Setup





On **SETUP** screen, touch **DEVICES/MODBUS**.

The **DEVICES/MODBUS** screen defines the Modbus network and device chain as well as set the banner name for the header.

Modbus Device Chain:
Banner Name displayed on top line.

Number of Devices should equal number of devices connected in Monitor's downstream device chain.

Upstream Modbus:
Address of Monitor on upstream side
Baud rate (9600/19200/38400)
Parity (even/odd/none)

Downstream Modbus Network characteristics are fixed and cannot currently be modified.

10.7.2 Modbus RTU Setup

Downstream Modbus settings cannot be changed.

Upstream Modbus provides network characteristics on the upstream side of the Monitor.

- **Address** is the address that the upstream Modbus master, such as the Building Management System (BMS), uses to address the Monitor. The downstream device addresses are incremented sequentially from this address. So, if the Monitor has address 20, the next three devices will appear 21, 22, and 23 to the upstream master device. (See Figure 33).
- **Upstream Modbus** settings for **Baud** rate and **Parity** must match those for the upstream Modbus master.

10.7.3 TCP/IP and Modbus TCP/IP Setup

For TCP/IP, the customer must provide an Ethernet cable connected to the Ethernet port (RJ45 header J11) on the Monitor. (See Figure 32.)

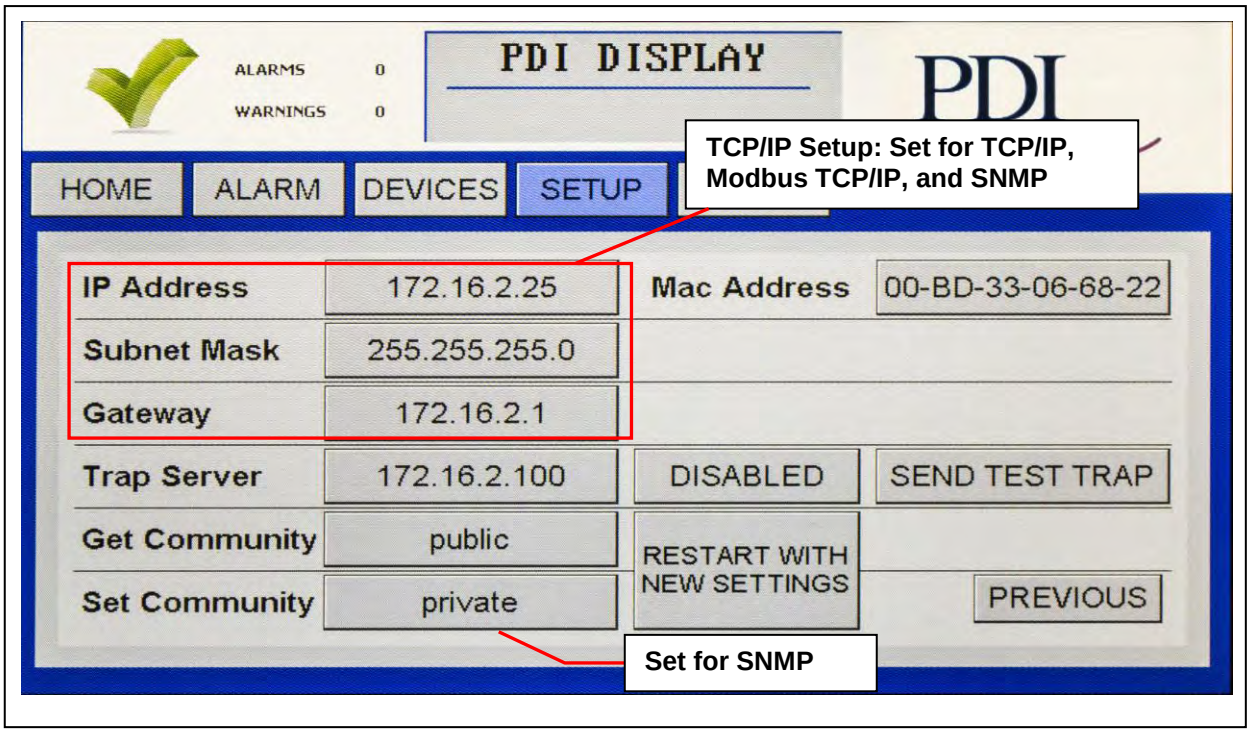
On the **SETUP** screen, touch **NETWORK/SNMP** to display the network parameters for TCP/IP (Figure 36). The following must be specified for Modbus TCP/IP:

- IP Address
- Subnet Mask
- Gateway

Each connected monitor must be assigned a unique address. DHCP is not supported.

Touch **RESTART WITH NEW SETTINGS** if any parameter is changed on this screen. The processor will reboot and search the network for connections.

Figure 36. Modbus TCP/IP and SNMP Setup



10.7.4 SNMP Setup

To use SNMP, the customer must connect an Ethernet link to the RJ45 header J11 (see Figure 32) on the Monitor using a standard Ethernet cable.

For SNMP setup, on the **SETUP** screen, touch **NETWORK/SNMP** to display the network parameters for SNMP (Figure 36).

In addition to the TCP/IP specification, the following must be specified for SNMP: •Specify the Trap Server IP address

- Toggle **ENABLED/DISABLED** for the trap server.
- Touch **SEND TEST TRAP** to verify operation.
- **Get Community** security string for Get operations.
- **Set Community** security string for Set operations.

Touch **RESTART WITH NEW SETTINGS** if any parameter is changed on this screen. The processor will reboot and search the network for connections.

10.8 Device Settings

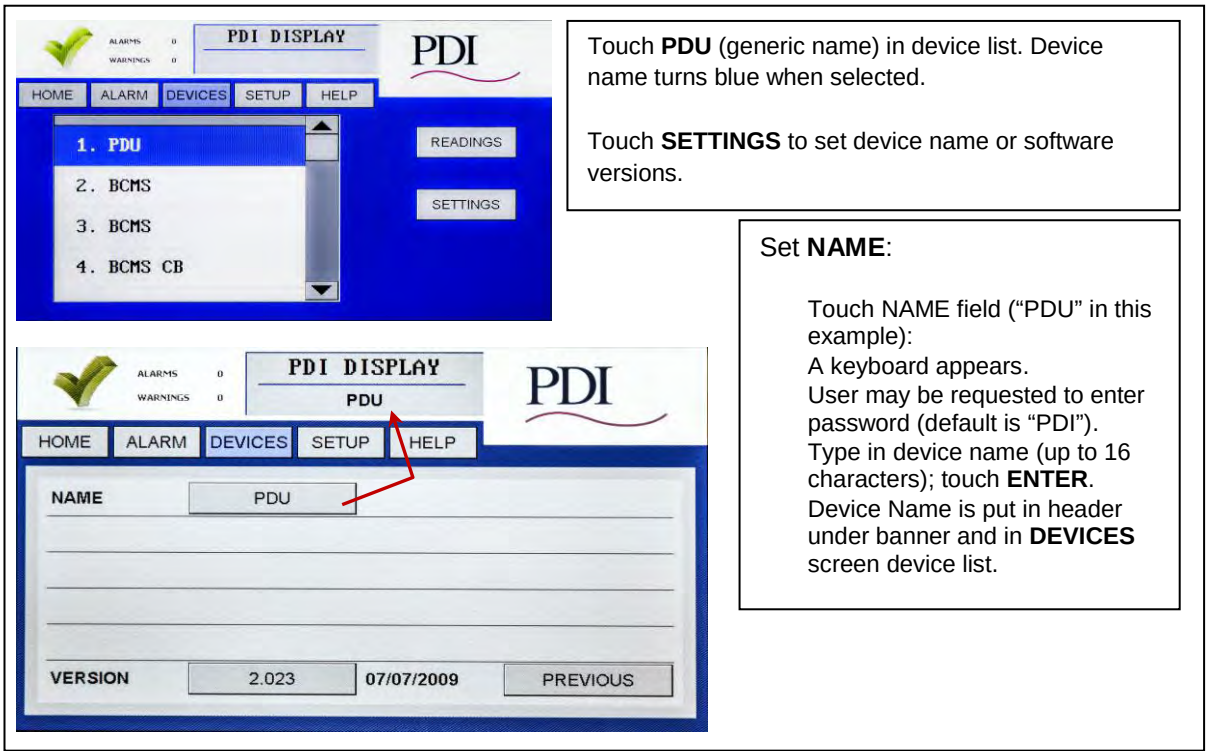
A "device" is a points list (or Modbus register map) representing a physical monitored entity, such as a panelboard. Each points list instance has a single Modbus address.

Each device has a **SETTINGS** screen for changing device name, software version, and device configuration. These settings provide information to the Monitor in addition to each device's own internal setup. Device settings are usually entered by Eaton manufacturing or service representatives, but can be entered by customer administrators.

10.8.1 PDU Device Settings

Use the **DEVICES** screen to show each device in the Color Monitor's chain. By selecting a device in the list, you can change the generic name (e.g. "PDU") to a name meaningful to your installation. Accessing the PDU device name is shown below.

Figure 37. Settings: PDU Device



To change device parameters on other devices in the PDU, such as panelboards or subfeeds, consult the *WaveStar® Color Monitor, Setup and Operation, P-164001109*.

10.9 Device Readings

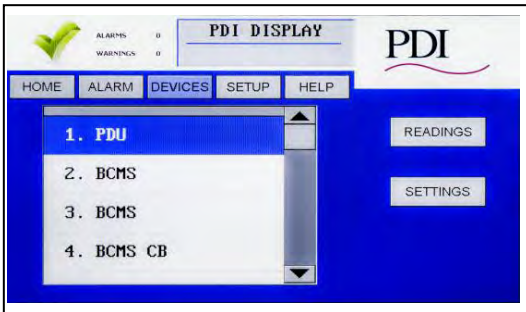
Each device in the Monitor's device chain has a READINGS screen chain, providing power monitoring information.

- Select (touch) **DEVICES** to see the device list and then READINGS.
- Use **PREVIOUS/NEXT** to step through the screen chain.

As an example, **READINGS** from the PDU are power measurements at input to and output from the PDU transformer (Figure 38).

Screens for device readings for all devices that can be monitored by the Color Monitor are shown and described in *WaveStar® Color Monitor, Setup and Operation, P-164001109*.

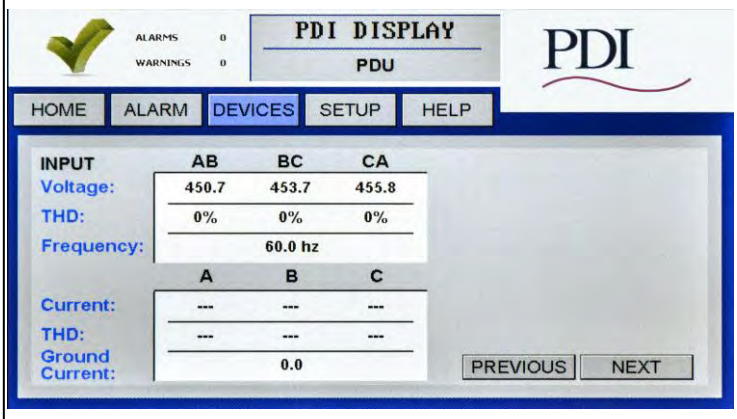
Figure 38. Readings: PDU



Select (touch) **PDU device name** in the device list. Device name turns blue when selected and device name displays in header.

PDU is the default generic device name.
Users can change the device name in **SETTINGS**.

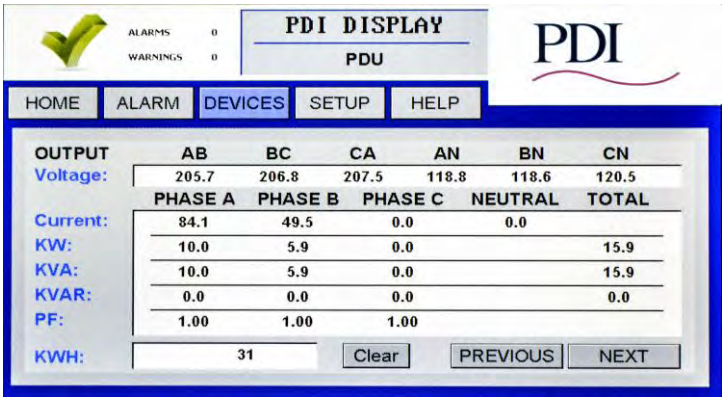
Touch **READINGS** to see PDU power monitoring data.



INPUT to the PDU transformer:

Voltage: AB BC CA
THD (total harmonic distortion):
AB BC CA
Frequency: in Hz

Current A B C (optional)
THD A B C (optional)
Ground Current



OUTPUT from the PDU transformer:

Instantaneous measurements:
Voltage: AB BC CA AN BN CN

ABC(N) phase readings and totals:
Current
KW
KVA
KVAR
PF

Cumulative Measurement:
KWH
Touch **Clear** to set KWH to 0.

Chapter 11 Monitoring: Alarms

The Color Monitor displays alarms and warnings for all devices in the Monitor's device chain. The Monitor reads the alarms and warnings from the points list (Modbus register map) of each device.

Because the Monitor receives power from the line side of the Main Circuit Breaker, it can be used to monitor power and diagnose power events, both during PDU Start-up or after an outage.

11.1 Summary Alarm Indicators

There are two Summary Alarms:

- PDU Remote Relay Summary Alarm signals that an alarm is present for the PDU M4G Board or Contractor Board.
- Color Monitor Summary Alarm signals that an alarm is presented on any of its downstream connected devices, including the PDU and Contractor Boards and all of the PDU's BCMS devices. It does not include auxiliary contacts for circuit breakers.

The Color Monitor indicates that there are extant alarms with three general indicators:

- The summary count of warnings and alarms for the Monitor's entire device chain is shown on every screen (Figure 39).

Figure 39. Alarm and Warning Summary Status Icons

When there are no alarms or warnings, a green check mark is displayed.

When alarms are present on any device, a red and yellow icon is displayed with the alarm and warning counts.

- There is also a light under the screen that glows green if none of the devices in the Monitor's chain has warnings or alarms and red if there are outstanding warnings or alarms (See, the light is in the bezel).
- In addition, the Monitor has a dry contact (NO) connection on the backpanel that signals a summary alarm whenever any alarm is present in the Monitor's device chain (See Monitor backpanel, Figure 32).

11.2 Alarm Screen and Alarm List

On any screen, touch the ALARM button to show the ALARM screen.

The ALARM Screen (Figure 40) lists all outstanding warning and alarms by device name with a date-time stamp in a scrollable list. If no alarms are outstanding, there will be only one line, "No Alarms". The warning or alarm gives the device name and locates the device component that is the alarm source. For example, for a BCMS panelboard device, the alarm may be located to

- the panelboard, such as "Over Current PB", or
- the main voltage feed to the panelboard, such as "Over Volt Main," or
- the individual panelboard circuit, such as "CB 19 Zero Current".

To further investigate individual circuits in warning/alarm state (Figure 41):

1. Note the device name and the warning/alarm.
2. Touch the DEVICES button to show the device list.
3. In the device list, scroll to the device name that has the warning/alarm. Touch the device name to show the device's circuit list.
4. Step through the device's screen chain with PREVIOUS/NEXT to find the ALARM heading.
5. Scroll within the circuit list on the first device screen to find circuit or other component in warning/alarm. An alarm may apply to a circuit or to the entire device, such as "Under Current PB."

Figure 40. ALARM Screen with an Alarm List

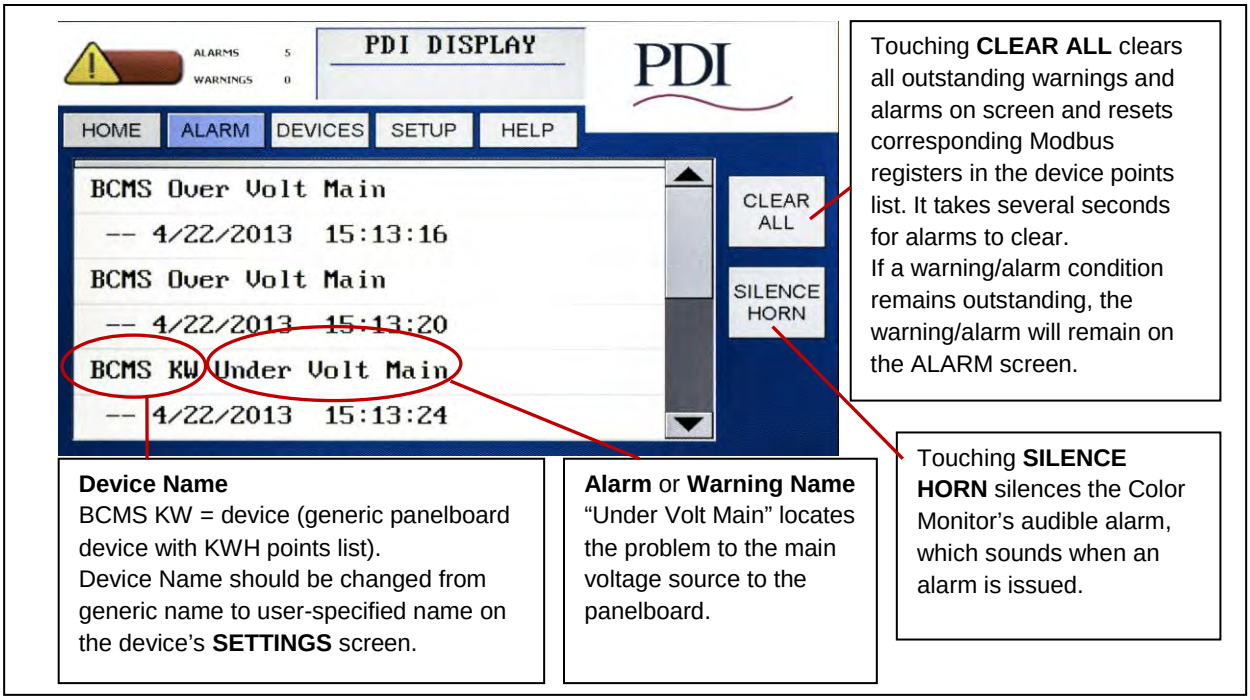
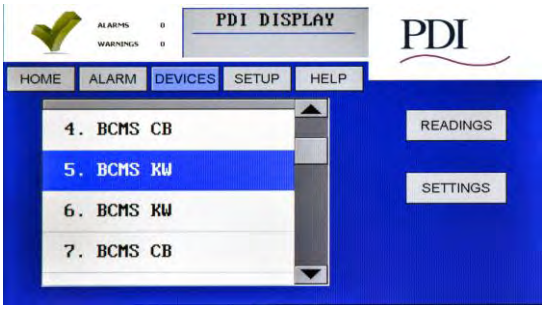


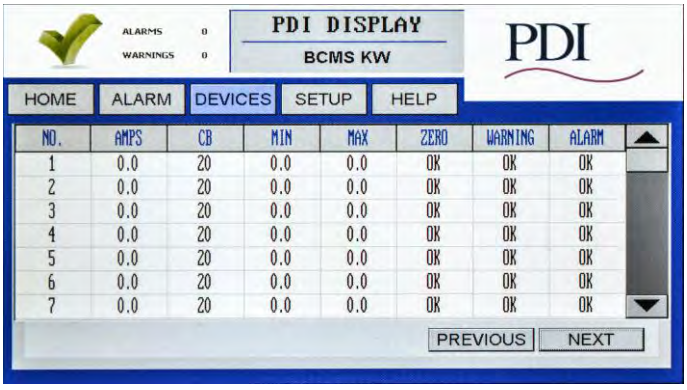
Figure 41. Finding the Circuits in an Alarm Condition



Touch **DEVICES** button to display the device list.

Find the **Device Name** noted in the alarm in the device list.

Touch the **Device Name** to display its screen chain.



Step through the device's screen chain (using **NEXT**) to find the screen with the **ALARM** column.

Scroll through the device's circuits to find the component in alarm. (Alarm shows as **ACTIVE** under **ZERO**, **WARNING**, or **ALARM**.)

Review information for that circuit on all of the device's screens.

11.3 Alarms by Device Type

Each device has its own alarm set based on its points list. Warnings and alarms that can be viewed on the Monitor are listed below. The Monitor does not display setpoints from the points lists, such as alarm thresholds.

11.3.1 Color Monitor Alarms

DISPLAY Comm. N Error (N is device number from 1-20): Communication error with one of the devices in the Monitor's downstream device chain

Alarm	Alarm Description
DISPLAY Comm. N Error (N is device number from 1-20):	Communication error with one of the devices in the Monitor's downstream device chain Ground

11.3.2 PDU Alarms

General PDU Alarms

Alarm	Alarm Description
EPO	Emergency Power Off on PDU has been engaged. When EPO button is pushed, the alarm is activated and the unit's main input circuit breaker will then be shunt-tripped off line.
Thermal Overtemp	Stage 1 transformer temperature alarm: 180ºF or higher temperature registered in the transformer windings.
Thermal Hightemp	Stage 2, PDU shutdown on transformer temperature alarm by tripping main PDU input circuit breaker when 195ºF or higher temperature is registered in the transformer windings. (Temperature threshold can vary by transformer and PDU.)
Phase Rotation	Input phase rotation is incorrect.
S1-S2 Phase Angle	Dual input sources are not synchronized; cannot shutdown one source and transfer load to the alternate source.
Ground Curr Trip	Ground current above preset level (10A) causes breaker trip (normally disabled, enable as option).
Phase Rotation Trip	Incorrect phase rotation causes breaker trip (normally disabled, enable as option).
Over Voltage Trip	Over voltage causes breaker trip (normally disabled, enable as option).
Under Voltage Trip	Under voltage causes breaker trip (normally disabled, enable as option).

PDU Transformer Input

Alarm	Alarm Description
NOTE: If the PDU is configured for dual inputs, "Input 1" or "Input 2" will prefix the alarm instead of "Input."	
Input Voltage AB High	Input voltage AB measures above threshold level in points list.
Input Voltage AB Low	Input voltage AB measures below threshold level in points list.
Input Voltage BC High	Input voltage BC measures above threshold level in points list.
Input Voltage BC Low	Input voltage BC measures below threshold level in points list.
Input Voltage CA High	Input voltage CA measures above threshold level in points list.
Input Voltage CA Low	Input voltage CA measures below threshold level in points list.
Input Frequency High	Input frequency measures above threshold level.
Input Frequency Low	Input frequency measures below threshold level.
Input Current A High	Input current phase A measures above threshold level (optional).
Input Current A Low	Input current phase A measures below threshold level (optional).
Input Current B High	Input current phase B measures above threshold level (optional).
Input Current B Low	Input current phase B measures below threshold level (optional).

Alarm	Alarm Description
Input Current C High	Input current phase C measures above threshold level (optional).
Input Current C Low	Input current phase C measures below threshold level (optional).

PDU Transformer Output

Alarm	Alarm Description
NOTE: If the PDU is configured for dual outputs, "Output 1" or "Output 2" will prefix alarm instead of "Output."	
Output Voltage AB High	Output voltage AB measures above threshold level in points list.
Output Voltage AB Low	Output voltage AB measures below threshold level in points list.
Output Voltage BC High	Output voltage BC measures above threshold level in points list.
Output Voltage BC Low	Output voltage BC measures below threshold level in points list.
Output Voltage CA High	Output voltage CA measures above threshold level in points list.
Output Voltage CA Low	Output voltage CA measures below threshold level in points list.
Output Voltage AN High	Output voltage AN measures above threshold level in points list.
Output Voltage AN Low	Output voltage AN measures below threshold level in points list.
Output Voltage BN High	Output voltage BN measures above threshold level in points list.
Output Voltage BN Low	Output voltage BN measures below threshold level in points list.
Output Voltage CN High	Output voltage CN measures above threshold level in points list.
Output Voltage CN Low	Output voltage CN measures below threshold level in points list.
Output Current A High	Output current phase A measures above threshold level in points list.
Output Current A Low	Output current phase A measures below threshold level in points list.
Output Current B High	Output current phase B measures above threshold level in points list.
Output Current B Low	Output current phase B measures below threshold level in points list.
Output Current C High	Output current phase C measures above threshold level in points list.
Output Current C Low	Output current phase C measures below threshold level in points list.
Output KW A High	Output KW phase A measures above preset level.
Output KW B High	Output KW phase B measures above preset level.
Output KW C High	Output KW phase C measures above preset level.
Output KW Total High	Output KW total measures above threshold level in points list.
Output KVA A High	Output KVA phase A measures above preset level.
Output KVA B High	Output KVA phase B measures above preset level.

Alarm	Alarm Description
Output KVA C High	Output KVA phase C measures above preset level.
Output KVA Total High	Output KVA Total measures above preset level.
Neutral Current High	Neutral current measures above preset level.
Neutral Current Low	Neutral current measures below preset level.
Ground Current High	Ground current measures above preset level.
Ground Current Low	Ground current measures below preset level.

Contractor Board Alarms

Alarm	Alarm Description
Build N (N = 1-8)	Building alarms, customizable names up to 8 characters can be set in software.
Digit N (N = 1-4)	Digital alarms, customizable names up to 8 characters can be set in software.

11.3.3 Enhanced Subfeeds

Alarm	Alarm Description
CB N Zero Current (N = 1-14)	Circuit N has lost current after previously measuring a minimum current.
CB N High Current Warning (N = 1-14)	Circuit N has exceeded current warning threshold.
CB N High Current Alarm (N = 1-14)	Circuit N has exceeded current alarm threshold.
Over Voltage	Over voltage measured to ESF board as specified in points list.
Under Voltage	Under voltage measured to ESF board as specified in points list.

11.3.4 BCMS Panelboard—Typical Alarms

Circuit Alarms

Alarm	Alarm Description
Note: The Color Monitor can number panelboard circuits sequentially for up to 336 circuits (8 x 42- circuit panelboards) as specified in device setup. Circuit alarms are identified by this number.	
CB N Zero Current (N = 1-336)	Circuit N has lost current after measuring a minimum current.
CB N High Current Warning (N = 1-336)	Circuit N exceeds high current warning threshold.
CB N High Current Alarm (N = 1-336)	Circuit N exceeds high current alarm threshold.

Panelboard Alarms

Alarm	Alarm Description
Over Current PB	Current feeding one panelboard is above alarm threshold.
Under Current PB	Current feeding one panelboard is below alarm threshold.
Over Curr both PBs	A common circuit feeding both panelboards is over alarm threshold.
Under Curr both PBs	A common circuit feeding both panelboards is under alarm threshold.
Over Volt Main	Over voltage measured on main voltage source to panelboard.
Under Volt Main	Under voltage measured on main voltage source to panelboard.
Over Volt Alt	Over voltage measured on alternate voltage source to panelboard.
Under Volt Alt	Under voltage measured on alternate voltage source to panelboard.

Chapter 12 Manual Dual PDU Option

A Power Pak PDU can optionally be configured in manufacturing as a Manual Dual PDU. A Manual Dual PDU has two independent voltage sources, each with its own main input circuit breaker and with lock-outs provided by Kirk Keys. The output load can be manually transferred from one source to the other in a make-before-break closed transition transfer.

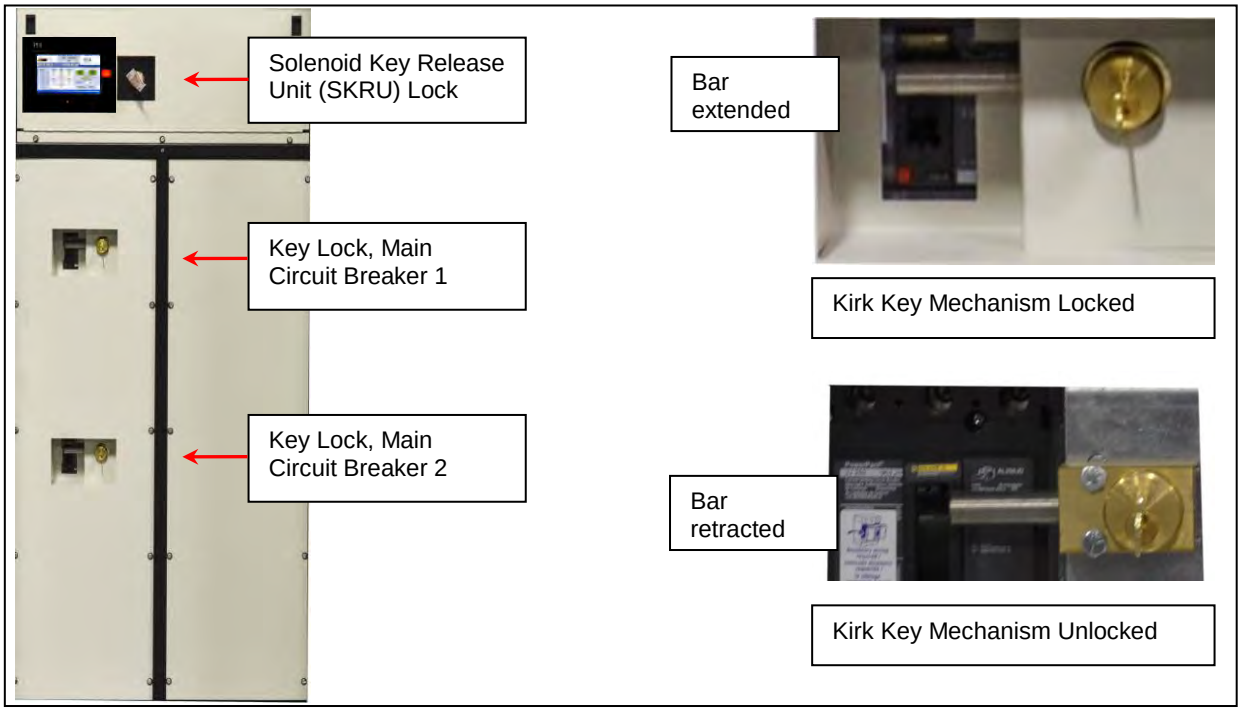
12.1 Initial Status: Circuit Breakers and Kirk Keys

The two main input circuit breakers have mechanical interlocks using Kirk Keys controlling access to the breakers and the Solenoid Key Release Unit (SKRU). There are three (3) locks (Figure 42) and two (2) keys. The starting breaker and lock settings for a transfer are as follows:

- Active power source: circuit breaker = closed; Kirk Key lock = unlocked; key in lock.
- Inactive power source: circuit breaker = open; Kirk Key lock = locked; no key in lock.
- Solenoid Key Release Unit (SKRU): Kirk Key lock = locked; key in lock.
- SKRU key is released by a "permissive signal" to the SKRU

Both power sources must be synchronized to perform the transfer.

Figure 42. PDU Internal Panel, Kirk Keys



12.2 Permissive Signal Options

The first step in a make-before-break transfer is sending a "permissive signal" to the SKRU to unlock its key. The PDU can be configured for any one of several mutually exclusive methods for providing a permissive signal. Each method must be selected at time of order and is wired in manufacturing:

- **Internal signal**. An internal permissive signal is generated through the Color Monitor's Sync Screen. The PDU M4G Board detects that both input sources are synchronized and can be switched, allowing the operator to release the SKRU key using the Color Monitor.
- **External signal**. An external permissive signal provides the SKRU key release directly. The PDU does not check to see that the two power sources are synchronized. Detecting that both power sources are synchronized is the customer's responsibility.
- **2-Stage External/Internal signal**. An external signal (dry contact or 120VAC) enables the internal signal. The PDU then determines whether both sources are synchronized and, if so, the operator uses the Color Monitor Sync Screen to release the SKRU key.

12.3 Customer Wiring for Permissive Signals

12.3.1 Internal Permissive Signal

An **internal permissive signal** requires no wiring at the customer site whether used alone or in the two-stage external/internal system.

12.3.2 External Permissive Signals

Customer wiring for an **external permissive signal** is the same whether the external signal is used alone to release the SKRU key or it is used in a two-stage system to enable the internal signal.

The customer connects either a dry contact or external applied 120VAC connection to a terminal block near the main breakers' Kirk Keys. The choice of dry contact or 120VAC connection must be selected at time of order.

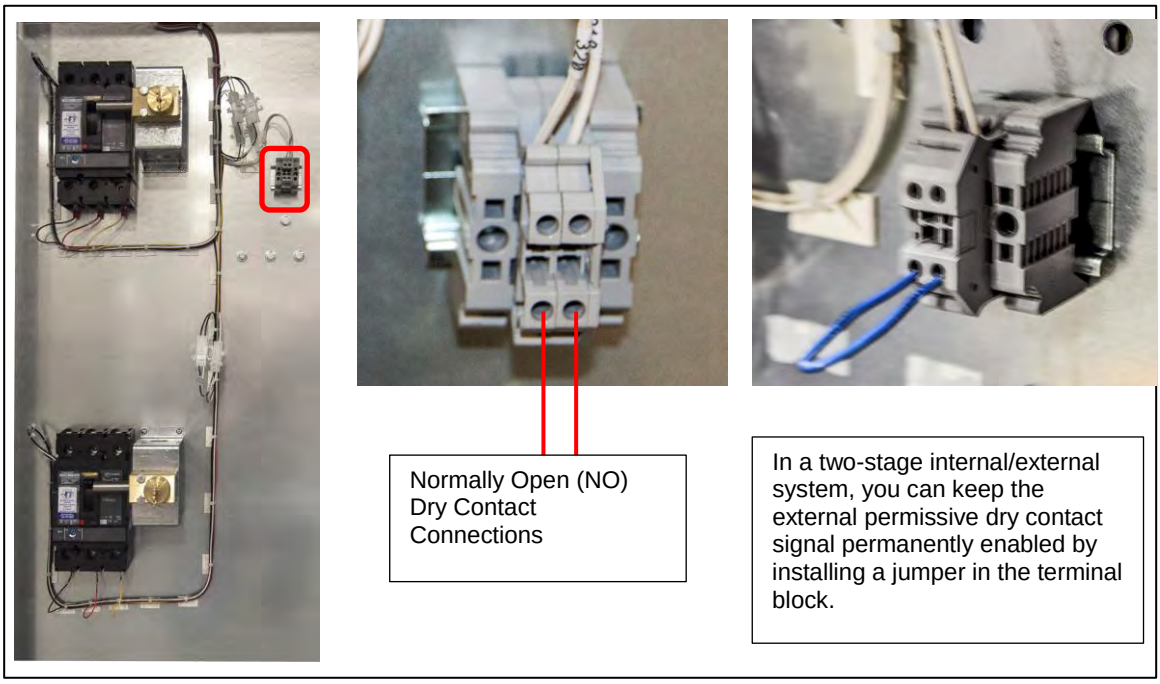
The customer must independently determine that the sources are synchronized. Typically, the external signal is sent from an Uninterruptible Power Supply (UPS).

12.3.3 Dry Contact External Permissive Signal

The dry contact must be a normally open (NO) dry contact. Closing the contact enables the signal (Figure 43).

In a two-stage external/internal system, if the dry contact is not connected to the terminal block, you can install a jumper in the terminal block to keep the external permission permanently enabled. This effectively reduces the two-stage system to an internal permissive signal only system.

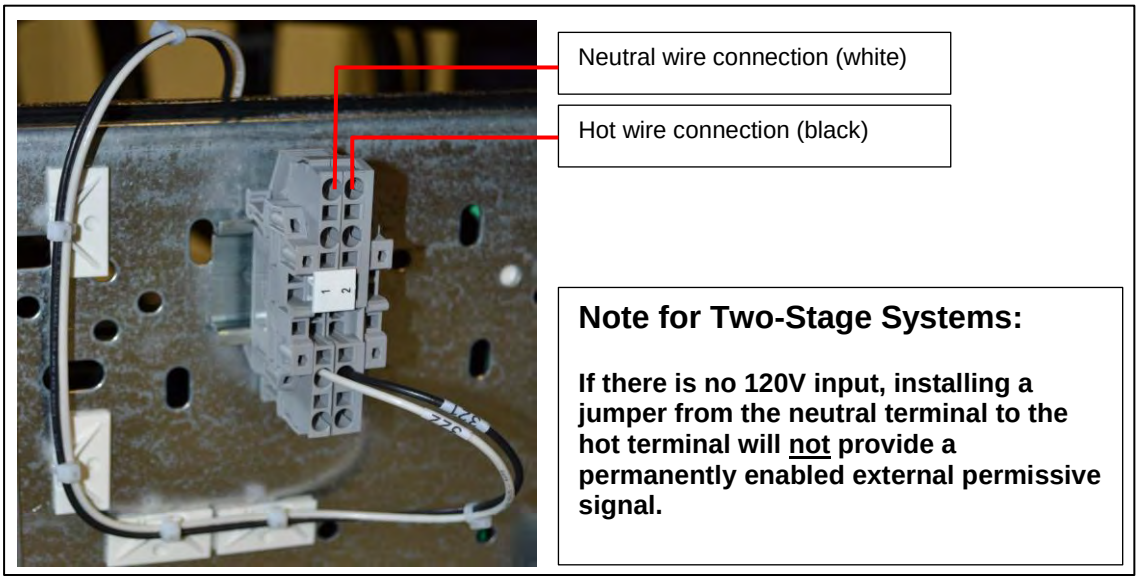
Figure 43. Dry Contact External Permissive Signal Connection



12.3.4 120VAC External Permissive Signal

The 120VAC external signal is connected to a terminal block in the PDU, similarly to the dry contact connection. The 120VAC neutral and hot wires should be connected as shown in Figure 44.

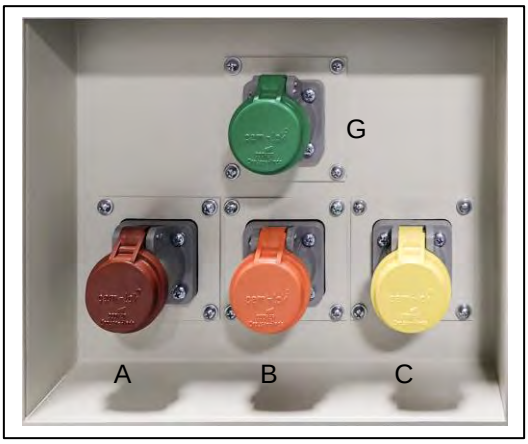
Figure 44. 120V External Permissive Signal Connection



12.4 Using Cam Locks with Alternate Power Source (Optional)

Both power sources are usually hard-wired to the two main circuit breakers. However, some customers optionally elect to connect an alternate power source via cam locks. Cam locks have ABCG input power connections and are color-coded for correct phase and ground connections.

Figure 45. Optional Cam Locks for Second Power Source



When cables are connected to the cam locks, the PDU M4G board will check that all ABC voltages are within specification (usually ±10%) and then check for correct phase rotation. The PDU will issue an input phase rotation error if the operator has incorrectly connected the cables, such as inserting B-phase into C-phase.

NOTE If the customer is using cam locks to connect an alternate power source, it is not recommended that they select the option to shut down the PDU on phase rotation error. If the operator incorrectly wires the phase cables into the cam locks, the PDU will shut down immediately.

12.5 Dual Input Source Transfer Procedures

There are three closed transition transfer procedures:

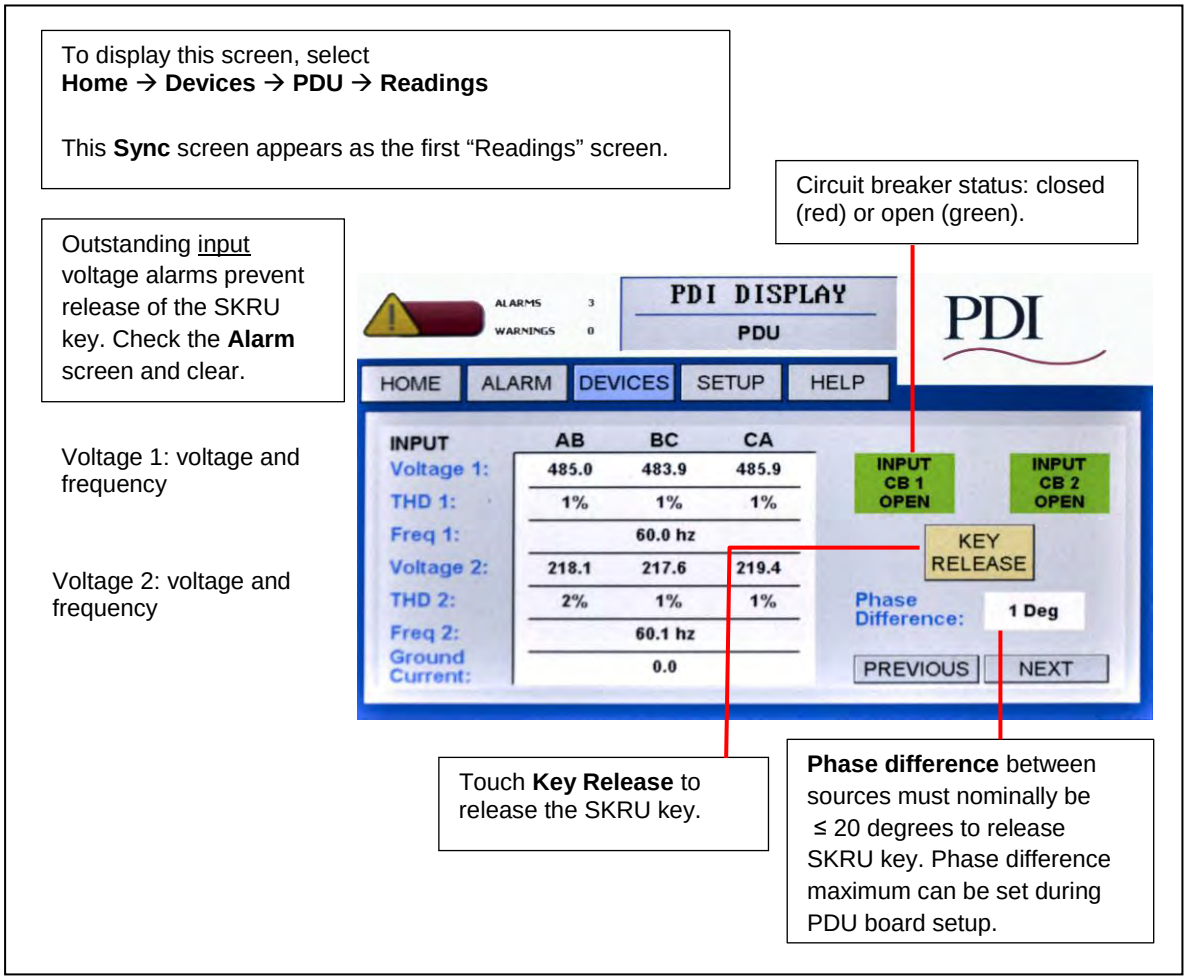
- Internal permissive signal using Color Monitor to release the SKRU key
- External permissive signal using dry contact or 120V input, bypassing Color Monitor
- Two stage permissive signal: external signal enables internal signal

Select the procedure suitable for your configuration.

12.5.1 Transfer Procedure: Internal Permissive Signal Only

The Monitor checks voltage readings for both sources from the PDU M4G board to determine if the two sources are synchronized. When both voltage sources are in synch, the operator can signal the SKRU to release its key using the Monitor **Sync** Screen (Figure 46). The operator then removes the SKRU key and inserts it into the Kirk Key lock for the inactive power source, allowing that breaker to be closed.

Figure 46. Color Monitor Synch Screen



To manually switch the load from one power source to the other using the Monitor, use the following procedure:

Table 12. Transfer Procedure Using Internal Permissive Signal

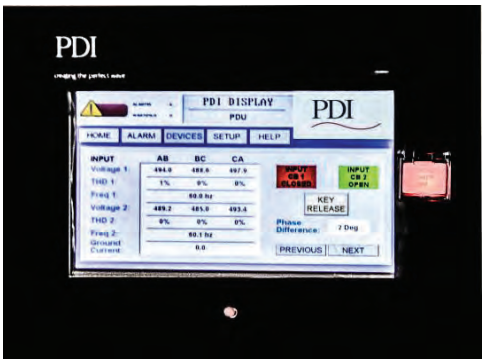
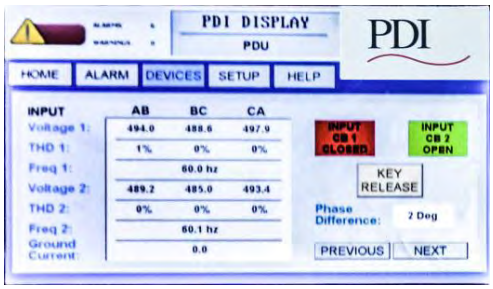
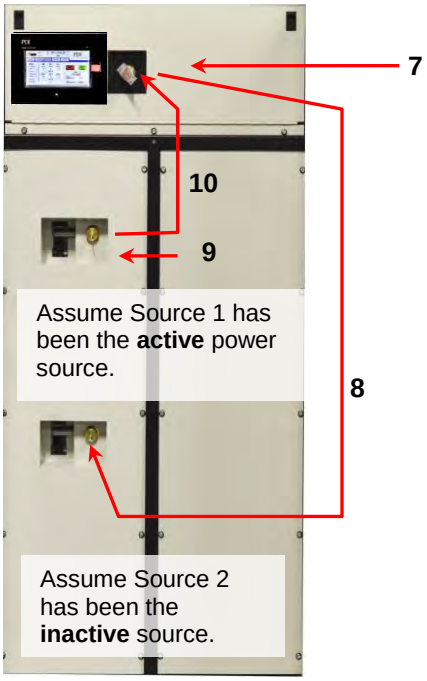
1. From the Color Monitor **Home** screen, go to **Alarm** screen and clear voltage alarms. 2. From the **Home** screen, touch **Devices**. 3. Select the **PDU** device (customer may have renamed the PDU device to a different name). 4. Touch Readings. 5. **Sync** screen appears. **Active** power source shows a closed circuit breaker (red). **Inactive** power source shows an open circuit breaker (green).	
6. When the Sync screen is displayed, the active source breaker should be closed (red) and the inactive source breaker open (green). If both sources look to be in sync, touch **KEY RELEASE** to release the SKRU key. The SKRU will <u>not</u> release the key if a. any input voltage alarms are present, or b. the phase difference between sources is greater than 20 degrees (value can be set in PDU Board setup).	
7. The operator should turn the SKRU (solenoid) key and remove it.	
8. The operator should then a. insert the SKRU key into the circuit breaker lock for the <u>inactive</u> power source (the <u>open</u> circuit breaker, in this example, Source A); b. turn the key; and c. close (turn on) the breaker. **NOTE:** At this point, both synchronized voltage sources are feeding the PDU and <u>both breakers will show closed (red)</u> on the **Sync** screen.	
9. Make the previously active source inactive. a. Open the circuit breaker for the previously active power source that you are turning off. b. Turn the key to lock the breaker.	
10. Move the key from this breaker to the SKRU (solenoid): a. Remove the key from the breaker. b. Insert it into the lock for the SKRU.	

Table 12. Transfer Procedure Using Internal Permissive Signal (Continued)

c. Turn the key. **NOTE:** Source A is now the only active source and shows red on the **SYNC** screen. Source B is locked open (off) and shows green on the **SYNC** screen.	

12.5.2 Transfer Procedure: External Permissive Signal Only

If an external permissive signal is to release the SKRU key, power source synchronization must be independently verified. The PDU does not check sources for synchronization through the SYNC screen; however, the operator must still touch the **SYNC** screen button to release the SKRU key.

Assuming the active source = Source 1, follow these steps:

1. An external permissive signal must be issued to enable the SKRU key release.
2. The operator should:
   a. bring up the Color Monitor **SYNC** screen,
   b. touch **KEY RELEASE** on the Color Monitor SYNC screen to release the SKRU key, and
   c. turn the SKRU key and remove it.
3. The operator should then
   a. insert the key in the lock for the main breaker of the inactive power source (Source 2),
   b. turn the key, and
   c. close the breaker.

NOTE At this point, both synchronized voltage sources are feeding the PDU.

4. Open the circuit breaker on Source 1.
   a. Open the circuit breaker for the previously active power source that you are turning off.
   b. Turn the key to lock the breaker.
5. Remove the key from the Source 1 circuit breaker, insert it into the SKRU lock, and turn the key.

At this point only Source 2 is feeding the PDU, and Kirk Key locks prevent any inadvertent change of sources.

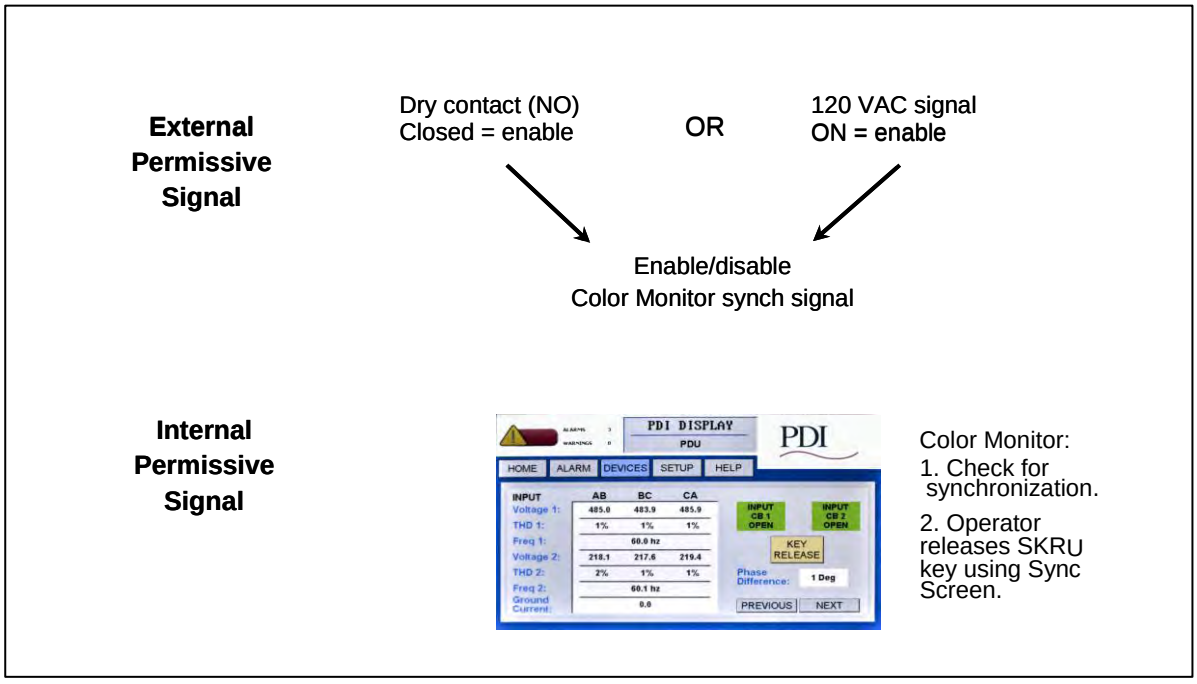
12.5.3 Transfer Procedure: External Plus Internal Permissive Signals

The PDU can be also be configured with a two-stage permissive signal (Figure 47):

Stage 1. An external permissive signal (120V or dry-contact signal) enables or disables the internal permissive signal to the SKRU key release signal via the Color Monitor.

Stage 2, internal permissive signal. The PDU checks sources for synchronization. The operator uses the Color Monitor Sync Screen to release the SKRU key. Use procedure described in 12.5.1 *Transfer Procedure: Internal Permissive Signal Only*.

Figure 47. Two-Stage Permissive Signal: External plus Internal



12.6 Open Transition Transfer

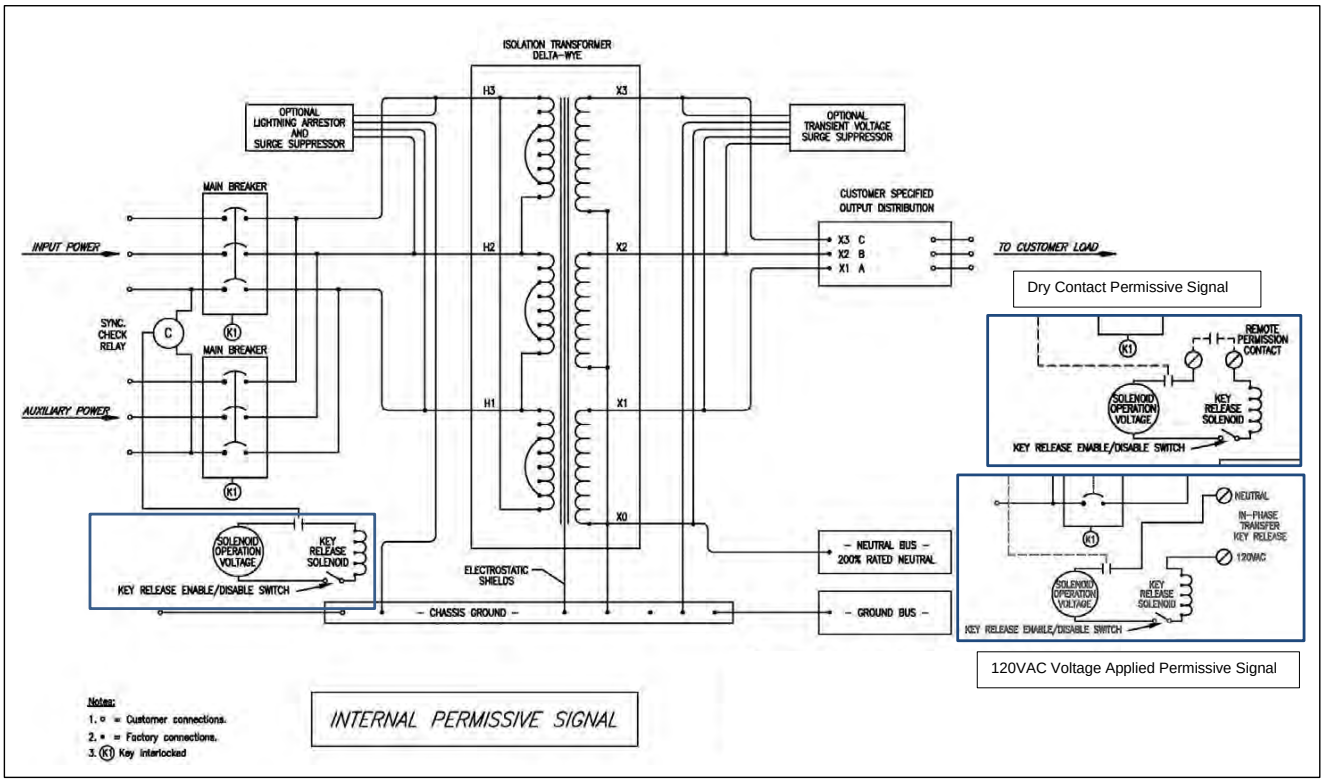
During maintenance you may wish to switch power sources in an open transition break-before-make transfer. Power continuity from one source to the other is not maintained. The load is dropped. The SKRU key is not used. To do an open transition transfer from the primary to the alternate source, follow these steps:

- Open (turn off) the primary source circuit breaker.
- Turn the key of the primary circuit breaker lock to extend the bar, locking the breaker. Remove the key.
- Insert the key into the alternate source circuit breaker lock and turn the key to retract the bar.
- Close the alternate circuit breaker, applying power to the PDU from the alternate source voltage.

⚠WARNING

Closing the alternate circuit breaker to re-energize the PDU can result in inrush on the upstream power sources, such as a UPS. Verify that your upstream power sources can handle the inrush or put the upstream UPS in bypass mode.

Figure 48. One-Line Manual Dual PDU with Permissive Signal Wiring Variations



Chapter 13 Eaton Service Contracts

Eaton Service contracts help to provide the added insurance that the reliability of your critical power systems is intact. By following our stringent maintenance procedures, Eaton's factory trained Customer Support Engineers provide the added assurance for the availability of critical systems, thereby maximizing the company's profitability. See below for further details.

13.1 The Service Promise

With factory-trained technicians in every major city in North America, Eaton can respond rapidly and provide on-site assistance in emergency down time situations. Eaton provides telephone support 24 hours a day, 7 days a week with a direct line to Service (1-800-843-9433).

13.2 Preventive Maintenance

During a preventive maintenance visit, Eaton technicians inspect, test, calibrate, update and clean components, as well as update software as applicable. You'll receive a report at the end of the visit detailing the results of the inspection and specific recommendations for remedial actions, proactive replacements, and upgrades.

13.3 Eaton Provides Flexibility and Commitment

- We understand that service plans are not "one size fits all." That's why we offer a broad range of service options, designed to meet the varied requirements and applications of businesses of all shapes and sizes. Eaton can modify your contract on variables such as number of PM visits per year, scope of coverage, response time and length of contract.
- Eaton employs 250+ field technicians with an average tenure of more than ten years. Eaton CSEs are experts on Eaton products and receive ongoing product training and certification. Our technicians have expertise in power, electrical engineering, software and connectivity, batteries, UPSs and related products, and can deliver advanced troubleshooting and a reduced mean time to repair.
- When you rely on an Eaton service plan, rest assured that every factory-trained field technician stocks a solid inventory of parts to remedy emergencies.

13.4 Time and Materials

In most cases the customer will be covered by startup service or Maintenance Contracts, however, there may be times when the customer needs Eaton service and lacks the benefits that these two packages provide. Therefore, Eaton provides Time and Material coverage for those in need of our customer support engineers.

13.5 Spare Parts Kits

Spare parts are available. Contact your sales representative or Eaton support (see 1.7 *Getting Help*).

Table 13. Spare Parts Kits for PowerPak PDU

Qty	Spare Parts Kit Components	Option		
		A	B	C
5	Assorted Fuses			
1	Control Power Transformer			
5	South-co Panel Retainer			
5	South-co Panel Clip			
5	South-co Panel Fastener			
5	South-co Panel Washer			

Table 13. Spare Parts Kits for PowerPak PDU (Continued)

Qty	Spare Parts Kit Components	Option		
		A	B	C
2	Panel Guide			
2	Panel Latch			
2	Panel Slide Latch			
1	WaveStar® Data Acquisition Card			
5	Emergency Power Off Assembly			
1	WaveStar® Color Monitor			
1	WaveStar® Contractor Board			
1	Complete Set of Ribbon Cables (6)			
1	BCMS Board			
1	Data Module Transformer			
1	Split Core Hot Fix Board with 6 CT's			

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