Eaton© Wavestar Static Transfer Switch 150A-1600A

Standalone STS and STS/PDU Systems
Installation and Operation Manual

Powering Business Worldwide

p/n: 164001128
Revision 02

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 General

This manual covers user operation and installation of the WaveStar® Static Transfer Switch (STS) or STS/PDU Systems from 150 Amperes to 1600 Amperes. The manual also covers STS/PDU systems up to 300KVA.

For standalone STS 2000A systems, see *WaveStar® Static Transfer Switch 2000A 3-Pole, Installation and Operation*, Control Number DOC15139.

The Eaton PDI STS or STS/PDU System WaveStar units are designed to be an integral part of your power system, allowing easy relocation and expansion of your present system capacity requirements. This manual will help you install and operate your WaveStar STS or STS/PDU System.

1.2 What the STS or STS/PDU System Does

The site UPS (Uninterruptible Power Supply) removes power anomalies originating between the power station and the site. The WaveStar STS (or STS/PDU System) mitigates the effects of the anomalies between the UPS and the STS. These anomalies include:

- Circuit breaker nuisance tripping
- Loss of one upstream UPS source
- Faulty transformers In the System PDU Units

The purpose of the transfer switch is to allow a transparent load transfer from one source to another source in case of a failure of one source or when manually initiated for testing or maintenance.

1.3 Stand Alone and STS/PDU System configurations

The stand-alone WaveStar STS or WaveStar STS/PDU System can be connected between two sources, generally two UPSs. The stand-alone WaveStar STS has a single output load. The WaveStar STS/PDU System is generally an integrated system consisting of the STS unit and any normal PDU distribution system.

There are three configurations of WaveStar. One is a stand-alone STS and there are also two configurations of STS/PDU systems.

- A stand-alone STS has two input sources and the output supplies redundant power to down stream loads. Source voltage will vary depending on the application.
- A primary STS/PDU system contains a single PDU with an internal transformer and STS bolted together. The two input sources are connected the STS and the STS output is connected to the PDU input. The PDU distribution is connected to the site loads. In this configuration the STS unit is generally a 480V application feeding the PDU transformer to be stepped down to the 120/208V for distribution.
- A secondary STS/PDU system contains two PDU's with internal transformers and a STS, all bolted together. Each input source is connected to the one PDU. The input of the PDU is generally 480V and is stepped down to 208V for the output. Each of the two PDU outputs is connected to the STS inputs. In this configuration, the STS unit is generally a 208V application. The STS output is connected to the distribution, which is located in the PDU sections. Since the PDU units are redundant, one PDU can be made "electrically cold" for maintenance while the other PDU powers the load.

1.4 Features/Options

The WaveStar Static Transfer Switch (STS) and the WaveStar STS/PDU system have the following relevant features:

1. Two transfer algorithms:
    a. POG: 4 Ms or less transfer time for outages; 2ms for manual transfers

b. VSS: The Volt Second Synchronizing algorithm reduces the inrush of magnetic load; the transfer time can range from 4ms to 8 Ms depending on the phase shift between the sources.

2. Security:

   - To reduce the possibility of issues with STS operation that may be factored to human input, there are several security options designed into the unit to protect the system.
   - No operations through the touch screen monitor can be completed without a valid login. A Password (PW) and PIN# are required by the operator in order to login. The PIN # identifies the operator and records their activities during the login period in the event log. There is also an optional fingerprint and/or swipe card device that can be installed for the auto entry of Password and the PIN #. Contact Eaton Customer Support for information regarding these options.

     If the front door is opened without a valid login, the unit alarms and the alarm is logged into the event log. All operation of the internal MCSW/MCCBs is tied in the event log to the operator's Login identification.

3. Maintainability:

   - Hot swap ability — Eaton CSEs cannot replace MCCBs, MCSWs, SCRs, DCPSs, or Primary Fans while energized due to electrical safety requirements.
   - All connections can be IR scanned without access to the rear.
   - Rear or side access is required for SCR replacement.

4. Reliability

   - There is a redundant operator interface (ROI) using LED's and toggle switches in the event the graphic display/touch screen is not operable
   - The STS unit is very reliable through the use of dynamic redundancy of Tri-Redundant logic; Tri-Redundant power supplies; quad-redundant gate drivers and N+3 redundant fans on units including fans.

5. Communication and Down Load capabilities:

   - Alarm and status data as well as waveform data can be transmitted to remote locations via Modbus RTU, WEB and E-mail as standard. Data can also be transferred via any of the following protocols as options: ModBus TCP/IP, SNMP, land line Modem or cell Modem.
   - This information can also be down loaded locally via, PC using USB port or Optional memory stick or using a PDA using IR. Contact the Eaton Factory or your local Sales representative regarding this option.

6. Human Engineering: To help assist the Human operators, the help system has been designed to provide support to perform basic tasks.

   - Voice over and text operating instructions are available through the help screen for various operations of a standard operating nature
   - The normal and redundant displays are visible with the door open. This allows the operator to continue viewing the instructions and or mimic while performing operations on the MCSW/MCCB.

7. Graphics Monitor/touch screen has the following screen features:

   - Wave form capture of events
   - STS and PDU voltage and current screens
   - Load trending screens
   - Voltage & current harmonics screens
   - Graphics one lines

- Alarm and log screens
- Operator controls
- Optional distribution and BCMS Data

8. Built in test
9. Using the optional built-in load bank the STS can be 100% tested. The Waveform capture capability can be used as a scope to allow the transfer waveforms to be observed while transferring with loads.

1.5 Features/ Options

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- If the front door is opened without a valid login, the unit alarms and the alarm is logged into the event log. All operation of the internal MCSW/MCCBs is tied in the event log to the operator's Login identification.

1.5.3 Maintainability

- Hot swap ability - all logic Printed Circuit Boards (PCBs) can be hot swapped, without loss of basic function and without placing the STS unit in bypass. Molded Case Switches (MCSW)/Molded Case Circuit Breakers (MCCB) can be replaced as long as they are not conducting at the time (They are on the opposite source of the one that the unit is selected to). However, it should be noted that once a MCSW is removed, the unit cannot transfer. This will allow for component replacement on the non-conducting side of the STS unit and it does not require side or rear access.

NOTE Maintenance on the units should only be performed by a qualified technician.

- All connections can be IR scanned without access to the rear.

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- The STS unit is very reliable through the use of dynamic redundancy of Tri-Redundant logic; Tri-Redundant power supplies; quad-redundant gate drivers and N+3 redundant fans on units including fans.

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1.5.7 Built in test

Using the optional built-in load bank the STS can be 100% tested. The Waveform capture capability can be used as a scope to allow the transfer waveforms to be observed while transferring with loads.

1.6 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.

1.7 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].

1.8 Symbols, Controls, and Indicators

The following are examples of symbols used on the UPS 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 the UPS or the UPS batteries in the trash. This product contains sealed, lead-acid batteries and must be disposed of properly. For more information, contact your local recycling/reuse or hazardous waste center.

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.

1.9 Getting Help

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 Static Transfer Switch website: Eaton PDI Static Transfer Switch

1.10 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:

- Disconnect power before drilling holes, attaching conduit, and attaching other power distribution 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.
- Leave ample space for attaching and routing wires.
- 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.

Chapter 3 Class A Computing Device: Information to User

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a class A computing device pursuant to subpart B of part 15 of FCC rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his/her own expense will be required to take whatever measures may be required to correct the interference.

Class A Computing Device: Information to User

Chapter 4 System Unpack and Inspection

NOTE Read the entire operator's manual before installing and operating the unit. Upon receipt of the STS or STS/PDU System, the installer should perform the following steps to assure a high quality installation.

4.1 External Inspections

1. While the STS or STS/PDU System is still on the truck, inspect the equipment and shipping skids for any signs of damage or mishandling. Do not attempt to install the system if damage is apparent. If the system shows any damage, note it on the freight bill and file a damage claim with the carrier within 24 hours. Please contact Eaton Service (1-800-843-9433) if damage has occurred.
2. Locate the bag containing the keys for the front door. This will be attached to the cabinet.
3. Compare the contents of the shipment with the bill of lading. Report any missing items to the carrier and Eaton immediately.
4. If the unit is to be stored before installation, it is recommended to sore the unit in a dry environment with temperatures in the range of – 40 °F to 176 °F. Use original packing materials or other suitable means to keep the unit clean. When opening the shipping package, use care not to puncture the container with sharp objects.

4.2 Unloading and Handling

1. Use the shipping skid provided to move the system as close as possible to the final installation position. A forklift or pallet jack can be used to move the skid. Do not exceed a 10-degree tilt if moving with a forklift. Tipping of the unit can cause it to fall which can cause damage or injury to personnel.
2. Exercise extreme care when handling STS or STS/PDU System cabinets to avoid equipment damage or injury to personnel.
3. Check the unit size and weight before moving. Please refer to operator's manual for this information.
4. Plan your route for moving the equipment. Ensure that all passages are large enough to accommodate the units and support the weight. Check for any non-negotiable corners or offsets in hallways.
5. To remove the units from the skids, carefully cut the bands holding the units to the pallets. Use cautions as bands are under tension and can cause personal injury. Remove all plastic wrapping and packing material from the units. Ensure that the unit is located on a level floor with room to maneuver around it.
6. Lift the units off the skids with a forklift capable of handling the weight. Lift the STS or STS/PDU System units from the front between the shipping skids. The unit is furnished with integral castors that allow the unit to be rolled into place after it has been removed from the shipping skid. Be careful not to damage the castors while lifting with the forklift.

4.3 Internal Inspections

1. Verify that all units have been received.
2. Open the front door and check the nameplate on the cabinets to verify that the model numbers correspond with the ones specified on the bill. Record the model and serial numbers in your operator's manual.
3. Verify the system's circuit breakers are in the "OFF" position prior to initial system start-up.
4. If spare parts were ordered, verify their arrival.
5. Remove the internal panels and check for any damage that may have occurred during shipment. Check for loose connections or unsecured components.

NOTE You should unpack your Eaton PDI product with the same care used in packing the product for safe and efficient delivery to your facility.

The inspection procedures in Chapter 5 *Installation Procedures* should be executed immediately upon arrival of your Eaton PDI equipment.

IMPORTANT

Review installation and equipment chapters for proper care and safety prior to final positioning and installation.

Chapter 5 Installation Procedures

The following section of your WaveStar Series Owner's Manual covers the general requirements for the installation of the standalone WaveStar STS or a WaveStar STS /PDU systems and its associated components. Accessories and special options are covered in the Appendix or separately by drawings/instructions shipped with the available options.

NOTE A licensed electrician or a trained Eaton field representative must install Unit. A trained Eaton field representative must perform start up or commissioning. To validate the warranty, Please complete the validation request form as provided in Chapter 5 *Installation Procedures* and notify Eaton Service Department upon completion of the startup to initiate the Warranty Coverage.

An installation drawing showing the input/output connection points similar to the one shown is located in the Appendix - Drawings and Arrangement Documents

5.1 Positioning the STS

The Standalone WaveStar STS is designed to require front and side access for installation, unless fitted with an under the floor junction box.

The WaveStar STS /PDU system, both primary and secondary, are designed to require only front and side access for installation.

The stand-alone WaveStar STS and WaveStar STS/PDU systems are designed to require only front access for only during normal operation, preventative maintenance, IR scanning, and service.

1. The standalone WaveStar STS and WaveStar STS /PDU systems are designed to allow the use of every available square foot of computer room space for operating various computer equipment. The WaveStar Series requires thirty-six inches (36”) of front access and if required, thirty inches (30") on side access for installation and service area. The thirty-six inches (36”) of front access space allows the unit to be fully serviced while also complying with the 1996 National Electric Code for access to Circuit Breaker distribution equipment.
2. The system is enclosed in a substantial cabinet and contains electrical apparatus such as molded case circuit breakers, SCRs and power delivery bus work. Consequently, floor loading should be addressed to verify the Eaton PDI system does not exceed the raised floor loading specifications. Refer to the installation drawings in the Appendix - Drawings and Arrangement Documents for weights and dimensions.
3. If additional raised floor supports are required, contact Eaton or your raised floor manufacturer for either floor jacks or full frame floor stands and their specifications.

5.2 Recommended Minimum Service Clearances

Service clearances are required on the STS and STS/PDU system where ever there are doors or removable service panels. The minimum service clearance required by the National Electrical Code Article 110-26 is 36 inches for units with voltages up to 150 volts to ground and 42 inches for units with voltages over 150 volts to ground. Clearance of at least 18 inches is required above the unit for cooling airflow.

5.3 Levelling Units and Attaching Units to Floor Stands

The STS or STS/PDU System can be installed on a bare floor or on optional floor stands in a raised floor application.

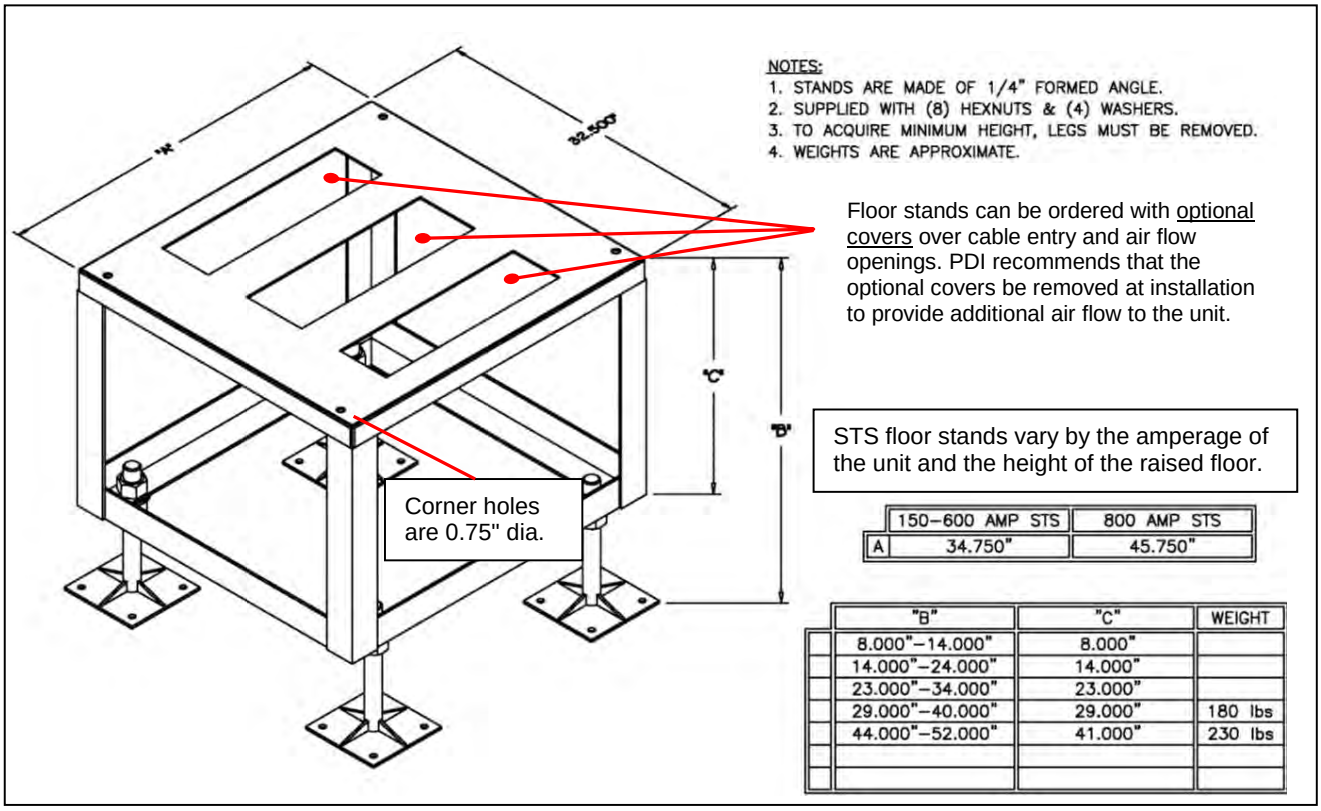
If installed on a bare floor, position the unit and adjust the leveling feet located in each corner of the frame base to level and stabilize the unit. If the PDU’s are part of the system, install the STS unit first as described above and then repeat the procedure for the PDU’s adjacent to the STS Unit. They are bolted together at the top hats for security and stability.

If the STS is installed on an optional floor stand, position the STS directly over the floor stand.

For 150-800A STS units, anchor the STS to the floor stand using one of the following techniques:

1. Use 1/2" all-thread to bolt the STS to the floor stand's corner holes (0.75" dia.).
2. Remove and invert the STS leveling feet. Bolt them to the floor stand using the removed hardware through the same holes in the STS and the corresponding corner holes in the floor stand.

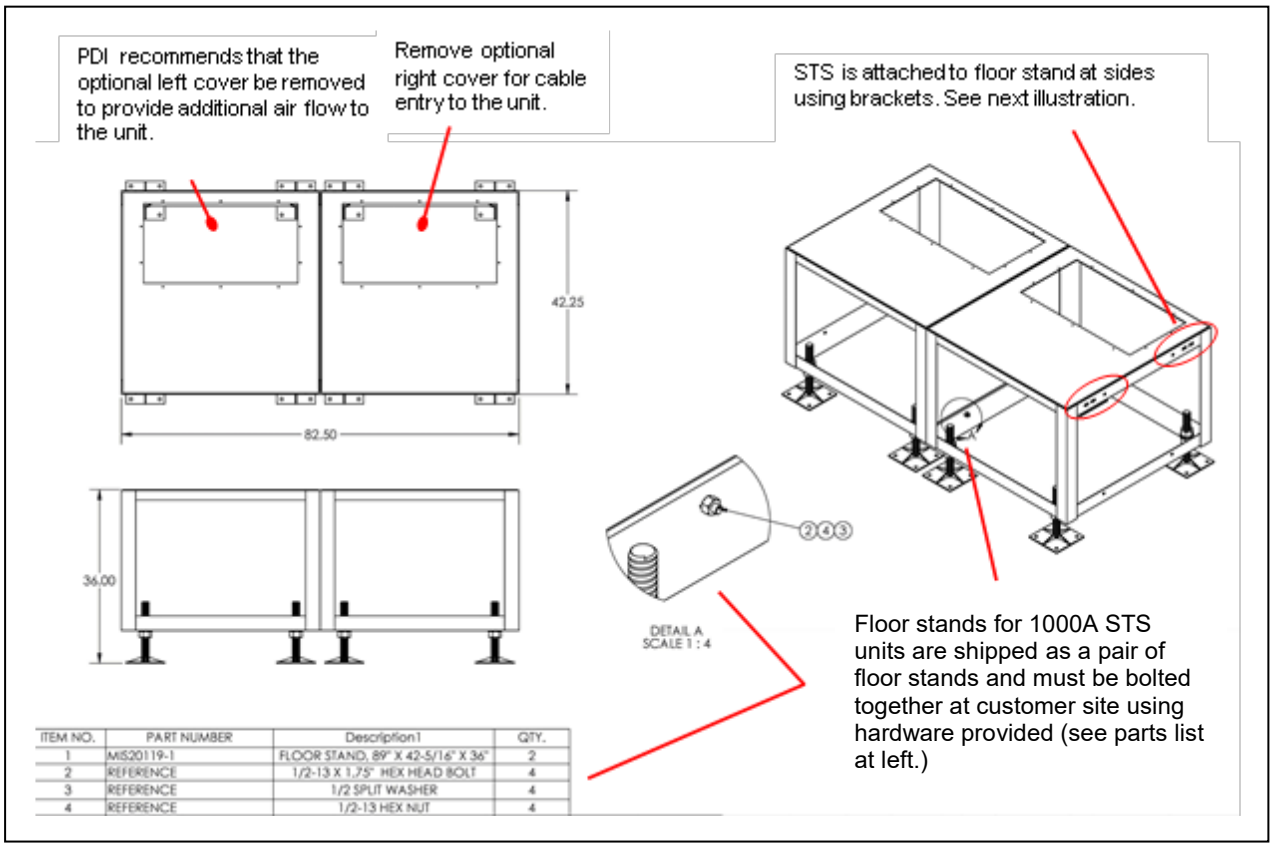
Figure 1. Floor Stands for 150A-800A STS



For 1000A STS units, a pair of floor stands must first be bolted together in the field using provided hardware. Then attach the STS 1000A to the assembled floor stand using (4) provided brackets. Installer provides additional connection hardware (bolts, nuts, etc.). See the following illustrations for more information.

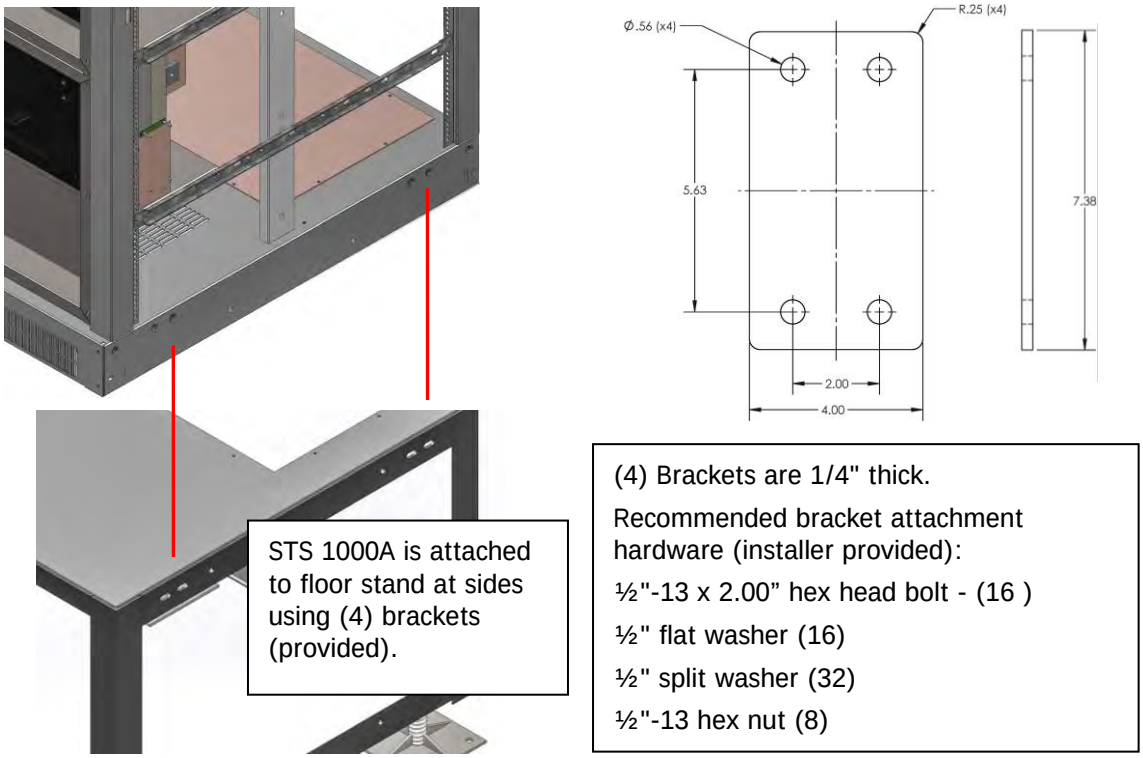
The 1000A floor stands can be ordered with optional covers. The right side cover (as shown on the following illustration) must be removed for cable entry. Eaton recommends that the optional left side cover also be removed at installation to provide additional air flow to the unit.

Figure 2. Floor Stand for 1000A Static Transfer Switch



ITEM NO.	PART NUMBER	Description1	QTY.
1	MIS20119-1	FLOOR STAND, 89" X 42-5/16" X 36"	2
2	REFERENCE	1/2-13 X 1.75" HEX HEAD BOLT	4
3	REFERENCE	1/2 SPLIT WASHER	4
4	REFERENCE	1/2-13 HEX NUT	4

Figure 3. Attaching 1000A Static Transfer Switch to Floor Stand



If the PDU's are part of the system, install the STS unit first as described above and then repeat the procedure for the PDU's. You should position the floor stand and adjust the feet located in each corner of the frame to level and stabilize the floor stand. Anchor the floor stand directly to the floor using the holes provided in the four feet.

Note for Primary or Secondary STS/PDU Systems: Cables are provided for interconnection of the units. Ensure that these cables are carefully laid out and routed between the units as you position the units before making the final tightening of the bolts to the floor stands and each other. Cables will be marked and routed in a way not to cause damage. A connection diagram will be included in your unit. Please refer to this diagram for these interconnections. Be sure to remove the sides that will be in between the STS and PDU sections. A bracket is provided to connect the cabinets. Once the units are placed into position, attach this bracket to hold the units together as a System.

5.4 Electrical Connection

⚠WARNING

Verify that all input power and control circuits are de-energized and locked out before making connections inside the unit. All power and control wiring should be installed by a qualified electrician.

1. **Power and Control Wiring:**

All power wiring and control wiring must comply with NEC and applicable local codes. Unless otherwise noted, please refer to your operator's manual for torque values. The two input feeds for the STS or STS/PDU System should be from two independent sources to avoid a common source failure. To ensure proper operation the two input sources should be at the same nominal voltage and phase rotation and synchronized within 15 degrees.

The input and output power wire size should be based on the upstream over current protection device, observing the NEC and local codes. The molded case switches typically contained in the stand-alone STS are non-automatic circuit breakers and rely on the upstream and/or load overcurrent protection. Upstream AC over current protection must be provided and should be rated equal to or less than the rating of the stand-alone STS molded case switches.

Control wire connections are only required for some options or in the case of a Secondary or Primary STS/PDU system. All systems will have numbered Connectors for interconnection and will be outlined in the "interconnection diagram" discussed earlier.

2. **System Grounding:**

   Grounding is primarily for equipment and personnel safety, although proper grounding alsoenhances equipment performance. All input and output power feeds must include an equipmentgrounding means as required by the NEC and local codes.

   If a 4-wire-plug-ground input feed is utilized, then the input power sources must be properly grounded. The neutral is not switched in the STS or STS/PDU System; therefore the two power sources must be solidly interconnected as outlined in the leveling system of these instructions. NEC prohibits grounding a power source at more than one point. In Secondary systems the Neutral will be bonded as outlined in the "interconnection diagram". A single Neutral to ground bond is also made.

3. **High Frequency (RF) Grounding (Computer Rooms)**

   In addition to the power grounding system, a reference grounding system for high frequency noise is desirable (with the two systems being bonded together for the same reference potential). A grid made up of 2-foot squares will provide an effective signal reference grounding system. The raised floor can be utilized if it has solidly connected metal stringers ensuring good electrical connection. If this type of floor is not available, a grid can be fabricated by laying a mesh (2-foot squares) of braided copper strap directly on the concrete sub floor (electrically connected at each intersection point). The frames of all the data processing equipment, including the WaveStar, should be connected (by the shortest possible distance) to the reference grid with braided copper strap. Finally, the signal reference grid should be bonded to the WaveStar for a single point equi-potent ground reference.

   For optimum performance all distances for power and high frequency grounding should be kept to an absolute minimum. To summarize, a radial grounding system of this type (utilizing a single ground point) will insure that your facility is electrically safe, complies with all code requirements, and will be essentially free of ground caused computer noise and problems.

Chapter 6 Site Requirements & STS Inspection

6.1 General Information

1. The upstream power inputs to the WaveStar must have protective circuit breakers rated no larger than the STS or STS/PDU System rating. Breaker Coordination is required.
2. The site environmental condition must be within the parameters listed in the section titled Chapter 14 *Technical Specification*.

6.2 Grounding

IMPORTANT

Grounding for the Wavstar must not violate building or national electric codes!

Improperly grounded systems can create unsafe conditions as well as electrical noise that cause data processing and transmission problems.

See Chapter 5 *Installation Procedures* for grounding details

6.3 Internal Wiring

Verify all Lug connections are tight. In the event that any loose connections are found during the installation of the unit, please contact Eaton Service (1-800-843-9433).

1. Check the main input connections at the main breakers and the bypass breakers to be sure vibration have not loosened the terminal screws.
2. In the same manner, check the feeders running from the load side of the input and bypass breakers.
3. Check the feeders running to the output circuit breaker or output switch.
4. Check all lugs for tightness on the following:
    a. \Neutral Bus
    b. Ground Bus
    c. Bus bars
    d. Circuit breakers
    e. SCR switch modules

6.4 Input Power And Load Cabling

WARNING

- The STS Source 1 and Source 2 inputs should be fed from separate and independent source feeders. If the sources are temporarily fed from a common upstream feeder, the unit should be left in bypass until two separate source feeders are available.
- Verify that incoming high voltage circuits are not energized before Making any connections in the input bus!

1. Input power and load cabling connections are on the top or bottom of the unit.

2. The input power to the WaveStar input buses must be installed in accordance with the electrical codes. Only a qualified electrical contractor should install wiring or torque the connections.

NOTE See appendix for input power connection information.

6.5 Control Interface

1. All control cabling to and from the WaveStar should be rated for 10 amperes and the insulation should be rated for 600 volts AC, unless otherwise specified on the drawings.
2. All monitored parameters and alarms are available via ModBus RTU protocol or optional SNMP. Connection to the unit is through a RS422/485 communications port using; see section XII for details on connecting to the ModBus interface on the contractor board.
3. Remote Source Select Option - Two external 120 VAC signals or the closure of two dry contacts can be used to control the remote selection of the preferred source. These signals or closures are generally used when two UPSs supply power to the system. If the preferred UPS goes to bypass mode, the "good" UPS should become preferred. Signal #1 (120 VAC) or closure will make PDU 1 preferred. Signal # 2 (120 VAC) or closure will make PDU 2 preferred. If both signals and closures are low (zero volts or open contacts) the preferred source control is returned to the system operator control panel. Any remote control signal or closure defaults the unit into an auto-retransfer "Yes" mode to ensure system redundancy. Normally the signals or closures are controlled by auxiliary contacts in the UPS bypass CB's. If both are signals or closures, the first input to the STS unit is recognized. If this option is purchased with the unit, the factory must be notified as to whether the remote control signal will be the application 120 VAC or a dry-contact closure. Contact your Eaton sales representative for additional information on this option.

Chapter 7 Startup/Power-Up of the Unit

1. Stand-alone STS Unit - see 17.3 *Appendix C – Installation Instructions – Stand Alone STS*
2. Primary STS/PDU System - see
3. Secondary STS/PDU System - see

Chapter 8 Operational Description – STS or STS/PDU System

8.1 The Three Pole, Two Position Transfer Switch

The transparent transfer, automatic transfer switch will consist of two power switch elements with logic to control the sensing and transfer functions of the unit. The transfer switch is a three pole, twoposition transfer device designed to automatically and/or manually transfer a load between two synchronized, three-phase power sources. The intelligence of the logic provides for fast transfers that are transparent to the load. The transfer from one source to another is not performed by connecting the two sources (Make before Break). This would cause cross feeding of one source to the other. The input power will be supplied from two different power sources, which are nominally of the same voltage, phase rotation, and frequency. The purpose of the transfer switch is to allow a transparent load transfer from one source to another source in the event of a failure of one source or when manually initiated for testing or maintenance. The transfer switch will allow for either source to be designated as the "preferred source". The load will be transferred to the "preferred source" whenever the source is intolerance and will remain connected to the "preferred source" until manually initiated to transfer or until the "preferred source" fails. The automatic retransfer to the "preferred source" can be disabled if so desired by an authorized operator from the "Settings" screen. This is generally used after a transfer from a source due to a preferred source power loss and the operator wishes to verify the preferred source input power is stable prior to retransferring. When the automatic retransfer is disabled, the logic will transfer the load from the failing source to the "good" source and will remain on that source even after the preferred source returns to acceptable limits. If the alternate source fails, the unit will transfer to the original source (Considering that it is still in acceptable limits).

8.2 Modes of Operation for the STS or STS/PDU System

The four available modes of operation are:

1. Normal mode - the STS operate per the above listed description
2. Remote Operator Interface mode – the operating of the STS is transferred to the remote panel with LED indicators and toggle switches.
3. Bypass - The WaveStar STS unit/system is equipped with Bypass MCCBs or MCSWs so that the unit can be placed in a configuration where the logic can be disconnected. This action requires the operator to toggle Kirk Keys and bypass breakers/switches to the desired source. Information on operation of this is found later in the manual and there is also information through the Help Screen to perform the Bypass operation.
4. Maintenance mode – the STS Unit is equipped with a Maintenance Bypass switch to bypass the logic for clearing of certain faults without taking the unit to Bypass. Consult with Eaton Customer Support prior to using this mode.

8.3 Operator Controls

There are 5 sets of operator controls:

1. Graphic/touch screen "source select" which is located on the "Home Screen". This provides the operator the ability to select the preferred source and manually change sources. This will be defaulted to Source 1 upon system startup.
2. Graphic/touch screen "retransfer yes/no" which is located on the "Switch Settings" Screen. This allows the operator to disable the auto retransfer function of the STS unit to the preferred source so that the source can be verified prior to reapplying the critical load. This will be defaulted to the "Yes" position which will allow for retransfers.
3. Graphic/touch screen "POG/VSS" which is located on the "Switch Settings" Screen. This selects the mode of transfer. This will be defaulted to the "VSS" Position.
4. Redundant operator interface (ROI) panel – This is a secondary operating panel located below the Graphic Display. In normal mode, this panel is not in use.

5. Input and bypass circuit breakers that must be manually toggled by the user.

8.4 Control Functions

8.4.1 Normal Mode

1. The WaveStar is in the auto mode when all of the following are true:
   a. The Redundant Operator Interface panel mode switch is in "normal" position.
   b. The Graphic/touch screen Home Screen "Preferred Source" icon switch is in either position.
   c. The Graphic/touch screen Switch Settings Screen "Mode - VSS/POG" icon switch is in either position.
   d. Graphic/touch screen Switch Settings Screen "Retransfer-Yes/No" icon switch is in "Yes" position.

   When the STS is in "Normal" or "auto" operation, the load is connected to the "preferred source", as long as all of the phases of the voltage and frequency of the source are within acceptable limits. Upon failure of the "preferred source", the load will be transferred to the "alternate source." The default transfer voltage limits are +/- 10% of the nominal input voltage for steady state conditions, with low voltage transfer limits having an inverse time relationship. This is within the CBEMA/ITS computer voltage tolerance envelope. After the "preferred source" returns to a condition that is within tolerance for at least the preset adjustable retransfer time delay (typically 4 seconds) the load will be retransfer automatically to the "preferred source".
2. Either input source can be designated as the "preferred source" by the "Preferred Source – 1 / 2" control switch icon on the Home screen which can be activated by an authorized operator.
3. In normal mode the there are two start, restart and transfer algorithms. These are POG and VSS.

   POG and VSS algorithms - Either the POG or VSS algorithm can be selected via the "Switch Settings" screen.

   - **VSS algorithm:** The Volt Second Synchronizing algorithm (Eaton PDI Patented) reduces the inrush of magnetic load; the transfer time can range up to 8 ms depending on the phase shift between sources. Up to 45 degree phase shift between sources the transfer time is up to 4 ms for outages and 2 ms for manual transfers.
   - **POG algorithm:** This algorithm has a shorter transfer time than the VSS algorithm, but inrush currents are not controlled.

8.4.2 Manual Transfer

Manual transfers can be accomplished using the "Preferred Source" switch icon on the Home Screen. The logic will allow manually initiated transfers between the two input sources if the selected source is within acceptable voltage limits and phase tolerances. As described above, this also changes the source that is designated as the Preferred Source.

8.4.3 Retransfer- Yes/No

This select switch icon which is located on the "Switch" Settings screen of the touch screen monitor. When the switch is in the "Yes" position, the logic will always connect the load to the selected "preferred source" as long as it is within specified, acceptable limits. This is the normal operating mode for the STS unit and the default position of the switch. After a transfer, once the "preferred source" has returned to within acceptable parameters, the unit will automatically switch the load back to the preferred source. When in the "No" position, the logic will not retransfer to the "preferred source" once a transfer has been performed, even after the "preferred source" returns to acceptable parameters. It will remain on the alternate source until it fails. If the other source is good, it will then transfer to the original preferred source.

8.4.4 Logic Controlled Functions

1. Transfer Inhibit Function in Auto Mode. This mode is controlled automatically by the logic. The load current is continually sensed and if it exceeds an adjustable preset level (which is deemed to represent an over

load or fault condition) the logic will disable the automatic transfer function of the Unit, even if the voltage on the selected source exceeds the transfer limits. The load current transfer inhibit will be automatically reset to normal conditions after the load current returns to normal for continued load protection against an input source failure.

2. Both Sources Fail Mode: If there is an outage of both sources detected, the logic locks on the last available source for 100 ms. After 100 ms, the logic will then transfer the load to the first available source that returns to a condition that is within acceptable limits.

   An example of this function is:

   Example #1:

   - Source/Transformer #1 is the preferred source and supporting the load.
   - Source/Transformer #1 experiences an outage.
   - The load is transferred to Source/Transformer #2.
   - The current inrush dips Source/Transformer #2 for 2 cycles (33.33 ms).
   - This causes the internal voltage monitors to detect an outage on both sources.
   - The logic locks the load on Source/Transformer #2 for 100ms, which allows the source voltage to stabilize, and the load is not dropped.

   Example #2:

   - Source/Transformer #1 is the preferred source and supporting the load.
   - Source/Transformer #2 experiences an outage (load remains on Source 1).
   - While Source/Transformer #2 is unavailable, Source/Transformer #1 experiences an 8ms transient outage.
   - The load remains connected to Source/Transformer #1 even though both sources experience outages for 8 ms.

3. Retransfer Hysteresis & Delay. The logic inhibits retransfer, even when retransfer is enabled, if the preferred source is not within the hysteresis setting. This setting is adjustable from 95 to 99% of nominal, i.e. the retransfer cannot occur until the preferred source voltage has returned to the hysteresis setting for an adjustable period of time (typically 4 seconds).

4. Excessive Transfers. If there are excessive transfers (typically four transfers within five minutes), the logic will automatically decrease the preset transfer points in -2% decrement for a total of -4%.

   If there are no transfers in a 60 minute period, the transfer point increment in 2% steps to the original preset point.

8.5 Shorted Power Switching Element

1. If there is a shorted power-switching element on the non-conducting side, the load is transferred to the non-conducting side and retransfer is inhibited. The input switch or circuit breaker on the previously conducting side is opened. An alarm is sounded and recorded with a time/date stamp in the event log.
2. If there is a shorted power-switching element on the conducting side, transfer is inhibited and the input switch or circuit breaker on the non-conducting side is opened. An alarm is sounded and recorded with a time/date stamp in the event log.
3. If Cross Current between sources is detected, the STS logic will transfer the load to the nonconducting side and lock on that source. An alarm is sounded and recorded with a time/date stamp on the event log.

8.6 Open Power Switching Element

If there is an open power-switching element on the preferred or alternate side, the load will either remain or transfer to the "good" side, and retransfer is inhibited. An alarm is sounded and recorded with a time/date stamp in the event log.

8.7 Maintenance Bypass

1. See the unit drawings in the Appendix for MCSW/MCCB configuration and location.
2. The WaveStar is furnished with key-interlocked maintenance bypass MCSW/MCCBs (Customer to designate whether to have MCSW or MCCB provided for the bypass disconnects at the time of order) which allow the transfer switch to be bypassed by the operator without interruption of the load power. When the unit is in maintenance bypass, all electronic components can be isolated from the input, output, and bypass connections to allow safe unit servicing without access to hazardous voltages.
3. MCSW/MCCB Interlocking Key Configuration:
    - The Source 1 and Source 2 bypass MCSW/MCCB are keyed interlocked. Only one can be closed at a time, but both can be open at the same time.
    - The Source 1 input MCSW/MCCB and the Source 2 bypass MCSW/MCCB are key interlocked with key #1. The key must be inserted into the lock and turned before that MCSW/MCCB can be closed.
    - The Source 2 input MCSW/MCCB and Source 1 bypass MCSW/MCCB are key interlocked with key #2. The key must be inserted and turned before that MCSW/MCCB can be closed.
    - The Bypass 1 MCSW/MCCB and the Bypass 2 MCSW/MCCB are key interlocked with key #3. The key must be inserted into the lock and turned before that MCSW/MCCB can be closed.
    - Key #1, key #2 and key #3 are different and none of these keys can be removed from a MCSW/MCCB unless the MCSW/MCCB is in the open position.
    - In the normal operation, the keys are in the input MCSW/MCCB's and the input MCSW/MCCB's are closed, and neither bypass MCSW/MCCB can be closed.

Example Procedure for going to bypass on the WaveStar on Source 1

(The load must be powered by Source 1):

1. Open Source #2 input MCSW/MCCB
2. Rotate and Remove the key from the Source 2 Input MCSW/MCCB and insert it in the Source 1 bypass MCSW/MCCB and turn.
3. Verify key #3 is in Bypass 1. (If the key #3 is located in Bypass 2, remove it and insert it in Bypass 1.
4. Close the Source #1 bypass MCSW/MCCB, since the MCSW/MCCB closes "around" the power switch element, bypass is transparent to the load.
5. Now both the Source 1 input MCSW/MCCB and the isolation MCSW can be opened and the STS Unit is bypassed.

Chapter 9 Graphics/Touch-Screen Operator Interface

There are several set-up screens that must be viewed to verify and set up STS operational parameters.

These are:

- Setting up Passwords and PIN numbers
- Initial set up via the "Settings" screen and the "Switch settings" screen
- ModBus and SNMP settings
- Banner and Time settings
- E-Mail settings
- Ethernet settings
- Web setting
- IR settings –contact factory

9.1 Home Screen

The Home Screen is the first screen displayed when the unit is turned on and it is also displayed when the "home" screen icon is touched at the bottom of the screen from any other screen. This screen displays STS input source power parameters, output power parameters, unit status, graphic one line, and rotary switch icon.

Figure 4. Home Screen

NOTE The monitor will revert back to the Home Screen after 5 minutes of operator inactivity. When this happens, the Operator will be logged out to prevent inadvertent or non-authorized operator usage.

The monitor is designed as so anyone can view the different screens for unit and power information, but a login is required in order to make any changes through the monitor. This is started from the Home Screen in the

section marked for Operator Login. The operator presses the "Log In" Icon, which will display the Keyboard screen for password and PIN # entry. Once entered, the operators PIN #, time, and date will be documented in the event log. To log in, the password is entered, and then the right arrow key followed by the PIN#. Once this is entered, press "OK".

Figure 5. Keyboard Screen

To Log out of the STS monitor, you press the "Log In" Icon and then press the "Cancel" Icon in the Keyboard Screen. This will take you back to the Home Screen as "Locked"

There are four levels of Passwords (PW's) available:

1. **Administrator:** no restrictions with the exception of calibration (only Eaton authorized service representatives can calibrate the unit), the Administrator is the only operator that can clear the event log and set the password and PIN# levels.
2. **Manager:** Same as the Administrator, except a manager cannot clear the Event Log, change remote communication parameters, or setup user password and PIN#.
3. **Operator:** Can only operate the home screen preferred source control and internal MCSW/MCCBs, without alarms. The operator can view all collected data through screen viewing.
4. **Service:** These are the passwords set for Eaton Authorized service representatives for when they come in to the site for scheduled and non scheduled maintenance. These passwords will be pre-set in the monitor prior to shipment. This has no restriction, with the exception that Service cannot clear the Event Log. This must be approved and completed under the Administrator login.

Once the unit is started up, contact Eaton service or work with the technician at the startup to get a temporary Administrator Password and PIN #. The password allows access and the PIN # identifies the operator. The administrator must never give out his password and PIN #, the STS security is based on the identification of all operators via the PIN #, and this security provides for accurate forensics if there is problem with the STS.

To initially set up STS users (the Operators), the Administrator presses the Log In icon. This will bring up the Keyboard Screen. When the administrators password and PIN # is entered and the OK Icon is touched, the Users Screen will be displayed.

The administrator will enter all of the other user (Manager and Operator) information, passwords and PIN #s

Change the administrator password and PIN #

Add spare PIN #'s for new operators.

Passwords and PIN #'s for use by Eaton service will be pre-installed on the unit when it arrives to the site by Eaton.

After initial startup, commissioning testing or restart, the administrator should clear any alarms that occurred during testing.

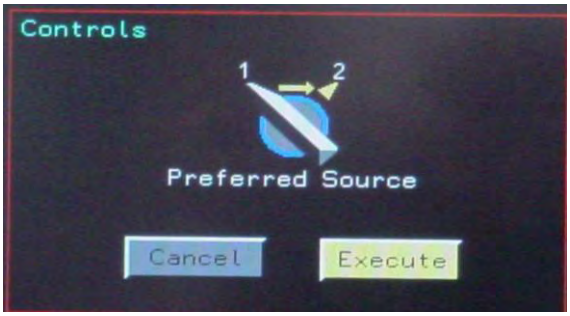
The operators PIN#, time, and date will be documented in the event log which can be accessed by pressing the Log Icon at the bottom of the Home Screen. Viewing screens to obtain data does not require log-in.

The row of button icons at the bottom of the screen will select all other major screens when pressed. The "next" icon will display two more rows of button icons.

Figure 6. Button Icons

The Controls section of the Home Screen allows the operator to select the "preferred source" and switch between two sources. After a successful login, the operator can switch the preferred source by touching the virtual switch to move from Source 1 to Source 2 as shown in the picture below. When this switch is moved the Execute Icon will be highlighted as a precaution. The operator must press the Execute Icon to transfer the source, or the Cancel.

Figure 7. Controls Panel



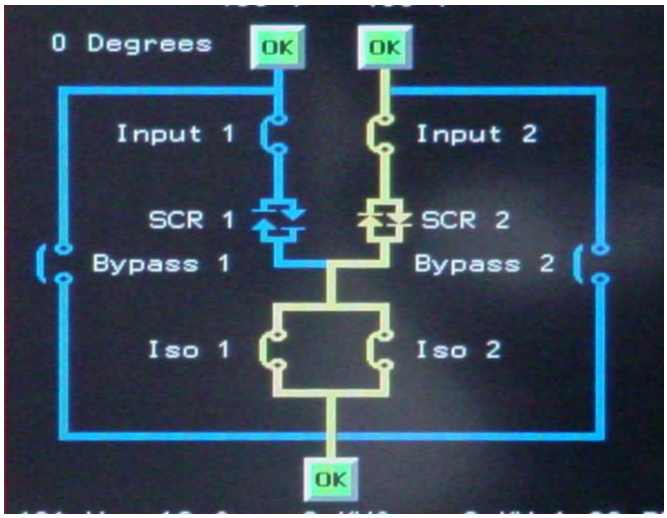
The Status Panel displays the general status of the unit. It shows which source is open or available, which bypass is being used, and how many alarms are present.

The Normal/Alarm icon found between the "Status" panel and the Graphic One Line, determines if there are any alarms present. If the Icon is green and reads Normal, then the CB/MCCB is in normal position and there are no alarms. If the Icon is red and reads Alarm, then the operator should press the Alarms Icon button on the bottom row to access the Alarms screen for details.

Figure 8. Status Panel

The Graphic One line is a display of the direction of the current. At the top of the Graphic One Line is the text display of both STS input source, and power parameters. Also the degree of phase shift between sources is displayed. At the bottom is the text display of the STS output power parameters.

Figure 9. Graphic One Line



9.2 Alarm Screen

Touching the "Alarms" button icon on the Home Screen displays "Alarm" screen.

This screen displays all date/time stamped points with the alarm listings. The red or green icons at the beginning of each row indicate whether that point is in alarm. If the icon is red, it is an alarm. If the icon is green and reads "OK" it is not an alarm. Each point has a description showing what kind of alarm it is.

Pressing the Clear Icon will clear all points from the Alarms Screen.

NOTE Should the alarms be active in the unit; the alarms will come back after clearing the screen.

Figure 10. Alarm Screen

9.3 Log Screen

Touching the "Log" button icon on the Home Screen displays the Event Log.

The Event Log Screen is a record of all events that have taken place while the STS have been in operational. Each event or alarm is Time/Date stamped in the order of occurrence. These events,(which include alarms, abnormalities, and operator logins and logouts) are described in the center panel. The arrows on the right side of the panel allow the operator to scroll through events.

When the Clear Icon is pressed all events in the Log are cleared from the screen. This action can only be completed by the Administrator.

Figure 11. Log Screen

9.4 Plots Screen

Touching the “Plots” button icon on the home screen displays the “Plots” screen.

The top two columns of the Plot Screen are the displays for Source 1 and Source 2’s voltage.

The lower two columns are the displays for the Output Voltage and the Output Amps.

These four columns display the three phases of each source and output as waveforms captures. The waveforms are color coded for each phase. Phase A is blue, Phase B is red, and Phase C is black. These displays will show breaks in the waves if there has been an outage or a transfer.

Figure 12. Waveform Capture

Likewise the bottom panel will display the time/date stamp of the operator, the outage, and/or the retransfer.

Pressing the Now icon will result in an instantaneous plot while touching the Clear icon will result in the plots being cleared.

The arrow icons on the right of the plots panel allow the operator to scroll through the listed plots to display the waveform captures for the specific event selected.

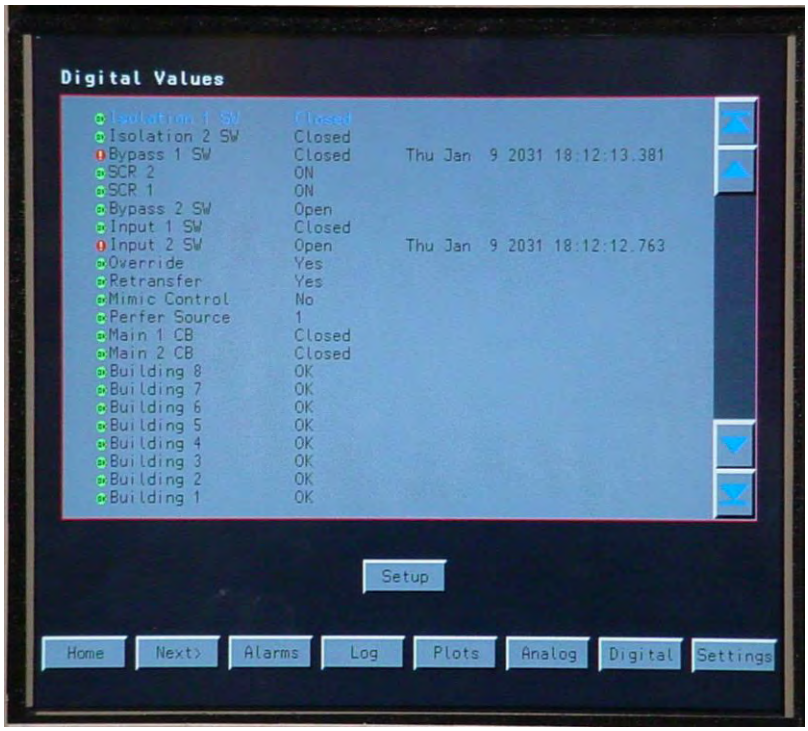
9.5 Digital Screen

Touching the "Digital" button icon on the Home Screen displays the "Digital" Screen.

The Digital Screen displays the Digital Values screen as shown above. There is a red or green indicator at the beginning of each row to indicate normal (green) and abnormal (red) states. The first column is the description of the digital value's alarm or abnormal state. The second column describes the status of the alarm or abnormal state listed in the first column.

The third column is the date/timestamp of when the alarm or abnormal state occurred.

Figure 13. Digital Values



9.6 Analog Values Screen

Touching the "Analog" button icon on the Home Screen displays the Analog Screen.

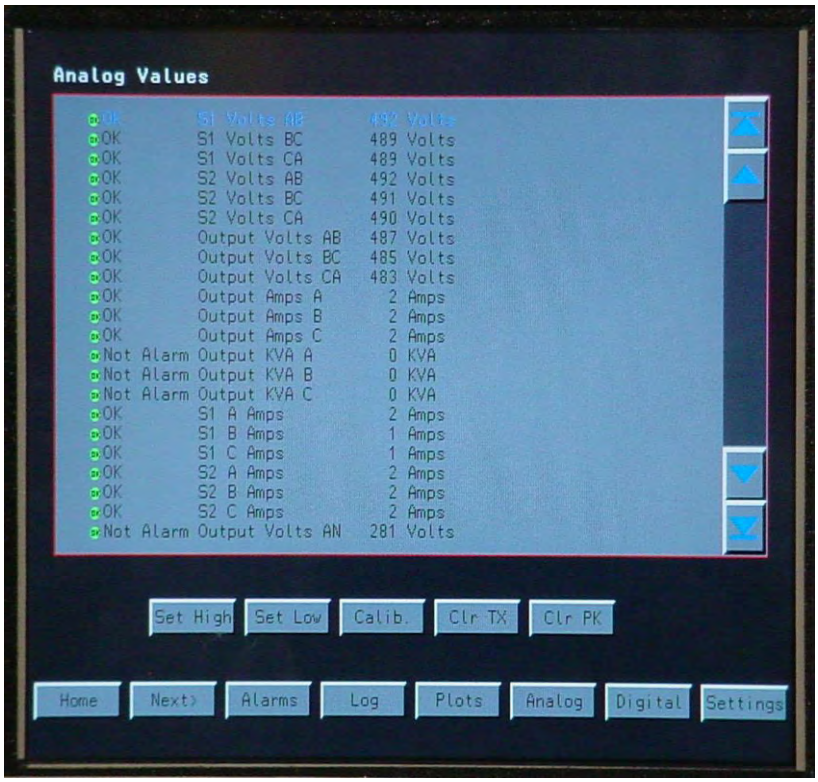
The Analog screen will display the analog Values screen shown in Figure 14.

The red or green indicators at the beginning of each row indicate normal (green) and abnormal(red) states. This column will display OK or Not Alarm if the value is normal or Alarm if the value is abnormal.

The second column is a description of measured parameters.

The third column is a description of the analog values. The four button icons below the Values panel are used to set the high and low limits for alarms, calibration of the values, and clear the text.

Figure 14. Analog Values



Touching these icons will display the Numeric Pad Screen for entering this data. Once the information is entered in the Numeric Pad Screen, the OK is pushed to accept the data.

The arrow Icons on the right side of the Values panel allows the operator to scroll through the text list to select the Analog Value to set.

Figure 15. Numeric Pad Screen

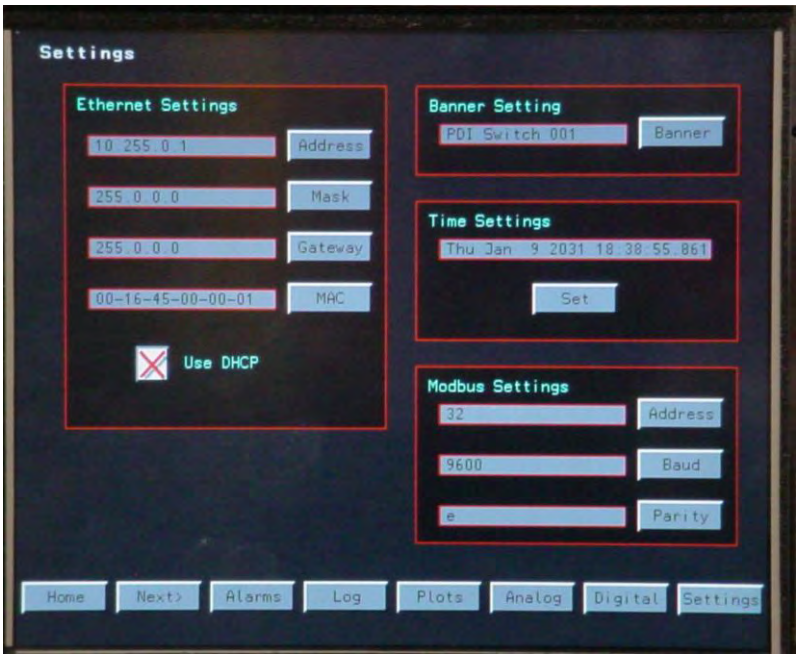
9.7 Settings Screen

Touching the "Settings" button icon on the Home Screen displays the "Settings" screen.

The Banner Settings Panel is used to set the Unit ID, which is displayed on the Home Screen. This can be done by pressing the Banner Icon which will bring up the Numeric Pad Screen for data entry.

The Time Settings Panel allows the operator to change the Date/Time settings. This can be done by pressing the Set Icon, which will bring up the Keyboard Screen.

Figure 16. Settings Screen



The Ethernet Settings Panel allows the operator to set a different IP address if a different address than the DHCP address is required. This Ethernet Panel also has IP settings for Mask, and Gateway. Mac IP settings are factory default and cannot be changed.

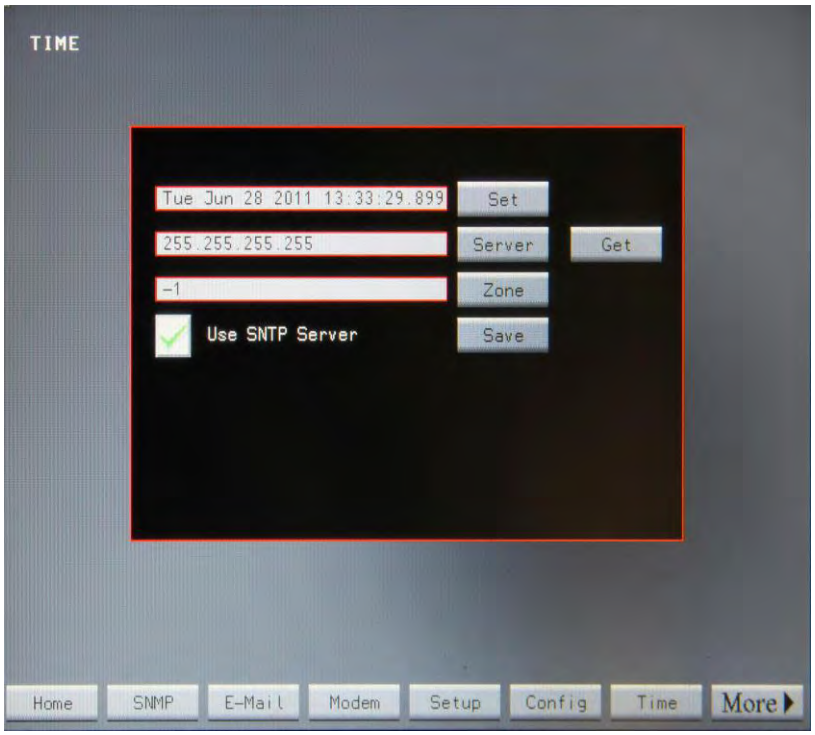
If the DHCP Icon is green then the DHCP address will be used under the Address settings. If the DHCP Icon is red, a separate address can be used in its place. The Modbus Settings Panel is used to set Modbus address, baud rate, and parity.

The Modbus address can be changed by pressing the Address Icon. This will display the Numeric Pad Screen for entering the address for the unit. Pressing the other icons in this panel will allow for the adjustment of those fields. The parity can be selected from the following: Even (E), Odd (O) or None (N).

9.8 Time Synchronization Settings Screen (SNTP)

The Time Synchronization feature with SNTP uses the Ethernet connection of the WaveStar Static Switch. This is the same Ethernet connection that is used for TCP/IP and SNMP Communications, so the Ethernet Setting on the "Settings" screen must be configured first and the Ethernet port must be connected to a network with a reachable timeserver supporting SNTP. The IP address of the time server must be known. This could be a dedicated time server possibly with a GPS receiver, a local computer running time server software, or a time server on the Internet. It is preferred to use a local time server.

Figure 17. SNTP Screen



To configure the WaveStar Static Switch to use SNTP follow these steps:

1. Select the "Time" screen.
2. Press the "Server" button and enter the time server's IP.
3. Press the "Zone" button and enter the time zone offset from UCT (-4 is Eastern Daylight time).
4. If the "Use SNTP Server" check box is a red X, press it to make it a green check mark.
5. Press the "Save" button to save the settings.
6. Press the "Get" button to verify that the time is set

9.9 Switch Screen

Touching the "Switch" button icon on the Home Screen displays the "Switch" screen.

The Switch Screen is used to adjust parameters for detection algorithms.

Figure 18. Switch Screen

The Control panel portion of the Switch Screen has two virtual switches:

Mode (VSS/POG): The Operator may switch between Volt Second Synchronization (VSS) algorithms that control the inrush of magnetic field during an out of phase transfer, or the POG algorithm that has shorter transfer times, but no inrush control. When the VSS/POG switch is touched to be moved, the Execute Icon will be highlighted as a precaution. The operator must press the Execute Icon to move the virtual switch to the opposite position, or the Cancel.

Figure 19. Mode Selection

Retransfer (YES/NO):

The second switch on the Control Panel is the Retransfer Switch. When set to "Yes", the STS will switch back to the original preferred source after an outage on that source has ended and the power on this source is within prescribed parameters. When the Retransfer switch is touched to be moved, the Execute Icon will be highlighted as a precaution. The operator must press the Execute Icon to move the virtual switch to the opposite position, or the Cancel.

Figure 20. Retransfer Selection

The Fast panel is used to set the parameters for the fastest detection algorithm. Since noise can trigger this detector, the settings should have larger limits than the Delay panel. These are generally set at 120% and 80%. When each of these Icons is pressed the Numeric Pad Screen is brought up for data entry. The Ratchet Icon determines the increase in the High and Low limits when there are multiple transfers in a short period of time; this is typically set at 2%.

The Delayed Panel sets the parameters for the slower detector. These parameters are typically set for the long period of the CEBMA/ITC curve, 100% and 10% with a delay of 1 second. When pressed, each Icon brings up the Numeric Pad Screen for data entry.

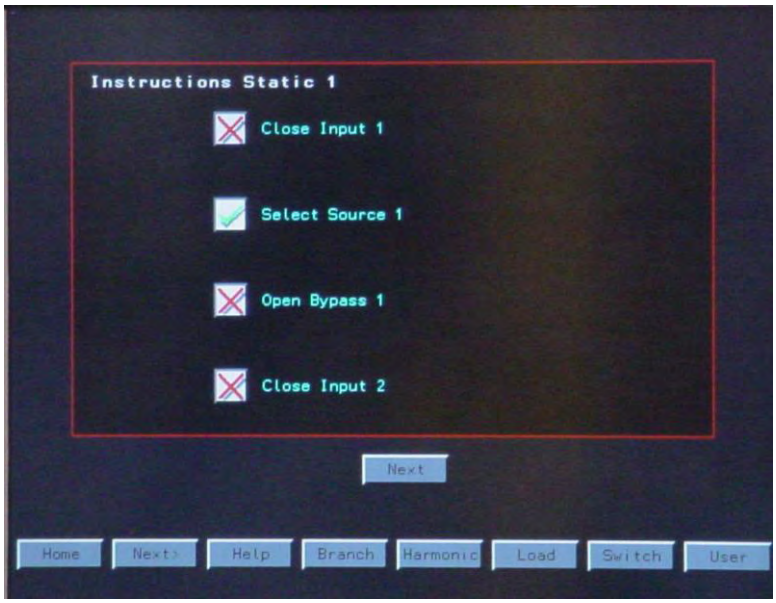
The Retransfer Delay panel sets the parameters for retransfer and determines the time the preferred source must be within tolerance before retransfer. When the Delay Icon is pressed the Numeric Pad Screen is brought up to enter the delay value.

9.10 Help Screen

Touching the “Help” button icon on the Home Screen displays the “Help” screen.

The Help Screen provides the Operator step by step instructions for performing certain functions in the STS unit. The procedures are listed and change when operations are performed to complete a specific function. It does this by using the Red/Green Icons in the order to which actions need to be completed from the top of the screen to the bottom.

Figure 21. Help Screen



The top icon will always be the first action that needs to be completed. Each action that needs to be performed by the operator will be marked with a red X. As the operator performs each task the Icon will change to a green check mark to show that it has been completed.

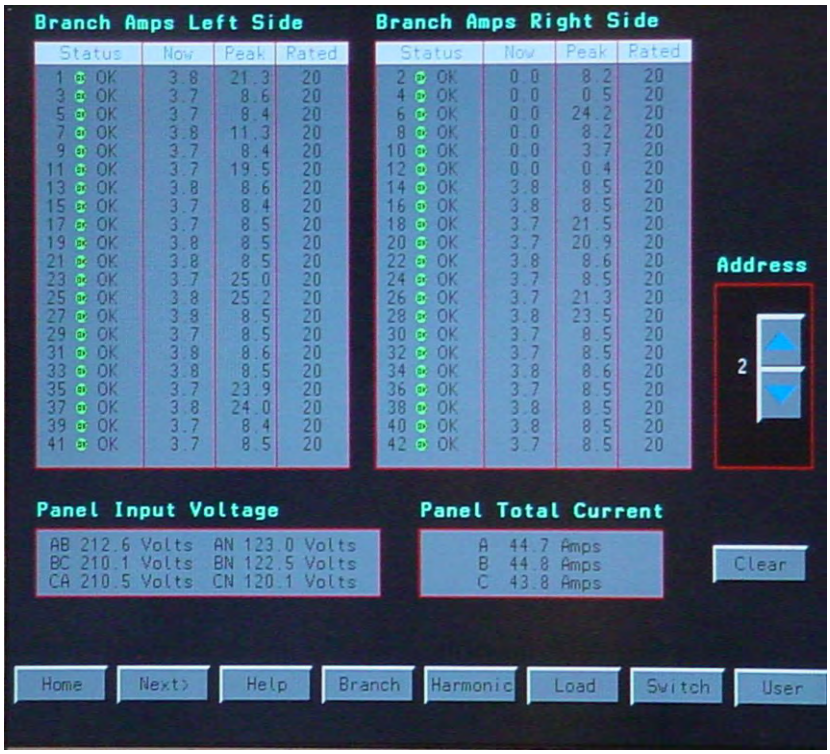
The Next Icon will switch the screen to additional function help that is programmed in the STS Unit.

9.11 Branch Screen

Touching the "Branch" button icon on the Home Screen displays the "Branch" screen. The Branch Screen displays the status of the Branch Circuit Breakers currents.

The Left and Right Branch Amps Panels represent the left and right Circuit Breakers. The Status column lists the Circuit Breaker number and current status. If the status has a green icon then its status is OK. If the icon is red, it will read one of three types of status. The Loss status denotes a recent loss in current or a tripped breaker. The Warn status means the current is up to 80% of breaker or higher. The Alarm status means the current is over 100% of breaker.

Figure 22. Branch Circuits Screen



The Now column displays the present current for each breaker. The Peak column displays the highest current that has occurred. The Rated column displays what the breaker is rated at.

The Panel Input Voltage panel located beneath the Left Branch Amp panel lists the line to line and line to neutral voltages.

The Panel Total Current panel located beneath the Right Branch Amp panel lists the currents for Phases A, B, and C.

The Clear Icon will clear all peaks, losses, warnings, and alarms when pressed. The Address arrows are for selecting the Modbus address of the Panel Board.

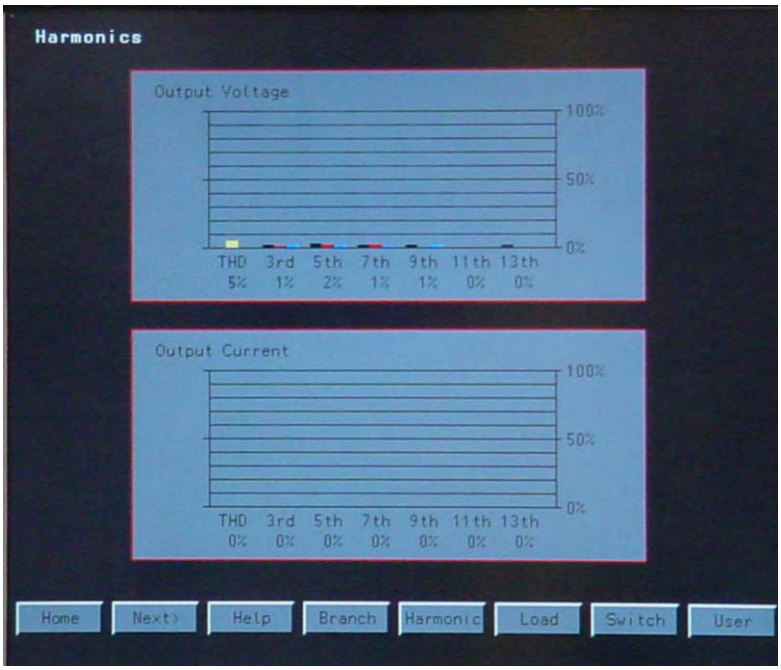
9.12 Harmonics Screen

Touching the “Harmonic” button icon on the Home Screen displays the “Harmonics” screen.

The Harmonics Screen displays both the Output Voltage and Current of the STS and at what percentage they are currently running.

The top panel displays the Output Voltage. It does this through graphic bars representing the three phases. Each phase is color coordinated as follows: Phase A is black, Phase B is red, and Phase Cis blue. The yellow bar on the left side of the panel represents the Total Harmonic Displacement (THD).

Figure 23. Harmonics Screen



The Output Current panel directly below the Output Voltage panel represents the current phases and THD in the same manner.

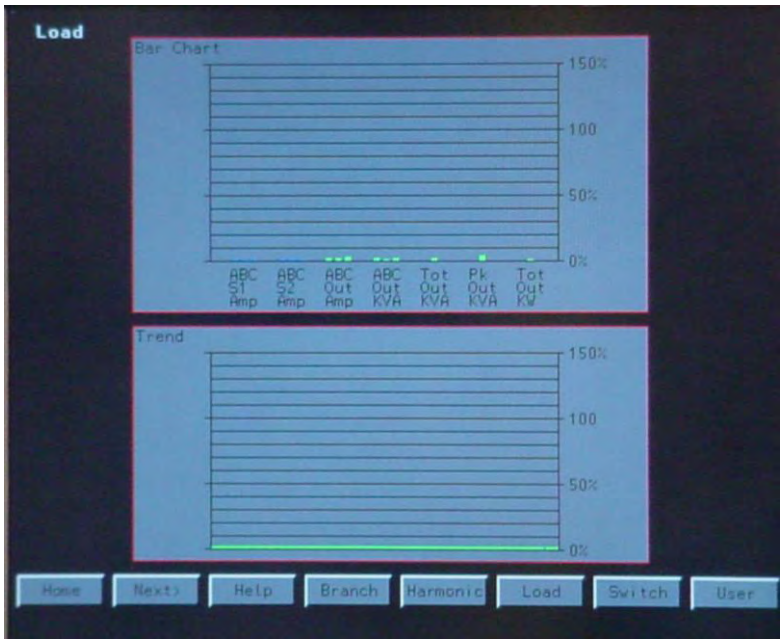
9.13 Load Screen

Touching the "Load" button icon on the Home Screen displays the "Load" screen.

The Load Screen displays the various phases of Sources, Outputs, and Total KVA, along with any trending that occurs.

The Bar Chart panel on the upper half of the screen displays the three phases (Phase A, B, and C) for Source 1 Amps, Source 2 Amps, Output Amps, and Output KVA. The last three columns are Total Output KVA, Peak Output KVA, and Total Output KW, and have only one graphic bar.

Figure 24. Load Screen



All graphic bars start green, but will turn yellow when they reach 80% or higher and will turn red when they reach 100% or higher.

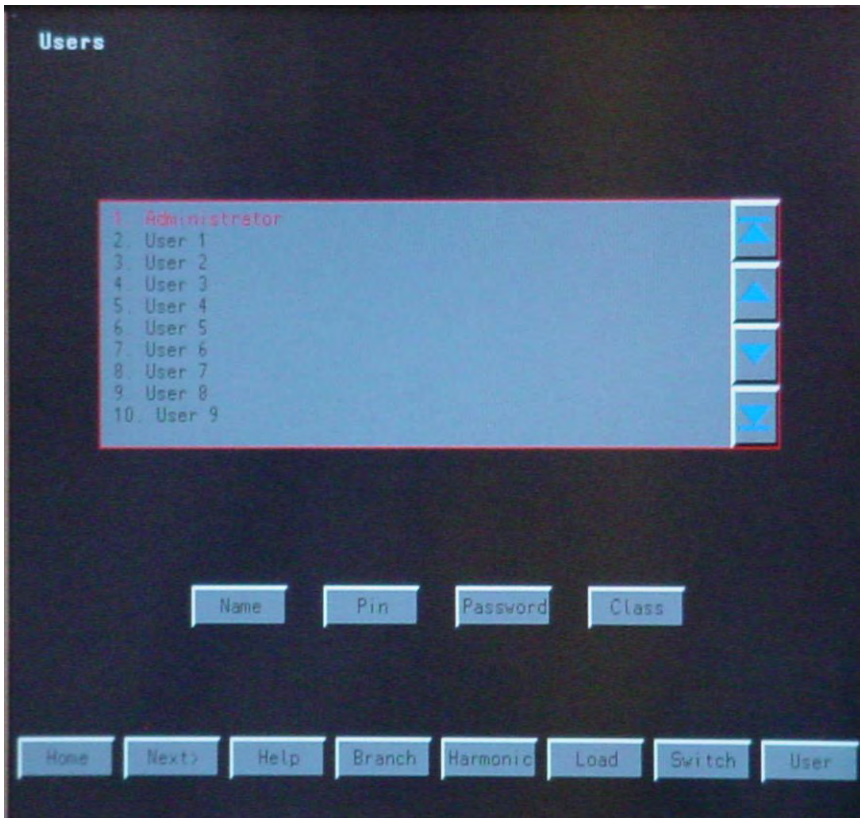
The Trend panel on the lower half of the screen represents the total KVA trending that occurs over time. The bar will fluctuate with the ebb and flow of KVA.

9.14 User Screen

Touching the "User" button icon on the Home Screen displays the "User" screen.

The Users Screen display show many Users are active and provides for the Administrator to set up new users and their level of access to the switch. Each user will be assigned a Password and PIN #. The Administrator is the only user allowed access to setup Names, Pins, Passwords, and Class. The arrow keys on the right side of the screen allow the Administrator to select the user to be set up or modified. Then by using one of the four icons below, the Name, PIN, password and Class can beset through the use of the either the Keyboard or Numeric Screen.

Figure 25. Users Screen



9.15 SNMP Screen

Touching the "SNMP" button icon on the Home Screen displays the "SNMP" screen.

The SNMP screen is used to send SNMP Traps to Management Stations or Contacts.

Pressing the Trap Icon will display the Numeric Screen to set the IP address of the Management Station SNMP Screen Pressing the Contact Icon will display the Keyboard Screen to set the name of the contact person who will be receiving the Traps.

Figure 26. SNMP Screen

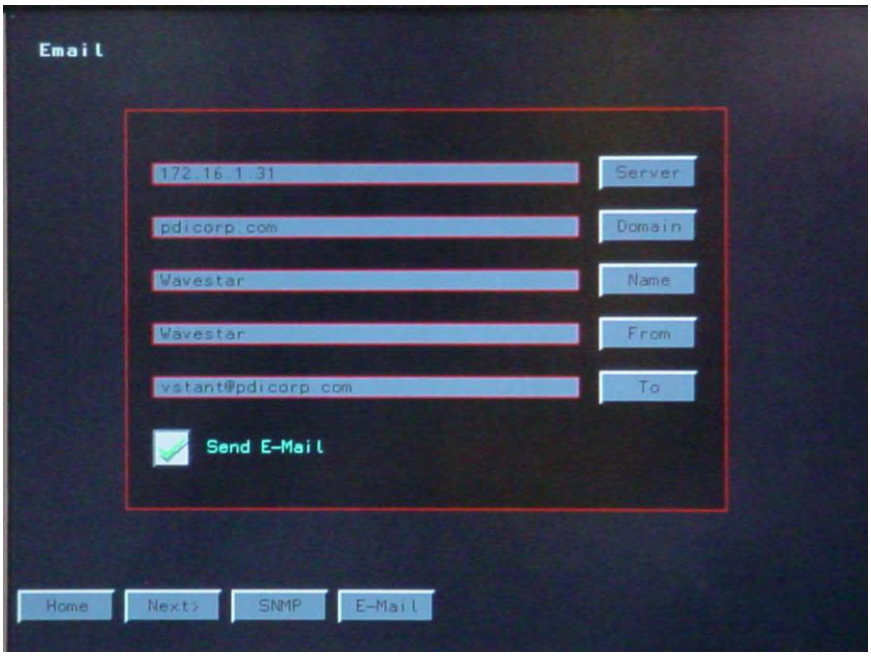
Pressing the Name Icon will display the Keyboard Screen to enter the name or designation of the STS. Pressing the Location Icon will display the Keyboard Screen to set the physical location of the STS. Touching the Send SMP Traps Icon will switch the Icon from green (ok to send traps) to red (do not send Traps)

9.16 Email Screen

Touching the "Email" button icon on the Home Screen displays the "Email" Screen.

The Email Screen allows the operator to set up the unit to send emails when there is an alarm or change of state on the unit. This can be done by pressing the icons on the right side to bring up either the Keyboard or Numeric Screens for entering the Server, Domain, Name, and from where and to where the email is to be sent.

Figure 27. Email Screen



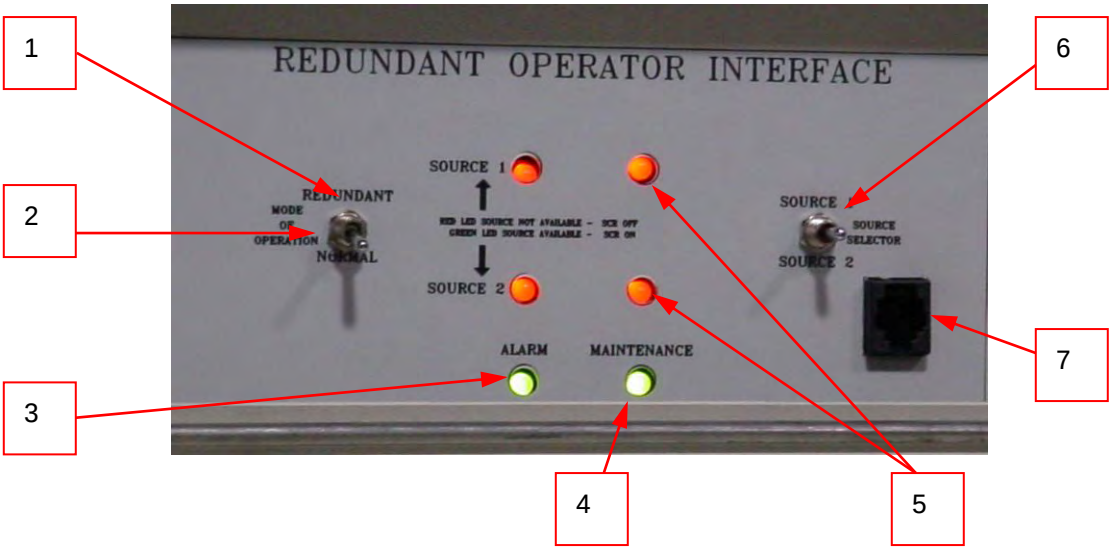
To have the Emails sent to multiple persons within an organization, the IT Administrator can set up a group mail address through MS Outlook or another mail portal and this address can be used in the WaveStar STS.

The Send Email Icon is red when the email has not been sent. When the operator presses the Icon, it will turn green indicating the email has been sent.

Chapter 10 Redundant Operator Interface (ROI)

This panel is used if main graphics display/touch screen fails, or if non-transfer manual operation is desired.

Figure 28. Redundant Operator Interface



1. When the "Mode of operation" switch is in the Redundant Position, this panel is active & main display is also active if operating properly. The "preferred select" icon on the main graphic screen is inactive. When the "Mode of operation" switch is in the in Normal Position, this panel is inactive & the main-graphics display is active.
2. Normal Position- This panel is inactive & the main-graphics display is active.
3. Alarm LED illuminated if there is any alarm or abnormal status.
4. LED illuminated if maintenance mode switch is in "maintenance" mode (abnormal mode)
5. Source 1 and Source 2 row of two LED's. The left LED indicates whether that source is Available. The right LED indicates if the source is powering the load. The indicators can be Red or Green. The definition of the color is shown on the panel.
6. Source Select Switch. This is a momentary toggle switch that can be used to transfer the load between sources. If a source is selected manually by the controls on this panel, that source will be preferred when returned to graphic mode (normal)
7. Service Port - to be used by service personnel only

Chapter 11 Communications

11.1 Modbus

The STS has an isolated RS422/RS485 Modbus RTU interface with soft bias provided. It can be configured for baud rate, parity, and address. Note that the address range is 1 to 255 and that the address if each device must be unique. Refer to for information on the configuration screen. Jumpers on the monitor circuit board select either a 2 wire or 4 wire configurations for connection. Contact Eaton Customer Service (1-800-843-9433).for assistance. The external connection for the RS422/RS485 is provided for by terminals that are located on the Customer Interface (Contractor)board. Refer to Chapter 13 *Remote Customer Interface* for information on the contractor board. The points list for the remote communication will be provided with the order, but you can contact the factory @ 1-800-843-9433 with the serial number of the unit and ask for customer support to e-mail you an electronic version.

11.2 SMNP

The STS supports SNMP over its Ethernet interface. Traps are sent if an alarm condition exists, and values can be read. The trap target IP address, name, contact, and location and these can be set from the SNMP screen. To have an electronic version of the MIB emailed to you, call the factory at 1-800-843-9433 and ask for customer support.

11.3 Web

The STS includes a web server. All values and alarms are displayed on various web pages. A link to email Eaton service as well as a link to the Eaton corporate web site is provided.

11.4 Modem Land Line

Contact the Eaton factory or your local Sales representative regarding the details of this option.

11.5 Modem Cell

Contact the Eaton factory or your local Sales representative regarding the details of this option.

11.6 Email

The STS can send email by SMTP if an alarm condition exists. The IP address of the SMTP server, domain, name, from email address, and the recipient's email address can be set from the EMAIL screen; refer to section X. The email will include a link to the alarm web page.

Chapter 12 Local Data Down Loading

12.1 USB Port

The unit has a USB Port for local downloading of data. The USB Port is located on the front of the display module. Contact the factory for further information on this option.

12.2 Memory Stick

Contact the factory regarding the details of this option

12.3 IR Connection

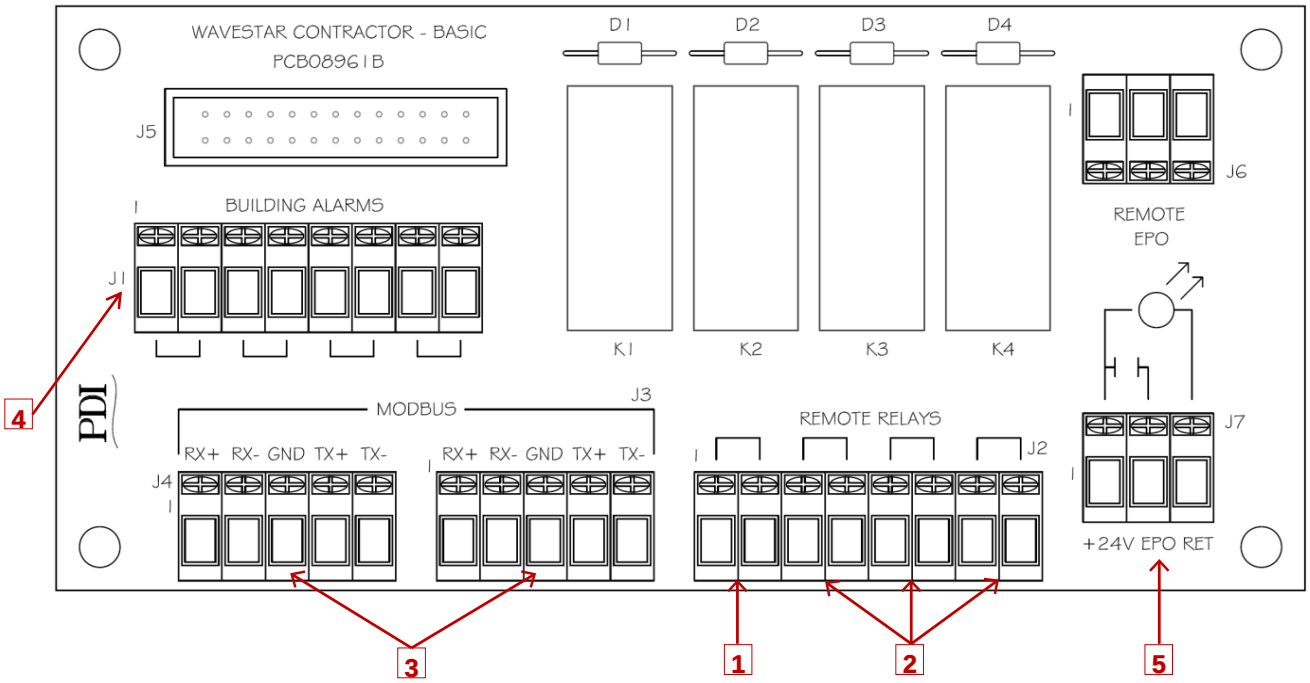
Contact the factory regarding the details of this option

Chapter 13 Remote Customer Interface

The Remote Customer Interface is available through ports and connection points in the WaveStar STS Unit that the customer uses to attach various interface points.

13.1 Standard Customer Interface Board (Contactor PCB)

Figure 29. Standard Customer Interface Board

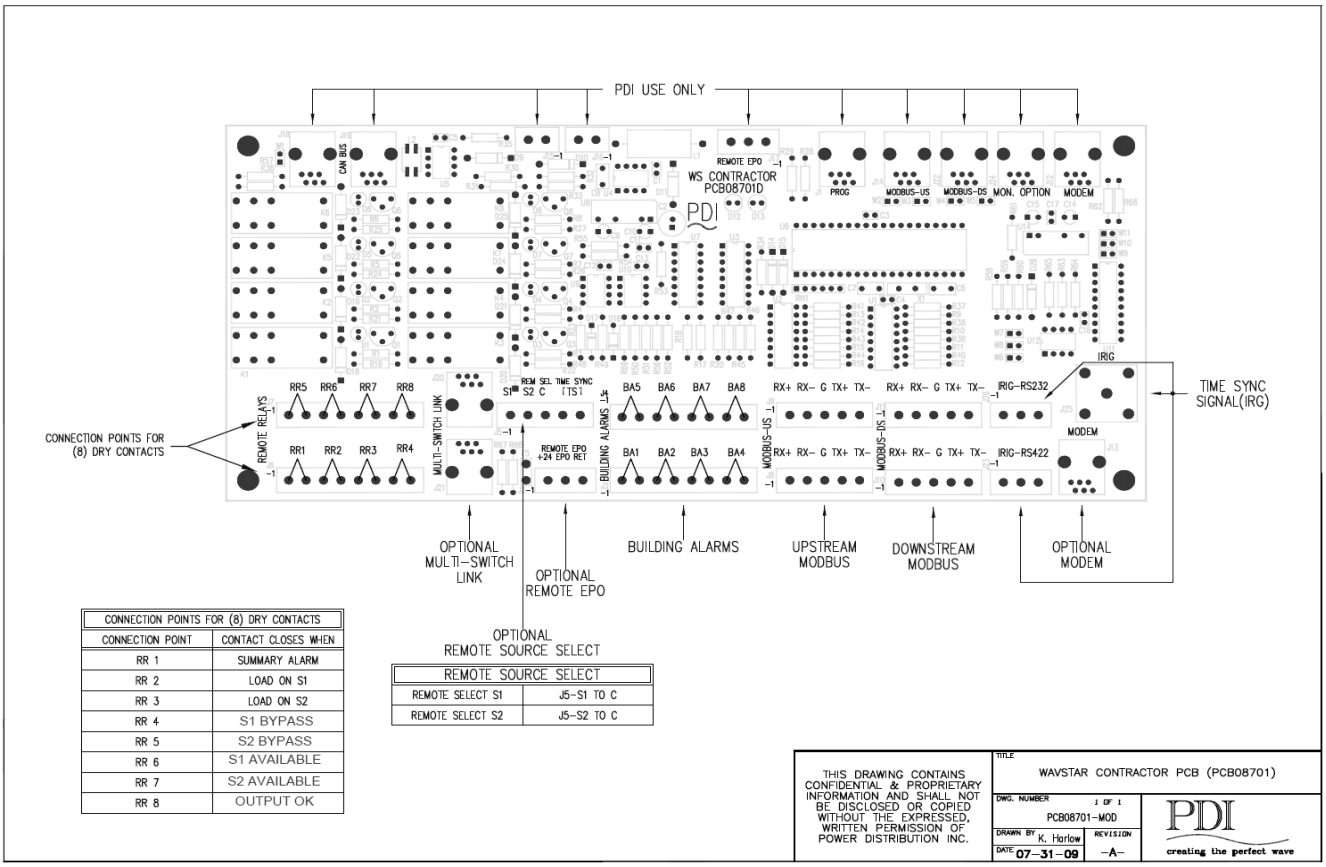


1. **Summary Alarm** – Dry Contact point to advise when unit is in alarm.
2. **Dry Contact Remote Relays** – Programmable N.O. or N.C. dry contacts for external output of specific internal alarms. Status points are:
   - Load on S1
   - Load on S2
   - Output OK
3. **ModBus Connection** – 4 wire configuration connection is located on the Customer connection terminal block
4. **Building Alarm** – Input terminal block to provide unit with input on four (4) external building alarms
5. **Remote EPO** – Connection point for input of remote EPO signal to system. This is a dry contact connection point. Connection of voltage to this point can cause damage to the unit. Connect external dry contacts to terminals marked +24V and EPO for EPO circuit. The return position is if there is also a light for the remote EPO button.
6. **SNMP-Web Enabled** – (Provided external to contractor board and not shown) Wire with jack connection to accept RJ45 plug hanging in area of Customer connection terminal block.

13.2 Enhanced Customer Interface Board (Contactor PCB) Option

The enhanced version of the Contractor board is available as an option. This expanded version allows for additional connection points of previously discussed interfaces as well as additional high end interface options.

Figure 30. Enhanced Customer Interface Board



CONNECTION POINTS FOR (8) DRY CONTACTS	
CONNECTION POINT	CONTACT CLOSES WHEN
RR 1	SUMMARY ALARM
RR 2	LOAD ON S1
RR 3	LOAD ON S2
RR 4	S1 BYPASS
RR 5	S2 BYPASS
RR 6	S1 AVAILABLE
RR 7	S2 AVAILABLE
RR 8	OUTPUT OK

REMOTE SOURCE SELECT	
REMOTE SELECT S1	J5-S1 TO C
REMOTE SELECT S2	J5-S2 TO C

Chapter 14 Technical Specification

14.1 Standards

The specified system is designed, manufactured, tested, and installed, as applicable, in accordance with:

- American National Standards Institute (ANSI)
- Canadian Standards Association (CSA)
- Institute of Electrical and Electronics Engineers (IEEE)
- National Electrical Code (NEC)
- National Electrical Manufacturers Association (NEMA)
- National Fire Protection Association (NFPA)
- Underwriters Laboratories Standards
- The STS/PDU is listed to UL and ULC standards 60950 and 1008
- The STS shall safely withstand without mis-operation or damage
- Transient voltage surges on either AC power input as defined by ANSI/IEEE C62.41 for Category B3 locations (high surge exposure industrial and commercial facilities)
- Electrostatic discharges (ESD) up to 10 kV at any point on the exterior of the unit
- Electromagnetic fields from portable transmitters within 3 feet (1 meter) of the unit

14.2 System Electrical Requirements

- Voltage Range: +15%, -10% of nominal
- Frequency: (60) Hz. +/-0.5 Hz
- Nominal standard Input Voltage: 208, 480, 600 volts three phase, 3-wire-plus-ground.
- Frequency: (60) Hz. +/-0.5 Hz
- The STS continuous current rating will match or exceed the PDU input requirements.
- Output Load Capacity: The STS/PDU is rated to carry full 100% load continuously.
- Rated KAIC: 42, 65, 100KAIC at 480 volts and below.
- Rated KAIC: 14, 25, 42, 65, at 600 volts
- Rated KAIC: 100KAIC, at 600 volts, for STS rated 2000 to 4000 amperes
- Standalone STS:
    1. Nominal STS input voltage ratings are: 600vac, 480vac, 240vac, 208vac, three phase, three wires plus ground, 60 Hz.
    2. The STS output voltage is the same as the input voltage.
- Primary or Secondary STS/PDU system:
    1. System Load and Transformer standard KVA ratings: 75, 100, 125, 150, 200, 225, 288, and 300 KVA. Higher ratings are available using 1200 and 1600 WaveStar STSs, contact the Eaton Factory or Sales Representative for further information.
    2. Nominal STS input voltage ratings are: 600vac, 480vac, 240vac, 208vac, three phase, three wire plus ground, 60 Hz.

3. Nominal system output Voltage, with nominal input voltage: 208/120 volts three phase, 4-wireplus-ground
4. The STS continuous current rating in a STS/PDU system will match or exceed the PDU input requirements

- Load Power Factor Range: 0.5 to 1.0, leading or lagging
- Load Crest Factor: Up to 3.5
- Source Voltage Distortion: Up to 15% THD plus notches, flat topping or/and ringing transients
- Sense and Transfer Times:
  1. POG algorithm: 4 Ms or less transfer time for outages; 2ms for manual transfers
  2. VSS algorithm: The Volt Second Synchronizing algorithm reduces the inrush of magnetic load; the transfer time can range from 4ms to 8 Ms depending on the phase shift between the sources.
- The system shall include a computer grade single point ground in accordance with FIPS Pub 94 and the requirements of NEC
- Overload Capability:
  1. 125% for 30 minutes
  2. 150% for 2 minutes
  3. 300% for 30 seconds
  4. 500% for 10 seconds
- SYSTEM Environmental Conditions ratings:
  1. Storage Temperature Range: -40° to +80°C
  2. Operating Temperature Range: 0° to 40°C
  3. Relative Humidity: 0 to 95% without condensation
  4. Operating Altitude: Up to 5000 feet above sea level without derating. If the operating Altitude is above 5000 feet, output current is derated by 6% per 1000 feet.
  5. Storage Altitude: Up to 40,000 feet above sea level
  6. Audible Noise:
  7. STS - Less than 60 dBA at 5 feet without alarm activation
  8. STS/PDU System - per ANSI requirements without alarm activation

14.3 System Reliability

MTBF - The STS or STS/PDU system is designed for high reliability and high availability with an MTBF exceeding 2,000,000 hours. To the fullest extent practical, redundant circuits and components are used to eliminate single points of failure.

14.4 Redundancy

The WaveStar STS has dynamic tri-redundant logic, with voting circuits. Each level monitors the power being supplied to the load, if one level does not transfer the load in specified times, the second level will transfer the load within the CBEMA/ITS curve.

The WaveStar STS has quad-redundant gate drivers, redundant drivers for each set of SCRs. The drivers cannot inhibit or out vote the other. Therefore, both source 1 and source 2 SCRs have two levels of isolated, independent gate drivers. The gate driver PCBs can be replaced while the load is supported using one of the internal bypass circuits.

The WaveStar STS has tri-redundant logic power supplies. The configuration of each DC logic power supply is such that a short circuit on one PCB cannot prevent the other PCBs from receiving tri-redundant power. Each PCB receives logic power via three isolated connectors. DCPSs can not be replaced by Eaton CSEs while online.

The WaveStar STS has two levels of operator controls and status displays. If the normal graphic/touch screen display fails there is a redundant operator panel and operator controls in the unit. Each operator control/display PCB can be hot swapped.

The WaveStar STS has N+3 fan redundancy on units that require force air cooling of the SCRs. STS rated 600 amperes and above required forced air cooling of the SCRs. The WaveStar STS uses tri-redundant fiber optic lite pipes and circular redundant CAN Bus to route logic signals between logic PCBs.

14.5 Electrical Noise Immunity

Noise immune signal bus(s) are used; optical and/or Can Bus are used to route signal between logic PCBs.

Each Signal Bus continuously transmits "Bus Integrity" signals, when not transmitting true data. If the "Bus Integrity" signals are not received by all receivers, then that bus is considered discontinuous and is alarmed. All signal buses are tri-redundant. The CAN Bus has circular redundancy so that there are two paths; one path can be severed and the signal will flow via the other path.

14.6 System Enclosure Construction

The Enclosures for both PDU and STS modules are constructed to NEMA Type-1 and are primed and painted with suitable semi-gloss enamel both inside and out. The Color is Pearl White with black top venting.

Each module cabinet is designed for the data center or telecommunication environment. Each cabinet has heavy-duty casters. Once the system is placed in its final position, the unit features stabilizing pads, which can be adjusted to stabilize the unit.

The Transformer / Distribution Module enclosure also includes a pre-punched output computer power cable landing tray on the front and/or sidecar side of the system featuring ample output cable space for both immediate and future cabling requirements.

Conduit termination plates will be provided in the bottom of the PDU module for termination of the output cables.

The distributed floor weight will be less than 250 lb. per. ft.

Access

The required service access for IR scanning and maintenance will be at the front of the STS module only.

Depending on configuration of the PDU distribution, only front access or front/side access is required only STS/PDU systems.

Hazardous Voltages Safety

The STS or STS/PDU system is designed to minimize the exposure of hazardous voltages to allow safe servicing of the unit while the load is energized. Barriers are used on and round any exposed surface with more than 42 volts peak applied including connections, to protect personnel during maintenance.

Secondary STS/PDU system Input Source Power Junction Boxes, Optional

The two input power sources are connected to the system via two power junction boxes. The junction box is a removable-covered, NEMA 12 box. Each box shall contains four (4) mechanical power terminal blocks accommodating two (2) 350 MCM AWG copper/aluminum wire for the connection of the DELTA configured incoming power feeds to the system.

Each power junction box is equipped with a ten foot (10') long system main input power cable is provided with each system. The cable consists of liquid-tight flexible metal conduit and contains the appropriate size and

number of copper conductors to comply with 1993 NEC standards. This field installed cable contains two (2) box connectors thus allowing ease of installation onto the power junction box and to the system.

14.7 System Cooling

Standalone STS

All units are air-cooled with perforated plates at the top and bottom of units and ventilation openings in side panels. Stand-alone STS units rated 600 amperes and above use on-board fans to provide forced air cooling. Stand-alone STS units rated 400 amperes or below are convection-cooled with optional fans.

Primary STS/PDU system

All units are air-cooled with perforated plates at the top and bottom of units and ventilation openings in side panels. The STS unit in a primary STS/PDU system with 480VAC input uses forced air cooling for units rated above 300 KVA. The STS unit in a primary STS/PDU system with 480VAC input uses convection air cooling with optional fans for systems rated 300 KVA and below.

Secondary STS/PDU systems

All units are air-cooled with perforated plates at the top and bottom of units and ventilation openings in side panels. The STS in a secondary STS/PDU uses on-board fans to provide forced air cooling for units rated 150 KVA and above. The STS unit in a secondary STS/PDU system uses convection air cooling with optional fans for systems rated 140 KVA and below.

Floor Stands

Floor stands for STS units have optional covers. Eaton recommends that customers remove the optional covers at STS installation to provide additional airflow to the unit.

Chapter 15 Trouble Shooting

⚠WARNING

- Danger: there is high voltage equipment inside the wavestar cabinet.
- Do not operate the unit without all covers securely in place.

⚠CAUTION

- Do not touch the printed circuit boards containing the processor and logic circuits Without first consulting the factory. Serious damage can be done by untrained Personnel.
- Do not allow servicing by unauthorized personnel. You may void your warranty.

If after reviewing and checking all the recommended correction procedures for any problem, please do not hesitate to contact Power Distribution, Inc. For service related calls or scheduling.

Symptom	Probable Cause
No power to unit.	No building power to Power Input bus. Restore building power.
	Unit not connected to Power Input bus. Connect unit to Power Input bus.
	Input breaker not closed Turn on or reset breaker.
Specific output circuit is dead.	Output circuit breaker is off. Turn on or reset breaker.
	Output circuit breaker and/or cable are not connected to Equipment. Connect (if authorized) output circuit to equipment and turn on.
No output voltage from unit but the unit indicators are on.	Input circuit breaker off or tripped. Check display panel for alarms; acknowledge or reset alarms then turn on or reset breaker.
Monitor display will not operate.	Blown Fuse (1, 2, 3, or 4)
Monitor will not display volts and amps.	Not in MONITOR mode. See Monitor section

Chapter 16 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.

16.1 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).

16.2 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.

16.3 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.

16.4 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.

Chapter 17 Appendices

17.1 Appendix A – Recommended Spare Parts List

WaveStar TRANSFER SWITCH

100 – 800 Amp Models

Table 1. Static Transfer Switch Spare Parts Kit (Option A)

WaveStar™ Static Transfer Switch Spare Parts Kit (Option A)		
Qty	**Description**	**Part #**
1	Battery, Lithium, 3V 2/3 AG	BAT09260
10	Bussman-FNQ.5 Fuse	FUS-FNQ.5
1	PCB, DCPS-Out-Top	PCB08553
1	PCB, DCPS-Out-Bottom	PCB08554
1	DC Gate Driver	PCB08028
1	Pulse Gate Driver	PCB08048

Table 2. Static Transfer Switch Spare Parts Kit (Option B)

WaveStar™ Static Transfer Switch Spare Parts Kit (Option B)		
Qty	**Description**	**Part #**
1	WaveStar™ Spare Parts Kit (Option A)	
1	22MM, 2 Pos Selector Sw	SWT01826
1	12V Contact Block, NO	SWT01829
1	Tri-Redundant SAS Board	PCB08383
1	12V Contact Block, NC	SWT01830
1	Surge Capacitor with Bracket	SSP02155
1	PCB, DCPS-S1,S2 - Top	PCB08555
1	PCB, DCPS-S1,S2 - Bottom	PCB08556

Table 3. Static Transfer Switch Spare Parts Kit (Option C)

WaveStar™ Static Transfer Switch Spare Parts Kit (Option C)		
Qty	**Description**	**Part #**
1	WaveStar™ Spare Parts Kit (Option A & B)	
1	24V, 4 pole relay	RLY04535

Table 3. Static Transfer Switch Spare Parts Kit (Option C) (Continued)

WaveStar™ Static Transfer Switch Spare Parts Kit (Option C)		
Qty	**Description**	**Part #**
1	PCB, Back up Operator Interface	PCB08940
1	Graphics Monitor Board	PCB08845
1	Touch Panel	DIS08899
1	Display, LCD	DIS08900
1	Inverter, Backlight	DIS08901

17.2 Appendix B – Upstream Circuit Breaker Rating

The WaveStar Static Transfer Switch (STS) must be protected by an upstream circuit breaker. To meet the ETL UL1008 certification, this upstream circuit breaker must be sized to the unit's full load rating or less.

NOTE NEC/Local codes may not allow continuous full-loading of the STS when using an 80% rated upstream circuit breaker.

To ensure maximum loading, the STS should be sized for 125% of the intended load, or the upstream protective device should be a 100% rated circuit breaker.

For additional information, please refer to your local codes and the National Electric Code (NEC).

17.3 Appendix C – Installation Instructions – Stand Alone STS

The WaveStar STS must be commissioned and acceptance tested by Eaton certified technician(s). The sequence of commissioning is

- Before applying power to the STS, open all MCSW or MCCBs in the STS:
- Verify the incoming power matches the unit rating.
- Verify the upstream protective devices are rated equal to or less than the rating of the STS.
- Verify the instantaneous trip settings on the upstream circuit breakers are set at maximum.
- Apply power to the STS with all internal MCSWs or MCCBs open
- Verify input phasing between sources is correct
- Close source 1, S1, bypass MCSW or MCCB and verify output voltage is present.
- Open S1 bypass MCSW or MCCB and close source 2, S2, bypass MCSW or MCCB and verify output voltage is present.

1. **Site Test and Initial Power UP (Phasing)**:
    - All the work performed in this section must be performed or witnessed by a Eaton Service Representative.
    - Before applying utility input power to the unit, the installing electrician and the Eaton service representative should be present to verify that the following initial conditions are met:
        – Inspect the power input and output bus connections and the building electrical service.

- Sizing of the building electrical service and voltage must match the WaveStar Bill of Materials (see Chapter 4 *System Unpack and Inspection*).
- Connection to the grounding electrode conductor.
- Check the building electrical service for correct voltage and over current protection.
- Place all unit circuit breakers is in the OPEN OR "OFF" position.

- Once all of the above conditions are met, incoming power should be applied by energizing the building power circuit breaker supplying the Automatic Transfer Device or Static Automatic Transfer Switch.

  The following measurements should now be performed:

- Measure the incoming voltage at the input to the unit. This should match the units rating (+5% to -10% from nominal rating).
- Check the phase rotation, (clockwise), and voltage at the source # 1 Power Input bus.

2. **Phasing Verification**:

   - With all Circuit Breaker's open, verify there is zero volts between the phase "a" poles on the line side of all input Circuit Breakers.
   - With all Circuit Breaker's open, verify there is zero volts between the phase "b" poles on the line side of all input Circuit Breaker's.
   - With all Circuit Breaker's open, verify there is zero volts between the phase "c" poles on the line side of all input Circuit Breakers.
   - With all Circuit Breaker's open, verify there is zero volts between the phase "a" poles on the line side of all bypass Circuit Breakers.
   - With all Circuit Breaker's open, verify there is zero volts between the phase "b" poles on the line side of all bypass Circuit Breakers.
   - With all Circuit Breaker's open, verify there is zero volts between the phase "c" poles on the line side of all bypass Circuit Breakers.

3. **Acceptance Testing**

   Performance Test the STS or STS/PDU System at Least 80% Load.

   Complete the Site Acceptance Test as Indicated in the "Site Acceptance Report". This test will be performed by the Eaton service Technician. The technician will ask the Customer Representative to sign the completed acceptance test report/Work Order, at which point the warranty period will begin.

17.4 Appendix F – VSS (Low Current INRUSH)

Eaton PDI WaveStar STS or STS/PDU System

Low Inrush Transfer Utilizing the Eaton PDI Volt Second Synchronization (VSS) Method

1. **Introduction**

   One of the limiting factors in applying STS or STS/PDU Systems (STS) in mission critical facilities has been the inability of the electrical infrastructures to withstand the transformer inrush when switching occurs on the primary (or 480 volt) side of the transformer. Inrush currents can reach as high as 10-12 times the transformer rating causing breakers and molded case switches in the STS (or devices upstream) to trip creating an outage in the facility.

   Eaton has a solution to this dilemma through our patented Volt Second Synchronization (VSS) transfer algorithm that controls magnetic inrush current in transformer loads and limits it to 1.5 times the rated current. The transfer outage time and the waveform distortions during transfers have an affect on non-

linear loads that are connected to the secondary side of the transformer. Short transfer outage times and waveform peak conservation algorithms is necessary for any STSs that feed non-linear loads.

Typically non-linear loads, servers and other computers use Switch Mode Power Supplies (SMPS) which generate non-linear load currents. The SMPS receives AC power from the transformer and generates DC power for the internal logic. SMPS only draw power from the peaks of the input power waveforms; RMS values are associated with linear loads and evaluations based on linear RMS loads will not provide accurate data for evaluation of SMPS applications.

To conserve all voltage waveform peaks, the transfer outage time of each phase must be short enough to assure that no peaks are lost. Since SMPS generally use single phase power, each individual phase must maintain power at the waveform peaks.

There are four methods of achieving low transformer saturation (inrush) currents when the transformer is connected to the load bus of an STS. These methods are as follows:

Phase Delay Method (referred to as phase displacement method)

Volt Second Balance Method

Volt Second Wave Shaping Method (with RMS conservation)

Eaton PDI Volt Second Synchronization (VSS) Method (with Peak conservation)

2. **Phase Delay Method**

   This method measures the half cycle phase delay from the time of the disconnection of one source to the reconnection of the other source with approximately the same half cycle delay; this will maintain volt second continuity.

   When transferring from one source to the other when the connecting source lags the disconnecting source there is a direct relationship between the size of the phase shift and the length of the outage.

   If the source phase shifts are small, the transfer outage is of short duration.

   If the source phase shifts are large, the transfer outage is of long duration.

   The transfer outage time of at least one phase can exceed 15 Ms, depending on the source phase shift and detect time. When the connecting source leads the disconnecting source the transfer outage is large at small phase angles.

   This method is simple to implement but does not support SMPS very well.

3. **Volt Seconds Balancing Method**

   This method determines the volt seconds applied to the magnetic load by the disconnecting source, and determines the volt seconds that will be supplied by the connecting source. The volt seconds applied to the magnetic load cannot exceed the maximum rated volt seconds.

   This basic algorithm must be optimized to obtain the desired waveform during the transfer outage.

   The Volt Second Wave Shaping Method (with RMS conservation) and Eaton PDI Volt Second Synchronization (VSS) Method (with Peak conservation), described below, are two separate and distinct solutions to optimize the limitations of the Volt Second Balancing Method.

   Volt Second Wave Shaping Method (with RMS conservation)

   This method insures that the maximum volt seconds rating of the transformer is not exceeded when the STS transfer between out of phase sources. The voltage waveform is shaped during the transfer transition time to maximize the RMS voltage when transferring. Since RMS voltage is meaningful for linear load and not non-linear loads, this is not the best algorithm for single phase non-linear loads but does not provide the best transfer algorithm for SMPS.

   Eaton PDI Volt Second Synchronization (VSS) Method (with Peak conservation)

This transfer algorithm, VSS with peak conservation, reduces magnetic load current inrush and maintains voltage peaks for the optimum operation of SMPS. The voltage waveform is shaped during the transfer transition time to maximize the peak power of the voltage waveform when transferring. This is the best algorithm for single phase non-linear loads and also maintains RMS voltage for linear loads.

4. **Conclusion**

Eaton has evaluated algorithms for all the above methods of reducing transformer current in-rush for initial start-up, restart-up and for transfer and has standardized on the VSS with peak conservation algorithm for the WaveStar STS systems.

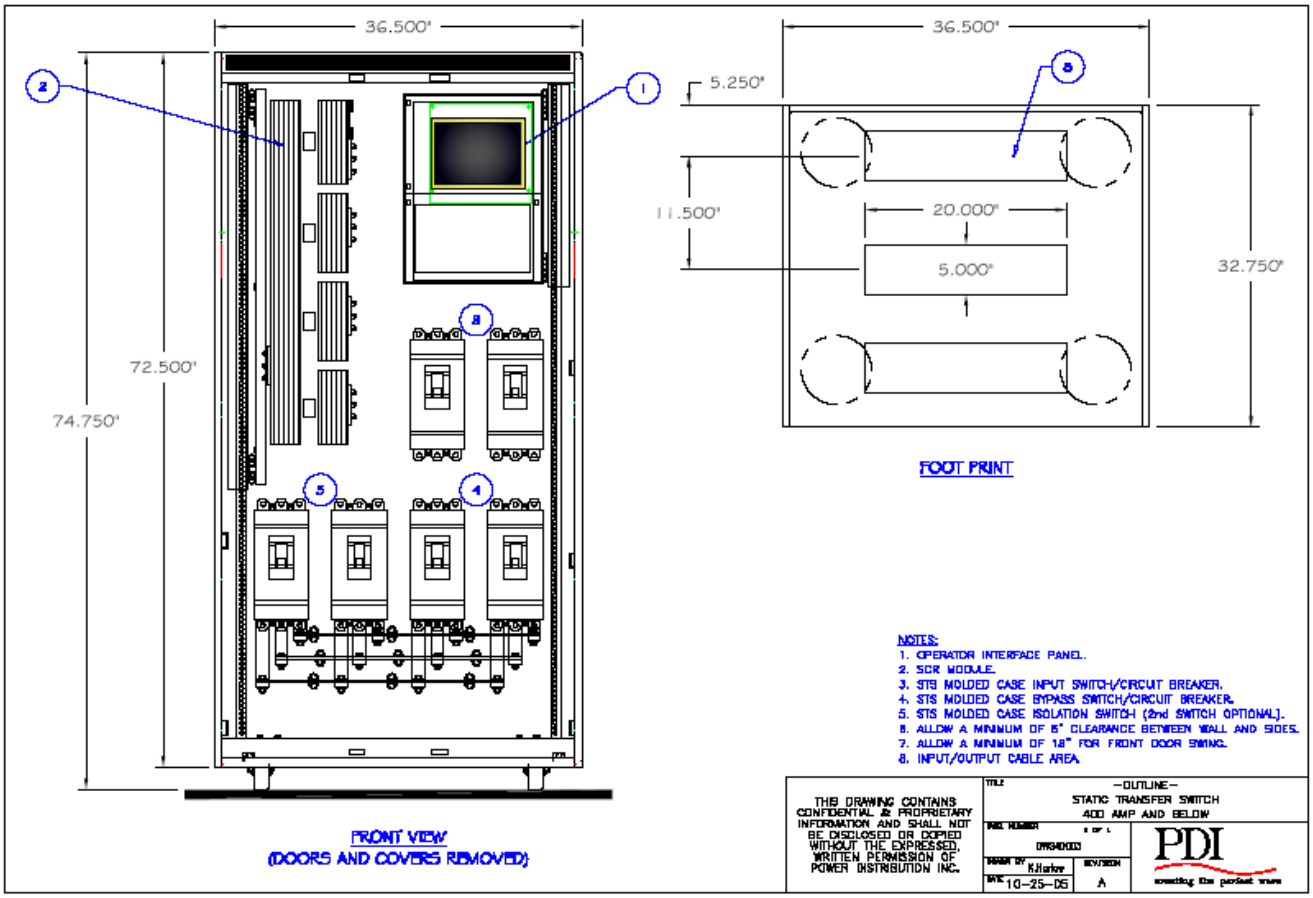
Figures 1 and 2 depict transfers at 15 degrees (both lagging and leading respectively) without the VSS feature. Figure 3 and 4 are examples of the same STS and transformer system with the VSS method. Figures 5, 6, 7 and 8 depict the same transfers performed 45 degrees out of phase.

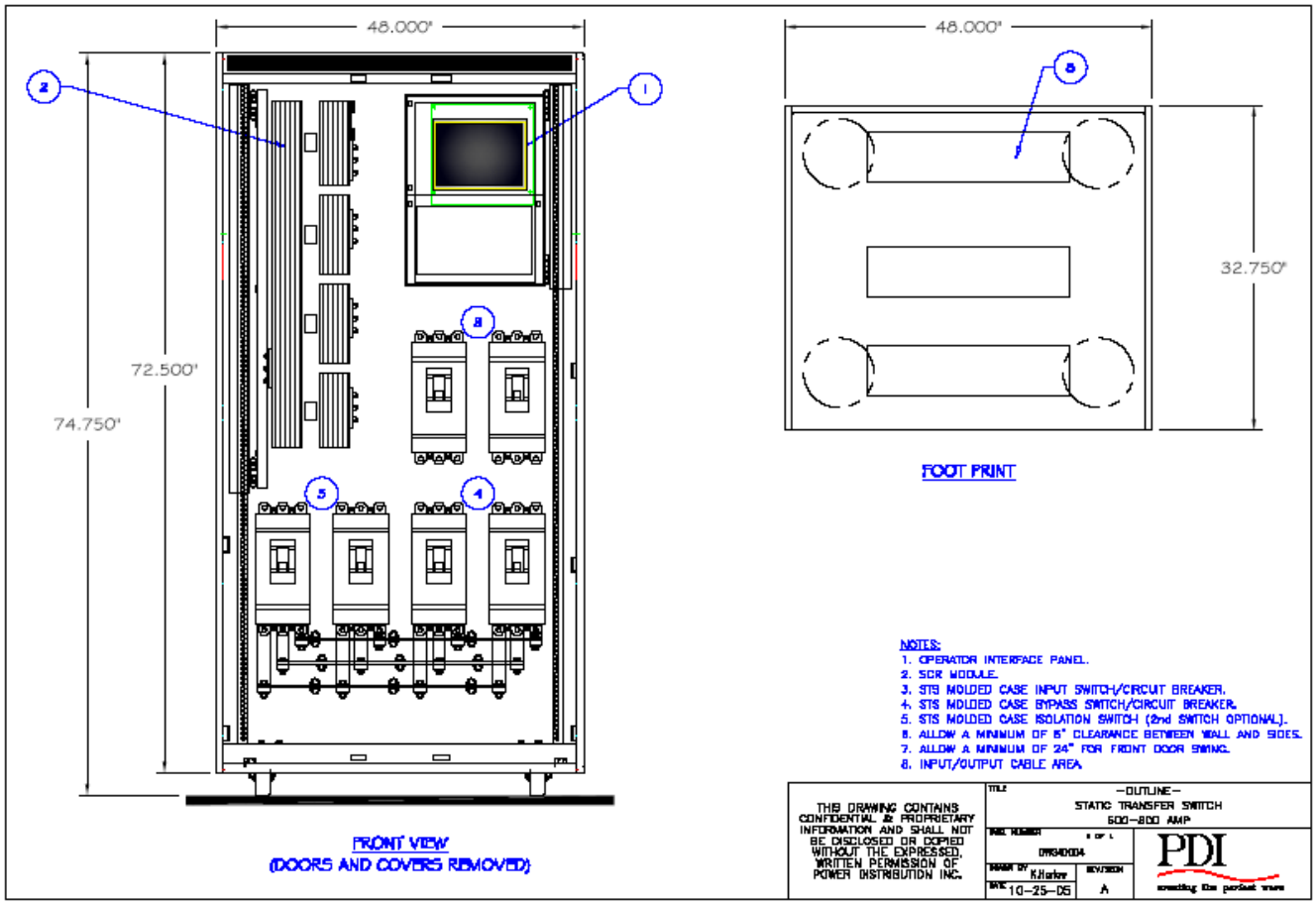
In each case the transfers were performed under no load conditions; no load conditions always result in higher inrush currents.

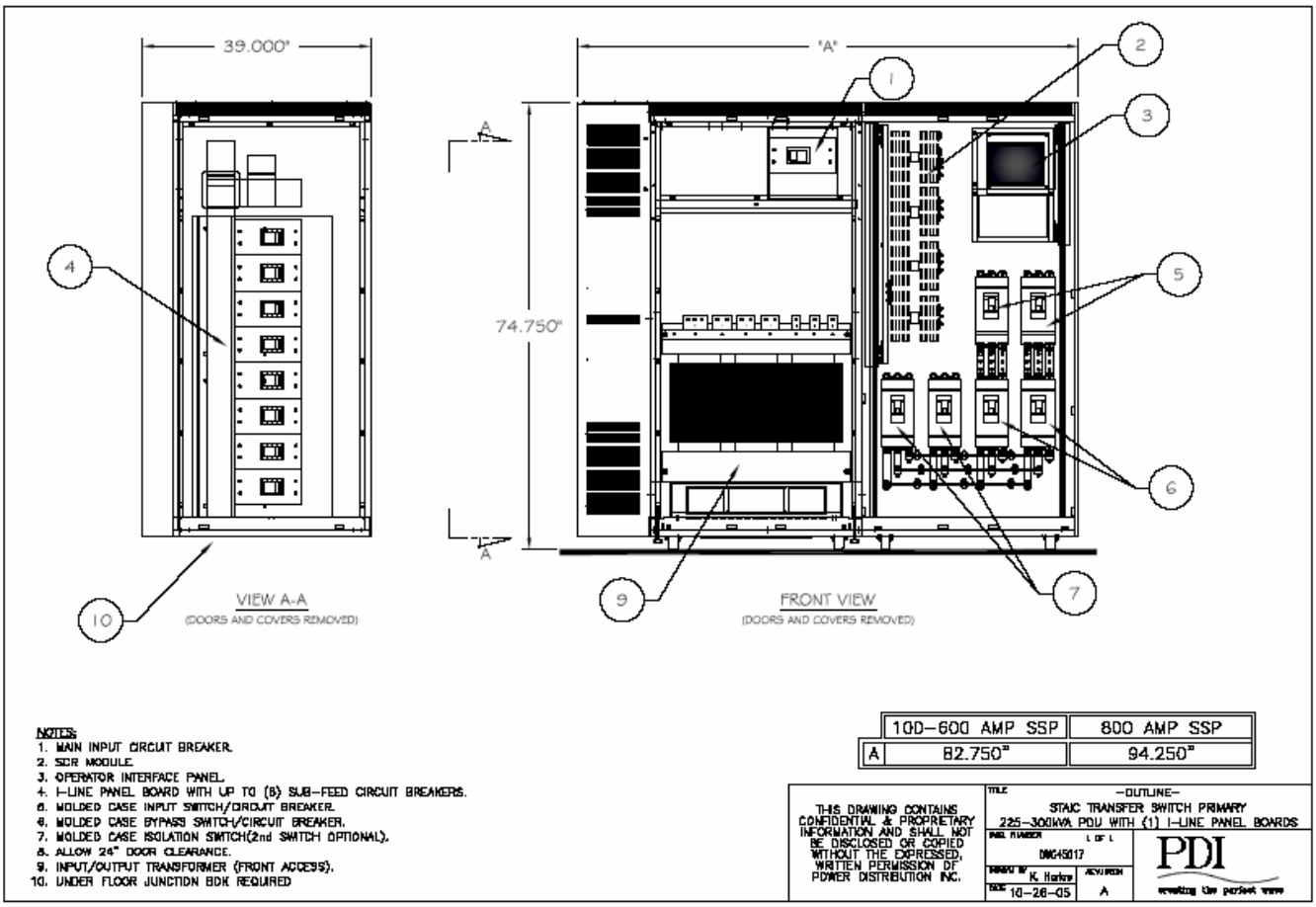
The waveforms indicate there is no loss in the applied voltage peaks; this will allow maximum power to be supplied to load SMPS.

When evaluating low inrush algorithms, the peak current during transfer is the most critical measure of performance. The Eaton PDI VSS method provides the best option to manage the transfer with less impact on the SMPS and other electrical equipment.

17.5 Appendix G – Standard Design Drawings




48.000"
72.500"
74.750"
FRONT VIEW
(DOORS AND COVERS REMOVED)
48.000"
32.750"
FOOT PRINT
NOTES:
1. OPERATOR INTERFACE PANEL.
2. SCR MODULE.
3. STS MOLDED CASE INPUT SWITCH/CIRCUIT BREAKER.
4. STS MOLDED CASE BYPASS SWITCH/CIRCUIT BREAKER.
5. STS MOLDED CASE ISOLATION SWITCH (2nd SWITCH OPTIONAL).
6. ALLOW A MINIMUM OF 6" CLEARANCE BETWEEN WALL AND SIDES.
7. ALLOW A MINIMUM OF 24" FOR FRONT DOOR SWING.
8. INPUT/OUTPUT CABLE AREA.
THIS DRAWING CONTAINS CONFIDENTIAL & PROPRIETARY INFORMATION AND SHALL NOT BE DISCLOSED OR COPIED WITHOUT THE EXPRESSED, WRITTEN PERMISSION OF POWER DISTRIBUTION INC.
TITLE
—OUTLINE—
STATIC TRANSFER SWITCH
600—800 AMP
DRAWN BY
K.Harker
DATE
10—25—05
REVISION
A
PDI



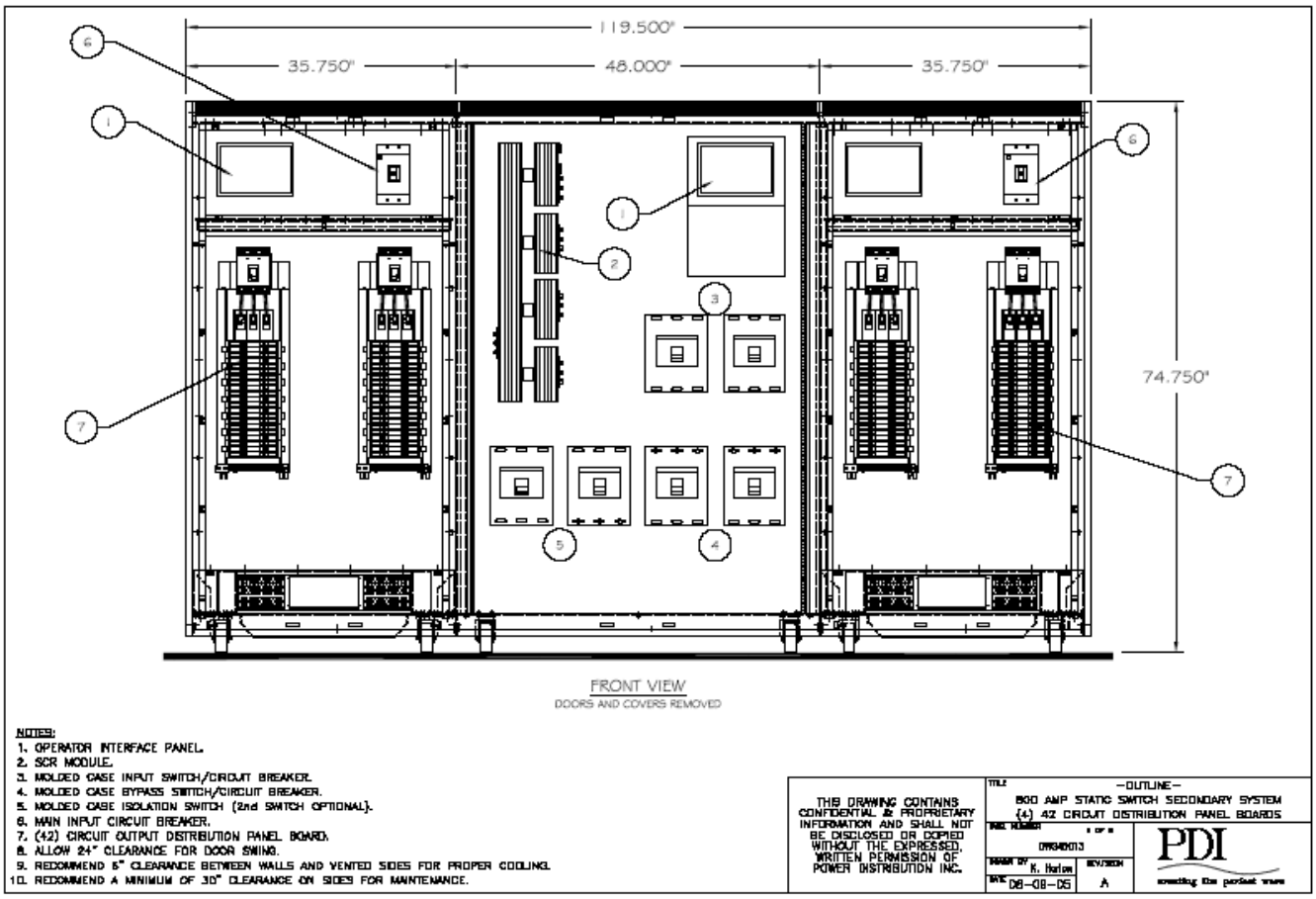
NOTES:
1. MAIN INPUT CIRCUIT BREAKER.
2. SCR MODULE.
3. OPERATOR INTERFACE PANEL.
4. I-LINE PANEL BOARD WITH UP TO (6) SUB-FEED CIRCUIT BREAKERS.
5. MOLDED CASE INPUT SWITCH/CIRCUIT BREAKER.
6. MOLDED CASE BYPASS SWITCH/CIRCUIT BREAKER.
7. MOLDED CASE ISOLATION SWITCH(2nd SWITCH OPTIONAL).
8. ALLOW 24" DOOR CLEARANCE.
9. INPUT/OUTPUT TRANSFORMER (FRONT ACCESS).
10. UNDER FLOOR JUNCTION BOX REQUIRED

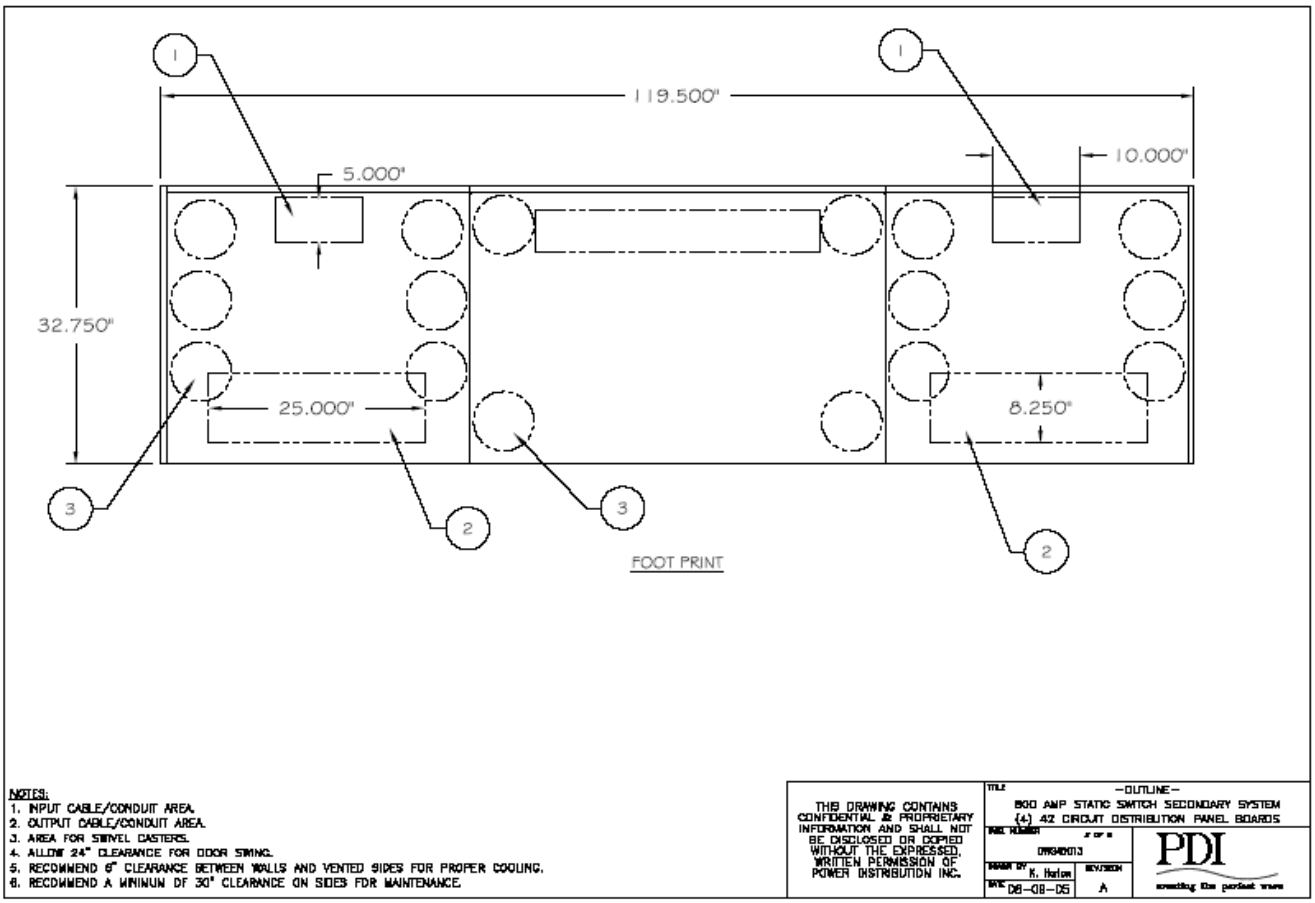
	100-600 AMP SSP	800 AMP SSP
A	82.750"	94.250"

TITLE: -OUTLINE-
STAIC TRANSFER SWITCH PRIMARY
225-300KVA PDU WITH (1) I-LINE PANEL BOARDS

DWG NUMBER: DWG45017 — L OF L
DRAWN BY: K. Harkins — REVISION: A
DATE: 10-26-05

PDI
creating the perfect wave


119.500"
35.750"
48.000"
35.750"
74.750"
1
2
3
4
5
6
7
FRONT VIEW
DOORS AND COVERS REMOVED
NOTES:
1. OPERATOR INTERFACE PANEL.
2. SCR MODULE.
3. MOLDED CASE INPUT SWITCH/CIRCUIT BREAKER.
4. MOLDED CASE BYPASS SWITCH/CIRCUIT BREAKER.
5. MOLDED CASE ISOLATION SWITCH (2nd SWITCH OPTIONAL).
6. MAIN INPUT CIRCUIT BREAKER.
7. (42) CIRCUIT OUTPUT DISTRIBUTION PANEL BOARD.
8. ALLOW 24" CLEARANCE FOR DOOR SWING.
9. RECOMMEND 6" CLEARANCE BETWEEN WALLS AND VENTED SIDES FOR PROPER COOLING.
10. RECOMMEND A MINIMUM OF 30" CLEARANCE ON SIDES FOR MAINTENANCE.
THIS DRAWING CONTAINS CONFIDENTIAL & PROPRIETARY INFORMATION AND SHALL NOT BE DISCLOSED OR COPIED WITHOUT THE EXPRESSED, WRITTEN PERMISSION OF POWER DISTRIBUTION INC.
TITLE
—OUTLINE—
800 AMP STATIC SWITCH SECONDARY SYSTEM
(4) 42 CIRCUIT DISTRIBUTION PANEL BOARDS
DRAWN BY
K. Harlow
REVISION
A
DATE
08-08-05
PDI



NOTES:
1. INPUT CABLE/CONDUIT AREA.
2. OUTPUT CABLE/CONDUIT AREA.
3. AREA FOR SWIVEL CASTERS.
4. ALLOW 24" CLEARANCE FOR DOOR SWING.
5. RECOMMEND 6" CLEARANCE BETWEEN WALLS AND VENTED SIDES FOR PROPER COOLING.
6. RECOMMEND A MINIMUM OF 30" CLEARANCE ON SIDES FOR MAINTENANCE.

TITLE: —OUTLINE—
800 AMP STATIC SWITCH SECONDARY SYSTEM
(4) 42 CIRCUIT DISTRIBUTION PANEL BOARDS

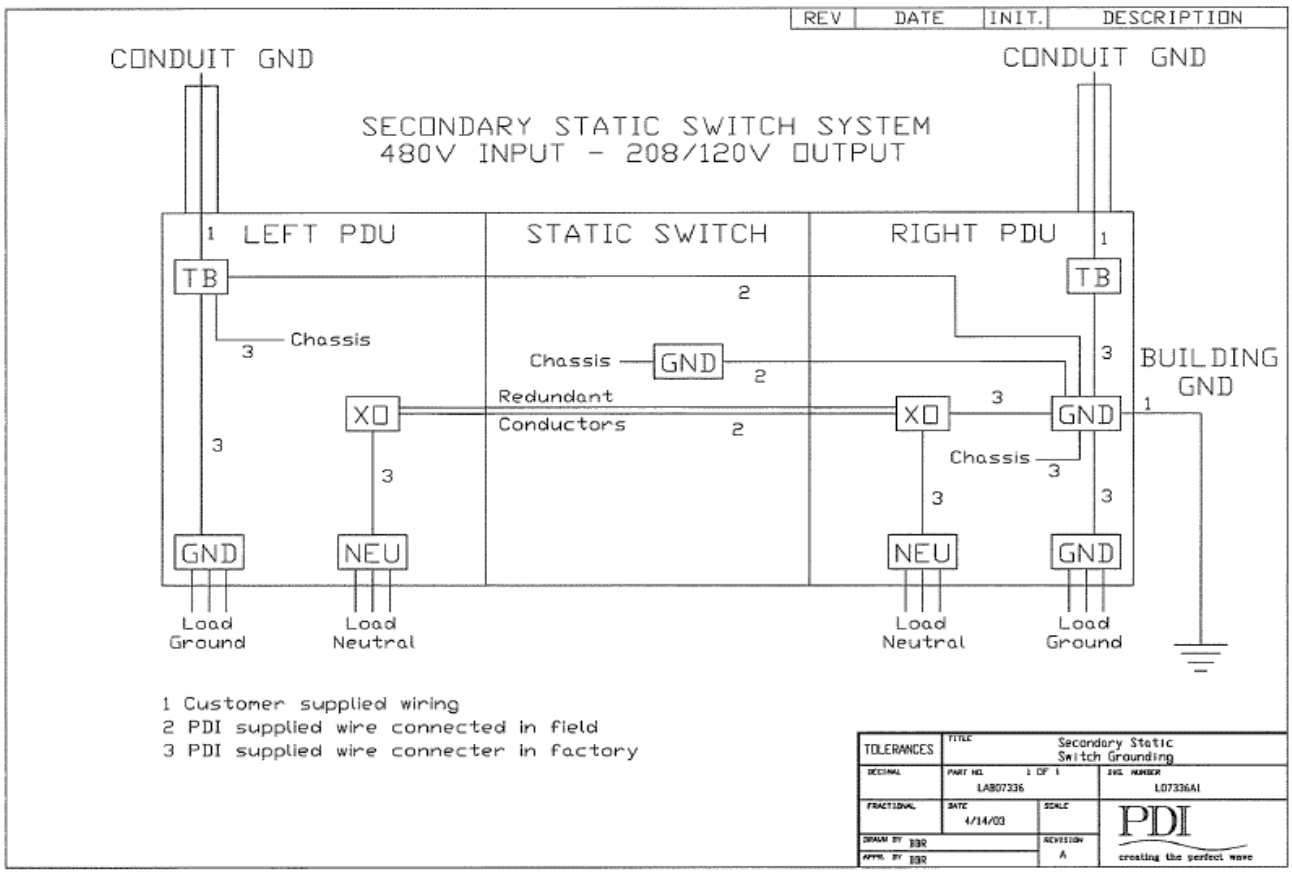
DWG NUMBER: DWG40013

DRAWN BY: K. Horton

REVISION: A

DATE: 08-08-05

PDI
exceeding the perfect wave


REV
DATE
INIT.
DESCRIPTION
CONDUIT GND
CONDUIT GND
SECONDARY STATIC SWITCH SYSTEM
480V INPUT - 208/120V OUTPUT
LEFT PDU
STATIC SWITCH
RIGHT PDU
TB
TB
Chassis
Chassis
GND
Redundant
Conductors
XO
XO
GND
BUILDING
GND
GND
NEU
NEU
GND
Load
Ground
Load
Neutral
Load
Neutral
Load
Ground
1 Customer supplied wiring
2 PDI supplied wire connected in field
3 PDI supplied wire connecter in factory
TOLERANCES
TITLE
Secondary Static
Switch Grounding
DECIMAL
PART NO.
LA807336
DWG. NUMBER
L07336A1
FRACTIONAL
DATE
4/14/03
SCALE
DRAWN BY BBR
APPR. BY BBR
REVISION
A
PDI
creating the perfect wave

17.6 Appendix I – Analog Screen Points Information

STS Analog Points: Below are the analog screen entries. Please note that custom STS's will have different points and the current points list may not apply:

Table 4. Analog Screen Points

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
S 1 Volts AB	Volts	1	None	161	532
S 1 Volts BC	Volts	2	None	162	533
S 1 Volts CA	Volts	3	None	163	534
S 2 Volts AB	Volts	4	None	164	535
S 2 Volts BC	Volts	5	None	165	536
S 2 Volts CA	Volts	6	None	166	537
Output Volts AB	Volts	7	None	167	538
Output Volts BC	Volts	8	None	168	539
Output Volts CA	Volts	9	None	169	540
Output Amps A	Amps	10	None	170	541
Output Amps B	Amps	11	None	171	542
Output Amps C	Amps	12	None	172	543
Output Amps N	Amps	13	None	173	544
Output KVA A	KVA	14	None	174	545
Output KVA B	KVA	15	None	175	546
Output KVA C	KVA	16	None	176	547
S 1 A Amps	Amps	17	None	177	548
S 1 B Amps	Amps	18	None	178	549
S 1 C Amps	Amps	19	None	179	550
S 2 A Amps	Amps	20	None	180	551
S 2 B Amps	Amps	21	None	181	552
S 2 C Amps	Amps	22	None	182	553
Output Volts AN	Volts	23	None	183	554
Output Volts BN	Volts	24	None	184	555
Output Volts CN	Volts	25	None	185	556
Ground Amps	Amps	26	None	186	557
KW Out A	KW	27	None	187	558

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
KW Out B	KW	28	None	188	559
KW Out C	KW	29	None	189	560
Out Frequency	Hz	30	*100 (6000=60.00)	190	561
S 1 Frequency	Hz	31	*100 (6000=60.00)	191	562
S 2 Frequency	Hz	32	*100 (6000=60.00)	192	563
Phase	Degrees	33	None	193	564
Output %KVA A	%	34	68=68%	194	565
Output %KVA B	%	35	68=68%	195	566
Output %KVA C	%	36	68=68%	196	567
Total KVA	KVA	37	None	197	568
Output PF A	%	38	*100 (92=0.92)	198	569
Output PF B	%	39	*100 (92=0.92)	199	570
Output PF C	%	40	*100 (92=0.92)	200	571
Total KW	KW	41	None	201	572
Xfers Total	Count	42	None	202	573
Xfers Since Clr	Count	43	None	203	574
Out Volts THD A	%	44	68=68%	204	575
Out Volts A 3rd	%	45	68=68%	205	576
Out Volts A 5th	%	46	68=68%	206	577
Out Volts A 7th	%	47	68=68%	207	578
Out Volts A 9th	%	48	68=68%	208	579
Out Volts A 11th	%	49	68=68%	209	580
Out Volts A 13th	%	50	68=68%	210	581
Out Volts THD B	%	51	68=68%	211	582
Out Volts B 3rd	%	52	68=68%	212	583
Out Volts B 5th	%	53	68=68%	213	584
Out Volts B 7th	%	54	68=68%	214	585
Out Volts B 9th	%	55	68=68%	215	586
Out Volts B 11th	%	56	68=68%	216	587
Out Volts B 13th	%	57	68=68%	217	588
Out Volts THD C	%	58	68=68%	218	589

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
Out Volts C 3rd	%	59	68=68%	219	590
Out Volts C 5th	%	60	68=68%	220	591
Out Volts C 7th	%	61	68=68%	221	592
Out Volts C 9th	%	62	68=68%	222	593
Out Volts C 11th	%	63	68=68%	223	594
Out Volts C 13th	%	64	68=68%	224	595
Out Amps THD A	%	65	68=68%	225	596
Out Amps A 3rd	%	66	68=68%	226	597
Out Amps A 5th	%	67	68=68%	227	598
Out Amps A 7th	%	68	68=68%	228	599
Out Amps A 9th	%	69	68=68%	229	600
Out Amps A 11th	%	70	68=68%	230	601
Out Amps A 13th	%	71	68=68%	231	602
Out Amps THD B	%	72	68=68%	232	603
Out Amps B 3rd	%	73	68=68%	233	604
Out Amps B 5th	%	74	68=68%	234	605
Out Amps B 7th	%	75	68=68%	235	606
Out Amps B 9th	%	76	68=68%	236	607
Out Amps B 11th	%	77	68=68%	237	608
Out Amps B 13th	%	78	68=68%	238	609
Out Amps THD C	%	79	68=68%	239	610
Out Amps C 3rd	%	80	68=68%	240	611
Out Amps C 5th	%	81	68=68%	241	612
Out Amps C 7th	%	82	68=68%	242	613
Out Amps C 9th	%	83	68=68%	243	614
Out Amps C 11th	%	84	68=68%	244	615
Out Amps C 13th	%	85	68=68%	245	616
Peak Total KVA	KVA	86	None	246	617
S1 Peak A Amp	Amps	87	None	247	618
S1 Peak B Amp	Amps	88	None	248	619

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
S1 Peak C Amp	Amps	89	None	249	620
S2 Peak A Amp	Amps	90	None	250	621
S2 Peak B Amp	Amps	91	None	251	622
S2 Peak C Amp	Amps	92	None	252	623
Rated Total KVA	KVA	93	None	253	624
Rated Phase Amp	Amps	94	None	254	625
Alarm Count		95	None	255	626
PDU 1 Volts AB	Volts	96	None	256	627
PDU 1 Volts BC	Volts	97	None	257	628
PDU 1 Volts CA	Volts	98	None	258	629
PDU 1 Volts AN	Volts	99	None	259	630
PDU 1 Volts BN	Volts	100	None	260	631
PDU 1 Volts CN	Volts	101	None	261	632
PDU 1 Amps A	Amps	102	None	262	633
PDU 1 Amps B	Amps	103	None	263	634
PDU 1 Amps C	Amps	104	None	264	635
PDU 1 KVA A	KVA	105	None	265	636
PDU 1 KVA B	KVA	106	None	266	637
PDU 1 KVA C	KVA	107	None	267	638
PDU 1 Total KVA	KVA	108	None	268	639
PDU 1 Peak Total KVA	KVA	109	None	269	640
PDU 1 %KVA A	%	110	68=68%	270	641
PDU 1 %KVA B	%	111	68=68%	271	642
PDU 1 %KVA C	%	112	68=68%	272	643
PDU 1 Total %KVA	%	113	68=68%	273	644
PDU 1 KW A	KW	114	None	274	645
PDU 1 KW B	KW	115	None	275	646
PDU 1 KW C	KW	116	None	276	647
PDU 1 Total KW	KW	117	None	277	648
PDU 1 PF A	%	118	*100 (92=0.92)	278	649
PDU 1 PF B	%	119	*100 (92=0.92)	279	650

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
PDU 1 PF C	%	120	*100 (92=0.92)	280	651
PDU 2 Volts AB	Volts	121	None	281	652
PDU 2 Volts BC	Volts	122	None	282	653
PDU 2 Volts CA	Volts	123	None	283	654
PDU 2 Volts AN	Volts	124	None	284	655
PDU 2 Volts BN	Volts	125	None	285	656
PDU 2 Volts CN	Volts	126	None	286	657
PDU 2 Amps A	Amps	127	None	287	658
PDU 2 Amps B	Amps	128	None	288	659
PDU 2 Amps C	Amps	129	None	289	660
PDU 2 KVA A	KVA	130	None	290	661
PDU 2 KVA B	KVA	131	None	291	662
PDU 2 KVA C	KVA	132	None	292	663
PDU 2 Total KVA	KVA	133	None	293	664
PDU 2 Peak Total KVA	KVA	134	None	294	665
PDU 2 %KVA A	%	135	68=68%	295	666
PDU 2 %KVA B	%	136	68=68%	296	667
PDU 2 %KVA C	%	137	68=68%	297	668
PDU 2 Total %KVA	%	138	68=68%	298	669
PDU 2 KW A	KW	139	None	299	670
PDU 2 KW B	KW	140	None	300	671
PDU 2 KW C	KW	141	None	301	672
PDU 2 Total KW	KW	142	None	302	673
PDU 2 PF A	%	143	*100 (92=0.92)	303	674
PDU 2 PF B	%	144	*100 (92=0.92)	304	675
PDU 2 PF C	%	145	*100 (92=0.92)	305	676
I Line 1 Amps A	Amps	146	None	306	677
I Line 1 Amps B	Amps	147	None	307	678
I Line 1 Amps C	Amps	148	None	308	679
I Line 1 KVA A	KVA	149	None	309	680
I Line 1 KVA B	KVA	150	None	310	681

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
I Line 1 KVA C	KVA	151	None	311	682
I Line 1 KW A	KW	152	None	312	683
I Line 1 KW B	KW	153	None	313	684
I Line 1 KW C	KW	154	None	314	685
I Line 1 PF A		155	*100 (92=0.92)	315	686
I Line 1 PF B		156	*100 (92=0.92)	316	687
I Line 1 PF C		157	*100 (92=0.92)	317	688
I Line 1 Total KVA	KVA	158	None	318	689
I Line 1 Total KW	KW	159	None	319	690
I Line 2 Amps A	Amps	160	None	320	691
I Line 2 Amps B	Amps	161	None	321	692
I Line 2 Amps C	Amps	162	None	322	693
I Line 2 KVA A	KVA	163	None	323	694
I Line 2 KVA B	KVA	164	None	324	695
I Line 2 KVA C	KVA	165	None	325	696
I Line 2 KW A	KW	166	None	326	697
I Line 2 KW B	KW	167	None	327	698
I Line 2 KW C	KW	168	None	328	699
I Line 2 PF A		169	*100 (92=0.92)	329	700
I Line 2 PF B		170	*100 (92=0.92)	330	701
I Line 2 PF C		171	*100 (92=0.92)	331	702
I Line 2 Total KVA	KVA	172	None	332	703
I Line 2 Total KW	KW	173	None	333	704
I Line 3 Amps A	Amps	174	None	334	705
I Line 3 Amps B	Amps	175	None	335	706
I Line 3 Amps C	Amps	176	None	336	707
I Line 3 KVA A	KVA	177	None	337	708
I Line 3 KVA B	KVA	178	None	338	709
I Line 3 KVA C	KVA	179	None	339	710
I Line 3 KW A	KW	180	None	340	711
I Line 3 KW B	KW	181	None	341	712

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
I Line 3 KW C	KW	182	None	342	713
I Line 3 PF A		183	*100 (92=0.92)	343	714
I Line 3 PF B		184	*100 (92=0.92)	344	715
I Line 3 PF C		185	*100 (92=0.92)	345	716
I Line 3 Total KVA	KVA	186	None	346	717
I Line 3 Total KW	KW	187	None	347	718
I Line 4 Amps A	Amps	188	None	348	719
I Line 4 Amps B	Amps	189	None	349	720
I Line 4 Amps C	Amps	190	None	350	721
I Line 4 KVA A	KVA	191	None	351	722
I Line 4 KVA B	KVA	192	None	352	723
I Line 4 KVA C	KVA	193	None	353	724
I Line 4 KW A	KW	194	None	354	725
I Line 4 KW B	KW	195	None	355	726
I Line 4 KW C	KW	196	None	356	727
I Line 4 PF A		197	*100 (92=0.92)	357	728
I Line 4 PF B		198	*100 (92=0.92)	358	729
I Line 4 PF C		199	*100 (92=0.92)	359	730
I Line 4 Total KVA	KVA	200	None	360	731
I Line 4 Total KW	KW	201	None	361	732
I Line 5 Amps A	Amps	202	None	362	733
I Line 5 Amps B	Amps	203	None	363	734
I Line 5 Amps C	Amps	204	None	364	735
I Line 5 KVA A	KVA	205	None	365	736
I Line 5 KVA B	KVA	206	None	366	737
I Line 5 KVA C	KVA	207	None	367	738
I Line 5 KW A	KW	208	None	368	739
I Line 5 KW B	KW	209	None	369	740
I Line 5 KW C	KW	210	None	370	741
I Line 5 PF A		211	*100 (92=0.92)	371	742
I Line 5 PF B		212	*100 (92=0.92)	372	743

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
I Line 5 PF C		213	*100 (92=0.92)	373	744
I Line 5 Total KVA	KVA	214	None	374	745
I Line 5 Total KW	KW	215	None	375	746
I Line 6 Amps A	Amps	216	None	376	747
I Line 6 Amps B	Amps	217	None	377	748
I Line 6 Amps C	Amps	218	None	378	749
I Line 6 KVA A	KVA	219	None	379	750
I Line 6 KVA B	KVA	220	None	380	751
I Line 6 KVA C	KVA	221	None	381	752
I Line 6 KW A	KW	222	None	382	753
I Line 6 KW B	KW	223	None	383	754
I Line 6 KW C	KW	224	None	384	755
I Line 6 PF A		225	*100 (92=0.92)	385	756
I Line 6 PF B		226	*100 (92=0.92)	386	757
I Line 6 PF C		227	*100 (92=0.92)	387	758
I Line 6 Total KVA	KVA	228	None	388	759
I Line 6 Total KW	KW	229	None	389	760
I Line 7 Amps A	Amps	230	None	390	761
I Line 7 Amps B	Amps	231	None	391	762
I Line 7 Amps C	Amps	232	None	392	763
I Line 7 KVA A	KVA	233	None	393	764
I Line 7 KVA B	KVA	234	None	394	765
I Line 7 KVA C	KVA	235	None	395	766
I Line 7 KW A	KW	236	None	396	767
I Line 7 KW B	KW	237	None	397	768
I Line 7 KW C	KW	238	None	398	769
I Line 7 PF A		239	*100 (92=0.92)	399	770
I Line 7 PF B		240	*100 (92=0.92)	400	771
I Line 7 PF C		241	*100 (92=0.92)	401	772
I Line 7 Total KVA	KVA	242	None	402	773
I Line 7 Total KW	KW	243	None	403	774

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
I Line 8 Amps A	Amps	244	None	404	775
I Line 8 Amps B	Amps	245	None	405	776
I Line 8 Amps C	Amps	246	None	406	777
I Line 8 KVA A	KVA	247	None	407	778
I Line 8 KVA B	KVA	248	None	408	779
I Line 8 KVA C	KVA	249	None	409	780
I Line 8 KW A	KW	250	None	410	781
I Line 8 KW B	KW	251	None	411	782
I Line 8 KW C	KW	252	None	412	783
I Line 8 PF A		253	*100 (92=0.92)	413	784
I Line 8 PF B		254	*100 (92=0.92)	414	785
I Line 8 PF C		255	*100 (92=0.92)	415	786
I Line 8 Total KVA	KVA	256	None	416	787
I Line 8 Total KW	KW	257	None	417	788
I Line 9 Amps A	Amps	258	None	418	789
I Line 9 Amps B	Amps	259	None	419	790
I Line 9 Amps C	Amps	260	None	420	791
I Line 9 KVA A	KVA	261	None	421	792
I Line 9 KVA B	KVA	262	None	422	793
I Line 9 KVA C	KVA	263	None	423	794
I Line 9 KW A	KW	264	None	424	795
I Line 9 KW B	KW	265	None	425	796
I Line 9 KW C	KW	266	None	426	797
I Line 9 PF A		267	*100 (92=0.92)	427	798
I Line 9 PF B		268	*100 (92=0.92)	428	799
I Line 9 PF C		269	*100 (92=0.92)	429	800
I Line 9 Total KVA	KVA	270	None	430	801
I Line 9 Total KW	KW	271	None	431	802
I Line 10 Amps A	Amps	272	None	432	803
I Line 10 Amps B	Amps	273	None	433	804
I Line 10 Amps C	Amps	274	None	434	805

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
I Line 10 KVA A	KVA	275	None	435	806
I Line 10 KVA B	KVA	276	None	436	807
I Line 10 KVA C	KVA	277	None	437	808
I Line 10 KW A	KW	278	None	438	809
I Line 10 KW B	KW	279	None	439	810
I Line 10 KW C	KW	280	None	440	811
I Line 10 PF A		281	*100 (92=0.92)	441	812
I Line 10 PF B		282	*100 (92=0.92)	442	813
I Line 10 PF C		283	*100 (92=0.92)	443	814
I Line 10 Total KVA	KVA	284	None	444	815
I Line 10 Total KW	KW	285	None	445	816
I Line 11 Amps A	Amps	286	None	446	817
I Line 11 Amps B	Amps	287	None	447	818
I Line 11 Amps C	Amps	288	None	448	819
I Line 11 KVA A	KVA	289	None	449	820
I Line 11 KVA B	KVA	290	None	450	821
I Line 11 KVA C	KVA	291	None	451	822
I Line 11 KW A	KW	292	None	452	823
I Line 11 KW B	KW	293	None	453	824
I Line 11 KW C	KW	294	None	454	825
I Line 11 PF A		295	*100 (92=0.92)	455	826
I Line 11 PF B		296	*100 (92=0.92)	456	827
I Line 11 PF C		297	*100 (92=0.92)	457	828
I Line 11 Total KVA	KVA	298	None	458	829
I Line 11 Total KW	KW	299	None	459	830
I Line 12 Amps A	Amps	300	None	460	831
I Line 12 Amps B	Amps	301	None	461	832
I Line 12 Amps C	Amps	302	None	462	833
I Line 12 KVA A	KVA	303	None	463	834
I Line 12 KVA B	KVA	304	None	464	835
I Line 12 KVA C	KVA	305	None	465	836

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
I Line 12 KW A	KW	306	None	466	837
I Line 12 KW B	KW	307	None	467	838
I Line 12 KW C	KW	308	None	468	839
I Line 12 PF A		309	*100 (92=0.92)	469	840
I Line 12 PF B		310	*100 (92=0.92)	470	841
I Line 12 PF C		311	*100 (92=0.92)	471	842
I Line 12 Total KVA	KVA	312	None	472	843
I Line 12 Total KW	KW	313	None	473	844
Fan 1 Amps	Amps	314	None	474	845
Fan 2 Amps	Amps	315	None	475	846
Spare 1 Amps	Amps	316	None	476	847
Monitor Power S1	Volts	317	None	477	848
Monitor Power S2	Volts	318	None	478	849
Monitor Power Out 1	Volts	319	None	479	850
Monitor Power Out 2	Volts	320	None	480	851
Monitor Power Backup	Volts	321	None	481	852
PDU 1 Xfmr Temp	Degrees C	322	None	482	853
PDU 2 Xfmr Temp	Degrees C	323	None	483	854
Dist 1 Amps A	Amps	324	None	484	855
Dist 1 Amps B	Amps	325	None	485	856
Dist 1 Amps C	Amps	326	None	486	857
Dist 2 Amps A	Amps	327	None	487	858
Dist 2 Amps B	Amps	328	None	488	859
Dist 2 Amps C	Amps	329	None	489	860
Dist 3 Amps A	Amps	330	None	490	861
Dist 3 Amps B	Amps	331	None	491	862
Dist 3 Amps C	Amps	332	None	492	863
Dist 4 Amps A	Amps	333	None	493	864
Dist 4 Amps B	Amps	334	None	494	865
Dist 4 Amps C	Amps	335	None	495	866

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
Dist 5 Amps A	Amps	336	None	496	867
Dist 5 Amps B	Amps	337	None	497	868
Dist 5 Amps C	Amps	338	None	498	869
Dist 6 Amps A	Amps	339	None	499	870
Dist 6 Amps B	Amps	340	None	500	871
Dist 6 Amps C	Amps	341	None	501	872
Dist 7 Amps A	Amps	342	None	502	873
Dist 7 Amps B	Amps	343	None	503	874
Dist 7 Amps C	Amps	344	None	504	875
Dist 8 Amps A	Amps	345	None	505	876
Dist 8 Amps B	Amps	346	None	506	877
Dist 8 Amps C	Amps	347	None	507	878
Dist 9 Amps A	Amps	348	None	508	879
Dist 9 Amps B	Amps	349	None	509	880
Dist 9 Amps C	Amps	350	None	510	881
Dist 10 Amps A	Amps	351	None	511	882
Dist 10 Amps B	Amps	352	None	512	883
Dist 10 Amps C	Amps	353	None	513	884
Dist 11 Amps A	Amps	354	None	514	885
Dist 11 Amps B	Amps	355	None	515	886
Dist 11 Amps C	Amps	356	None	516	887
Dist 12 Amps A	Amps	357	None	517	888
Dist 12 Amps B	Amps	358	None	518	889
Dist 12 Amps C	Amps	359	None	519	890
Dist 13 Amps A	Amps	360	None	520	891
Dist 13 Amps B	Amps	361	None	521	892
Dist 13 Amps C	Amps	362	None	522	893
Dist 14 Amps A	Amps	363	None	523	894
Dist 14 Amps B	Amps	364	None	524	895
Dist 14 Amps C	Amps	365	None	525	896

Table 4. Analog Screen Points (Continued)

Name	Units	Value Index	Value Scale	Low Alarm Index	High Alarm Index
Dist 15 Amps A	Amps	366	None	526	897
Dist 15 Amps B	Amps	367	None	527	898
Dist 15 Amps C	Amps	368	None	528	899
Dist 16 Amps A	Amps	369	None	529	900
Dist 16 Amps B	Amps	370	None	530	901
Dist 16 Amps C	Amps	371	None	531	902

17.7 Appendix J – Analog Screen Points Information

Analog Alarm Default Settings

Table 5. Analog Alarm Default Settings

Voltage Alarms 600 Volt Points				
Parameter	**High Limit**	**Setting**	**Low Limit**	**Setting**
V phase-phase	110%	660	90%	540
V phase-neutral	110%	380	90%	311

Voltage Alarms 480 Volt Points				
Parameter	**High Limit**	**Setting**	**Low Limit**	**Setting**
V phase-phase	110%	528	90%	432
V phase-neutral	110%	305	90%	249

Voltage Alarms 208 Volt Points				
Parameter	**High Limit**	**Setting**	**Low Limit**	**Setting**
V phase-phase	110%	229	90%	187
V phase-neutral	110%	132	90%	108

Table 6. Current Alarms

Current Alarms		
Current	**High Limit**	**Setting**
200a	110%	220
250a	110%	275
300a	110%	330
350a	110%	385
400a	110%	440
450a	110%	495
500a	110%	550

Table 6. Current Alarms (Continued)

600a	110%	660
700a	110%	770
800a	110%	880

Table 7. KVA Phase and KVA Total Alarms

KVA Phase and KVA Total Alarms for 600 Volt Unit						
Current	**Parameter**	**High Limit**	**Setting**	**Parameter**	**High Limit**	**Setting**
200a	KVA ϕ	110%	76	KVA total	110%	228
250a	KVA ϕ	110%	95	KVA total	110%	285
300a	KVA ϕ	110%	114	KVA total	110%	343
350a	KVA ϕ	110%	133	KVA total	110%	400
400a	KVA ϕ	110%	152	KVA total	110%	457
450a	KVA ϕ	110%	171	KVA total	110%	514
500a	KVA ϕ	110%	190	KVA total	110%	571
600a	KVA ϕ	110%	228	KVA total	110%	685
700a	KVA ϕ	110%	266	KVA total	110%	799
800a	KVA ϕ	110%	304	KVA total	110%	913

KVA Phase and KVA Total Alarms for 480 Volt Unit						
Current	**Parameter**	**High Limit**	**Setting**	**Parameter**	**High Limit**	**Setting**
200a	KVA ϕ	110%	61	KVA total	110%	183
250a	KVA ϕ	110%	76	KVA total	110%	229
300a	KVA ϕ	110%	91	KVA total	110%	274
350a	KVA ϕ	110%	107	KVA total	110%	320
400a	KVA ϕ	110%	122	KVA total	110%	366
450a	KVA ϕ	110%	137	KVA total	110%	412
500a	KVA ϕ	110%	152	KVA total	110%	457
600a	KVA ϕ	110%	183	KVA total	110%	549
700a	KVA ϕ	110%	213	KVA total	110%	640
800a	KVA ϕ	110%	244	KVA total	110%	732

KVA Phase and KVA Total Alarms for 208 Volt Unit						
Current	**Parameter**	**High Limit**	**Setting**	**Parameter**	**High Limit**	**Setting**
200a	KVA ϕ	110%	26	KVA total	110%	79
250a	KVA ϕ	110%	33	KVA total	110%	99
300a	KVA ϕ	110%	40	KVA total	110%	119
350a	KVA ϕ	110%	46	KVA total	110%	139
400a	KVA ϕ	110%	53	KVA total	110%	159
450a	KVA ϕ	110%	59	KVA total	110%	178

Table 7. KVA Phase and KVA Total Alarms (Continued)

500a	KVA ϕ	110%	66	KVA total	110%	198
600a	KVA ϕ	110%	79	KVA total	110%	237
700a	KVA ϕ	110%	92	KVA total	110%	277
800a	KVA ϕ	110%	106	KVA total	110%	317

Table 8. Switch Default Settings

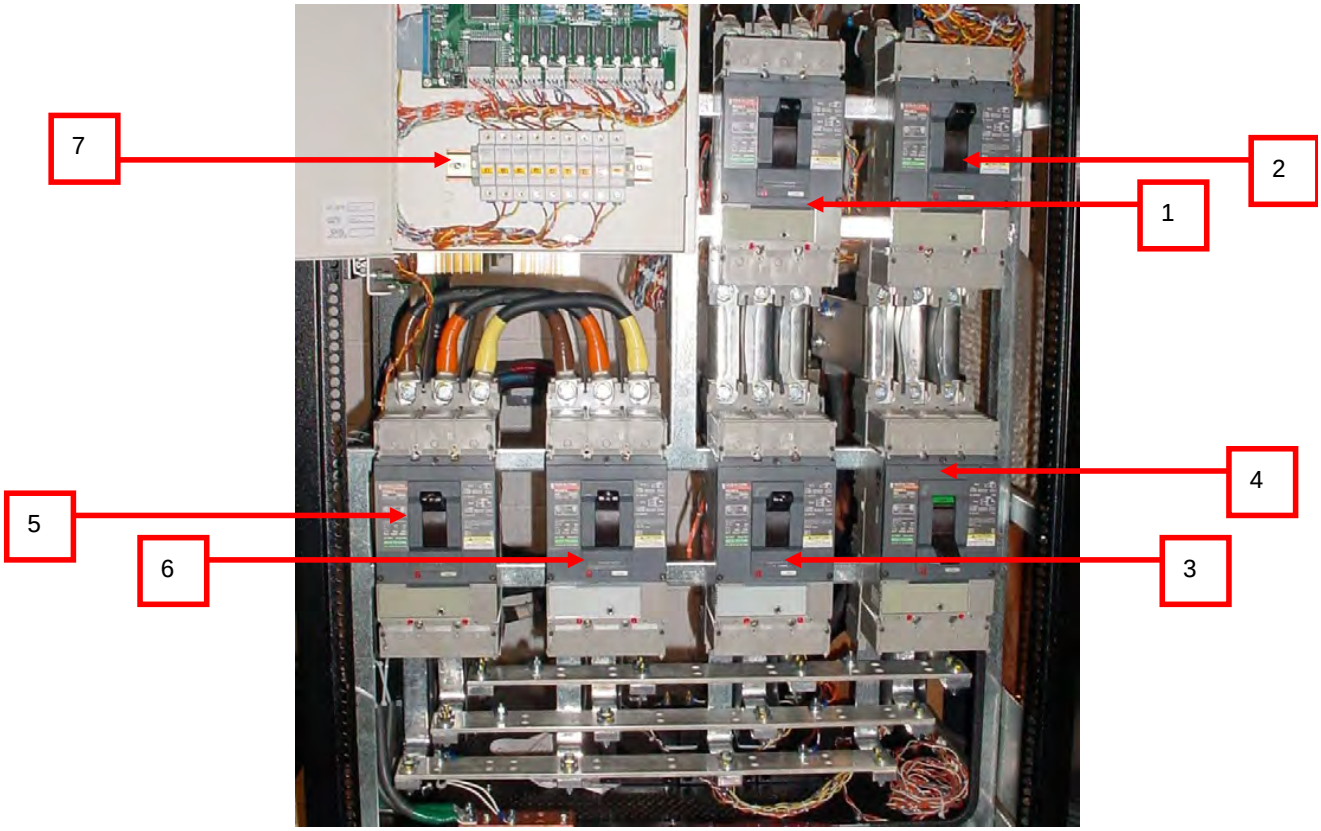
Switching – Fast Settings	
Parameter	**Value**
High Limit	120%
Low Limit	80%
Delay	0 Samples
Ratchet	2%

Switching – Slow Settings	
Parameter	**Value**
High Limit	110%
Low Limit	90%
Delay	256 Samples
Ratchet	0

Switching – Selectors	
Switch	**Value**
Mode	VSS
Retransfer	Yes

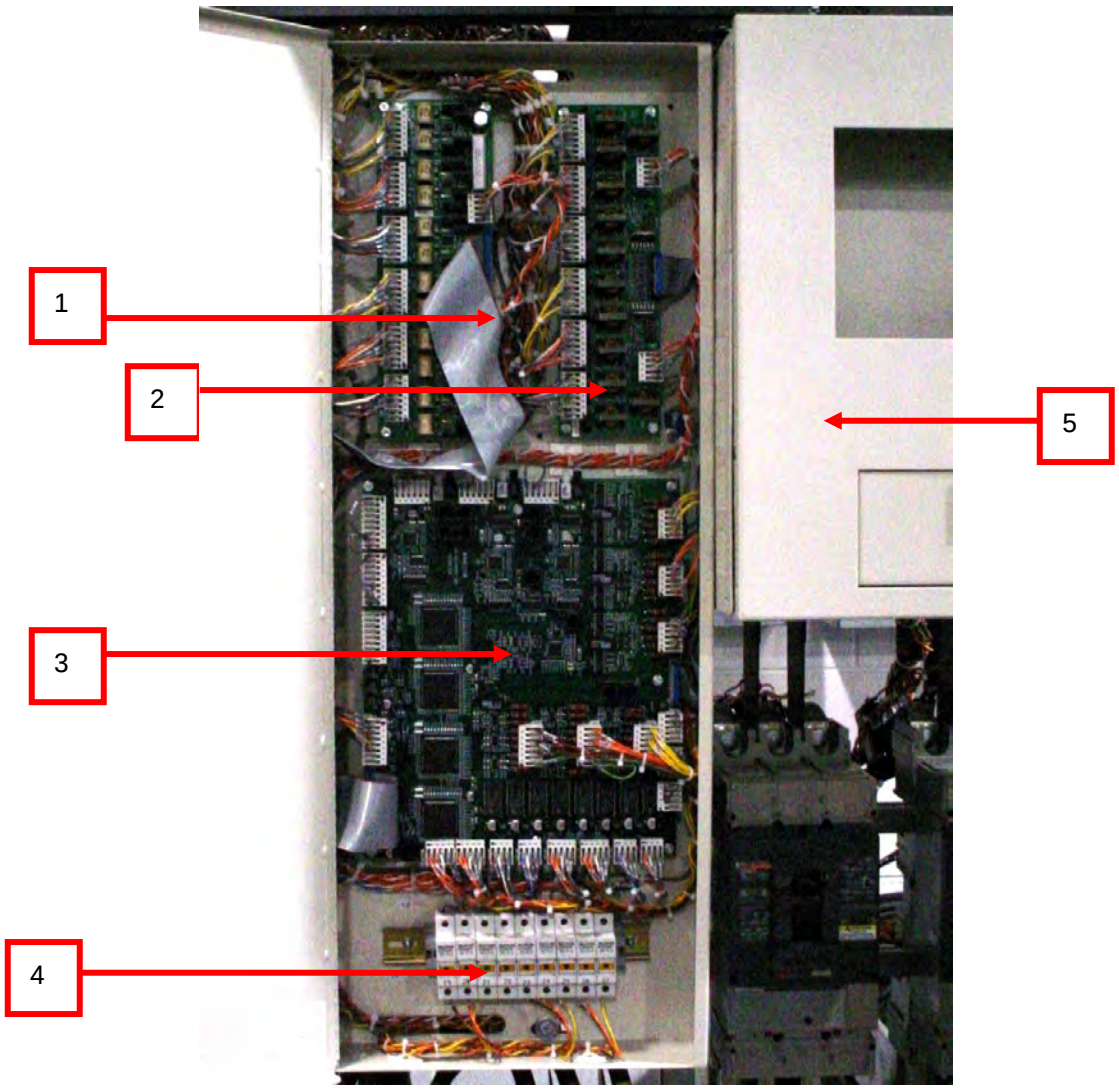
Switching – Retransfer	
Parameter	**Value**
Delay	10 Seconds

17.8 Appendix K – Internal Component Identification



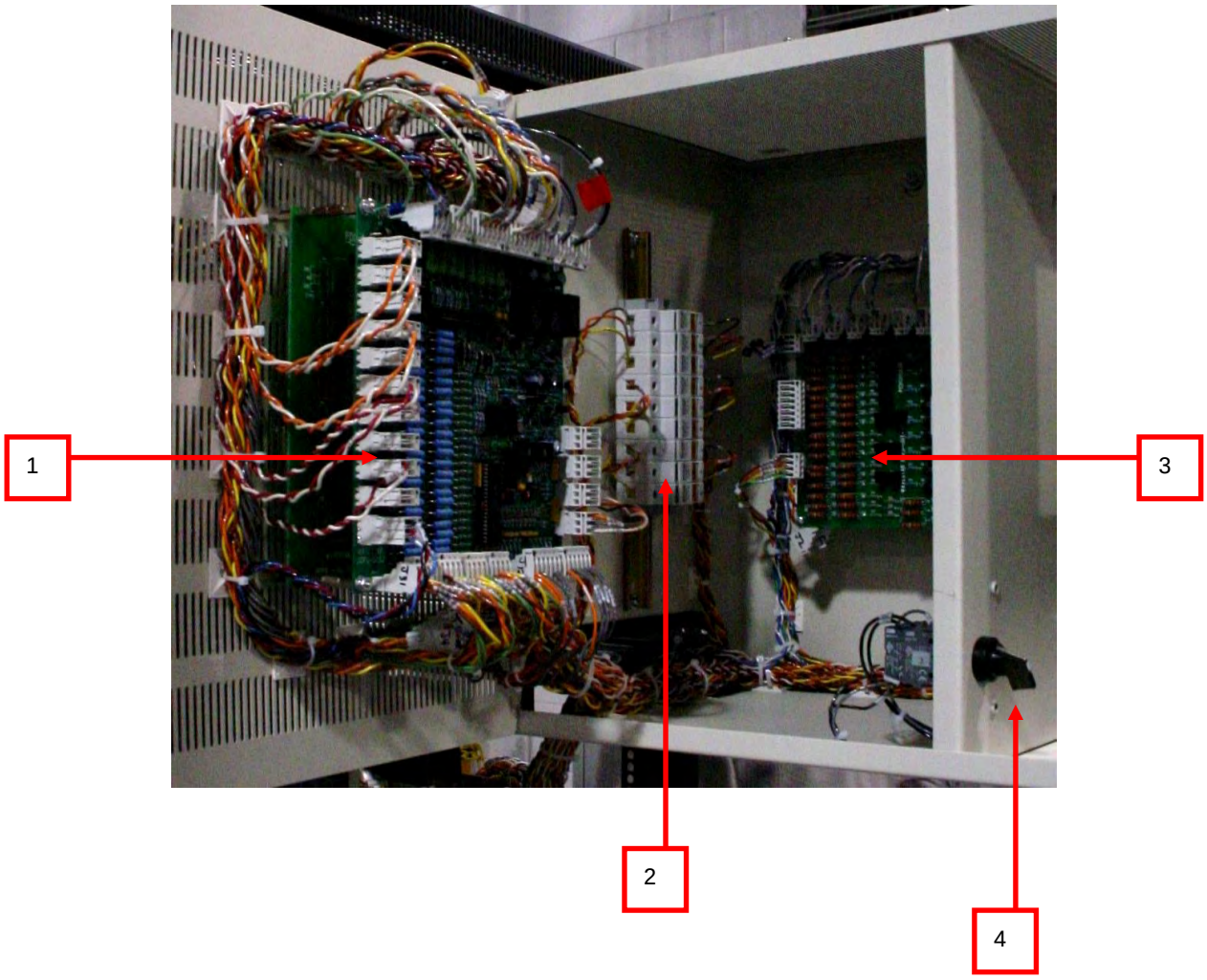
MCSW Circuit Breakers

1. 1.Input 1
2. 2.Input 2
3. 3.Bypass 1
4. 4.Bypass 2
5. 5.Isolation 1
6. 6.Isolation 2 (Optional)
7. 7.SAS Logic Fuses



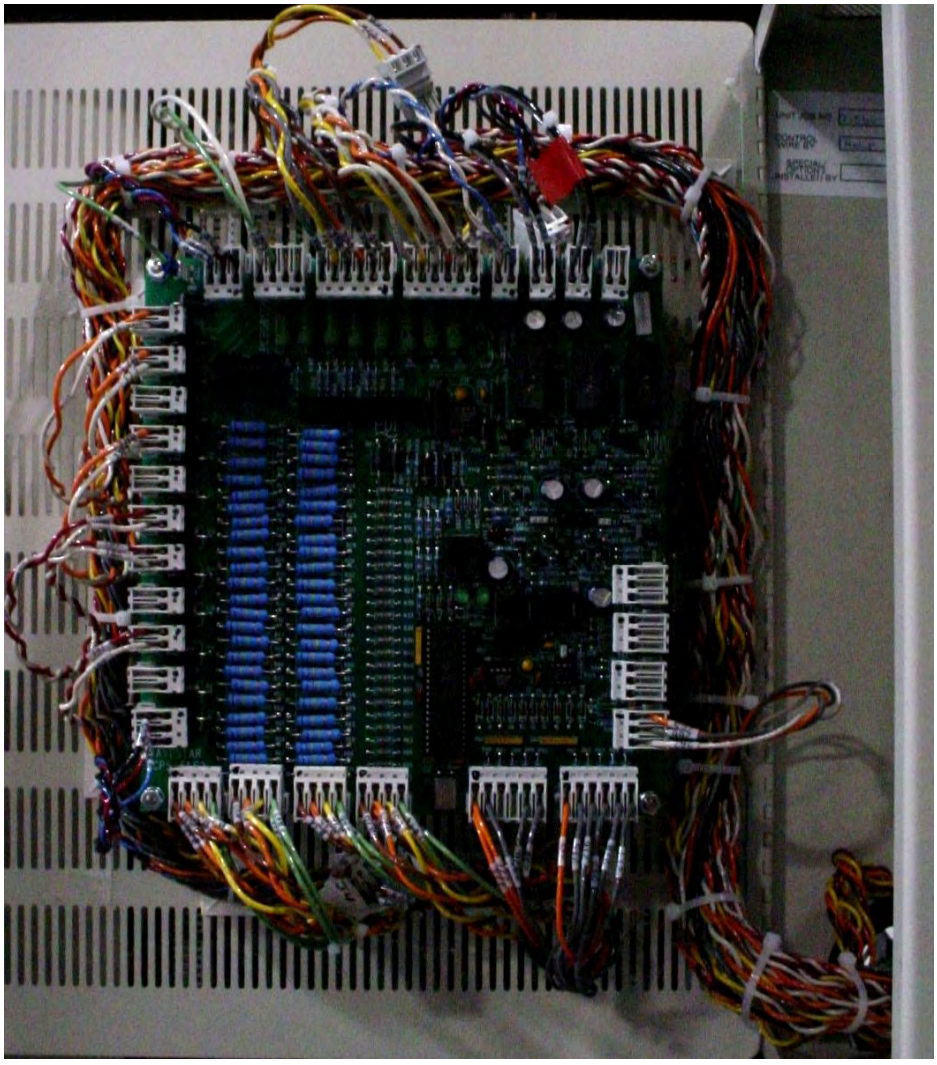
STS Logic Box

1. Pulse Gate Driver
2. DC Gate Driver
3. SAS PCCB
4. SAS Logic Fuses
5. Draw-Out Logic Box



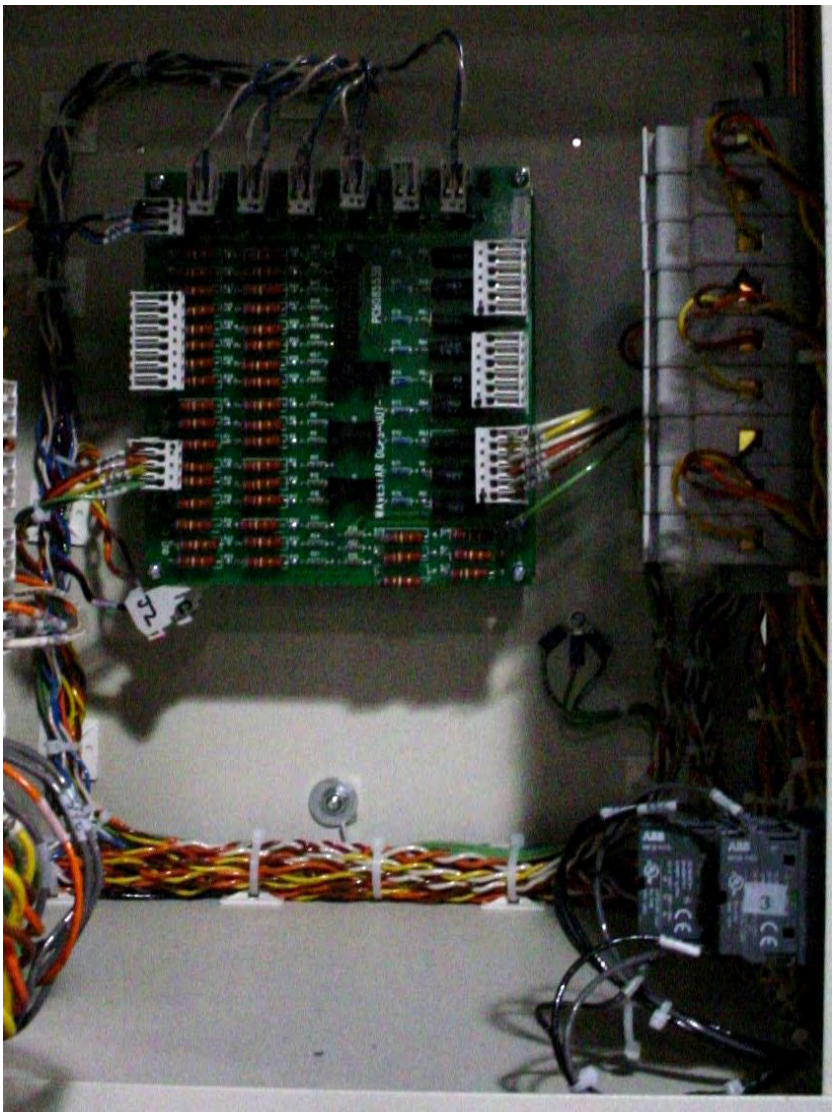
STS Draw-Out Logic Box

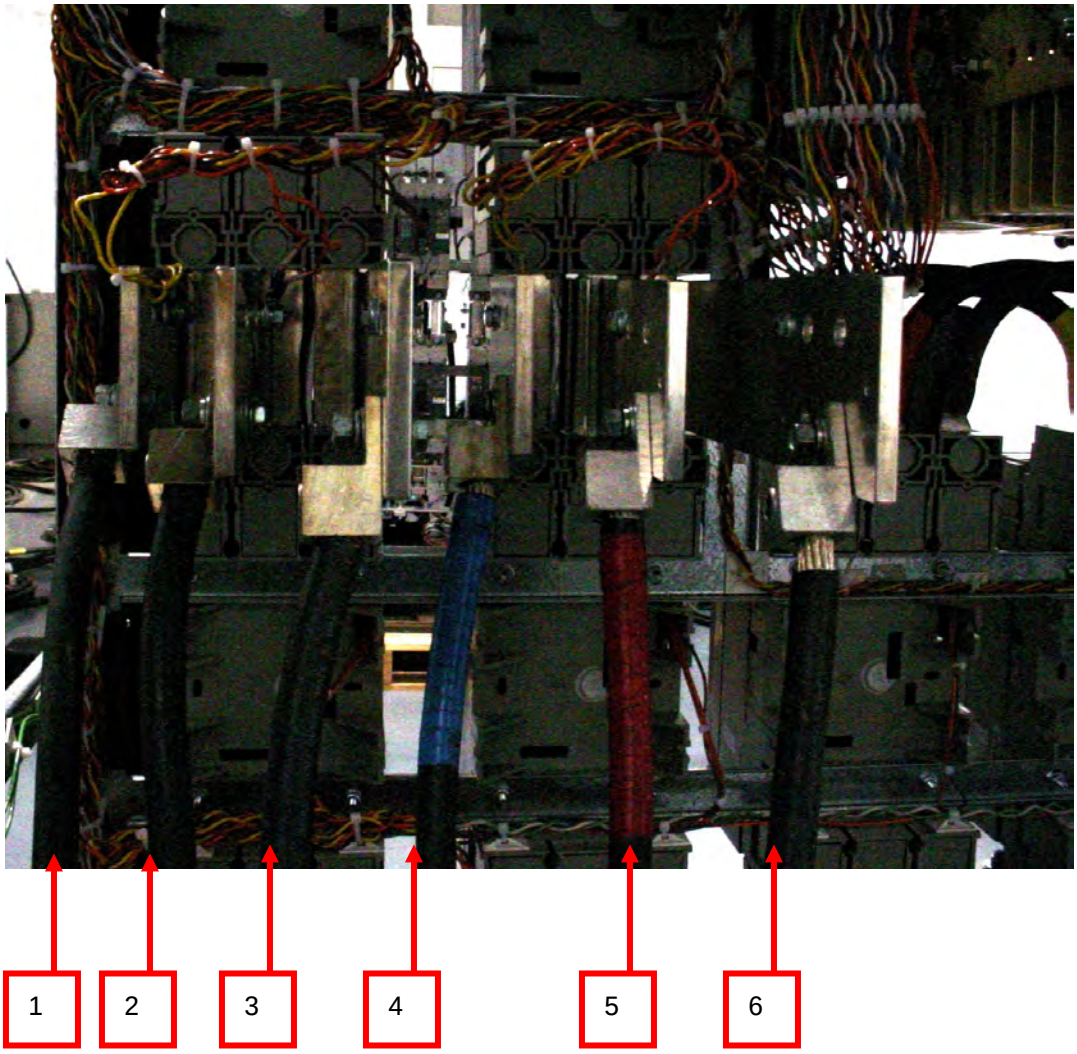
1. S1/S2 DCPS PCB
2. Power Supply Fuses
3. Output DCPS PCB
4. Maintenance Mode Switch



Source 1/ Source 2 DCPS PCB – boards for the two sources are stacked.

Figure 31. Output DCPS PCB





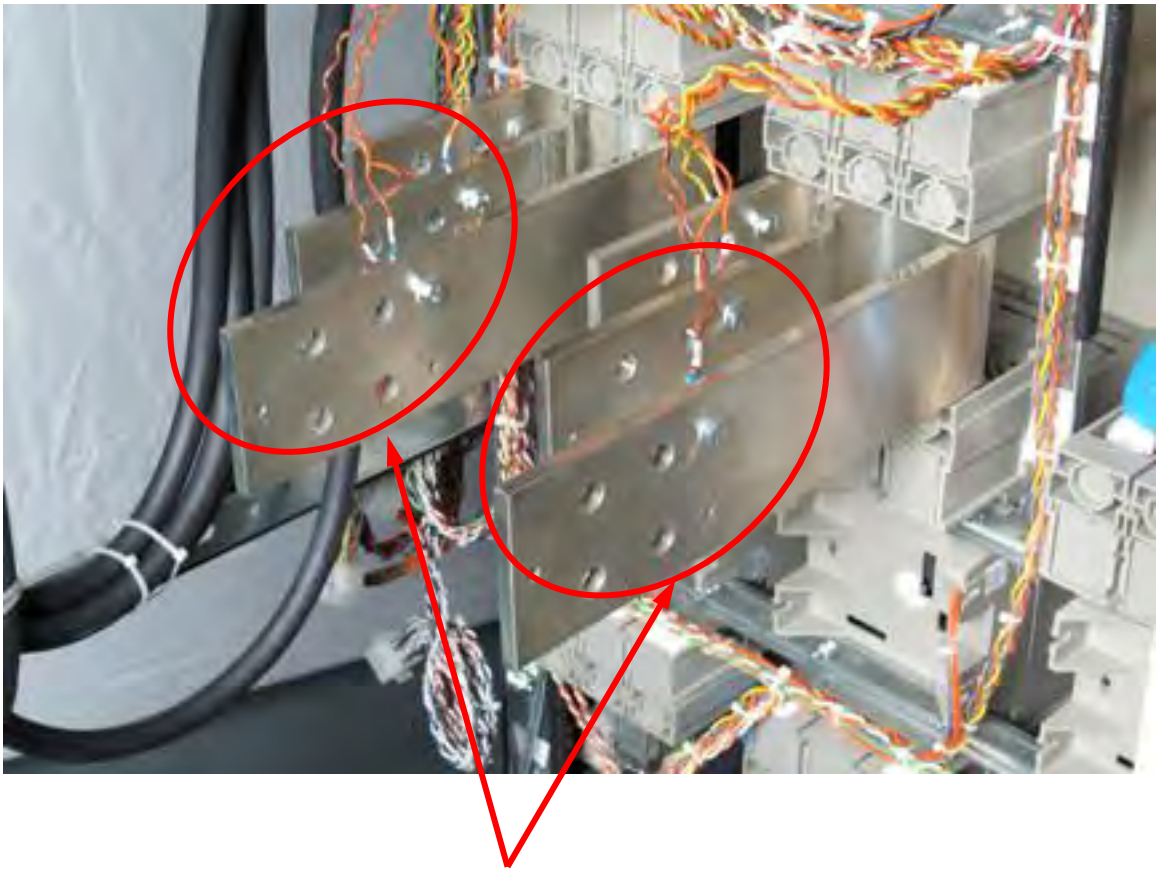
MCSW Power Supply

1. Source 2 Phase C
2. Source 2 Phase B
3. Source 2 Phase A
4. Source 1 Phase C
5. Source 1 Phase B
6. Source 1 Phase A

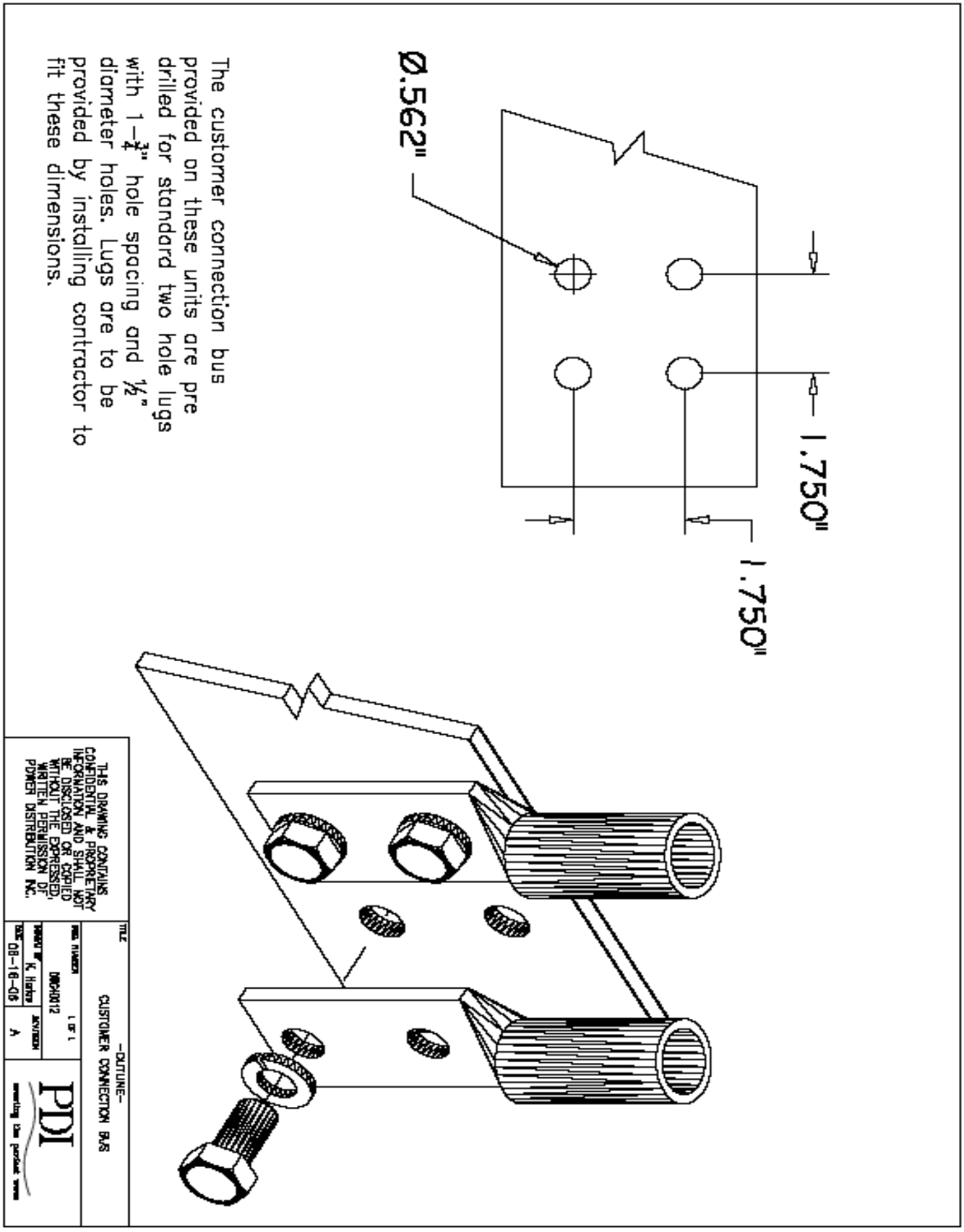
17.9 Appendix L – Internal Connection Detail

Connection to the input breakers (Source 1 and Source 2) is made directly to the bus work on the backof the breakers. This bus work is provide with pre-drilled holes for standard two hole lugs that have 1¾"spacing and ½" diameter holes.

Lugs for connection to the bus are provided by others (i.e. The installing Contractor) and should be sized to fit these dimensions..



Three Phase Bus for customer connection


Ø.562"
1.750"
1.750"
The customer connection bus provided on these units are pre drilled for standard two hole lugs with 1-¾" hole spacing and ½" diameter holes. Lugs are to be provided by installing contractor to fit these dimensions.
THIS DRAWING CONTAINS CONFIDENTIAL & PROPRIETARY INFORMATION AND SHALL NOT BE DISCLOSED OR COPIED WITHOUT THE EXPRESSED, WRITTEN PERMISSION OF POWER DISTRIBUTION INC.
TITLE
-OUTLINE-
CUSTOMER CONNECTION BUS
PART NUMBER
DWG#0012
1 OF 1
DRAWN BY K. Harker
DATE 08-16-06
REVISION
A
PDI
creating the perfect wave

17.10 STS Testing / Commissioning Methodology

The Eaton PDI WaveStar Static Transfer Switch (STS) has built-in redundant logic and transfer abilities. The primary logic is connected to the line side of input Molded Case Switches (MCSW) and output bus in the static switch to detect upstream events – this then allows the switch to sense and transfer sources. The primary logic has embedded software that controls both the low inrush algorithm and the concurrent recording of any switch transfer events with its real time wave form capture feature. The secondary logic is connected to the load side of the input MCSWs in the static switch and is used to trigger the switch to transfer upon opening of the input MCSWs along with the primary logic.

When performing transfer testing / operation of the static switch, the recommended method is to perform transfers automatically by using the front touch screen / graphics on the static switch or alternatively to manually use the redundant operation interface panel. When performing outage testing, the preferred method is to perform any outage operation by opening the upstream breaker suppling power to the either source on the static switch. This simulates a true site event and allows the primary logic to detect a real event upstream of the switch. If an outage is performed by opening the MCSWs at the static switch, the switch will still fail safe and transfer, however some of the primary logic has been bypassed and thus, this is not the recommended method for initiating an outage.

When connecting load banks to the static switch to test the switch operation under load conditions, it is important that the fan logic on the load banks is connected to a separate power source. The reason for this method is that in some cases, the load bank's fan logic may not sustain power during the 4 ms to 8 ms transfer of the switch – this may cause the load banks to drop power during an event that is seen by the switch to be normal and recorded on the switch as a "good" transfer event as per the design of the switch.

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