

## **GUIDE SPECIFICATIONS**

### **Static Transfer Switch**

#### **1.0 GENERAL**

#### **1.1 SUMMARY**

The STS is a three pole, two-position transfer device designed to automatically and manually transfer a load between two synchronized, three-phase, ac power sources. The transfer is transparent to the load. The input power will be supplied from two different AC power sources, which are nominally of the same voltage, phase rotation, and frequency. The purpose of the switch is to provide a transparent load transfer of less than 4 milliseconds under normal conditions, from one source to another source, in case of failure of one source or when manually initiating transfers for testing or maintenance. If a transformer is connected to the output of the STS inrush is limited by slightly increasing the transfer time but keeping it well within the CBEMA and ITS limits, therefore the transfers are transparent to the load.

The transfer action will not connect the two sources, which would cause cross feeding of one source to the other. 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 that source is in-tolerance and will remain connected to the "preferred source" until manually initiated to transfer or until the "preferred source" fails. All transfers are transparent to the load. The automatic retransfer to the "preferred source" can be disabled if so desired by the user from the operator control panel. When the automatic retransfer is disabled, the logic will transfer the load from the failing source to the "good" source and will remain on the "good" source until it fails.

The STS module is furnished with an isolation MCSW and key-interlocked bypass molded case switches (MCSW). The bypass MCSW's can be operated manually. Transferring from static mode to bypass mode, on the same source, and retransfer back to static mode is transparent to the load.

The STS shall be designed with no rear or side access required for installation and normal maintenance.

#### **1.2 STANDARDS**

- A. The specified STS shall be designed, manufactured, tested, and installed, as applicable, in accordance with:
- B. American National Standards Institute (ANSI)
- C. Canadian Standards Association (CSA)
- D. Institute of Electrical and Electronics Engineers (IEEE)
- E. National Electrical Code (NEC)
- F. National Electrical Manufacturers Association (NEMA)
- G. National Fire Protection Association (NFPA)
- H. Underwriters Laboratories Standards
- I. The STS/PDU shall be UL, ULc or ETL listed to UL1008.
- J. The STS shall safely withstand without mis-operation or damage:
  - 1. 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)
  - 2. Electrostatic discharges (ESD) up to 10 kV at any point on the exterior of the unit
  - 3. Electromagnetic fields from portable transmitters within 3 feet (1 meter) of the unit

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### 1.3 DEFINITIONS

- A. STS – Static Transfer Switch
- B. SCR – Silicon Controlled Rectifier
- C. MTBF – Mean Time Between Failure is the actual arithmetic average time between failures of the critical AC output bus.
- D. MCCB - Molded Case Circuit Breaker is an over current device which has automatic thermal and magnetic overload trip elements for overload and short-circuit/fault protection
- E. MCSW – Molded Case Switch is a circuit breaker which has no automatic thermal overload trip element but does have a magnetic trip element for short-circuit/fault protection. Overload protection must be provided by an upstream over current device.

### 1.4 STS ELECTRICAL REQUIREMENTS

- A. Current ratings 250, 400, 600 or 800A.
- B. Voltage Range: 208, 480 or 600v.
- C. Frequency: (60) Hz. +/-0.5 Hz
- D. Nominal transformer output Voltage, with nominal input voltage: 208/120 volts, 3 phase, 4-wire-plus-ground or 480 or 600 volts, 3 phase, 3-wire-plus-ground.
- E. Load Power Factor Range: 0.5 to 1.0, leading or lagging
- F. Load Crest Factor: Up to 3.5
- G. Source Voltage Distortion: Up to 15% THD plus notches, flat topping or/and ringing transients
- H. Sense and Transfer Time: 4-milliseconds or less under normal in-phase conditions.
- I. Sense and Transfer Time: Up to 8-milliseconds for high inrush conditions.
- J. The STS shall include a computer grade single point ground in accordance with FIPS Pub 94 and the requirements of NEC
- K. Overload Capability:
  - 125% for 30 minutes
  - 150% for 2 minutes
  - 300% for 30 seconds
  - 500% for 10 seconds

### 1.5 STS ENVIRONMENTAL CONDITION

- A. Storage Temperature Range: -40° to +80°C
- B. Operating Temperature Range: 0° to 40°C
- C. Relative Humidity: 0 to 95% without condensation
- D. Operating Altitude: Up to 5000 feet above sea level without derating  
Above 5000 feet, current rating is derated by 6% per 1000 feet
- E. Storage Altitude: Up to 40,000 feet above sea level
- F. Audible Noise: Less than 60 dBA at 5 feet without alarm activation

### 1.6 STS RELIABILITY MTBF

- A. The STS shall be designed for high reliability and high availability with an MTBF exceeding 2,000,000 hours. To the fullest extent practical, tri-redundant circuits with voting shall be used to eliminate single points of failure.

### 1.7 REDUNDANCY

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- A. Triple redundant logic shall be standard (with an option for a second level of redundancy or spacial triple redundancy) 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.
  - B. There shall be a triple redundant simple logic voting PCB, with voltage detection, which is independent of the main logic PCB. This provides an extra layer of protection for the continuous operation of the static transfer switch.
  - C. There shall be two levels of gate drivers on each set of SCRs. Each level cannot inhibit or out vote the other. Both the source 1 and source 2 shall have two levels of isolated, independent gate drivers. One gate driver can be replaced while under power (“Hot Swap”) without losing any performance.
  - D. There shall be triple redundant logic power supplies. The configuration of each DC logic power supply shall be such that a short circuit on one PCB cannot prevent the other PCBs from receiving triple redundant power. Each PCB shall receive logic power via three isolated connectors. The power supplies are mounted in separate modules so that one-power supply modules, including the transformers can be replaced while under power (“Hot Swap”) without any loss of performance.
  - E. There shall be two levels of operator controls and status displays:
    - Graphical Touch Screen Interface
    - Back Up LED InterfaceIf the normal graphic/touch screen display fails there is a redundant mimic panel and operator controls inside the unit. Each operator control/display PCBs can be replaced while under power (“Hot Swap”).

### **1.8 ELECTRICAL NOISE IMMUNITY**

- A. Noise immune signal bus(s) shall be used; optical and/or Can Bus shall be used to route signal between logic PCBs.
- B. Each Signal Bus shall continuously transmit “Bus Integrity” signals, when not transmitting true data. If all receivers do not receive the “Bus Integrity” signals, then the bus is considered discontinuous and is alarmed. All signal buses shall be redundant
- C. All signal buses shall be redundant.

### **1.9 HUMAN ENGINEERING**

- A. In order to reduce the probability of human error occurring during STS operations, the following must be incorporated into the STS
  - 1. Written operating instructions must be visible on the door of the STS enclosure.
  - 2. The graphical touch screen interface and redundant LED interface must be visible with the door open.
  - 3. Optional biometric security: Each opening of the door may be time/date stamped and logged by using an optional biometric security finger print and/or swap card (“FPSC”) is available to log any one who changes system parameters. The FPSC can be configured to only allow authorized personnel to change system settings. The door may be alarmed so only authorized personnel can open the door without an alarm sounding and logging.

### **1.10 REPAIRABILITY**

- A. All molded case switches or non-auto circuit breakers shall be of a plug-in or draw-out type to allow replacement without de-energizing the load.
- B. All control and logic components shall be mounted separate from the power components.

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- C. All PCBs or circuit breakers must be capable of being replaced while under power (“Hot Swap”).

#### **1.11 STS COMMUNICATIONS**

- A. It is becoming increasingly important for power quality products to provide information along with the power. If the unit is becoming overloaded, there must be an alert (Alarms). If there is an outage, the event will be recorded for review after the event occurred (Forensics).
- B. The STS shall provide down-loadable log of events, alarms, voltage and current values, frequency, and waveforms that have been captured.
- C. The data shall be communicated by the following standards:
  - 1. **Modbus RTU** using RS422/485, 2 wire or 4 wire interface.
  - 2. **SNMP** (Simple Network Management Protocol) is the Internet standard protocol developed to manage nodes (servers, workstations, routers, switches and hubs etc.) on an IP network.
  - 3. **HTTP-** (Hypertext Transfer Protocol) monitors web pages from the Static Switch server using a standard Web browser.

#### **1.12 OUTPUT TRANSFORMER CURRENT INRUSH REDUCTION**

- A. The STS shall automatically power up when connected to at least one power source. The initial start up or restart current inrush shall be less than twice the rated transformer current
- B. The STS will control the transformer in-rush on initial power-up; restart after shut down and upon load transfers.
- C. The out-of-phase transfer inrush will be limited to 1.5 times the rated transformer current
- D. The inrush is limited by using a patent pending flux and/or volt-second synchronizing algorithm. The algorithm increases the transfer time to synchronize the flux and /or volt-seconds. The transfer time is within the CBEMA and ITS limits therefore the transfers are transparent to the load.
- E. The transfer time for normal in-phase conditions is 4 milliseconds or less.

#### **1.13 STS ENCLOSURE CONSTRUCTION**

- A. The STS enclosures shall be constructed to NEMA Type-1 and shall be primed and painted with suitable semi-gloss enamel both inside and out. Color shall be Pearl White or as specified by owner.
- B. Each module cabinet is designed for the data center or telecommunication environment. Each cabinet has heavy-duty casters. Once the STS is placed in its final position, the unit features stabilizing pads, which can be adjusted to stabilize the unit.
- C. The distributed floor weight will be less than 250 lb per sq ft.
- D. The STS shall include a computer grade single point ground in accordance with the requirements of NEC and FIPS- 94.
- E. The unit will be designed to operate from sources that are solidly or impedance grounded.
- F. The STS shall be constructed such that all input and output field connections can be made from either the front or from the side of the unit. Rear access shall not be required for installation.
- G. The STS can be tipped 15 degrees in any direction without damage.

#### **1.14 STS ACCESS**

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- A. The required service access will be at the front only of the STS module and side or rear of the PDU module.

#### **1.15 HAZARDOUS VOLTAGES SAFETY**

- A. The STS shall be designed to minimize the exposure of hazardous voltages to allow safe servicing of the unit while the load is energized. Barriers shall be used on and around any exposed surface with more than 42 volts peak applied including connections, to protect personnel during maintenance.

#### **1.16 INPUT SOURCE POWER JUNCTION BOXES, OPTIONAL**

- A. The two input power sources are connected to the STS via two power junction boxes. The junction box is a removable-covered, NEMA 12 box. Each box shall contain 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 STS.
- B. Each power junction box shall be equipped with a 10-foot long STS main input power cable is provided with each STS. 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 STS.

#### **1.17 STS COOLING**

- A. The STS shall utilize convection air-cooling for 250 and 400A units.
- B. Redundant fans shall be provided for 600 and 800A units.
- C. No filters shall be provided in the Transformer/ Distribution Module or the STS.

#### **1.18 STS RATINGS**

- A. Nominal standard Input Voltage: 208, 480, 600 volts three phase, 3-wire-plus-ground.
- B. Frequency: (60) Hz. +/-0.5 Hz
- C. Nominal transformer output Voltage, with nominal input voltage: 208/120 volts three phase, 4-wire-plus-ground
- D. Load and Transformer standard KVA ratings: 50, 75, 100, 125, 150, 200, 225, 300 KVA
- E. The STS continuous current rating will match or exceed the PDU input requirements round.
- F. Output Load Capacity: The STS/PDU shall be continuous rated to carry a full 100% load.
- G. Rated KAIC: 22 at 480 volts and below (65 & 100 kAIC optional up to 800A)
- H. Rated KAIC: 22 at 600V (65 & 100kAIC optional up to 800A)

#### **1.19 SUBMITTAL REQUIREMENTS**

- A. The information with the bid shall include the following items.
- B. Technical proposal, including STS one-line diagram, specification, unit ratings, transformer ratings, frame size and current ratings of circuit breakers.
- C. Outline and installation drawings showing dimensions and weight of the equipment, along with external power cable connections and recommended cable entrances and exits. Details of recommended service clearances.
- D. One (1) set of recommended spare parts for the specified STS shall be furnished upon request.
- E. Delivery Submittal
- F. Outline and installation drawings showing dimensions and weight of the equipment, along with external power cable connections and recommended cable entrances and exits. Details of recommended service clearances.

## **2.0 PRODUCT**

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## **2.1 OPERATOR CONTROLS**

- A. All normal operating controls, displays and instrumentation shall be located on the front of the STS module. The operating panel mounted on the front of the STS module (Operator Interface/ Display) shall be easily accessible for monitoring and controlling the operation of the STS.

## **2.2 CIRCUIT BREAKER CONTROLS**

- A. The STS breakers shall be located on the front of the STS. All breakers shall be mounted behind closed doors.

## **2.3 STS CONTROL PANEL**

- A. The STS shall be provided with a control panel for operator interface to configure and monitor the system parameters. The control panel shall be located on the front of the STS module and can be operated without opening the hinged front door. The display shall not be mounted to the front door so the door can be easily removed for installation and maintenance.
- B. The STS shall be provided with a backlit, color, graphics display with a touch-screen for the operator to input data to the system. The display supplies the operator with system information, status information, a one-line diagram of the STS, active alarms, waveforms, alarm history information, and operating instructions.
- C. The STS shall be provided with a back up LED monitor. This monitor is redundant to the graphical interface and will allow for operation of the STS in the event that the graphical interface fails or needs to be serviced.

## **2.4 GRAPHICAL INTERFACE SCREENS**

- A. The summary screen shall have one line of the STS which indicates: the STS power flow, the status of all MCSWs, status of all operator controls, the voltage and currents at each input and the output and an indicator if there are alarms. Also this screen indicates the phase shift between inputs. This screen shall allow the operator, if allowed, control operation of the system
- B. The summary screen shall be the default screen and shall give the operator a complete “picture” of the system.
- C. The alarm screen shall display all active alarms with time/date stamping and a brief description of the alarm.
- D. The Event log screen shall display the alarm log, status change log, operator control change log, and door openings log (optional). All events from the fingerprint/card swap device will be logged (optional). All events are to be time/date stamped to 5Ms. The alarm log contain 512 of the latest events
- E. The waveform capture screen shall capture the waveforms of both inputs and the output when there is a power anomaly that would cause the system to transfer the load. There will be lines on the waveform to determine the transfer time. This screen shall have a time/date stamped log of the last 256 waveforms.
- F. The metering screen shall have a text display of all input and output currents, voltages (line-to-line and phase), P.F., KW, KVA, frequency of each source. This screen shall indicate the percent load; load tenting for a 30-day period, total number of transfers and phase shift between sources.
- G. The metering shall be true-RMS with plus/minus 2% accuracy.
- H. The optional distribution current screen shall display the current, in amperes, of all or any the distribution devices.

- I. Other screens will allow an operator, after being authorized, to change system set points, silence and reset the audible alarm. To facilitate system operation, step-verify-step start-up, transfer, and maintenance bypass procedures shall be displayed on the screen.
- J. The control panel shall be equipped with an RS232 port and Flash memory to allow system software to be upgraded, by authorized personnel, without shutting down the load.

**2.5 DATA DOWNLOADS**

A.The control panel shall allow operators to down load all the waveform and alarm logs

**2.6 ALARM MESSAGES**

A.The alarm circuit shall continue to monitor event for at least 20 seconds after the loss of both input sources so that the cause of total shutdown can be recorded

B.. The following alarm messages shall be displayed and logged:

Source 1 out-of-tolerance	Source 1CB open	Power Supply Failed
Source 2 out-of-tolerance	Source 2 CB open	ID of failed power supply
Sources out of Sync	ISO #1 CB open	LCM voting disagreement
Source 1 over voltage	ISO #2 CB open	Simple logic voting disagreement
S1undervoltage (fast)	S1 Bypass CB closed	S1 & S2 sources failed
S1undervoltage RMS (slow)	S2 Bypass CB closed	S1 Gate drive module 1 failed
Source 2 over voltage	S1 SCR Open	S1 Gate drive module 2 failed
S2 under voltage (fast)	S2 SCR Open	S2 Gate drive module 1 failed
S2 under voltage RMS (slow)	S1 SCR Shorted	S2 Gate drive module 2 failed
Output over current	S2 SCR Shorted	STS Heat Sink Over-temp 1
Redundant display controls enabled	Power supply fuse blown	REPO/EPO activated
Source 1 Over/Under Frequency	Control Module Fail	STS on alternate source
Source 2 Over/Under Frequency	Maintenance Mode	STS Heat Sink Over-temp 2
Source 1 Phase Rotation Error	Manual Override	
Source 2 Phase Rotation Error	Auto Retransfer Inhibit	PDU Input CB Open
Output under voltage	Output Over/Under Frequency	Loss of optical bus integrity signal
Output over voltage	Transfer Inhibit	Loss of CAN bus integrity signal

C. An audible alarm shall be activated when any of the alarms occurs. All alarms shall be displayed in text form.

**2.7 OPERATOR CONTROLS**

A. The graphic display touch screen shall allow an authorized Operator to Control the system

B. The authorized operator can control the following operations:

- Automatic or override selection

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- Audible Alarm SILENCE
  - Retransfer disable
  - Source selection;
  - To select the preferred source in auto mode
  - Select maintenance mode (internal)
  - Redundant Display/control enable (internal)

## 2.8 STATIC TRANSFER SWITCH MODULE

- A. The STS shall consist of two solid-state switch elements with logic to control switching and sensing functions. The three phase, dual position design connects the load to source 1 or source 2. Each solid-state switch element will consist of three sets of three-phase hockey PUK style Silicon Controlled Rectifiers (SCRs) connected in an AC switch configuration. The SCRs shall be rated 1,200 ampere continuous. USE OF "BRICK" OR "GEL FILLED" TYPE SCRS IS NOT ACCEPTABLE FOR SWITCH APPLICATIONS. The STS withstand rating shall be in accordance with UL 1008 without SCR protective fusing. Transfer from one source to the other, regardless of direction, shall be break before make with a maximum open transition time of 4 milliseconds on all phases
- B. The Static Transfer Switch shall be a three-pole, double-throw; solid-state, automatic or manual transfer switch that is fed from two AC power sources. One source shall be designated as the preferred source while the other is the alternate source. Selection of which input source is preferred shall be user selectable from the operator control panel. All transfers shall be a break-before-make with no overlap in conduction from one source to the other. All transfers, including sense and transfer times, shall have less than 4-milliseconds interruption in power to the load, under normal conditions.
- C. The STS shall contain four (4) MCSWs switch control input disconnect functions, two (2) plug-in MCSWs switch control the bypass function, and one or two (optional) plug-in MCSW which control output/ isolation. All MCSW shall be of plug-in design and shall be 100% rated at the ambient temperature specified.
- D. Key interlocks shall be provided for the MCSWs to prevent the operator from closing both the bypass non-automatic breakers at the same time.
- E. The solid state elements shall be high speed Silicon Controlled Rectifiers (SCRs) connected in anti-parallel pairs to transfer the AC power. The outputs of the two sets of non-automatic circuit breakers are connected to furnish power to the load through the one or two (optional) output MCSW
- F. Under normal conditions, power shall be provided by the preferred input. Either source 1 or source 2 can be designated preferred.
- G. The STS shall include an automatic mode so upon the failure of the preferred source of power, the STS will sense and transfer the load to the good alternate source within 4 milliseconds under normal conditions. The transfer will be break-before make.
- H. The Static Transfer Switch shall automatically power up when connected to at least one the power source. The start up current inrush shall be less than twice the rated transformer current.
- I. All wiring and cables shall be copper or plated copper. Aluminum shall be used for heat sinks only. All bus shall be rated per the UL or National Electric Code.
- J. The SCRs shall be PUK type and rated to carry the full 100% rated load. The SCRs shall be rated not to be damaged including shorting or opening or not to have a hazardous device failure when the system is subjected to the available fault currents, continuous current and overload current specified in this specification

## 2.9 MODES OF OPERATION



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- A. Normal Mode - The unit is fed by two sources with the output connected to the load. In normal operation, the load shall be connected to the preferred source as long as all phases of the preferred source are within the acceptable limits. Upon failure of the preferred source, the load shall be transferred to the alternate source until such time as the preferred source returns to within the acceptable limits.
  - B. The automatic retransfer to the preferred source can be disabled if so selected from the operator control panel. When the automatic retransfer is disabled, transfers from the alternate source to the preferred source shall not be disabled when alternate source fails.
  - C. High Load Current Inhibit - If the load current exceeds an adjustable preset level, factory set at two times full rating, due to fault condition, the logic shall disable transfer even if the voltage on the selected source exceeds the transfer limits. The load current transfer inhibit may be automatically or manually reset after the current returns to normal to allow for continued protection against a source failure.
  - D. Manual or Override Transfer - The STS shall allow manual (override) initiated transfers between the two sources, providing the alternate source is within acceptable voltage limits and phase tolerances with the preferred source. Allowable phase differences between the sources for manually initiated transfers shall be adjustable from the operator control panel. The STS shall be capable of tolerating transfers up to 180 degrees out of phase for over ride conditions. However, the user-adjustable phase synchronization window shall be typically be limited to +/- 10 degrees. If the transfer is manually initiated, the STS shall transfer between the two sources without interruption of power to the load greater than 2 milliseconds provided that both sources are available and synchronized within the adjustable phase window. Where the two frequencies of the sources are not the same. Manual transfers can be delayed by the logic until the two sources are within the phase synchronization window.
  - E. SCR Failure - The STS shall continuously monitor the status of the SCR. If a shorted SCR on the source powering the load is shorted, the logic shall automatically alarm and trip open the other source input breaker. If there is a shorted SCR on the other source, the logic shall automatically transfer and alarm the condition and trip open the other source input breaker. If an SCR is open, the logic shall automatically alarm the condition and transfer to the other source. All open and shorted SCR alarm conditions shall be latched and require the system to be repaired and reset to restore normal operation.

### **3.0 EXECUTION**

#### **3.1 PACKING AND SHIPMENT**

- A. The STS shall be adequately packaged and braced to prevent damage to the unit while in transit. Each section shall be bolted to a skid and enclosed in a protective covering.

#### **3.2 FACTORY TESTING**

- A. The complete STS shall be inspected and tested in the factory to demonstrate full compliance with manufacturer's standard test procedures and the purchase specification.
- B. Factory testing shall include the following tests:
  - A complete visual inspection of the equipment, both internally and externally.

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- A complete test of the equipment including static switch transfers and operations.
  - A complete test of all controls and control panel including verification of proper operation of all metering and monitoring parameters.
  - A complete hi-pot test of the power components.
  - Equipment load test.