# APC by Schneider Electric <br> MGE EPSILON STATIC TRANSFER SWITCH 100 Ampere - 600 Ampere Three-Phase Static Transfer Switch 

THIS GUIDE SPECIFICATION IS WRITTEN IN ACCORDANCE WITH THE CONSTRUCTION SPECIFICATIONS INSTITUTE (CSI) MASTERFORMAT. THIS SECTION MUST BE CAREFULLY REVIEWED AND EDITED BY THE ARCHITECT OR THE ENGINEER TO MEET THE REQUIREMENTS OF THE PROJECT. COORDINATE THIS SECTION WITH OTHER SPECIFICATION SECTIONS IN THE PROJECT MANUAL AND WITH THE DRAWINGS.
WHERE REFERENCE IS MADE THROUGHOUT THIS SECTION TO "PROVIDE", "INSTALL", "SUBMIT", ETC., IT SHALL MEAN THAT THE CONTRACTOR, SUBCONTRACTOR, OR CONTRACTOR OF LOWER TIER SHALL "PROVIDE", "INSTALL", SUBMIT", ETC., UNLESS OTHERWISE INDICATED.
THIS SECTION IS WRITTEN TO INCLUDE THE 2004 MASTERFORMAT AND THE 1995 MASTERFORMAT VERSIONS. WHERE APPLICABLE, THESE ITEMS ARE BRACKETED AND, IN EACH CASE, UNLESS OTHERWISE INDICATED, THE FIRST CHOICE APPLIES TO THE 2004 MASTERFORMAT AND THE SECOND CHOICE APPLIES TO THE 1995 MASTERFORMAT.

## SECTION [26 36 33] [16495]

## STATIC TRANSFER SWITCHES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions, [Division 01 - GENERAL REQUIREMENTS] [Division 1 - GENERAL REQUIREMENTS], and other applicable specification sections in the Project Manual apply to the work specified in this Section.

### 1.2 SUMMARY

A. Scope: Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for a static transfer switches (STS) as required for the complete performance of the work, and as shown on the Drawings and as herein specified.
B. Section Includes: The work specified in this Section includes, but shall not be limited to, solid state, three-phase STS to be used for connecting critical loads to one of two independent sources in redundant power supply systems. In addition to hardware and software design criteria, the theory of normal operation and operation under various other conditions (fault included) are specified for the STS design.

1. The STS design shall be used for stand-alone units or for attachment to PMM's in the PMM Plus and PMM Ultra configurations, which shall require that the STS enclosure match the PMM in height and depth. Future projects may include, but shall not be limited to, integrating the STS into the PMM and developing a separate stand-alone STS line with increased height and smaller footprint.

### 1.3 REFERENCES

A. General: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
B. European Standards (EN):

1. EN 50082-1, "Electromagnetic Compatibility - Generic Immunity Standard; Residential, Commercial and Light Industry."
2. EN 50082-2, "Electromagnetic Compatibility - Generic Immunity Requirements, Part 2: Industrial."
C. Federal Communications Commission (FCC):
3. FCC 47 CFR Part 15, "Radio Frequency Devices."
D. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
4. ANSI/IEEE 446, "Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications" (copyrighted by IEEE, ANSI approved).
5. ANSI/IEEE C62.41, "Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits" (copyrighted by IEEE, ANSI approved).
E. International Organization for Standardization (ISO):
6. ISO 9001, "Quality Management Systems - Requirements."
F. Military Standardization Documents (MIL):
7. MIL-HDBK-217, "Reliability Prediction of Electronic Equipment."
G. National Electrical Manufacturers Association (NEMA):
8. NEMA AB 1, "Molded Case Circuit Breakers and Molded Case Switches."
9. NEMA ST 1, "Specialty Transformers (Except General-Purpose Type)."
10. NEMA ST 20, "Dry-Type Transformers for General Applications" (copyrighted by NEMA, ANSI approved).
H. National Fire Protection Association (NFPA):
11. NFPA 70, "National Electrical Code" (copyrighted by NFPA, ANSI approved) - hereinafter referred to as NEC.
I. Underwriters Laboratories, Inc. (UL):
12. UL 1008, "Standard for Automatic Transfer Switches" (copyrighted by UL, ANSI approved).
13. UL 1950, "Standard for Safety of Information Technology Equipment Including Electrical Business Equipment."

### 1.4 DEFINITIONS

A. Definitions, Acronyms, and Abbreviations:

1. STS: Static transfer switch.
2. SCR: Silicon controlled rectifier.
3. FPGA: Field programmable gate array.
4. UL: Underwriters' Laboratories, Inc.
5. PMM: Power management module.
6. MTBF: Mean time before failure.
7. MTTR: Mean time to replace.

### 1.5 SUBMITTALS

A. General: See [Section 013300 - SUBMITTAL PROCEDURES] [Section 01300 - SUBMITTALS].
B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications.
C. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data.
D. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed wiring and field-installed wiring, and between components provided by the manufacturer and those provided by others.
E. Operation and Maintenance Data: Submit operation and maintenance data to include in operation and maintenance manuals specified in [Division 01 - GENERAL REQUIREMENTS] [Division 1 - GENERAL REQUIREMENTS].

### 1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of static transfer switches of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years.
2. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing static transfer switches similar in type and scope to that required for this Project.
B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.
3. Work shall also be designed in accordance with the following:
a. ANSI/IEEE 446.
b. UL 1008.
C. Pre-Installation Conference: Conduct pre-installation conference in accordance with [Section 013119 - PROJECT MEETINGS] [Section 01200 - PROJECT MEETINGS]. Prior to commencing the installation, meet at the Project site to review the material selections, installation procedures, and coordination with other trades. Pre-installation conference shall include, but shall not be limited to, the Contractor, the Installer, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Architect/Engineer.

### 1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.
B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

## $1.8 \quad$ PROJECT CONDITIONS

A. Environmental Requirements: Do not install static transfer switches until space is enclosed and weatherproof, wet work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

### 1.9 WARRANTY

A. General: See [Section 017700 - CLOSEOUT PROCEDURES] [Section 01770 - CLOSEOUT PROCEDURES].
B. Special Warranty: The Contractor shall warrant the work of this Section to be in accordance with the Contract Documents and free from faults and defects in materials and workmanship for period indicated below. This special warranty shall extend the one year period of limitations contained in the General Conditions. The special warranty shall be countersigned by the Installer and the manufacturer.

1. The static transfer switches shall be covered by a full parts and labor warranty from the manufacturer for a period of 12 months from date of installation or acceptance by the Owner or 18 months from date of shipment from the manufacturer, whichever occurs first.
C. Additional Owner Rights: The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run
concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Basis of Design: Product specified is "MGE Epsilon Static Transfer Switch; 100 Ampere - 600 Ampere Three-Phase Static Transfer Switch" as manufactured by APC by Schneider Electric. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The Architect/Engineer will be the sole judge of the basis of what is equivalent.

### 2.2 GENERAL TOPOLOGY

A. The digital STS shall be a solid state, three-phase, break-before-make, dual position switch designed to connect a critical three-phase load to one of two separate, independent, synchronized sources of three-phase power and provide voltage to its output terminals for any load from 0 percent to 100 percent of its rating. The STS shall consist of six pairs of SCR's connected in an AC switch configuration. Each three-phase input shall be fed through a molded case automatic switch which shall provide short circuit protection by means of a magnetic trip only. The switch shall then feed three pairs of hockey-puck SCR's, each pair consisting of two SCR's in an anti-parallel arrangement. The SCR outputs for each corresponding phase from both inputs shall then be connected and fed through an output isolation molded case switch to the output terminals. These SCR's shall be rated to carry the full 100 percent load (continuous rated) while operated as stipulated herein and at the maximum ambient temperature specified.
B. The source to which the load shall be normally connected to shall be designated as the preferred source, and the other redundant, standby source as the alternate source. Selection of which input source is preferred will be Owner-selectable from the operator control panel, by control contact inputs, or through the communications port(s).
C. 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 (more degraded than the alternate source), the load shall be transferred to the alternate source until such time as the preferred source returns to within acceptable limits. If while on the preferred source, the alternate source falls outside acceptable limits (out of tolerance), then automatic transfer shall be inhibited until the alternate source returns to within acceptable limits.
D. The STS solid state switching devices shall be hockey-puck type SCR's with a minimum peak inverse voltage rating of 1800 volts continuous at 125 degree junction temperature and open gate conditions for reliability. The thermal margin on junction temperature at full load current shall be at least $25^{\circ} \mathrm{C}$ below maximum junction temperature for an ambient temperature of $40^{\circ} \mathrm{C}$. Cooling shall be natural convection two-sided cooling with heat sinks on models rated 200 amperes and lower. Forced air cooling using fans (with one redundant fan) shall be used on models rated 400 amperes and higher.
E. SCR's shall have a rupture rating or be protected in a manner compatible with the specified fault current availability. Rupture protection may be eliminated if the SCR overload capability can sustain a dead short on the load side. Fuses shall not be used on the SCR's if possible. Molded case switches with magnetic trips shall be used to provide short circuit protection only. Upstream and/or downstream devices shall provide overcurrent protection.
F. Transfers and re-transfers between sources shall be break-before-make and control logic shall have protective sensing circuits to ensure that there is no cross-connection between the two sources.
G. A separate redundant circuit for back-feed protection shall be provided to ensure that there is no cross-connection between the two sources in the event of a shorted SCR on the inactive side with the upstream circuit breaker open.
H. Keyed interlocks shall be provided on the two bypass switches to prevent closure of both at the same time. An optional interlocking scheme shall be offered for additional keyed interlocks on the source isolation switches to ensure that prior to bypassing to a particular source, the STS shall transfer the load to that source (if the load is not already being powered by that source). On closure of a bypass switch, the control logic shall also shunt trip opposite bypass and input isolation switches if necessary to prevent cross-connection of the two sources.
I. The microprocessor-based core control shall use FPGA's for input and output signal processing and control sequencing. Separate analog-to-digital (A/D) circuits shall allow selection of faster and more accurate devices to optimize sensing time. The STS shall be certified to UL 1008 and C-UL certified for Canada.

### 2.3 ELECTRONIC CONSTRUCTION

A. Active electronic devices shall be solid state. Relays shall be sealed with covers. Capacitors shall be non-PCB type and internally protected in accordance with applicable UL standards. Circuit boards and relays shall have mechanical restraints designed to prevent loosening of these devices while in transit, being relocated, or in service.
B. The design shall allow a minimum of $25^{\circ} \mathrm{C}$ operating margin from the maximum allowable junction temperature of solid state semiconductor devices.
C. Subassemblies shall be constructed for ease of access and replacement of parts. Subassemblies shall be front, top, or side accessible. Circuit boards shall use industry-accepted connectors. The equipment shall be constructed so that each power component can be replaced without soldering. MTTR for any assembly shall not exceed 15 minutes.
D. Internal circuit cards shall employ connectors with corrosion-resistant pins for reliability. Some circuit boards shall have LED indicators to annunciate critical board functions for ease of troubleshooting and maintenance.
E. Circuit cards shall be screened against premature failure and shall have the ability to report diagnostics and failures to the central display.

### 2.4 PRODUCT SPECIFICATIONS

A. Technical Ratings:

1. Nominal Input Voltage: 208 volts AC, 220 volts AC, 240 volts AC, 440 volts AC, 480 volts AC, 575 volts AC, 600 volts AC, $\pm 15$ percent, three-phase, 3 wires plus ground.
2. Nominal Output Voltage: 208 volts AC, 220 volts AC, 240 volts AC, 440 volts AC, 480 volts AC, 575 volts AC, 600 volts AC, $\pm 15$ percent, three-phase, 3 wires plus ground to correspond with input voltage.
3. Maximum Continuous Current: 100 amperes, 200 amperes, 400 amperes, 600 amperes.
4. Molded Case Switch Rating: 250 amperes, 400 amperes, 600 amperes.
5. Input/Output Frequency: 50 hertz/ 60 hertz, $\pm 5$ hertz.
6. Load Power Factor: Unity to 0.60 lagging or leading.
7. Non-Linear Loads Capability: 100 percent of its rating up to maximum crest factor of 3.5 .
8. Overload Rating: 150 percent for 15 minutes; 1000 percent for three cycles.
9. Source Voltage Distortion: Up to 10 percent THD with notching and ringing transients.
10. Output Voltage Distortion: Less than 1 percent added.
11. Voltage Transient Withstand: Up to 6 kV ( 6000 volt spike) per ANSI/IEEE C62.41 for Category B3, and shall meets EN 50082-1 (with optional TVSS installed). Such transient levels shall not effect the operation of the STS. The STS may transfer on overvoltage conditions.
12. Short Circuit Withstand: Up to 100 kA.
13. Harmonic Current Feedback from the Load: Unlimited.
14. Emission Limits: Meets FCC 47 CFR Part 15 Class A, EN 50081-2.
15. Sense and Transfer Time: $1 / 4$ cycle ( 4.17 milliseconds) total sense and transfer time maximum.
16. Control Power Supplies: Triple redundant with failure alarm.
17. SCR Detection: Open and shorted SCR detection.
18. Cooling and Fans: Convection cooling on 200 ampere model; forced air cooling with redundant fan(s) on 400 ampere and 600 ampere models.
19. MTBF: Greater than 400,000 hours per MIL-HDBK-217.

## B. Physical Specifications:

1. Enclosure Type: NEMA 1, freestanding, modular configured with hinged dead-front construction protecting high voltage areas.
2. Enclosure Dimensions:
a. Depth: 30 inches $(762 \mathrm{~mm})$ to match existing PMM line. System shall pass through standard 36 inch ( 914 mm ) wide door.
b. Height: 72 inches ( 1829 mm ).
c. Width: 24 inches ( 610 mm ) or less for 200 ampere STS; 42 inches ( 1067 mm ) or less for 400 ampere and 600 ampere STS. Future optional configurations for integration with the PMM or for stand-alone STS's may offer different dimensions.
3. Accessibility: Front access for operation and maintenance; front or side access for Owner power connection points.
4. Power Connections/Busbars: Power connections and terminations shall be solid copper braced rated for 100 kAIC (400 ampere/600 ampere models may be a combination of copper bus bars and cables).
5. Cable Entry: Top and bottom.
6. Mounting: 360 degree casters and leveling jacks with 1 inch ( 25 mm ) minimum adjustment.

## C. Environmental Characteristics:

1. Operating Temperature: $50^{\circ} \mathrm{F}\left(10^{\circ} \mathrm{C}\right)$ to $104^{\circ} \mathrm{F}\left(40^{\circ} \mathrm{C}\right)$.
2. Storage Temperature: $14^{\circ} \mathrm{F}\left(-10^{\circ} \mathrm{C}\right)$ to $140^{\circ} \mathrm{F}\left(60^{\circ} \mathrm{C}\right)$.
3. Relative Humidity: 10 percent to 95 percent non-condensing.
4. Operating Altitude (Above Sea Level): 0 feet ( 0 m ) to 8500 feet ( 2591 m ).
5. Non-Operating Storage/Transport Altitude: -150 feet ( -46 m ) to 50,000 feet ( $15,240 \mathrm{~m}$ ).
6. Audible Noise: Less than 65 dBA at 5 feet ( 1524 mm ) (with audible alarm off) or as appropriate for kVA rating per NEMA ST 20.
D. Agency Standards, Approval, and Compliances:
7. The STS system shall be designed, manufactured, tested, and installed in accordance with:
a. American National Standards Institute (ANSI).
b. UL 1008.
c. UL 1950.
d. c-UL (UL-certified for Canada).
e. Institute of Electrical and Electronic Engineers (IEEE).
f. . NEC, Article 702.
g. NEMA ST 1.
h. NEMA ST 20.
i. NEMA AB 1.
j. National Fire Protection Association (NFPA).
k. ISO 9001.
I. FCC 47 CFR Part 15, Class A.
m. Federal Information Processing Standards (FIPS).
8. The STS system shall be certified by a national inspecting and testing laboratory (i.e., UL).

### 2.5 THEORY OF OPERATION

A. Automatic Transfers:

1. Automatic fast transfer of the load from one source to the other shall be accomplished by turning off the active source SCR's and turning on the inactive source SCR's in a sequence
and timing that shall allow a combined sense and transfer time of less than $1 / 4$ cycle (4.17 milliseconds).
2. Automatic transfer shall be initiated under any of the following conditions, provided transfer is authorized and the inactive source is not more degraded than the active source:
a. Under-voltage (fast or slow) on any phase of the active source. On sensing a peak current overload condition, a check shall be made for an under-voltage condition indicating that the under-voltage condition caused the overload. In this case, automatic transfer shall be inhibited, the fault shall be memorized (manual reset required) and the load shall stay on the active source until the overload condition is cleared and the system is reset.
b. Over-voltage (slow) on any phase of the active source.
c. Under-frequency of the active source.
d. Over-frequency of the active source.
e. Open SCR on the active side (transfer to inactive side, then shunt trip active CB and inhibit re-transfer until repair is made and the system is reset).
f. Shorted SCR on the inactive side (transfer to shorted inactive side, then shunt trip previously active CB to prevent re-transfer. Inhibit transfers and re-transfer until repair is made and the system is reset).
g. SCR over-temperature on the active side (if there are no current overload faults, transfer to inactive side and inhibit re-transfer until repair is made and the system is reset. If inactive side subsequently fails, transfer back to the active side if it is within acceptable limits, including, but not limited to, over-temperature limits).
h. SCR gate drive power supply failure on the active side (transfer to inactive side and inhibit re-transfer until repair is made and the system is reset).
i. MOV (TVSS) failure on the active side.

## B. Manual Transfers:

1. The STS shall be able to be operated as a manual switch when the manual control keyed switch on the front panel is in the on position, enabling the manual control pushbuttons and some setpoint changes, for the following manual operations:
a. Manual Change Preferred Source Pushbutton: Shall select other source as preferred, causing a transfer (without break) to the selected source if it is available and within acceptable limits and is not the active source. If the two sources are outside the preset in-sync phase window, a transfer (with break) shall be able to be made by pressing the manual override limits pushbutton simultaneously (pre-conditions shall be manual control switch in on position; inactive source is available and within acceptable limits).
b. Manual Return to Preferred Source Pushbutton: If auto-re-transfer is disabled, pressing this pushbutton shall temporarily enable auto-retransfer and initiate a re-transfer back to the preferred source, overriding Owner-selected auto-retransfer time delay. Then auto-retransfer shall again be disabled after this manual retransfer.
2. To prevent normal automatic transfers, the operator can use the change preferred source pushbutton to transfer to the desired source, and then shut down the feeder to the other inactive source.
C. Automatic Re Transfers: Automatic re-transfer of the load from the alternate source back to the preferred shall be accomplished by turning off the active alternate source SCR's and turning on the inactive preferred source SCR's. This shall be done in a sequence and timing that shall allow a combined sense and transfer time of less than $1 / 4$ cycle ( 4.17 milliseconds). Providing the inactive preferred source is not more degraded than the active alternate source, re-transfer shall occur under the following conditions:
3. If re-transfer is not prohibited, re-transfer shall occur after an Owner-selected time delay after the preferred source becomes available and within acceptable limits.
4. If re-transfer is prohibited, re-transfer shall be able to be manually initiated by pressing the manual return to preferred source pushbutton (pre-conditions shall be manual control switch in on position; inactive preferred source is available and within acceptable limits). Transfer shall be temporarily authorized for a preset time.
D. Transfer Authorization/Prohibition: Transfer shall be prohibited under the following conditions (memorized conditions require manual system reset):
5. Transfer prohibit input from the operator control panel, control contact input, or communications port.
6. Peak current overload.
7. External power fault (peak current overload caused by undervoltage), memorized.
8. Over-temperature (active or inactive switch), memorized.
9. Shorted SCR (active or inactive switch), memorized.
10. Open SCR (active switch), memorized.
11. Reverse power.
12. Inactive source out-of-tolerance.
13. Inactive source power supply fault.
14. Phase rotation fault.
15. Inactive input isolation switch open.

## E. Maintenance Bypass/Molded Case Switches/Live System Test:

## 1. Switch Arrangement:

a. A manually operated maintenance bypass switching arrangement shall be included to permit complete isolation of the static switch SCR assemblies for servicing without disrupting power to the critical loads. The maintenance bypass shall consist of:

1) STS input isolation switch. One for each static switch SCR assembly (two total; CB1, CB2).
2) STS output isolation switch. One for both static switch SCR assemblies (one total; CB3A). A second redundant output isolation switch (CB3B) shall be available as an option.
3) Maintenance bypass switch. One for each static switch SCR assembly (two total; CB4, CB5).
b. STS circuit breakers shall be automatic switches with magnetic trip only with plug-in bases for ease of removal for replacement, calibration or testing, without interruption of power to the critical load. Switches shall be equipped with shunt trips and auxiliary contacts. Continuously activated shunt trips shall not allow closing of the switch (not even as much as a contact-to-contact touch).
2. Electrical Bypass Switch Interlock: If either maintenance bypass switch is closed, the opposite maintenance bypass switch shall be electrically shunt-tripped.
3. Electric Input-Bypass Switch Interlock: If the output switch and either maintenance bypass switch are closed, the opposite input isolation switch shall be electrically shunt-tripped.
4. Mechanical Key Intelocks: Mechanical kirk key interlocks shall be provided on the two maintenance bypass switches (CB4 and CB5) to prevent an operator from closing both bypass switches at the same time. A single key shall allow closure of one switch at a time. Additional key interlocks on the two STS input isolation switches (CB1, CB2) to ensure that the STS is on the source that the operator intends to bypass to, shall be available as an option.
5. Live System Test: While in maintenance bypass, and with the STS output isolation switch off, the STS shall be able to be tested with both sources connected to the STS through the input isolation switches (using the SCR's to make actual transfers).
6. EPO: In the event of an emergency power off (EPO) condition, all switches shall be shunt-tripped.
F. Preferred Source Selection (Symmetrical Operation): At the operator's option and without any degradation of performances or loss of protective features, the unit may be operated with either source designated as the preferred source. Also, the current alternate source shall be able to be switched to be the preferred source (using LCD screen, the manual hard key, communication port or remote input contact).

## G. Sensing and Transfer Times:

1. Voltage and/or current sensing using fast digital conversion techniques shall be employed for both sources to meet a maximum 2 milliseconds sensing time requirement (to sense a deviation of power quality outside of the Owner parameters).
2. Total sense and transfer time shall be $1 / 4$ cycle ( 4.17 milliseconds) maximum.

## H. Overload Operation:

1. On sensing a peak current overload (crest factor setting, 3.5 maximum), automatic transfers shall be inhibited and the load shall stay on the active source until the overload condition is cleared. On sensing peak current overload condition, a check shall be made for an under-voltage condition indicating that the under-voltage condition caused the overload. Automatic transfer shall be inhibited and the load shall stay on the active source until the overload condition is cleared and the system is reset (this fault condition shall be memorized).
2. An overload alarm shall be given if the load current exceeds the RMS current overload setting for more than 30 seconds. This overload condition shall not cause an automatic transfer.
I. Shorted SCR Protection (Including Back-Feed Protection): The STS design shall include, but shall not be limited to, sensing circuits to detect a shorted SCR and in addition to the following actions, shall initiate audible and visual alarms:
3. In the event of a shorted SCR in the active side powering the load, the unit shall alarm, and stay on the active side. Then the SCR isolation switch on the inactive side shall be shunt-tripped to prevent transferring to the inactive source. Automatic transfer and re-transfer shall be inhibited until repair is made and the system is reset.
4. In the event of a shorted SCR in the non-conducting SCR in the inactive side that is not powering the load at the time, the unit shall alarm. The STS shall immediately transfer the load to the inactive side to eliminate cross-connect current between the shorted sources. The SCR isolation switch in the previously active side shall be shunt-tripped to prevent re-transfer. Automatic transfer and re-transfer shall be inhibited until repair is made and the system is reset. A separate redundant back-feed protection circuit shall be provided.
J. Open SCR Protection: The STS design shall include, but shall not be limited to, sensing circuits to detect an open SCR and in addition to the following actions, shall initiate audible and visual alarms:
5. In the event of an open SCR in the active side powering the load, the unit shall alarm and immediately transfer to the inactive side. Then the SCR isolation switch on the previously active side shall be shunt-tripped. Automatic retransfer shall be inhibited under such conditions until repair is made and the system is reset.
K. Source Cross-Connection Protection: The STS transfer logic shall check that the two input sources, of any combinations, are never connected in a fashion to allow current flow from one source to the other without first passing through the load. The logic circuitry shall have protective sensing circuits that prohibit this conduction. Transfers and re-transfers between sources shall be break-before-make to prevent any cross-conduction, even in out-of-phase conditions.
L. Settings; Fixed and Adjustable:
6. Voltage Rating: 208 volts, 220 volts, 240 volts, 440 volts, 480 volts.
7. Current Rating: 100 amperes, 200 amperes.
8. Frequency Rating: 50 hertz, 60 hertz (default shall be 60 hertz).

Table of personalization accessible via panel display:

| Parameter (Configuration) | Setting Range | Default Setting |
| :--- | :---: | :---: |
| Nominal Voltage Rating | $208 \mathrm{~V}, 220 \mathrm{~V}, 240 \mathrm{~V}, 440 \mathrm{~V}, 480 \mathrm{~V}, 575 \mathrm{~V}$, | 480 V |
|  | 600 V |  |$]$|  |
| :---: |
| Nominal Frequency Rating |
| Maintenance Mode |
| Parameter (Transfer) |
|  |
| Automatic Re-Transfer Authorization |
| Auto-Re-Transfer Delay (Tret) |
| Transfer Break Time Delay (Ttrou) |

Table of personalization accessible via J-BUS:

| Parameter (Advanced Configuration) | Setting Range | Default Setting |
| :---: | :---: | :---: |
| Zone | E: EMOA / N: NASA | N |
| Nominal Current Rating | 100A, 200A, 400A, 600A | 200A |
| Neutral Present | 0 : No/1: Yes | 0 |
| Supply starting from the load | 0 : $\mathrm{No} / 1$ : Yes | 0 |
| Transfer Abort Delay (Tno_trans) | 10 seconds to 30 minutes ( 1 sec . steps) | 60 sec . |
| Operating Time |  | 0 |
| Automatic Transfer Authorization | 0: authorized / 1: forbidden | 0 |
| Slow Under/Over-Voltage Delay (Tcdult) | 1 msec . to 20 msec . (1 msec. steps) | 10 msec . |
| RMS Under/Over-Voltage Delay (Tcdurms) | 200 msec . to 5 seconds ( 100 msec , | 1 sec . |
| Detection of UV w/Overload Delay (Tcdcc) | 1 msec . to 20 msec . (1 msec. steps) | 5 msec . |
| RMS Current Overload Delay (Tcsi1 10) | - | 30 sec . |
| Regular Out-of-Sync Delay (Tdph12) | 5 periods to 15 periods (1 period steps) | 10 periods |
| Rolling Out-of-Sync Delay (Tdph12p) | 1 period to 5 periods (1 period steps) | 2 periods |
| SCR Queue Delay (Tqueue) | 100 usec. to 500usec. (50usec. steps) | 300usec. |
| Parameter (Tolerances) | Setting Range | Default Setting |
| Fast Over-Voltage | +20\% to +32\% (1\% steps) | +25\% |
| Fast Under-Voltage | -20\% to -32\% (1\% steps) | -25\% |
| Slow Over-Voltage | +5\% to $+20 \%$ (1\% steps) | +10\% |
| Slow Under-Voltage | $-5 \%$ to -20\% (1\% steps) | -10\% |
| RMS Over-Voltage | +5\% to +20\% (1\% steps) | +15\% |
| RMS Under-Voltage | -5\% to -20\% (1\% steps) | -15\% |
| Over-Frequency | +1\% to +10\% (1\% steps) | +5\% |
| Under-Frequency | -1\% to -10\% (1\% steps) | -5\% |
| In Phase Window | $0^{\circ}$ to $\pm 45^{\circ}$ ( $5^{\circ}$ steps) | $\pm 15^{\circ}$ |
| Peak Current Overload (Irms x Crest Factor) | ( $\times 3.5$ ) fixed | 3500 |
| Parameter (Hysteresis) | Setting Range | Default Setting |
| Fast Over/Under-Voltage Hysteresis | 0\% to 6\% (1\% steps) | 3\% |
| Slow Over/Under-Voltage Hysteresis | 0\% to 6\% (1\% steps) | 3\% |
| RMS Over/Under-Voltage Hysteresis | 0\% to 3\% (1\% steps) | 1\% |
| Over/Under-Frequency Hysteresis | 0\% to 5\% (1\% steps) | 2\% |

Table of industrialization personalization:

| Parameter (Sensor) | Setting Range | Default Setting |
| :--- | :---: | :---: |
| Technical Voltage Gauge : CteU | $208 \mathrm{~V}, 220 \mathrm{~V}, 240 \mathrm{~V}, 440 \mathrm{~V}, 480 \mathrm{~V}, 575 \mathrm{~V}$, |  |
| 600 V |  |  |$)$

## Missing:

| Preferred Source selection | $0: S 1 / 1:$ S2 | 0 |
| :--- | :---: | :---: |
| Phase Rotation | $0: \mathrm{ABC} / 1: \mathrm{CBA}$ | 0 |

## M. Front Control Panel Description/Operation:

### 4.13 <br> Front Control Panel Description/Operation




## SOFT KEYS:



## HARD KEYS:



## MIMIC DIAGRAM:



## N. Alarm; Visual and Audible:

| Alarm Event | Visual (LCD) | Audible <br> (Horn) | Latched | Auto Dial | Snap-Shot | Summary Alarm |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Source 1 Phase Sequence | Yes | Yes | Yes |  |  | Yes |
| Source 2 Phase Sequence | Yes | Yes | Yes |  |  | Yes |
| Source 1 Over-Voltage | Yes | Yes | Yes | Yes | Yes | Yes |
| Source 2 Over-Voltage | Yes | Yes | Yes | Yes | Yes | Yes |
| Source 1 Under-Voltage | Yes | Yes | Yes | Yes | Yes | Yes |
| Source 2 Under-Voltage | Yes | Yes | Yes | Yes | Yes | Yes |
| Source 1 Over-Frequency | Yes | Yes | Yes | Yes | Yes | Yes |
| Source 2 Over-Frequency | Yes | Yes | Yes | Yes | Yes | Yes |
| Source 1 Under-Frequency | Yes | Yes | Yes | Yes | Yes | Yes |
| Source 2 Under-Frequency | Yes | Yes | Yes | Yes | Yes | Yes |
| Open SCR1A | Yes | Yes | Yes | Yes | Yes | Yes |
| Open SCR1B | Yes | Yes | Yes | Yes | Yes | Yes |
| Open SCR1C | Yes | Yes | Yes | Yes | Yes | Yes |
| Open SCR2A | Yes | Yes | Yes | Yes | Yes | Yes |
| Open SCR2B | Yes | Yes | Yes | Yes | Yes | Yes |
| Open SCR2C | Yes | Yes | Yes | Yes | Yes | Yes |
| Shorted SCR1A | Yes | Yes | Yes | Yes | Yes | Yes |
| Shorted SCR1B | Yes | Yes | Yes | Yes | Yes | Yes |
| Shorted SCR1C | Yes | Yes | Yes | Yes | Yes | Yes |
| Shorted SCR2A | Yes | Yes | Yes | Yes | Yes | Yes |
| Shorted SCR2B | Yes | Yes | Yes | Yes | Yes | Yes |
| Shorted SCR2C | Yes | Yes | Yes | Yes | Yes | Yes |
| Source 1 Peak Current Overload | Yes | Yes | Yes | Yes | Yes | Yes |
| Source 2 Peak Current Overload | Yes | Yes | Yes | Yes | Yes | Yes |
| Current Overload(>110\% >30 sec. warning) | Yes | Yes | Yes | Yes | Yes | Yes |
| Source 1 Blown MOV Fuse | Yes | Yes | Yes |  |  | Yes |
| Source 2 Blown MOV Fuse | Yes | Yes | Yes |  |  | Yes |
| Source 1 CB1 Open | Yes | Yes |  |  |  | Yes |
| Source 2 CB2 Open | Yes | Yes |  |  |  | Yes |
| Bypass 1 CB4 Closed | Yes | Yes |  |  |  | Yes |
| Bypass 2 CB5 Closed | Yes | Yes |  |  |  | Yes |
| Output CB3A Open | Yes | Yes |  |  |  | Yes |
| Output CB3B Open | Yes | Yes |  |  |  | Yes |
| Auto Transfer Inhibited | Yes | Yes | Yes |  |  | Yes |
| Out of Sync | Yes | Yes |  |  |  | Yes |
| Auto Re-Transfer Disabled | Yes | Yes | Yes |  |  | Yes |
| Auto Re-Transfer Failed | Yes | Yes | Yes |  |  | Yes |
| Control Pwr Supply 1 (S1) Failure | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Pwr Supply 2 (S2) Failure | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Pwr Supply 3 (Output) Failure | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Pwr Supply 4 (EPO) Failure | Yes | Yes | Yes | Yes | Yes | Yes |
| Control Logic (FPGA) Failure | Yes | Yes | Yes | Yes | Yes | Yes |
| SCR1 Over-Temperature | Yes | Yes | Yes | Yes | Yes | Yes |
| SCR2 Over-Temperature | Yes | Yes | Yes | Yes | Yes | Yes |
| Fan Failure | Yes | Yes | Yes | Yes |  | Yes |
| SCR1 Gate Power Supply Warning(+24V) | Yes | Yes | Yes | Yes | Yes | Yes |
| SCR2 Gate Power Supply Warning(+24V) | Yes | Yes | Yes | Yes | Yes | Yes |
| SCR1 Gate Power Supply Failure(+5, $\pm 15 \mathrm{~V}$ ) | Yes | Yes | Yes | Yes | Yes | Yes |
| SCR2 Gate Power Supply Failure(+5, $\pm 15 \mathrm{~V}$ ) | Yes | Yes | Yes | Yes | Yes | Yes |
| In Manual Control Mode | Yes | Yes |  |  |  | Yes |

O. Status Indications:

| Condition | Visual <br> (LCD) | Visual <br> (Mimic) | Output <br> Contact | Latched | Auto Dial | Snap-Shot | Summary <br> Alarm |
| :--- | :---: | :---: | :---: | :--- | :--- | :--- | :--- |
| STS on Source 1 | Yes | Yes | Yes |  |  |  |  |
| STS on Source 2 | Yes | Yes | Yes |  |  |  |  |
| Source 1 Available | Yes | Yes | Yes |  |  |  |  |
| Source 2 Available | Yes | Yes | Yes |  |  |  |  |
| Summary Alarm | Yes | Yes | Yes |  |  |  |  |
| In Sync | Yes | Yes | Yes |  |  |  |  |
| Overload | Yes | No | Yes |  |  |  |  |
| STS Auto Transfer Inhibited | Yes | No | Yes |  |  |  |  |
| Source 1 is Preferred | Yes | Yes | No |  |  |  |  |
| Source 2 is Preferred | Yes | Yes | No |  |  |  |  |
| Source 1 ØA-B Voltage Meter | Yes | No | No |  |  |  |  |
| Source 1 ØB-C Voltage Meter | Yes | No | No |  |  |  |  |
| Source 1 ØC-A Voltage Meter | Yes | No | No |  |  |  |  |
| Source 2 ØA-B Voltage Meter | Yes | No | No |  |  |  |  |
| Source 2 ØB-C Voltage Meter | Yes | No | No |  |  |  |  |
| Source 2 ØC-A Voltage Meter | Yes | No | No |  |  |  |  |
| Load ØA Current Meter | Yes | No | No |  |  |  |  |
| Load ØB Current Meter | Yes | No | No |  |  |  |  |
| Load ØC Current Meter | Yes | No | No |  |  |  |  |
| Output Load KVA Meter | Yes | No | No |  |  |  |  |
| Output Load KW Meter | Yes | No | No |  |  |  |  |
| Output Load PF Meter | Yes | No | No |  |  |  |  |
| Phase Difference Meter | Yes | No | No |  |  |  |  |
| PMM ØA-B Voltmeter | Yes | No | No |  |  |  |  |
| PMM ØB-C Voltmeter | Yes | No | No |  |  |  |  |
| PMM ØC-A Voltmeter | Yes | No | No |  |  |  |  |
| PMM ØA-N Voltmeter | Yes | No | No |  |  |  |  |
| PMM ØB-N Voltmeter | Yes | No | No |  |  |  |  |
| PMM ØC-N Voltmeter | Yes | No | No |  |  |  |  |
| PMM ØA Current meter | Yes | No | No |  |  |  |  |
| PMM ØB Current meter | Yes | No | No |  |  |  |  |
| PMM ØC Current meter | Yes | No | No |  |  |  |  |
| PMM Neutral Current meter | Yes | No | No |  |  |  |  |
| PMM KVA meter | Yes | No | No |  |  |  |  |

P. Event Log: Chronology shall be recorded of at least the last 2000 events including, but not limited to, alarms, date and time stamped by an on-board real time clock, in the order of occurrence, with one resolution. Data shall be displayed on an alphanumeric LCD display with a text description of the alarm next to the event time. Data shall be retrievable via an RS-232/RS-485 port for Owner collection. The data logger shall function in a first-in first-out mode and shall be equipped with an internal battery connected to protect data in the event both power supplies experience an outage. Data shall remain in the log indefinitely for future review or evaluation.
Q. Transfer Counter: The transfer counter shall be based on: 1) from first day use; and 2) since last reset, and shall be date and time stamped.

## R. Owner Interface/Connections:

## Isolated Form C Relay Output Contacts (from core control output status signals):

| Indication |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| STS on Source 1 |  |  |  |  |  |  |
| STS on Source 2 |  |  |  |  |  |  |
| Source 1 Available |  |  |  |  |  |  |
| Source 2 Available |  |  |  |  |  |  |
| Summary Alarm |  |  |  |  |  |  |
| In Sync |  |  |  |  |  |  |
| Overload |  |  |  |  |  |  |
| STS Auto Transfer Inhibited |  |  |  |  |  |  |
| PMM Overload Alarm |  |  |  |  |  |  |
| Spare |  |  |  |  |  |  |
| Spare |  |  |  |  |  |  |
| Spare |  |  |  |  |  |  |

## Customer Control / Alarm Inputs (to core control input control signals):

| Condition |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Select Source 1 as Preferred |  |  |  |  |  |  |
| Select Source 2 as Preferred |  |  |  |  |  |  |
| Inhibit Auto Transfers |  |  |  |  |  |  |
| Remote Emergency Power Off (REPO) |  |  |  |  |  |  |

## Standard Communications Port: RS232 / RS485 Serial Port

## Options:

- Dual output isolation circuit breaker.
- Four keyed interlocks (bypass and source isolation CBs).
- Current-limiting circuit breakers (CB's with thermal magnetic trips) (instead of switches with magnetic trips only).
- Transient voltage surge suppression (TVSS) on each input source.
- Up to two optional communications cards (an additional RS-232/RS-485 communication port and/or and additional six relay dry contact alarm array) may be installed on the STS.


## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect/Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

### 3.2 INSTALLATION

A. General: Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings.

### 3.3 DEMONSTRATION

A. General: Provide the services of a factory-authorized service representative of the manufacturer to provide start-up service and to demonstrate and train the Owner's personnel.

1. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
2. Train the Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.
3. Review data in operation and maintenance manuals with the Owner's personnel.
4. Schedule training with the Owner, through the Architect/Engineer, with at least seven day's advanced notice.

### 3.4 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the static transfer switches shall be without damage at time of Substantial Completion.

## END OF SECTION

