**Product guide specification**

**Cyberex® SuperSwitch® 4 (4-pole STS)**

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# General

## Summary and scope

These specifications describe requirements for a [200A] [400A] [600A] [800A] digital static transfer switch (DSTS) at [208V] [415V] volts AC, 2 source, 3 phase, 4 wire + ground, 60 Hz. The manufacturer shall furnish all materials and equipment to be fully compatible with electrical, environmental, and spatial conditions at the installation site.

## Standards

The DSTS equipment and components shall be manufactured in compliance with the applicable requirements of the following standards:

* Listed to UL 1008S
* American National Standards Institute (ANSI)
* Canadian Standards Association (CSA)
* Institute of Electrical and Electronics Engineers (IEEE)
* ISO 9001
* ANSI/NFPA 70 (2008)
* National Electrical Code (2008)
* National Electrical Manufacturers Association (NEMA)
* Underwriters Laboratories (UL).
* ANSI/IEEE C 62.41 Surge/Noise suppression
* ISO 9001:2008 certification for quality management system

## Definitions

The following definitions shall apply throughout this specification:

* DSTS – a complete automatic digital static transfer switch and associated accessories.
* Bypass – the direct power flow from one source to the critical load as required for maintenance of the DSTS without disruption of the load.
* Redundant – the inclusion of one additional device than is required to achieve continuous operation without disruption of the load.
* Owner, User or Buyer – the owner; or the owner’s designated representative(s).
* Manufacturer – the firm or corporation who will manufacture and deliver the DSTS equipment specified herein.
* Specifications – the technical instructions described or portions of standards referenced herein, and any addenda thereto.

## System description

### Environmental requirements

The DSTS shall be capable of withstanding any combinations of the following environmental conditions without mechanical or electrical damage or degradation of operation.

* Operating ambient temperature: 0 to 40°C.
* Non-operating storage temperature: 0 to 80°C.
* Relative humidity: 0 to 95% non-condensing.
* Noise Level: < 65dba at 3 meters from the DSTS for 200A – 800A units.
* Maximum operating altitude without de-rating: 6000 feet above sea level.
* Equipment shall be designated for indoor use in a clean (dust-free) temperature and humidity-controlled environment.
* AC to AC efficiency at full nominal rating shall not be less than 99.0% at 415V or 98.7% at 208V.

### Electrical characteristics

* Nominal source voltages: [208V] [415V] volts AC plus ± 10%, 3 phase, 4 wire + ground (neutral switched).
* Source frequencies: [60Hz] ± 5%.
* Continuous current rating: [200A] [400A] [600A] [800A]
* Neutral rating: 100%
* Load power factor: Unity to 0.70 lagging or leading.
* Short circuit current rating (SCCR): [65kA] [100kA]
* Load crest factor: Up to 3.5
* Overload rating:
* 125% for 30 minutes
* 150% for 1 minute
* 200% for 10 seconds
* 1000% for 3 cycles
* 1500% for 1 cycle
* Harmonic current fed back from the load: Unlimited (*as long as continuous current rating is not exceeded on phases or neutral*)
* Source voltage THD in the line feeding the load:
* Maximum 5% total harmonics or as acceptable to the load.
* Maximum 3% single harmonic or as acceptable to the load.
* Voltage transient withstand without failure or miss operation, present on the line: Up to 20,000-volt spike, per IEEE C62.41 Category C3 Standards. Such transient levels shall not affect the operation of the DSTS except to cause a transfer due to overvoltage beyond pre-set limits.
* Short circuit and overload rating shall be such that the unit does not drop the load while such conditions are being protected or acted on by properly rated circuit breakers in the owner’s distribution system.

### Construction and enclosure

* The DSTS assembly shall be constructed in modular configuration for maximum ease of maintenance and installed in NEMA Type-1 metal enclosures made of 11-gauge steel frame and 16-gauge steel sides.
* The enclosure shall have all normal operating controls, instrumentation, display and lights mounted on the front door. All control setting adjustments for voltage level sensing shall be via a Graphical User Interface (GUI) menu driven software on a color LCD panel on the front of the unit. The DSTS shall enable an internal set of PCB-mounted auxiliary operators that allow basic control functions to be affected from inside the DSTS by qualified service personnel.

1.4.3.1 Access requirements

* Individual enclosures shall require front access for equipment operation and removal of serviceable parts such as pc boards, SCR assemblies and plug-in breakers. Front doors shall be lockable to provide access only by authorized personnel. Deadfronts shall be provided behind the lockable front doors to allow safe operation of breakers and to cover all energized parts.
* Installation and torqueing of customer connections shall require [Front] [One Side] [Rear] access (*model dependent*)

### Modularity of construction

Sub-assemblies shall be constructed for ease of access and replacement of parts. Circuit boards shall use industry-accepted connectors. Connectors shall be chosen such that erroneous connections are not possible. SCR assemblies shall be pullout style for ease of replacement and minimal downtime.

### Bracketing and wiring

Brackets and securing hardware shall be electroplated with corrosion resistant material. Internal wiring conductors shall be combined into cables or bundles and tied securely together. All wiring shall be clearly marked. All logic and control connections shall be routed away from any power runs for noise suppression.

### Conducting material

All internal bus work shall be fabricated of custom-formed copper and shall be rated for 1000 amperes per square inch cross section or to not exceed a temperature rise of 50°C in free air. Aluminum bus work shall not be acceptable for use in the DSTS.

### Material and workmanship

All materials and parts comprising the DSTS shall be new, of current manufacture, high grade, and free from all defects or imperfections, and shall not have been in prior service, except as required during factory testing. Workmanship shall be of the highest quality.

### Short circuit bracing

Unit construction and component selections shall incorporate ratings, support and bracing methods to allow for the specified short circuit withstand rating of the unit; including all electro-mechanical and power electronic devices, interconnections, cable and bus work.

### Surge/noise suppression

Power SCRs used in the system shall be conservatively rated for dv/dt of at least 800 V/µSec. The design of the unit and component selections shall provide capability to withstand noise spikes per ANSI/IEEE C 62.41 standards (2 kV impulse) without malfunction or any device breakdowns or sporadic transfers.

## Warranty

The DSTS manufacturer shall guarantee the entire system against defective material and workmanship for a period of one (1) year from date of shipment.

With purchase of factory start-up services and used in the continental United States, the manufacturer shall include labor and expenses for a period of one (1) year from date of the factory start-up, not to exceed eighteen (18) months from date of factory shipment.

## Reliability

As the intended use of the DSTS is to achieve the ultimate reliability of availability of power to critical loads, using two available power paths, it is required that this device not introduce additional failure contributions that would interfere with maintenance of power to the load, as long as one or the other of the connected sources are available and within tolerance of the load. The following critical reliability parameters are therefore required. The DSTS shall have a demonstrated MTBDE of > 1.5 million hours.

### Experience and service history

The manufacturer shall have a minimum of 30 years of experience in the design and manufacture of standalone digital static transfer switches and a minimum of 6,000 installed locations with a proven history of reliable operation. For the purposes of checking references of the bidder, a list of at least 10 sites with a description of the switch, switch rating, complete site contact information and the number of years in operation can be furnished upon request. Prior experience with UPS bypass switches is not acceptable for this project. It is the owner’s intent to purchase products only from qualified bidders with a well-established history of DSTS products.

### High reliability logic components

The DSTS logic shall be fault tolerant in that no single point of failure on the communications bus, internal wiring or any board can cause a disturbance of power to critical loads, as long as two sources of power are available.

# Product

## Manufactured Units

2.1.1 STS Manufacturers: Subject to compliance with requirements, provide products by ABB (Cyberex).

## Components

### Non-automatic circuit breakers

* All molded case switches (MCSs) shall be plug-in or drawout style for ease of removal for replacement, calibration, or testing, without interruption of service to the critical load. Six (6) non-automatic breaker/switches shall be provided for the DSTS. There shall be two breakers/switches for load bypass to each input, two for SCR input source isolation, one to each source, and two for SCR load isolation. All non-automatic switches shall be rated to carry the 100% rating of the digital static transfer switch at the ambient temperature specified.
* Mechanical interlocks shall be provided on the switches/breakers to prevent operators from closing both bypass MCSs at the same time.
* Step-by-step guided software with lighted LED indicators shall be provided for each breaker to aid the operator in placing the unit into, and taking the DSTS out of, bypass.
* Both input source MCSs will be equipped with shunt trip that interface with the logic and will activate in conditions to prevent cross connect.
* There shall be provisions to test the system and logic while in maintenance bypass, without load disruption.

### Silicon controlled rectifiers (SCRs)

The DSTS consists of eight pairs of SCRs connected in a 3-phase and neutral switch configuration. The SCRs shall be hockey puck type and rated to carry the full 100%, continuous rated, load under nominal conditions. Use of “brick” or “gel filled” type SCRs are not allowed for all switch applications with available fault levels that may cause an SCR rupture phase to ground of such devices if not properly fused. Additionally, SCRs shall be oversized to allow the use of circuit breakers as the means of protection for these devices. SCRs shall have a non-rupture rating or be protected in a manner compatible with the specified fault current availability.

### Circuit boards

* Major circuit boards shall have LED indicators to annunciate critical board functions for ease of troubleshooting and maintenance.
* The circuit boards shall have no single points of failure that could cause a loss of power to connected loads, when two power sources are available.
* Circuit boards will minimize the use of through-hole components and shall use surface mount technology for the majority of board level components.

### Ventilation and cooling

* Enclosure design shall provide adequate ventilation to ensure that all components are operated within their safe, intended thermal ratings.
* Fans shall be equipped with reliable hall-effect sensors for failure detection. Mechanical vane type switches are not permitted.
* Software shall be provided with cooling fan sensing and monitoring that are user configurable.
* Air intake shall be from the bottom to utilize benefits of raised floor cooling applications. Optionally, air intake from the front for solid floor applications.
* The design of the unit ventilation shall take into account continuous operation in an ambient temperature of 40°C, 0-95% non-condensing humidity and an under-voltage condition of -10%; or a simultaneous combination of these elements. Provide a grill to ensure against falling of external objects into the unit.

### DSTS control panel

The DSTS graphical user interface (GUI) shall have a long life touch screen liquid crystal display (LCD). The LCD shall measure at least 10 inches. The display shall contain all normal operating controls, metering and status indications. Additionally, the display shall possess a mimic screen depicting the overall DSTS power flow.

## Metering, alarm and monitoring system

The DSTS shall provide the following minimum metering, alarm and monitoring functions.

### Alarms – system (audible and visual):

* Output unavailable
* Source breaker open
* Load breaker open
* Fan failure
* Cabinet over temperature
* Logic power supply failure
* Communications failure (external and internal)
* Heatsink over temperature
* EPO

### Alarms – preferred and alternate sources (audible and visual):

* Transfer failure
* Input fail
* Overload
* CB open
* Over voltage (amber and red) – fast/slow
* Under voltage (amber and red) – fast/slow
* Over frequency
* Under frequency
* Shorted SCR
* Open SCR
* Inactive source over current (ISOC)
* TVSS fault
* Gate drive power supply failure
* Gate drive communication error
* Source out of sync
* Phase rotation

### Alarm – event logging

* The DSTS shall display a chronology of the last 5,000 events including alarms and warnings date and time stamped by local real time clock in the order of occurrence. The date and time stamp shall provide 1 millisecond resolution. Data shall be displayed on the GUI display along with a text description of the alarm or warning event. Data shall be retrievable via an Ethernet or USB Service port for customer collection. The Data logger shall function in a first-in first- out mode and shall be provided with an internal battery backup to protect data in the event both power sources fail. Data shall remain in the log indefinitely for future review or evaluation, and shall be filtered and/or sorted by date, time & type of event.
* A USB port will be standard to allow a USB memory stick to be used to download events and easily transfer event information to a PC for analysis.

### Metering

* Voltmeter with output, preferred, and alternate sources for each phase; line to line (A-B, B-C and A-C), line to neutral (A-N, B-N, and C-N), and ground to neutral, all displayed simultaneously for instant comparison by operator.
* Ammeter with output, preferred and alternate sources, for each phase (A, B and C, and neutral), all displayed simultaneously for instant comparison by operator, for instant detection of an open phase.
* Ammeter with output ground for each phase.
* Frequency meter – both sources.
* Phase angle meter – between sources.
* Harmonic voltage distortion of the load (voltage and current) in THD as well as individual frequencies up to 13th harmonic in % of total.
* Transfer counter from last date reset (display count). Resetting shall require passwords.
* Source power factor
* Thermal data of display board, cabinet and fans
* Maximum peak current (amps peak) since last reset
* System information

### Annunciation points

The DSTS shall provide a total of 16 isolated Form C contacts to indicate the status of alarms and for interface to building management systems:

* Summary alarm
* Summary warning
* Status of source 1
* Status of source 2
* Source 1 available
* Source 2 available
* Unacknowledged events
* On preferred source
* Eight user configurable alarm relays

### Interface points

The DSTS shall provide ten isolated inputs to accept user’s contact closures to indicate the following:

* EPO
* Remote EPO
* Source 1 preferred
* Source 2 preferred
* Transfer/hold to source 1
* Transfer/hold to source 2
* Temporary retransfer enable
* Auto transfer disable
* Available for custom applications

Monitoring – the DSTS shall be equipped with waveform capture. The waveform capture feature uses digital signal processors and high-speed analog to digital converters to simultaneously sample sources and output voltages and currents. The waveform data is collected every 260µsec as 12-bit samples to provide a high level of accuracy. The DSTS is capable of storing 17 waveform capture events for both transfer and non-transfer events. Each measurement contains a total of 10 cycles; 5 cycles prior to the event and 5 cycles after the event. The waveform can be sent via email or downloaded to a USB memory stick and imported into an Excel spreadsheet for viewing and analysis.

## Communications and connectivity

The DSTS shall provide communications connectivity and protocols to interface with the user’s building management system (BMS), local network and portable devices using the following methods. The manufacturer shall provide comprehensive documentation to facilitate the interface with the user’s systems.

All remote communications with the DSTS using internet, Modbus or serial protocols shall be strictly limited to monitoring. There shall be no provision that allows the DSTS to be remotely controlled or remotely perform any function that could cause a load drop.

### Modbus over RTU (via RS 485)

The DSTS shall provide serial (2 wire or 4 wire) standard Modbus connectivity over RS 485. The DSTS shall be designated as “slave” and assigned a single Modbus ID.

### Modbus over TCP, via Ethernet

The DSTS shall provide Modbus TCP over Ethernet.

### Serial service port, via USB

The DSTS shall provide a dedicated USB service port for use by authorized field service personnel for the purposes of performing maintenance tasks including diagnostics and software upgrades. The USB service port shall also facilitate software upgrades via a USB storage device, as well as, alarm/warning and metering/configuration data downloads.

### Remote software upgrade

The DSTS shall provide the following functions for communicating the status via the Internet or Intranet:

* FTP and TFTP – The DSTS shall provide means for authorized field service personnel to performing remote software upgrade.

## Functional and operational requirements

### Normal mode

* The DSTS is fed from two sources. The sources are referred to as “preferred” and “alternate”. The output of the DSTS is connected to the critical load. The DSTS shall operate with inputs from two synchronized 3 phase AC, 4 wire, 60Hz sources within +/- 10% of the DSTS’ rated voltage, from a grounded neutral wye system.
* The DSTS shall provide voltage to its output terminals for any load from 0 to 100% of rating, at any power factor or degree of non-linearity. One power source shall be the normal source, and when it is within normal limits, it shall supply AC power to the critical loads. The other shall be the alternate source and shall be immediately available for use in the event the normal source exceeds its pre-set limits so that the critical load does not have an operational interruption. Voltage and phase angle adjustments to define the acceptable range shall be user-defined through the user interface located outside the equipment without special equipment.

### Transfer operation

* Upon loss of the primary source the DSTS shall transfer the load to the alternate source by turning off the primary source SCRs and turning on the alternate source SCRs in a sequence and timing that allows a total combined sense and transfer time of less than 4ms during normal conditions where the two sources are in phase. During this operation sequence the neutral SCRs shall transfer with overlap delay of 1 cycle (16.7ms).
* The DSTS shall only perform a break-before-make or “open transition” between sources. This methodology prevents momentary connection between two sources.
* The alternate power source shall be monitored continuously to inhibit transfer to a failing or out-of-spec source before turning on the alternate side SCRs. If the alternate power source is outside the pre-set power quality limits, then it is disqualified and the transfer is inhibited. The control panel shall indicate when a transfer has been inhibited due to a disqualified source. The control panel shall separately indicate an out-of-synch condition.

### Symmetrical operation

The DSTS shall allow the preferred source to be selected at the operator’s discretion. There shall be no difference in the operation or performance of the DSTS because of which source is selected as “preferred” or “alternate”. The operator must have administrative password access to change the source preference from the local user interface of the DSTS.

### Automatic retransfer operation

After a transfer event the DSTS shall be capable of automatically re-transferring the load back to the preferred source. This operation shall be user-selectable by selecting "Auto-retransfer On", or "Auto-retransfer Off". The "On" selection allows re-transfer to occur after a user-selected time delay of 0 to 120 seconds. The "Off" selection requites that re-transfer be manually initiated. Selection shall require administrative password access from the control interface. Re-transfer shall not occur if the two sources are not within the phase and voltage tolerance limits pre-set by the user unless the alternate source is entirely lost.

### Manual transfer operation

The digital static transfer switch shall be capable of operating as a manual switch by disabling the transfer feature which is normally “enabled”. When the DSTS is in the “disabled” mode the operator shall manually command it to transfer to a qualified source by evoking the “manual transfer” command. If the incoming source is “rolling” in and out of synchronization the DSTS shall wait for the synchronized state, then perform the transfer. It shall then be up to the user to place the DSTS back into the transfer “enabled” state so that it will perform automatic transfers.

### Load uninterrupted transfer

Transfer from one source to the other, regardless of direction, shall appear uninterrupted to the load in-spite of the intrinsic break-before-make transfer of the DSTS. There shall be no direct flow of current from one source to the other under any conditions.

### Pre-set limits, sensing and adjustments

* All settings shall be adjustable by the user. No setting shall be “purchased pre-set from factory” requiring replacement of parts, pot adjustments or component replacements by the supplier’s technicians chargeable to the user. Adjustable parameters are:
* Voltage and frequency limit settings: Acceptable voltage and frequency limits shall be individually adjustable by an operator within the allowable limits. There shall be three levels of user-definable voltage set-points; “good”, “marginal” and “unacceptable”. These adjustments shall be for the full range of 0 to +100% of nominal for over voltage and under voltage and made possible through the menu selection on the control panel display. Administrative password access shall be required to make these adjustments. The unit shall transfer to the alternate source if the above limits are exceeded on the active source and, stay in that position until such time that the preferred source returns to normal.
* Power quality detection method: The DSTS does provide a robust algorithm for power quality detection using a synchronous rotation frame phase locked loops. It also monitors each phase individually should an imbalance condition occur. In addition, the DSTS uses high efficiency digital IIR filters to be immune to distortions caused by harmonic or imbalanced loads. This method gives the DSTS the ability to detect power quality issues in less than 2 milliseconds.
* Retransfer time delay: The DSTS shall provide an adjustable retransfer delay from one to 120 seconds through menu options.
* Phase angle adjustments: The DSTS shall only permit a transfer when the active and inactive sources are within a user-defined phase angle window defined by single number of degrees leading (plus) or lagging (minus) the active source. The DSTS shall be able to do an emergency transfer within a phase difference window of any number of degrees between the sources whose phase difference is between 0 to 180 degrees.

### Short circuit or overload operation

Under short circuit or overload conditions in the load, transfer shall be inhibited until the fault or overload is cleared by downstream protective devices.

### Shorted or open SCR detection and protection

The DSTS shall include sensing circuits to annunciate a shorted or open SCR in either of its source legs. Sensing circuits shall detect a failed SCR in any of the phases in the switch and shall initiate audible and visual alarms, which indicates the location of the failed SCR.

* In the event of an open SCR in the active side powering the load, the unit shall alarm and immediately make a transfer to the inactive side. The isolation breaker on the previously active side shall be shunt tripped. Retransfer shall be automatically prohibited under such conditions until the repair is made and the alarm is acknowledged and reset.
* If an SCR in the active side shorts while that source is powering the load, then this condition shall be sensed, and an alarm indicator shall be actuated. The SCR isolation breaker on the inactive side shall be shunt tripped. Automatic transfer to inactive side shall be prohibited until repair is made and the alarm is acknowledged and reset.
* If an SCR in the inactive side shorts while the active side is powering the load, this condition shall be sensed and an alarm activated. The DSTS shall immediately transfer to the inactive side. The isolation breaker on the active side shall be shunt tripped. Retransfer shall be prohibited until repair is made and the alarm is acknowledged and reset.

### Dynamic inrush restraint

The DSTS shall be available with Real Time Flux Control™ for Dynamic Inrush Restraint (DIR) transfer algorithm for all DSTSs located on the primary (delta) side of distribution transformers. The DSTS shall use digital signal processors to continuously monitor and compute the flux trapped in the transformer in real time, while continuously determining which SCRs to fire independently should a power quality event occur. When installed and enabled, the Real Time Flux Control™ for DIR shall ensure that the transformer flux has been equalized and limit the peak inrush in the transformer to below 1.2x during asynchronous transfers outside of the user adjustable phase angle window. In the event that an emergency transfer between out-of-phase sources is attempted, DIR feature shall consider the volt-second integral at the primary of the downstream transformer, the phase difference between the sources and the instantaneous values of the sources; and independently determine which SCRs to fire during the transfer. The DIR transfer shall always ensure that asynchronous transfers exceed the ITIC and CBEMA curve standards for critical loads. Settings shall permit the DIR function to always be enabled; or to be disabled when phase angle difference between the sources is within a user-defined “transfer enabled” window and enabled when the phase difference between the sources is outside the “transfer enabled” window.

# Execution

## Overview

Factory start-up and user training, preventive maintenance service and full service for the above specified system shall be included upon request. The manufacturer shall nationally employ service organizations of factory-trained field service personnel dedicated to the start-up, maintenance and repair of the manufacturer’s power equipment.

The manufacturer shall maintain, 24 hours per day, 365 days per year, an answering service to facilitate in providing technical support and emergency service dispatching.

### Installation, inspection and factory authorized start-up

Installation and start up shall include the following:

* Ensure removal of temporary shipping bracing.
* Verify all internal electrical connections for tightness as specified.
* Review the field assembly and connection of components.
* Inspect accessible components for cleanliness, for mechanical and electrical integrity and for evidence of damage or deterioration.
* Pretest and adjust all transfer, monitoring and/or control parameters as required.
* Correct all deficiencies before proceeding with tests. Correct deficiencies identified by tests and retests.
* If applicable, adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout the normal operation cycle of the facility.
* Record circuit monitors set-ups, if applicable.
* Measure output voltage of branch circuit panelboard, if applicable. Verify proper operation of equipment, including circuit monitor and input and output control circuits.
* Submit test reports.

### Training

Concurrent with factory authorized system startup the manufacturer’s field service engineer shall train the owner’s operating personnel in the proper operation of the system. Training shall last a minimum of two hours and shall include:

* Safety precautions
* Features of project equipment
* Voltage adjustment procedures, if applicable
* Routine inspection and test procedures
* Routine cleaning
* Interpretation of reading of warnings and alarms

**End of specification**