LayerZero
Power Systems, Inc.

Static Transfer Switches

The Foundation Layer

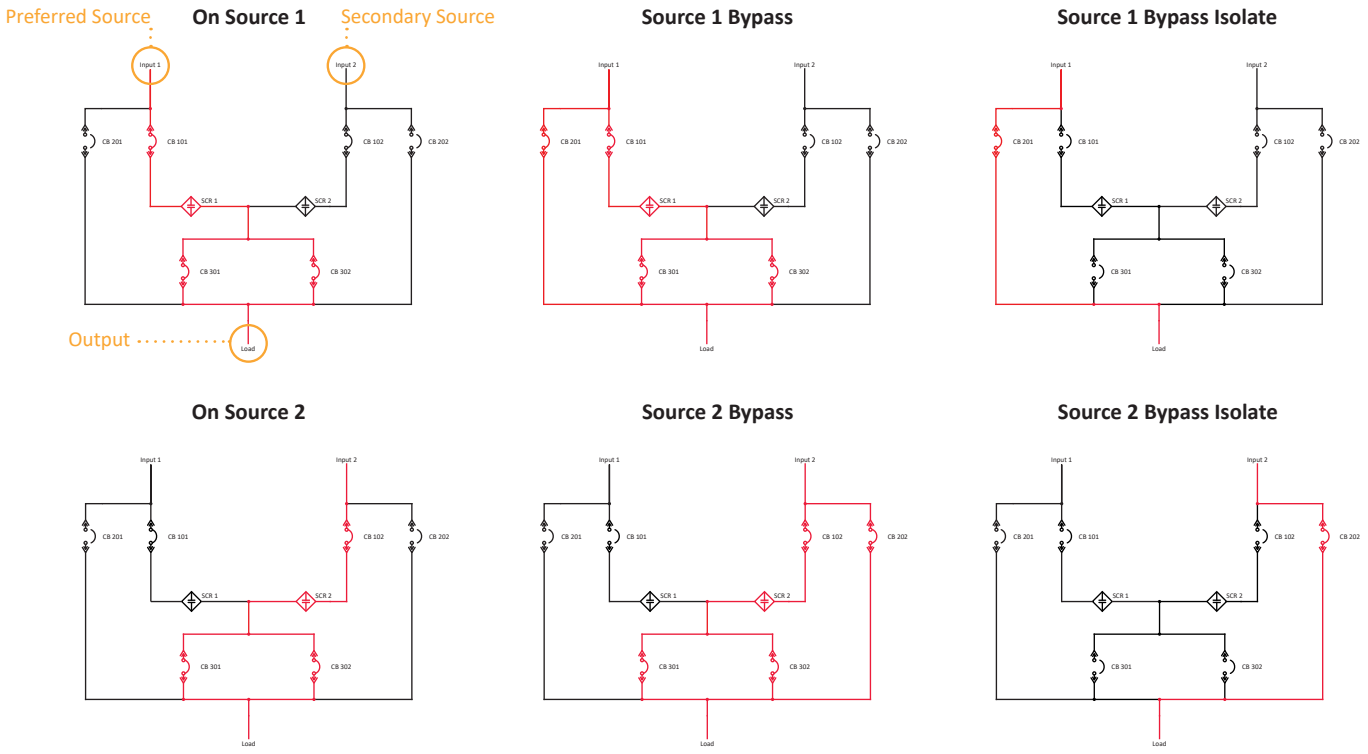
What is a Static Transfer Switch?

The LayerZero eSTS Static Transfer Switch provides an automatic transfer between two or three input power sources and a single output.

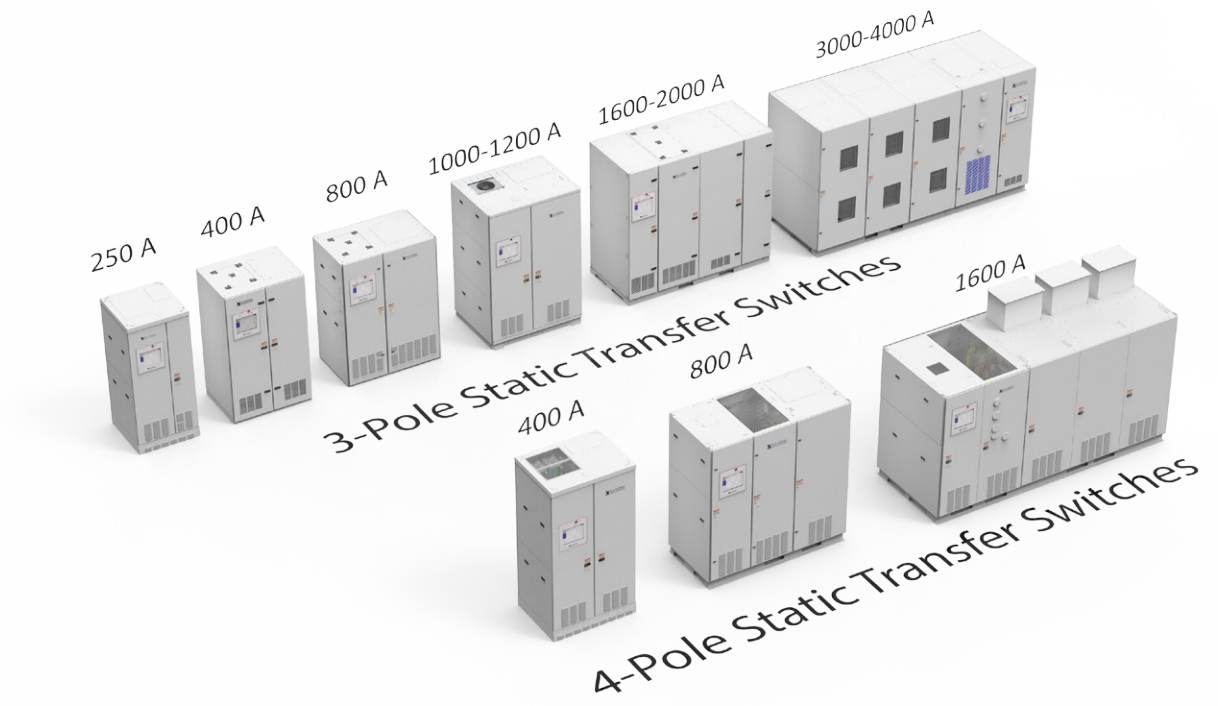
Each input source (Preferred Source + Secondary Source) is required to be always-on and ready-for-use. In a normal operating condition, one of the two sources is designated as the “preferred source”, and the eSTS powers the load from the preferred source.

If at any time the primary source goes out of specification, the eSTS will instantaneously transfer the load to the alternate source. The transfer between sources is so fast that the load never recognizes that a transfer was made, and connected equipment does not experience any interruption in power.

Static Transfer Switch Modes of Operation



LayerZero eSTS - Product Overview



LayerZero eSTS Static Transfer Switch Standard Configuations

LayerZero Power Systems designs Static Transfer Switches in configurations ranging from 250 A - 4000 A, in either 3-pole or 4-pole configurations, with 2 or 3 power sources. Systems can utilize either SMR (Three-CPU Redundancy) or TMR (Nine-CPU Redundancy) configurations, to best-fit the level of reliability and redundancy required for the application.

Integrated Transformer and Distribution Options

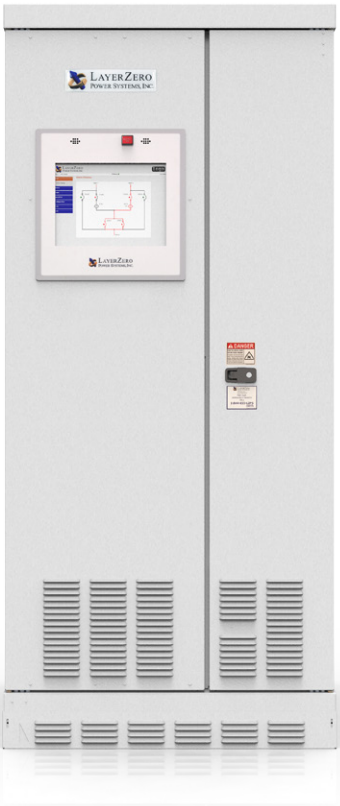
LayerZero provides integrated Static Transfer Switch/Power Distribution Unit options that combine STS units with transformers and distribution in a single-cabinet design. STS/PDU options include a variety of input voltages, transformers on either the primary or secondary side of the STS, and distribution options in either ELP (Exposed Live Parts) or NELP (No Exposed Live Parts) configurations. A single-cabinet design simplifies installation, reduces system complexity, and integrates more-easily with power quality monitoring systems.

LayerZero eSTS Products ETL Listed to UL 1008S

Current	250 A, 400 A, 600 A (3-pole), 800 A, 1200A (3-pole)
Voltage	208, 220, 380, 400, 415, 480, 575, 600
Withstand Rating	10, 14, 18, 20, 25, 35, 42, 50, 65, 85, 100
Type (Redundancy)	SMR, TMR
Poles	3, 4
Number of Sources	2, 3

The LayerZero eSTS is the Industry-Standard in Reliability

Since 2001, LayerZero Power Systems has established a reputation for building the most reliable static transfer switches in the industry. Designed for applications that require the highest standard in power reliability, the LayerZero Series 70 eSTS: Static Transfer Switch provides unparalleled power protection, a last line of defense before the critical load is compromised. If the primary source goes out of specification, eSTS transfers to the secondary source *so fast* that the critical load output experiences no interruption. As is standard with all LayerZero products, the eSTS Static Transfer Switch comes equipped with built-in waveform capture and ITIC plotting, so that equipment operators immediately know if a transfer was made within the bounds of the ITIC curve. Immediately upon transfer, an email is sent with a picture of the waveform - so you don't have to look for it.



Available in 3-Pole and 4-Pole configurations from 250 A to 4000 A, the LayerZero Series 70: eSTS Static Transfer Switch helps maintain power continuity for enterprises of all sizes.

Please contact LayerZero for custom-designed 3-source or 5000 A configurations.

How Does LayerZero STS Help Increase Electrical System Reliability?

Connecting sensitive electronic equipment directly to utility power is risky. The quality of utility power can vary - and events such as undervoltages, overvoltages, spikes, surges, and even momentary outages can cause serious business disruptions.

Unplanned power outages can lead to signifcant losses in revenue, as well as increased costs in outage detection, recovery, and equipment repair. If the the cost of downtime is higher than the cost of building redundant power systems, it makes financial sense to deploy redundant systems that guarantee a reliable electrical supply.

The LayerZero eSTS increases reliability in two ways. First, the LayerZero eSTS static transfer switch is a very high-quality and high-reliability component in the electrical system. Utilizing the highest quality and high-reliability components in an electrical system helps prevent faults and problems in the from occuring in the first place. Second, eSTS is designed with built-in redundancy, so in the unlikely event that an individual component fails, power can be safely bypassed and a single part can be replaced without compromising the overall reliability of the system.

The Static Transfer Switch plays an essential role in maximizing electrical power reliability in critical facilities, and it is cruicial to select the right supplier. LayerZero Power Systems is the leading manufacturer of high-reliability Static Transfer Switch technologies, we have combined innovation, technology, and unparalleled industry knowledge to become the preferred STS provider to power distribution professionals worldwide. The designers at LayerZero Power Systems are masters of problem solving, and our experts will be happy to help guide you through the specification process and answer any questions about you may have about products.

eSTS Has Multiple Dimensions of Reliability

eSTS Standard Reliability Features

- ☑ **Dynamic Phase Compensation:** Protects Upstream Sources and Downstream Critical Loads by Eliminating Transformer Inrush
- ☑ **Safe Bypass Procedure:** Eliminates Human Error When Performing Bypass Procedures with the Mechanical Bypass Interlock
- ☑ **Voice Guided Bypass:** Standardize Processes with Step-By-Step Audio and Video Guidance To Assist Operators
- ☑ **Convection Cooling:** Maintenance-Free Natural Convection-Cooled Heat Dissipation System
- ☑ **Epoxy Coated Buswork:** Maximizes Reliability By Eliminating The Possibility of Bus-To-Bus Faults
- ☑ **Silver Plated Terminals:** Silver Has Excellent Conductivity To Provide Superior Electrical Performance and Reliability
- ☑ **Maintenance-Free Joints:** Brazed Joints Are Permanent And Maintenance-Free, Maximizing Product Life
- ☑ **Machined Hardware:** Machined Cap Screws and Engineered Disc Springs Maintain Constant Torque Throughout Product Life
- ☑ **Screw Thread Inserts:** Prevents Screws From Loosening Under Vibration For Long-Term Reliability
- ☑ **Optical Fiber Based Controls:** Eliminates Noise and Interference While Isolating Components from High Voltage
- ☑ **Serialized Critical Board Tracking:** Critical Boards Are Serialized And Cataloged in an Active Database For Traceability

Single Modular Redundancy (SMR) Topology

High-Reliability Redundancy with No Single Point-of-Failure

Single Modular Redundancy is a high-reliability topology, designed to provide redundant voting logic at a lower cost than Triple Modular Redundancy.

LayerZero SMR has built-in logic redundancy, utilizing three independent processors - one for each input source and another for the output. The signal path between each transfer control processor and gate drive is isolated and independent, ensuring integrity in communications between each processor and gate drives.

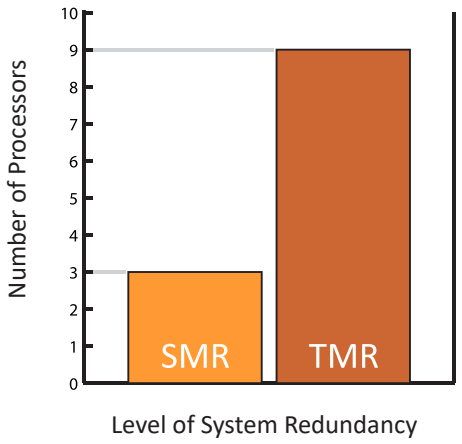
When coupled with the fault-tolerance and redundancy of the other components, the reliability of SMR-enabled eSTS systems is greater than competing products that do not have such capabilities.

Levels of Redundancy in LayerZero SMR Systems include:

- Elimination of all single points of failure
- Redundancy of power supplies
- Segmentation of gate drives by Source and Phase

The LayerZero SMR STS is well-suited for STS based dual cord distribution systems.

SMR vs. TMR



Triple Redundant Power Supply Architecture

(Standard in SMR & TMR Systems)

To provide the highest system reliability, each control group has power fed from multiple power supplies.

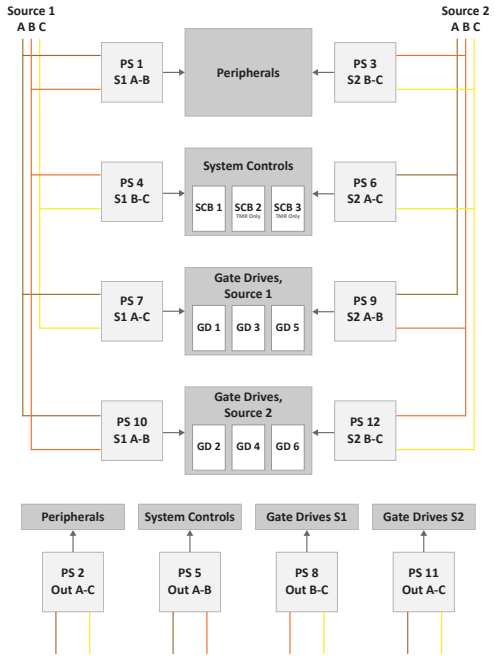
The eSTS is divided into four (4) logical control groups:

- System controls
- Source 1 gate drives
- Source 2 gate drives
- Peripherals.

The three (3) available sources of power from which to supply control power to each control group are:

- Source 1
- Source 2
- STS Output.

LayerZero's 3-pole, 2-source STS design incorporates twelve (12) power supplies (3 power sources x 4 failure groups.) The resultant control power topology utilizes all possible power paths to the four logical STS failure groups; and is the most comprehensive and redundant power supply system in existence.



*4-pole and/or 3-source STS has additional power supplies.

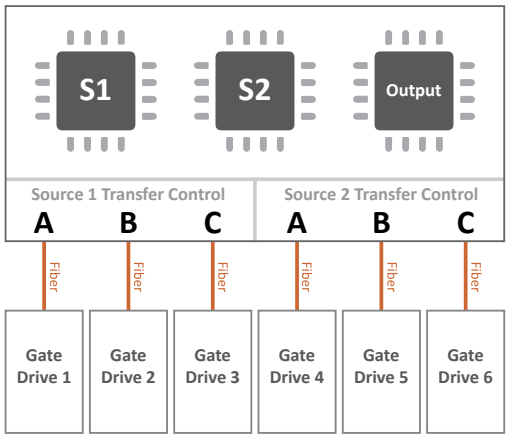
Independent Processors for Maximum Reliability

eSTS SMR with Triple CPUs

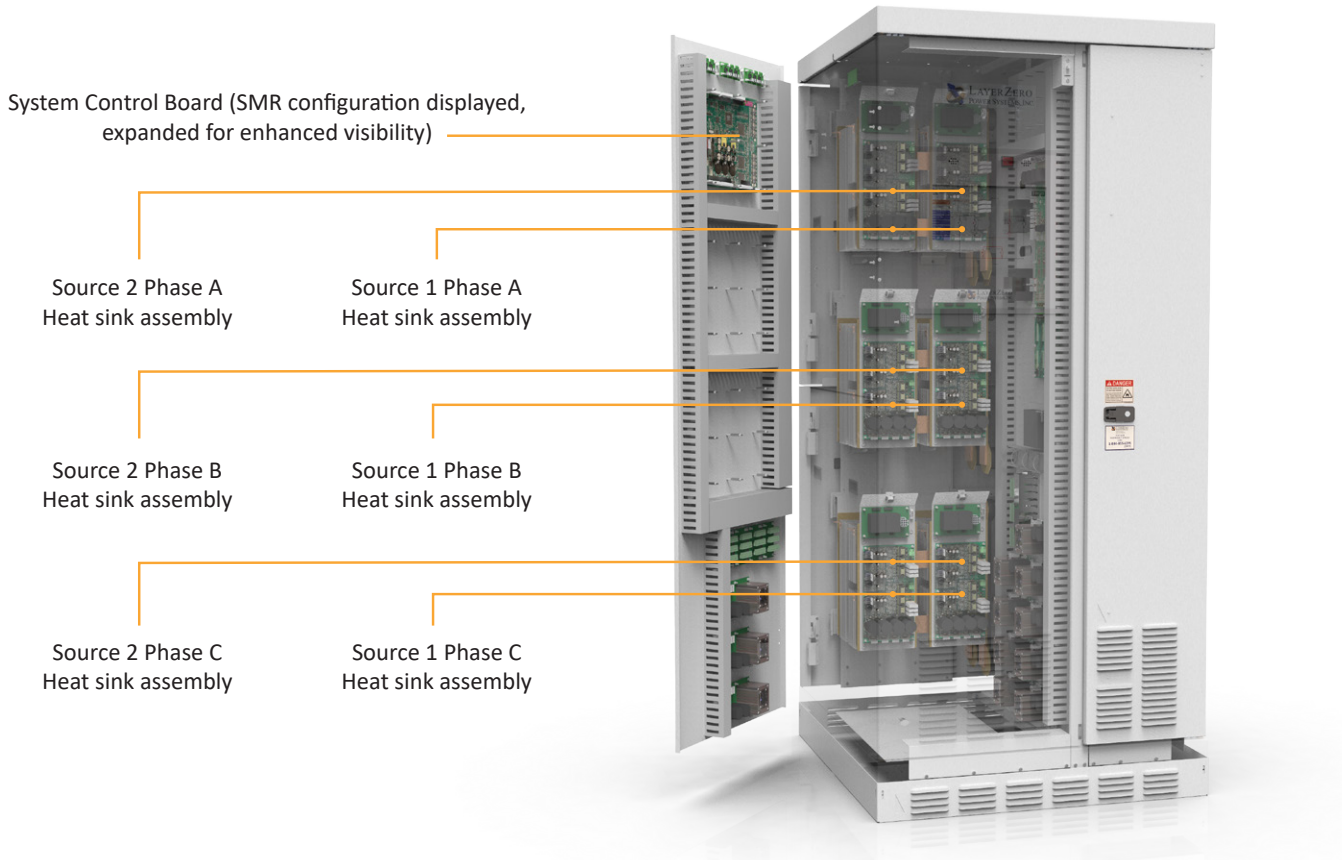
Triple processors are standard in all SMR configurations, and make eSTS controls more reliable and fault-tolerant.

The eSTS design utilizes:

- Separate/independent processors for Source 1, Source 2 and Output power quality analysis
- If Source 1 processor malfunctions then system is able to be commanded to transfer to Source 2; & vice versa.
- If main control system fails then STS continues to conduct power to the load from the existing source of power. (However STS is unable to transfer to the other source)
- Staggered gate drive arrangement for uniform heat dissipation.

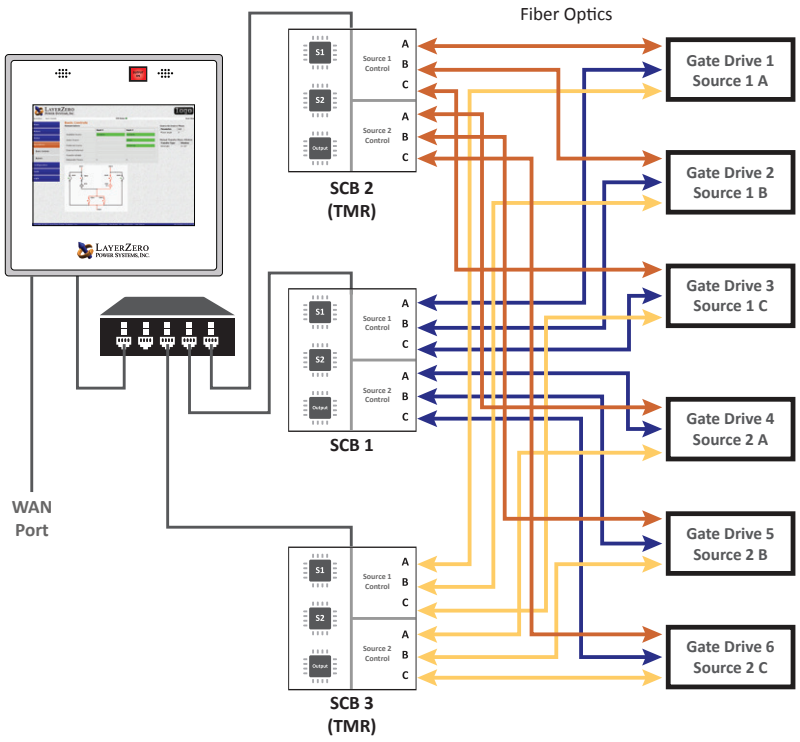


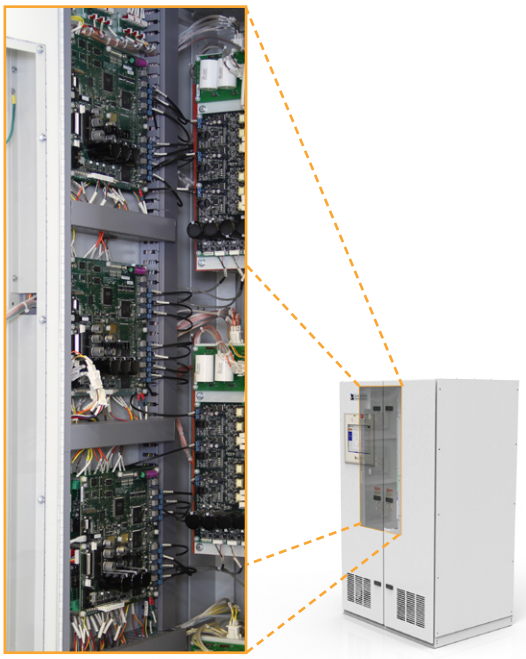
Each SMR-enabled system has three independent CPUs for reliability, connected to separate gate drives using independent control paths.



Staggered Heat Sink Arrangement: 250 A eSTS Gate Drives with front panels and control sections hidden for visibility

Achieve Ultimate System Reliability with TMR (Triple Modular Redundancy)





TMR Enabled-STS Systems Have Three SCBs and Nine Independent CPUs for Maximum Reliability

TMR - The Highest Level of System Reliability (Optional)

For applications that require the highest level of system reliability, LayerZero offers the TMR option. LayerZero TMR has all the redundancy of SMR, plus each STS has three independent sets of analog and digital data acquisition and control systems. There is no direct communication between the three systems. The three systems do not even share a common system clock.

- Each control system acquires voltage and current data independently
- Each control system determines whether a source is good/bad independently
- Upon loss of a source, each control system makes decisions to transfer independently

Even if an entire control path or its subcomponent were to fail; and then if the active power source were to fail, the STS is able to complete its mission of transferring to the alternate source.

Triple Modular Redundancy, a proper noun, is a based on proven statistics and stringent mathematics. There are similar sounding terms used in the mission-critical industry to describe other STS products terms such as, tri- or triple- redundant – but they simply do not yield the same, high level of reliability as “Triple Modular Redundancy”.

Triple Modular Redundancy - The Science of Reliability

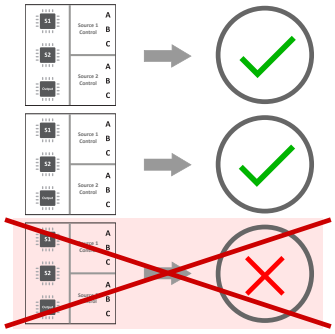
Fault Tolerance in Mission-Critical Infrastructure for Maximum System Reliability

Triple Modular Redundancy (TMR) increases reliability by masking potential equipment failures with physical redundancy. If a single component, such as a System Control Board, fails - systems with TMR have built-in extra equipment/processes to make it possible to continue normal operation with the broken components.

Triple Modular Redundancy works by partitioning the system into modules, triplicating the modules, and placing majority voters in between the modules. Any errors produced by a single faulty module are masked by the two redundant modules. If a single module fails in a TMR-enabled STS, the built-in system redundancy will mask the fault, and the eSTS will still be 100% functional.

To use Triple Modular Redundancy in a Static Transfer Switch, an STS must have at least three observers, three controllers, three gate drives for each pair of Silicone Controlled Rectifiers (SCRs), and redundant power. LayerZero's TMR topology utilizes three System Control Boards (SCBs), allowing for error correction. If one out of three SCBs is wrong - a "voter" will disregard the one erroneous value. With TMR, reliability is increased between one to two orders of magnitude.

Triple Modular Redundant System Disagreement

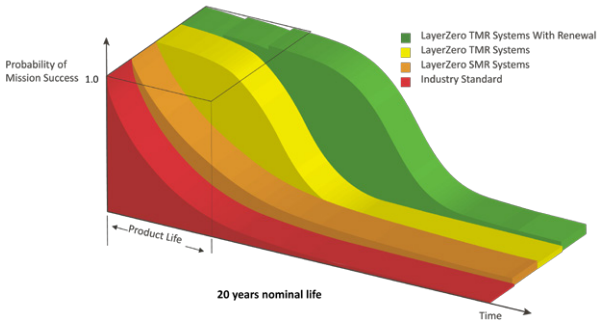


Triple Modular Redundancy Allows for Error Correction. If one SCB disagrees with the other two, the system disregards the wrong value.

The LayerZero TMR eSTS eliminates all single points of failure by utilizing a voting mechanism at the output of each critical board, so that if a vital component were to fail, the remaining two control systems would ensure the sensing/switching integrity of the system. Furthermore, an immediate alarm would indicate failure of the lost control-system, providing operators with the opportunity to replace the critical board, while restarting the life expectancy of the TMR system control.

Do Your Application Require The Reliability of TMR?

The decision to utilize Single Modular Redundancy or Triple Modular Redundancy in a power distribution system depends on the level of reliability needed. TMR systems will always have a higher reliability than Single Modular Redundant systems, however, the triple-redundant architecture of TMR systems is, in many cases, beyond the limits of what is practical. Extremely high levels of system reliability can certainly be achieved with TMR, however, the initial cost of such systems is significantly higher than systems with Single Modular Redundancy. Triple Modular Redundancy only makes financial sense under circumstances where the cost of any downtime is higher than the costs of equipment redundancy. TMR STS systems are ideally suited for mission-critical applications when reliability simply cannot be compromised in single cord or dual cord power systems. Please schedule a consultation with LayerZero to discuss whether your application could benefit from TMR.



STS with TMR is designed to continue to meet specification in the event of a catastrophic failure of one of the observer or controller or drive or power supply systems. With appropriate and timely service and maintenance the TMR System can be Renewed to maintain virtually 100% probability of mission success.

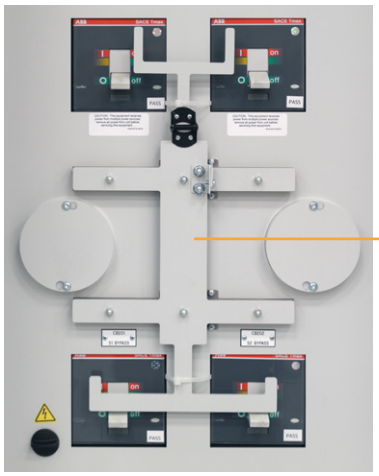
Safe Bypass Procedure to Eliminate Human Error

Mechanical Bypass Interlock

In order to minimize the possibility of operator error during source bypass operations, LayerZero provides:

1. Interlocked breakers
2. Mechanisms to ensure that a source cannot be bypassed without the STS on the correct source.
3. Safeguards to make certain that sources cannot be connected to each other inadvertently.
4. A voice-prompted bypass procedure that guides the operator through the sequence.
5. A step-wise pictorial & video presentation is provided on the touch-screen display during bypass.

LayerZero's exclusive "Double Goalpost" design physically prevents the bypass procedure from being completed out-of-sequence

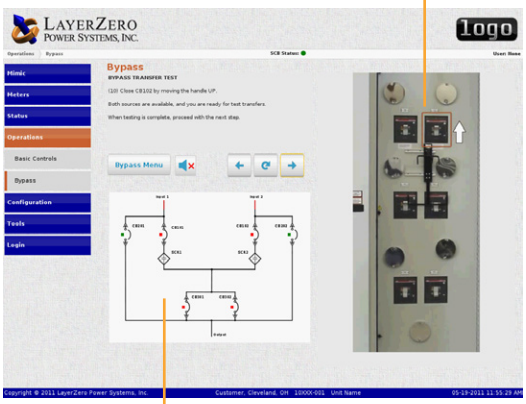


Voice Guided Bypass

Operator error during maintenance bypass has been known to be a reliability hazard. To help prevent operators from completing the bypass procedure out-of-sequence, our product features a voice prompted bypass procedure. This instructs the operator in a step-by-step course of action of the process, with only one operation per screen. Visual and audio cues provide clear instructions on the bypassing sequence, reducing the probability of operator error.

If the system detects that a step is completed out-of-order, the GUI will change color, and bold warnings are displayed informing the user that the sequence is incorrect.

Videos with graphical overlays give step-by-step instructions on how to complete the bypass procedure



One line diagram displays real-time system status

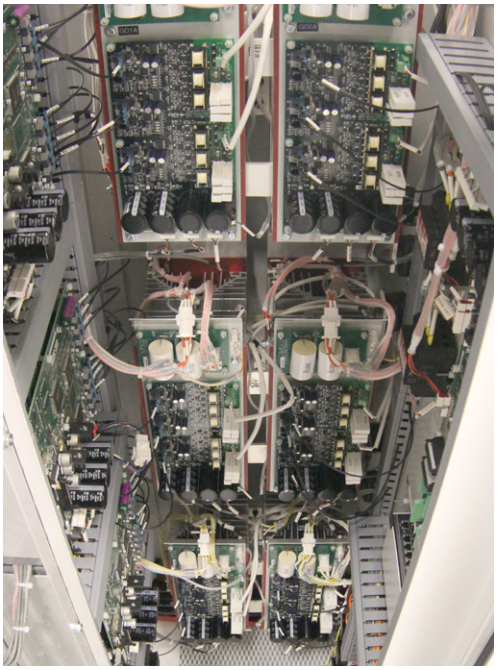
Natural Convection Cooling for Thermal Management up Through 1200 A

No Fans, Dust Filters, or Fan Fuses

The Series 70: eSTS Static Transfer Switch utilizes a maintenance-free natural convection-cooled heat dissipation system on switches up through and including 1200 A.

Fans and fan sensors are some of the most common components to fail. For maximum uptime, LayerZero's eSTS systems do not contain any fans, dust filters to change, or fan fuses to replace.

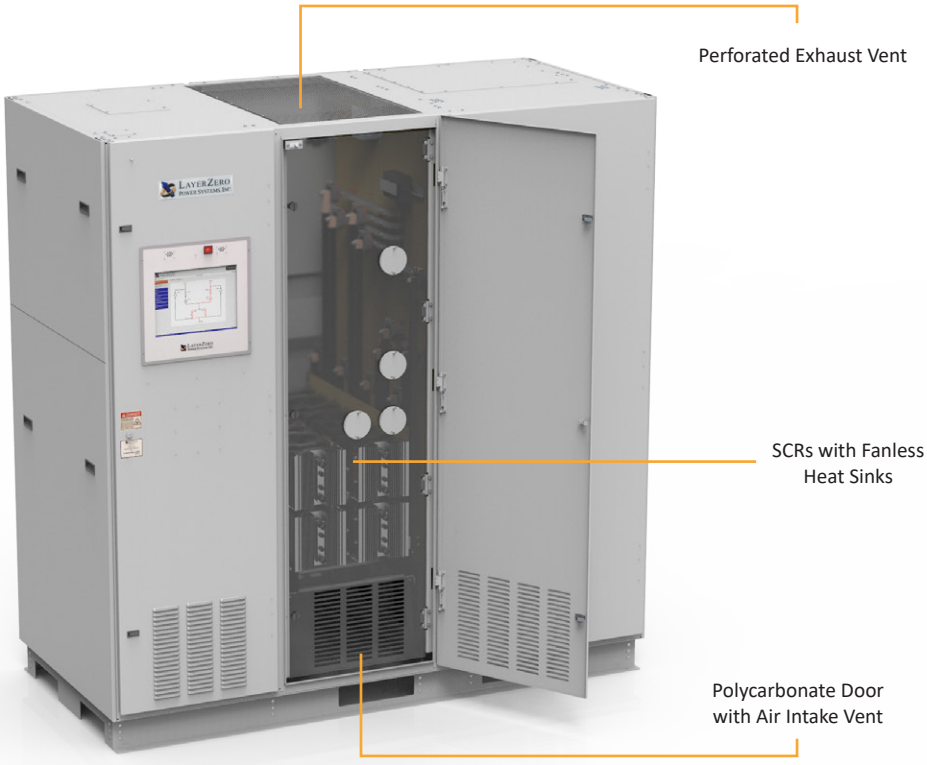
The heat sink arrangement is staggered between sources and phases to minimize the creation of extreme thermal gradients between heat sink columns when conducting on one source or the other.



Staggered Heat Sink/Gate Drive Arrangement in 400 A eSTS

Maintenance-Free Cooling

- No fans
- No dust filters to change
- No fan fuses to replace



Designed for Maximum Reliability: No Detail Is Too Small for LayerZero

Epoxy Coated Buswork/Maintenance Free Joints

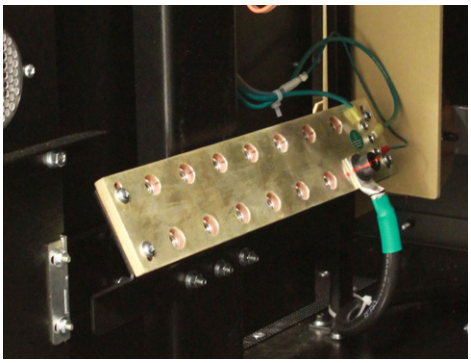
Epoxy Coating and Brazed Joints are used on areas that are inaccessible. Our usage of epoxy coated buswork helps improve worker safety, and makes the system inherently more reliable by eliminating the possibility of bus-to-bus faults.

Bus joints are permanently brazed and are maintenance-free.

Epoxy helps protect buswork from corrosion, dust, and moisture

Low-Maintenance Engineered Hardware Solutions

LayerZero utilizes brush silver plating on all bus joints and terminals to be able to provide the highest performance. Silver has high conductivity and low resistance - resulting in less heating, and requiring less maintenance over time.



Carefully Engineered Bolted Connections

Our bolted connections utilize machined cap screws and engineered disc springs. The result is a flat pressure vs deflection profile to ensure that all bolted connections maintain constant torque through the life of the product.

These technologies have been well tested in disparate environments of wide temperature ranges to help ensure that, once connections have been tightened, they stay that way.

Inspired by the Recommendations of NFPA-70E, Built for Operator Safety

LayerZero Products Are The Safest In The Industry

Safety in the data center is a serious concern, as the hazards associated with arc flash and electrical shock kill, blind, and burn thousands of workers annually. Most of the damage caused by workplace accidents can be prevented. We believe it is the responsibility of manufacturers to proactively design equipment that does not require exposure to energized parts during normal operations. Our Series 70 product line was developed to exceed the recommendations of NFPA-70E and to help data centers drastically reduce the risks of exposure to electrical energy.

LayerZero Static Transfer Switches are equipped with a variety of safety features that are designed to protect operators, such as portholes that allow bolted connections to be IR scanned with the dead-front doors closed, a sectionalized design, and true front-only access.

eSTS Is Fully Equipped with Safety Features

eSTS Standard Safety Features

- ☑ **InSight™ IR Portholes:** Bolted Connections & Critical Boards Can Be IR Scanned With the Dead-Front Doors Closed
- ☑ **Sectionalized Components:** Isolated Sections That Can Be Safely De-Energized For Performing Maintenance
- ☑ **Polycarbonate Windows:** Allows Critical Board LEDs To Be Viewed With The Dead-Front Door Closed
- ☑ **Front-Only Access:** Installation and Maintenance Can Be Safely Performed Without Side or Rear Access
- ☑ **Dead Front Hinged Doors:** Barrier To Provide A Safe Working Area With No Exposed Live Parts
- ☑ **Front-Only Access Design:** True front only access that does require rear access for installation or to IR scan bolted connections.

Scan Bolted Connections With the Dead Front Doors Closed

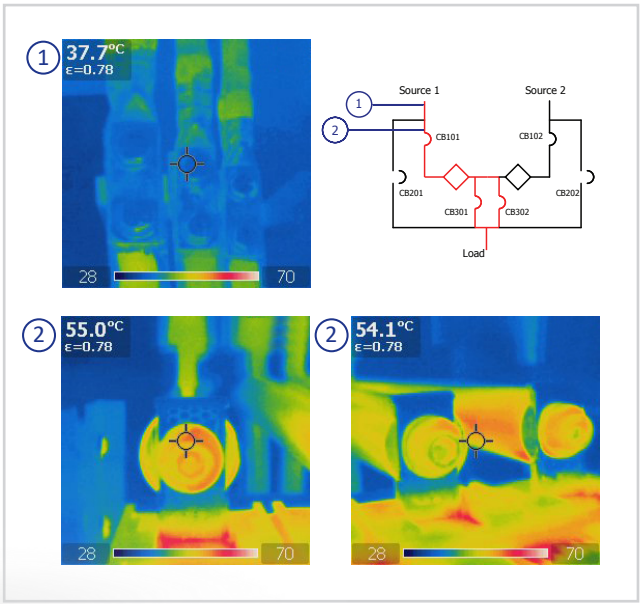
InSight™ IR Portholes Permit Scanning of Bolted Connections with Dead-Front Doors Closed

Strategically positioned IR-scan portholes to enable safe thermal scanning of all bolted connections with the dead front closed, without exposing the operator to power circuit voltage. Thermal scans can be done from the front – without ever having to open the dead-front door.

The IR window swivels upward and unlocks with key-hole access to reveal a mesh, allowing the operator to point-and-shoot thermal cameras to obtain readings.

The arrangement of eSTS internal components was designed from the ground-up for true front-only access, users are not required to pose in difficult and awkward positions to perform normal operations.

Rear or side access is not required on eSTS units to IR scan bolted connections and critical boards (rear access is required to scan some bolted connections on eSTS units ≥ 2000 A).



IR Portholes in eSTS
(Door and side panel hidden for visibility)

Sectionalized Components to Minimize Risk

De-Engergizable Sections for Operator Safety

Normal interface sections (breakers/switches) are physically separated from the power electronics sections and control electronics sections so that maintenance on a section can be safely performed.

If maintenance is required on the electronics section, power is bypassed to allow for safe repairs to be made. All communications to the gate drives are optically isolated to minimize risk.

- When the system is in bypass isolate:
  - All PCBs are denergized
  - All SCRs are denergized
  - All heat sinks are deenergized

- As an *added safety feature*:
  - The "Output On" LED remains on during bypass isolate
  - Light is powered by A-B phase of output
  - Small transformer is located on right side of eSTS
  - "Output On" light wire is insulated for safety

The "Output On" light lets operators quickly know if the STS is energized with the doors closed.

Low Mean Time to Repair Components

To minimize repair time, Series 70: eSTS is designed to be serviceable from the front of the unit. eSTS is equipped with either plug-in or draw out breakers that do not require side or rear access to replace.

In addition, there is a physical separation between logic and power sections - electronic components are sectionalized for maximum serviceability.

If a critical board needs to be replaced, an eSTS can be placed into bypass mode, and the control section will be completely deenergized for repair while the eSTS is powered.

Draw-out breaker on 800 A eSTS

Transformer Inrush Mitigation with Dynamic Phase Compensation

LayerZero's Patented Algorithm Eliminates Transformer Inrush

Static transfer switches have been used effectively to provide redundancy to power distribution paths that feed mission critical loads. Static transfer switches (STS) may be installed on the line side or the load side of distribution transformers; each topology has its benefits and potential pitfalls. The line side STS is less expensive and takes up less floor space, watt-for-watt.

However, if not properly designed and coordinated, the line side STS can have deleterious effects of its own during out-of-phase transfer events.

Dynamic Phase Compensation Transfer is a technique invented by LayerZero Power Systems to minimize transformer saturation current during out-of-phase static transfers on the primary side of transformers.

LayerZero Power Systems was patented the technology for a source transfer invention utilized by the company's Static Transfer Switches, to automatically compensate for differences in phases between sources, eliminating downstream transformer inrush from out-of-phase transfers. The innovative invention operates by introducing an appropriate time delay during the transfer, the duration of the delay is a function of the phase angle between the two sources at the instant of transfer.

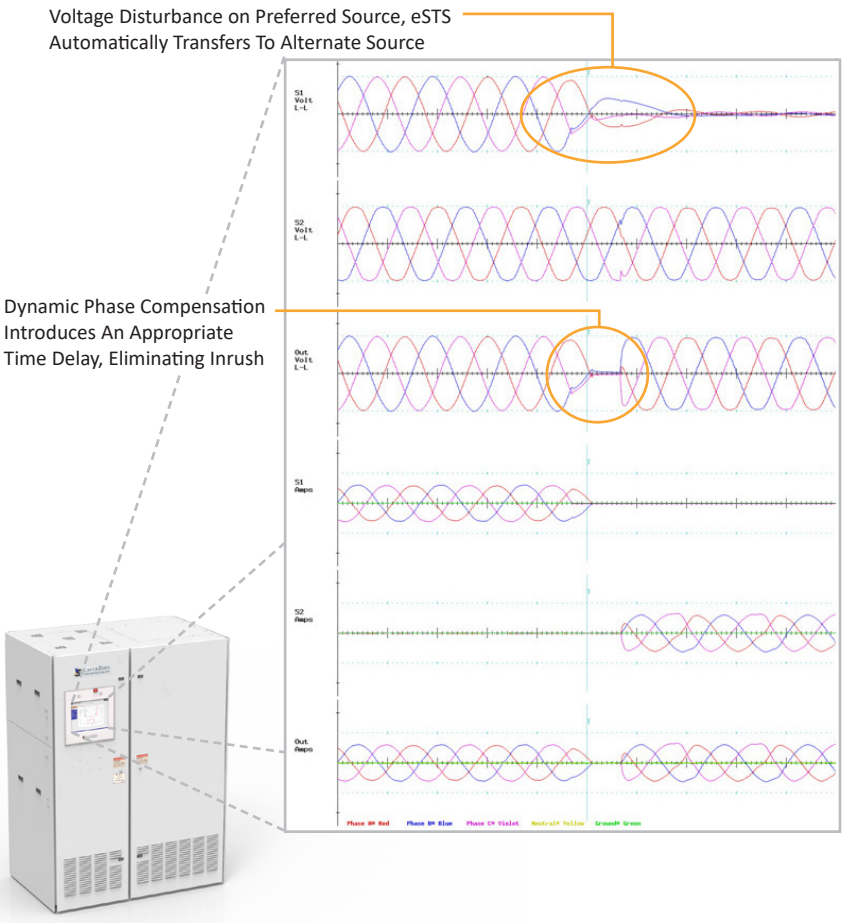
The phase of the voltage waveform from each power source is sensed continuously, and the phase difference is known at all times, so that it can be used when the transfer is necessary. The eSTS monitors the voltage from the first power source, and initiates the transfer from the first power source to the second power source in response to an unacceptable condition from the first power source. The second power source is connected only after waiting for a period of time corresponding to the appropriate time delay.

When Source 1 and Source 2 are out of phase and the transfer switch performs a ¼ cycle transfer, the transformer is already magnetized.

The magnetic flux of the transformer must be balanced going from one source to another.

Nothing could be simpler than a time delay that stays inside of the CBEMA curve.

We can verify that the transfer will not impact connected equipment by checking to see if each phase is within the bounds of the associated ITIC curve.



Reliable Transfers Even When Sources Are Completely Out-of-Phase

The LayerZero eSTS Intelligently Waits For The Perfect Moment To Transfer

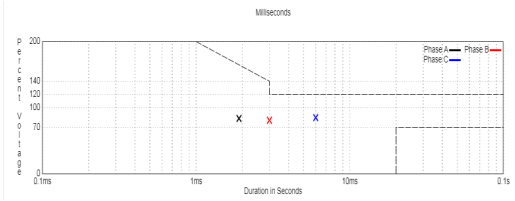
In many products used in the power distribution industry, when a transformer is initially connected to a source of AC voltage, a substantial surge of current called Transformer Inrush may occur. During out of phase STS transfers, a transient current larger than the transformer current can flow for several cycles, potentially resulting in circuit breaker trips and loss of critical load.

Our exclusive Dynamic Phase Compensation technology helps protect upstream sources and downstream critical loads from transformer inrush currents by constantly monitoring the power and introducing an appropriate delay in switching. This delay significantly reduces inrush currents for out-of-phase transfers, preventing upstream tripping, and eliminating potential UPS overload.

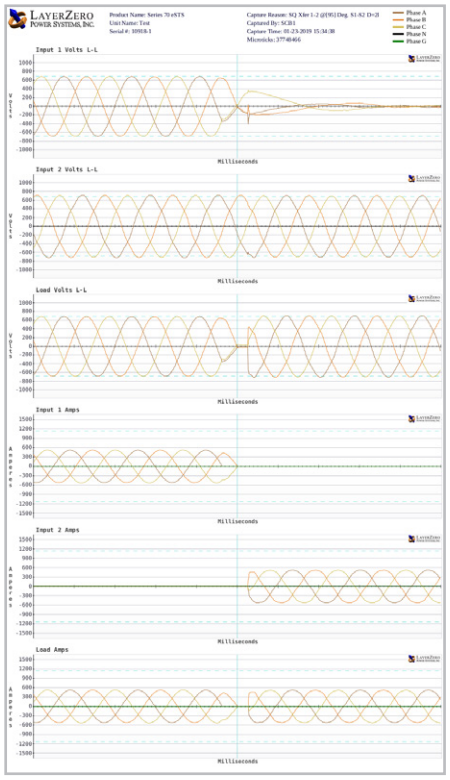
LayerZero's Dynamic Phase Compensated Transfer eliminates this inrush seen in traditional STS. Sample waveform captures with the phase angle at 90° through 180° are shown below. It is important to note that:

1. There is no inrush (current excursion) in the Output Amps waveform; and

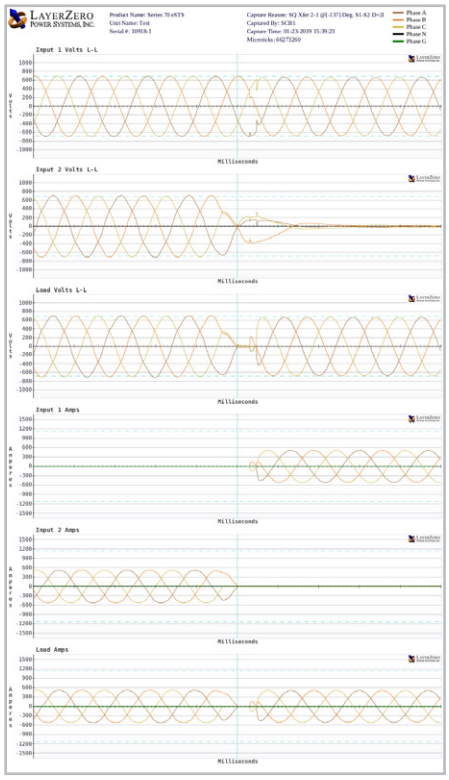
2. The output voltage (critical load voltage) is within the CBEMA/ITIC bounds (maximum allowable outage = 20 milliseconds). Phase difference greater than 180° yields a longer transfer time; but well within the bounds prescribed by CBEMA/ITIC.



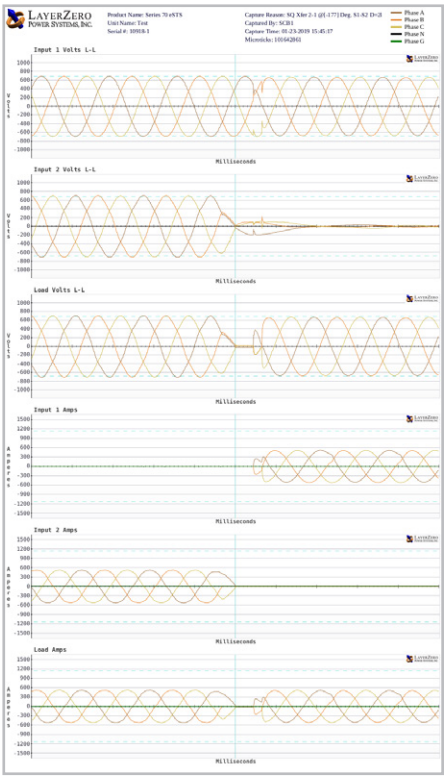
180° Out-of-Phase Transfer is Within the Bounds of ITIC Curve



Source Transfer
90° Out-of-Phase



Source Transfer
150° Out-of-Phase



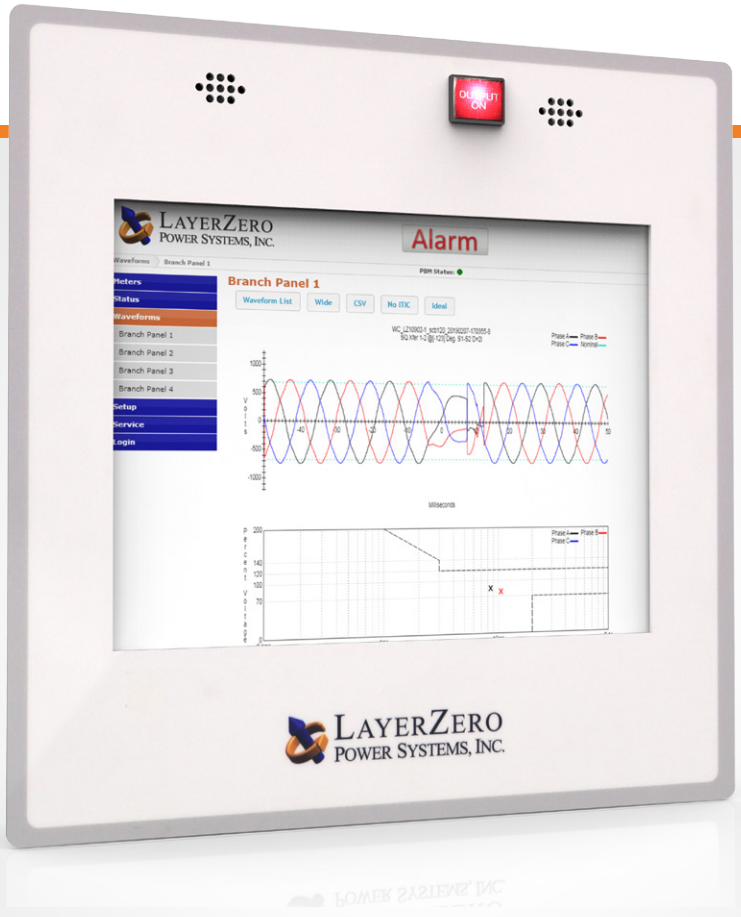
Source Transfer
180° Out-of-Phase

LayerZero Does Power Quality Monitoring Better than Everyone Else

LayerZero's SSQM Provides Answers to Power Quality Questions

The Series 70: eSTS is equipped with SSQM (Static Switch Quality Monitoring), an all encompassing monitoring system with local and remote communications options. From basic monitoring & alarm reporting, to advanced power quality monitoring functionality, SSQM provides a wide-range of options to help you be aware, be vigilant, be proactive in your quest to create a safe, stable and reliable operation.

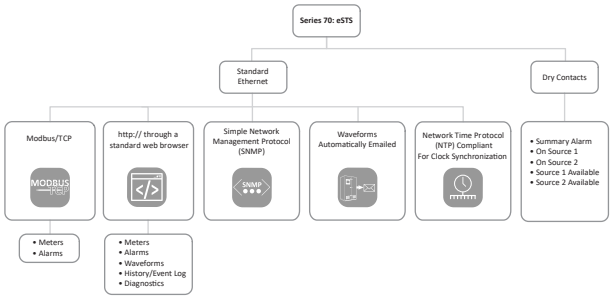
Connectivity is achieved via CAT5 cable utilizing open protocols. LayerZero SSQM provides connectivity options for Ethernet and SNMP. In addition, SSQM synchronizes with network clocks via Network Time Protocol (NTP). Monitoring options include real-time waveform capture and ITIC plotting of events.



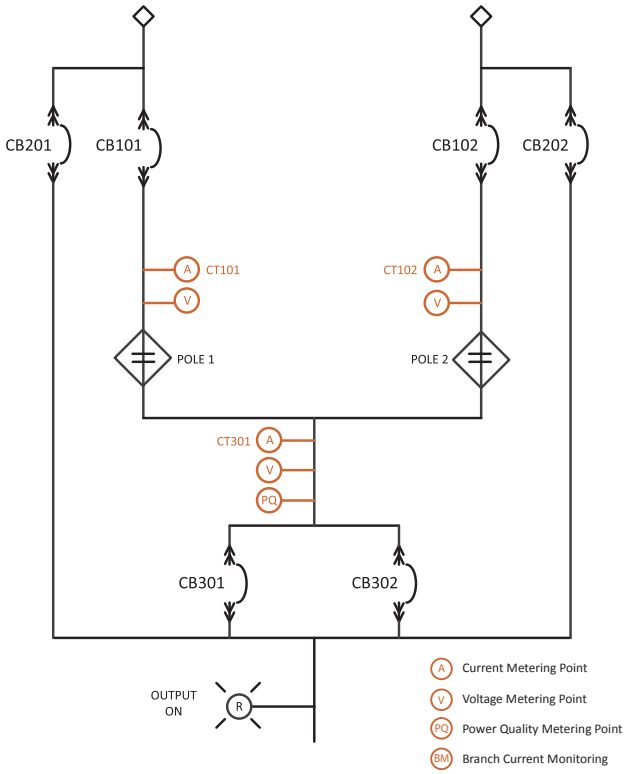
Monitoring and Communications with LayerZero SSQM

LayerZero is being aware of all activity in your critical power distribution systems, it is an all encompassing monitoring system with local and remote communications options. From basic monitoring, alarms, to advanced power quality monitoring functionality, LayerZero SSQM provides a wide-range of options to help you maintain the highest level of reliability.

LayerZero gives you a vendor-neutral “Birds Eye” view of your entire critical power distribution infrastructure. LayerZero maximizes reliability, letting you know if a source has quality issues, if a UPS output is bad, or if there are any alarms. In addition, LayerZero empowers users with the capability to go back in time to retrace the exact sequence of historical events. No other tool in the mission-critical industry empowers users with this robust capability.



SSQM Communications Protocols



SSQM eSTS Power Quality Monitoring Locations

eSTS Standard Connectivity Features

- ☑ **Ethernet Connectivity:** Secure VPN Router Connects To Network For Advanced Remote Monitoring Capabilities
- ☑ **Modbus/TCP:** Open Connectivity to Existing Monitoring Systems Without Proprietary Limitations
- ☑ **NTP Time Clock Synchronization:** Facilitates Timeline-Based Logging For Post-Event Reconstruction
- ☑ **SNMP Connectivity:** Permits Remote Management Via Simple Network Management Protocol

eSTS LayerZero SSQM Features

- ☑ **Real-Time Waveform Capture:** Automatically Captures A Picture Of The Power Three-Cycles Before and After Every Event
- ☑ **ITIC Plotting:** Generate ITIC Plots to Verify If Connected Equipment Was Impacted by Power Quality Events
- ☑ **Local Touch-Screen Interface:** Password-Protected Color Touch-Screen GUI For Local STS Setup/Operation/Administration
- ☑ **Black-Box Forensics:** Captures and Records All Events To Provide Vital Information In Root-Cause Analysis
- ☑ **Waveforms Automatically Emailed:** Capability to Send Waveform Captures To Designated Individuals For Every Transfer

Automatically Generate Waveforms of Power Quality Events

Real-time Waveform Capture

Precise voltage and current data is necessary to understand why a transfer was made. Detailed records of transfers such as waveform captures help operators better understand the root cause of events, helping engineers properly eradicate problems.

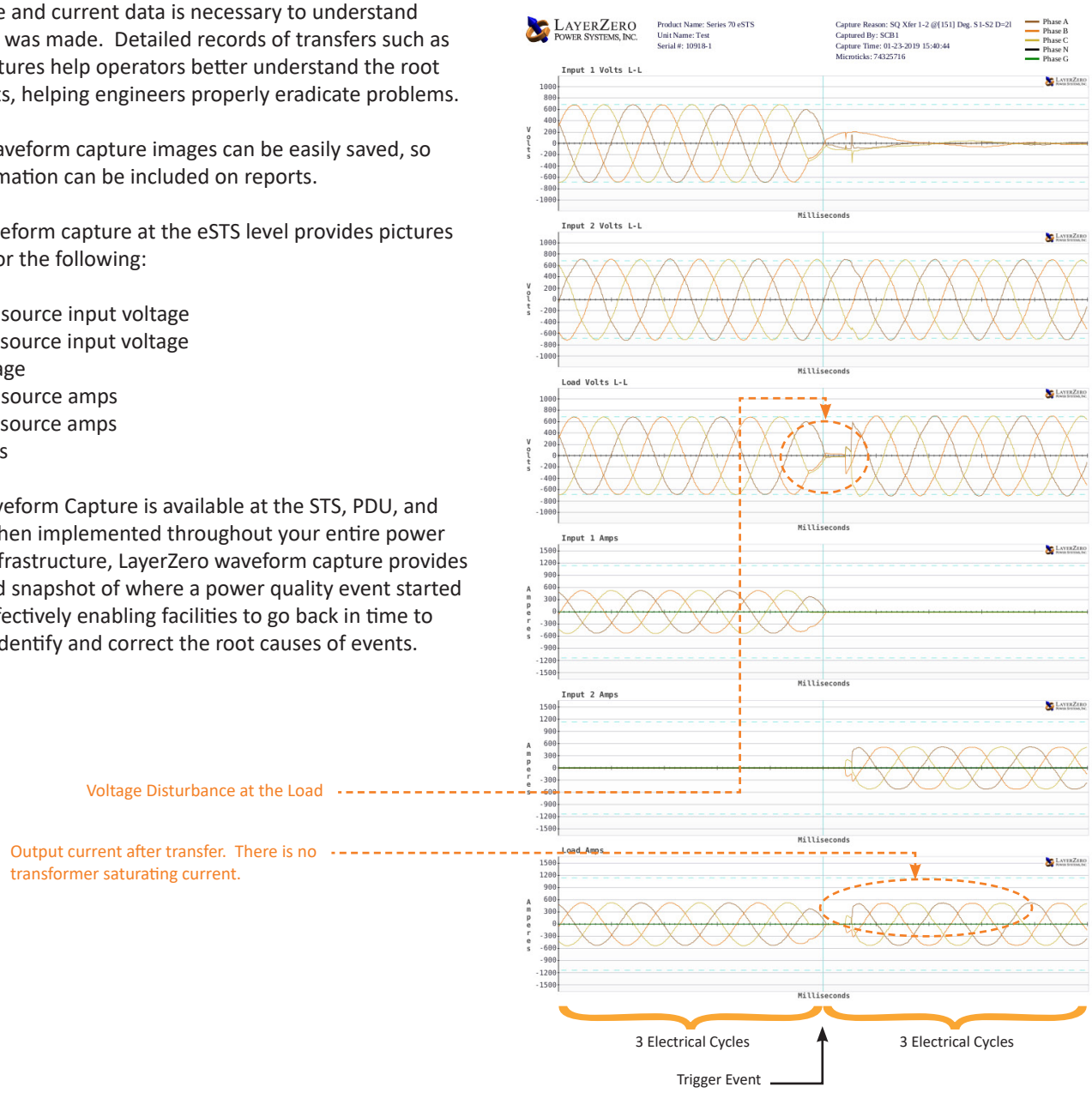
In addition, waveform capture images can be easily saved, so that this information can be included on reports.

LayerZero waveform capture at the eSTS level provides pictures of all phases for the following:

- Preferred source input voltage
- Alternate source input voltage
- Load voltage
- Preferred source amps
- Alternate source amps
- Load amps

LayerZero Waveform Capture is available at the STS, PDU, and RPP levels. When implemented throughout your entire power distribution infrastructure, LayerZero waveform capture provides a timestamped snapshot of where a power quality event started and ended, effectively enabling facilities to go back in time to methodically identify and correct the root causes of events.

Example Waveform Capture of Source 2 to Source 1 Transfer Event, 150 Degrees Out-of-Phase



Waveforms Automatically Emailed

Every product we design and manufacture, can be browsed to for remote access to captured waveforms. We make it easy - our Static Transfer Switches automatically email pictures of source transfers, so if an incident occurs, you don't have to look for waveforms.

Conveniently Plot Disturbance Points on the ITIC Curve

Generate Easy-to-Understand Plots on the Impact of Power Quality Events

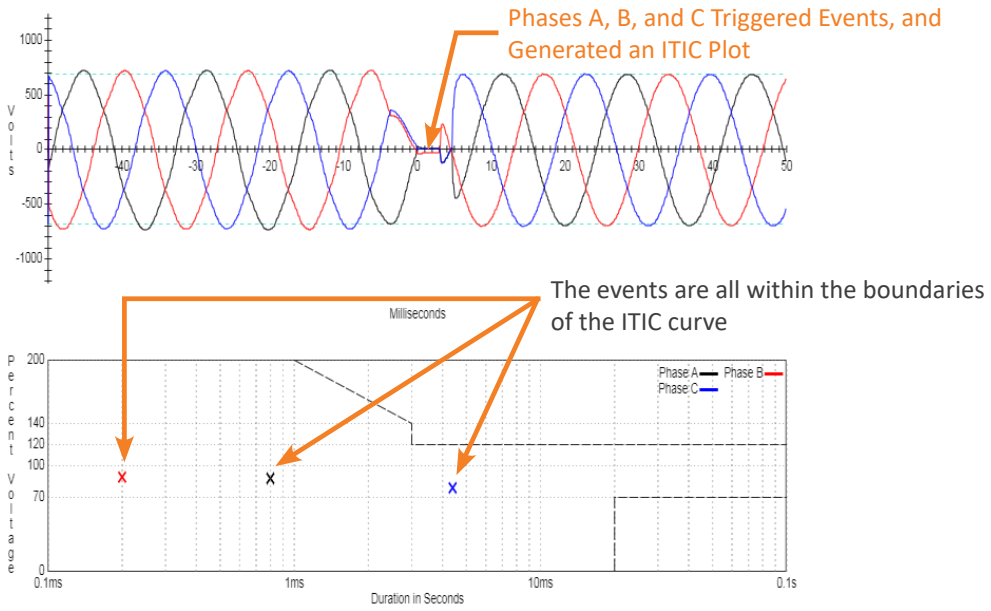
All LayerZero Power Systems products have on-board power quality analyzers that break down power sources into samples. If the power quality goes out of specification on a source, eSTS will transfer to the alternate source, automatically generating waveform captures and ITIC curves of the event. This data is remotely accessible by connecting to the unit via web browser.

In the test below, the STS was connected to two sources 150 degrees out-of-phase. Source 2 breaker was opened, causing the STS to perform an automatic transfer to the primary source. A delayed transfer occurred, causing events on Phases A, B, and C, automatically generating ITIC plots.

Unlike waveform captures, ITIC plots are easy-to-read, and do not require expert analysis to understand.

Source 2 to Source 1 Transfer Event, 150 Degrees Out-of-Phase - WFC & ITIC Plot

Dynamic Transfer was enabled during these tests in order to mitigate transformer inrush while completing the transfer within the boundaries set by the Information Technology Industry Council (ITIC).



The ability to keep the transfers within the ITIC limits was verified through the Voltage Disturbance Analysis Tool (VDAT) plot shown above in the captured waveform.

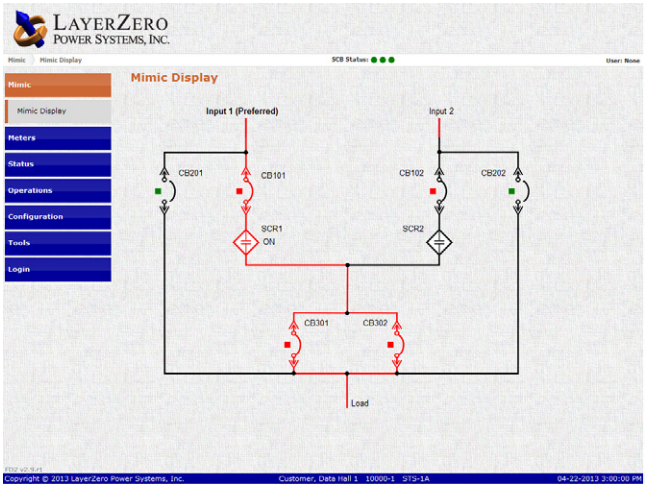
Intuitive and Simple Touch Screen Controls for Local Administration

Maximize Operator Effectiveness with an Easy-to-Use Interface

The local interface utilizes a password-protected color touch-screen GUI for eSTS setup, operation, and administration. Carefully designed to be an easy-to-learn experience, the user interface for the eSTS can be utilized with limited training - reducing costs, maximizing productivity, while limiting the risk for operator error.

The GUI is organized into six main sections:

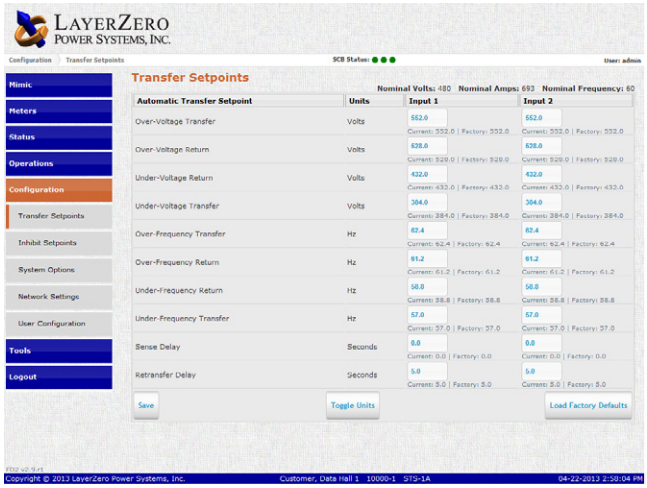
- Mimic
- Operations
- Meters
- Configuration
- Status
- Tools



The mimic display screen on the eSTS GUI shows a real-time schematic of the current STS status

The meters section displays meters, waveforms, peak currents, voltage spectrum, and current spectrum.

The status section shows alarms, the event log, system info, and system status



The configuration section allows users to adjust setpoints, system options, network settings, and configure users.

Troubleshoot Power Quality Events with Post-Catastrophe Reconstruction

Applying the "Black Box" Principle to Mission-Critical Power Distribution

LayerZero Power Systems Static Transfer Switches save all events into a timestamped "Black Box" for analysis and post-incident reconstruction. All events are documented in the internal "Black Box", and may be viewed as "summarized events" by users on the "Event Log" page on the eSTS GUI. Access to black box data is accessible both locally and remotely.

Some events cause the action of posting an alarm, while other events cause the action of clearing an alarm. LayerZero Power Systems provides an 'Alarms Troubleshooting Reference' document which provides a list of each alarm message, the urgency that it indicates, a description of what can cause that alarm, and a description of the steps to perform to troubleshoot the alarm condition.

Common events include:

- Alarm Set or Cleared
- CB state change
- Waveform captured
- Source quality change outside of limits
- GUI & Web page selects
- Source availability change
- SCR gating change
- User logged in or out on the GUI

Full and complete event data is stored internally, and this data can be analyzed when needed by LayerZero engineers.

Traditional Post-Catastrophe Reconstruction

Standard mission-critical power machines have traditionally provided rudimentary data to the user regarding catastrophic events. Some common complaints about this conventional event recording include:

1. Successive events are too far apart in time to be useful;
2. Event records tend to be vague and lead to more unanswered questions;
3. Event records only take a snapshot of the actual event and provide no information regarding the status of equipment parameters before and after the event.
4. Some events are missed entirely.

A natural outcome of these shortcomings is that eradication of the root-cause of the alarming event does not occur. The event then systematically becomes an "out-of-the-ordinary" academic acknowledgment. Conventional power event recording schemes do not satisfy the needs of the modern, sophisticated facility engineer who needs "quality" information.

The LayerZero Approach: Black Box Forensics

To eradicate these problems, LayerZero has borrowed cutting-edge concepts from the aviation industry's "Black Box" principle. The concept, as applied to the eSTS, is simple:

1. Provide successive event information with ten microsecond resolution;
2. Provide a brief snapshot of each event with a lead-in for further inquiry; and
3. Provide a real-time status indicator of all machine parameters at the exact instant of each recorded event.

A High Level Processor is supplied with a compact flash disk. Communication is via fiber optics and the result is a "Black Box" data recorder. Event logs, alarms, diagnostics and Waveform Capture are accessible via a VPN Router that comes standard with each unit. Time-stamping resolution is 10 microseconds; fast enough to catch any mechanical or electrical activity. Each transfer event as well as transfer-inhibit event is captured and stored on solid state memory in the form of a real-time waveform capture three cycles before and three cycles after an event. The root cause analysis of the electrical system is facilitated by the Black Box.

SSQM

Power Monitoring Parameters

SSQM Parameters		Mains
Voltage Inputs and Output	Voltage (Volts)	✓
	Voltage Average of Phases (Volts)	✓
	Frequency (Hertz)	✓
	Total Harmonic Distortion (Percent VTHD)	✓
	Phase Rotation	✓
Current Inputs	Current (Amps)	✓
	Current Average of Phases (Amps)	✓
	Current Imbalance (Percent)	✓
	Real Power (kilowatts)	✓
	Apparent Power (kilovolt-amperes)	✓
	Reactive Power (kilovolt-amperes reactive)	✓
	Power Factor	✓
	Crest Factor	✓
	Crest Factor Average of Phases	✓
	Phase Difference Between Sources	✓
	Phase Difference Between Sources and Output	✓
Alarms	Summary Alarm	✓
	On Source (1/2/3)	✓
	Source Fail (1/2/3)	✓
	Source Preferred (1/2/3)	✓
	Source 1st Alternate (1/2/3)	✓
	Source Over/Under Voltage (1/2/3)	✓
	Source Over/Under Frequency (1/2/3)	✓
	Source Not Available (1/2/3)	✓
	Output Failure	✓
	Source Overcurrent (1/2/3)	✓
	Source Exceeds Manual Limit (1/2/3)	✓
	Source Exceeds Automatic Limit (1/2/3)	✓
	Bypassed to Source (1/2/3)	✓

eSTS Product Options

Seismic Floor Stands and Anchors:

Floor stands and anchors are available for all of our floor-mounted products. The stands secure to the flooring below the raised floor, and are seismic conformance tested.

Distribution Cabinets:

LayerZero STS products can be fitted with distribution options, including subfeed and 42-panel options. All distribution options have the option to include the finger-safe SafePanel™ panel board.

Transformer Options:

Transformer options are available on STS products, either on the primary or secondary-side.

Redundant Output CB:

CB302 is available as an option, to provide a redundant output path for additional maintainability.

Junction Boxes:

Junction box options are available for all eSTS products, simplifying installation and organizing cable access.

Custom Paint Colors:

All LayerZero products have the option to be painted in any standard RAL color.

Learn more at www.LayerZero.com

LayerZero Power Systems, Inc.

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