

Application Note

DECS-400 Convection Cooled Retrofit Solutions for Alterrex Main Field Stationary Bridges

The Alterrex excitation system was developed in the early 1970s for use on large coal-fired steam plants to provide dc to the generator field. See Figure 1. The Alterrex system was a unique design to provide fast voltage response and reliable operation. Unlike previous exciters, the system consisted of an ac rotating exciter with no commutators. It provided a three phase ac output connected via slip rings and brushes to a remote stationary bridge cabinet assembly, a voltage regulator to control the exciter shunt field, and a dc field breaker to isolate the generator field output at shutdown.

The high current capacity stationary bridge assembly consisted of three or more 1200 amp ac to dc rectifier bridges connected in parallel to provide outputs ranging from 2000 to 6000 dc amps for the main field. One additional bridge was connected in parallel to provide (N+1) redundancy in the event of a failure of one of the bridges. To isolate a defective bridge and provide maintenance capability, each bridge included a disconnect switch to isolate the ac input and dc output from the bridge to affect removal and provide maintenance. See Figure 2.



Figure 1: Large 800 MW turbine generators, like the one shown above, utilize the Alterrex excitation system.

The Problem

The semiconductor technology of the 1970s limited the size of the semiconductors used and the approach to cooling them. These unique stationary bridges utilized water as a cooling mechanism. See Figure 3.

To obtain the highest current capacities possible with the existing technology, water cooled bridges were used with a sophisticated array of plumbing, pumps, valves, and copper tubing networked to cool the semiconductors. See Figure 4.

With time, the corrosive properties of the water cooling system deteriorated the copper tubing, developing leaks at joints that could result in unsuspected grounds and/or machine trips depending upon the severity of the water leak. Although the

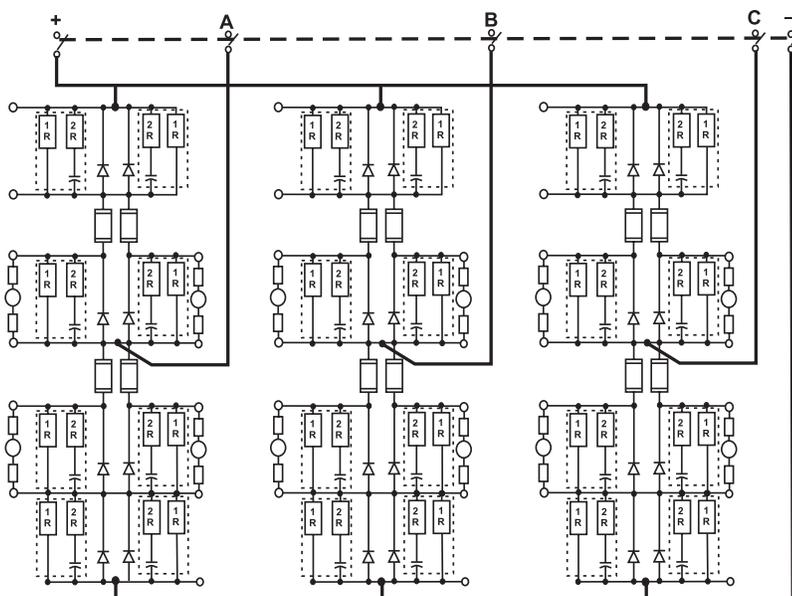


Figure 2: Schematic of existing Alterrex rectifier bridges



Figure 3: Two fixed rectifier bridges in cabinet with disconnect switch

bridges were reliable for the time, with age, the water cooling system has created problems over the years, causing costly machine trips at critical time periods when generation is at a premium. The problem can be compounded by an aging voltage regulator system that also has become obsolete with age. The solution has been to either fix the water leaks and replace the voltage regulator or replace the entire Alterrex excitation system for a new static exciter, which can be very expensive. A new static exciter system rated for 3000 to 6000 amps, including installation, could cost more than a million dollars when new hardware, design, and installation are considered. Today, a more economical solution is offered using the latest in semiconductor design technology and keeping the ac Alterrex exciter.

The Improved Solution

Semiconductor technology has come a long way since the original semiconductors were selected and packaged into the Alterrex stationary bridges. The original rectifier bridge required 24 diodes that were series and paralleled to have sufficient peak inverse voltages for the system and assure adequate current capacity. Each diode was filtered with an RC snubber circuit for commutation and resistors were provided for balancing currents for the series diodes. It was a very complex but necessary array for maintaining semiconductor

reliability. Since then, large silicon wafers in semiconductors, combined with improved heat sink technology, have dramatically increased the current carrying capacity of the semiconductors that provides a new alternative to replacing only the problem-prone water cooling system with a static exciter.

The new retrofit solution is simple and provides a functionally equivalent bridge that is convection-cooled rather than water cooled and packaged to fit into the existing location.



Figure 4: Plumbing leaks often become problems on the line side of the water valves

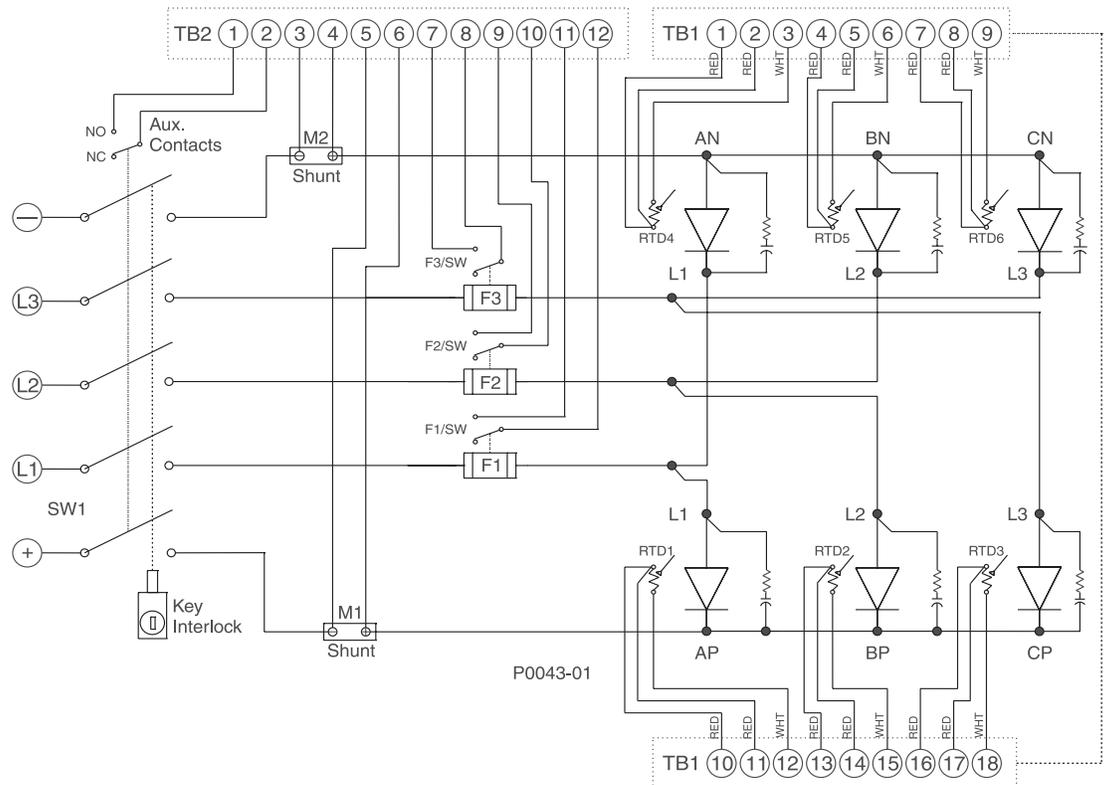


Figure 5: Schematic for retrofit of new rectifier bridge with disconnect switch

The new stationary bridges utilize large wafer design to provide more than 2000 amp rating capacity in a single three-phase full wave bridge rectifier. See Figure 5.

The old rectifier system included 24 semiconductors per bridge, each device being fused. The new system utilizes only six (6) 5765 amp semiconductors. Each device is compressed between two high efficiency heat sinks designed to dissipate heat in a cabinet of up to 50 degrees Centigrade in a convection cooled environment. Three (3) inline fuses, one for each

phase, are provided to protect against any fault and to ensure the long life of the power semiconductor. The power fuses have failed indicators, one for each fuse, that can be wired to annunciate failure caused by excessive overload on the front panel of the cabinet assembly. At the input and output of the diode bridges, RC snubber circuits provide appropriate dvdt protection. For thermal monitoring, there are a total of six (6) RTDs, one for each semiconductor of the three phase bridge, along with an RTD relay for each bridge that provides alarms if overtemperature occurs. Alternatively, each of the RTDs can be wired to the control room DCS for remote monitoring. See Figure 6.

The existing rectifier bridges provided maintenance capability, and the new retrofit solution provides similar assurances. A five pole disconnected switch with an auxiliary contact for switch status annunciation includes three (3) ac line inputs and two (2) dc output disconnects for connection to the bus to electrically isolate the bridge for emergency repair so that it may be removed from the system. The disconnect switch is load break capable. If opening is required during operation, the switch can be operated and load shifts immediately to the other bridges. The switch has an optional kirk-keyed interlock system with rotary motion providing a positive disconnect when access is needed, as well as a status contact that indicates switch position. An optional outside cabinet disconnect bridge capability



Figure 6: Remodeled convection-cooled 2000 amp rectifier bridge using the same mounting location bus

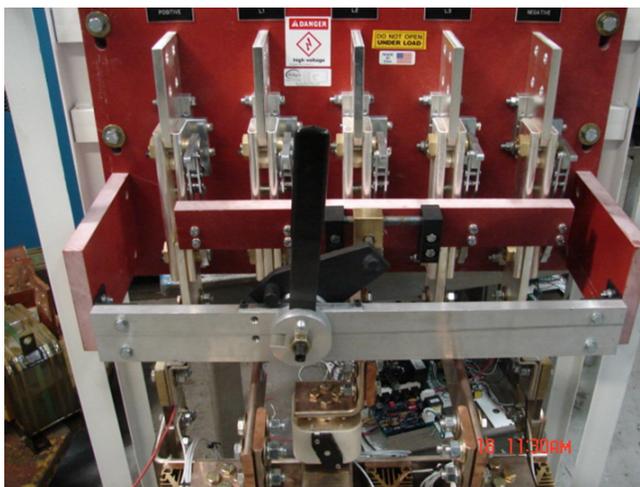


Figure 7: Enhanced rotary action switch for positive disconnect with load break capability with other bridges in parallel.



Figure 8: Basler offers the redundant DECS-400 setup in a custom NEMA 1 enclosure.

Existing Technology	Proven Solution
Bridge Rating: 1200 Amps	Bridge Rating: 2000 Amps, recommended rating 1600 Amps
(24) Diodes	(6) High Capacity Current Diodes
(12) Power Fuses	(3) Power Fuses
PIV Rating: 800 V	PIV Rating: 2800 V
Diode Rating: 800 Amps	Diode Rating: 5765 Amps
Water Cooled	Convection Cooled
Ambient Temperature: 50 Degrees C	Ambient Temperature: 50 Degrees C
(5) Pole Pullout Disconnect Switch	(5) Pole Rotary Action Disconnect Switch w/ status Indication with Load Breaker
(24) Fuse Indicating Lights	(3) Fuse Indicating Status
	(1) RTD Relay Monitor
	(6) RTD Semiconductor Monitoring
Individual Diode Snubber	AC and DC Snubber Circuit
	Optional Internal Kirk-key interlock for disconnect switch or outside cabinet rectifier bridge disconnect capability

Table 1: Alterrex stationary bridge comparison table

also may be provided, which eliminates the need to open the cabinet door to disconnect the bridge from operation.

Installation is painless and fast, because the new bridge assembly utilizes the same bolt locations for the disconnect switch and new rectifier bridge. See Figure 7. The disassembly of the old system and reassembly of the new hardware into the new cabinet can be accomplished in less than eight (8) hours per bridge.

See Table 1 for a comparison of the features in the convection-cooled solution versus the existing technology.

The Voltage Regulator Excitation System

Where issues exist with the Alterrex voltage regulator, the vintage excitation system can be replaced with a digital, integrated design incorporating redundant

0.2% voltage regulators, manual control, under and overexcitation limiters, power system stabilizer, and redundant rectifier bridge capability with automatic transfer. See Figure 8.

The solution, either replacing only the stationary rectifier bridge or a combined solution of the voltage regulator and stationary rectifier bridge, offers a practical, lower cost remedy to aging problems in lieu of a major replacement of the Alterrex ac exciter and associated equipment for a complete static exciter system. For more information, see Application Notes EX-ALTI and EX-ALT2.

For More Information

For information on Basler’s complete range of exciter solutions and to access product documentation, Application Notes, and Technical Papers, visit www.basler.com. To discuss your application, consult Basler Electric at 618.654.2341.