OPERATION AND MAINTENANCE OF THE Z-SWITCH SOLID STATE CONTACTOR

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A65045 Z-Switch Description:

Cableform part number A65045 is a Solid State Contactor to replace an electromechanical contactor that switches the positive leg of a load on a 540 volt DC supply. The solid state contactor receives a 50-90 volt input signal then verifies an operational state of the system cross checks both IGBTs and applies the connected 540V power supplied to the load through two series IGBTs. The unit has a fail safe circuit design which part of includes redundant IGBTs. There are six Light Emitting Diodes, (LED), which operate to indicate state of the solid state contactor.

Solid State Contactor Overview:

The solid state contactor consists of three sections: control section, relay section, and power section.

The inputs to the unit are 50-90 control voltage input tabs, a POS (positive 540V) post, and HEAT (heater connection) post. The negative reference for the 540V input is a connection to the heat sink base to train chassis.

The unit has two rows of tabs, six per row, that consist of four duplicate relay outputs (common: **COM**, normally closed: **NC**, and normally open: **NO**) to provide feedback of contactor output state.

Solid State Contactor Operation:

The solid state contactor will turn on two IGBTs to connect 540V to a load. The solid state contactor can be enabled before or after high voltage (540 volts) is applied to the unit. LED's on the unit indicate the state of the contactor and are described as follows:

Indicator LED	What it means when lit
IGBT (1) OFF	IGBT#1 is off
540 VOLTS ON	high voltage on
IGBT (2) OFF	IGBT#2 is off
LOAD OK	no error from driver
CONTROL VOLTS ON	15volts on control
SYSTEM OK	IGBTs functioned when commanded on

Solid State Contactor Typical Sequence of Operation:

The typical sequence of operation (without any faults) will be:

The unit has 540V applied, and the unit does not have control voltage and therefore the IGBTs are off.

In the off condition, the top three lamps will be lit.

When the contactor is commanded on (Control voltage applied) all six lamps will light.

After a 1.5 second delay the *IGBT (1) OFF* lamp and *IGBT (2) OFF* lamp will then turn off indicating the "on" state of the IGBTs. At this point the heater will have 540 volts applied.

If the control voltage is applied before the 540 volts is applied the sequence will be similar except that the top three lamps and *System OK lamp* will not be lit until the 540 volts is applied releasing the lockout function (no delay).

Solid State Contactor Internal Components:

The solid state contactor principal hardware consists of two IGBTs (IGBT1, IGBT2), and a flywheel diode (FD1),

The solid state contactor has two circuit board assemblies. The circuit boards are A65164 Control board, and A65269 Relay board. The circuit board assembly descriptions follow.

A65164 Control Assembly Overview:

Cableform part number A65164 is the Control circuit board designed to be used in the Z-switch solid state contactor replacement unit A65045. The control circuit board provides operational signaling to the power components provided all permissives are OK.

A65263 Relay Assembly Overview:

The Relay Assembly contains the output state relays.

This assembly has one relay which closes immediately upon control voltage being applied. This relay will de-energize approximately 10 seconds after it energizes.

There are two relays which are used to transmit the state of the Z-switch output. When both IGBTs are turned on and functioning properly, 1.5 seconds after control voltage is applied, the two output relays energize.

Functionally, the relay operation is that the control voltage relay closes immediately. The output state relays close when the Z-switch operating properly. This is usually 1.5 seconds after control voltage is applied. Approximately ten seconds after control voltage is applied the control relay drops out and the output state relays indicate the current state of the Z-switch operation.

Electrical Specifications for Eurostar Contactor Replacement:

Nominal Control System Voltage: 72V.
Maximum: 90V. Minimum: 50V.

Nominal Heating Resistor System Voltage: 530V.
Maximum: 600V. Minimum: 450V.

Transient Spike on Control System Voltage: 500V max for 50u seconds.

Transient Spike on High Voltage: 1000V max for 5u seconds.

Maximum Continuous Load Current: 60A.

Control Output Contact Rating: 10mA at 72V.

Control Output Contact Insulation Resistance: 1,000 M Ohm.

General Technical Specifications:

Ambient Temperature Range: -10º C - +40º C.

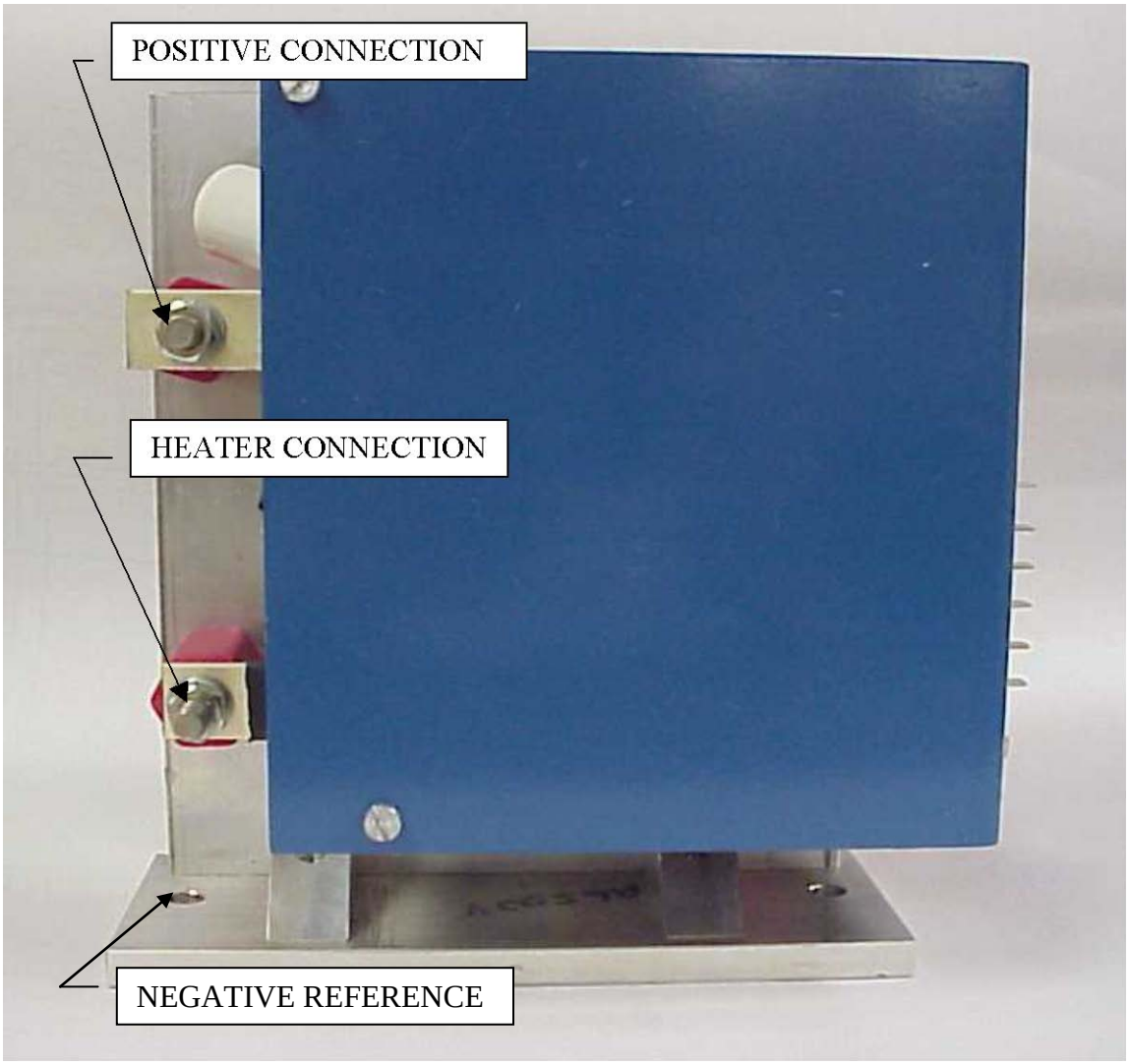
Humidity: 90% non-condensing.

Altitude: 1000 Meters Above Sea Level without derating.

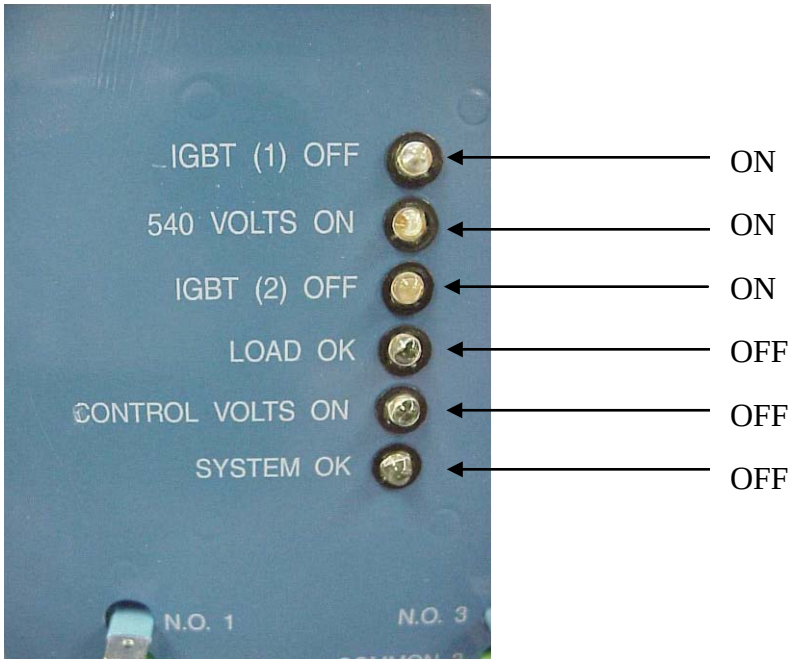
Shock Maximum: 30m/Sec. * Sec. For 10ms.

Vibration Maximum: 10m/ Sec. * Sec. At 40Hz.

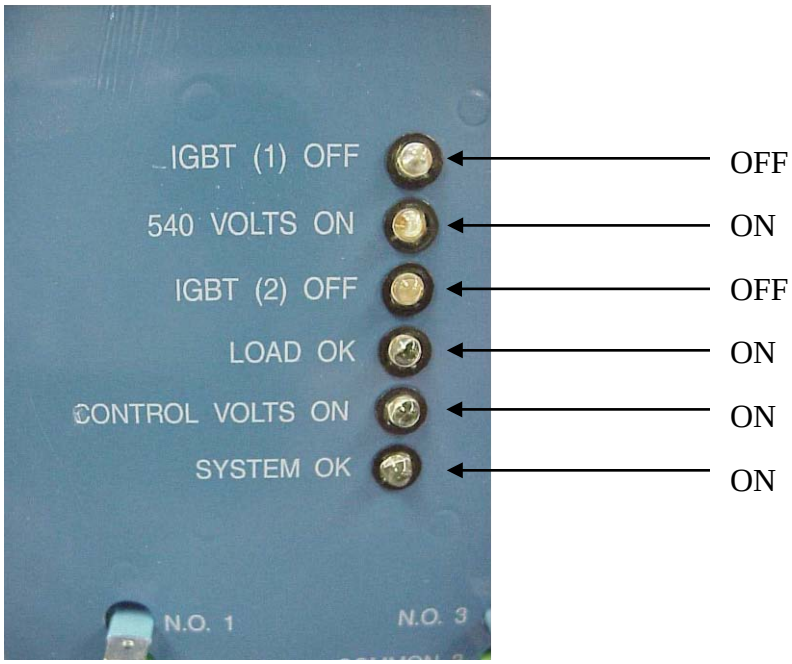
Storage Temperature Range: -40º C to +60º C.



Side View Photo



Indicator light sequence when 540VDC applied with no control voltage.



Indicator light sequence operating properly with Heater ON.

Troubleshooting the Z-Switch

Indicator lamp troubleshooting guide

If for any reason the correct lamps are not lit during any phase of operation use the following table to determine the reason and corrective actions necessary.

When idle the top three lamps should be lit. The bottom three should be off.

Idle State 540VDC ON Control voltage OFF		
Indicator LED	**Proper state**	**If not in proper state:**
IGBT (1) OFF	Lit	IGBT #1 has failed. Replace Z-switch.
540 VOLTS ON	Lit	Check high voltage supply to Z-switch.
IGBT (2) OFF	Lit	IGBT #2 has failed. Replace Z-switch.
LOAD OK	OFF	Control voltage has been applied. Remove voltage.
CONTROL VOLTAGE ON	OFF	Control voltage has been applied. Remove voltage.
SYSTEM OK	OFF	Control voltage has been applied. Remove voltage.

When operating, the first and third lamp should be OFF. All other lamps should be illuminated.

Operating State 540VDC ON Control voltage ON		
Indicator LED	**Proper state**	**If not in proper state:**
IGBT (1) OFF	OFF	IGBT #1 has failed to operate. Replace Z-switch.
540 VOLTS ON	Lit	High voltage supply has been lost. Check supply voltage.
IGBT (2) OFF	OFF	IGBT #2 has failed to operate. Replace Z-switch.
LOAD OK	Lit	The external wiring or load circuit has been noticed to have a short circuit or ground fault. Check load and wiring. Replace Z-switch if load and wiring are healthy.
CONTROL VOLTAGE ON	Lit	The +15VDC within the Z-switch has failed to appear. Check that control voltage is 50-90VDC. If control voltage input is healthy, replace the Z-switch.
SYSTEM OK	Lit	The Z-switch has indicated there is a fault. Check load and wiring to load. If all is healthy, replace the Z-switch.

If there is a condition in which both the *Load OK* and the *System OK* lamps are not lit when the *Control Voltage ON* lamp is lit it is an extreme possibility the resistor circuit is no longer healthy. Check all wiring and the resistor for ground faults and short circuits.

Note: Prior to replacing the Z-switch for any indicated fault reset the control voltage and attempt operation. It is possible for the Z-switch to lock out due to a fault which has occurred externally and has subsequently cleared itself. Reset of the Z-switch from a lock out is accomplished only through removing control voltage.

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