

	www.basler.com +1 618.654.2341 (USA) info@basler.com	Model	DXCB-2 De-Excitation/Crowbar Module
		Part Numbers	9500900100, 9500900101, and 9500900102

INTRODUCTION

The DXCB-2 De-Excitation/Crowbar Module protects the generator field and exciter circuits by providing a low-impedance path for currents that would otherwise cause excessively high transient voltage or damaging arcs. A DXCB-2 module can be operated in one of two modes: de-excitation (DX) or crowbar (CB).

In DX mode, the DXCB-2 module provides a path for the generator field current when its field breaker is opening or when the normal path is not available.

In CB mode, the DXCB-2 module provides a low-resistance path for large positive voltages across the generator field and exciter bridge. Generator pole-slip is one source of high voltage.

The enclosure of the DXCB-2 offers electric shock protection from incidental contact. An identical footprint and functional compatibility make for simple replacement of a DXCB with a DXCB-2.

DXCB-2 Models

Three versions of the DXCB-2 module are available. Part number 9500900100 is rated for up to 600 Vdc nominal field voltage and can conduct up to 2,000 Adc for one second. Part number 9500900101 is rated for up to 1,000 Vdc nominal field voltage and can conduct up to 5,000 Adc for one second. Part number 9500900102 has identical ratings to part number 9500900101 but has a higher range of jumper-selectable trip voltage values. Reference Table 3 for jumper-selectable trip voltages for each model.

SAFETY

As with all electrical equipment, appropriate safety measures must be taken when dealing with excitation equipment. High voltage is present within the excitation cubicles; their magnitudes depend upon the particular system. Opening the sources (e.g., disconnecting device 41) does not completely disconnect the high voltages. As long as the machine is still physically connected to the system, there is a possibility that a safety hazard exists.

Warning!

Bodily injury could result if contact is made with components in this apparatus which carry either line voltage or are subject to abnormally high voltages. References to the circuit diagrams, notably within other documentation, disclose hazardous areas.

Every precaution must be taken when working at the excitation control switchgear to ensure that all high voltages are isolated and avoided by test personnel. In addition to the machine terminal voltage (460 Vac or greater) at the excitation transformer, there may be other sources of power entering the cubicles, such as 125/250 Vdc and/or 120/240 Vac used to feed certain devices. A good rule to follow is to assume that all connections are live and dangerous until proven otherwise and to avoid all body contact with any of these voltages.

SPECIFICATIONS

Power Supply Requirements

Voltage: 125 Vdc (112.5 to 137.5 Vdc)
Current: 100 mAcd (maximum)

Pin Assignments

DXTBP: 1 (+), 3 (–)

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DXCB-2 Module Ratings

Low Voltage, Part Number 9500900100

Voltage: 600 Vdc
Current: 100 Adc continuous
2,000 Adc for one second

High Voltage, Part Numbers 9500900101 and 9500900102

Voltage: 1,000 Vdc
Current: 100 Adc continuous
5,000 Adc for one second

V_{DRM} (Repetitive Peak Off-State Voltage) and V_{RRM} (Repetitive Peak Reverse Voltage) Rating

Low Voltage Style: 2,800 V maximum
High Voltage Style: 4,200 V maximum

Field Connections

Input Current: Anode (A)
Output Current: Cathode (K)

Control Firing Input

Voltage: 24 Vdc or 125 Vdc (factory set based on system)
Current: 10 mAdc (maximum)

Pin Assignments

DXTBP: 2 (+), 4 (-)

Relay Driver Output and Phase Back

Relay Driver

Voltage: +24 Vdc
Current: 20 mAdc

Phase Back

Voltage: +24 or -24 Vdc (factory set based on system)
Current: 20 mAdc

Pin Assignments

DXTBP: 5 (-), 6 (+)

CE Compliance

This product has been evaluated and complies with the relevant essential requirements set forth by the EU legislation as part of a system, not as a stand-alone device.

EC Directives

- Low Voltage Directive (LVD) 2014/35/EU
- Electromagnetic Compatibility (EMC) 2014/30/EU
- Hazardous Substances (RoHS2) 2011/65/EU

Harmonized Standards used for Evaluation

- IEC 62103:2003 (pertinent EMC sections)
- EN 62477-1:2012
- EN 61000-6-2:2005
- EN 61000-6-4:2007; with AMD 1:2011
- EN 50581:2012, Ed 12

Environment

Temperature

Operating: -40°C to 60°C (-40 to 140°F)
Storage: -40°C to 65°C (-40 to 149°F)

Humidity

0 to 95%, non-condensing

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Physical

Weight: 48.6 lb (22.1 kg)
Size (W x H x D): 16.25 x 11.22 x 10.52 inches
(412.6 x 285.0 x 267.2 millimeters)

INSTALLATION

The DXCB-2 is typically preinstalled in the excitation control system. If replacement is necessary, carefully label and document each of the connections to the DXCB-2 in order to properly reconnect the new module. The DXCB-2 must be monitored and adjusted to fit the specific application at initial startup, whether it is a new unit or a replacement.

DXCB-2 Connections

DXCB-2 connections consist of a screw terminal connector and bus bar connections. See Figure 1 for connector and bus bar locations. Locator letters in Figure 1 correspond to the lettered descriptions in Table 1.

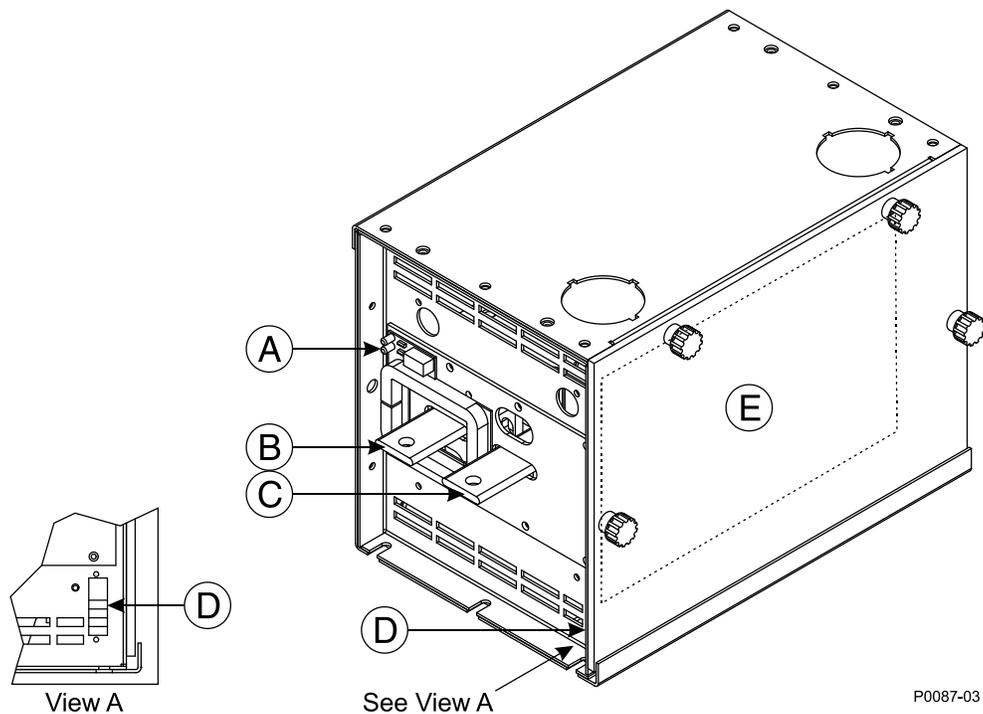


Figure 1. Connector and Circuit Board Locations

Table 1. Connector and Circuit Board Descriptions

Locator	Description
A	Conduction Monitor Circuit Board.
B	Anode (A).
C	Cathode (K).
D	Connector (DXTBP).
E	Control Circuit Board.

Screw Terminal Connector

A connector with screw-down compression terminals is used for the power supply input, control firing logic input, and relay driver output. The connector, and the header it plugs into, have a dovetailed edge that ensures proper connector orientation. Connector screw terminals accept a maximum wire size of 12 AWG. The maximum screw torque is 5.3 in-lb or 0.6 N•m.

Bus Bar Connections

Bus bar connections are provided for the anode and cathode of the thyristor. The maximum torque for the supplied hardware is 27 ft-lb (37 N•m).

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OPERATION

Figure 2 illustrates a typical excitation system using two DXCB-2 modules. One module is operating in de-excitation (DX) mode and the other is operating in crowbar (CB) mode.

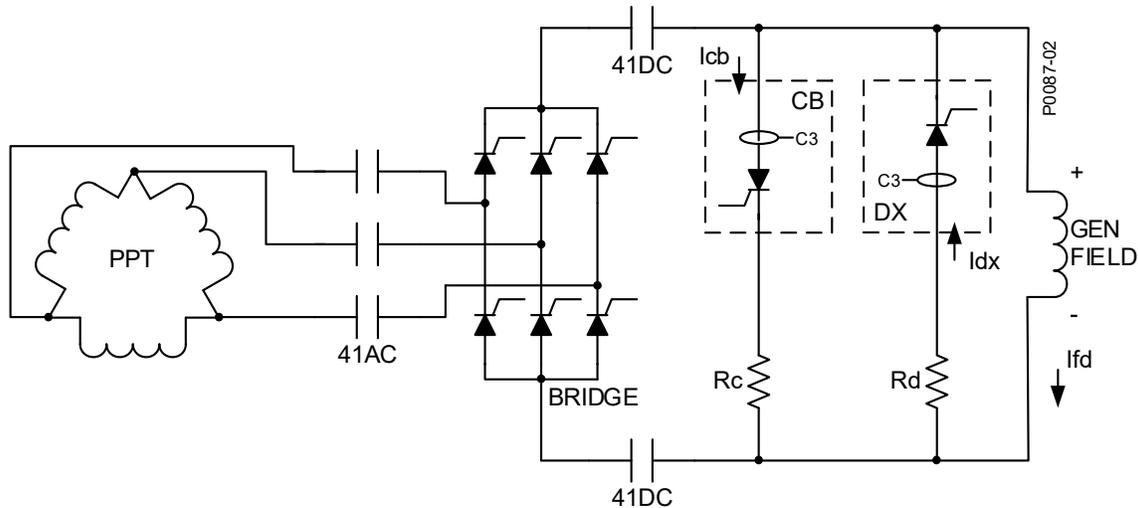


Figure 2. Typical Application

The normal path for current is through the power potential transformer (PPT), ac breaker (41AC), exciter bridge, field breaker (41DC), and the generator field. If this current path is interrupted, such as when the ac breaker opens, the generator field acts as a large inductor and develops the necessary voltage to keep the field current (I_{fd}) from changing. The de-excitation circuit provides a path for this current. A resistor, R_d , may be provided to absorb energy from the generator field. This reduces the time it takes to de-excite the generator when a dc interrupt device is used.

The crowbar circuit provides a low resistance path to large, positive voltages, created from a Pole Slip/Out of Step condition. A resistor, R_c , limits the bridge current when the crowbar is conducting.

In typical applications, two DXCB-2 modules, one configured for CB and one configured for DX, share a resistor (R_c or R_d).

When the thyristor conducts, a logic level feedback signal is provided to the excitation system. The excitation system design will dictate action taken when the thyristor conducts. Typically, a system trip is initiated.

Conduction Monitor Board

The conduction monitor board detects current flow when the flux density in the air gap exceeds the pickup threshold of the Hall-effect switch. LEDs DS1, DS2, and DS3 light to indicate current flow. The Hall-effect switch has a pickup threshold of approximately 30 amperes.

Control Circuit Board

The control circuit board interfaces with the excitation system to fire the thyristor.

Thyristor Firing

Applying 125 Vdc or 24 Vdc (depending on the system) to pins 2 and 4 of connector DXTBP, initiates thyristor firing. When thyristor firing is initiated, a train of pulses fire the thyristor for as long as the voltage is present. The initial high intensity of the firing pulse train decreases after approximately 200 milliseconds. If a power supply failure occurs, capacitors provide enough energy to fire the thyristor for 500 milliseconds. A gate pulse transformer isolates the control firing circuitry from the thyristor gate.

Thyristor Current Flow Indication

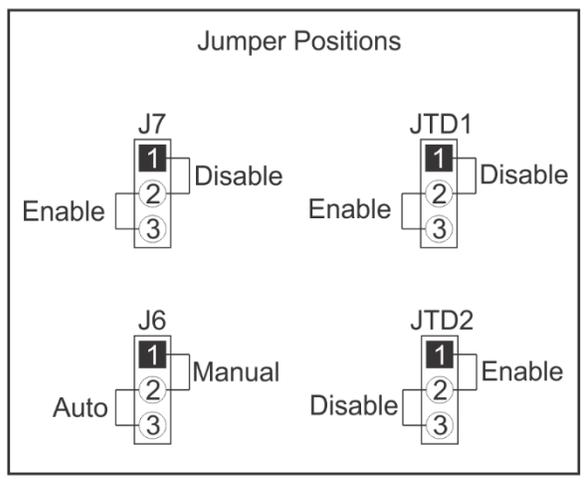
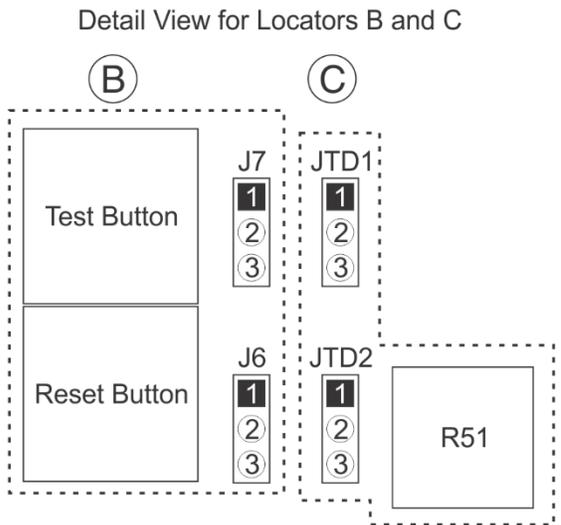
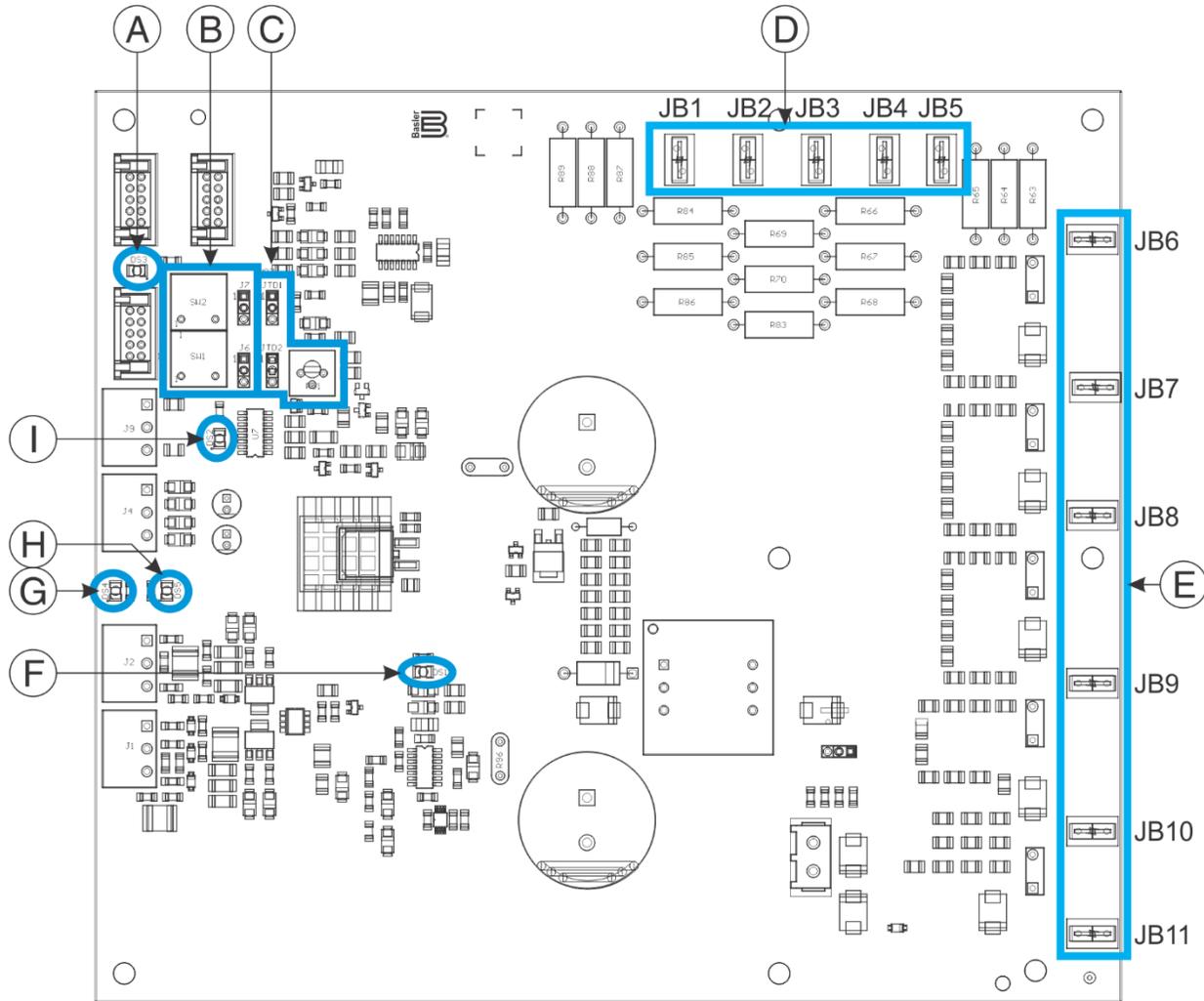
Relay Driver

The control circuit board monitors the conduction monitor board to detect current flow through the thyristor. When thyristor current is detected, the control circuit board supplies current sensor relay driver (CSRD) output voltage (+24 Vdc). CSRD Active LED DS2 lights when the relay driver is energized. The CSRD output has an adjustable time delay, from 50 milliseconds to 1.35 seconds, that is controlled by jumpers JTD1 and JTD2 and potentiometer R51. See Figure 3 for jumper and potentiometer locations. Locator letters in Figure 3 correspond to the lettered descriptions in Table 2.

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Phase Back

The control circuit board can also provide a phase back signal of +24 Vdc to an MGR type exciter or -24 Vdc to an M300 type exciter. Phase back output voltage is factory set based on exciter type.



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Figure 3. Control Circuit Board LED and Jumper Locations

Table 2. Control Circuit Board LED and Jumper Descriptions

Locator	Description
A	Control and Conduction Monitor board communication LED DS3.
B	Test (SW1) and Reset (SW2) pushbuttons, Jumpers J6 and J7.
C	CSRD output time delay adjustment jumpers and potentiometer.
D	Current-limiting resistance adjustment stabs JB1 through JB5.
E	Firing voltage adjustment stabs JB6 through JB11.
F	Thyristor firing LED DS1.
G	+15 Vdc power supply LED DS4.
H	-24 Vdc power supply LED DS5.
I	CSRD active LED DS2.

To obtain the desired CSRD output time delay, observe the following guidelines:

- For a 50-millisecond time delay, set JTD1 to D (disable) and JTD2 to D (disable).
- For a 350-millisecond time delay, set JTD1 to E (enable) and JTD2 to D (disable).
- To add up to one second of delay time, set JTD2 to E (enable) and adjust R51 for the desired time delay.

Break-Over Diodes

The break-over diodes (BOD) fire the thyristor when field voltage exceeds the jumper-selected threshold. The BODs operate even when the DXCB-2 module is not powered; however, current flow will not be indicated by the conduction monitor LEDs, and the feedback signal will not be provided to the excitation system.

Depending on the system requirements, up to five BODs are connected in series with appropriate current-limiting resistors and stabs for selecting firing voltages. Part numbers 9500900100 and 9500900101 are equipped with five 600-volt BODs while part number 9500900102 is equipped with two 800-volt BODs and three 600-volt BODs. Stabs JB1 through JB5 determine current-limiting resistance. Stabs JB6 through JB11 determine firing voltage. Table 3 lists the jumper settings for current-limiting resistance and firing voltage selection. Figure 3 shows the stab locations.

Table 3. BOD Jumper Settings for Current Limiting Resistance and Firing Voltage Selection

P/N 9500900100 P/N 9500900101	600 V	1,200 V	1,800 V	2,400 V	3,000 V
P/N 9500900102	800 V	1,600 V	2,200 V	2,800 V	3,400 V
Jumper JB6 to:	JB10	JB9	JB8	JB7	Remove jumper
Connect Thyristor Anode Jumper to:	JB5	JB4	JB3	JB2	JB1

The BOD firing voltage level should be coordinated to quickly discharge energy in the field while protecting the generator field and preventing damage to the rectifier bridge. See IEEE Std 421.6™ (2017) for more detail. The BOD threshold must be set below the field high-potential test level. See IEEE Std. 421.3™ (2016).

For de-excitation mode, the BOD firing voltage level should be:

- Set lower than the contact voltage rating of the 41DC breaker or contacts. When the 41DC is opened under load, the voltage that develops across its contacts should be greater than the break-over voltage so that the de-excitation thyristor will be fired.
- Coordinate with surge protection.
- Set higher than the maximum negative output of the exciter bridge plus a "safety factor" to prevent inadvertent de-excitation operation.

When 41AC is used, BOD firing cannot be relied upon to fire the de-excitation circuitry. The voltage developed by the contacts of an ac breaker attempting to interrupt dc current will likely be insufficient.

For crowbar mode:

- Set less than the peak reverse voltage (PRV) of the exciter bridge thyristors.
- Set greater than the maximum positive output of the exciter bridge, including the commutation spike voltage.

Test Function

A Test pushbutton, located on the control circuit board, simulates current flow through the thyristor. Jumper J7 must be in the E (enable) position to perform this test.

Reset Function

The control circuit board Reset button is operated to reset the CSR signal and enable a restart of the excitation system following operation of the DXCB-2 module. Manual reset of the DXCB-2 module is needed only when it is configured for Manual Reset mode. Manual Reset mode is selected by placing jumper J6 in the M (manual) position. Placing jumper J6 in the A (auto) position selects Auto Reset mode. In Auto Reset mode, the DXCB-2 module resets automatically and operation of the Reset button is not required to restart the system.

See Figure 3 for the locations of the pushbuttons and jumpers. Locator letters in Figure 3 correspond to the lettered descriptions in Table 2.

Note
When the DXCB-2 module operates while configured for Manual Reset mode (jumper J6 in M position), the Reset button must be operated before attempting to restart the excitation system.

Power Supply

The DXCB-2 accepts 125 Vdc operating power at DXTBP terminals 1 (+) and 3 (–).

Parallel Operation

Logic firing and BOD firing may be paralleled to allow either or both to fire the required thyristor. In some applications, only one type of firing (BOD or logic) may be utilized.

As shown in Figure 4, control circuit boards are paralleled using ribbon cable connections to J10 and J11. This feature provides redundancy and increases the rating for certain types of operation.

There are two types of parallel operation: control firing and self-firing.

Control Firing

For parallel operation via control firing, the firing pulses are synchronized.

See *Retrofitting a DXCB with a DXCB-2* if retrofitting a DXCB with a DXCB-2 module.

Self-Firing

For de-excitation or crowbar applications, a resistor is required when DXCB-2 modules are paralleled, either R_c or R_d.

Note
For de-excitation operation via self-firing, the excitation system must have a breaker rated for the required voltage. For parallel operation without separate discharge resistors in series with each thyristor, the voltage across the parallel thyristor may disappear before self-firing occurs.

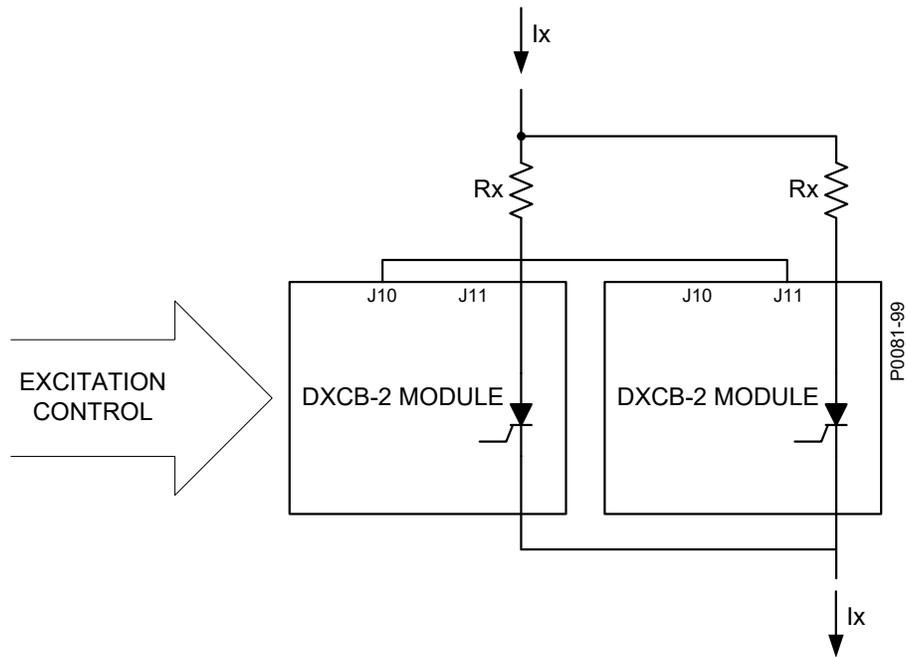


Figure 4. Parallel Operation with Resistor

MONITORING

DXCB-2 monitoring consists of eight LED indicators. See Figure 3 for LED locations on the control circuit board and Figure 5 for LED locations on the conduction monitor circuit board.

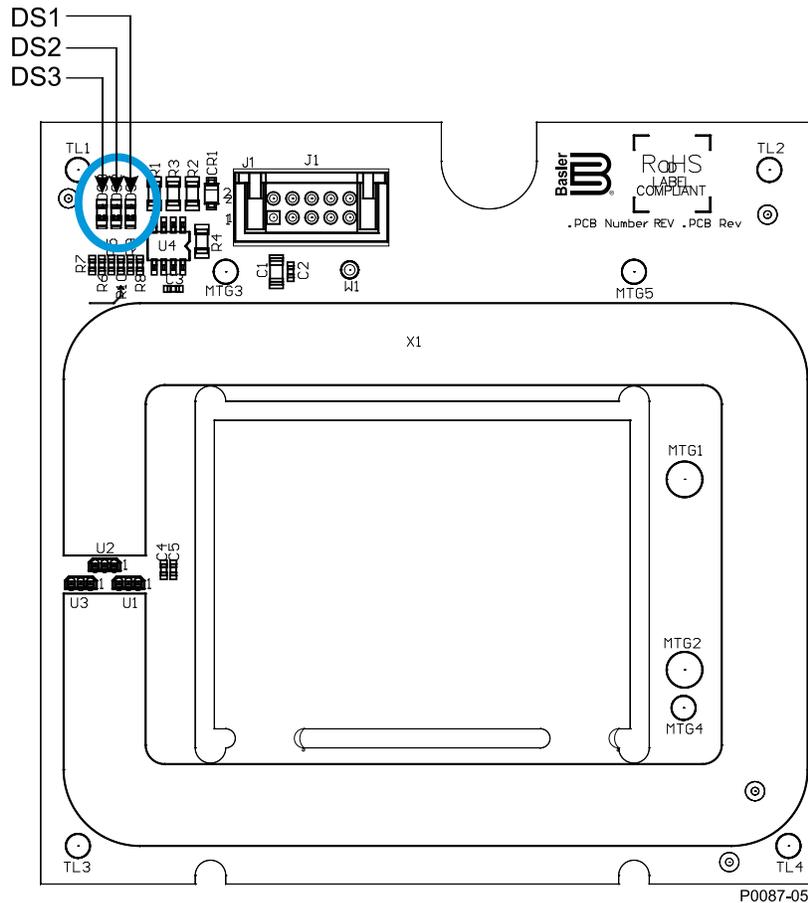


Figure 5. Conduction Monitor Circuit Board LED Locations

Control Board and Conduction Monitor Board Communication LED (DS3)

Located on the control board, this red LED lights to indicate a proper connection between the control board and conduction monitor board.

CSRD Active LED (DS2)

Located on the control board, this red LED lights when thyristor current is detected and the DXCB-2 is supplying CSRD output voltage.

Current Flow LEDs (DS1, DS2, DS3)

Located on the conduction monitor board, these redundant, red LEDs light to indicate current flow.

Thyristor Firing LED (DS1)

Located on the control board, this red LED lights when the thyristor is being fired.

Operating Power LEDs (DS4, DS5)

Red LED DS4 lights to indicate the presence of +15 Vdc. Red LED DS5 lights to indicate the presence of -24 Vdc.

RETROFITTING A DXCB WITH A DXCB-2

DXCB-2 modules contain a series of three internal Zener diodes. In some DXCB module applications, these Zener diodes are installed external to the module, inside the excitation cubicle. When retrofitting a DXCB with a DXCB-2 this series of Zener diodes must be shorted, if present. Perform the steps in the following procedure to locate and short the Zener diodes:

1. Following all applicable safety precautions, remove the DXCB from service.
2. Carefully label and document each of the connections to the DXCB in order to properly reconnect the new module.
3. Disconnect the bus bar connections and retain the hardware for later use. Unplug the DXTBP connector. Remove the mounting hardware and retain for later use. Remove the DXCB module.
4. Using system schematics, locate a terminal block designated as either "DXTB" or "TBZB".
5. In some applications, there may be four diodes connected to the terminal block. Refer to the system schematics to determine which diodes are the three Zeners connected in series.
6. Refer to Figure 6. In this example, the Zener diodes are connected to terminals 1, 3, 5, and 7. Install a jumper across terminals 1 and 7.

For the jumper, use 18 AWG, 600 V, 125°C polyethylene insulated, single conductor, stranded tinned copper, 6 inches (152.4 mm) in length. Strip 0.25 inches (6.3 mm) of the insulation from the ends. Install 600 V fork lugs (P/N RB2213) on either end. Torque terminal screws to a maximum of 12 in-lb (1.36 N•m).

7. Install the new DXCB-2 module using the mounting hardware removed in step 3. Reconnect the bus bars using the hardware removed in step 3. Torque bus bar hardware to 27 ft-lb (37 N•m). Reconnect the DXTBP connector.
8. Return the DXCB-2 to service.

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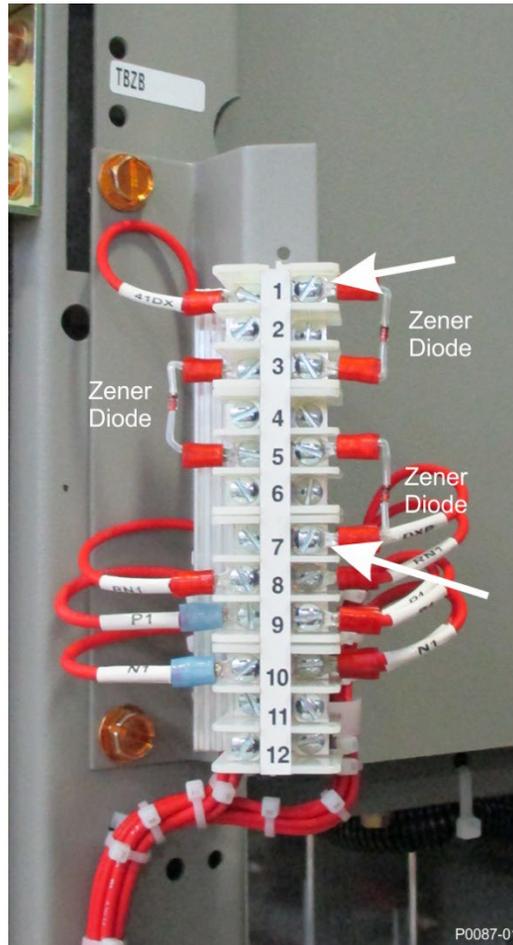


Figure 6. Zener Diode Locations for Retrofitting a DXCB with a DXCB-2

MAINTENANCE

This device contains long-life aluminum electrolytic capacitors. For devices that are not in service (spares in storage), the life of these capacitors can be maximized by energizing the device for 30 minutes once per year.

SPARE PARTS

A reasonable stock of spare parts minimizes downtime in the event of malfunction. When ordering spare parts, care should be taken to specify the style numbers (or other identification) which are printed on the nameplate. Careful documentation of the original connections is essential any time the DXCB-2 is removed. It is recommended that at least one DXCB-2 is stocked.

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