

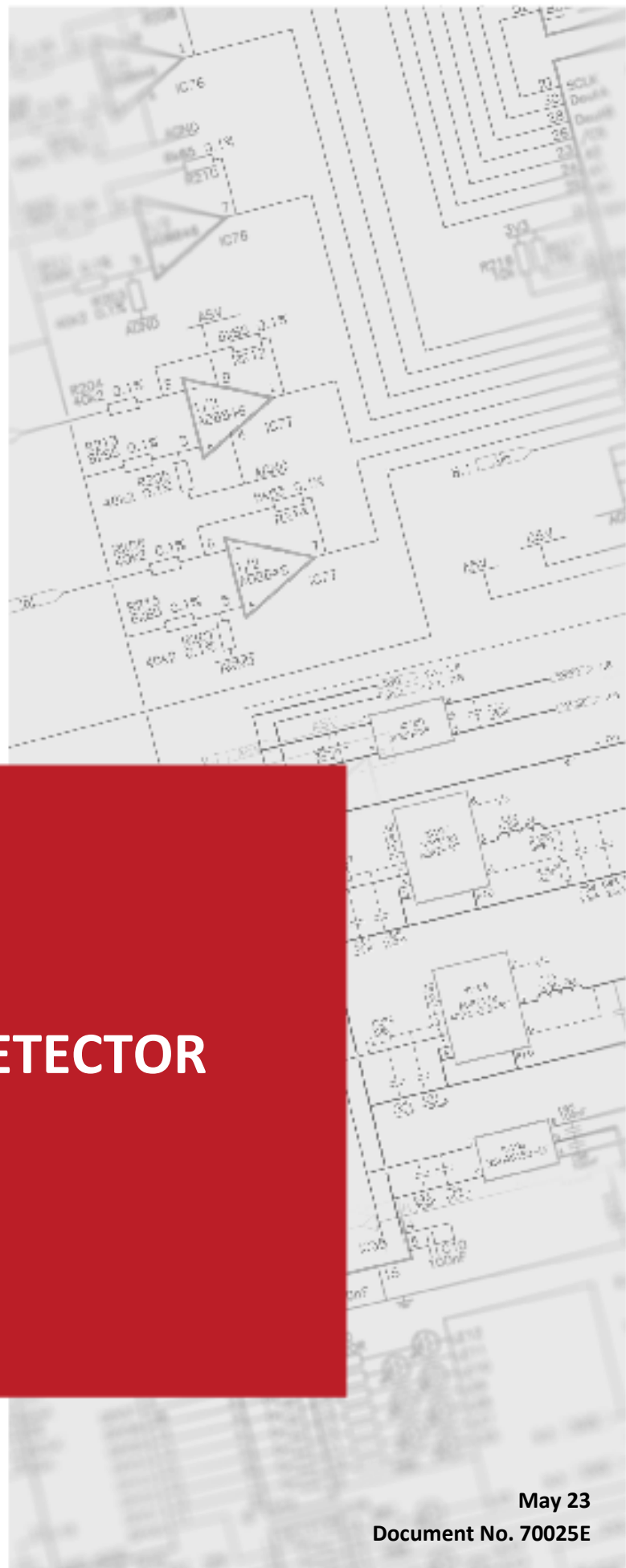


Application Note

SHORTED CONTACTOR DETECTOR

Product Model

SCD



May 23

Document No. 70025E

Document Revisions

Date	Version Number	Approved By	Document Changes
08-07-2022	ORIG	DCS	Original draft
08-24-2022	A	DCS	Block Diagram Update
09-14-2022	B	DCS	Revise switch drawings to match as built.
11-1-2022	C	DCS	Add Clarification.
05-25-2023	D	DCS	Add generic kit 4

Languages

This document is only published in the English language.

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1 BACKGROUND

1.1 Description of the User

DANGER!



Qualified Personnel Only.

The information contained in this manual is intended for Qualified Personnel, as defined by the National Electrical Code (NEC). Always follow Electrical Safety in the Workplace per NFPA 70E or equivalent standard in your location.

The qualified system integrator must be able to work with the end user to design and determine if the use and implementation of this option configuration mitigates shorted contactor safety issues.

1.2 Explanation of Symbols

This section defines the symbols used throughout this document.



DANGER!
Danger indicates a hazard with a high level of risk which, if not avoided, will result in immediate, serious personal injury or loss of life. Examples are: exposed high voltage; exposed fan blades.



CAUTION!
The Caution symbol indicates a hazard which *could result* in non-life threatening personal injury or damage to equipment. CAUTION may also be used to alert against unsafe practices.



NOTICE
The Notice symbol is used for making recommendations on use or supplementary information. Non-compliance with these recommendations may result in damage to the control, welding machine or workpiece and voiding of the warranty.

1.3 Important Safety Instructions

Before installing, starting up, or operating the [SCD], carefully read all safety instructions to ensure safe use of the product.

SAVE THESE INSTRUCTIONS

The safety instructions are part of the product. Keep the instructions in a safe and easily accessible place near the product.



Never open the enclosure door when the breaker is in the ON position.



Always disconnect power before servicing or establishing electrical connections with the product.

2 Scope

AC Weld Controls employ SCR contactors to switch the voltage to the welding transformer. When SCRs fail, they usually fail in a shorted state. This applies un-restricted full line voltage to the welding transformer primary. If the secondary is allowed to conduct current, unexpected power can be developed less than or equal to the source power to the machine.

DANGER!



Note: No matter what the size of the equipment the secondary path typically cannot dissipate the power developed for the duration of time the machine may be in this state. Typical power levels cause the machine to become a safety hazard. Hazards may include molten or extremely hot secondaries, burns, fire, hazardous arcing and machine or tooling damage.

This option can be added to EN7000 series controls to provide shorted contactor detection.

Depending on the safety analysis of the machine a decision is made if protection is needed from shorted SCR failure.

The Shorted Contactor Detection feature can assist in this mitigation especially when this function is not integrated into the weld control.

If it is determined that weld control monitoring is not sufficient this option may be used redundantly along with the weld control circuitry.

NOTICE



Note: Many welding machines do not incorporate shorted contactor condition.

This option can be field installable, and kits are available for most needs. This option also can be included with new control orders.

No studies or MTTF calculations have been done and thus are not provided.

3 Theory of operation

The option is titled Shorted Contactor Detection and is abbreviated with the characters SCD.

The SCD is designed around a microcontroller watchdog timer. Watchdog timers typically have an input that must be repetitively strobed, or the watchdog timer will time out and reset the microcontroller. When the watchdog timer loses the strobe, it is assumed the micro controller was executing abnormal code and needed to be forcibly reset. The SCD functionality is similar.

The SCD requires a repetitive impulse on its input, L1 and H1, or it will turn on the output relay tripping the SCD output that is typically tied to the weld control shunt trip or some other isolation means.

The repetitive pulses are derived by the voltage across the welding contactor L1 and H1. When the weld control is not welding the contactor will be open, thus no weld current. All the line voltage will be dropped across the contactor on the L1 and H1 terminals. The SCD option internally passes this AC voltage to a zero-cross detector. The output of this detector is fed to the watchdog input.

If the SCR was to fail (Turn On) conducting, (shorting) the voltage across L1 to H1 would go to 0 and the weld transformer would see full line voltage. Pulses to the input of the watchdog timer would stop and the watchdog timer would time out and the SCD output would turn on and typically trip the weld control breaker, via a shunt trip, isolating the fault.

The SCD PCB limits L1 H1 input current to 10mA. The maximum input voltage is 27 VAC. This input may be fed from the 410430 Transformer PCB or can be put in series with a snubber as the input is current limited and has 600 VAC isolation.

To prevent the SCD option from false fault outputs when welding at high power levels, the watchdog is disabled during real weld cycles using the weld circuit pulse transformer drive signal.

The watchdog output signal feeds 1 of 3 solid state relay configurations, depending on the assembly chosen. The variants are 24 VDC Normally Open, 24 VDC Normally Closed and 25-120 VAC. See [Table 1: SCD Board Variants](#).

Test inputs are available to test the functionality of the option. See [Figure 3 Block Diagram](#).

Closure from 0VDC to P5-2 (SW1 or SW3) removes impulses from the SCR Voltage Detector and Watch Dog Timer will attempt to time out and turn on the shunt trip output, If the Weld Control Firing Pulses are not present.

Closure from P5-1 to P5-3 will mimic Weld Control Firing Pulses. This will disable the Watch Dog Timer and Shunt trip output will not activate.

When Test Switch is turned to the left position (No Trip), SW2 & 3 are closed. The impulses from the SCR Voltage Detector are removed from the Watch Dog Input and the Watch Dog Disable will also be activated. Since the Watch Dog Disable has the highest priority the Shunt Trip output will not activate even though the SCR Voltage Detector pulses are gone. (Indicating a SCR short) This confirms operation of the Firing Pulse input circuit that disables the Watch Dog Timer.

When Test Switch is turned to the right position (Trip), SW1 alone is closed, and SCR Voltage Detector Pulses removed. Since Weld Firing Pulses are not seen (Watch Dog Disable) the Shunt Trip output will now activate, further testing the SCD Watch Dog output and solid-state relay output circuitry.

The test switch test switch functions may be automated if the application requires it. Standard normally open contacts can be used, possibly from a PLC or other automation.



Figure 3 Block Diagram

4 Design Safety Concerns

4.1.1 Test Switch

The option can be supplied with a 3-position test switch. Use of this switch will activate the SCD output.

This switch can be used to test the SCD function. This switch is not required. When the test switch is not used, no jumpers are required.

CAUTION!



Repeated breaker shunt trip operation can contribute to shorter breaker mechanical life. Using this switch may not be advised when breakers have a limited life time.

DANGER!



Breakers may not support tripping under load without replacement or service. If access to this switch would allow testing of the option when the breaker is under load, the breaker could fail.

When used this switch may need to be located in a location secure from improper use.

Some applications may require scheduled testing. The switch can be replaced by a PLC with custom software to test the SCD regularly.

4.1.2 L1 H1 Wiring

DANGER!



Wiring for the H1 and L1 may be of concern, since these Control Leads connect directly to high current sources, limited only by the weld control breaker, care must be taken. The breaker may not protect these smaller wires. Choices and decisions need to be made if fuses are required and how an open fuse will affect operation.

5 Main Component Overview

This section contains an overview of the available variants of the SCD feature and major components in the system.

The SCD PCB is available in three different variants. The part number of the PCB defines the variant. The features of each variant are shown in [Table 1: SCD Board Variants](#).

Part Number	Description
410429	SHORTED CONTACTOR DETECT, AC OUTPUT, NORMALLY OPEN CONTACTS
410429-001	SHORTED CONTACTOR DETECT, DC OUTPUT, NORMALLY OPEN CONTACTS
410429-002	SHORTED CONTACTOR DETECT, DC OUTPUT, NORMALLY CLOSED CONTACTS

Table 1: SCD Board Variants

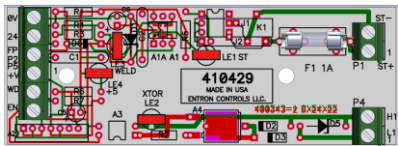


Figure 6 SCD PCB only

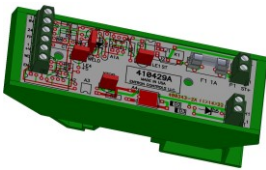


Figure 5 SCD PCB in DIN Rail holder

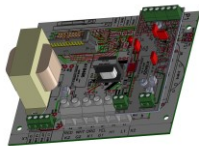


Figure 4 SCD PCB on 410406-002

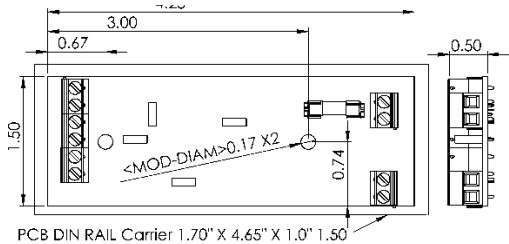


Figure 7 SCD PCB dimensions

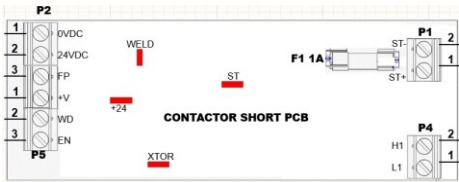


Figure 8 SCD wiring

5.1 SCD PCB CONNECTOR PIN-OUT DESCRIPTIONS

5.1.1 P1 SHUNT TRIP OUTPUT CONNECTIONS

P1-1 & 2 provide dry contacts that close or open depending on the SCD PCB variant, when a shorted contactor is detected.

Pin #	Designation	Description
P1-1	ST+	PLUS OUTPUT. One side of a Solid-State Relay contact pair used to alarm or trip a shunt trip relay. Turns on pulses when a shorted contactor is detected. DC outputs 0-30V at 1A. AC outputs 24-240 VAC 1A
P1-2	ST-	MINUS OUTPUT. Other side of a Solid-State Relay contact pair used to alarm or trip a shunt trip relay. Turns on pulses when a shorted contactor is detected. DC outputs 0-30V at 1A AC outputs 24-240 VAC 1A

Table 2: P1 Connections

5.1.2 P1 OUTPUT CONNECTOR P2 INPUT CONNECTIONS

Provides power for the SCD PCB and also receives weld controller firing pulses to disable the SCD output when truly welding.

Pin #	Designation	Description
P2-1	0V	0 VDC INPUT. Connect to 0 VDC side of 24 VDC source. Voltage range 22-26 VDC. Current Draw 500 mA. Powers logic on this PCB. 0V reference for FIRING PULSES.
P2-2	24	24 VDC INPUT. Connect to +24 VDC side of 24 VDC source. Voltage range 22-26 VDC. Current Draw 500 mA. Powers logic on this PCB
P2-3	FP	FIRING PULSE INPUT. Connect to positive going SCR pulse transformer gate firing pulses 20 VDC MAX.

Table 3 P2 INPUT CONNECTION

5.1.3 P4 INPUT CONNECTIONS

P4 receives the H1 L1 voltage indication in 1 of 2 ways. Mode 1 accepts voltage from a step-down transformer. Mode 2 accepts voltage from a series connected snubber.

When using as a 27 VAC input mode 1

Pin #	Designation	Description
P4-1	L1	LINE 1 INPUT. Connect to one side of a voltage source (410430) derived from the contactor H1 and L1 connections. 27 VAC MAX (13 VAC for 240 VAC LINE).
P4-2	H1	WELD TRANSFORMER H1 INPUT. Connect to other side of a voltage source (410430) derived from the contactor H1 and L1 connections. 27 VAC MAX (13 VAC for 240 VAC LINE)

Table 4 P4 INPUT CONNECTIONS MODE 1

OR when using as a current limited and isolated to 600 VAC input, mode 2.

Pin #	Designation	Description
P4-1	L1	LINE 1 INPUT. Connect to Contactor L1. (480 or 240)
P4-2	H1	WELD TRANSFORMER H1 INPUT. Connect to one side of 230/480 VAC RC Snubber. Connect other side of RC snubber to contactor H1. See also Block Diagram.

Table 5 P4 INPUT CONNECTIONS MODE 2

The 410429 assemblies may be mounted to 410406-002 power cards and then use the RC snubber on the power card. See [Figure 4 SCD PCB on 410406-002](#).

410430-001 is a PCB with just a snubber and can be used if a RC snubber is not available.

5.1.4 P5 TEST SWITCH CONNECTIONS.

P4 connects to the test switch 600014-060 and provides inputs to the SCD PCB for testing of the SCD option.

Pin #	Designation	Description
P5-1	+V	OUTPUT. Voltage pull up. Connection for push to test switch. Connected internally to a 1K resistor to +24 VDC. Use with P5-3.
P5-2	WD	INPUT. WATCHDOG REMOVE INPUT PULSES. Connection for push to test switch. When this connection is connected to OV, the input pulses to the watchdog are removed.
P5-3	EN	INPUT. DISABLE WATCHDOG INPUT. (MIMICS FIRING PULSES) Connection for push to test switch. When connected to +V the watchdog is disabled. Use with P5-1.

Table 6 P5 CONNECTIONS

Main Component Overview

410340 TRANSFORMER PCB PIN-OUT DESCRIPTIONS

5.1.5 LED INDICATORS

LEDs provide a visual status indication for input and output functions on the SCD PCB.

LED #	Designation	Description
LE1	ST	Normally off pulses on when shorted contactor is detected.
LE2	XTOR	Turns on when voltage is detected across P4-L1 to P4-H1. Normally on.
LE3	WELD	Turns on when the SCD PCB receives Firing Pulses. Turns on during weld time.
LE4	+5	Turns on indicating +5 VDC on SCD PCB. Derived from P2-2 24VDC. On when 24 VDC is present.

Table 7 LED INDICATORS

5.2 410340 TRANSFORMER PCB PIN-OUT DESCRIPTIONS

The Transformer PCB is available in two different variants. The part number of the PCB defines the variant. The features of each variant are shown in [Table 1: SCD Board Variants](#).

Part Number	Description
410430	SHORTED CONTACTOR TRANSFORMER
410430-001	SHORTED CONTACTOR SNUBBER (NOT AVAILABLE AT THIS TIME)

Table 8: Transformer Board Variants

For outside dimensions use same dimensions as shown for 410429. See [Figure 7 SCD PCB dimensions](#).

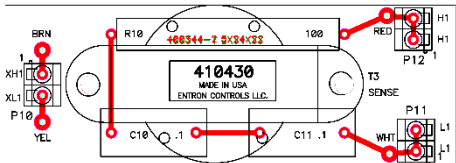


Figure 9 Transformer PCB

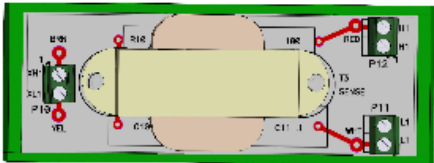


Figure 10 Transformer PCB in DIN Rail holder.

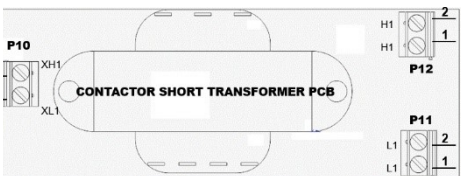


Figure 11 transformer PCB wiring

5.2.1 P10 OUTPUT CONNECTOR

P10 -1 & 2 are the 27 VAC output from the on-board transformer.

Pin #	Description
Designation	Description
P10-1 XH1	27 VAC OUTPUT. Connect to CSD PCB 410429 PCBs on H1 P4-2.
P10-2 XL1	27 VAC OUTPUT. Connect to CSD PCB 410429 PCBs on L1 P4-1.

Table 9 P10 OUTPUT CONNECTOR

5.2.2 P11 INPUT CONNECTOR L1

P11-1 & 2 is the L1 input to the on-board transformer.

Pin # Designation	Description
P11-1 L1	LINE 1 INPUT. Connect to Contactor L1. (480 or 240).
P11-2 L1	Same electrical connection as P11-1. Use either pin 1 or 2.

Table 10 P11 INPUT CONNECTOR

5.2.3 P12 INPUT CONNECTOR H1

P12-1 & 2 is the H1 input to the on-board transformer.

Pin # Designation	Description
P12-1 H1	WELD TRANSFORMER H1 INPUT. (480 or 240 WELD TRANSFORMER H1 INPUT. Connect to contactor H1 connections.
P12-2 H1	Same electrical connection as P12-1. Use either pin 1 or 2.

Table 11 P12 INPUT CONNECTOR

6 730014-060 SHORTED CONTACTOR TEST SWITCH.

This switch is used to test functionality of the SCD. The SCD PCB can be used without this assembly and no jumpers are required.

The switch can be turned to the left (TEST NO TRIP) closing switch 2 and 3. This will not trip the breaker but still tests the DISABLE portion of the watchdog timer. If the SCD option were to trip the breaker the SCD option would need service.

When the switch is released, it will return to the center operate position. When rotated to the right (TEST TRIP) switch 1 is closed and L1 H1 pulses are removed and the SCD option trips. If the SCD option did not trip the SCD option would need service. See section 3 and figure 14 for more detail.

6.1.1.1 SWITCH LOCATION

The test switch is provided to offer some security in knowing the operation of the SCD option is functional. The end user requirements will determine the need for this switch and how often it is used. If needed the switch may be replaced by PLC automation that may check operation regularly.

6.1.1.2 SWITCH CAUTIONS

CAUTION!



The test switch may contribute to shorter life on certain breakers.

DANGER!



The test switch should never be used during a weld cycle as some breakers may be single use under load. Protection from inadvertent testing may be required.

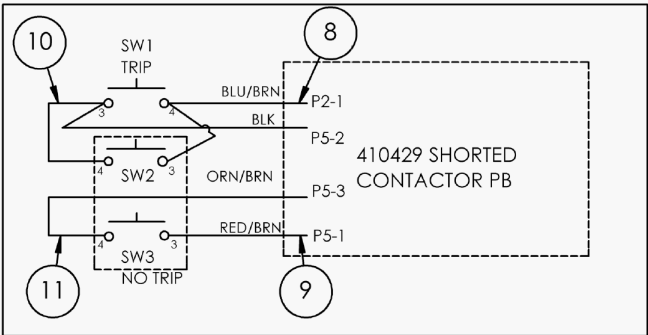


Figure 12 Test switch wiring.

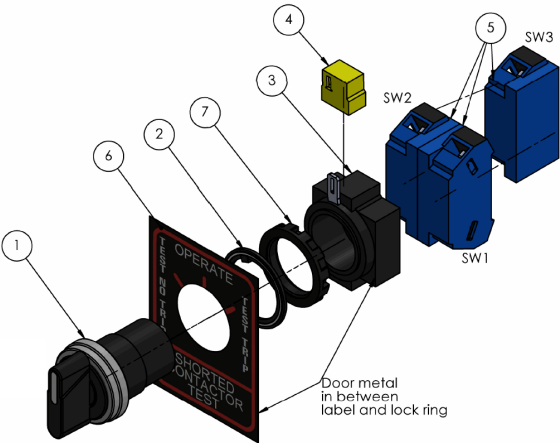


Figure 13 Test switch assembly



Figure 14 Test switch label.

7 EN7000 Field Retrofit

EN7000 series controls may have this option added in the field. The part numbers for the kits are shown below. They are designed to work specifically with EN7000 TC3000 Controls. The kit should be selected based on the breaker installed in the cabinet.

- Kit 1 600819 can be used for EN7000 TC3000 with 800 AMP breakers.
- Kit 2 600819-001 can be used for EN7000 TC3000 with 1250 AMP breakers.

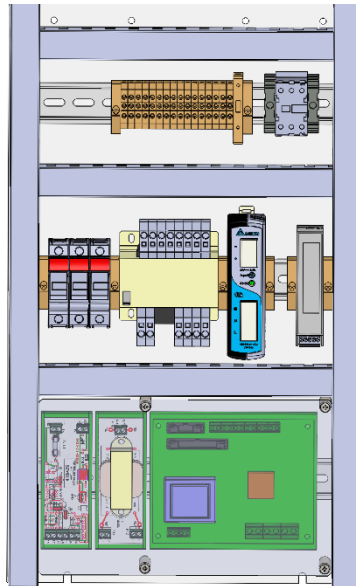


Figure 15 EN7000 retrofit detail.

The kits come complete with the 410429-001, 410430 and DIN rail components that can be used to mount the PCBs on existing DIN rail beside the power card. A replacement protection cover is provided to replace the shorter cover in the existing control. Replacement spacers are also provided so the cover now clears the transformer on the 410430. Re-use existing hardware.

Both kits come with a test switch assembly 730014-060. If used, mount as required.

Wire and ferules are provided to complete the modification. See wiring diagram 3U3734 and interconnect the components.

8 Testing

NOTICE



It is recommended that the SCD function is tested on a regular basis to ensure it is in working condition.

The Push to test is a great resource and tests a majority of the SCD functionality. The switch can be temporally or permanently hooked up for testing.

The ideal test would be to short out the L1 H1 connection (weld transformer secondary open) and check for detection. Some welding transformers have open secondary excitation currents in the 1-10 AMP range. Thus, this could be reasonably accomplished using a suitable relay or switch and fuse. If weld transformer KVA is extremely high, disconnecting the welding transformer may be required also.

Alternately the shunt trip may be disconnected for testing of the SCD. When the SCD detects a shorted contactor, the ST led will pulse and voltage to the shunt trip can be confirmed thus saving un necessary breaker tripping.

DANGER!



Alternately, a jumper across L1 to H1 with a 600V fuse may be appropriate for first install.

NOTICE



Note this jumper would be applied with power off. When power is applied the breaker should trip immediately. Use caution.

9 Kit Bill of Materials

The figure 16 below is a spread sheet listing all the components in the kit assemblies. It can be used with this manual in developing new kit numbers. Drawing numbers are also included. This sheet will be updated as new kits are offered. At this time in printing, the only control kits developed are for EN7000 series controls built in the UK.

		Kit 1	Kit 2	Kit 3	Kit 4		
		For first EN7000 TC3000 retrofit in field for 800A breakers for TW, KIT	For Texas EN7000 TC3000 retrofit in field for 1250A breakers for TW, KIT 2	Generic min. kit FOR UK with BREAKER KIT 3	Generic min. kit FOR US EN7000 KIT 4		
ITEM	REV	QTY 600819	QTY 600819-001	QTY 600819-002	QTY 600819-003	US ENTRON #	Description
1	ORIG	1	1	1	1	730014-060	CONTACTOR SHORT TEST SWITCH
2	ORIG	0	0	0	1	410429	PCB Asssem. External Contactor Short Detection 24-240 VAC 1A
2	ORIG	1	1	1	0	410429-001	PCB ASSEM Sorted contactor 24 VDC NO OUTPUT
2	ORIG	0	0	0	0	410429-002	PCB ASSEM Sorted contactor 24 VDC NC OUTPUT
3	ORIG	1	1	1	1	410430	PCB ASSEM Shorted contactor transformer
3	ORIG	0	0	0	0	410430-001	PCB ASSEM Shorted contactor Snubber
4	ORIG	0	0	0	0	410405-001	PCB ASSEM EN8001 POWER PCB
5	ORIG	0	0	0	0	314062	Suppressor module -varistor - .32, .48 V
6	ORIG	0	0	0	0	314063	Control relay - 1 NO + 1 NC - <= 690 V - 24 V DC standard coil
7	ORIG	0	0	0	0	309106	SHUNT TRIP 450 VAC FOR BF 800A BREAKER NF800 CEW
8	ORIG	1	1	0	0	309107	SHUNT TRIP 24 VDC FOR BF 800A BREAKER NF800 CEW
9	ORIG	0	0	0	0	309108	SHUNT TRIP 24 VDC FOR BF TERASAKI TB2 1250A Breaker
10	ORIG	0	0	0	0	309613-001	SHUNT TRIP 120 VAC EATON PD FRM2
11	ORIG	0	0	0	0	309613-002	SHUNT TRIP 120 VAC EATON PD FRM3
12	A	2	2	2	2	318064	PCB holder cut to 1.5"
13	A	4	4	4	4	318065	END CAP
13	A	2	2	2	2	318066	DIN RAIL MOUNT
14	A	8	8	8	8	318067	Screw to fix end cap
15	ORIG	1	1	0	0	341063	Protection Cover
16	ORIG	4	4	0	0	559066	Pillars - NP8 0.95-B-M4
17	ORIG	0	0	0	0	318030	DIN RAIL END STOP
18	ORIG	0	0	0	0	559033	HEX STANDOFF NYLON 6-32 1"
19	ORIG	0	0	0	0	557111	SCREW #6-32 x 3/25 NYLON PHIL PH
20	ORIG	0	0	0	0	900357	WIRE 600V/GRY WBLKSTRP-18AWG
21	ORIG	0	0	0	0	900339	WIRE 600V/GRY WBLKSTRP-18AWG
22	ORIG	0	0	0	0	900338	WIRE 600V/BLU WREDSTRP-18AWG
23	ORIG	0	0	0	0	900026	WIRE 600V/ORG WREDSTRP-18AWG
24	ORIG	20	20	0	0	900032	WIRE 600V/BLK-18AWG
25	ORIG	25	25	0	0	345044	WIRE 600V/BLUE-18AWG
26	ORIG	1	1	0	0	313734 ISS1 REV A	LUG, FERRULE, INSULATED, 18 AWG
27	ORIG	0	0	0	0	EN7000 V2 NO CB TC 2000V TC 3000 WIRING DIAGRAM	EN7000 V2 NO CB TC 2000V TC 3000 WIRING DIAGRAM
28	ORIG	0	0	0	1	421663-002	EN7000 SERIES WIRING DIAGRAM WITH SHORTED CONTACTOR DETECTION
29	ORIG	1	1	1	1	700255	APP NOTE, Shorted Contactor
30	B	2	2	0	0	219124	DIN RAIL TERM BLOCK

Table 12 SCD Bill Of Material

10 Technical Support

10.1.1 Internet

The latest version of the documentation and other helpful resources in the ENTRON Document Library page found in the Resource section of the ENTRON website: <https://www.entroncontrols.com>

10.1.2 Documentation Request

Documentation, user instructions and technical information can be requested by emailing ENTRON Controls at customerservice@entroncontrols.com

Please include your name and email

10.1.3 Service and Technical Support

For service and technical support, we request that customers fill out the Technical Support Form found on our website at link below:



TECHNICAL SUPPORT FORM LINK

<https://www.entroncontrols.com/resources/technical-support.html>

After the web form has been completed, your case will be assigned to one of our technical specialists who will contact you directly.

For all other questions, our customer service team is available to assist. The contact information for each our manufacturing and service sites is shown in the table below. Please contact the site for your specific region.

Manufacturing Site	Country	Phone	Email	Regions Supported
ENTRON UK	England	+44-1384-455401	tech.support@entroncontrols.com	Europe, Asia, Africa, Rest of World
ENTRON US	USA	+1-864-416-0190	tech.support@entroncontrols.com	USA, Canada
ENTRON MX	Mexico	+52-844-415-9081	soporte@entronmx.com	Mexico, Central America

11 RELATED DOCUMENTATION

#	Document Title	Version #	Location	Author
3U3734	EN7000 V2 TC2000/TC 3000 WIRING DIAGRAM	ISS1/A	UK	UK
421563-002	EN7000 SERIES WIRING DIAGRAM WITH SHORTED CONTACTOR DETECTION	orig	US	US