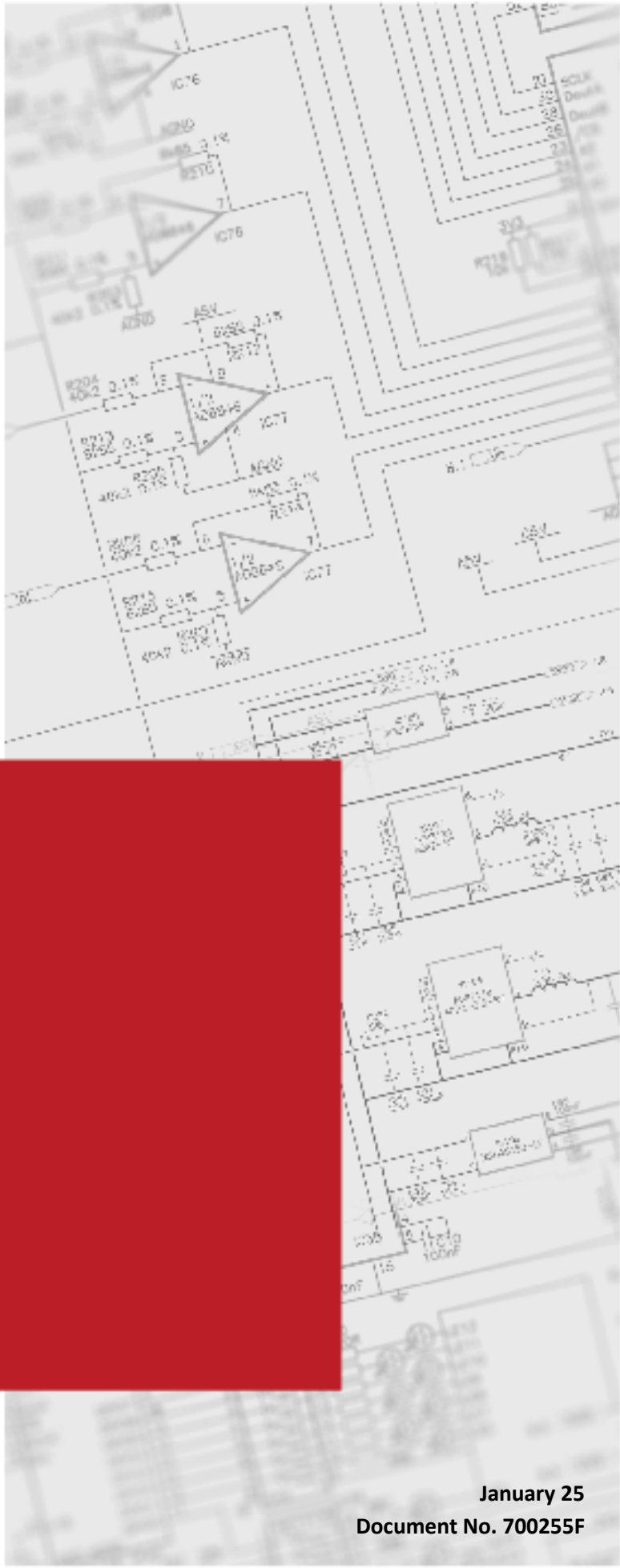

ENTRON™

Application Note

SHORTED SCR DETECTOR

Product Model

SSD

January 25

Document No. 700255F

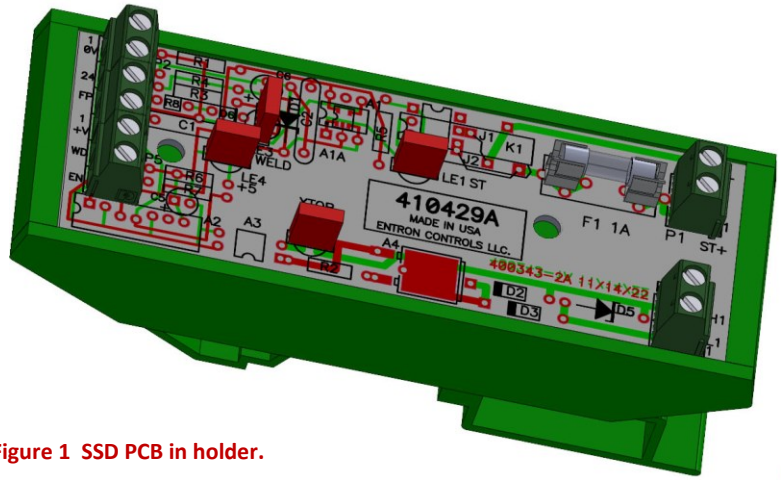

Figure 1 SSD PCB in holder.

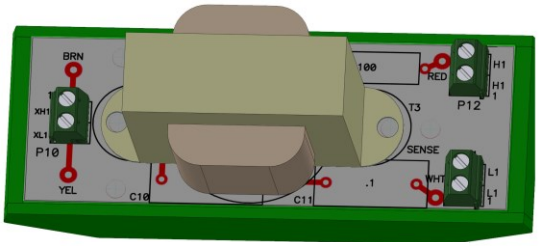

Figure 2 Transformer PCB in holder

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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
05-25-2023	E	DCS	Update table 12 SSD Bill of Materials
12-19-2024	F	ZJC	Changed all “Contactor” references to “SCR”

This
document is only published in the English language.

Table of Contents

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!
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!

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

NOTICE

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 [SSD], 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.

DANGER!

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

DANGER!

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

2 Scope

AC Weld Controls employ SCR welding 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 SCR detection.

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

The Shorted SCR 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 SCR 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 SCR Detection and is abbreviated with the characters SSD.

The SSD 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 SSD functionality is similar.

The SSD requires a repetitive impulse on its input, L1 and H1, or it will turn on the output relay tripping the SSD 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 SCR L1 and H1. When the weld control is not welding the SCR will be open, thus no weld current. All the line voltage will be dropped across the contactor on the L1 and H1 terminals. The SSD 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 SSD output would turn on and typically trip the weld control breaker, via a shunt trip, isolating the fault.

The SSD 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 SSD 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: SSD Board Variants.

Test inputs are available to test the functionality of the option. See Figure 3 Block Diagram.

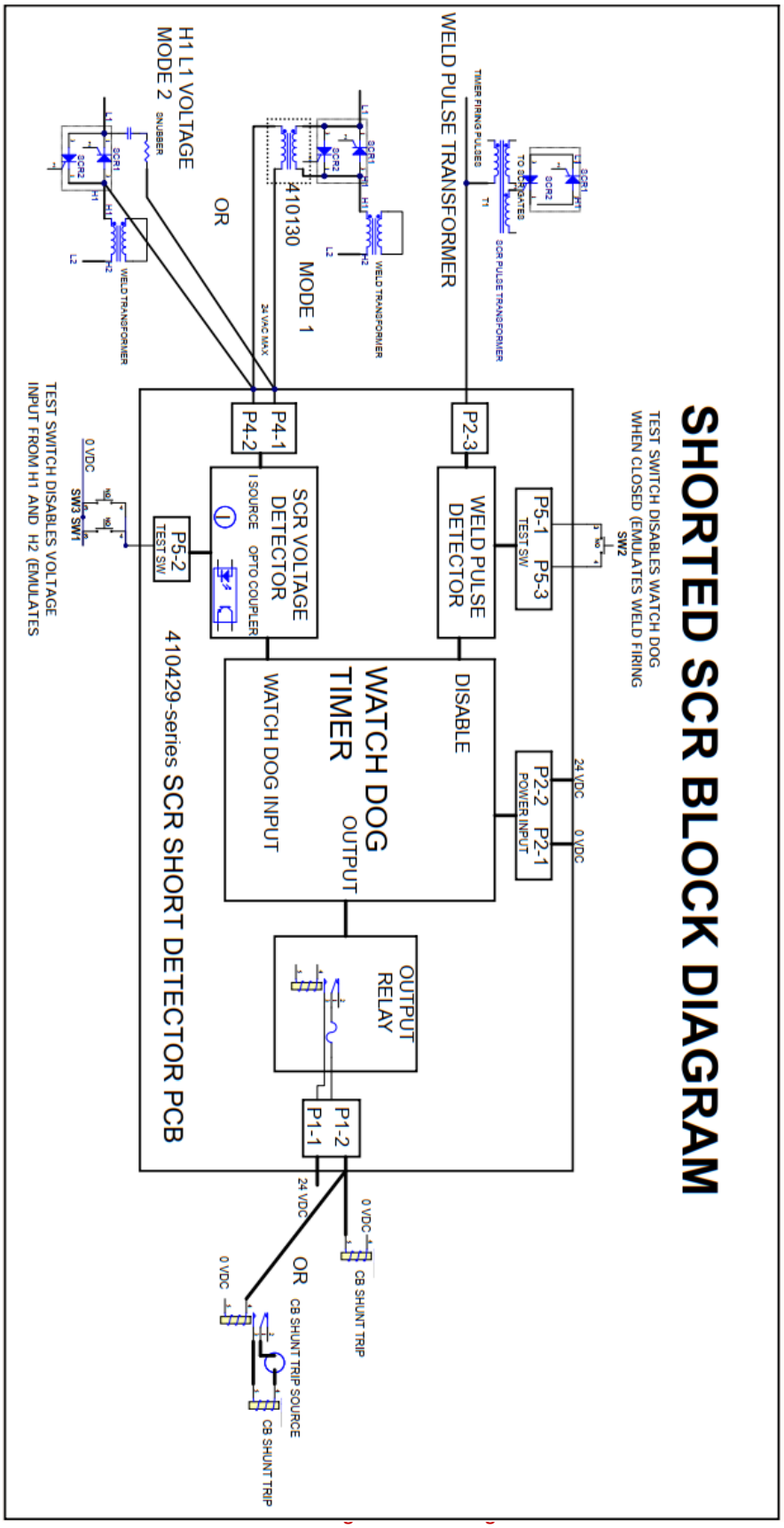
Closure from 0VDC to P5-2 (SW1 or SW3) removes impulses from the SCR Voltage Detector and Watch Dog Timer will attempt to time out and turn on the shunt trip output, If the Weld Control Firing Pulses are not present.

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 SSD 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.



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 SSD output.

This switch can be used to test the SSD 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 SSD 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 SSD feature and major components in the system.

The SSD 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: SSD Board Variants.

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

Table 1: SSD Board Variants

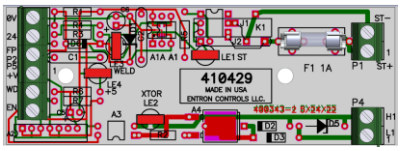


Figure 6 SSD PCB only

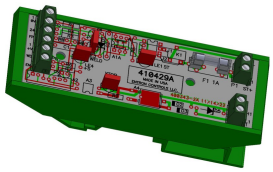


Figure 4 SSD PCB in DIN Rail holder

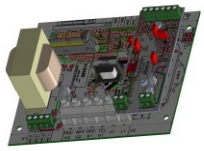


Figure 5 SSD PCB on 410406-002

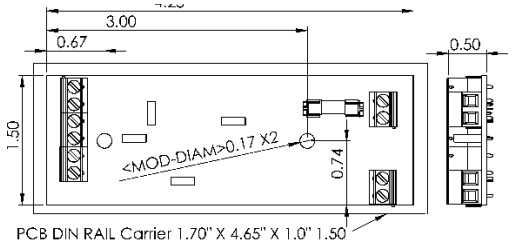


Figure 7 SSD PCB dimensions

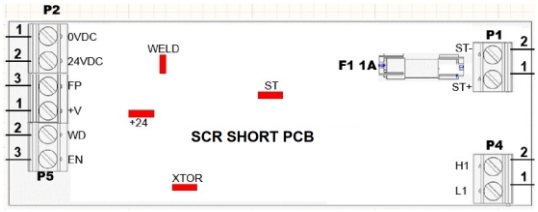


Figure 8 SSD wiring

5.1 SSD 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 SSD PCB variant, when a shorted SCR 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 SCR 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 SCR 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 SSD PCB and also receives weld controller firing pulses to disable the SSD 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. OV 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 SCR 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 SCR 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 SCR 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 SCR 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 SSD 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 SSD PCB for testing of the SSD 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

5.1.5 LED INDICATORS

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

LED # Designation	Description
LE1 ST	Normally off pulses on when shorted SCR is detected.
LE2 XTOR	Turns on when voltage is detected across P4-L1 to P4-H1. Normally on.
LE3 WELD	Turns on when the SSD PCB receives Firing Pulses. Turns on during weld time.
LE4 +5	Turns on indicating +5 VDC on SSD 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: SSD Board Variants.

Part Number	Description
410430	SHORTED SCR TRANSFORMER
410430-001	SHORTED SCR SNUBBER

Table 8: Transformer Board Variants

For outside dimensions use same dimensions as shown for 410429. See Figure 7 SSD PCB dimensions.

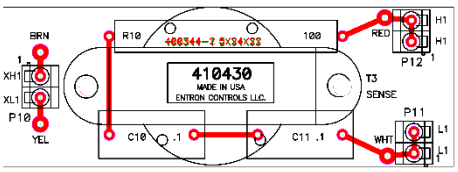


Figure 9 Transformer PCB

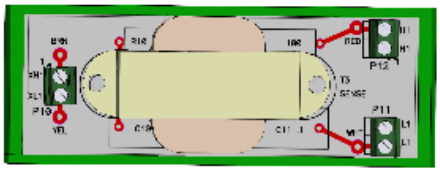


Figure 10 Transformer PCB in DIN Rail holder.

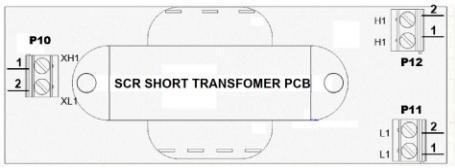


Figure 11 transformer PCB wiring

5.2.1 P10 OUTPUT CONNECTOR

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

Pin # Designation	Description
P10-1 XH1	27 VAC OUTPUT. Connect to SSD PCB 410429 PCBs on H1 P4-2.
P10-2 XL1	27 VAC OUTPUT. Connect to SSD 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 SCR 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 SCR TEST SWITCH.

This switch is used to test functionality of the SSD. The SSD 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 SSD option were to trip the breaker the SSD 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 SSD option trips. If the SSD option did not trip the SSD 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 SSD 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.

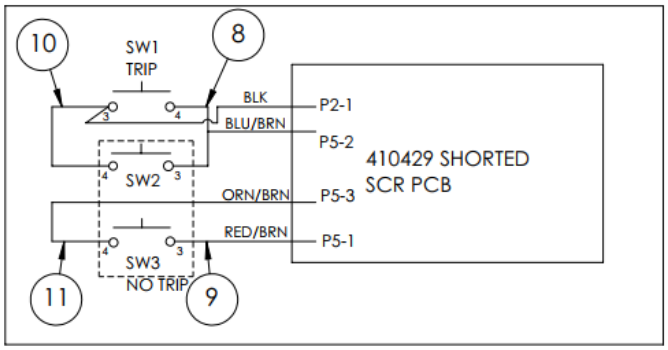


Figure 12 Test switch wring.

Figure 14 Test switch label.

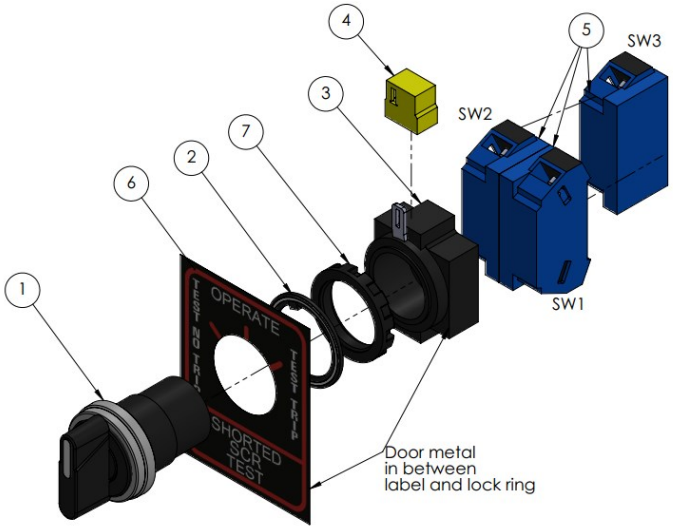


Figure 13 Test switch assembly

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.

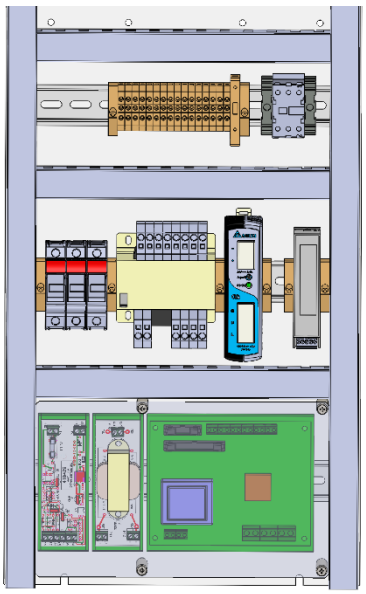


Figure 15 EN7000 retrofit detail.

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 SSD 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 SSD 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 SSD. When the SSD 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 US.

		Kit 1	Kit 2	Kit 3	Kit 4	Kit 3					
		For first EN7000 TC3000 retrofit in field for 800A breakers for TW. KIT 1	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	Generic min. kit FOR UK with BREAKER no test switch KIT 5					
ITEM	**REV**	**QTY 600819**	**QTY 600819-001**	**QTY 600819-002**	**QTY 600819-003**	**QTY 600819-004**	**US ENTRON #**	**Description**	**MFGR NAME**	**MFGR PART #**	**SM UK PART #**
1	C	1	1	1	1	0	730014-060	SCR SHORT TEST SWITCH			
2	B	0	0	0	1	0	410429	PCB Assem, External SCR Short Detection 24-240 VAC 1A			
2	B	1	1	1	0	1	410429-001	PCB ASSEM Sorted SCR 24 VDC NO OUTPUT			
2	B	0	0	0	0	0	410429-002	PCB ASSEM Sorted SCR 24 VDC NC OUTPUT			
3	A	1	1	1	1	1	410430	PCB ASSEM Shorted SCR transformer			
3	A	0	0	0	0	0	410430-001	PCB ASSEM Shorted SCR Snubber			
4	A	0	0	0	0	0	410406-001	PCB ASSEM EN6001 POWER PCB			
5	ORG	0	0	0	0	0	314062	Suppressor module - varistor - 32...48 V	Square D	LA4KE1E	
6	ORG	0	0	0	0	0	314063	control relay - 1 NO + 1 NC - <= 690 V - 24 V DC standard coil	Square D	CA3SK11BD	
7	ORG	0	0	0	0	0	309106	SHUNT TRIP 450 VAC FOR BF 800A BREAKER NF800 CEW	Mitsubishi	SHT-4SWRS	BF 218269
8	ORG	1	0	0	0	0	309107	SHUNT TRIP 24 VDC FOR BF 800A BREAKER NF800 CEW	Mitsubishi	SHT-48-4-SWRS	BF TEMP-SH220223C
9	ORG	0	1	0	0	0	309108	SHUNT TRIP 24 VDC FOR BF TERASAKI TB2 1250A Breaker	TERASAKI	3936	
10	ORG	0	0	0	0	0	309613-001	SHUNT TRIP 120 VAC EATON PD FRM2	EATON		
11	ORG	0	0	0	0	0	309613-002	SHUNT TRIP 120 VAC EATON PD FRM3	0		
12	A	2	2	2	2	2	318064	PCB Holder cut to 1.5"	OKW	0	219044
13	A	4	4	4	4	4	318065	END CAP	OKW	CME/E/EC0000E	219045
13	A	2	2	2	2	2	318066	DIN RAIL MOUNT	OKW	CME/E/FE0000E	219046
14	A	8	8	8	8	8	318067	Screw to fix end cap	OKW	CME/M/SCR	222024
15	ORG	1	1	0	0	0	341063	Protection Cover	BF UK		282027 Ishue 2
16	ORG	4	4	0	0	0	555066	Pillars - NP8.0-95-B-M4	BF UK		210092
17	ORG	0	0	0	0	0	318030	DIN RAIL END STOP			
18	ORG	0	0	0	0	0	555003	HEX STANDOFF NYLON 6-32 1"	KEYSTONE	1903E	
19	ORG	0	0	0	0	0	557111	SCREW; #6-32 x.3125; NYLON; PHL PH	MC MASTER	94735A728	
20	ORG	0	0	0	0	0	900357	WIRE;600V;GRY W/BLK STRP;18AWG			
21	ORG	0	0	0	0	0	900339	WIRE;600V;ORG W/RED STRP;18AWG			
22	ORG	0	0	0	0	0	900338	WIRE;600V;BLU W/RED STRP;18AWG			
23	ORG	20'	20'	0	0	0	900026	WIRE;600V;BLACK;18AWG			
24	ORG	20'	20'	0	0	0	900032	WIRE;600V;BLUE;18AWG			
25	ORG	25	25	0	0	0	345044	LUG; FERRULE; INSULATED; 18 AWG			
26	ORG	1	1	0	0	0	3U3734 ISS1 REVA	EN7000 v2 TC 2000/ TC 3000 WIRING DIAGRAM			3U3734
27	ORG	0	0	0	0	0		EN7000 v2 NO CB TC 2000/ TC 3000 WIRING DIAGRAM			3U3735
28	A	0	0	0	1	0	421563-002	EN7000 SERIES WIRING DIAGRAM WITH SHORTED SCR DETECTION			
29	F	1	1	1	1	1	700255	APP NOTE, Shorted SCR.			
30	B	2	2	0	0	0	219124				219124

Table 12 SSD 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 US	USA	+1-864-416-0190	tech.support@entroncontrols.com	USA, Canada

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 SCR DETECTION	A	US	US