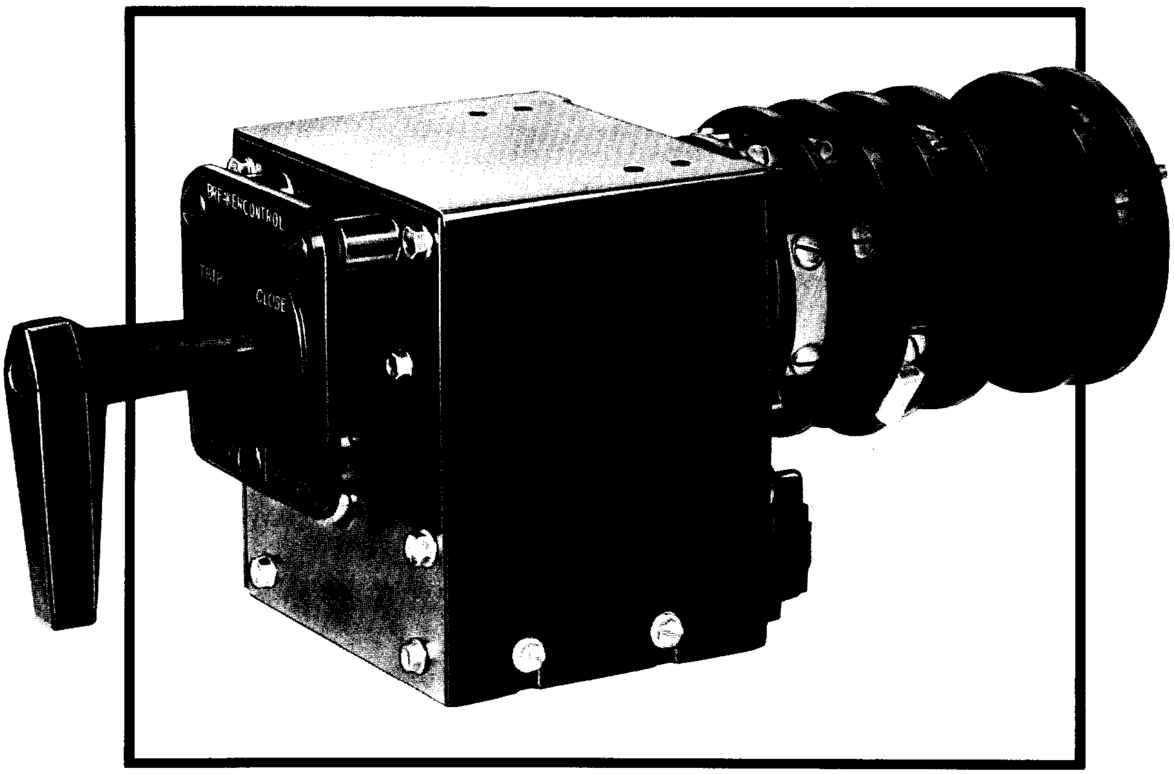
Technical Publication

CSR-1

Effective January 1997

ELECTRICALLY OPERATED CONTROL SWITCH RELAY

FOR BOTH MANUAL AND REMOTE SUPERVISORY CONTROL OF POWER CIRCUIT BREAKERS



ELECTROSWITCH
• SWITCHES & RELAYS
UNIT OF ELECTRO SWITCH CORP.

180 King Avenue, Weymouth, Massachusetts 02188
Telephone: 781/335/5200
FAX: 781/335/4253

ELECTRICALLY OPERATED CONTROL SWITCH RELAY FOR BOTH MANUAL AND REMOTE SUPERVISORY CONTROL OF POWER CIRCUIT BREAKERS

ELECTROSWITCH
Weymouth, Massachusetts

ABSTRACT

This paper describes a new device -- a Control Switch Relay -- that combines present control switches with a remote-controlled solenoid. This enables the use of this single device to do both the manual and supervisory control function in the operational control of power circuit breakers. The Control Switch Relay eliminates the need for substation redesign with redundant, separate relays when manual substations convert to supervisory control. The paper describes the design of the device, details three standard circuits, and outlines applications data. The units are qualified to ESC-STD-1000 which includes aging and seismic vibration requirements to ANSI/IEEE 323-1984 and IEEE-STD-344-1987 for class 1E uses in nuclear power generating stations. The testing also satisfies ANSI/IEEE C37.90-1989 and ANSI/IEEE C37.98-1987.

INTRODUCTION

Substations and other utility systems presently use manual control switches to control the operation of power circuit breakers. To manually CLOSE or TRIP the breaker the control switch is turned either to the left (TRIP) or to the right (CLOSE). When the control switch handle is released, it returns to the normal (vertical) position. When the switch is turned, a mechanical target, which is part of the control switch, is turned as well (GREEN for TRIP, RED for CLOSE). The target remains latched when the handle returns to normal thereby always showing the last active position.

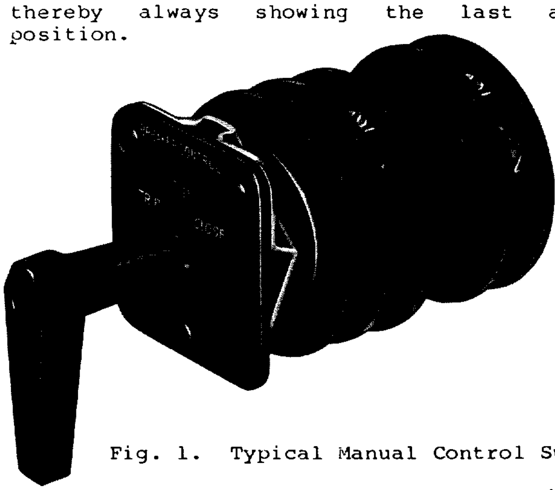
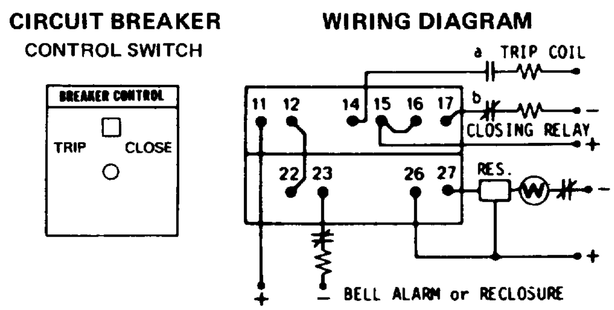


Fig. 1. Typical Manual Control Switch

Because of the flexible construction of control switches, a great variety of TRIP contacts, normal after CLOSE contacts, etc. are easily available in just about any conceivable combination. As a result, the control switch is a very important device and does much more than just control the breaker. It can act like a controller, a programmer, and also sets up alarm circuits and indicator lights.



CONTACT CHART

DECK	CONTACTS	POS. TRIP	nat	nac	CLOSE
1	11 —‖— 12		X	X	
	15 —‖— 14	X			
	16 —‖— 17				X
2	22 —‖— 23			X	X
	26 —‖— 27			X	X

n a t = normal after TRIP
n a c = normal after CLOSE

Fig. 2. Typical Control Switch Contact Layout

With the advent of supervisory control of substations and other remote-controlled utility equipment, the manually operated control switch lost most of its usefulness except when the equipment was operated manually. For supervisory control, redundant relay circuits were developed to duplicate the control switch functions. This necessitated a great deal of redesign, and often, new equipment. Some functions, easy with control switches, are difficult and lost with custom relays. Substation design evolution required unique relay schemes to match many different schematics. In addition, the manual control switch target may not agree with other targets or indicators.

A simple answer to the problem...the addition of a remotely controllable drive mechanism to the present control switch? The result...manual operation just like before but also electrically operable by supervisory control techniques? Direct retrofit of presently used control switches is the result. No new circuit design is required and there is no loss of present operating characteristics.

This paper describes such a device. The type CSR Control Switch Relay combines a high energy rotary solenoid with a conventional control switch. This provides manual or electric operation by supervisory control.

When panel mounted, the CSR looks like presently used manual control switches.

General Release March 1, 1978 (revision of Technical Bulletin CSR-1 dated December 1, 1976). Revised (updated specifications) May 22, 1981, April 1, 1985, August 1, 1986, February 9, 1990, June 15, 1991, February 15, 1993, January 1, 1997

Manually it feels the same and operates the same, and the same combinations of contacts are available. It mounts on the same panels with no rework and only needs the addition of supervisory control leads to set it up for electric operation.

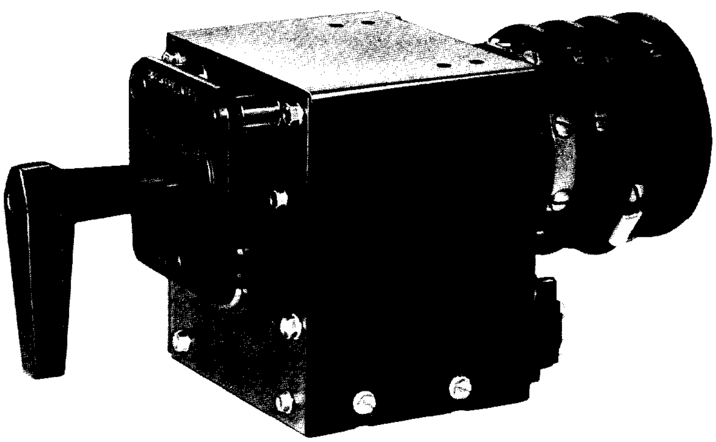


Fig. 3. Series 24 CSR Control Switch Relay

BASIC CIRCUIT OPERATION

Three basic circuits have been developed to satisfy the different power industry applications:

1. The standard Circuit A has a factory adjustable time delay that holds the CSR in the commanded position for 1 to 3 seconds. The command contact closure time should be greater than 100 milliseconds and less than the time delay setting (to avoid pumping).
2. The standard circuit B has a time delay that holds the CSR in the command position for 1 second. It also has anti-pumping circuitry so that the command contact may be closed indefinitely (but greater than 100 milliseconds).
3. The standard circuit C has no built in time delay. It exactly follows (or is a slave to) the operation of the command contact.

The control of the CSR Control Switch Relay for electric operation requires no special wiring. It only requires NO contacts (S1 and S2) to command the CSR to either the TRIP or CLOSE position. Low level contacts (rated 1 ampere) may be used since S1 and S2 do not control the rotary drive solenoid directly.

The standard station control bus voltage is used on all three circuits. The device, as shown in the following three figures is in the vertical NORMAL position. The CSR coil form shown on the figures represents the rotary solenoid that drives the CSR. Its operation is further described later under THE ELECTRO-MECHANICAL DRIVE. LS1 is a linear solenoid within the device that changes the sense of direction of the CSR from left (TRIP) to right (CLOSE). The contacts shown as CSR are contacts within the device. The other component designations are the conventional ones.

<u>Circuit A: 1 to 3 Seconds Time Delay with no Anti-pumping Circuitry</u>

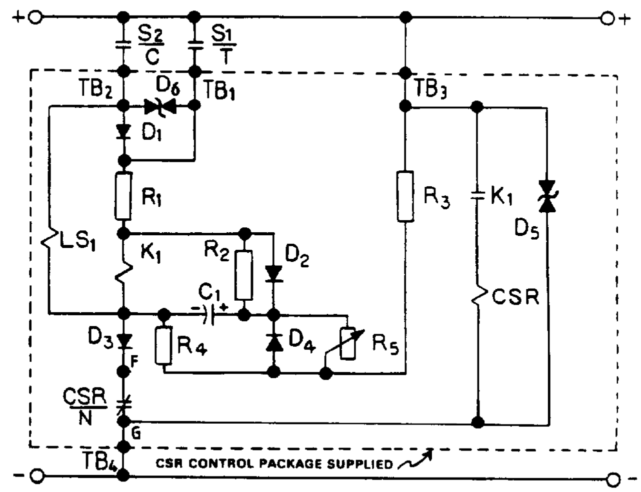


Fig. 4. CSR Control Circuit A - Using Time Delay

This circuit includes a time delay circuit (R2, C1) to keep K1 actuated for 1 to 3 seconds to insure that the CSR function is completed reliably. An adjustable resistor (R5) is included to enable the adjustment of time within the 1 to 3 second range (factory set).

A momentary closure of S1 (for a minimum of 100 milliseconds) causes the CSR to index to the TRIP position (to the CLOSE position if S2 is actuated). It remains there for 1 to 3 seconds depending on the adjustment of R5, and then spring-returns to the NORMAL, vertical position.

When TRIP position is commanded by S1, current flows through R1 charging C1 through the forward biased diode D2 (R1 limits the charge current to about 1 ampere). C1 charges very quickly because of the low circuit resistance of the D2 diode path. Simultaneously to the source voltage developing across C1, it also develops across relay K1, which operates thereby closing contact K1, and thereby closing the CSR solenoid circuit causing the CSR to index to the TRIP position. This causes the $\frac{CSR}{N}$ contact to open, C1 holds K1 closed by discharging through the K1 coil and R2. This is a high resistance discharge path for C1 in contrast to the low resistance charging path through D2 thereby providing the time delay.

The operation of the CLOSE position follows the same sequence of events except the linear solenoid LS1 operates before relay K1 thereby setting the CSR sense of direction (as previously mentioned) before the CSR rotary solenoid is actuated.

Resistance R3 and R4 act as voltage dividers so that C1 can be continually energized at a low voltage. This voltage serves to maintain the dielectric of the electrolytic capacitor C1 through long periods of CSR inactivity. If completely discharged for long periods of time and charged up quickly, failure might occur, if the low voltage was not maintained.

Diode D3 is used to avoid damage to the polarity sensitive diodes and capacitor in the event of an incorrect field hook-up of the station voltage. D5 is a bipolar diode, consisting of two zeners with a common junction, used to protect the circuit from transients (clips to 200V in 125VDC circuits). It is also to protect the control bus and and allowing this circuit to be used with sensitive static relays or other solid-state components.

Circuit B: 1 Second Time Delay with Anti-pumping Circuitry

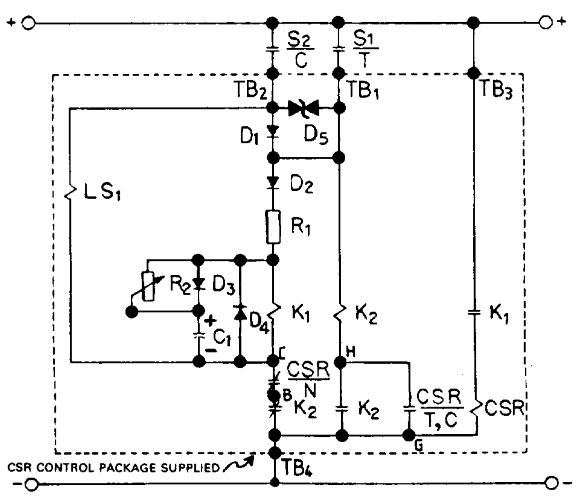


Fig. 5. CSR Control Circuit B with Anti-pumping Circuitry

This circuit operates like the circuit previously described, but includes a second relay (K2) which has a normally closed (NC) contact and a normally open (NO) contact as shown in Fig. 5. C1 was chosen to provide a small time delay (about 1 second). The $\frac{CSR}{N}$ contact was then placed in the linear solenoid (LS1) circuit to immediately open this circuit as soon as the LS1 function is completed.

A momentary closure of S1 (for a minimum of 100 milliseconds) causes the CSR to index to the TRIP position (to the CLOSE position if S2 is actuated). It remains there for about 1 second depending on the adjustment of R2 and then returns to the NORMAL position.

When the TRIP position is commanded by S1, current flows through R1, charging C1, and operating K1. Contact K1 closes completing the CSR solenoid circuit and the CSR indexes to the TRIP position, whereby the $\frac{CSR}{T,C}$ contact closes actuating the K2 relay opening the normally closed K2 contact, thereby opening the K1 relay circuit, thereby opening the CSR solenoid circuit and the CSR returns to its normal position after the time delay caused by the RC network. At the same time the normally open contact K2 has closed sealing in relay K2 as long as S1 or S2 remain closed. This keeps the normally closed K2 contact open, thereby the K1 relay circuit, thereby the K1 contact, and thereby the CSR solenoid so the CSR cannot operate again or "pump" until S1 and S2 are opened and thereby opening the K2 seal-in.

The CLOSE position works in the same manner by actuating S2, which actuates the linear solenoid LS1 first, thereby changing the sense of direction from counterclockwise to clockwise rotation of the CSR.

A tantalum foil capacitor (C1) is used having superior shelf life and can be completely discharged for long periods of time. The voltage divider circuit is not required because of this. The bipolar diode is also not needed since the circuit will not be subject to exterior transients (it is normally "off"). A bipolar diode may be added if the CSR is used with sensitive static relays or other such devices.

Circuit C: Time Delay and Anti-pumping provided by the Command Contacts

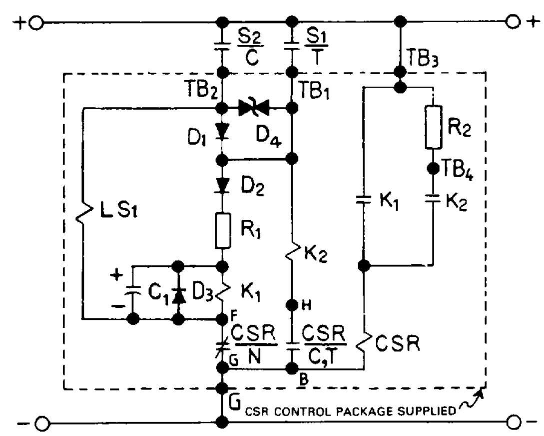


Fig. 6. CSR Control Circuit C Using Hold-in Resistor

This circuit operates like the circuits previously described. It includes a second relay (K2) which has a normally open (NO) contact and associated circuitry allows the CSR to remain in the TRIP or CLOSE position indefinitely -- as long as S1 or S2 remains closed. The wattage of R2 is chosen based on the anticipated time the circuit is activated.

A momentary closure of S1 (for a minimum of 100 milliseconds) causes the CSR to index to the TRIP POSITION (to the CLOSE position if S2 is actuated). It remains there until S1 (or S2) is opened and then returns to the NORMAL position.

When the TRIP position is commanded by S1, current flows through R1 and the coil of K1 charging C1 and operating K1. Contact K1 closes completing the primary CSR solenoid circuit. The CSR indexes to the TRIP position, whereby the $\frac{CSR}{N}$ contact opens, opening the K1 relay circuit and the K1 contact, and thereby opening the full-power CSR solenoid circuit. At the same time the $\frac{CSR}{T,C}$ contact closes actuating the K2 relay coil and thereby the K2 contact. This completes the reduced-power CSR relay circuit whereby resistor R2 limits the current to the CSR to a value sufficient to hold the CSR in the indexed position but not enough to cause overheating of the CSR solenoid coil. The CSR will remain in the indexed position until S1 is opened, thereby opening the K2 relay coil and the K2 contact. This avoids the "pumping" action possible with other methods.

The CLOSE position works in the same manner by actuating S2, which actuates the linear solenoid LS1 first, thereby changing the sense of direction from counterclockwise to clockwise rotation of the CSR.

<u>Master/Slave Operation of Electrical Equipment</u>

Circuit C shown in Fig. 6 provides a true master/slave control of circuit breakers, or any other electrical equipment. The action of the CSR follows the command of S1 or S2. CLOSE S1, and the CSR indexes to the TRIP position (or whatever the designation of the CCW position); open S1, and the CSR returns to the vertical (normal) position. The same happens in the CW direction by commanding with S2. This is especially useful in generating plants where the equipment to be controlled is far removed from the control room. Instead of bringing heavy wires long distances, only the smaller (and fewer) control wires are brought to the control room; the CSR stays with the equipment. This is also useful for class 1E equipment for nuclear power plants where operating redundancy is required for safety. If the control switch in the control room is not operable due to fire or other reasons, another control contact placed elsewhere can operate the CSR. If all else fails, the CSR can be operated manually.

<u>Breaker Seal-in Method</u>

Circuit C may also be used in conjunction with "a" and "b" breaker auxiliary contacts so that the breaker circuit can be sealed-in.

The breaker itself will turn off the CSR when its operation is complete. This arrangement is shown on Fig. 7. S1 (or S2) initiates the action, as soon as K2 operates (and the dropping resistor R2 is inserted), $\frac{CSR}{N}$ contact opens, K1 drops out, $\frac{CSR}{T}$ (or $\frac{CSR}{C}$) closes, sealing in K2 (and the breaker circuit). When the breaker operates the "a" auxiliary contact (or "b") opens, opening the K2 circuit, and K2 drops out, and the CSR returns to the normal position.

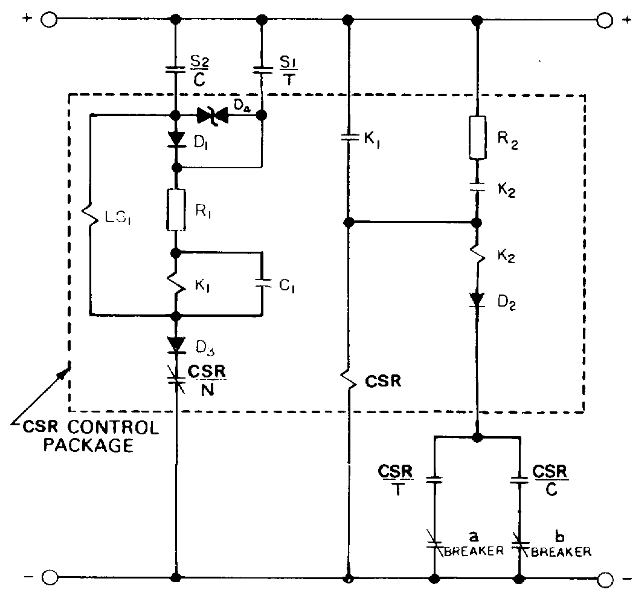


Fig. 7. CSR Control Circuit C Used to Operate a Breaker with Seal-in

<u>Transient Protection</u>

The CSR Control Switch Relay is designed and tested to operate reliably in a normal power industry environment. This includes being subjected to transients on the control bus up to 3.5KV. Since the CSR is normally isolated from the bus, it will experience transients only if they occur in the operating mode. This precludes the possibility of a detrimental, accumulating affect over the life of the unit. As such, no transient protection is needed with circuits B and C. Circuit A with its voltage divider circuit does remain on the bus and therefore contains a bipolar diode, as previously explained, to clip the transients to an acceptable value.

Because of the nature of the operation of the rotary solenoid, the CSR does generate transients that may be of interest to the user. These transients are less than 2KV and generally in the 1.5KV to 1.8KV range. When the CSR is used in conjunction with unprotected static devices, like solid-state relays, a bipolar diode is recommended across the rotary solenoid and the relay contact. This arrangement is shown as diode D5 on Fig. 4.

BASIC SWITCH/RELAY CONTACTS

The CSR Control Switch Relay contacts operate on the original, reliable principle of knife switches -- double-sided, double-wiping, spring wiper blades closing on both sides of a terminal. To provide a closed contact, two terminals are bridged or shunted. Fig. 9 shows this contacting arrangement.

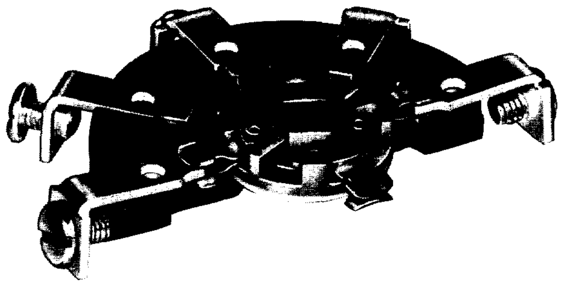


Fig. 8. Double-sided, double wiping knife-type contact configuration

Contact Materials

The wiper blades are made from a phosphor-bronze alloy that combines superior spring qualities with good electrical conductivity. This material and blade design has been proven by extensive laboratory testing as well as more than thirty years of field use and experience. Initially used in rugged naval ship applications, it is also used in industrial applications such as railroad locomotives and earth moving equipment. It has been used for more than ten years in power industry applications, as well.

The blade assembly is shock-proof and virtually bounce-proof. This makes it ideal for high-speed, quick-make, quick-break devices like the CSR.

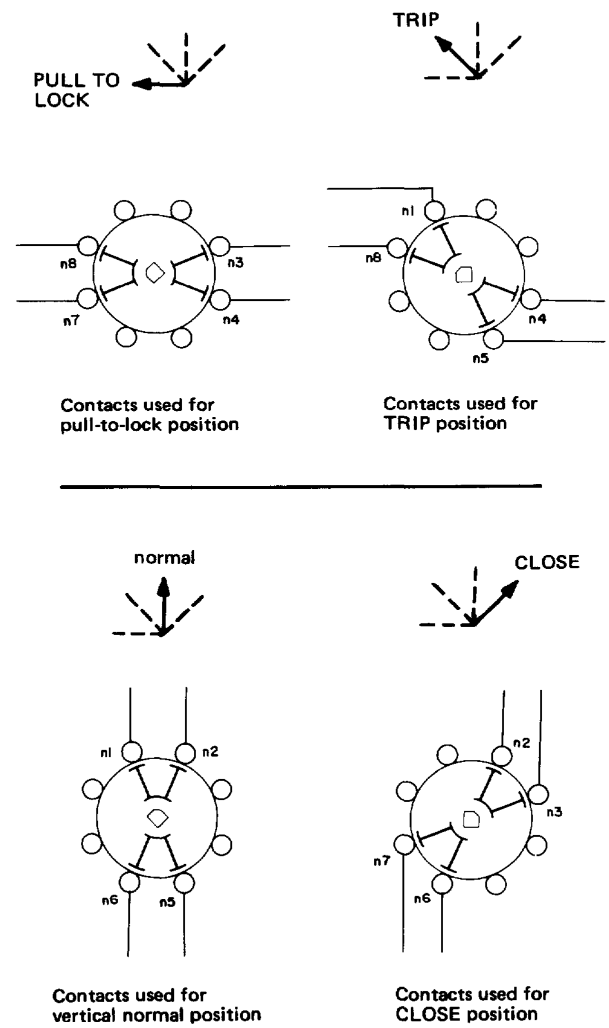
The blades are formed, assembled, and riveted nearly closed. The gap is machine adjusted to provide a uniform high pressure. The gap does not change with time and use. Normal use tends to improve the contact surfaces due to the rubbing action. This provides a burnishing as well as cleaning action.

The contact surface conductivity is enhanced by a silver overlay stripe that lasts the life of the unit. This ensures a good contact even in those cases where the CSR is not operated for long periods of time.

The terminals are made of electrically and environmentally compatible copper material with a silver overlay stripe at the contact area plus an overall silver plate to ensure a lastingly good contact surface for customer wiring purposes. Similarly, the terminal screws are made from silver-plated brass.

Contact Deck Arrangement

The blade and terminal configuration enables the use of multicontacts in the same deck, and simple stacking procedures enable the fabrication of many independent contacts in one relay. Specifically, two NO contacts or two NC contacts are provided in each deck, and ten decks can be stacked, resulting in a relay with up to twenty contacts. This deck arrangement is illustrated in Fig. 9.



NOTES:

- The numbers are the same for all decks.
- "n" becomes the deck number, e.g., 11 and 12 are CLOSE contacts on deck 1; 51 and 52 are CLOSE contacts on deck 5.
- TRIP plus normal after TRIP contacts have the same contact numbers as the normal position contacts.
- CLOSE plus normal after CLOSE contacts have the same contact numbers as the CLOSE contacts.
- Decks with slip contacts are placed at bottom of switch/relay.

Fig. 9. Basic CSR Deck Layouts

Contact Charts

The illustration above shows construction of the relay and is shown as information for the user. Traditional contact charts are more appropriate, as shown on Fig. 10.

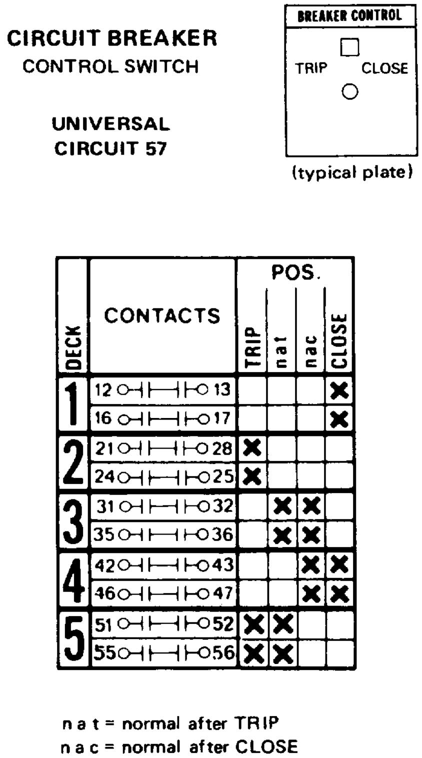


Fig. 10. Typical CSR Contact Chart

BASIC CHARACTERISTICS

The CSR Control Switch Relay is available in the field proven series 24 size configuration. Complete ratings data follows:

Operating Voltage

The CSR Control Switch Relay is a direct current auxiliary relay, and as such, may be energized as explained on pages 2, 3, and 4 at the maximum design voltage without exceeding 50°C temperature rise (55°C ambient), using class 105 insulation and the applied thermocouple method of temperature determination.

The standard coil sizes are, as follows:

TABLE I

Coil Voltage Data

COIL	NOMINAL VOLTAGE	VOLTAGE RANGE
C	48VDC	41-56VDC
D	125VDC	106-140VDC

Coil Burden Data

The CSR operating rotary solenoid coil burden data is outlined in Table II.

TABLE II

Coil Burden Data

COIL	COIL CIRCUIT VOLTS	COIL CIRCUIT DC OHMS @25°C	BURDEN (AMPS) AT RATED VOLTAGE
C	48VDC	4.83	9.9
D	125VDC	18.96	6.6

As previously described the control bus needs to supply the burden of Table II but the circuit interruption is done with the CSR control circuitry. Refer to Fig. 4 to 7 for the burden time demand. Further data on burden of the other circuit components is in the Appendix.

Response Time

The CSR Control Switch Relay will operate reliably over the full voltage range. All operating times are measured with voltages suddenly applied and removed. Operating time values are measured with relay "cold" -- coil at room ambient (20-25°C) before measurement is made. The CSR units respond and operate in less than 100 milliseconds (approximately 60mSec.).

Contact Ratings

The CSR Control Switch Relay has been tested to many different circuit conditions. The interrupting ratings are based on 10,000 operations of life, using suddenly applied and removed rated voltage, with no extensive burning of contacts. Inductive ratings are based on tests using standard inductance L/R=0.04 for DC and cosθ=0.4 for AC. The Interrupting Rating column headed "double-contacts" means two contacts in series. Short-time, and continuous ratings are based on temperature rise in contact members and supporting parts not exceeding 50°C above ambient.

TABLE III

Contact Ratings

CONTACT CIRCUIT VOLTS	INTERRUPTING RATING (AMPS) RESISTIVE SINGLE CONTACT	RESISTIVE DOUBLE CONTACT	INDUCTIVE SINGLE CONTACT	INDUCTIVE DOUBLE CONTACT	SHORT TIME RATING (AMPS)*	CONTINUOUS RATING (AMPS)
12VDC					60	30
24VDC					60	30
48VDC					60	30
125VDC	3		3		60	30
250VDC	-		-		-	-
600VDC	-		-		-	-
120VAC	20		20		60	30
240VAC	15		15		60	30
480VAC	10		10		60	30
600VAC	6		6		60	30

*Short time current for one minute

Ratings shown with a dash are not recommended. Ratings that are blank are in the process of being evaluated and may be available upon request.

Allowable Variation From Rated Voltage

The relay contacts are not sensitive to normal variations in voltage. The interrupting capacity is important as indicated in Tables II and III. Variations of plus and minus 20% in rated voltage need not be considered as long as the interrupting current is not exceeded.

VERIFICATION TESTING

The CSR Control Switch Relay has undergone extensive laboratory testing to verify its ruggedness and reliability under a variety of power industry applications. The most important tests include aging since experience with similar electro-mechanical devices shows that failure will most likely occur after electro-mechanical endurance tests. These aging tests accelerate mechanical wear and electrical contact erosion and pitting due to arcing.

The aging tests are conducted in conformance with the following specifications and standards:

- ANSI/IEEE 323-1984 IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations
- IEEE Std 344-1987 IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations
- ANSI/IEEE C37.90-1989 Standard for Relays and Relay Systems Associated with Electric Power Apparatus
- ANSI/IEEE C37.98-1987 Standard for Seismic Testing of Relays

The testing is performed in accordance with ESC Std-1000-General Specifications for Rotary Switches and Auxiliary Relays for Utility Applications including Class 1E Equipment Requirements for Nuclear Power Generating Stations. The tests include ratings evaluation tests, aging tests to simulate forty years operating life, and seismic tests.

Aging Tests

Aging tests are run in accordance with ANSI/IEEE 323-1984 and ESC Std-1000 and consist of the following run in sequence):

1. Visual and mechanical examination
2. Circuit configuration and operation
3. Dielectric withstanding voltages - 2200VRMS (600VRMS at end of life)
4. Insulation resistance - 100 megohms minimum (50 megohms at end of life)
5. Contact resistance - 10 milliohms maximum
6. Radiation aging - 10 megarads (10^7)
7. Elevated temperature - 120 hours at 80°C
8. Elevated humidity - 96 hours at 95% RH
9. Temperature rise (contacts) - 50°C maximum
10. Aging - 10,000 cycles at 20A-600VAC and 3A-125VDC (both resistive)
11. Seismic vibrations - ZPA = 5g
12. After test measurements (in order) - item 3, 4, 5, 9, 2, 1

Details on the background of these tests plus the methods and procedures are outlined in ESC Std-1000.

Seismic Tests

The series 24 Control Switch Relay is subjected to fragility testing in a seismic environment after aging to an accelerated life estimated to be forty years. This sequence is outlined under Aging Tests. The seismic tests are in accordance with IEEE Std 344-1987 and ANSI/IEEE C37.98-1987. The tests are performed in accordance with ESC Std-1000. Broadband repeatable multifrequency input motions are used. The Fragility Response Spectrum (FRS) envelopes the Standard Response Spectrum (SRS) shown in Fig. 11 using a biaxial input motion.

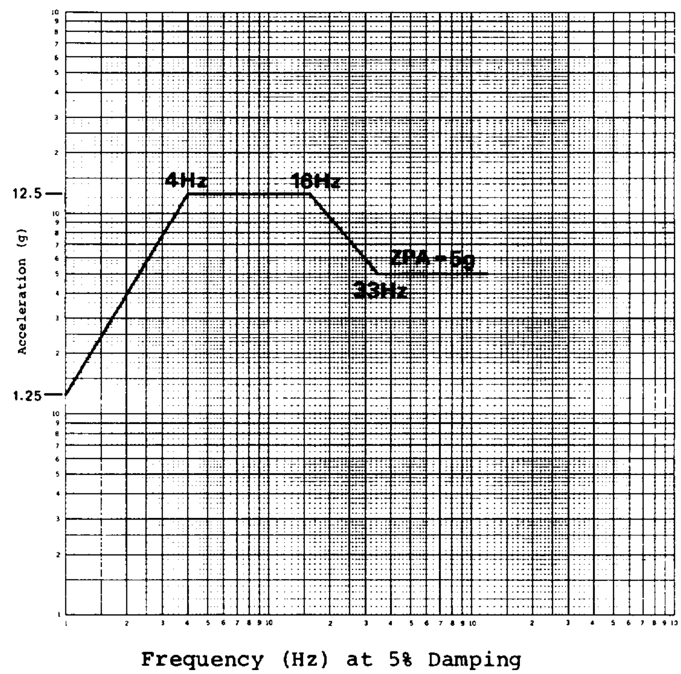


Fig. 11. Multifrequency Broadband Standard Response Spectrum (SRS)

THE ELECTRO-MECHANICAL DRIVE

The CSR Control Switch Relay utilizes a high-energy, high torque, compact rotary solenoid to drive the rotary relay contacts when the CSR is operated electrically by remote control. A drive system was specially designed to take advantage of the best features of the rotary solenoid to provide high speed with snappy and positive action of the relay contacts.

The mechanical action is shown on the photograph of Fig. 12 and illustrated in the following four figures. This invention is covered by U.S. Patent #4,001,740.

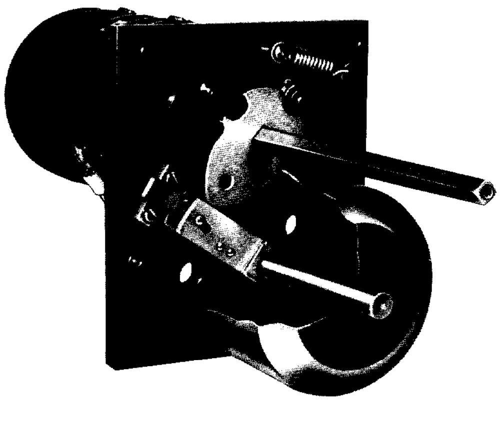


Fig. 12. CSR Electro-mechanical Drive Assembly

The rotary solenoid is mounted apart from the control switch operating shaft. A drive arm is attached to the solenoid, a roller to the end of the drive arm, and a cam to the control switch shaft.

Manual operation, remains the same as the present control switch.

The control switch requires an increasing amount of torque as it turns, since it rotates against a torsion spring (trying to return the unit to the vertical position). The torque of the rotary solenoid is at its maximum of about 45 in-lbs. at the beginning of its stroke and decreases as its rotating angle increases. A roller is affixed to the end of the drive arm for efficient transfer of the mechanical energy. The cam is attached to the switch shaft. The shape of the cam provides uniform torque to the control switch shaft over its entire rotary angle of 45°. The relationships of the parts are illustrated on Fig. 13.

To get a counterclockwise rotation of the CSR Control Switch Relay to the trip position (45° CCW), the rotary solenoid is actuated, driving the solenoid drive shaft clockwise (CW); the roller at the end of the solenoid drive shaft strikes and rolls down the right face of the cam, and drives the cam and control switch shaft in the CCW direction to the TRIP position. When the excitation on the solenoid is released, the solenoid drive arm returns to normal and the torsion spring in the CSR Control Switch Relay returns the CSR back to its normal, vertical position. This operation is illustrated in Fig. 13.

The rotary solenoid is a unidirectional device and the CSR Control Switch Relay must operate in both the clockwise (CW) and the counterclockwise (CCW) directions (TRIP and CLOSE). The CCW direction of operation is described above. To get a CW rotation of the CSR to the CLOSE position, the roller at the end of the solenoid drive arm is mounted in a slot; the roller is moved by a linear solenoid so that actuation of the rotary solenoid causes the roller to strike and roll down to the left face of the cam; the CSR, then, rotates clockwise to the CLOSE position (see Fig. 14.). The return of the CSR to the normal, vertical position happens the same way as described for the CCW operation.

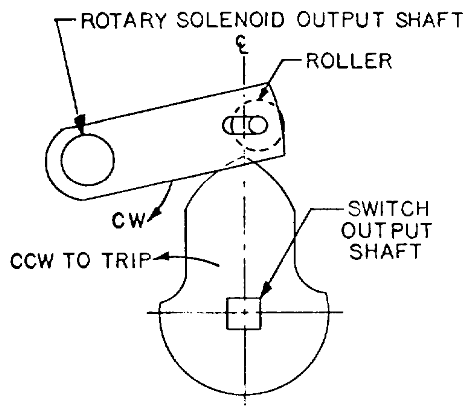


Fig. 13. Relationship of solenoid and control switch shafts for operation to TRIP position

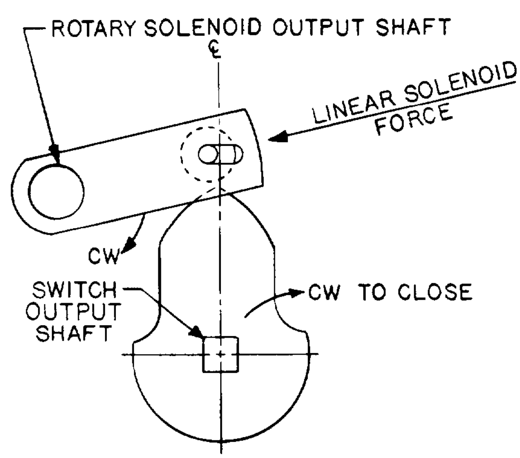


Fig. 14. Relationship of solenoid and control switch shafts for operation clockwise to the CLOSE position

The torsion of the CSR return spring is very low in the normal, vertical position, and normally does not return precisely to this vertical position. For positive operation a detent position was added to the cam. The bottom of the cam is notched and a spring loaded roller pulls into this notch when the switch shaft approaches the vertical normal position.

Applications may need a PULL-TO-LOCK position after TRIP position as a safety lock-out when equipment is worked on. As described above, more detent positions are added at horizontal locations (90° and 270°) that may be used if needed, creating a manually actuated TURN-TO-LATCH location as this safety lock-out. This is illustrated in Fig. 16.

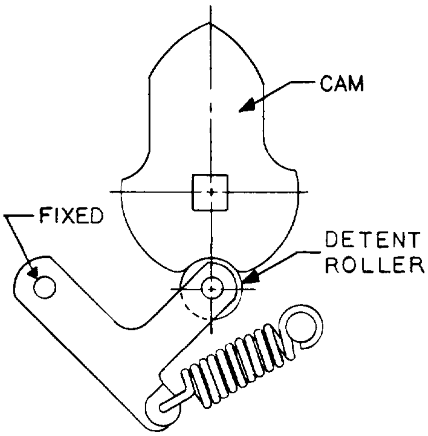


Fig. 15. Detent mechanism for positive normal (vertical) positioning

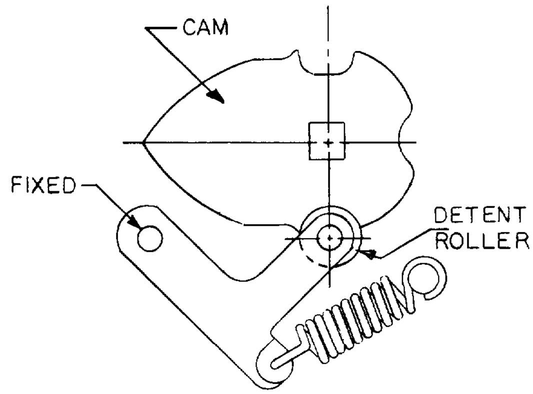
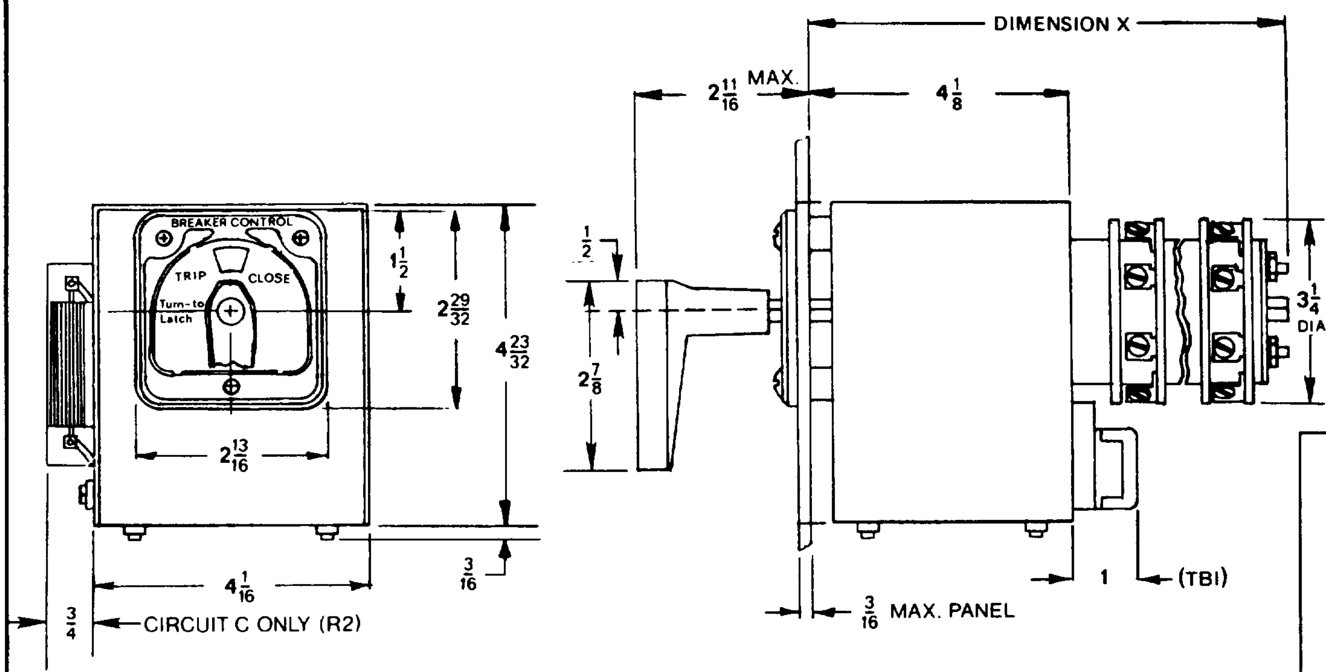


Fig. 16. Detent mechanism for positive manual TURN-TO-LATCH positioning (shown in the 270° beyond TRIP position)

ELECTROSWITCH
• SWITCHES & RELAYS
UNIT OF ELECTRO SWITCH CORP.
Weymouth, MA 02188 Tel: 781/335/5200 • Fax 781/335/4253

MASTER DRAWING

CONTROL SWITCH RELAY SERIES 24 CSR



DIM. "X" (INCHES)

DECKS	STD	SLIP CONTACTS
1	6.5	7.9
2	7.1	8.6
3	7.9	9.0
4	8.6	9.7
5	9.0	10.5
6	9.7	11.0

INTERRUPTING RATINGS:

UND. LAB. INC. LIST.*
20A-120VAC
15A-240VAC
6A-600VAC
3A-125VDC
1A-250VDC

CSA CERTIFIED*
20A-600VAC (res)
15A-600VAC (ind)
2A-125VDC
2HP-240/480VAC

OTHER RATINGS:

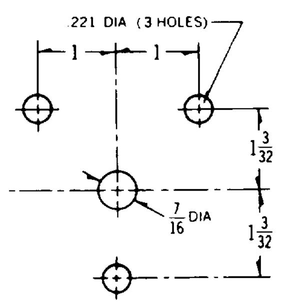
Momentary Current (thermal)
3 SEC-200A
30 SEC- 75A
60 SEC- 60A

Overload (50 operations)
95A-120VAC
65A-240VAC
35A-600VAC

Making ability for
Circuit Breaker Coils
95A-125VDC

Dielectric Strength - 2200VRMS
Insulation Resistance - 100 megohms
Contact Resistance - 10 milliohms

PANEL DRILLING (INCHES)



*UL & CSA on switching portion only

OTHER TECHNICAL DATA

Bulletin CSR-1
Tested to ESC-STD-1000
Contacting & catalog numbers on separate sheet
Control circuit wiring diagrams are shown on separate sheets:

Circuit	Sheet
A	246Std-1A
B	246Std-1B
C	246Std-1C

REVISIONS: (A) ECN#20743 WDS 11-18-92 JR

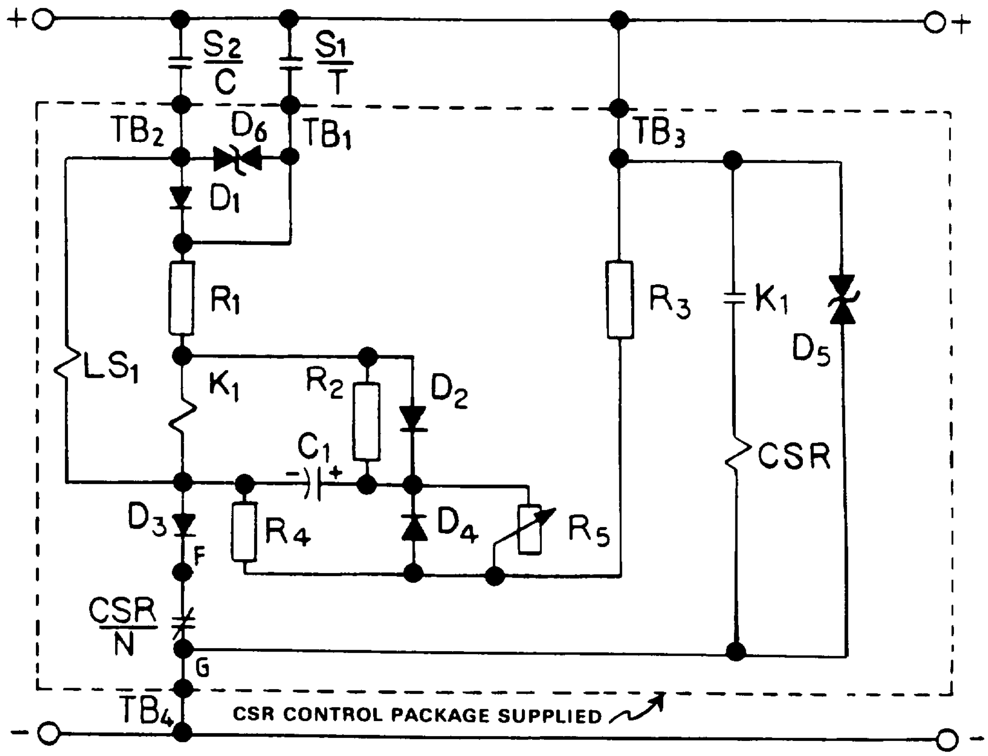
MADE BY: JM	DATE: 5/1/81		DWG. NO: 246STD-1	REV
APPR. BY: MMR	DATE: 5/1/81		SHEET 1 OF 1	A

ELECTROSWITCH
• SWITCHES & RELAYS
UNIT OF ELECTRO SWITCH CORP.
Weymouth, MA 02188 Tel: 781/335/5200 • Fax 781/335/4253

MASTER DRAWING

CONTROL SWITCH RELAY
SERIES 24 CSR

CONTROL CIRCUIT WITH 1-3 SECONDS FACTORY SET TIME DELAY



A momentary closure of S1 *(100 milliseconds minimum, 1 second maximum)* causes the CSR to index to the TRIP position *(to the CLOSE position if S2 is actuated)*. It remains there for 1 to 3 seconds depending on the adjustment *(by the factory)* of R5 and then spring returns to the normal vertical position. More operating detail in TECHNICAL BULLETIN CSR-1.

S1 or S2 may be operated again within 5 seconds and then not more than once per minute *intermittent duty cycle)*

Response time-approx. 60mSec
D3 protects from incorrect hookup
R3, R4 keep voltage on C1
D5,D6 protects circuit from transients

ITEM	DESCRIPTION	24VDC	48VDC	125VDC
R1	Resistor, 1 watt	18 Ω	56 Ω	120 Ω
R2	Resistor, 1 watt	1200 Ω	7.5K Ω	15K Ω
R3	Resistor, 1 watt, or:	500 Ω, 3W	3.6K Ω	8.2K Ω
R4	Resistor, 1 watt, or:	300 Ω, 3W	2.2K Ω	5.1K Ω
R5	Resistor, 1 watt	20K Ω max	100K Ω max	100K Ω max
C1	Capacitor	1300uf 25WDC	350uf 50WDC	100uf 150WDC
D1,D2 D3,D4	Diode 1000PIV, 1 amp	✓	✓	✓
D5	Zener diode, breakdown	39VDC	75VDC	200VDC
K1	Relay	400 Ω	2.5K Ω	5K Ω
TB	Terminal Block	✓	✓	✓
LS1	Linear Solenoid	14.3 Ω	32.5 Ω	235 Ω
CSR	Rotary Solenoid	1.17 Ω	4.83 Ω	18.96 Ω
D6	Zener diode, breakdown	200VDC	200VDC	200VDC

OTHER TECHNICAL DATA
Bulletin CSR-1
Tested to ESC-STD-1000
Contacting & catalog numbers on separate sheet
Dimensions, ratings, etc. on Drawing Master 246STD-1

REVISIONS: (A) ECN#18153 WDS 2-9-90 JR (B) ECN#20743 WDS 11-18-92 JR

MADE BY: JM	DATE: 5/1/81	CONTROL CIRCUIT A WIRING DIAGRAM	DWG. NO: 246STD-1A
APPR. BY: MMR	DATE: 5/1/81		SHEET 1 OF 1

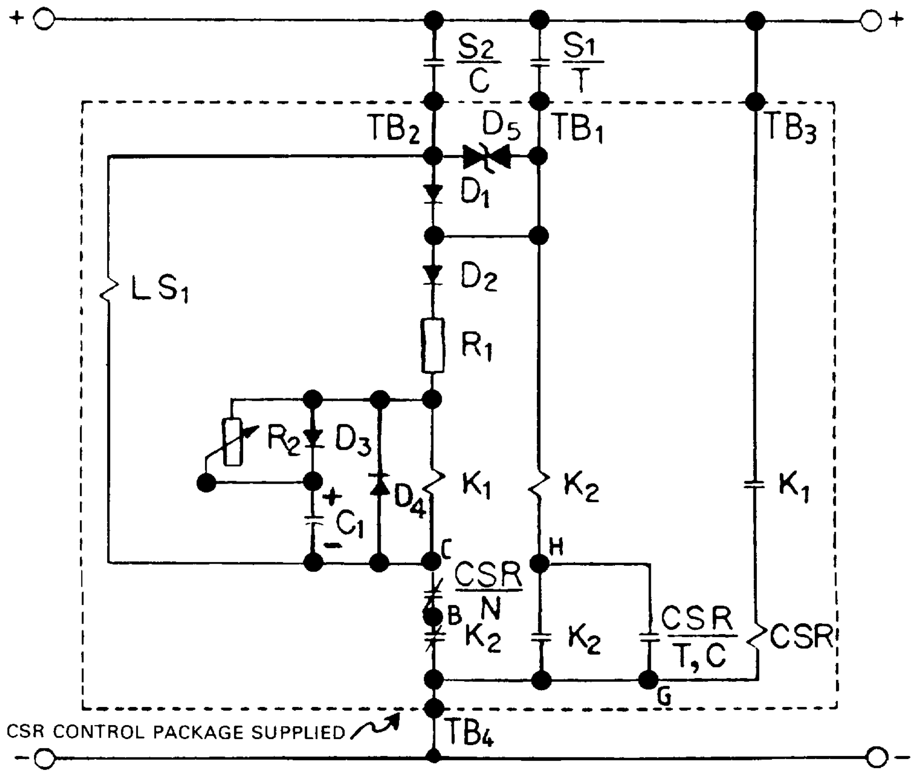
REV **B**

ELECTROSWITCH
• SWITCHES & RELAYS
UNIT OF ELECTRO SWITCH CORP.
Weymouth, MA 02188 Tel: 781/335/5200 • Fax 781/335/4253

MASTER DRAWING

CONTROL SWITCH RELAY
SERIES 24 CSR

CONTROL CIRCUIT WITH 1 ± ½ SECOND FACTORY SET TIME DELAY AND K2 SEAL-IN RELAY FOR ANTI-PUMPING



A momentary closure of S1 *(100 milliseconds minimum, unlimited maximum)* causes the CSR to index to the TRIP position *(to the CLOSE position if S2 is actuated)*. It remains there for 1 ± 1/2 second and then returns to the NORMAL vertical position. In the indexed positions $\frac{CSR}{T,C}$ completes the K2 relay circuit, opening the K1 relay circuit, allowing the CSR to return to NORMAL, and sealing-in the K2 relay circuit thereby keeping the K1 relay circuit open, thereby providing the anti-pumping feature. More operating details in TECHNICAL BULLETIN CSR-1.

COMPONENTS USED

ITEM	DESCRIPTION	48VDC	125VDC
C1	Capacitor	100 uf 50VDC	25uf 150VDC
D1,D2 D3,D4	Diode 1000PIV, 1 amp	✓	✓
K1	Relay, SPST	4K Ω	5K Ω
K2	Relay, SPDT	1.8K Ω	8K Ω
LS1	Linear Solenoid	32.5 Ω	235 Ω
R1	Resistor, 1 watt	120 Ω	240 Ω
R2	Variable Resistor, 1W	20K Ω max	20K Ω max
CSR	Rotary Solenoid	4.86 Ω	18.96 Ω
TB	Terminal board	✓	✓
D5	Zener diode, breakdown	200VDC	200VDC

Response time-approx. 60 milliseconds

OTHER TECHNICAL DATA

Bulletin CSR-1

Tested to ESC-STD-1000

Contacting & catalog numbers on separate sheet

Dimensions, ratings, etc. on Drawing Master 246STD-1

REVISIONS: (A) ECN#18153 WDS 2-9-90 JR

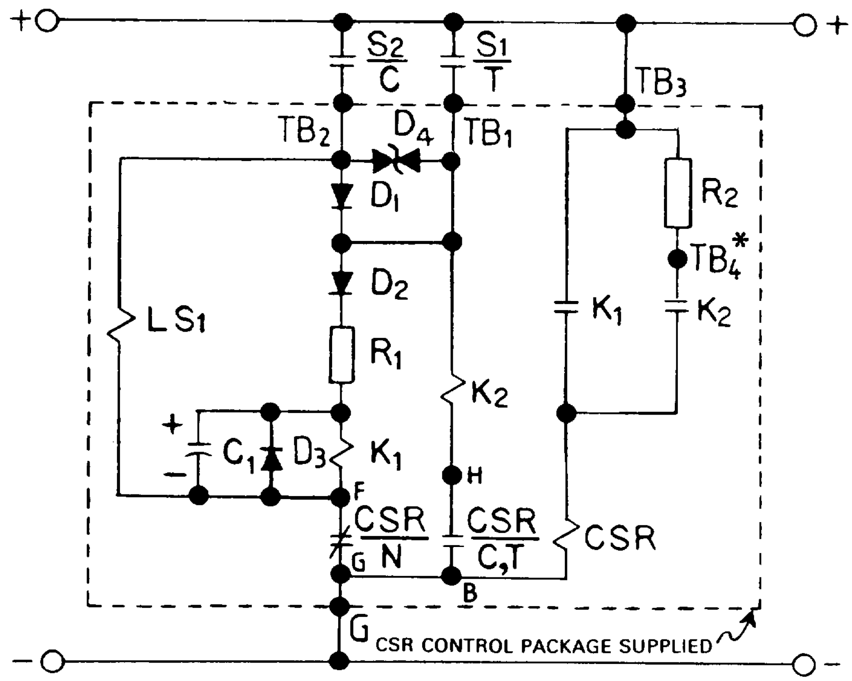
MADE BY: JM	DATE: 5/1/81	CONTROL CIRCUIT B WIRING DIAGRAM	DWG. NO: 246STD-1B	REV A
APPR. BY: MMR	DATE: 5/1/81		SHEET 1 OF 1	

ELECTROSWITCH
• SWITCHES & RELAYS
UNIT OF ELECTRO SWITCH CORP.
Weymouth, MA 02188 Tel: 781/335/5200 • Fax 781/335/4253

MASTER DRAWING

CONTROL SWITCH RELAY
SERIES 24 CSR

CONTROL CIRCUIT WITH HOLD-IN RESISTOR — THE CSR REMAINS IN THE INDEXED POSITION AS LONG AS S1 OR S2 REMAINS CLOSED THEREBY PROVIDING FLEXIBLE TIME DELAY AND ANTI-PUMPING



* TO AVOID DAMAGE TO COMPONENTS, MAKE NO EXTERNAL CONNECTIONS TO TB_4

A momentary closure of S1 *(100 milliseconds minimum, 15 seconds maximum)* causes the CSR to index to the TRIP position *(to the CLOSE position if S2 is actuated)*. It remains there until S1 *(or S2)* is opened and then it returns to the NORMAL vertical position.

In the indexed position CSR/C,T contact closes, actuating K2 relay and K2 contact inserting hold-in resistor R2 into CSR coil circuit *(reducing CSR current from high operate value to low hold-in value)*. At the same time CSR/N contact opens dropping out the CSR operate circuit of K1 relay and contact. This provides anti-pumping feature. More details in TECHNICAL BULLETIN CSR-1.

COMPONENTS USED

ITEM	DESCRIPTION	48VDC	125VDC
C1	Capacitor	100uf 50VDC	25uf 150VDC
D1,D2 D3	Diode 1000PIV, 1 amp	✓	✓
K1,K2	Relay, SPST	2.5K Ω	5K Ω
LS1	Linear Solenoid	32.5 Ω	235 Ω
R1	Resistor, 1 watt	120 Ω	240 Ω
R2	Resistor, 50 watt	10 Ω	75 Ω
CSR	Rotary Solenoid	4.83 Ω	18.96 Ω
TB	Terminal Block	✓	✓
D4	Zener diode, breakdown	200VDC	200VDC

Response Time — Approx. 60 milliseconds

OTHER TECHNICAL DATA

Bulletin CSR-1
Tested to ESC-STD-1000
Contacting & catalog numbers on separate sheet
Dimensions, ratings, etc. on Drawing Master 246STD-1

REVISIONS: (A) ECN#18153 WDS 2-8-90 JR (B) ECN#20743 WDS 11-18-92 JR

MADE BY: JM	DATE: 5/1/81	CONTROL CIRCUIT C WIRING DIAGRAM	DWG. NO: 246STD-1C	REV
APPR. BY: MMR	DATE: 5/1/81		SHEET 1 OF 1	B

ELECTROSWITCH
• SWITCHES & RELAYS
UNIT OF ELECTRO SWITCH CORP.
Weymouth, MA 02188 Tel: 781/335/5200 • Fax 781/335/4253

CONTROL SWITCH RELAY
SERIES 24 CSR

CATALOG NUMBER ____________
ENGRAVING CODE ____________
REV

HANDLES	ACTIONS	OTHER FEATURES
☐ Pistol-grip	☐ Maintained in Latch Position	☐ Slip Contacts
☐ ____________	☐ Spring Return to Normal Position	☐ Turn-to-latch

Panel Thickness ________ Depth behind panel ________

Operating Voltage ________ Control Circuit ________

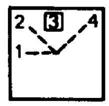
OTHER

Use for all except slip contacts						Use for Switches with slip contacts				
TITLE ENGRAVING:										
	POSITION ENGRAVING									
DECK / CONTACTS* HANDLE END	POSITIONS							3 from		
	1	2	3	4	5	1	2	2	4	4

* Terminal Numbers are preliminary pending factory review and approval.

HANDLE POSITIONS

☐ 45°



☐ TARGET

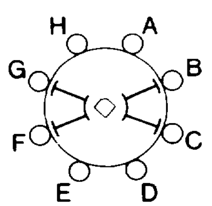
H	A	B	C	D	E	F	G
11	12	13	14	15	16	17	18
21	22	23	24	25	26	27	28
31	32	33	34	35	36	37	38
41	42	43	44	45	46	47	48
51	52	53	54	55	56	57	58
61	62	63	64	65	66	67	68
71	72	73	74	75	76	77	78
81	82	83	84	85	86	87	88
91	92	93	94	95	96	97	98
101	102	103	104	105	106	107	108

● denotes terminal used
SHOW JUMPERS TO BE SUPPLIED

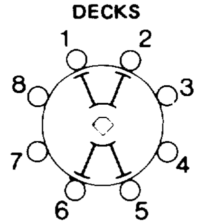
SLIP CONTACTS WILL BE GROUPED AT REAR OF SWITCH.

STANDARD DECKS

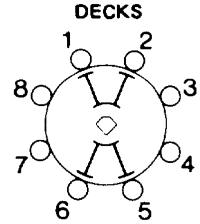
SLIP CONTACT DECKS



CONTROL DECK



DECKS 1 –



DECKS

DOCUMENT CONTROL
Quality Assurance - ANSI/ASME NQA-1-1983
Qualification - ESC-STD-1000
DRAWING MASTER - 246STD-1

(Factory use - Pin Shaft ________ from handle end)

REVISIONS:

MADE BY:	DATE:	COMPANY	DWG NO.
APPR. BY:	DATE:		SHEET OF

SERIES 24 CSR CONTROL SWITCH RELAYS

HOW TO ORDER

1. Select desired control circuit from pages 2 to 4.
2. Select switch contacting from Bulletin 24-1 or complete contacting chart on page 14 (or advise factory of the contacting required in a manner convenient to you).
3. Select or advise control voltage.
4. Choose appropriate catalog number below (or advise the above data and a catalog number will be assigned).

SERIES 24 CSR

CATALOG NUMBERS FOR THE FOLLOWING CONTROL CIRCUITS AND CONTROL VOLTAGES

SWITCH CIRCUIT FROM BULLETIN 24-1	A 1-3 SEC. TIME DELAY		B 1 SEC. TIME DELAY, SEAL-IN RELAY		C UP TO 15 SEC. DELAY, HOLD-IN RESISTOR	
	48VDC	125VDC	48VDC	125VDC	48VDC	125VDC
38	8838CA	8838DA	8838CB	8838DB	8838CC	8838DC
40	8840CA	8840DA	8840CB	8840DB	8840CC	8840DC
41	8841CA	8841DA	8841CB	8841DB	8841CC	8841DC
42	8842CA	8842DA	8842CB	8842DB	8842CC	8842DC
43	8843CA	8843DA	8843CB	8843DB	8843CC	8843DC
44	8844CA	8844DA	8844CB	8844DB	8844CC	8844DC
45	8845CA	8845DA	8845CB	8845DB	8845CC	8845DC
46	8846CA	8846DA	8846CB	8846DB	8846CC	8846DC
50	8850CA	8850DA	8850CB	8850DB	8850CC	8850DC
52	8852CA	8852DA	8852CB	8852DB	8852CC	8852DC
57	8857CA	8857DA	8857CB	8857DB	8857CC	8857DC
58	8858CA	8858DA	8858CB	8858DB	8858CC	8858DC

The circuit-breaker CONTROL SWITCH RELAYS include an engraved nameplate, mechanical target, and pistol grip handle. Circuits 50, 52 and 58 also have a TURN-TO-LATCH position. Also included are the control circuits explained with figure 4 on page 2 (circuit A), figure 5 on page 3 (circuit B), and figure 6 on page 3 (circuit C). These circuits are repeated in complete detail on pages 11 to 13.

CSR CONTROL SWITCH RELAYS have the same flexibility of design as the series 24 line of INSTRUMENT and CONTROL SWITCHES and are available with all the different contact configurations expected from this type of switch. Refer to Bulletin 24-1 for details.

ELECTROSWITCH
• SWITCHES & RELAYS
UNIT OF ELECTRO SWITCH CORP.
180 King Avenue, Weymouth, MA 02188
Telephone: (781) 335-5200 • FAX: (781) 335-4253

SP398/5M