ABB Power T&D Company Inc.
Relay Division
Coral Springs, FL 33065

Instruction Leaflet

41-241.31A

Effective: October 1982

Supersedes I.L. 41-248.31A, Dated October 1978

Type CW Power Relay
for Class 1E Applications
30° Characteristic for three phase

CAUTION: Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

These relays have been specially designed and tested to establish their suitability for Class IE applications. Materials have been selected and tested to insure that the relays will perform their intended function for their design life when operated in a normal environment as defined by ANSI standard C37.90-1971, when exposed to radiation levels up to 10^4 rads, and when subjected to seismic events producing a Shock Response Spectrum within the limits of the relay rating.

"Class IE" is the safety classification of the electric equipment and systems in nuclear power generating stations that are essential to emergency shutdown of the reactor, containment isolation, cooling of the reactor, and heat removal from the containment and reactor, or otherwise are essential in preventing significant release of radioactive material to the environment.

The type CW relay for three-phase application is a single phase induction type relay providing over-power or reverse-power protection for electrical equipment or circuits and synchronous motor loss-of-field protection. It is not intended for use as a fault protective relay.

The CW relay for three-phase application uses phase-to-phase voltage and line current, with maximum torque occuring when the relay current leads the relay voltage by 30° at system unity power factor. Tap value is the volt-amperes at which the contacts close with relay current leading relay voltage by 30°. One CW relay is required for balanced three phase system and three relays are required for unbalanced conditions.

When used for motor protection, the relay is connected in such a way that current, (I_A), leads voltage, (V_{BA}), by 150 degrees when the motor is operating at unity power factor. Loss of excitation to the motor causes a large var flow into the motor without appreciable change in the watt flow. As the current goes more lagging, operation of the CW permits tripping or alarm action.

CONSTRUCTION

The relay consists of a product operated unit, a phase shifter and an indicating contactor switch (ICS), shown in Fig. 1.

All possible contingencies which may arise during installation, operation or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding this particular installation, operation or maintenance of this equipment, the local ABB Power T&D Company Inc. representative should be contacted.

Printed in U.S.A.

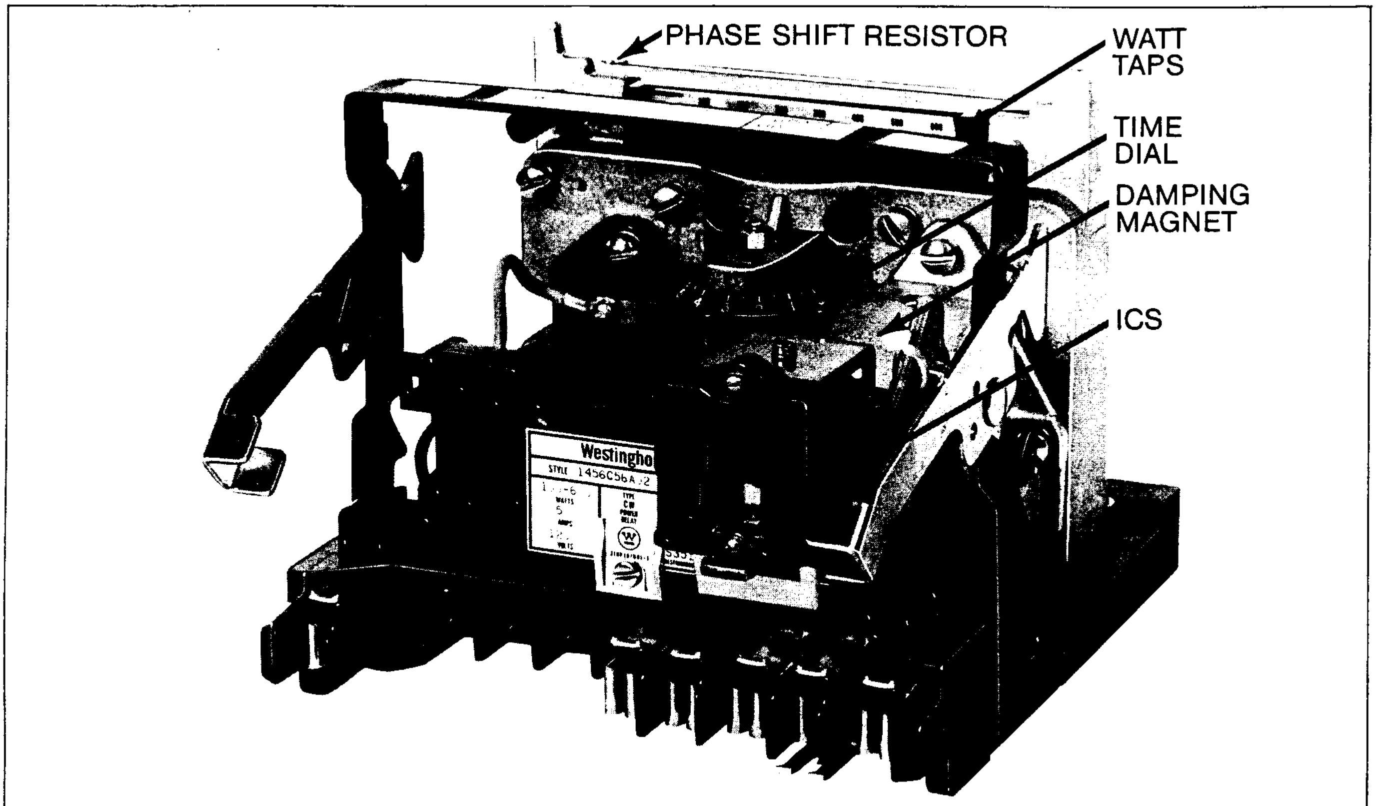


Fig. 1. Front view of Type CW Power Relay without Case.

Product Type Unit

The electromagnet for the main element has a tapped current coil located on the center leg of an "E" type laminated structure and two potential coils on the outer legs. This is shown schematically in Fig. 2. Operating torque is obtained by energizing the tapped coil with line current and the two outer coils with line potential from the line potential transformers. Out of phase air gap fluxes necessary for operating torques are produced by a phase shifting network in conjunction with the potential coils. Maximum torque occurs when the current leads the voltage by 30 degrees as illustrated in Fig. 3. The voltage is independent of the direction of power flow. This provides a reference so that the disc can rotate in either direction depending upon direction of the line current. The combination of voltage and current produces an operating torque proportional to power.

PHASE SHIFTER - The phase shifter network consist of a resistor in series with the potential coils.

Indicating Contactor Switch Unit (ICS)

The dc indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

CHARACTERISTICS

The type CW relays are available in the following ranges and taps:

Volts Line-to-Line	($I_L V_{LL}$) ($\sqrt{3}$ single phase watts)	
	Range	Taps
120	20 - 120	20 - 30 - 40 - 60 - 80 - 100 - 120
	100 - 600	100 - 150 - 200 - 300 - 400 - 500 - 600
208	35 - 200	35 - 50 - 70 - 100 - 140 - 175 - 200
	175 - 1000	175 - 250 - 350 - 500 - 700 - 875 - 1000

Typical 60 hertz Time-Power Curves are shown in Figs. 4 & 5. The curves are taken at maximum torque which occurs with the current leading the voltage by 30 degrees. (within $\pm 4^{\circ}$)

Trip Circuit

The main contacts will safely close 30 amperes at 250 volts dc and the seal-in contacts of the indicating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts dc, and will carry this current long enough to trip a breaker.

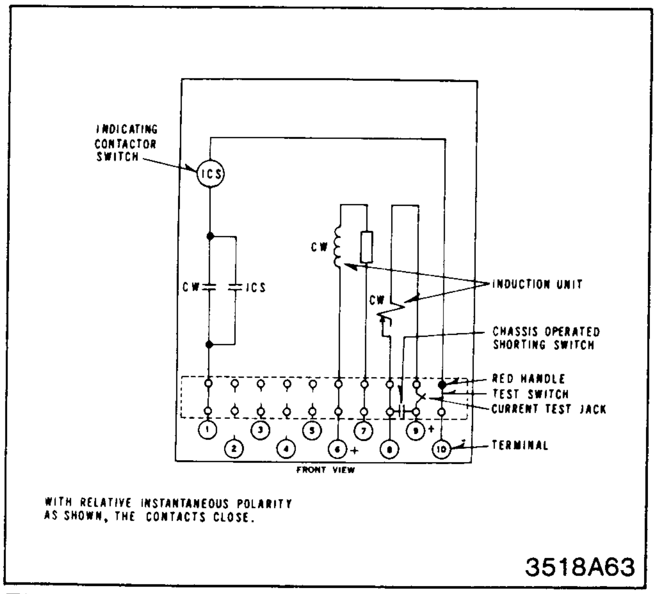


Fig. 2. Internal Schematic of the Type CW Relay in the Type FT-11 Case.

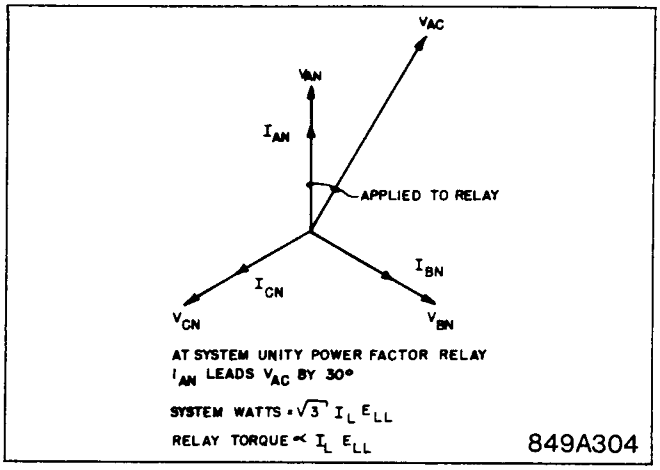


Fig. 3. Current and Voltage Phasors at System Unity Power Factor Applied to Type CW Relay

Trip Circuit Constants

Indicating Contactor Switch Coil.

Ampere Pickup	Ohms dc Resistance
0.2	8.5
1.0	0.37
2.0	0.10

SETTINGS

The watt tap and the time dial setting must be selected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will respond to multiples of tap value watts in accordance with the various typical time-watts curves, $\pm 5\%$.

Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight.

In order to avoid opening current transformer circuits when changing taps under load, the relay must be first removed from the case. Chassis operating shorting switches on the case will short the secondary of the current transformer. The taps should then be changed with the relay outside of the case and then re-inserted into the case.

Overwatt Application

The CW for three phase application has taps which represent the minimum balanced three phase watts divided by $\sqrt{3}$ that will cause the disc to move. Tap value is also voltamperes at which the disc will begin to move with current leading voltage applied to the relay by 30 degrees. When connected for watt sensing the relay current leads relay voltage by 30 degrees when the system current and line-to-neutral voltage are in phase.

Assume:

R_C = ct ratio = 600:5 = 120

R_V = vt ratio = 4200:120 = 35

P = power = 1000 primary kilowatts (3ϕ) desired trip level

Direct Solution :

$$T = \frac{P}{R_C R_V \sqrt{3}} = \frac{1{,}000{,}000}{120\,(35)\sqrt{3}} = 137.5$$

Indirect Solution :

$$I_P = \frac{P}{\sqrt{3} V_{LL}} = \frac{1{,}000{,}000}{\sqrt{3}\,4160} = 138.8 \text{ a primary}$$

I_S = 138.8/120 = 1.157 a secondary

V_S = 4160/35 = 118.86 volts line-to-line

T = $I_S V_S$ = 1.157 (118.86) = 137.5

Use Tap 150 (closest to 137.5) on 100-600 watt relay.

P = 150/137.5 (1000) = 1091 kW actual

Time dial 2 will give 2 second operation at 2182 kilowatts. (See Fig. 4)

Motor Loss of Field Application

The usual setting of the CW relay for this application (Fig. 7) is 20 watts, time dial 2 on the 20-120 watt relay. When, on loss of field, the motor power factor goes approximately 30 degrees lagging (watts and vars into the motor) and more, the contacts of the CW close after the time delay established by the time dial setting.

In this application, the CW would operate during motor starting and a field breaker 41a switch may be used to prevent this by controlling the voltage circuit. This allows the motor to be accelerated, and the field breaker closed before the CW is operative.

Note that the use of field breaker 41a switch control, prevents loss of field detection on accidental field breaker opening. Other provisions must be incorporated to trip the controller when 41a is used and the field breaker opens following field application. If 41a is not used directly, it may drive a timer that closes the coil circuit when 41 closes and has time delay release when 41 opens.

This same relay will detect loss of synchronism in the first slip cycle provided the slip frequency is sufficiently low that the CW current stays in the "operate" area long enough to produce operation.

Indicating Contactor Switch (ICS)

There are no settings to make on the indicating contactor switch (ICS).

Close the main relay contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than the particular ICS nameplate rating. The indicator target should drop freely.

Repeat above except pass 85% of ICS nameplate rating current. Contacts should not pickup and target should not drop.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the four mounting holes on the flange for the semi-flush type FT case. The mounting screws may be utilized for grounding the relay. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its mounting screws and the relay panel. Ground wires should be affixed to the mounting screws as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting.

For detail information on the FT case refer to I.L. 41-076 for semi-flush mounting.

ADJUSTMENT AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

Product Unit

NOTE: A spring shield covers the reset spring of the product unit. To remove the spring shield, requires that the damping magnet be removed first. The screw connection holding the lead to the moving contact should be removed next. The second screw holding the moving contact assembly should then be loosened not removed. (CAUTION: this screw terminates into a nut held captive beneath the molded block. If screw is removed, difficulty will be experienced in the re-assembly of the moving contact assembly.) Slide the spring shield outward and remove from relay. Tighten the screw holding the moving contact assembly to the molded block.

Contact

The index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-watt curves.

Minimum Trip Volt Amperes -- Set the time dial to position 6. Using the lowest tap setting, alternately apply tap value volt amperes plus 3% and tap value volt amperes minus 3% with the current leading the voltage by 30°. The moving contact should leave the backstop at tap value plus 3% and should return to the backstop at tap value minus 3%. The relay should be calibrated with 10 times tap value at the number six time dial position. Check several points on the typical time curves. Time curve calibration is affected by adjusting the position of the permanent magnet keeper. Note that with current leading voltage by 30 degrees the actual watts applied to the relay are .866 times tap value at pickup.

Indicating Contactor Switch (ICS)

Initially adjust unit on the pedestal so that armature fingers do not touch the yoke in the reset position (viewed from top of switch between cover and frame). This can be done by loosening the mounting screw in the molded pedestal and moving the ICS in the downward position.

a. Contact Wipe -- Adjust the stationary contact so that both stationary contacts make with the moving contacts simultaneously and wipe 1/64" to 3/64" when the armature is against the core.

b. Target -- Manually raise the moving contacts and check to see that the target drops at the same time as the contacts make or up to 1/16" ahead. The cover may be removed and the tab holding the target reformed slightly if necessary. However, care should be exercised so that the target will not drop with a slight jar.

c. Pickup -- The unit should pickup at 98% rating and not pickup at 85% of rating. If necessary, the cover leaf springs may be adjusted. To lower the pickup current use a tweezer or similar tool and squeeze each leaf spring approximate equal by applying the tweezer between the leaf spring and the front surface of the cover at the bottom of the lower window.

If the pickup is low, the front cover must be removed and the leaf spring bent outward equally.

Current Coil Ratings:

Range	Amperes	
	Continuous	1 Sec.
20-120 Watt Range 35-200 Watt Range	5 A	230A
100- 600 Watt Range 175-1000 Watt Range	8A	370A

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts always give the complete nameplate data.

ENERGY REQUIREMENTS

The 60 hertz burdens of the type CW Relay Three-Phase Application are as follows :

Relay Range	Potential Circuit			Current Circuit			
WATTS	Voltage	Voltamperes	Current lags by	Current	Relay Tap	Voltamperes	Current lags by
20 - 120	120	17.9	60°	5 amp.	20	16.2	78°
100 - 600	120	17.9	60°	5 amp.	100	5.4	77°
35 - 200	208	18.8	59°	5 amp.	35	16.2	78°
175 - 1000	208	18.8	59°	5 amp.	175	5.4	77°

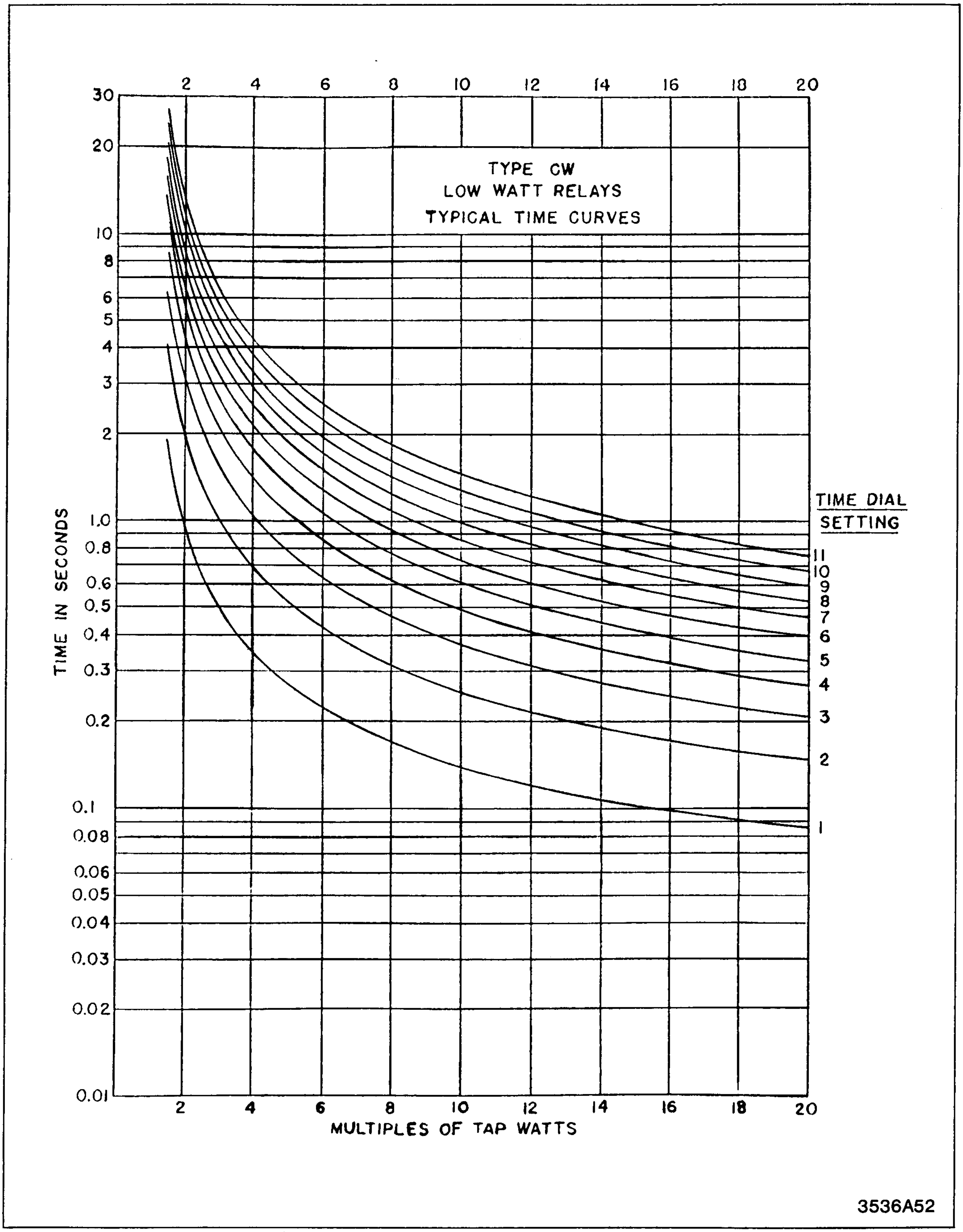


Fig. 4. Typical 60 Hertz Time Curves of the 20-120 and 35-200 watt Type CW Relay.

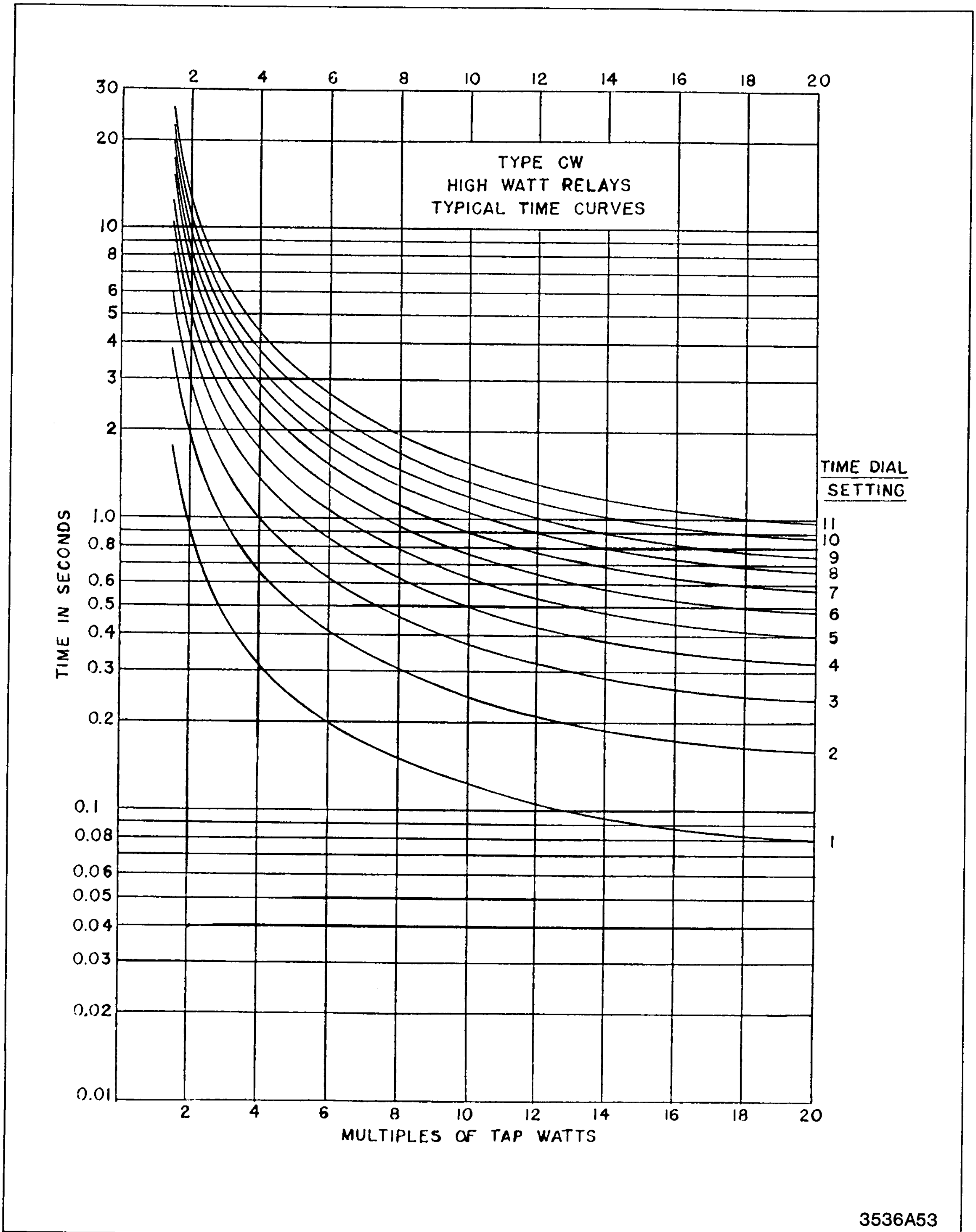


Fig. 5 Typical 60 Hertz Time Curves of the 100-600 and 175-1000 watt Type CW Relay.

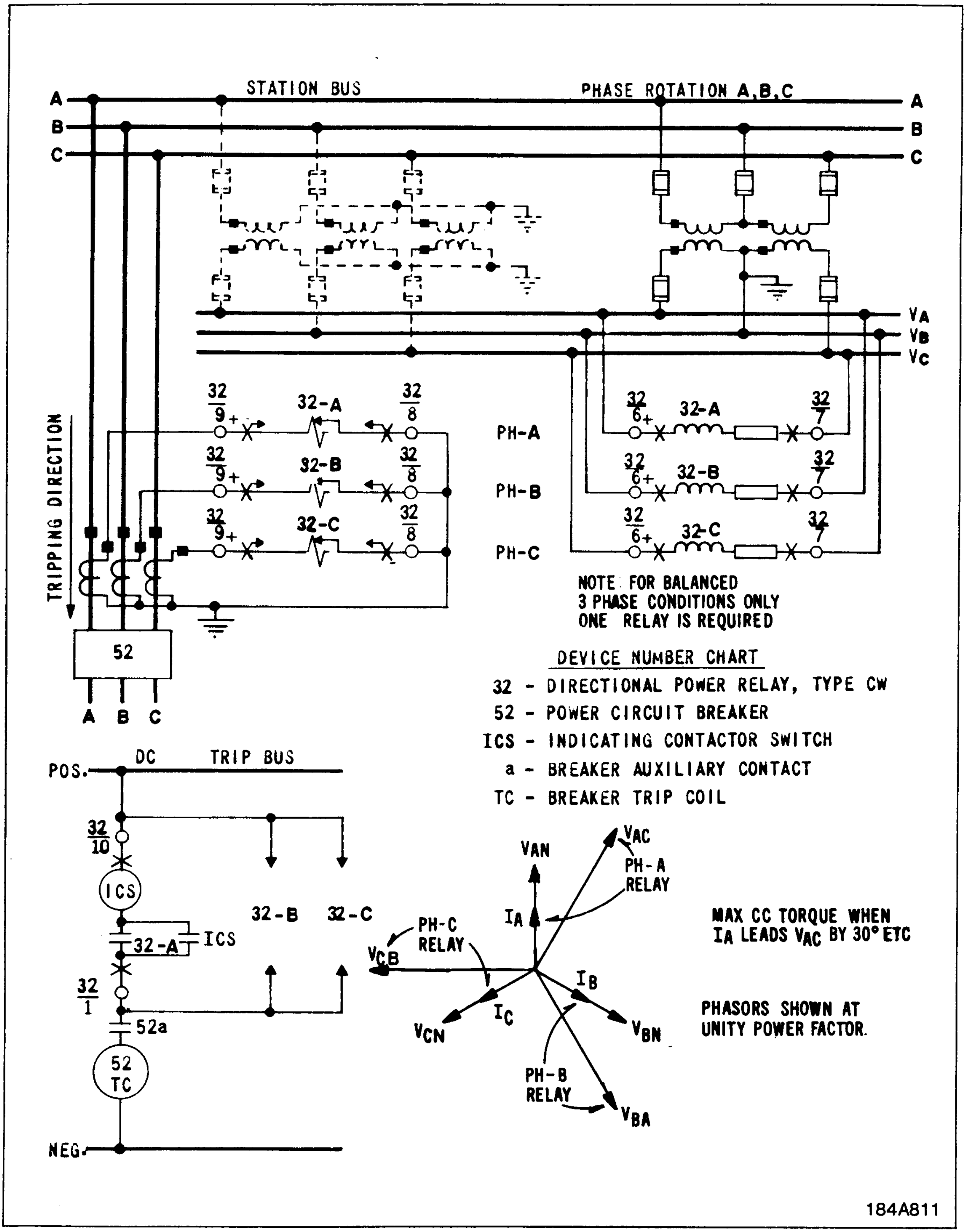


Fig. 6. External Schematic of Three Type CW Relays on a Three-Phase System. NOTE: For Balanced Three Phase Conditions only One CW Relay is required.

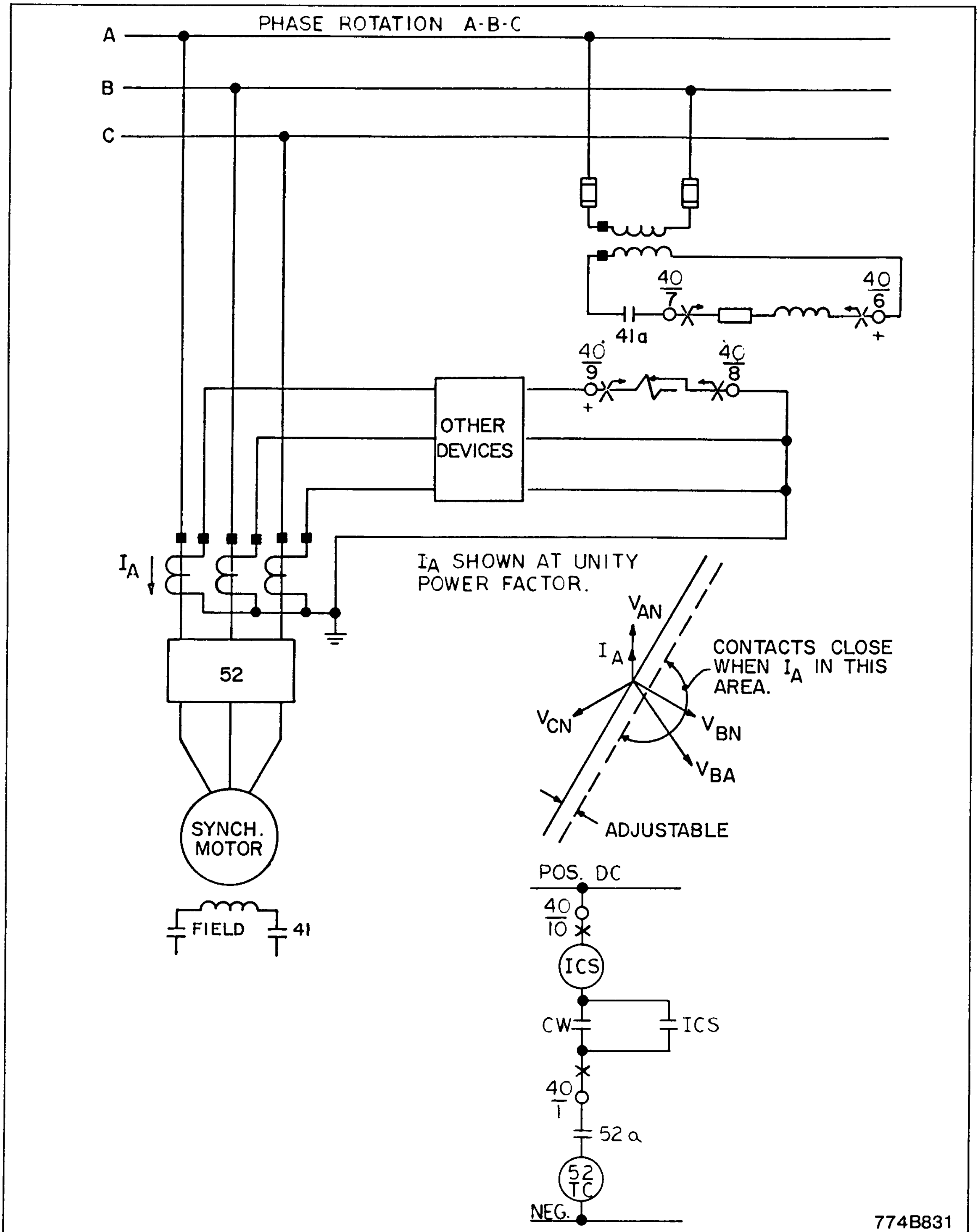
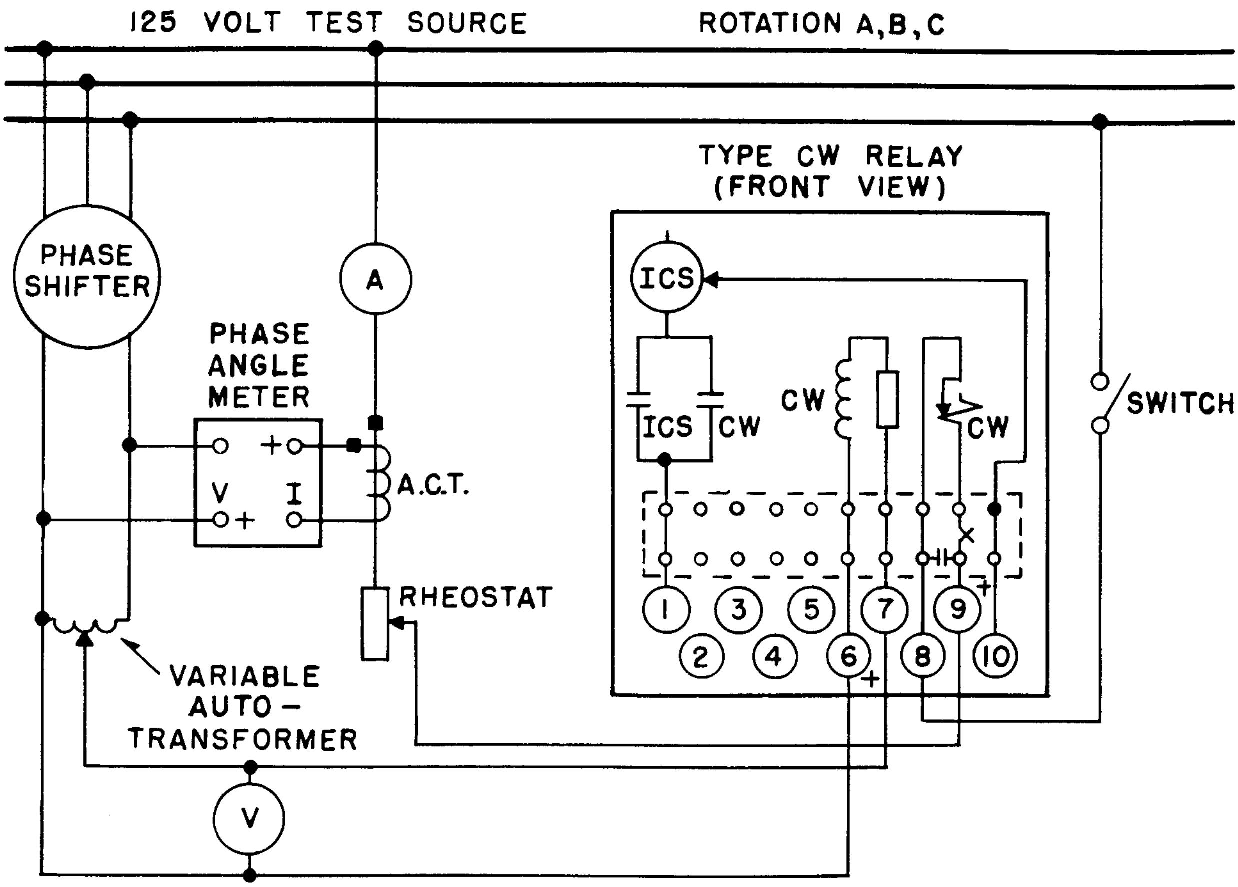


Fig. 7. External Schematic of a Three-Phase Connection of One CW Relay for Loss of Field Protection.



NOTE:
MAXIMUM TORQUE ANGLE IN THE TRIPPING DIRECTION OCCURS WHEN THE CURRENT LEADS THE VOLTAGE BY 30° WITH CONNECTIONS AS SHOWN.

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Fig. 8. Diagram of Test Connections for Type CW Relay in FT-11 Case

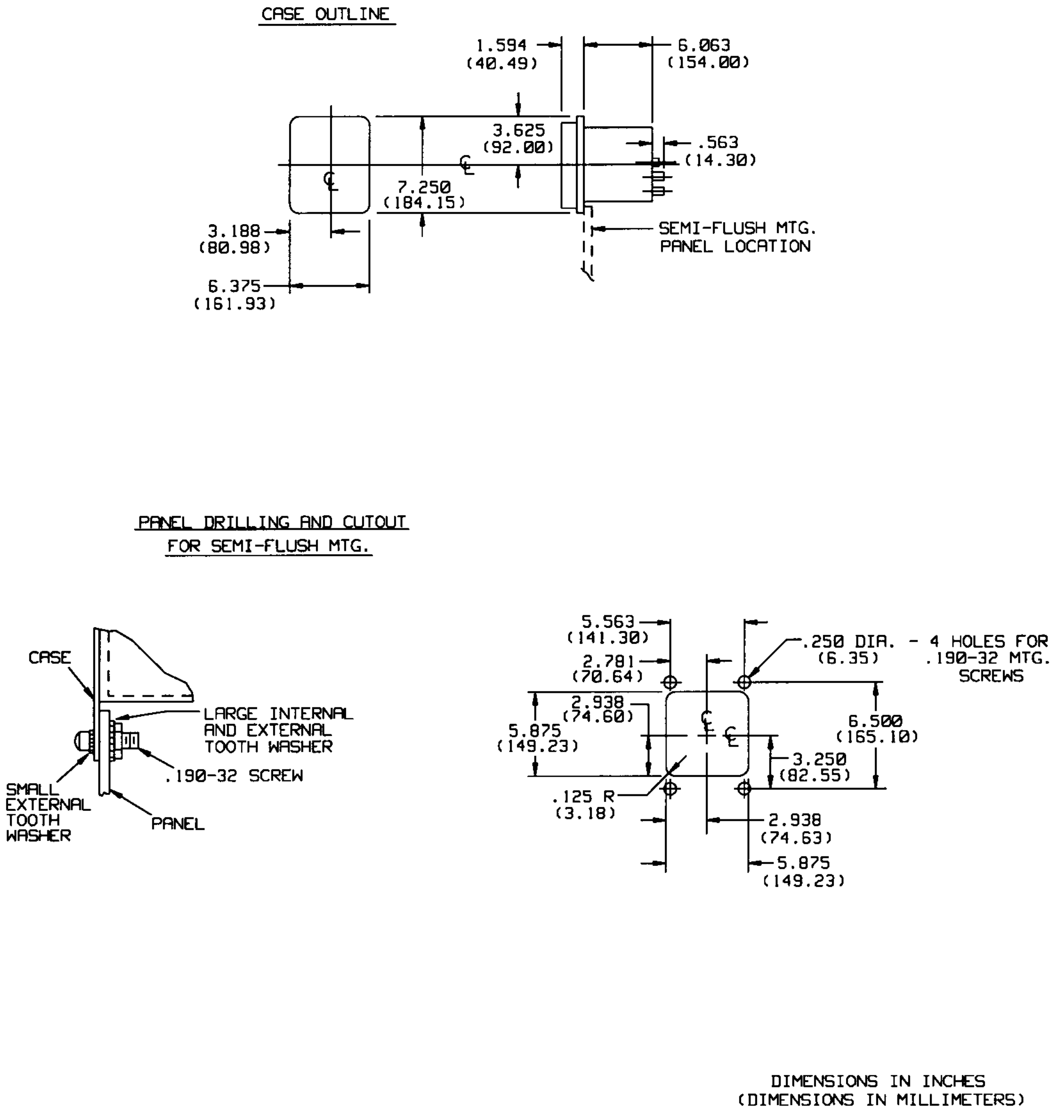

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Figure 9. Outline and Drilling Plan for the Type CW Relay in the FT-11 Case

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