**ABB Automation Inc.**
Substation Automation and Protection Division
Coral Springs, FL 33065

Instruction Leaflet

**41-759.4G**

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( ▌ ) Denotes Change Since Previous Issue

# Type AR Auxiliary Relay

## Ultra High Speed, High Threshold

Class 1E Applications

**CAUTION**

**Before putting protective 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 can close properly. Operate the relay to check the settings and electrical connections.**

## 1.0 APPLICATION

These relays have been specially designed and tested to establish their suitability for Class 1E applications in accordance with the ABB Power T&D Company program for Class 1E Qualification Testing as detailed in bulletin STR-1. Materials have been selected and tested to insure that the relays will perform their intended function for their design life when operated in normal environment as defined by ANSI standards; 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 1E" 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.

### 1.1 ULTRA HIGH SPEED

The AR relay is a four-pole auxiliary type relay, especially designed for ultra high speed circuit breaker tripping duty in protective relaying systems. The AR relay is well suited for bus arrangements where more than one breaker must be tripped. It can provide isolation as well as high speed tripping. The AR relay may also be applied to provide isolation of primary and back-up relaying, and provide high speed tripping for zone one faults.

However, when the AR relay is energized by the thyristor trip circuit of the SDG, SKD, SRU, SBFU, STU-91, or STU-92 relays, a 22 ohm resistor or its equivalent must be added in parallel with the AR relay. Without this resistor, it is possible that when dc voltage is suddenly applied to the relay, sufficient current will flow through the series R-C circuit paralleling the tripping thyristor to cause the 10-watt AR relay to pickup.

### 1.2 TIME DELAY RELEASE (DROPOUT)

The time delay release AR relay has a high speed, less than 1 cycle (16.6 msec) operate time and a time delay release designed for use in reclosing circuit coordination and other general purpose application. The delays are 6 cycles minimum (100 msec) or 12 cycles minimum (200 msec),

### 1.3 HIGH THRESHOLD

The high threshold AR relay is a sensitive high speed auxiliary relay with 4 NO contacts designed to be secure against misoperation due to inadvertent grounding of a station battery or the trip lead. With the battery balanced with respect to ground, the maximum momentary voltage that can be applied to an auxiliary relay for either of these grounds is half battery voltage. The operating level of the high threshold AR exceeds these levels.

*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.*

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## 2.0 CONSTRUCTION AND OPERATION

### 2.1 AR UNIT

The relay consists of four stationary contact screws, four leaf spring moving contacts, a moving armature and card assembly, which operates the moving contacts; a U shaped laminated core, a coil, a frame, a molded insulation block and usually a series resistor. Refer to Figure 1 (page 7).

The armature and card assembly slip over a hinge pin which is inserted in the laminations. The moving and stationary contacts are mounted on the molded insulating block. The molded block and the coil and lamination assembly are mounted to the frame. All contacts are fine silver.

When the coil and resistor are energized, the armature is attracted to the laminations. The card moves with the armature thereby operating the moving contacts. The tension of the moving contacts is the resetting force.

High speed operation is obtained by the inertia of the moving parts, a sensitive electromagnet, and the low L/R ratio of the operating circuit.

### 2.2 TIME DELAY

The AR unit used for a time delay dropout is similar to the one described above. The series resistor in the above is replaced by a resistor and capacitor combination shunting the AR coil.

The printed circuit module contains the proper number of capacitors for the time delay circuitry controlling each AR unit.

### 2.3 INDICATING CONTACTOR SWITCH UNIT (ICS) (WHEN USED)

The indicating contactor switch is a small dc operated 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.

### 2.4 ENCLOSURE

The various relays use the following cases:

1. Front connected molded case reference Figure 16
2. FT-11 reference Figure 17
3. FT-22 reference Figure 18

## 3.0 CHARACTERISTICS

### 3.1 ULTRA HIGH SPEED

The AR unit used in the ultra high speed, 3 millisecond operate time relay has a sensitivity of 0.5 watts. By the proper combination of the AR unit and a large series resistor, an optimum speed of 3 milliseconds is obtained for an energy input of 10 watts.

All relays are capable of being energized continuously. All relays will pickup when 80% of rated voltage is applied to the coil circuit, and will drop out if the voltage is reduced to 5% of rated voltage.

Tables 1, 2 and 3 page 3, give the following typical and/or test values for the ultra high speed units.

Table 1 – Operating Data - Coil ohms - Series Resistor ohms

Table 2 – Contact Ratings

Table 3 – Contact Bounce

### 3.2 TIME DELAY

The operate time of the relay with time delayed release is less than 16 milliseconds at rated voltage for a normally open contact. The relay will have a 0.1 second (or 0.2 second) release time after being energized at least 40 milliseconds.

### 3.3 HIGH THRESHOLD

The relay operates in approximately 4 milliseconds for an energy input of 10 watts. The reset time is typically 16 milliseconds.

The relay is adjusted to have a pickup value less than 80% of rating, but not less than 50% of the typical battery equalizing charge voltage, i.e., minimum pickup is greater than

28 volts for 48 volt rating
70 volts for 125 volt rating

## Table 1

| Operating Data – Ultra High Speed | | | | | | | |
|---|---|---|---|---|---|---|---|
| Coil Circuit Volts | Coil Circuit dc ohms 25° C | | Typical Time (Milliseconds) | | | Operating Volts | |
| | | | Pickup (Operate) | | Dropout† (Reset) | | |
| dc | Coil | Series Resistor | NO Contact Closes | NC Contact Opens | NC Contact Closes | Must Pickup | Must Dropout |
| 24 | 4 | 50 | <3 | 1.5 | <4 | 19 | 2.4 |
| 48 | 14 | 200 | <3 | 1.5 | <4 | 38 | 4.8 |
| 125 | 100 | 1500 | <3 | 1.5 | <4 | 100 | 12.5 |
| 250 | 170 | 6000 | <3 | 1.5 | <4 | 200 | 25.0 |
| 62.5 | 1080 | None | 5 | 1.5 | <4 | 50 | |

† *Without Coil Suppression*

## Table 2

| Contact Rating of Normally Open Contacts | | | | | |
|---|---|---|---|---|---|
| Contact Circuit Volts dc | Interrupting Rating (Amperes) | | | | Carry Rating (Amperes) |
| | Resistive | | Inductive† | | |
| | Single | Double | Single | Double | Continuous |
| 48 | 3.750 | 20.0 | 1.750 | 20.0 | 3 |
| 125 | 0.500 | 1.7 | 0.350 | 1.20 | 3 |
| 250 | 0.250 | 0.5 | 0.150 | 0.250 | 3 |

† *L/R = .005 for I>1 ampere*
*L/R = .040 for I<1 ampere*

## Table 3

| Contact Bounce | | |
|---|---|---|
| | Typical Effective Bounce Time in Milliseconds | |
| Contact Loading | Normally Open | Normally Closed |
| Dry Circuit | 2-4 | 6-8 |
| 10 Watts (one AR Relay) | 1.0 | -- |
| Breaker Trip Coil | 0.2 | -- |

## Table 4

| | With Relay De-energized | | | With Relay Energized | |
|---|---|---|---|---|---|
| Contact Arrangement | NO Contact gap (inches) | NC Contact force (Grams) | Force to move the NO Contact spring away from the card | NC Contact gap (inches) | NO Contact force (Grams) |
| 4 NO | **.018 Min.** | -- | 4 Grams ±1 | -- | 15-40 |
| 3 NO - 1 NC | **.018 Min.** | 15 Min. | † 6 Grams ± 1 | .013 Min. | 15-40 |
| 2 NO - 2 NC | **.018 Min.** | 15 Min. | † 8-11 Grams | .013 Min. | 15-40 |

† *For this check to be made accurately, it is necessary to back out the NC stationary contact screw. This will disturb the factory calibration and therefore it is recommended this check not be made on a relay which passes all other checks.*

140 volts for 250 volt rating

The relay will drop out at 10% of rated voltage or higher. The relay is only available in a 4 make contact configuration. Typical effective contact bounce is outlined in Table 3, page 3.

**Trip Circuit Constants**

| Indicating Contactor Switch (ICS). | |
|---|---|
| **Ampere Pickup** | **Ohms dc Resistance** |
| 0.2 Amp Rating | 8.5 ohms dc |
| 1.0 Amp Rating | 0.37 ohms dc |
| 2.0 Amp Rating | 0.10 ohms dc |

**NOTE: Use only one**

### 3.4 CONTACT RATING

Each relay contact is rated 3 amps continuous and will make and carry 30 amps long enough to trip a breaker.

Material transfer will be minimized and contact life extended, if positive polarity is connected to the moving contact.

## 4.0 SETTINGS

### 4.1 AR UNIT

No settings are required.

### 4.2 ICS UNIT (WHEN USED)

No settings are required.

## 5.0 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 are 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.

## 6.0 ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not require readjustment after receipt by the customer. The following “routine test” is recommended for new equipment and prior to readjustment or recalibration. If the adjustments have been changed or the relay taken apart for repairs, the calibrations instructions should be followed.

## 7.0 ACCEPTANCE AND ROUTINE TEST

The following checks are recommended to insure that the relay is in proper working order:

### 7.1 AR UNIT (ULTRA HIGH SPEED)

**1. Armature gap**

The armature gap should be approximately .009 inches measured at the narrowest part of the armature gap.

**2. Visual inspection**

For relays having normally closed contacts, the contact spring should not be touching the card.

**3. Contact gaps and forces**

All gram measurements should be made at the end of the moving contact spring per Table 4 page 3.

**4. Contact operate and reset times**

Check values in Table 1 page 3 that have tolerances.

### 7.2 TIME DELAYED RELEASE

1. Mechanical settings are per paragraphs 1, 2, and 3 above; 7.1 AR (ULTRA HIGH SPEED).

2. Apply rated voltage to the relay for a minimum of 40 milliseconds. Upon removal of the voltage the normally open contacts should require 0.1 to 0.15 (or 0.2 to 0.3) seconds to open.

### 7.3 HIGH THRESHOLD

The relay should pickup at 80% of rating and should not pickup below:

28 volts for 48 volt rating
70 volts for 125 volt rating
140 volts for 250 volt rating

**1. Contact gaps**

Normally open contacts should have a gap of .018 to .023 inch.

**2. Contact pressure**

On relays with four normally open contacts, contacts should have approximately 5 grams pressure on the card in the de-energized position, and 15 to 30 grams contact pressure in the energized position. Pressure readings are taken at the end of the contact spring.

**3. Armature gap**

The armature gap should be approximately .010 inches measured at the narrowest part of the armature gap.

**4. Contact operate time**

Approximately 4 milliseconds at rated voltage.

## 8.0 CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments disturbed. This procedure should not be used until it is a apparent that the relay is not in proper working order. (See “Acceptance and Routine Test”, page 4)

### 8.1 ULTRA HIGH SPEED AND TIME DELAY RELEASE

a. Adjust the set screw at the rear of the top of the frame to obtain a 0.009-inch gap at the rear end of the armature air gap.

b. Adjust each contact spring to obtain 4 grams pressure at the very end of the spring. This reading is taken when the pressure is sufficient to move the spring away from the end of the slot of the card.

On the two normally open, two normally closed contact relay, adjust each normally open contact spring of 8 grams to just move the contact spring away from the card. Adjust the normally closed contacts for 15 grams spring pressure, to just move the contact spring away from the card (see Figure 1). Then adjust the normally closed stationary contact to just move the contact spring away from the card.

On the three normally open, one normally closed contact relay, adjust each normally open contact spring for 6 grams to just move the contact spring away from the card. Adjust the normally closed contact for 15 grams spring pressure, to just move the contact spring away from the card (see Figures 1). Then adjust the normally closed stationary contact to just move the contact spring away from the card.

c. Adjust each normally open stationary contact screw to obtain a contact gap of 0.020 to 0.022 inches. Energize the relay and the normally open contacts should have 15 to 30 grams contact follow. The normally closed contact, if any, should have a contact gap of .015 inches.

When calibrated as outlined above, the Ultra High Speed relay should meet the characteristics of Tables 1 and 3 on page 3

When calibrated as outlined above, the time delay release relay should meet the characteristics of Table 4 (page 3) and have a release time of 0.1 seconds (or 0.2 seconds) minimum when energized for at least 0.04 seconds (40 milliseconds).

### 8.2 HIGH THRESHOLD

a. Adjust the set screw at the rear of the top of the frame to obtain a 0.010-inch gap at the rear end of the armature air gap.

b. Adjust each contact spring to obtain 5 grams reset pressure at the very end of the spring. This pressure should be sufficient to move the spring away from the edge of the slot of the card.

c. Adjust each stationary contact screw to obtain a contact gap of 0.020 to 0.022 inches. Energize the relay and the normally open contacts should

have 15 to 30 grams contact follow.

d. Apply rated voltage to the relay in line with the terminal polarity designation. Then calibrate by adjusting the spring tension until the relay picks up in the line with the following chart:

31 volts for 48 volt rating
80 volts for 125 volt rating
160 volts for 250 volt rating

### 8.3 INDICATING CONTACTOR SWITCH (ICS) (WHEN USED)

Initially adjust unit on the pedestal so that armature fingers do not touch the yoke in the reset position. This can be done by loosening the mounting screw in the molded pedestal and moving the ICS in the downward position.

1. Contact Wipe. Adjust the stationary contacts 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.

   For double trip ICS, adjust the third contact so that it makes with its stationary contact at the same time as the two main contacts or up to 1/64" ahead.

2. 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.

3. Pickup. Unit should pickup at 98% of 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 approximately equal by applying the tweezer between the leaf spring and the front surface of the cover at the bottom of the lower window.

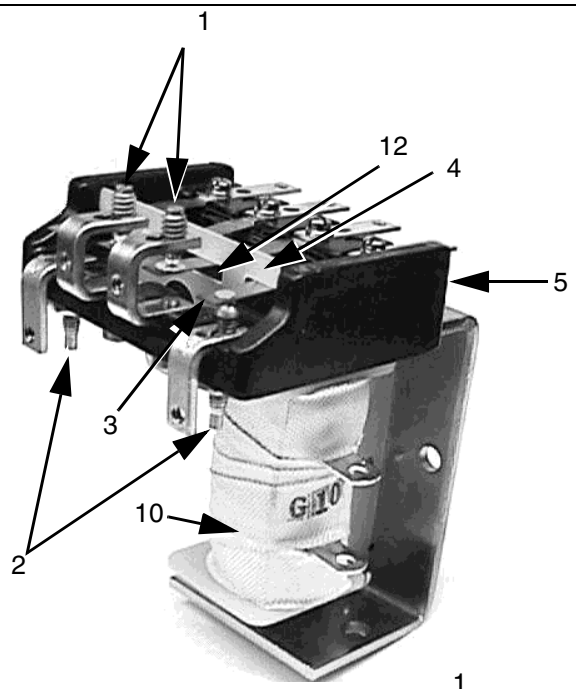
   If the pickup is low, the front cover must be removed and the leaf springs bent outward equally.

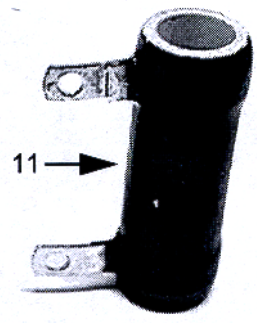
## 9.0 RECOMMENDED ROUTINE MAINTENANCE

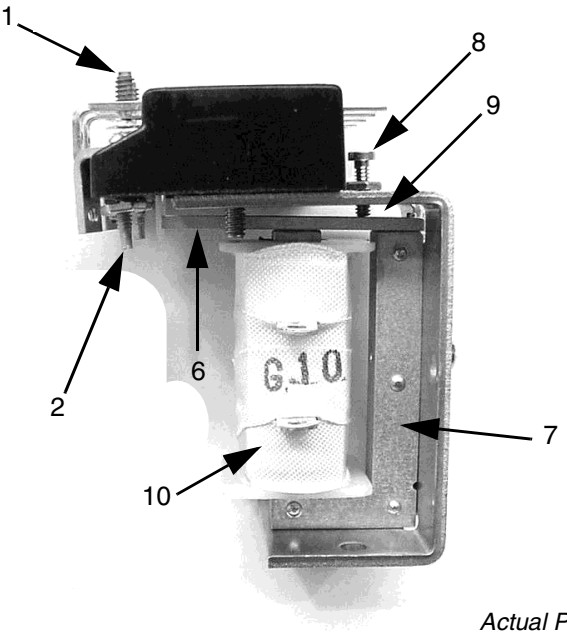
For worst case operating conditions: 30 amps resistive, contact make duty; the contact should be inspected each year or 50 operations and replaced every two years or 100 operations.

## 10.0 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.




*Actual Photo*

1. Normally closed stationary contact screws
2. Normally open stationary contact screws
3. Moving contact and leaf spring assembly
4. Moving card assembly (card)
5. Molded insulation block
6. Molded armature
7. U-shaped laminated core
8. Armature gap adjustment set screw
9. Armature gap
10. Relay Coil
11. Internal series resistor
12. Before checking the normally closed contact pressure, there should be a gap between the moving contact spring and the card.

*Figure 1. Type AR Unit and internal resistor*

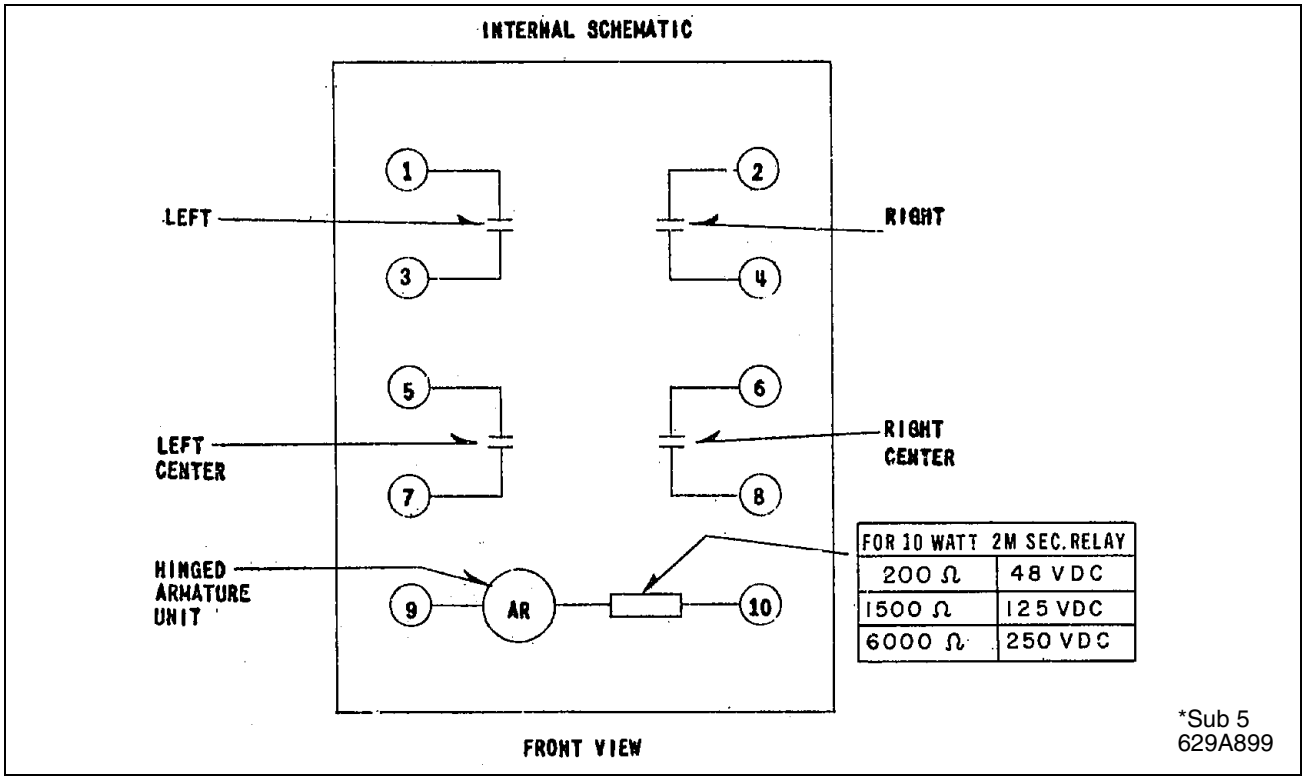



*Figure 2. Internal Schematic of The type AR High Speed Auxiliary Relay in Front Connected Molded Case (4M).*

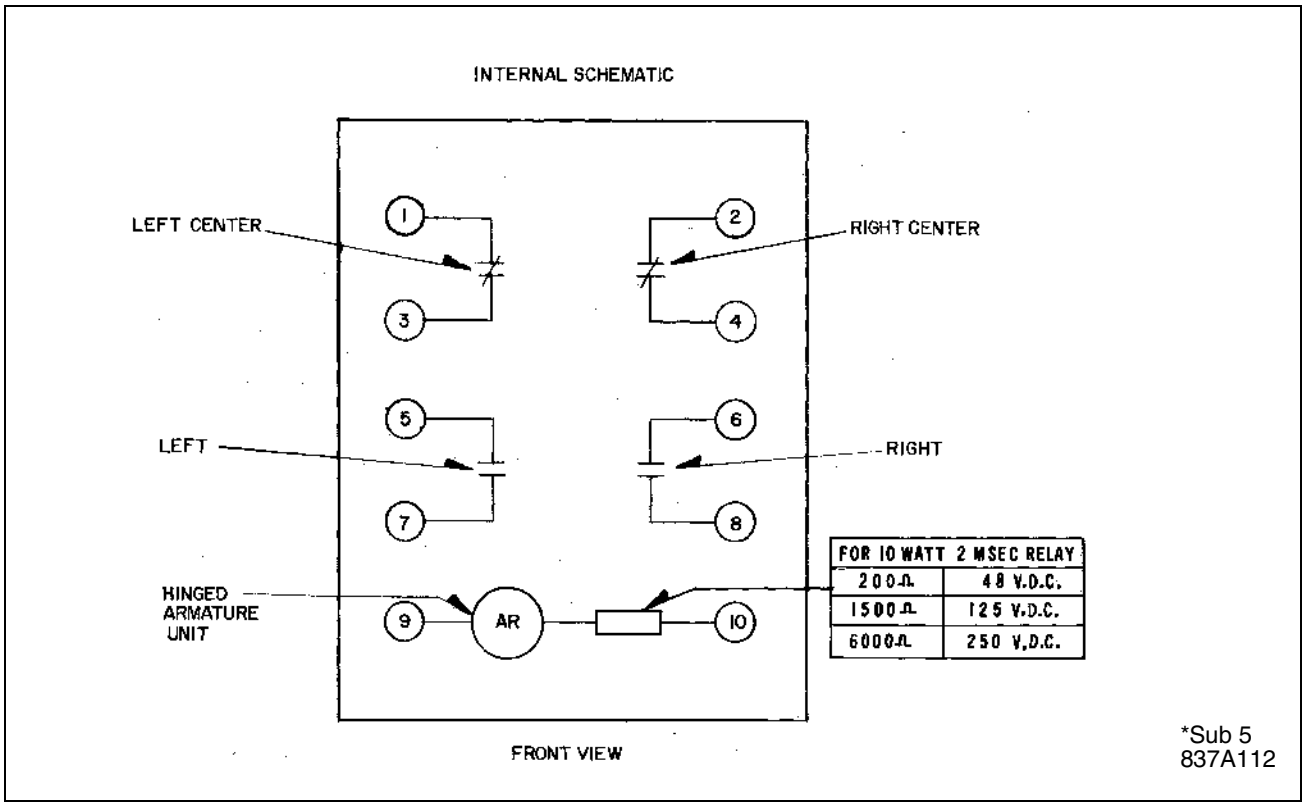



*Figure 3. Internal Schematic of the Type AR High Speed Auxiliary Relay In Front Connected Molded Case (2M - 2B).*

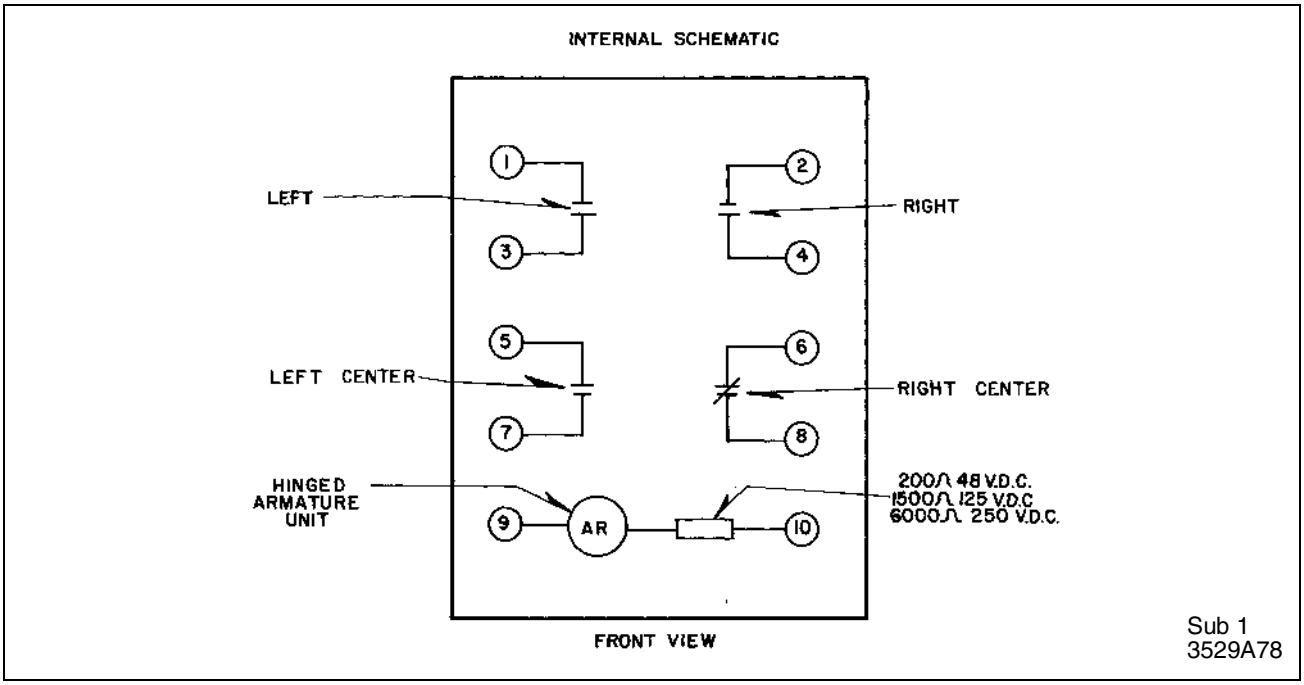



*Figure 4. Internal Schematic of the Type AR High Speed Auxiliary Relay in Front Connected Molded Case, (3M-1B).*

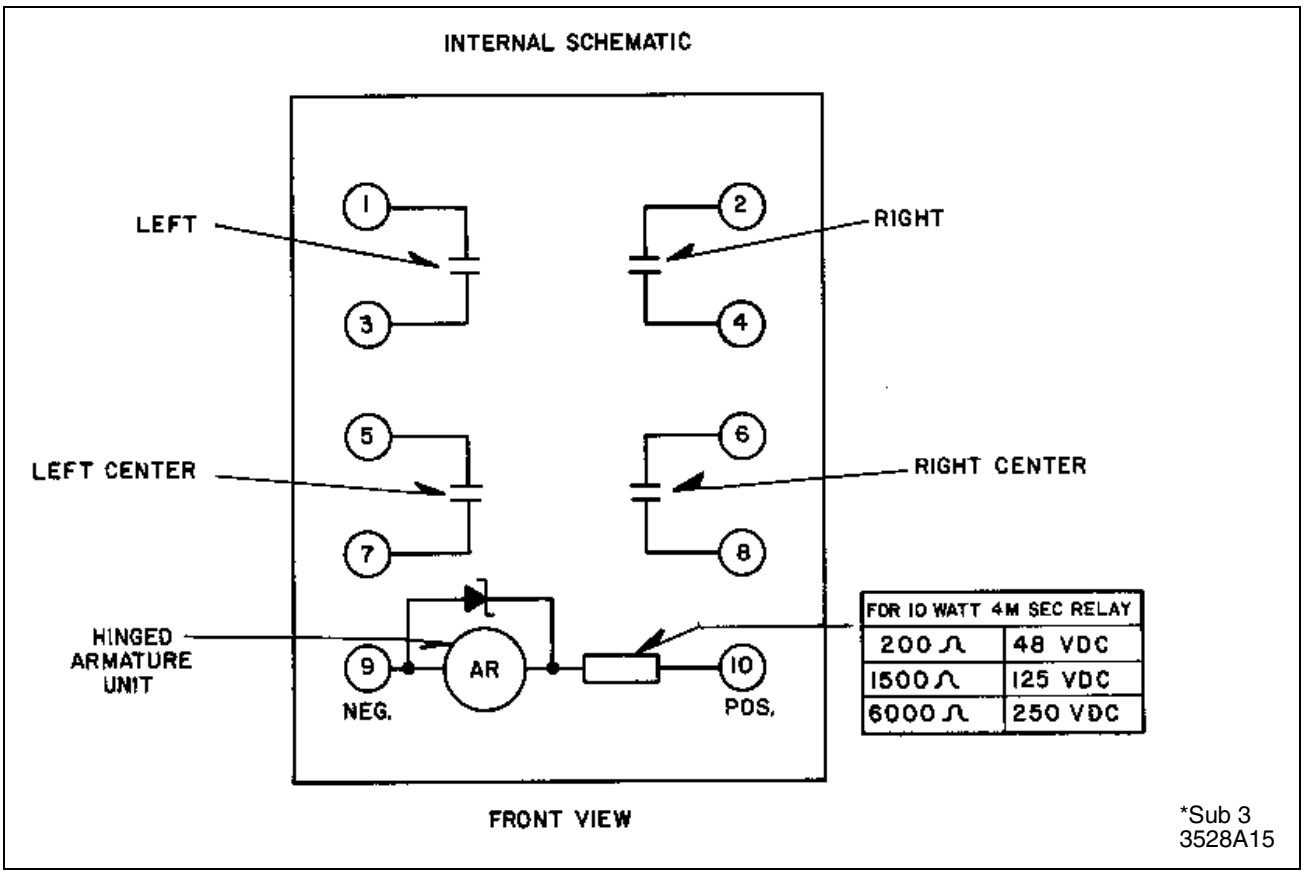



*Figure 5. Internal Schematic of the Type AR High Speed Auxiliary Relay, in Front Connected Molded Case (4M, High Threshold.*

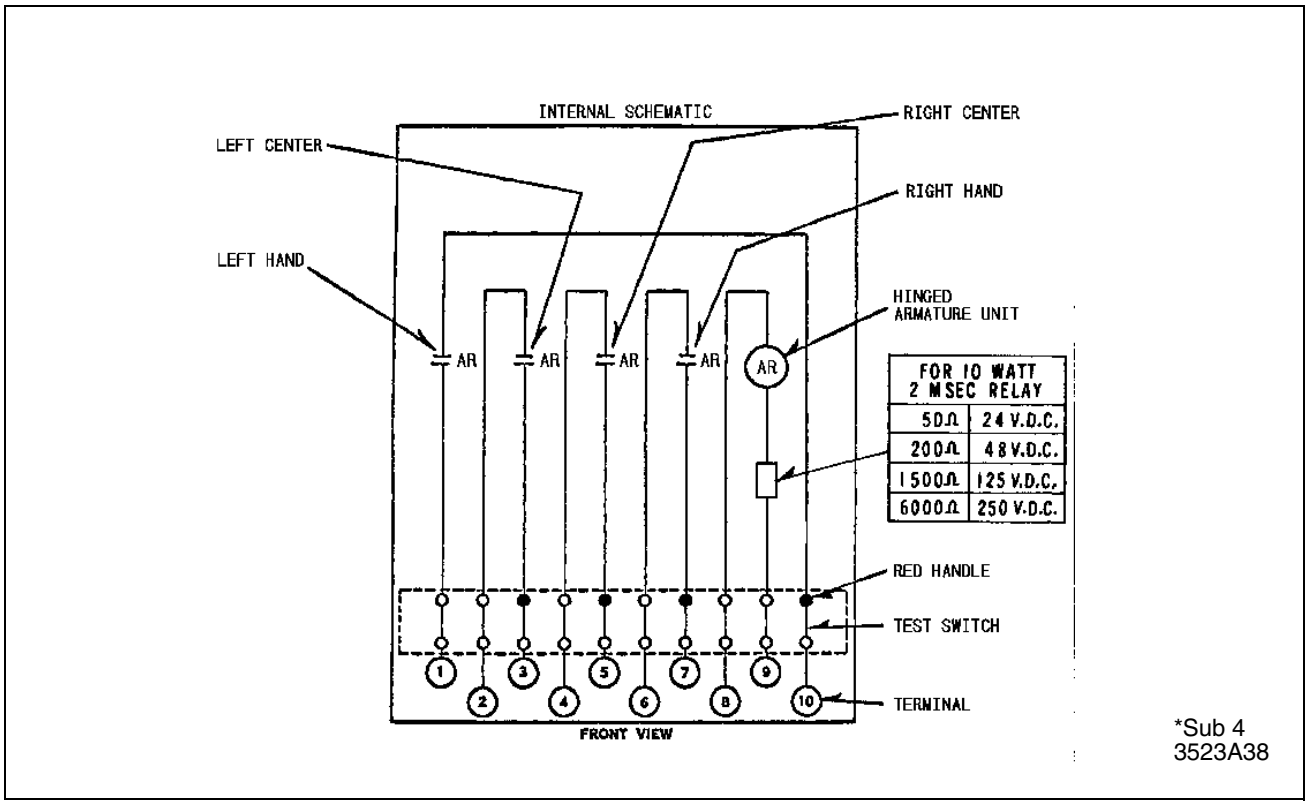



*Figure 6. Internal Schematic of the Type AR High Speed Auxiliary Relay in FT-11 Case (4M).*

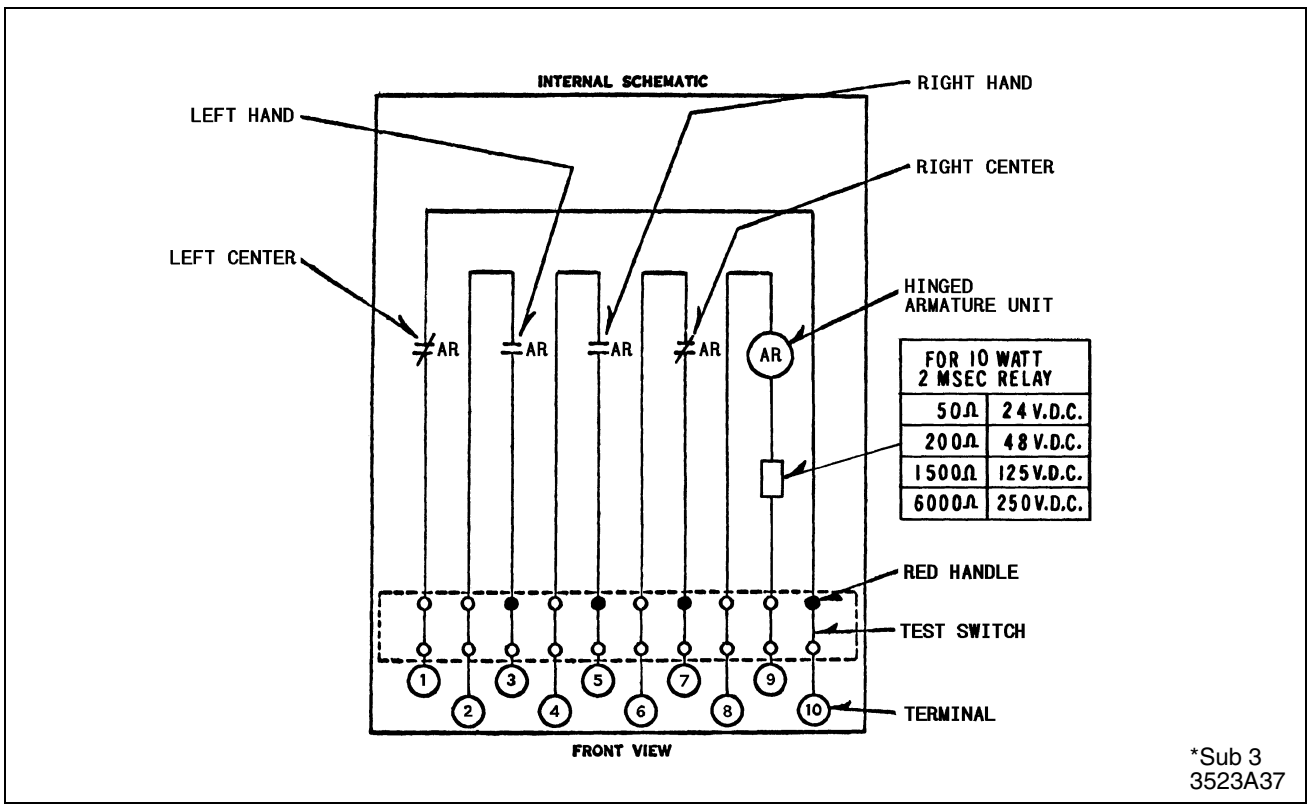



*Figure 7. Internal Schematic of the AR High Speed Auxiliary Relay in FT-11 Case (2M-2B).*

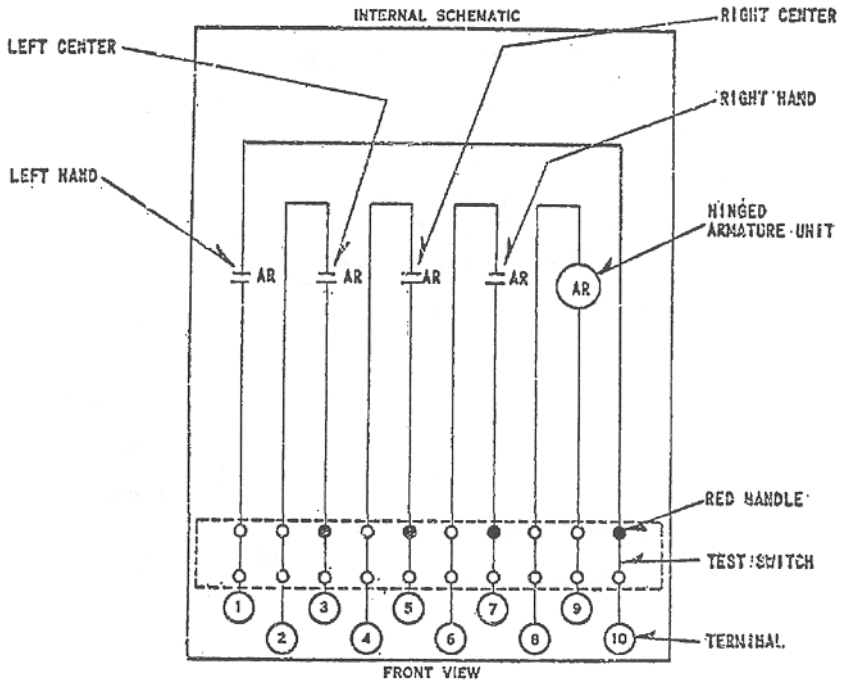



*Figure 8. Internal Schematic of the Type AR High Speed Auxiliary Relay In FT-11 Case (4M), and without Internal Series Resistor.*

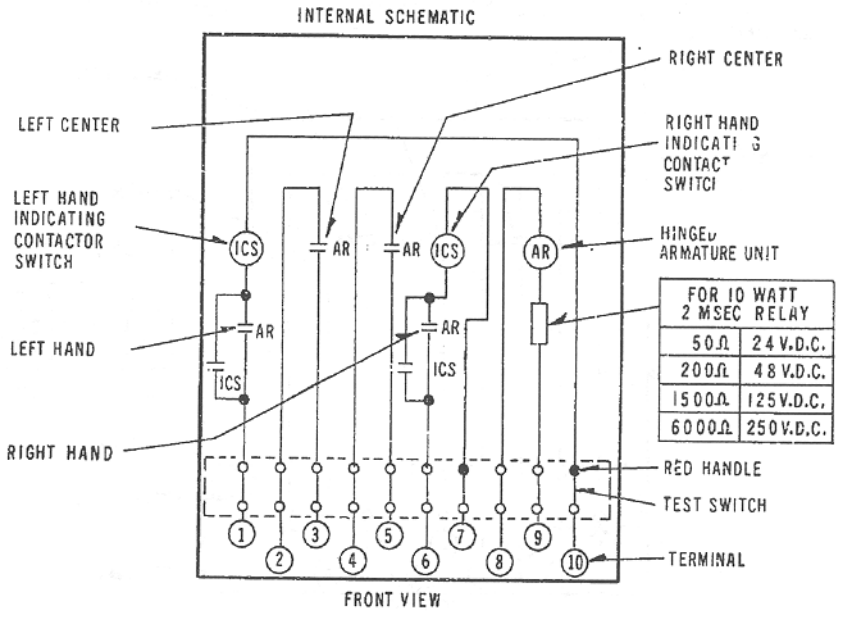



*Figure 9. Internal Schematic of the Type AR High Speed Auxiliary Relay in FT-11 Case (4M), with 2 ICS Units.*

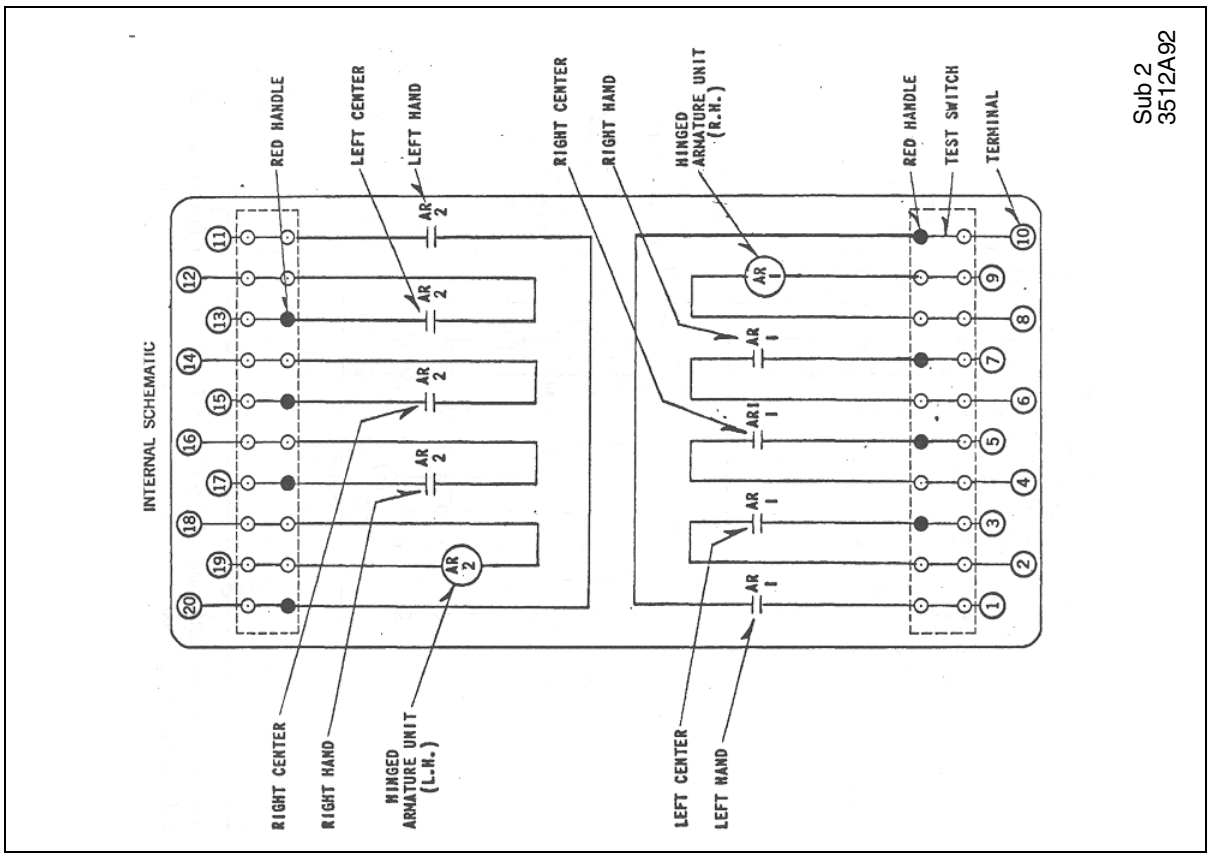



*Figure 11. Internal Schematic of the Type AR High Speed Auxiliary Relay, 2 Units in FT-22 Case (4M and 4M), without Internal Series Resistor*

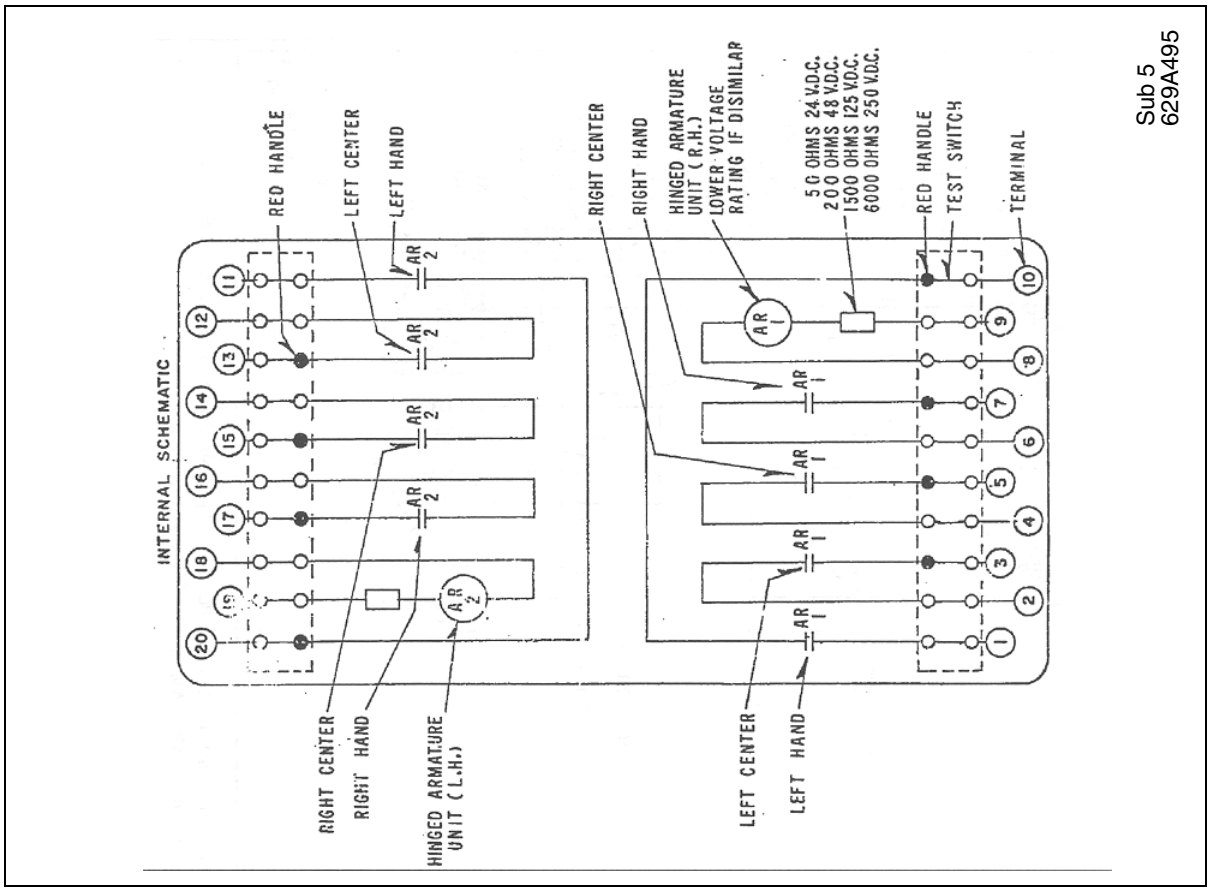



*Figure 10. Internal Schematic of the Type AR High Speed Auxiliary Relay, 2 Units in FT-22 Case (4M and 4M).*

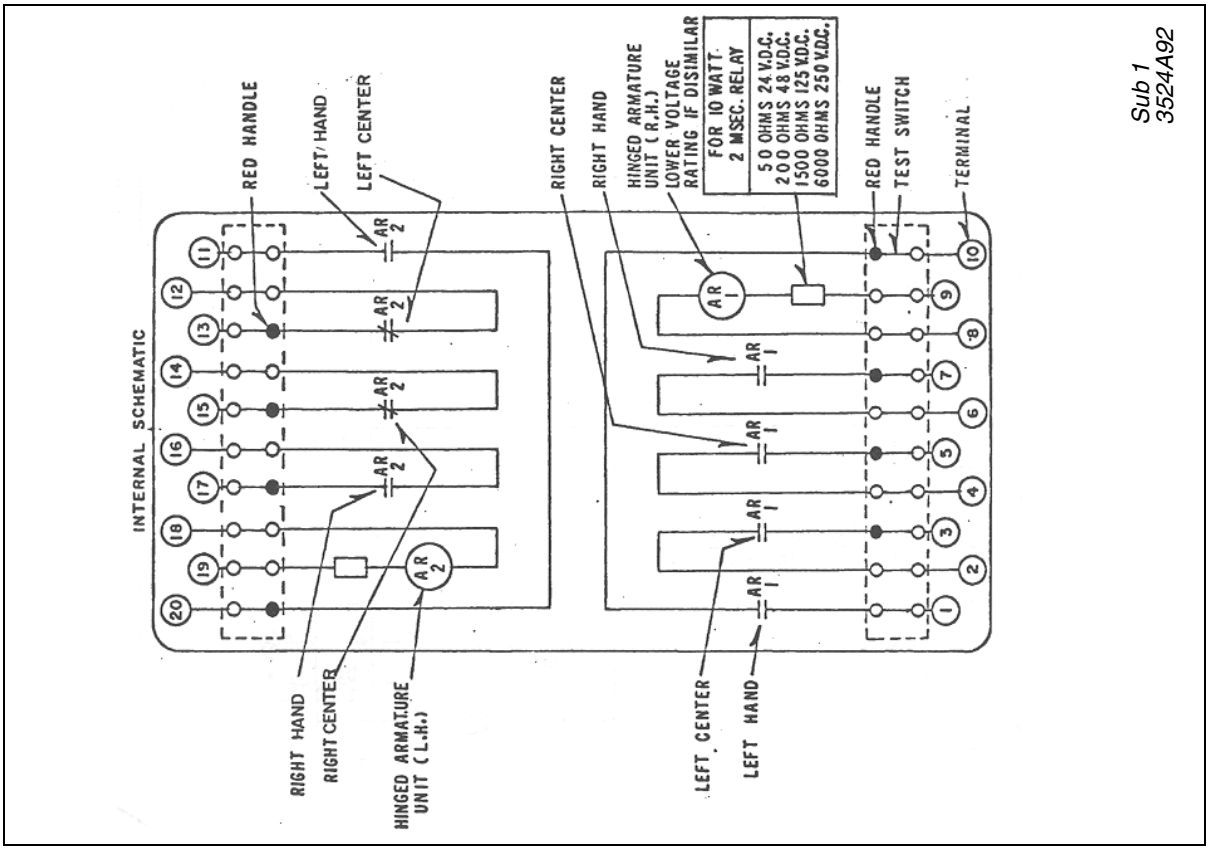



*Figure 13. Internal Schematic of the Type AR High Speed Auxiliary Relay, 2 Units in Type FT-22 Case (4M and 2M-2B).*

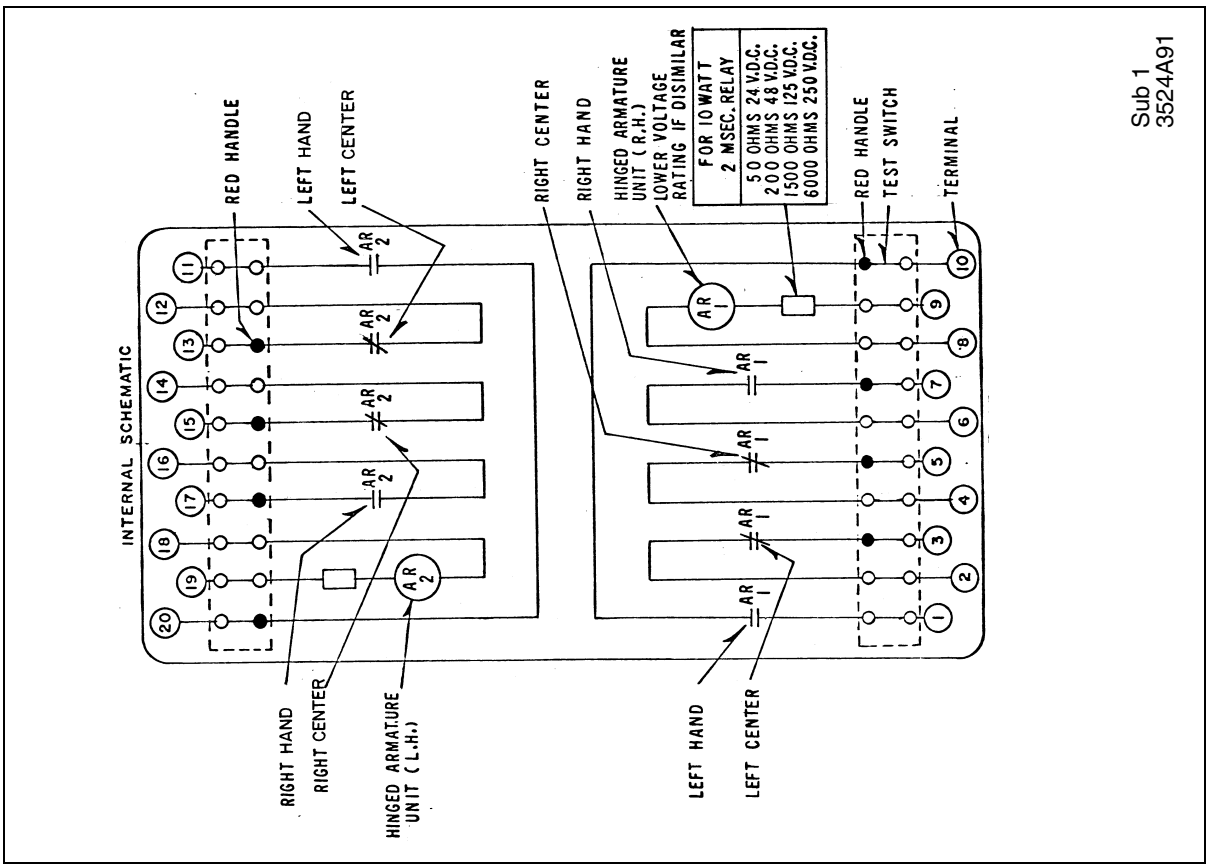



*Figure 12. Internal Schematic of the Type AR High Speed Auxiliary Relay, 2 Units in FT-22 Case (2M-2B and 2M-2B).*

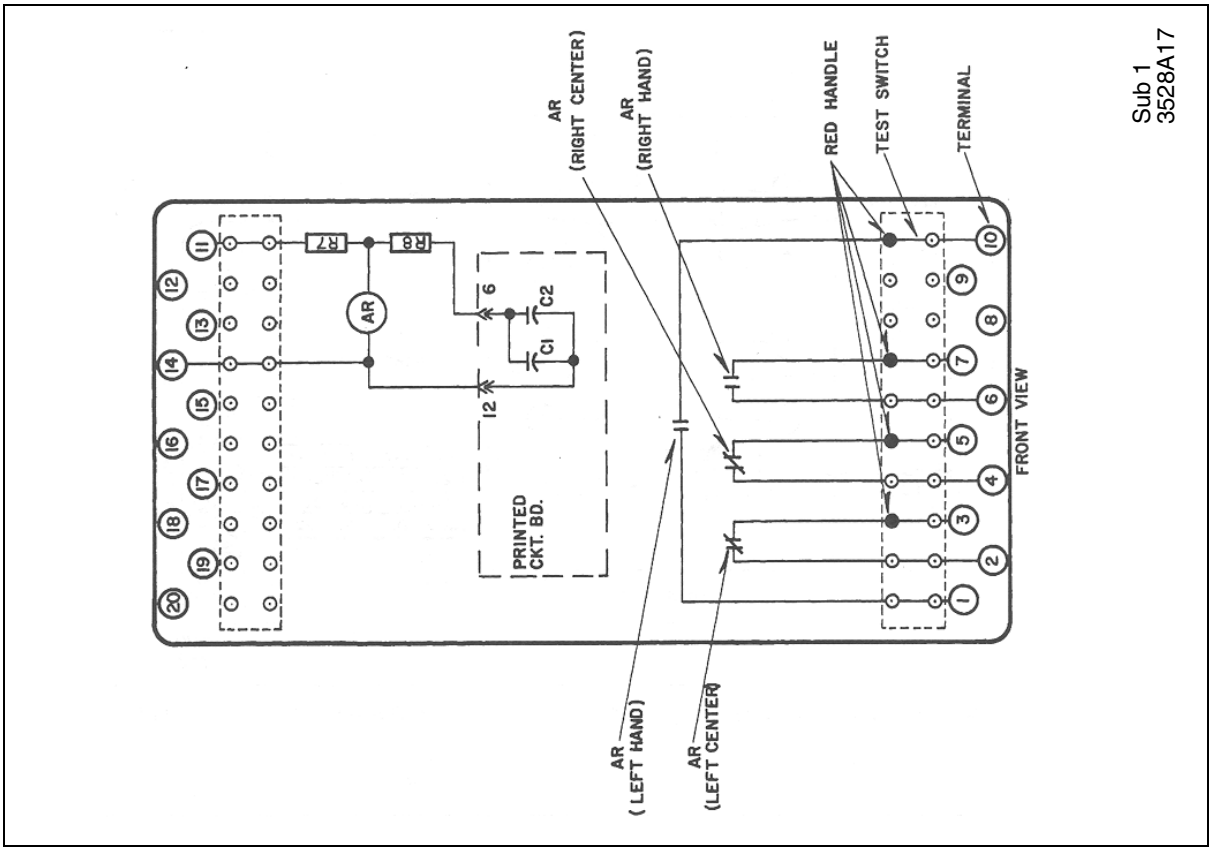



*Figure 15. Internal Schematic of the Type AR Relay with Time Delay, in FT-22 Case, (2M-2B).*

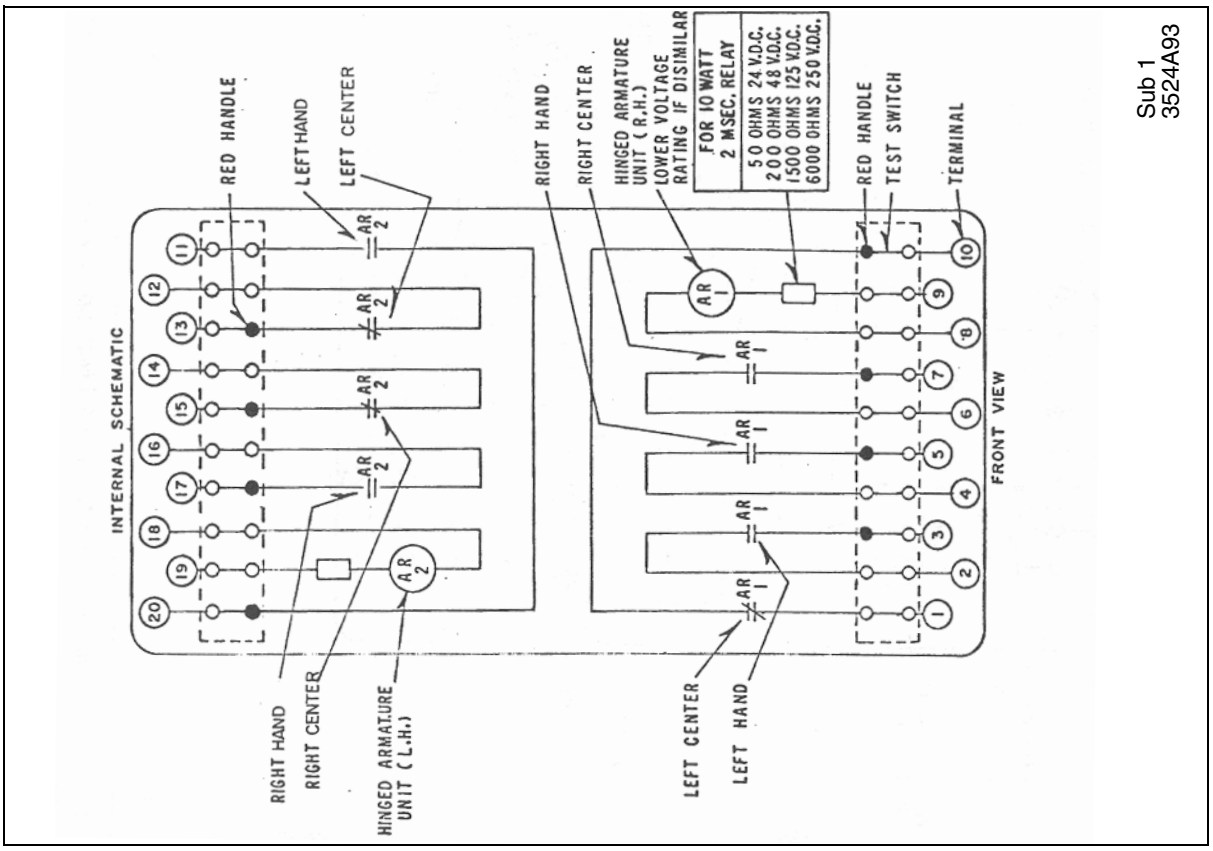



*Figure 14. Internal Schematic Type AR High Speed Auxiliary Relay, 2 Units in FT-22 Case (3M-1B and 2M-2B).*

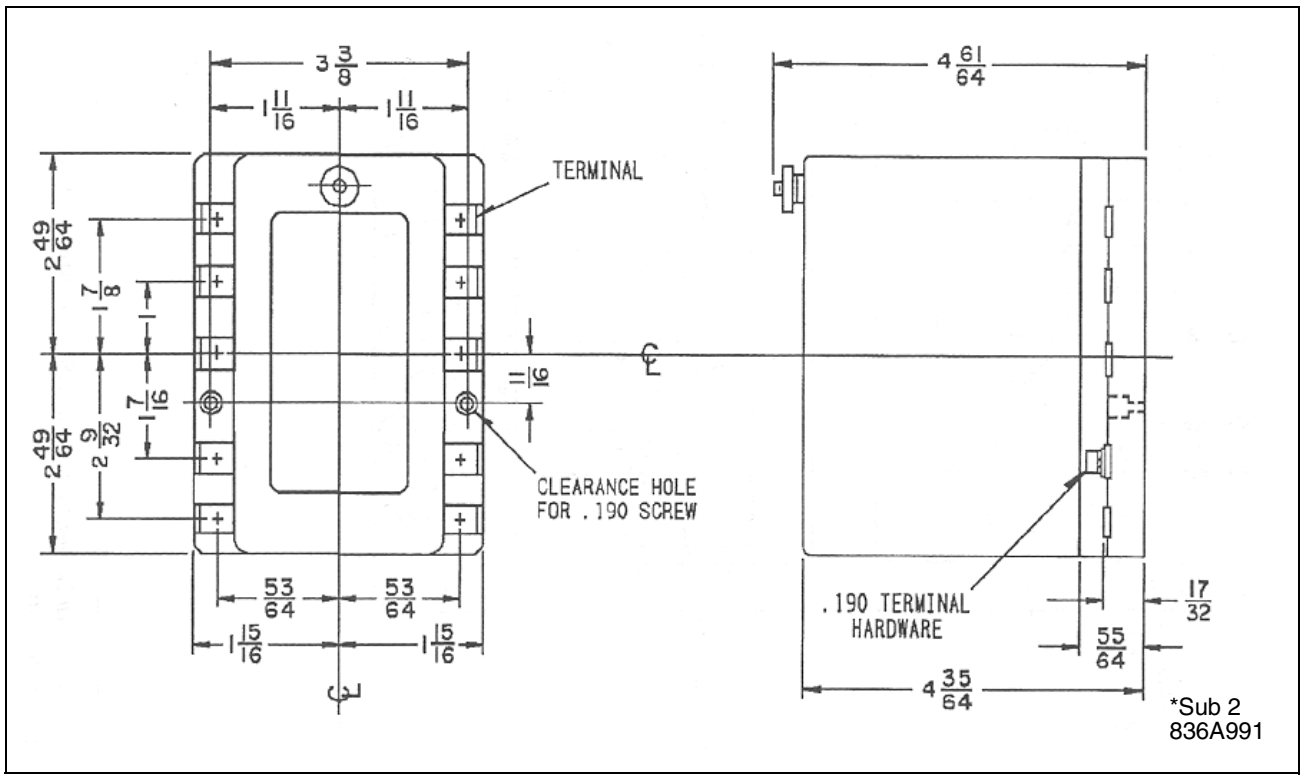



*Figure 16. Outline and Drilling Plan for the Type AR Relay in the Front Connected Molded Case.*

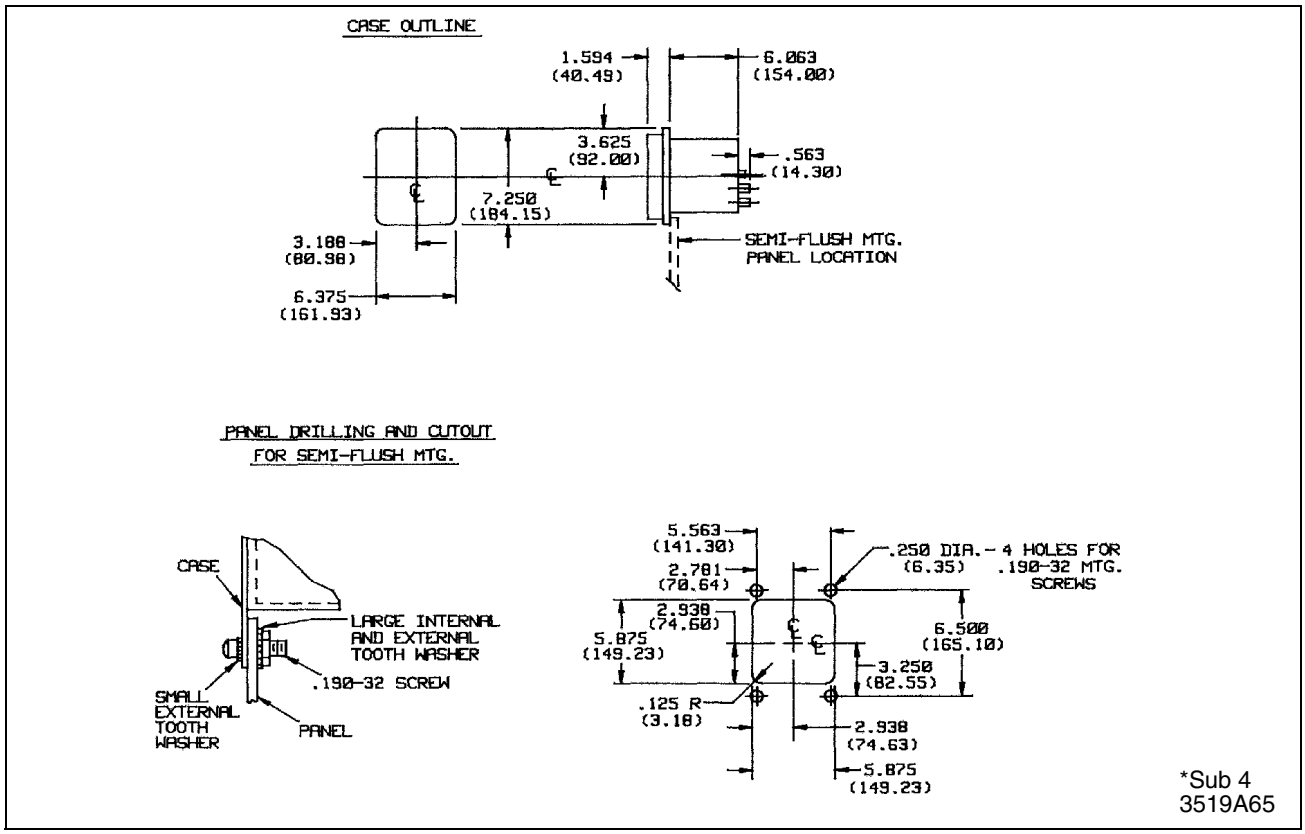



*Figure 17. Outline and Drilling Plan for the Type AR Relay in Semi-Flush FT-11 Case.*

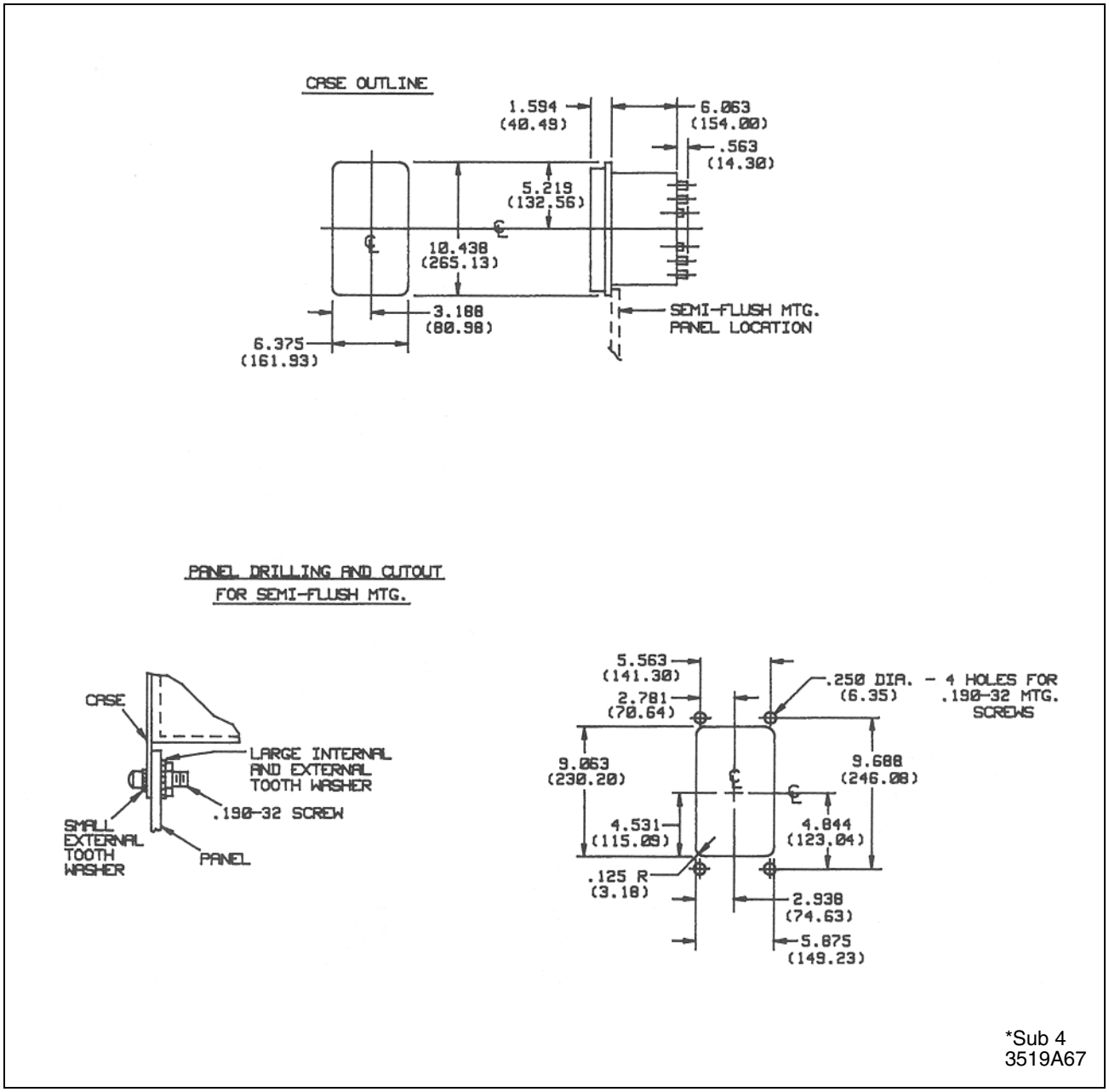



*Figure 18. Outline and Drilling Plan for the Type AR Relay in Semi-Flush FT-22 Case.*

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