IB 7.2.1.7-4
Issue D

INSTRUCTIONS

Overcurrent Relay for Motor Protection

Effective: June 2018
(|) Denotes Changes Since Previous Issue

CIRCUIT SHIELD ®

TYPES 49/50/51, 49/50, 49

Catalog Series 214 Standard Case

Catalog Series 414 Drawout Test Case

TABLE OF CONTENTS

INTRODUCTION

These instructions contain the information required to properly install, operate, and test the ABB Circuit-Shield™ Type 49/50/51, Type 49/50, and Type 49 Motor Overcurrent Relays.

The relay is housed in a case suitable for conventional semiflush panel mounting. All connections to the relay are made at the rear of the case and are clearly numbered. The 414 series relay provides totally drawout construction with integral test facilities. Current transformer shorting is accomplished by a direct-acting spring and blade assembly upon removal of the relay from its case. Sequenced disconnects prevent nuisance tripping during withdrawal or insertion of the relay if the normally-open contact is used in the application. The 214 series relay is of partial drawout construction with the input transformers remaining in the case upon withdrawal of the lower circuit board.

All settings are made on the front panel of the relay behind a removable clear plastic cover. The targets are reset by means of a push-button extending through the relay cover.

PRECAUTIONS

The following precautions should be taken when applying these relays:

1. Incorrect wiring may result in damage. Be sure wiring agrees with the connection diagram for the particular relay before energizing.

2. Apply only the rated voltage marked on the relay front panel. For units rated for dc control power, the proper polarity must be observed.

3. A tripping circuit must be interrupted by an "a" contact to remove high current from the output circuit. Do not exceed contact ratings.

4. When applying high input currents during testing, interrupt the current immediately after the relay operates to prevent thermal stress.

5. High voltage insulation tests are not recommended. See section on testing for additional information.

6. The entire circuit assembly of the relay is removable. The unit should insert smoothly. Do not use excessive force.

7. Follow test instructions to verify that the relay is in proper working order.

8. When handling this relay, take all the necessary precautions to prevent damage from static electricity. This relay contains static sensitive components which could be damaged without proper grounding.

CAUTION: *since troubleshooting entails working with energized equipment, care should be taken to avoid personal shock. Only competent technicians familiar with good safety practices should service these devices.*

PLACING THE RELAY INTO SERVICE

1. RECEIVING. HANDLING. STORAGE

Upon receipt of the relay (when not included as part of a switchboard) examine for shipping damage. If damage or loss is evident file a claim at once and promptly notify the nearest Asea Brown Boveri office. Use normal care in handling to avoid mechanical damage. Keep clean and dry.

2. INSTALLATION

Mounting- The outline dimensions and panel drilling and cutout information is given in Fig. 3.

Connections Internal connections are shown in Figure 2. *Note that the external connections will be different for the 214 series and 414 series units. Typical external connections are shown in Figure 1.*

These relays have metal front panels which are connected through printed circuit board runs and connector wiring to a terminal at the rear of the relay case. The terminal is marked "G". In all applications this terminal should be wired to ground.

FAST-RESET terminals 15 and 16 are provided for use during testing or for special applications. A momentary contact closure will fully reset the relay overload memory. CAUTION: *the overload (49) unit will be inoperative whenever terminals 15 and 16 are connected; therefore, if a contact is used, it must provide only a momentary closure.*

Control power polarity must be observed for relays rated for use on dc control. For relays rated for ac control voltage, it is preferred (but not required) that the grounded end of the supply be connected to terminal 8 and the hot side to terminal 7.

All units are supplied with an external power resistor mounted on the back of the relay and wired to terminals 9 and 10. This resistor must be connected for proper operation.

Operating Mode Selector Plug:
An internal RESET SELECT selector plug is provided to choose whether the relay output contacts will either latch(HAND reset) or reset automatically (SELF reset) after the relay has operated. All units are shipped with the contacts set in the self reset mode. If the contacts are set in the hand reset mode, the output contacts will latch and must be manually reset by depressing the target reset push button located on the front panel of the relay.

3. SETTINGS
CURRENT PICKUP TAPS

The tap block, located on the upper part of the front panel, is the "pickup" or "ultimate trip setting" for the OVERLOAD (49) unit. The settings are marked in ct secondary amperes.

By means of the screwdriver VERNIER adjustment next to the tap block, the relay effectively has a continuous range. With the vernier turned fully counterclockwise, pickup corresponds to the tap setting. As the vernier is turned clockwise, pickup increases, until at the fully clockwise position, pickup corresponds to the next highest tap value. With the tap pin in the highest position, the vernier also gives additional range equivalent to one tap position.

The tap pin may be moved with the relay in service. When the pin is pulled out, pickup switches to the maximum tap setting.

OVERLOAD (49 unit)
This is the time-dial setting for the overload unit of the relay. The dial is marked: 1, 2, 3, 4, 5. These marks correspond to the minutes required for the relay to trip with an applied input current of 2 times the pickup setting. The dial is continuously adjustable between 1 and 5. Refer to time-current curve 605838 on page 9. The time curves shown are labeled 1 through 5 corresponding to the dial position.

STALL (51 unit)
This is the time-dial setting for the locked rotor unit of the relay. The 51 unit has its pickup fixed at 3 times the relay tap setting. The STALL dial is marked: 5, 10, 15, 20, 30. These marks correspond to the seconds required for the relay to trip with an input current of 6 times the relay pickup setting. The dial is continuously adjustable between 5 and 30 seconds. See time-current curve 605837 on page 10.

FAULT (50 unit)
This is the pickup setting for the instantaneous unit of the relay. The dial is marked in multiples of the pickup setting of the relay. For example: with a tap setting of 3.1 amperes and the FAULT dial at 8 multiples, the pickup current is 3.1 X 8 = 24.8 amperes.
The dial is continuously adjustable from 4 to 16 multiples. See time-current curve 605837 on page 10.

4. INDICATORS

TARGETS

For the Type 49/50/51, operation targets are provided for the 49 and 50/51 functions. For the Type 49/50, targets are provided for the 49 and 50 functions; and for the Type 49, a target is provided for the 49 function. Control power must be present to reset the targets, and the overload unit must be in a "thermally-reset" condition.

PICKUP INDICATOR

A light-emitting-diode is provided to indicate when the input current is above the pickup setting. The led will flash on and off at a rate that is related to the current value: the higher above pickup, the faster the rate of flashing. With the OVERLOAD dial set at 1 minute, approximately 40 flashes will occur prior to a trip operation (assuming the relay was fully reset when the overload was applied). For a 5 minute setting approximately 200 flashes will occur.

IMPORTANT: the pickup indicating led is not an operation target. Once a trip occurs the state of the indicating led is indeterminate. It may go out or it may remain continuously lighted. The led will remain in that state until secondary current is re-established into the input of the relay. The relay is "timing-out" only when the led is flashing.

APPLICATION DATA

The ABB Circuit-Shield™ Type 49/50/51 three-phase Overcurrent Relay provides three important functions for the protection of motors: overload, locked rotor, and fault detection. Although packaged in one case, the three functions are individually adjustable, allowing optimum protection without compromise among the various elements. Settings are easily made with all adjustments on the front panel of the relay.

OVERLOAD PROTECTION (Function 49)

The overload function has time-current curves which match the allowable heating times of typical motors, thus allowing use of the full capability of the machine, without the risk of damage due to continuous or repetitive overloads. The time-current curves are given in 605838, on page 9.

Unlike bi-metals or other thermal type relays, the Type 49 element has memory of previous overloads with long reset time; long enough to ensure proper protection in applications involving repetitive overloads and hard starts. If a second overload occurs before the full reset of the memory, the relay will trip in a time shorter than shown by the current curves. This relationship may be expressed by the equation below, which is a rough approximation. For more accurate information, please contact the factory.

$$T_2 = 1 - T_1 + \frac{T_{12}}{T_R} \quad \text{(Valid when } T_2 \text{ less than 1)}$$

where T_R is the time in minutes required for a specific time dial setting:

Time Dial	1	2	3	4	5
T_R	2.4	4.8	7.2	9.6	12

T_2 is the time required for the second overload to cause the relay to trip, as a fraction of the value read from the time current curve.

T_1 is the time for which the first overload lasted, expressed as a fraction of the time allowed by the time-current curve. For example, with the relay set on time dial #1, if the first overload was 2 times pickup and lasted 20 seconds:

$$T_1 = \frac{20}{60} = \frac{1}{3} \quad \text{(for time dial \#1)}$$

T_{12} is the time between removal of first overload and application of the second, in minutes.

Solutions to the equation yielding values greater than 1 are not valid, and should be set equal to 1.
Note that the solution is in terms of the time required for a trip. There is no requirement that the second overload be the same magnitude as the first. For example if the second overload is 2X pickup, and T_2 was calculated as 100%, then the second overload can last as long as 60 sec. (using time dial #1), before a trip occurs. However, if the second overload happens to be 4X pickup, it can only last 16 seconds or a trip will occur. The minimum interval between overloads may be calculated by setting $T_2 = 1$; then $T_{12} = T_1 T_R$. Another example is shown graphically in Fig. 5 for a repetitive overload of 200% tap value, with the 49 unit time dial set at 2 minutes.

LOCKED ROTOR PROTECTION (Function 51)

This element is designed to provide stalled rotor and high-overload protection. The shape of this curve accommodates both full and reduced voltage starts. The time delay is adjustable from 5 to 30 seconds at 6 times the overload setting, allowing its use even with motors having very long starting times.

PHASE FAULT PROTECTION (Function 50)

This instantaneous element is adjustable from 4 to 16 multiples of the overload unit setting. The operating time of this unit is such that on fused motor starters the relay will trip before the fuse opens on low grade faults, thus saving fuses, but the fuse will be faster than the relay for faults above the interrupting capability of the starter.

COMPOSITE CHARACTERISTIC

An example of the composite Time-Current Tripping Characteristic for a relay equipped with the 49, 50, and 51 elements is given in Figure 6. For this example the relay settings are: pickup tap at 120% of motor full load current; time dial (49) set at 2 minutes; time dial for stall unit at 5 seconds; and instantaneous pickup at 7.2 times full load amperes.

CHARACTERISTICS OF COMMON UNITS

Relay Type	Function	Connection Diagram	Control Voltage	Catalog Number
49	Overload	16D414B	24 Vdc	414A0096
			48 Vdc	414A0036
			110 Vdc	414A0006
			125 Vdc	414A0046
			220 Vdc	414A0026
			250 Vdc	414A0056
			120 Vac	414A0066
49/50	Overload, Fault	16D414B	24 Vdc	414B0096
			48 Vdc	414B0036
			110 Vdc	414B0006
			125 Vdc	414B0046
			220 Vdc	414B0026
			250 Vdc	414B0056
			120 Vac	414B0066
49/50/51	Overload, Fault, Locked Rotor	16D414B	24 Vdc	414C0096
			48 Vdc	414C0036
			110 Vdc	414C0006
			125 Vdc	414C0046
			220 Vdc	414C0026
			250 Vdc	414C0056
			120 Vac	414C0066

SPECIFICATIONS

INPUT CIRCUIT

Rating:	3 multiples of tap setting – continuous 200 amperes – 1 second (5 amp unit) 40 amperes – 1 second (1 amp unit)
Frequency:	50/60 Hz.
Burden:	0.02 ohms, resistive (5 amp unit) 0.10 ohms, resistive (1 amp unit)
Pickup Taps:	2.5, 2.8, 3.1, 3.5, 4.0, 4.5 (5 amp unit) 0.5, .56, .62, 0.7, 0.8, 0.9 (1 amp unit)

TOLERANCES

Pickup: +/- 10% of setting.
Operating Time (49/51): +/- 10% of setting.

Note: tolerances shown are with respect to printed dial markings on the relay. Final operating values may be set by test using pickup vernier and time dials.

TEMPERATURE RANGE

Nominal:	25 degrees C ambient
Additional +/ - 5% tolerance:	-15 to +55 degrees C
Must operate:	-30 to +70 degrees C

OUTPUT CONTACTS (Link Selectable For Hand Reset Or Self Reset)

Each contact at	120 vac:	at 125 vdc:	at 250 vdc:
Tripping:	30 amperes	30 amperes	30 amperes
Continuous:	5	5	5
Break:	2	0.3	0.1

For units with selector link in the hand-reset position, the contacts are reset by pressing the TARGET RESET pushbutton. If the contacts do not reset at that time, additional time must be allowed for motor cooling.

CONTROL VOLTAGE

See relay nameplate for rating. Models available for:

120 vac	50/60 hz,	0.07 amp max.
125 vdc	(100-140 range)	0.07 amp max.
110 vdc	(88-125 range)	0.07 amp max.
220 vdc	(175-246 range)	0.07 amp max.
24 vdc	(19-29 range)	0.15 amp max.
250 vdc	(200-280 range)	0.08 amp max.
48 vdc	(38- 58 range)	0.08 amp max.

IMPORTANT: OBSERVE CT POLARITY

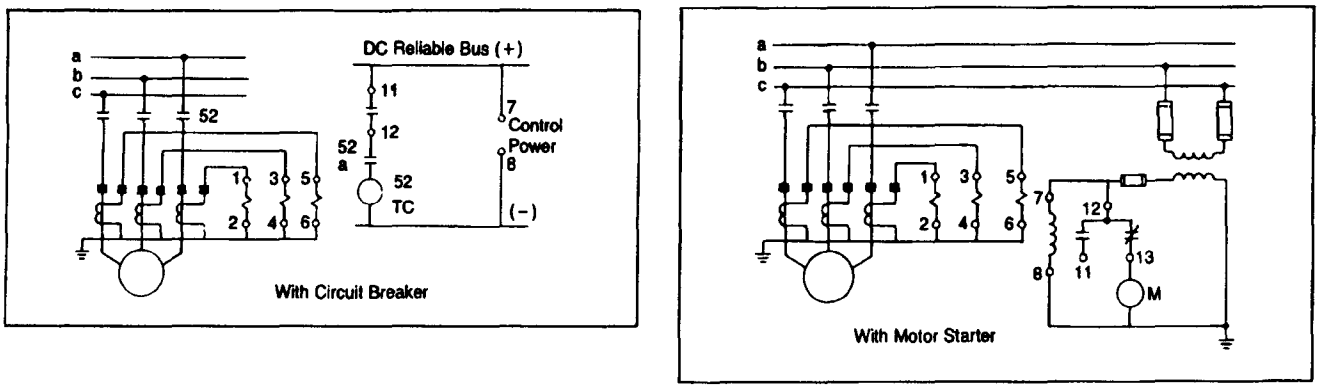


Figure 1: Typical External Connections

16D414B Motor Overload Relay
Types 49, 49/50, 49/50/51
Drawout Test Case

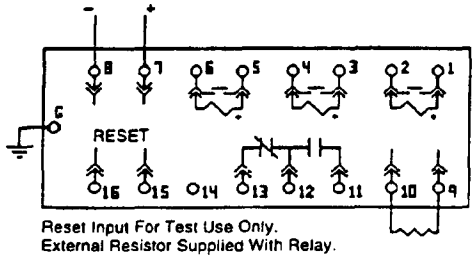


Figure 2: Internal Connections

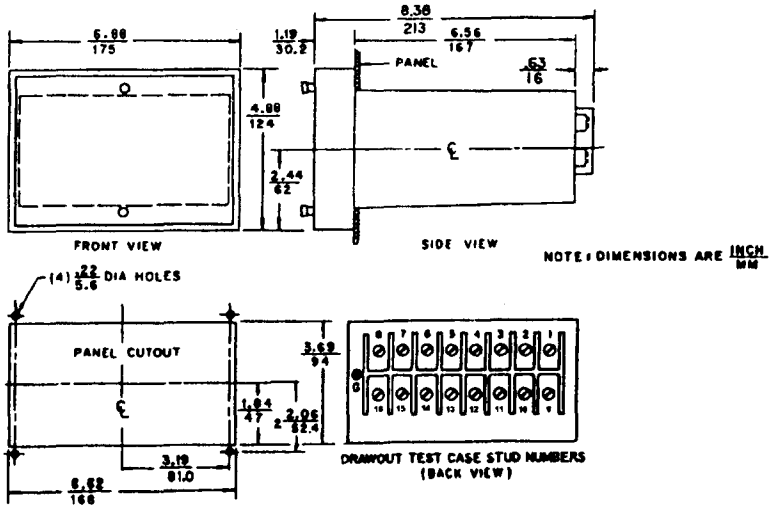


Figure 3: Relay Outline and Panel Drilling

Figure 4

Type 49
Allowable Time Between Overloads
for a 2 Minute Curve

Trip Times in Percent of Times
from Time-Current Curves

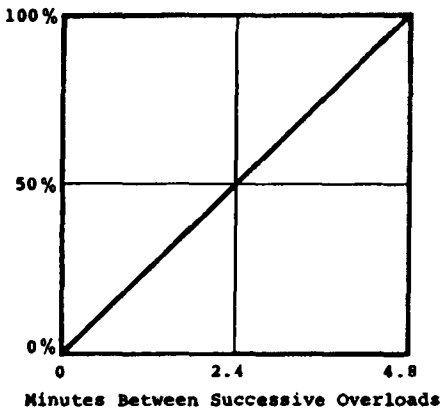


Figure 6
Example
Type 49/50/51 Composite Motor Protection

Overload Unit Set at 1.2 times full load amps.
Locked Rotor Unit set at 5 second curve.
Instantaneous Unit Set at 7.2 times full load amps

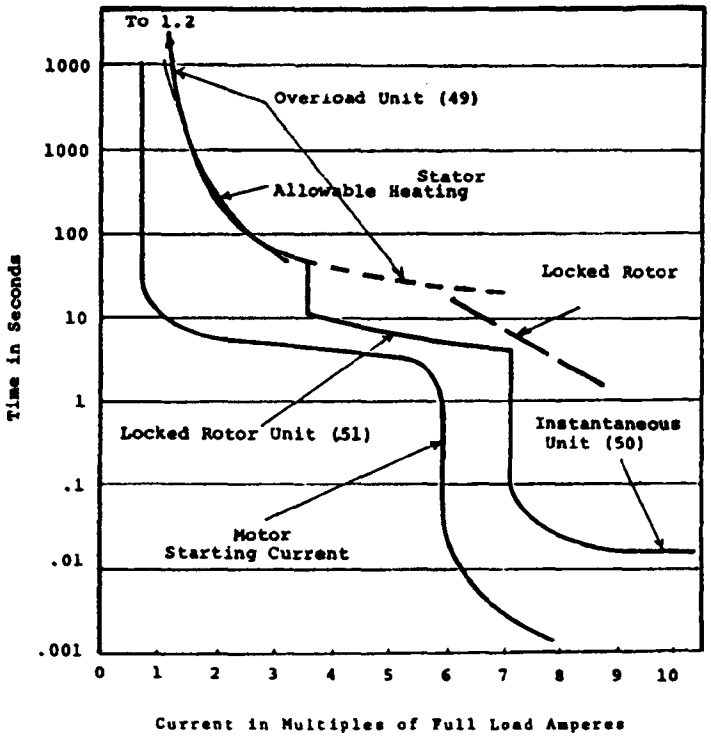
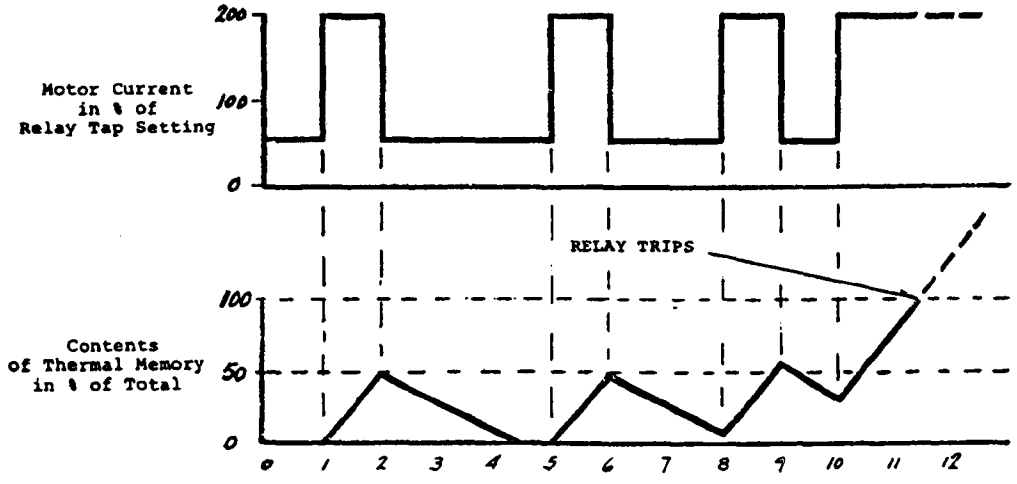
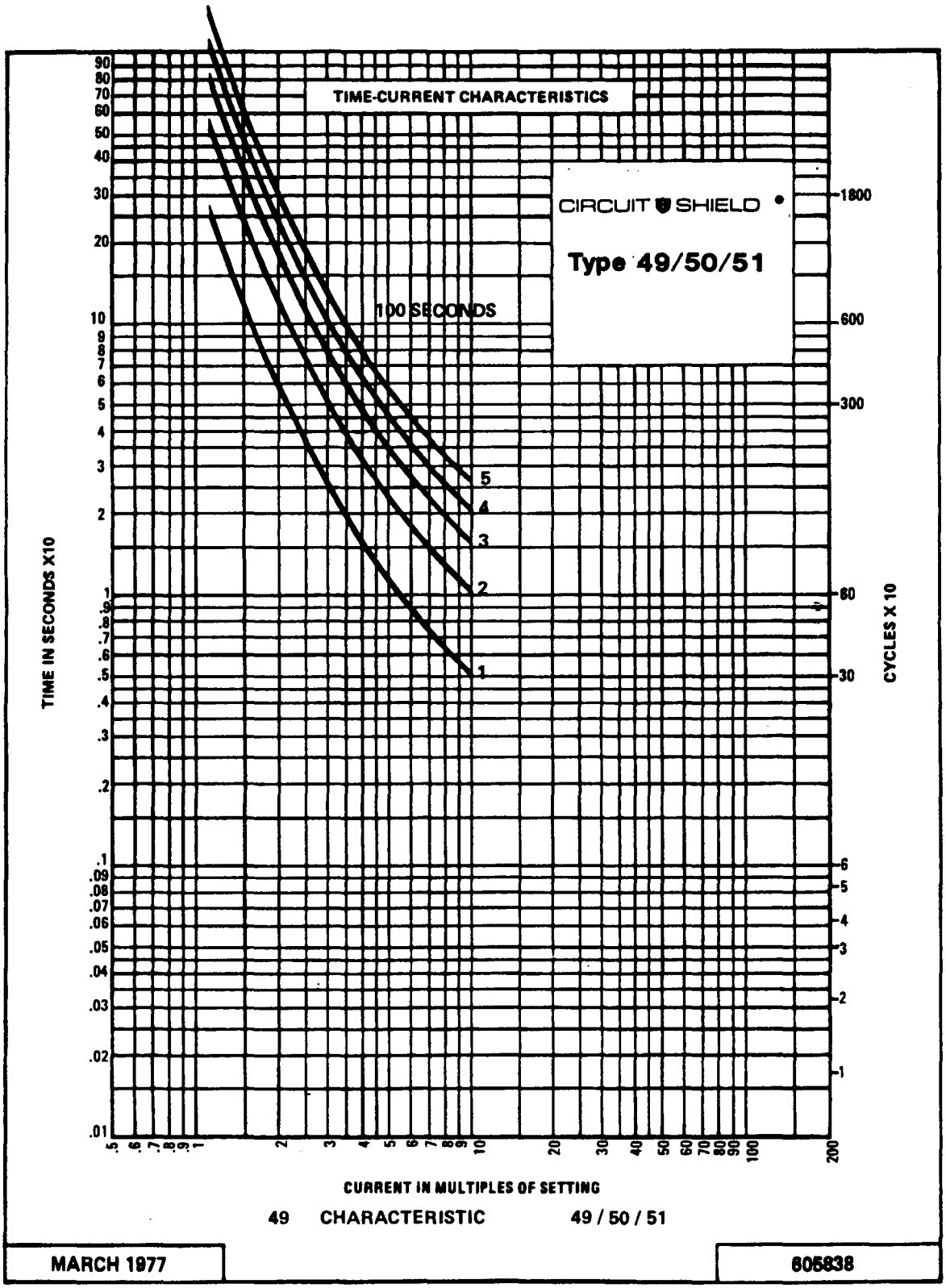
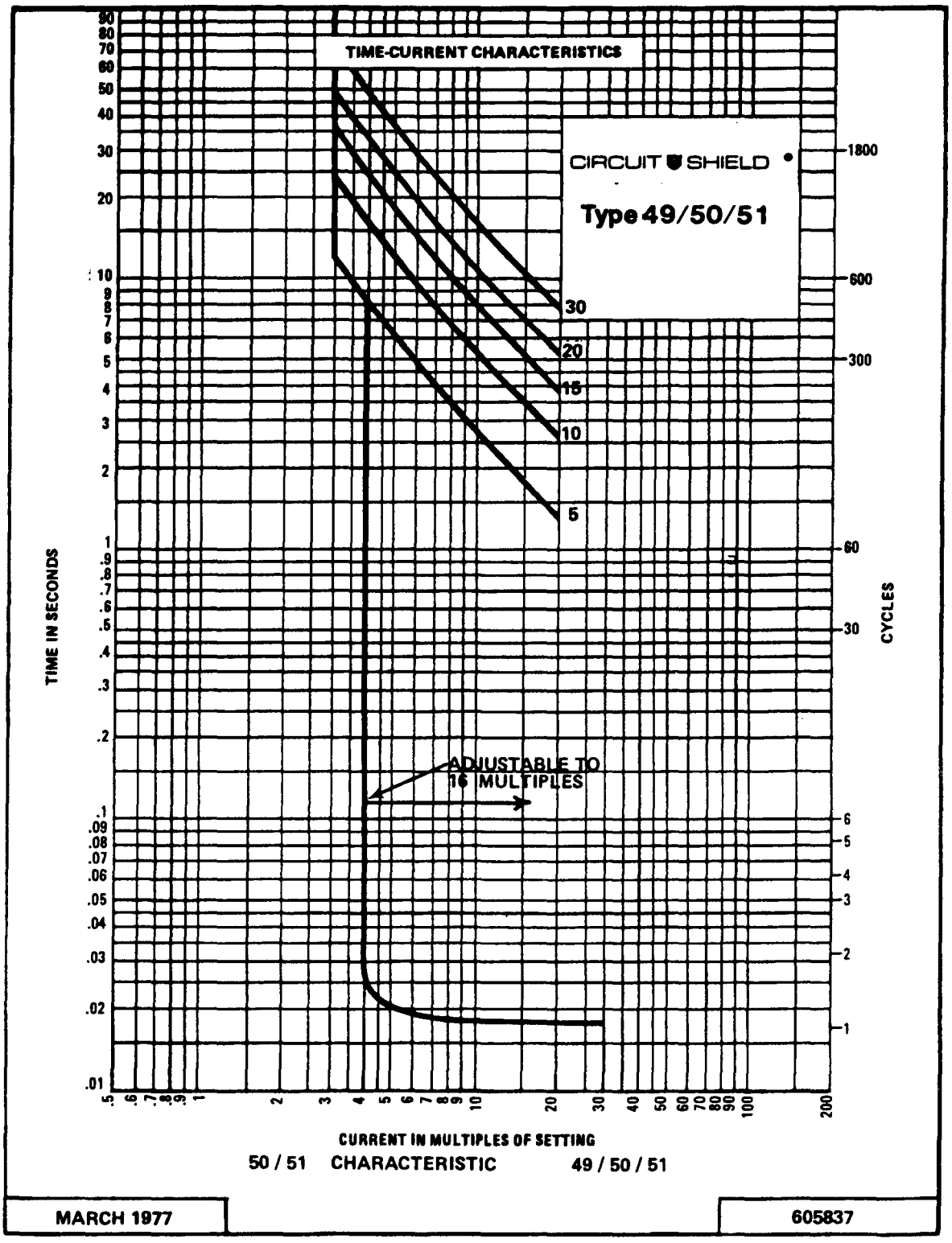


Figure 5
Example
Type 49
Typical Operation of Thermal Memory Unit
2 Minute Time Dial





Note: Full size transparencies available on request from the factory.


TIME-CURRENT CHARACTERISTICS
CIRCUIT SHIELD
Type 49/50/51
30
20
15
10
5
ADJUSTABLE TO
16 MULTIPLES
TIME IN SECONDS
CYCLES
CURRENT IN MULTIPLES OF SETTING
50 / 51 CHARACTERISTIC
49 / 50 / 51
MARCH 1977
605837

TESTING

1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on the Type 49/50/51 relays. Follow test instructions to verify that the relay is in proper working order. We recommend that an inoperative relay be returned to the factory for repair; however, a schematic diagram will be provided on request. Renewal parts will be quoted by the factory on request.

214 Series Units

Drawout circuit boards of the same catalog number are interchangeable. Also units with catalog numbers of the form 214xxxx2 may replace units with catalog numbers the same except of the form 214xxxx1 (hand-reset units),where all digits except the last are identical. Similarly, units of the form 214xxxx3 may replace units of the form 214xxxx0 (self-reset units). A unit is identified by the catalog number stamped on the front panel and the serial number stamped on the bottom side of the drawout circuit board.

The board is removed by using the metal pull knobs on the front panel. Removing the board in service does not open circuit the CT's; however, in applications using the normally closed contact, *a trip will result.*

An 18 point extender board (cat 200X0018) is available for use in troubleshooting.

414 Series Units

Metal handles provide leverage to withdraw the relay assembly from the case. Removing the unit in an application that uses the normally closed contact will cause a trip. The assembly is identified by a catalog number stamped on the front of the unit and a serial number stamped on the bottom of the board.

Test connections are readily made to the Drawout relay unit by means of standard banana plugs. Current connections are made to the vertical posts at the blade assemblies. Control power and output connections are made at the rear vertical circuit board. This rear board is marked for easier identification of the connection points.

Should separation of the upper and lower circuit boards be needed, remove (2) screws that attach the left and right handle assemblies to the upper printed circuit board. The lower board may then be withdrawn forward from the printed circuit connector. An 18 point extender board (cat. 200X0018) is available from the factory if access to the lower circuit board is required for troubleshooting.

A test plug assembly, catalog 400X0001 is available for use with the 414 series units. This device plugs into the relay case on the switchboard and allows access to all external circuits wired to the case. See Instruction Book IB 7.7.1.7-8 for details on the use of this device.

2. HIGH POTENTIAL TESTS

High potential tests are not recommended. A hi-pot test was performed at the factory before shipping. If a control wiring insulation test is required, partially withdraw the relay unit from the case sufficient to break the rear connections before applying the test voltage.

3. BUILT-IN TEST FEATURE

Tests should be made with the main circuit de-energized.

A built-in trip test feature is provided as a convenient means of testing the operation of the relay and the associated trip circuit. Be sure to record or mark the relay settings before proceeding, so you can easily return to the proper settings at the end of the procedure.

To check the FAULT (50) function, set the Fault dial at 4 multiples. Press the TRIP test button. The relay should trip instantaneously and display the (50) target.

To check the STALL (51) function, set the Fault dial at 8 multiples (or higher) to avoid instantaneous operation. Set the Overload dial at 5 to avoid overload operation. Depress and hold the TRIP button. The relay should operate in approximately the time in seconds set on the Stall dial and a target should be displayed for the 51 function. (The pickup led should flash during this test, indicating proper operation of the overload unit.)

The above tests are quick functional checks that can be performed without test equipment. High accuracy should not be expected.

RETURN ALL SETTINGS TO ORIGINAL VALUES.

4. ACCEPTANCE TESTS

A typical test circuit for use with a single-phase test current source is shown in Figure 7. The test current connections must be as shown. Also, since the relay is designed for three-phase applications and responds to the average of the 3 phase currents, a test current correction must be made for single-phase testing: the test current source must be set to 1.5 times the desired test current to obtain the correct response. (If a three-phase test source is available, no correction would be required). Apply proper control power per the nameplate rating of the relay.

Thermal memory considerations: when control power is initially applied to the relay, the thermal memory is set at approximately half-way to the trip point. Therefore, during testing it is preferable that the control power be applied continuously. Also, terminals 15 and 16 should be momentarily shorted prior to any timing test of the overload (49) element, to insure that the thermal memory is fully reset.

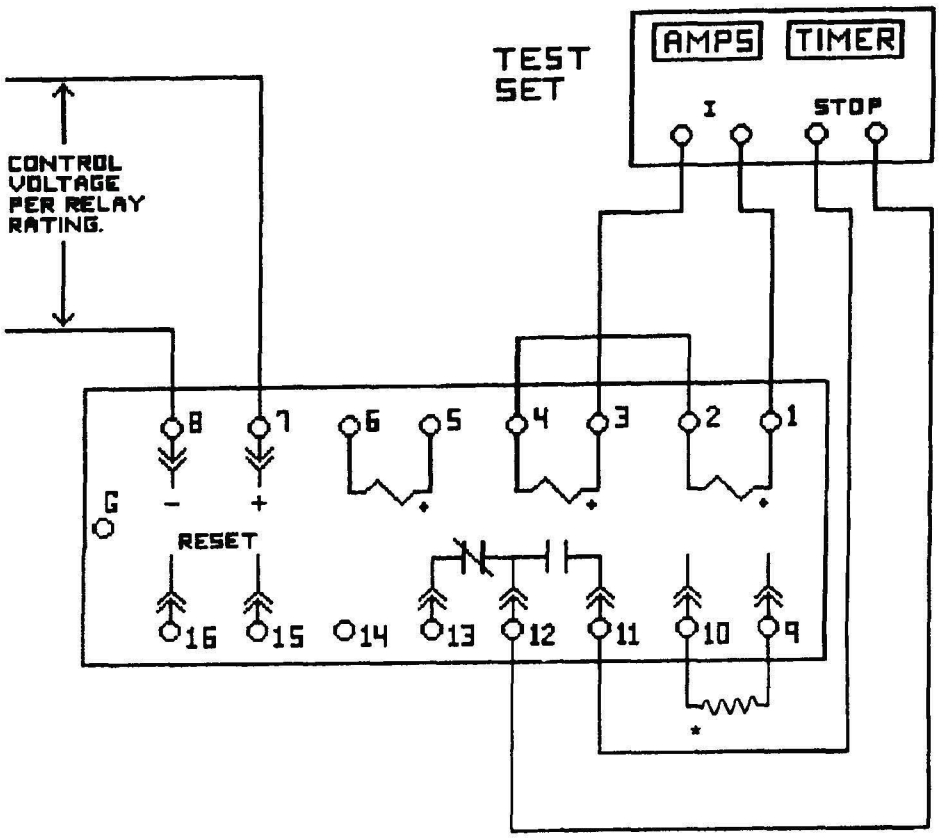
Interaction Between Elements: some settings and test currents may cause the relay to trip on a function other than that expected. Check the time-current curves for the planned test current level and time-dial settings prior to running a test. Usually one or more dials can be set temporarily higher to avoid such interaction.

Pickup test: set the desired tap (use 2.5 if none specified). The vernier should be fully counterclockwise. Increase the test current slowly until the pickup lamp begins flashing. Note the test current (Remember the 1.5x factor when testing with a single-phase source). Pickup should be within +/-10% of the tap setting (3.37 - 4.13 amperes if the 2.5 ampere tap is used with single-phase testing). Pickup may then be set exactly to the desired value using the vernier adjustment.

Fault Unit (50): set the Stall dial to maximum. Set the Fault dial to the desired setting (use 8x it none specified). Increase the current quickly to determine the instantaneous unit pickup current. Do not apply high currents more than a few seconds due to the thermal stress. If the unit does not trip immediately remove the test current and review your procedures. (Remember the 1.5x factor when testing with a single-phase source). The setting may be trimmed as necessary to obtain the required operating value. (If a setting of less than 6x is to be used, the final adjustment must be deferred until the stall function is checked). Timing tests of the Fault element are not recommended due to the difficulties in controlling and measuring very short times. If a timing test must be run, preset the test current for 2 times the fault element pickup setting. Operating time of 0.03 seconds or less is acceptable.

Stall Unit (51): set the Fault dial at 8x or higher. Set the Overload dial at 5. Set the Stall dial to the desired delay. (Use 10 seconds if none specified). Momentarily short terminals 15-16 to reset the overload unit. Apply a test current of 6x the overload pickup setting. (Remember the 1.5x factor when testing with a single-phase source). The relay should trip on the 51 function within +/-10X of the setting. (9-11 seconds if set at 10). If the required setting is known the final timing adjustment may be made using the time-dial and repeating the test.

Overload Unit (49): set the test current to 2x the pickup value. (Remember the 1.5x factor when testing with a single-phase source). Set the overload time-dial to the desired setting. (Use #1 dial if none specified). Reset the thermal memory. Apply the test current. The relay should time out within +/-10% of the value shown on the overload curve 605838 (54 - 66 seconds if dial # 1 used). If the required setting is known, the final timing adjustment may be made using the time-dial and retesting.



* Resistor supplied with Relay

Figure 7: Typical Test Connections

Notes:

1. For single-phase testing as shown, adjust current to 1.5 times desired test current level.
2. Momentary current closure across terminals 15 to 16 fully resets memory circuit of the (49) overload function.

OBSOLETE UNITS -- CATALOG SERIES 214A, 214B, 214C

The relays referenced here are obsolete and no longer in production. They have been superseded by the improved series 414A, 414B and 414C units covered by this instruction book. The information that follows is a guide to these older units, especially in the event you are replacing one with the newer relay.
Drawout circuit boards of the same catalog number are interchangeable. Also units with catalog numbers of the form 214xxxx2 may replace units with the same catalog number of the form 214xxxx1 (hand-reset units), where all digits except the last are identical. Similarly, units of the form 214xxxx3 may replace units of the form 214xxxx0 (self-reset units). A unit is identified by the catalog number stamped on the front panel and the serial number stamped on the bottom side of the drawout circuit board. The major difference between the 214xxxx0, 214xxxx1 series and the 214xxxx3, 214xxxx2 series unit is that the latter models use hermetically sealed output trip contacts.

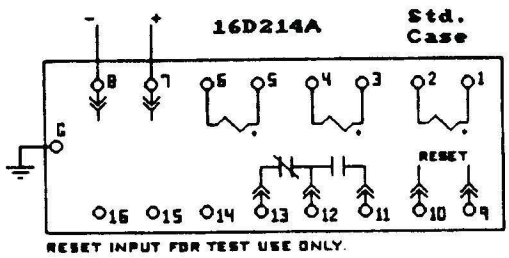
CATALOG SERIES 414A00x6, 414B00x6, 414C00x6

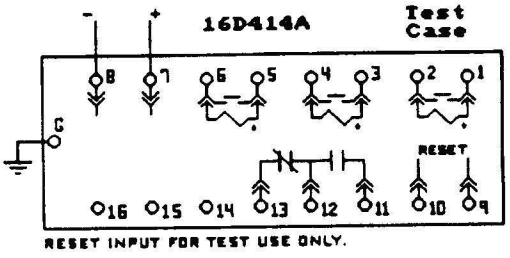
The 414A, 414B and 414C series units with catalog numbers ending with the digit "6" have been designed to provide a field selectable link for changing the output contacts to either "self-reset" or "manually reset". Earlier models had to be purchased with preselected output contact modes.
Drawout circuit boards are *not interchangeable* between the 414xxxx2,3 or the 414xxxx6 series. However, the rear terminal connections are the same for all three series, therefore, the entire relay including the case assembly may be replaced with no change in the external wiring.

The following is a list of recommended replacement units for the older models:

Old models			New models	
214A00x1	214A00x0	16D214A	414A00x6	16D414B
214B00x1	214B00x0	"	414B00x6	"
214C00x1	214C00x0	"	414C00x6	"
214A00x2	214A00x3	16D214A	414A00x6	16D414B
214B00x2	214B00x3	"	414B00x6	"
214C00x2	214C00x3	"	414C00x6	"
414A00x2	414A00x3	16D414A	414A00x6	16D414B
414B00x2	414B00x3	"	414B00x6	"
414C00x2	414C00x3	"	414C00x6	"

Note: To complete the catalog number for the above relay list, the "x" must be replaced by a control voltage digit.
Control voltage: x = 0 for 110 Vdc x = 5 for 250 Vdc
= 3 for 48 Vdc = 6 for 120 Vac
= 4 for 125 Vdc





Note: Units rated for 250 Vdc control are supplied with a 8200 ohm, 25 watt resistor connected to terminals 14 and 15. This resistor must be connected to these rear terminals for proper relay operation.