ABB

IB 7.9.1.7-2
Issue C

INSTRUCTIONS

Loss of Excitation Relay

CIRCUIT SHIELD ®

Type 40

Catalog Series 426

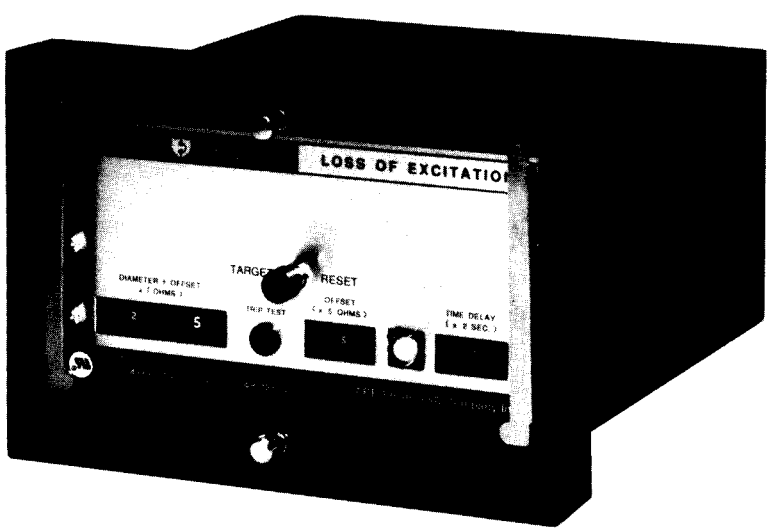


TABLE OF CONTENTS

Introduction.....Page 2
Precautions.....Page 2
Placing Relay into Service.....Page 3
Application Data.....Page 4
Maintenance and Testing.....Page 9
Catalog Series 226 Units.....Page 14

INTRODUCTION

These instructions contain the information required to properly install, operate, and test the ABB Circuit-Shield ™ Type-40 Loss of Excitation Relay, Catalog Series 426.

The Type 40 is housed in a relay case suitable for conventional semi-flush panel mounting. The unit is of 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 dis-connects eliminate any possibility of nuisance tripping during withdrawal or insertion of the relay if the normally open contact is used in your scheme. All connections to the relay are made at terminals located on the rear of the case and clearly numbered.

The impedance and time settings are located on the front panel behind a removable clear cover. Provisions for a meter seal are included. A target indicator is also mounted on the front panel. The target is reset by means of a push-button extending through the cover. Control voltage must be present to reset the target.

Earlier models of the Type 40, catalog series 226 are covered in IB 7.9.1.7-1. Note that if a 426 series unit is used to replace a 226 unit, the connections to the rear terminals are not the same. See reference information on page 14.

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 before energizing. Be sure that the control voltage is applied in the correct polarity.

2. Apply only the rated control voltage marked on the front panel.

For relays with dual-rated control voltage, the control voltage selector plug located on the lower circuit board MUST be placed in the correct position for the system control voltage. For the Type 40 relay it will be necessary to separate the lower board from the upper. See section on connections.

3. The entire assembly of the relay is removable. This assembly should insert smoothly. Do not use excessive force.

4. Follow test instructions to verify that the relay is in proper working order. If a relay is found to be inoperative we suggest that it be returned to the factory for repair. However, by specifying the relay catalog number, a schematic may be obtained through your local sales engineer should you desire to repair the relay.

5. CAUTION: *since troubleshooting entails working with energized equipment, caution 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 Asea Brown Boveri. Keep the relay clean and dry and use normal care in handling to avoid mechanical damage.

2. INSTALLATION

MOUNTING:

The outline dimensions, panel drilling and cutout information is given in Figure 1.

CONNECTIONS:

Typical connection diagrams are shown in the APPLICATION section.

A movable link on the vertical rear circuit board (inside surface) allows you to choose a normally open (NO) or normally closed (NC) contact for rear terminals 15 – 16.

Special care should be taken to connect control power in the proper polarity.

For relays with dual rated control voltage, the control voltage selector link located on the lower circuit board must be placed in the correct position for the system control voltage. For the Type 40 relay it will be necessary to separate the lower board from the upper to gain access. 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. Reverse the procedure to reassemble.

The Type 40 has a metal front panel which is connected through printed circuit board runs to a rear terminal marked "G". In all applications this terminal should be wired to ground.

3. SETTINGS

DIAMETER + OFFSET

Referring to the relay characteristic shown in Fig. 2, this group of 2 thumbwheel switches sets the magnitude of the impedance X_1. This setting is direct reading in ohms, and a range of 10 – 159 ohms in 1 ohm steps is provided. Settings below 10 ohms should not be used.

OFFSET

Referring to the relay characteristic, this thumbwheel switch sets the magnitude of the impedance X_2. The magnitude of X_2 in ohms is equal to ONE HALF the setting on the thumbwheels. The range of the setting switches is 0 – 15, which gives an impedance range of 0 - 7.5 ohms. The 0 setting should generally not be used.

TIME DELAY

This thumbwheel switch sets the operating time of the relay. The time delay in seconds is equal to 0.2 times the setting on the thumbwheels. The range of the setting switches is 0 – 15, which gives a time delay range of 0 – 3 seconds. The 0 setting must not be used.

CAUTION
The setting switches should not be changed with the relay in service. An incorrect trip may occur.

APPLICATION DATA

The ABB Circuit-Shield™ Type 40 is an offset mho impedance relay used for loss of excitation protection of a generator operating in parallel with other system generators.

Loss of excitation can be detrimental to the system as well as to the affected machine. Depressed internal voltage causes the machine to take VARS. The system generators must then supply the system deficit and the machine VARS as well. The decay of the internal voltage causes reduced power output. The resulting imbalance of mechanical input and electrical output causes machine acceleration, and ultimate loss of stability may occur.

The power swing due to loss of excitation is detected by the off set mho characteristic shown 1n Fig. 2. The apparent impedance viewed from the generator bus changes as a function of the advancing generator angle and reaches a value between the transient reactance X'_d and the synchronous reactance X_d of the generator. The Type 40 relay's characteristic encloses the area of final impedance and trips the unit upon detection of the condition.

A sample calculation for determining settings is given on page 8.

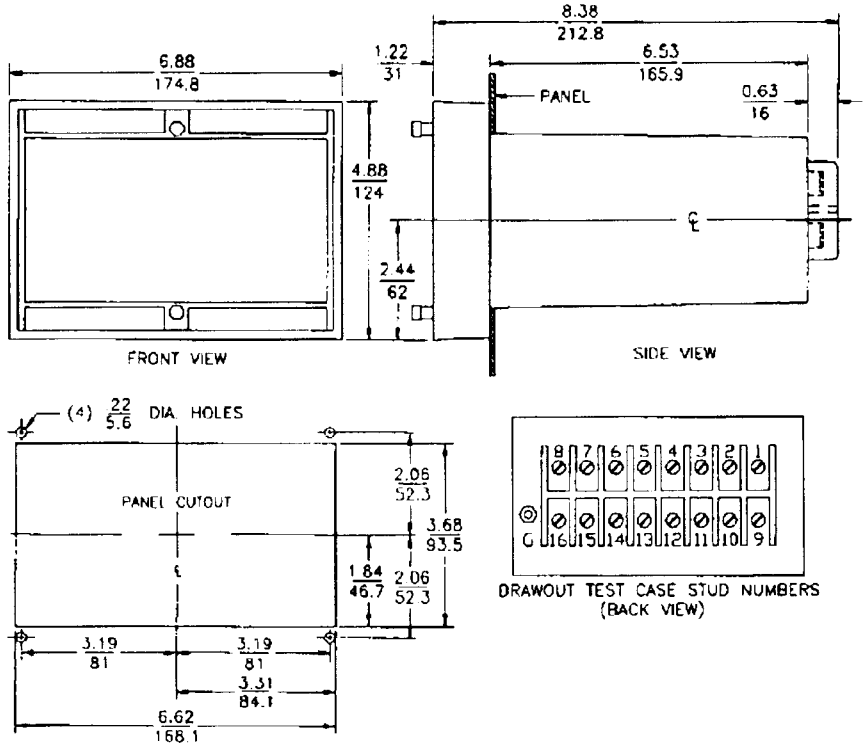


Figure 1: Relay Outline and Panel Drilling

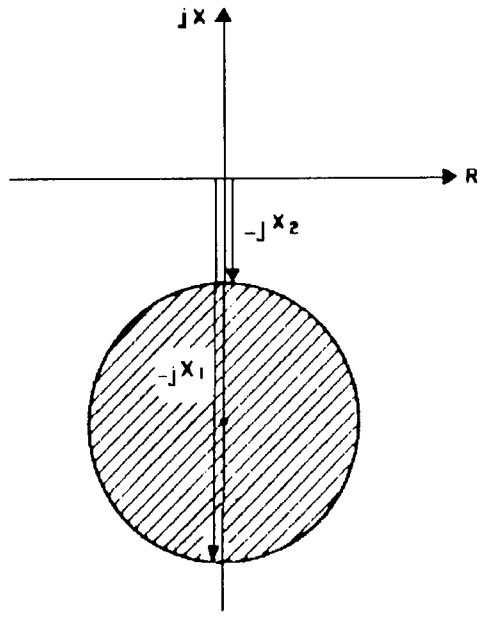


Figure 2: Type 40 Characteristic

SPECIFICATIONS

INPUT CIRCUIT RATING:	Potential – 120 Vac nominal, 208 Vac max. continuous Current – 5 amp nominal, 10 amp continuous, 200 amperes, one second. Models available for 50 Hz and 60 Hz.
BURDEN:	Potential – 0.3 VA at 120 V. Current – 0.7 VA at 5 A.
MHO CIRCLE ADJUSTMENT:	Diameter + Offset – 10 to 159 ohms in 1 ohm steps. Offset – 0 to 7.5 ohms in 0.5 ohm steps. (values are phase-to-neutral ohms)
TIMER:	0.2 to 3.0 seconds in 0.2 second steps.
CONTROL POWER:	models available for 48/125 Vdc at 0.06 ampere; 48/110 Vdc at, 0.06 ampere; 250 Vdc at 0.06 ampere; 220 Vdc at 0.06 ampere; 120 Vac at 0.03 ampere. (see page 13 for 24/32 Vdc) Allowable range: 48 Vdc nominal: 38 – 58 Vdc 110 Vdc nominal: 88 – 130 Vdc 125 Vdc nominal: 100 – 142 Vdc 250 Vdc nominal: 200 – 280 Vdc 220 Vdc nominal: 176 - 246 Vdc 120 Vac nominal: 100 – 135 Vac
OUTPUT CIRCUIT:	(1) normally open contact., and (1) selectable, normally open or normally closed. Selection by movable link inside relay.

OUTPUT CIRCUIT RATING:

Each contact at	125Vdc:	250Vdc:
Tripping Duty	30A	30A
Continuous	5A	5A
Opening	0.3A	0.1A

TEMPERATURE RANGE:	Minus 20 to +75 degrees C.
SEISMIC CAPABILITY:	6g ZPA biaxial broadband multi frequency vibration, (IEEE 501-1978), without damage or malfunction.
TRANSIENT IMMUNITY:	More than 2500V, 1Mhz. bursts at 400 Hz. repetition rate; fast transient test; EMI test.
DIELECTRIC:	2000 Vac. RMS, 60 seconds, all circuits to ground; 5 kV impulse test.
UL RECOGNIZED:	UL File No. E103204

Note: External resistor supplied on the rear of the relay case connected between terminals 9 & 10 must be in place for normal operation. (NOT required on units rated for 120 Vac control voltage.)

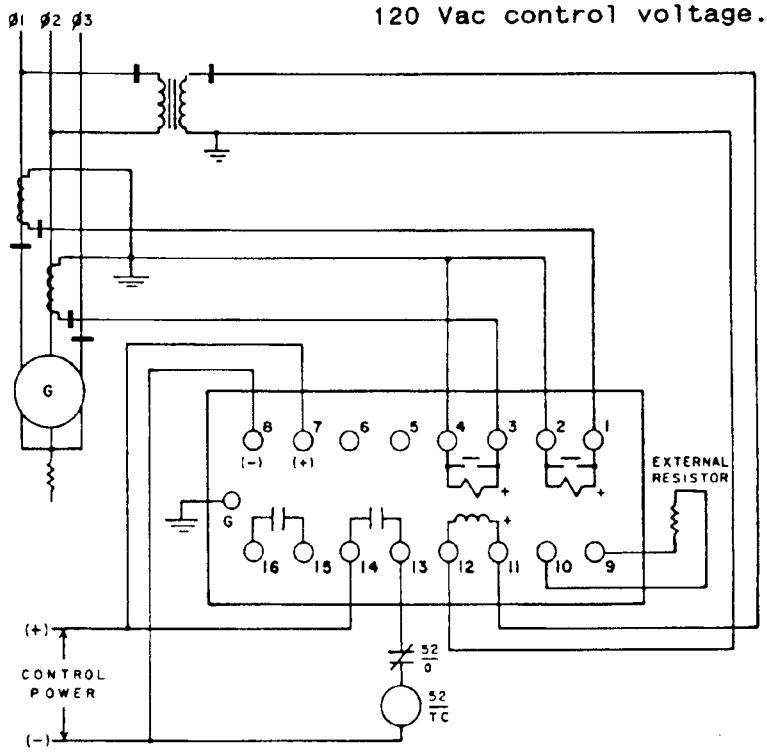


Figure 3: Typical Connections - Type-40 426 Series Units

Note: Contact at 15-16 can be converted to normally closed.

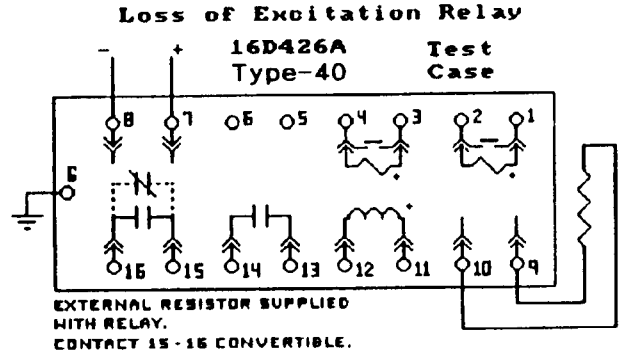


Figure 3a: Internal Connections for 426 Series Units

DETERMINATION OF SETTINGS

The mho characteristic with offset gives selectivity and security being unaffected by power swings and faults in the system.

For a generator directly connected to a bus, the OFFSET should be 1/2 the direct axis transient reactance, or 1/2X'd. Use the next highest available setting on the relay. The offset should never be set less than 0.5 ohms. The DIAMETER + OFFSET setting should be equal to the direct axis synchronous reactance of the machine X_d.

SAMPLE CALCULATION

Information Required	Assumed Values for Calculation
PT Ratio	13200 : 120 = 110 : 1
CT Ratio	3000 : 5 = 600 : 1
(Secondary ohms = primary ohms X CT Ratio / PT Ratio)	
Transient Reactance X'_d (percent)	20 %
Synchronous Reactance X_d (percent)	120 %
Generator Rating (MVA) (3 phase rating) (base rating of percent reactances)	50 MVA
Generator Rating (kV)) (base rating of percent reactances)	13.8 kV

Calculation	Results Using Assumed Data
1. T = CT Ratio / PT Ratio	1. 600 / 110 = 5.45
2. Base ohms (primary) = (kV)^2 / MVA	2. (13.8)^2 /50 = 3.81
3. Base ohms (sec) = T x base ohms (pri)	3. 5.45 x 3.81 = 20.8
4. X'_d (per unit) = X'_d (pct)/ 100	4. 20 / 100 = 0.2
5. X_d (per unit) = X_d (pct)/ 100	5. 120 / 100 = 1.2
6. X'_d (sec) = X'_d (pu) x base ohms (sec)	6. 0.20 x 20.8 = 4.16
7. Desired Offset = 1/2 X'_d	7. 0.5 x 4.16 = 2.08
8. X_d (sec) = Xd (pu) x base ohms (sec)	8. 1.2 x 20.8 = 24.96

SAMPLE CALCULATION (continued)

Relay Settings

Since the desired offset in our sample calculation is 2.08 ohms, we would set the relay at 2.5 ohms which is the next higher available setting. The OFFSET thumbwheel switch would be set at 5, which is equivalent to 2.5 ohms.

Since X_d is 24.96 ohms, we would set DIAMETER + OFFSET to 25 ohms. The thumbwheel switches would be set to 25.

The TIME DELAY setting should be determined by means of a stability study; however, 0.2 seconds would be a typical setting. A setting of 1 on the switch is equivalent to 0.2 seconds.

TESTING

1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on these 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 is available on request. Renewal parts will be quoted on request to the factory.

The Type 40 uses a control relay as the output stage. This relay may be ordered from the factory. A replacement target head assembly may be ordered should the target be mechanically damaged.

Drawout Unit

Drawout units of the same catalog number are interchangeable. Leverage to withdraw the unit is provided by the pivoting handles on the front panel. Removing or inserting a drawout unit in its case will not cause a nuisance trip if the normally open contact is used in your scheme. The drawout unit is identified by the catalog number on the front panel and a serial number stamped on the bottom of the circuit board.

Should separation of the upper and lower circuit boards be necessary, 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 is available from the factory if access to the lower circuit board is required during testing or troubleshooting.

Test Plug

A test plug assembly, catalog number 400X0001 is available for use with the 426 series relay. 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 the test plug.

2. HIGH POTENTIAL TESTS

Do not apply high voltage tests to solid-state relay circuits. If a control wiring insulation test is required, withdraw the unit from its case before applying the test voltage.

3. BUILT-IN TEST FEATURE

Tests should be made on a de-energized main circuit. If tests must be made on an energized circuit, be sure to take all necessary precautions. Control power must be available to test.

The built-in test is provided as a convenient functional test of the relay and associated trip circuit. When you depress the button labeled TRIP, the pickup circuit of the relay is actuated. The relay then times out, the output contacts operate to trip the associated breaker or auxiliary, and the target is displayed. The test button must be held down for the operating time set on the relay in order to obtain an operation.

4. ACCEPTANCE TESTS

Typical test circuit connections for checking the relay's characteristics are shown in Figure 4. 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. AC voltage, control power, and output connections are made at the rear vertical printed circuit board. This board is marked for easier identification of the connection points.

Note: in order to test the drawout unit, a resistor must be connected temporarily between terminals 9 and 10 on the rear vertical circuit board. The value of this resistor depends on the control voltage rating of the relay (refer to front panel). The value of the resistor is marked on the vertical circuit board. A 25 watt rated resistor is sufficient. If no resistor is readily available, the resistor assembly mounted on the rear of the relay case could be removed and used. Be *sure to remount the resistor on the case at the conclusion of testing*.

Acceptance test procedure:

1. Make relay settings:

DIAMETER + OFFSET = 20 (20 ohms)

OFFSET = 4 (2 ohms)

TIME DELAY = 1 (0.2 sec)

2. Apply proper DC control voltage.

3. Check impedance characteristic:

   a. Set current to 5.0 amperes.

   b. Adjust phase shifter or test source so that the current leads the voltage by 90 degrees (+/- 0.5 deg).

   c. Reduce the voltage to zero and close S1. Slowly increase the voltage. The relay should pick up at 9.5 – 10.5 volts. (10v / 5.0 a = 2.0 ohms)

   d. Continue to increase the voltage. The relay should drop out at 95 – 105 volts. (100v / 5.0 a = 20 ohms)

   e. Move current input connection to terminals 3 and 4 and repeat steps a. to d. (Reverse the leads as shown by dashed lines in Figure 4)

4. Check time delay:

   a. With 5.0 amperes current, set voltage at 50 volts. (This 10 ohm test point is within the circle.)

   b. Open S1 and reset the timer.

   c. Close S1. The relay should operate and stop the timer. The time delay should be 0.19 – 0.25 secs.

5. Other settings may be checked if desired:

   a. Test current should be selected between 2 and 20 amperes. Currents above 10 amperes should not be applied continuously.

   b. As the voltage is increased from 0 volts, the relay should trip at $V = I \times X_2$ (+/- 10%), and drop out at, $V = I \times X_1$ (+/- 10%), where X_2 is the OFFSET setting and X_1 is the DIAMETER + OFFSET setting.

   c. For time delay tests, select a test condition within the circle. The operating time should be equal to the setting in seconds +/- 3%, +50ms/-0ms. (The two tolerances are additive.)

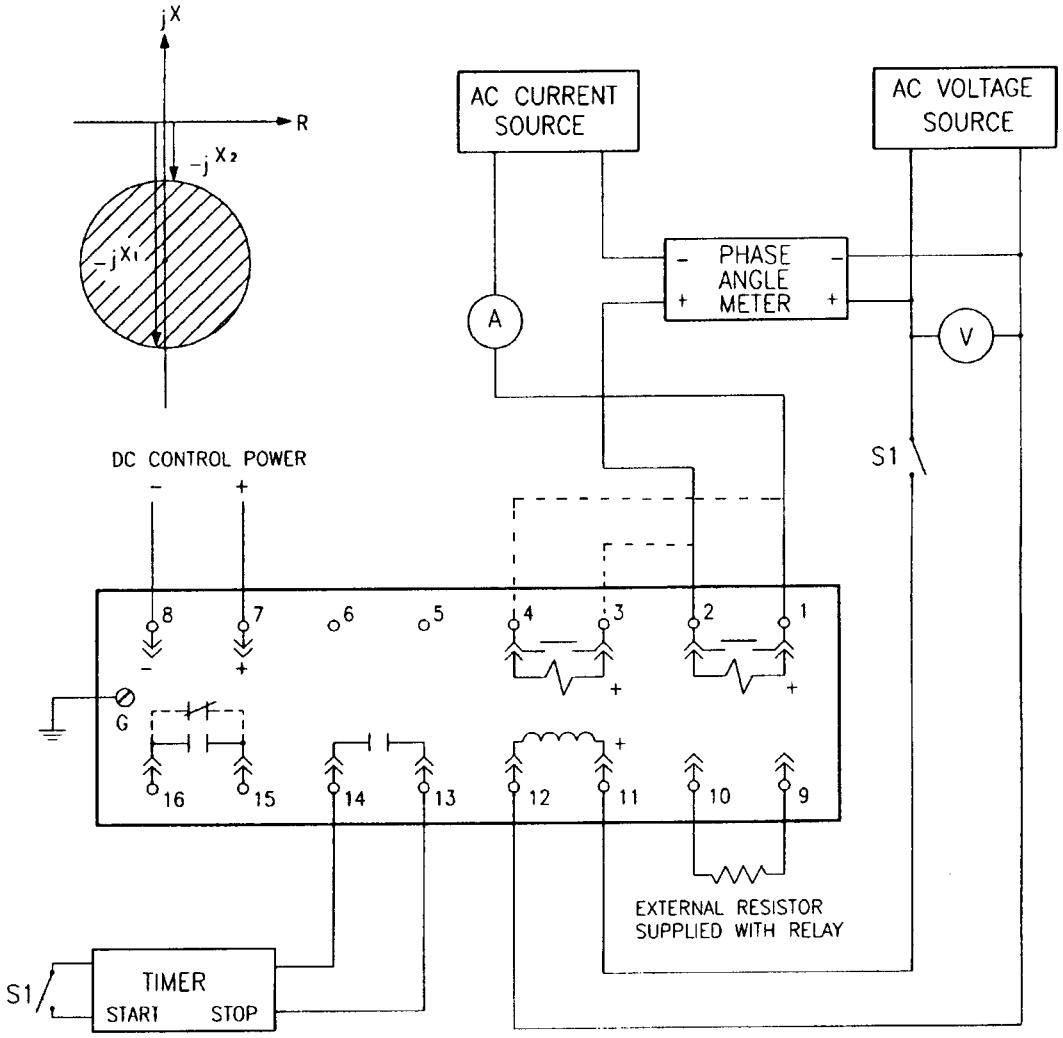


FIGURE 4: TYPICAL TEST CIRCUIT CONNECTIONS

NOTE: Reversal of current source leads required as shown by dashed lines when testing input at terminals 3 and 4.

NOTES ON THE USE OF 24VDC OR 32VDC CONTROL VOLTAGE WITH TYPE 40:

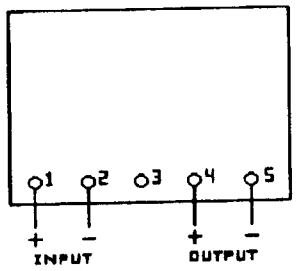
The Type 40 relay is not offered directly with a 24 or 32vdc control voltage rating. A separate dc:dc inverter is offered for either of these voltages. Select the Type 40 with 48vdc capability, and set the internal control voltage selector link to the 48vdc position. Choose the Type 96 dc:dc inverter to match the system control voltage. One inverter is needed for each Type 40 relay. Connect the system control voltage to the inverter input, and the 48vdc nominal inverter output to the Type 40 relay.

Be sure to observe proper polarity at both the inverter and relay inputs.

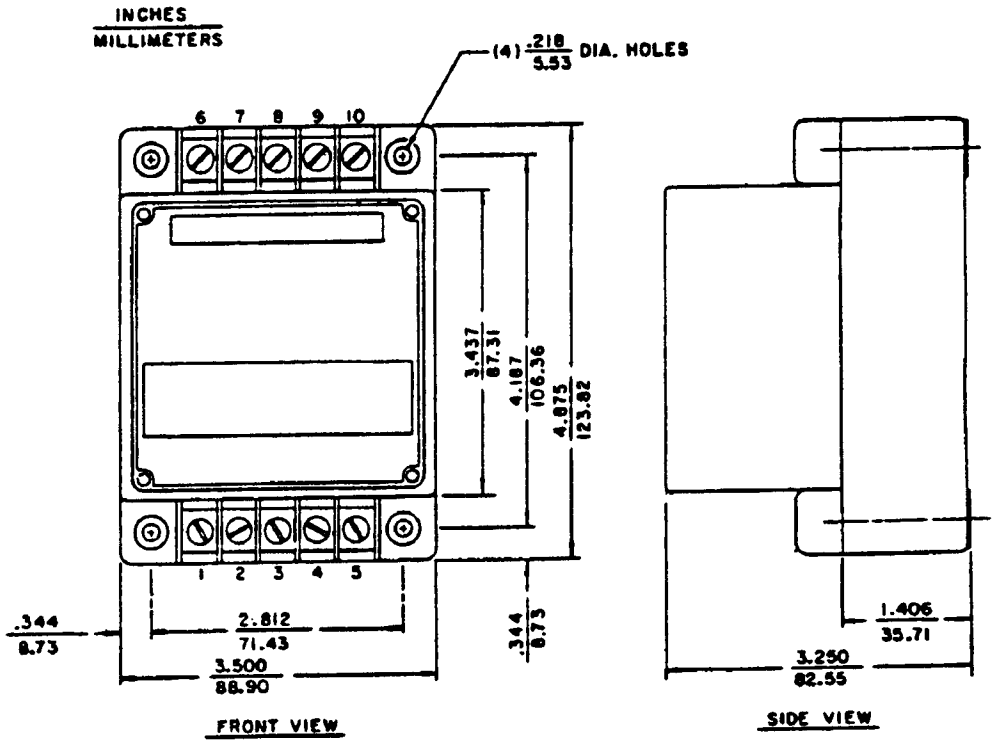
Type	Input Rating	Output Rating	Catalog
96	24vdc nominal	48vdc nominal	200P2448
	32vdc nominal	48vdc nominal	200P3248

DC - DC INVERTER
5S200A
TYPE 96

Type 96 Internal Connections



Type 96 Outline



TYPE 40 UNITS, CATALOG SERIES 226:

Units of catalog series 226 are functionally equivalent to the newer 426 series units covered by this instruction book.

Catalog series 226 units are of the older, partial drawout design. Units of catalog series 426 are preferred for new installations due to their improved test facilities.

In the event a 226 series unit must be replaced with a 426 series unit, the entire case assembly must be changed and wiring changes are necessary. The 426 case assembly mounts in the same panel cutout, as the 226 unit.

The following information is provided as a guide to selecting a replacement unit and to make the wiring changes:

Type	Frequency	Control Voltage	Catalog Numbers 226 Series	426 Series
40	60 Hz	48/125 Vdc	226E1170	426E1170
		48/110 Vdc	226E1100	426E1100
		250 Vdc	226E1150	426E1150
		120 Vac	226E1160	426E1160
	50 Hz	48/125 Vdc	226F1170	426F1170
		48/110 Vdc	226F1100	426F1100
		250 Vdc	226F1150	426F1150
		120 Vac	226F1160	426F1160

Diagram 16D226A

226 Series Units

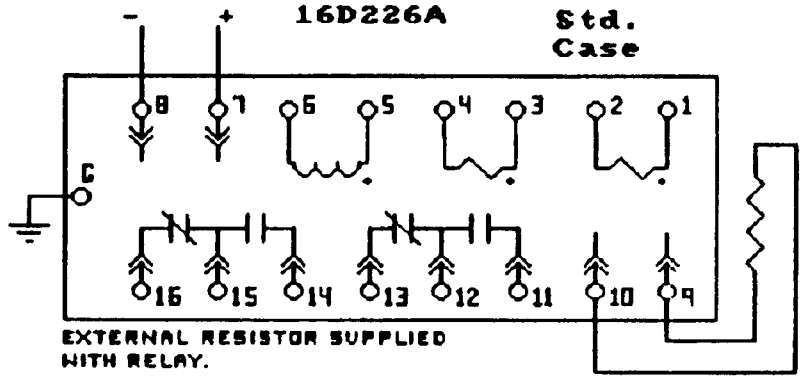
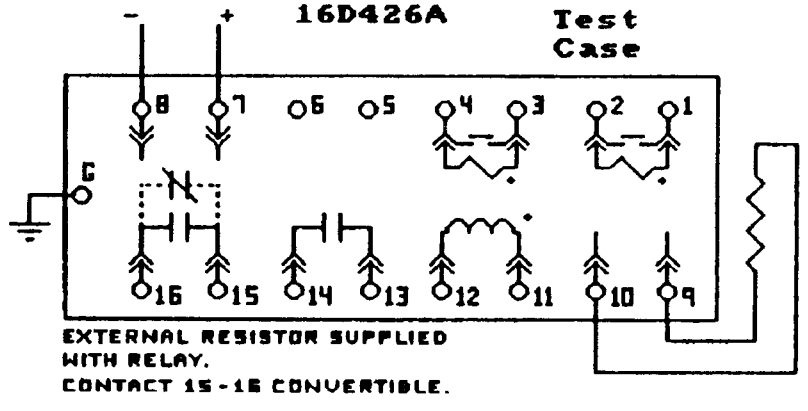


Diagram 16D426A

426 Series Units



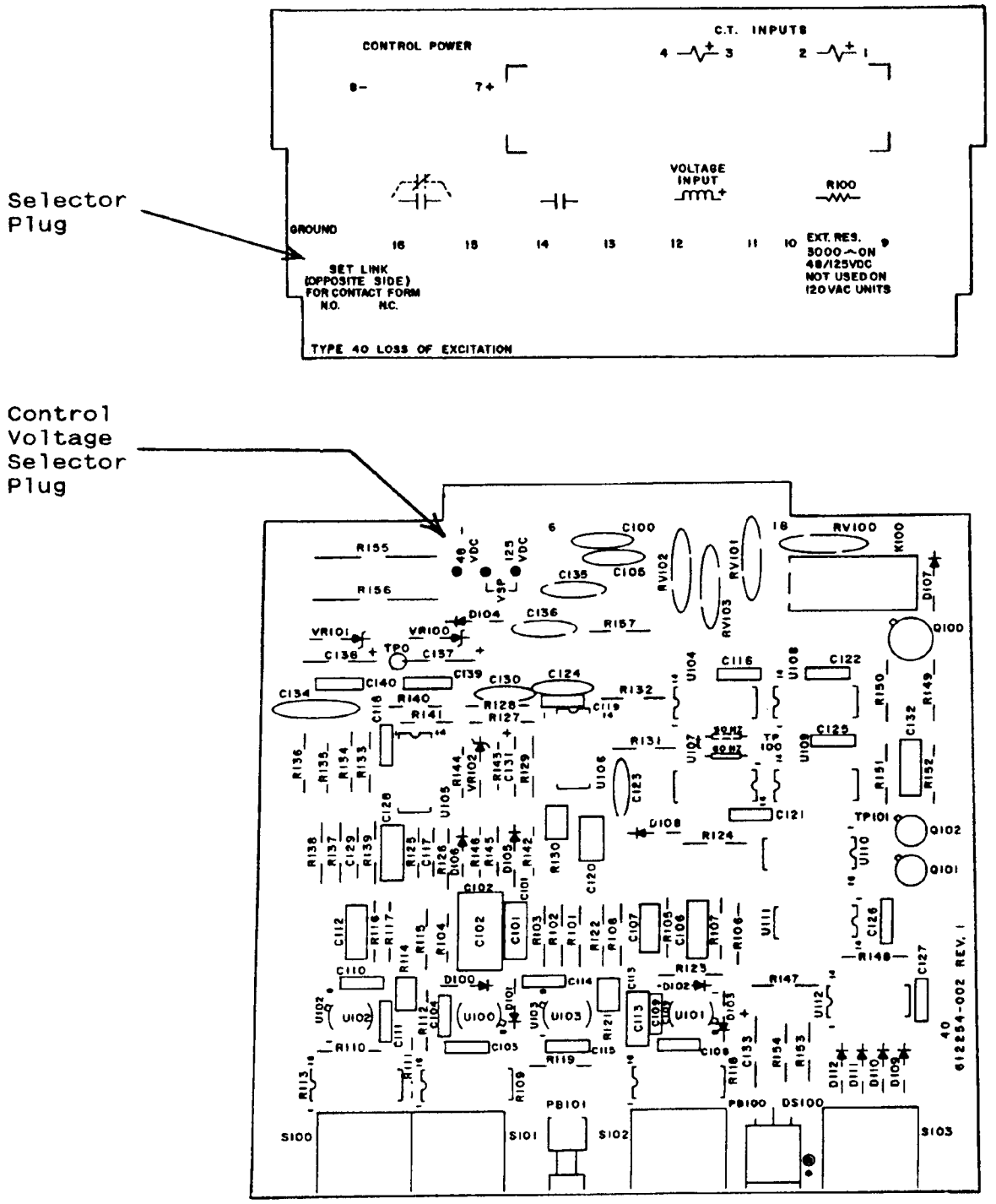


Figure 5: Typical Circuit Board Layout

Note: Circuit board layouts are shown for reference only. Variations may exist on boards in service.