INSTRUCTIONS

Reverse Power Relay

CIRCUIT SHIELD ®

TYPE 32R

Catalog Series 437W/437G  Drawout Test Case
Catalog Series 437P/437F  Drawout Test Case
Catalog Series 237P/237F  Standard Case

ASEA BROWN BOVERI
TABLE OF CONTENTS

Introduction.........................Page 2
Precautions............................Page 2
Placing the Relay into Service......Page 3
Application Data.......................Page 4
Testing................................Page 12
Obsolete Units........................Page 15

INTRODUCTION

These instructions contain the information required to properly install, operate, and test the ABB Circuit-Shield™ Type 32R Reverse Power Relay, catalog series 237P, 437P, 237F, 437F, 437W, and 437G. 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 437 series relays provide 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 closed contact is used in the application. The 237 series relays are of partial drawout construction, with the input transformers remaining in the case upon withdrawal of the lower circuit board.

Most settings are made on the front panel of the relay, behind a removable clear plastic cover. The target is reset by means of a pushbutton extending through the 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 use with dc control power, the proper polarity must be observed.

3. For units 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. On earlier 437 series units the upper and lower circuit boards must be separated to gain access to the plug.

4. For catalog series 237 units, a shorting link or jumper is required from terminal 16 to terminal Q. This is not used on series 437 units.

5. Drawout elements should insert in the case smoothly. Do not use excessive force.

6. High voltage insulation tests are not recommended. A high-pot test was performed on the relay at the factory. See section on Testing for additional information.

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

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 your ABB representative or the factory. 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. 1.

Connections:
Internal connections are shown in Fig. 2. Typical external connections are shown in Figures 3 and 4.

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.

External Shorting Link (237P/237F series only): A shorting link or jumper is required from terminal 16 to terminal G. See paragraph on High Potential Tests, section on Testing, for purposes of this link. This connection is not required on series 437 series units.

For units with dc control power rating, proper polarity must be observed when connecting to terminals 7 and 8. For units rated for ac control power, an internal isolation transformer is used, so polarity need not be observed.

Control Voltage Selector Plug:
Apply only the rated control voltage marked on the front panel of the relay. 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 units rated for use on 120 vac control (if the factory has not used a soldered jumper) the plug must be placed in the 24/48vdc position; a transformer-rectifier circuit on the upper board converts the 120 vac to dc, the value depending on the model. For relays rated for use on 110 vdc, the plug should be placed in the 125vdc position if not specifically marked 110. On 437 series units rated 24 or 32vdc, an inverter on the upper circuit board converts the voltage to 48vdc. The plug on the lower board should be in the 48vdc position if a soldered jumper is not used.

On earlier versions of the 437 series units, the upper and lower circuit boards must be separated to gain access to the plug. See section on Testing for the procedure.

Phase-shift Selector Plug:
An internal selector plug is provided to set the relay's internal phase shift to 30° or 0°. (Not provided on earlier 237P/237F/437P/437F series units with lower printed circuit boards 612289-003,-002,-001.) See connection diagrams for notes on the proper placement of this plug. See circuit board layouts for location of plug. The upper and lower circuit boards will have to be separated on some models to inspect or position this link.

Circuit Board Interconnection Cable (437W/437G series only): A 3 conductor cable is used to connect the upper and lower printed circuit boards on these units. Inspect to be sure that the cable connectors are properly positioned and seated at both ends.

3. SETTINGS

237P/237F/437P/437F Series Units (Current Directional Types)

Pickup:
A pickup dial is provided so that the sensitivity of the relay to power reversal can be adjusted to fit the application. Pickup is continuously adjustable from approximately 0.025 amperes to 0.7 amperes.

Time Delay:
The Type 32R is provided with a time delay on pickup. The delay on standard units is continuously adjustable from 1 to 30 seconds (definite time characteristic). The time delay should be set to the time needed to prevent nuisance operations due to temporary self-correcting power reversals. Relays with non-standard delay ranges will be marked appropriately.

437W/437G Series Units (Power Measurement Types)

Pickup:
A continuously adjustable pickup dial is provided to set the sensitivity of the relay to power flow. The approximate range will be marked on the front panel. The dial is non-linear to provide greater resolution at the more sensitive settings, and can be set by test if desired.
Time Delay:
The 437W/437G series is provided with a time delay on pickup. An internal link must be positioned to set the timing function for a definite-time characteristic or for an inverse characteristic. The definite delay on standard units is continuously adjustable from 1 to 30 seconds. The inverse characteristic curve is shown in Figure 6. Relays with non-standard delays will be marked appropriately. The time delay should be set to the time needed to prevent nuisance operations due to temporary self-correcting power reversals. A setting of 10-15 seconds is typical.

4. INDICATORS

LED Pickup Indicator:
A light-emitting-diode pickup indicator is provided to assist in testing and to provide operating personnel with information on the status of the relay. This can be especially helpful when placing the relay into service and making initial settings. The relay's timer will be timing when this indicator lights, and if the condition persists, the relay will operate. If the indicator is flashing on and off, system conditions are near the relay's operating threshold, however, the timer is reset whenever the led goes out, and a relay operation will not occur.

Target Indicator:
When the relay's output contacts transfer to trip the breaker, the target indicator is signalled electronically to set and display orange. The target retains indication even on loss of control voltage, and must be reset manually. In order to reset the target, control power must be present and the inputs to the relay below pickup.

APPLICATION DATA

The most common application for ABB Type 32R relays is the reverse power (anti-motor) protection of a generator and its prime-mover. The magnitude of power required to motor the generator varies widely depending on the type of prime mover (diesel, gas turbine, etc.) These relays provide wide sensitivity ranges and high continuous ratings to allow full use of the sensitivity. Only one single-phase relay is required in this application, as the reverse power will be essentially equal in all phases. A relay setting of 20-50% of the power required to motor the particular machine being protected is suggested. A time delay sufficient to override temporary self-correcting power reversals, such as occur during synchronizing, should be set. A typical setting would be 15 seconds.

Catalog Series 237P/237F/437P/437F:

Relays in this series are current-directional relays, rather than true power measurement types. The operating characteristic is shown in Figure 5. An advantage of this type of unit is that its sensitivity to current magnitude and direction does not change with the magnitude of polarization voltage. Although the normal polarization voltage to the relay is 120vac, the relay will be fully polarized at voltages down below 10 volts. An internal phase-shift circuit provides the 30 degree shift required so the line-to-line polarization voltage can be properly compared in phase to the line current. (If the phase A-to-neutral voltage is used, the internal phase-shift link should be set to 0°, rather than 30°.)

For unity power factor conditions, the three-phase kilowatts to cause relay operation can be estimated by the following calculation:

\[ KW = \sqrt{3} \times V \times I \times N \]

where

- \( V \): system line to line voltage in kilovolts.
- \( I \): relay pickup setting in amperes.
- \( N \): CT ratio.

An adjustable definite-time delay characteristic with a range of 1 to 30 seconds is provided on standard units. For unusual applications, special time ranges including instantaneous operation can be provided. Contact the factory.

Reverse VAR Detection:
If this model is connected as shown in Figure 4, and set-up with an internal 0° phase-shift, it becomes a reverse var detector, used for loss-of-field protection in installations where the cost of an impedance type relay, such as the ABB Type 40, can not be justified. Catalog series 437W/437G units are now preferred for this application.
Catalog Series 437W/437G:

Relays of this series are "true" directional power relays in that they measure power according to the formula:

\[ P = V \times I \times \cos \theta \]

These relays may be used for the anti-motoring protection of generators, and are preferred in cases where significant third-harmonic current may be present. The relay may be used in any application where an action must be taken at a set power level; for example, on a tie between 2 systems where power flow is to be restricted to, or an alarm sounded at, a certain level in one direction.

An internal link is provided which allows the relay to be set up for a maximum torque angle of either: I lag V by 0 degrees; or, I lag V by 30 degrees. When set in the 30 degree position, the line-to-line input voltage is internally adjusted by a \( 1/\sqrt{3} \) factor to maintain the correct scaling for single-phase watts.

Typical connections for reverse power detection are shown in Figure 3. 437W/437G series relays may be reconnected to provide reverse VAR detection, as shown in Fig 4.

437W/437G series relays include an internal link to select timer operation to have a definite-time characteristic, or to have an inverse timing characteristic. The definite delay is adjustable 1-30 seconds. The inverse characteristic is shown in Figure 6.

Figure 1: Relay Outline and Panel Drilling

Figure 2: Internal Connection Diagrams
### CHARACTERISTICS OF COMMON UNITS

#### Type 32R Current Directional Types

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10 A</td>
<td>0.025A-</td>
<td>160 v</td>
<td>I lag V</td>
<td>1-30</td>
<td>48/125vdc</td>
<td>437P4671, 437F4671</td>
</tr>
<tr>
<td></td>
<td>0.7A</td>
<td></td>
<td>30 deg. sec.</td>
<td></td>
<td>48/110vdc</td>
<td>437P4601, 437F4601</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24/32vdc</td>
<td></td>
<td>220vdc</td>
<td>437P4611, 437F4611</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>250vdc</td>
<td></td>
<td>437P4611</td>
<td>437F4651</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>120vac</td>
<td></td>
<td>437P4661</td>
<td>437F4661</td>
</tr>
</tbody>
</table>

**Notes:**
1. Series 237P/237F have the same electrical characteristics as corresponding 437P/437F shown above, and internal connections per 16D237C. 437 series units in the drawout-test-case are preferred for new installations due to their improved testing features.

2. These units now include an internal link that allows the maximum torque angle to be set for either 30° or 0°, I lag V. Earlier versions had a fixed angle of 30° (last digit in catalog number = 1), or 0° (last digit in catalog number = 2).

#### Type 32R Power Directional Types

<table>
<thead>
<tr>
<th>Max. Cont. Current</th>
<th># Pickup Range</th>
<th>Nominal Rated Voltage</th>
<th>* Time Delay</th>
<th>Control Voltage</th>
<th>Catalog Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 A</td>
<td>5-60 Watts</td>
<td>120 v</td>
<td>1-30 sec.</td>
<td>437W4850</td>
<td>437Q4850</td>
</tr>
<tr>
<td>10 A</td>
<td>9-104 Watts</td>
<td>208 v</td>
<td>1-30 sec.</td>
<td>437W7850</td>
<td>437Q7850</td>
</tr>
<tr>
<td>10 A</td>
<td>13-150 Watts</td>
<td>120 v</td>
<td>1-30 sec.</td>
<td>437W4750</td>
<td>437Q4750</td>
</tr>
<tr>
<td>10 A</td>
<td>22-260 Watts</td>
<td>208 v</td>
<td>1-30 sec.</td>
<td>437W7750</td>
<td>437Q7750</td>
</tr>
<tr>
<td>6 A</td>
<td>1.7-20 Watts</td>
<td>120 v</td>
<td>1-30 sec.</td>
<td>437W4650</td>
<td>437Q4650</td>
</tr>
<tr>
<td>6 A</td>
<td>3-35 Watts</td>
<td>208 v</td>
<td>1-30 sec.</td>
<td>437W7650</td>
<td>437Q7650</td>
</tr>
</tbody>
</table>

**VOLTAGE DIGIT SELECTION CHART** (437W or 437Q series units): each of the catalog numbers listed above contains an 'x' for the control voltage designation. To complete the catalog number you must replace the 'x' with the proper control voltage digit shown in the table below. The internal connection diagram is related to the control voltage, and is also given below.

<table>
<thead>
<tr>
<th>Control Voltage</th>
<th>Code Digit for &quot;x&quot;</th>
<th>Internal Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 vdc</td>
<td>9</td>
<td>16D437C</td>
</tr>
<tr>
<td>32 vdc</td>
<td>8</td>
<td>16D437C</td>
</tr>
<tr>
<td>48/125 vdc</td>
<td>7</td>
<td>16D437B</td>
</tr>
<tr>
<td>48/110 vdc</td>
<td>0</td>
<td>16D437B</td>
</tr>
<tr>
<td>220 vdc</td>
<td>2</td>
<td>16D437C</td>
</tr>
<tr>
<td>250 vdc</td>
<td>5</td>
<td>16D437B</td>
</tr>
<tr>
<td>120 vac</td>
<td>6</td>
<td>16D437C</td>
</tr>
</tbody>
</table>

**Other Notes for 437W/437Q Series Units:**

- # Max torque angle internally adjustable 0° I lag V, or 30° I lag V, with selector link. Watts are line-to-neutral value (see page 5).
- * Definite-time; internal selector link provided for inverse delay, see Figure 6.
SPECIFICATIONS:

INPUT CIRCUIT RATINGS:
Potential - 120 Vac, nominal rating: 160 Vac, max continuous.
208 Vac, nominal rating: 270 Vac, max continuous.
Current - continuous: see charts page 6.
390 amperes, 1 second (10 amp rated units)
200 amperes, 1 second (6 amp rated units)

INPUT CIRCUIT BURDEN:
Potential - 0.3 VA at 120 vac.
Current - less than 1 VA at 5 Amperes.

SENSITIVITY: see charts on page 6.

MAXIMUM TORQUE ANGLE: internal link to set 30° or 0° Iop lag Vpol.

OPERATING TIME: standard units adjustable 1 to 30 seconds, definite time.
(Consult factory if special range required.)
437W/437G series units also include link to select inverse delay, see Figure 6.

CONTROL POWER: models available for: 48/125 vdc at 0.05 ampere typ. standby.
48/110 vdc at 0.05 ampere
24/ 32 vdc at 0.05 ampere (437P/437F)
24 vdc at 0.12 ampere (437W/437G)
32 vdc at 0.10 ampere (437W/437G)
220 vdc at 0.05 ampere
250 vdc at 0.05 ampere
120 vac at 0.05 ampere
allowable variation:
units rated 110 vdc and above: +12%/-20%.
units rated 48 vdc and below: +/-20%.

OUTPUT CIRCUIT RATINGS: each contact @125vdc @250vdc @120vac
Tripping: 30 amps 30 amps 30 amps
Continuous: 5 5 5
Opening Inductive: 0.3 0.1 2

TEMPERATURE RANGE: -20 deg C to +70 deg C.
Repeatability over temperature range:
237P/237F/437P/437F operating characteristic: +/-5 degrees.
pickup current at 1.0PF: +/-5%.
time delay: greater of +/-5% or +/-20ms.
437W/437G pickup at 1.0 PF: +/-5%.
time delay: +/-5%.

DIELECTRIC STRENGTH: 2000 vac rms, 50/60 Hz., 60 seconds, all circuits to ground.
FIGURE 3: TYPICAL CONNECTIONS FOR THE REVERSE POWER PROTECTION OF GENERATORS

General Notes:
1. If phase-sequence is A-C-B, connect 32R terminal 10 to phase C potential, rather than to phase B as shown above.
2. If the potential transformers are connected Y-Y instead of open-delta as shown, relay may be connected phase a-to-neutral if the internal maximum-torque-angle selector plug is set for 0°.

Notes for 437W/437G series units only:
A. For connection shown, with internal link on 30 degree position, power measured is per the formula:
   \[ \text{Single-phase Watts} = \left( V_{9-10}/\sqrt{3} \right) \times I_{1-2} \times \cos \phi. \]
B. If the internal link is set on the 0° position the measurement is per the formula: \[ \text{Single-phase Watts} = V_{9-10} \times I_{1-2} \times \cos \phi. \]
FIGURE 4: TYPICAL CONNECTION FOR REVERSE VAR DETECTION

General Note:

1. Catalog Series 437W/437G preferred for this application.

2. If phase sequence is A-C-B, reverse the connections at terminals 9 and 10 of the relay.

Notes for 437W/437G series units only:

A. For connection shown, with internal link on 0 degree position, VARS measured per the formula: Single-phase VARS = V9-10 * I1-2 * cos θ, where θ is the angle between Ia and Vbc.
Figure 5: Current-Directional Operating Characteristic 437P/F, 237P/F Series Units

Figure 6: Timing Characteristic For 437W/437G Series Units with Timing Selector Link in the INV (inverse) Position.
Figure 7:
Typical
Lower PC
Layout
437P/437F
237P/237F
Series

Factory
Calibration
Pots:
R11
Maximum
Torque Angle
R17
Sector Width
R19
Time Delay

Control Voltage Selector Plug
Maximum Torque Angle Selector Plug (not supplied on earlier units)

Figure 8:
Typical
Lower PC
Layout
437W/437G
Series

Phase Angle Calibration Pot (factory adjustment)
Maximum Torque Angle Selector Plug

Control Voltage Selector Plug
Pickup Calibration Pot
Timing Calibration Pot
Time Curve Selector Plug
TESTING

1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on the Type 32R relay. 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.

237P/237F Series Units:

Drawout circuit boards of the same catalog number are interchangible. 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.

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

437P/437F/437W/437G 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 panel 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 assembly. Control power and output connections are made at the rear vertical circuit board. This rear board is marked for easy identification of the connection points.

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. Certain units also require the removal of the (2) screws on the bottom of the lower board that secure the board to the backplane board. The lower circuit board can then be withdrawn forward from the printed circuit connector. An 18 point extender board (catalog 200X0018) is available from the factory if access to this assembly is required for troubleshooting.

Note that on 437W/437G series units there is a 3 conductor color coded cable that connects the upper and lower printed circuit boards. Carefully remove the cable from the connector on the lower circuit board before separating the boards. Be sure to restore this cable before testing or returning the relay to service. The cable must be reconnected in the same orientation, with position #1 on the upper board connecting to position #1 on the lower board.

Test Plug:
A test plug assembly, catalog 400X0001, is available for use with the 437 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, the following procedures are given based on the catalog series of the relay:

237 series units: withdraw the drawout element from the case. Disconnect the link or jumper between terminals 16 and G on the rear of the relay case. (This link is used to connect certain internal surge suppression components to ground in normal operation. Failure to remove this link will result in current leakage to ground during testing.) Be sure to reconnect the link when testing is completed.

437 series units: withdraw the drawout element from the case before applying test voltage. (Note: a link provided on the upper circuit board is temporarily removed when high potential tests are conducted on the relay at the factory. After testing the link is restored to its position to connect certain surge suppression components to ground for normal operation. This link is labelled "Remove for Hipot".)
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 make this test.

The built-in test is provided as a convenient functional test of the relay and associated trip circuit. The test function works as follows: when you depress the button labelled TRIP, the pickup circuit of the relay is actuated. The relay then times out and the output contacts transfer to trip the associated breaker or auxiliary relay, and the target is displayed. The test button must be held down continuously for the operating time set on the relay in order to obtain an operation. The pickup led should light during this period, indicating timing is underway.

4. **ACCEPTANCE TESTS - Catalog Series 237P/237T/437P/437T**

**Without Phase-Shifting Source:**

A typical acceptance test circuit is given in Figure 8. The control voltage source should match the relay's front panel rating. On dual-rated units be sure the internal selector link has been positioned properly. The ac source should be 60 Hz. or 50 Hz. to match relay's rating, and the voltage and current outputs must be essentially in phase.

a. Set the PICKUP dial to 0.1 ampere and the TIME dial to 1 second.

b. Apply control voltage. Depress the TARGET RESET button. The target should reset to black. Apply approximately 120 vac to the voltage input.

c. Apply the current signal and increase until the pickup light comes on solidly and the contacts transfer. (The pickup light may blink near pickup.) The target should set to orange when the output contacts transfer. Current at the operating point should be between 0.07 and 0.13 amperes.

d. Increase the input current to 0.5 ampere. Turn off the test source and reset the timer. Start the test set. The relay should operate to stop the timer between 0.9 and 1.1 seconds.

e. Reverse the current leads at terminals 1 and 2 of the relay. Reset the target. Apply voltage and current and increase the current signal to 1 amp. The relay should not pick up.

f. If the actual settings to be used in the application are known, the relay should be calibrated by repeating steps (c) and (d), except adjusting the relay dials until the desired pickup current and time delay are obtained. Timing tests should be run with the current set at 150% of pickup or higher.

**With Phase-Shifting Source:**

If a test set with the ability to shift the phase of the ac input current and voltage is being used, a check of the operating characteristic can be made in place of test (e) above. A typical test circuit is shown in Fig. 9. First perform the tests (b), (c), and (d) given above. (Set test set voltage source for 120 vac at 0 degrees, current source also at 0 deg). Then determine the operating characteristic:

a. Set the relay's pickup at 0.1 ampere and the time delay at 1 second. If the relay is equipped with a maximum torque angle selector plug (see Figure 7) place the plug in the 30° position for this test.

b. For the standard Type 32R (catalog 237xxxx1 or 437xxxx1), set the phase angle of the voltage source on the test set to 120v at 30° lead. Set the current source on the test set to 1 ampere. Vary the phase of the current signal. The relay should pick up and trip for phase angles from 90° lead through 0° to 90° lag. The relay should not operate for phase angles from 90° lag through 180° to 90° lead. The tolerance on the operating characteristic is +/−6 degrees.

**Note:** for relays without the 30° internal shift (catalog 237xxxx2 or 437xxxx2), or for the 0° position of the maximum torque angle selector plug (see Fig 5) set the voltage source at 120v, 0°.
5. ACCEPTANCE TESTS - Catalog Series 437W/437G

Important: see note at top of page 15 regarding test connections.

Important: catalog series 437W/437G units are power measurement relays; therefore, variations in the voltage magnitude, current magnitude, and phase angle between them will have an effect on the operating point of the relay.

Important:
With the max torque angle selector link in the 0° position, the relay operates on the quantity: \( P = V_{a} I_{1} * \cos \theta \).

With the max torque angle selector link in the 30° position, the relay operates on the quantity: \( P = (V_{a} / \sqrt{3}) I_{1} * \cos (\theta - 30°) \), where \( \theta \) is the angle by which the applied voltage leads the current.

Without Phase-Shifting Source:
A typical acceptance test circuit is given in Figure 8. The voltage and current outputs of the test set must be in phase. The control voltage source should match the relay's front panel rating. On dual-rated units be sure the internal selector link is positioned properly. The ac source should be 60 Hz, or 50 Hz, to match the relay's rating. Set the internal selector links for 0 degree phase shift and definite time delay.

a. Set the front panel PICKUP and TIME DELAY dials to minimum.

b. Apply control voltage. Depress the TARGET RESET button. The target should reset to black. Apply 69 vac to the voltage input.

c. Apply the current signal and increase until the pickup light comes on and the contacts transfer. The target should set to orange when the output contacts transfer. Power in watts = 69 Volts x Amps. Calculated power should be within +/-10% of the relay's minimum pickup rating.

d. Increase the current setting to two times the value required for pickup. Turn off the source and reset the timer. Start the test set. The relay should pick up and time out, stopping the timer. Time delay should be within +/-10% of the time dial setting.

e. Reverse the current input leads at terminals 1 and 2 of the relay. Apply five amperes current. The relay should not pick up.

f. If the actual settings to be used in the application are known, the relay should be calibrated by repeating steps (c) and (d), except adjusting the relay's front panel dials until the desired pickup and operating time are obtained.

Note: if the 30 degree internal phase shift is required for the application, reposition the internal selector link for 30°. The applied ac input voltage should be increased to 120 vac. The current level must be increased by a factor of 1.15 to account for the 30 degree internal phase shift. Power measured = \((V/\sqrt{3}) I \cos 30° \). \( \cos 30° = .866 \)

Note: if the inverse timing curve is to be used, reposition the internal selector link. Refer to the timing characteristic in Figure 6 for expected operating times. Timing tests should be performed with the input power set at 2 multiples of pickup or higher.

Additional Checks With Phase-Shifting Source:
If a test set with the ability to shift the phase of the ac input current and voltage is being used, additional checks of the operating characteristics can be made:

g. If the 30° phase shift selection is made, test (f) above can be performed at unity power factor by setting the voltage to lead the current by 30 degrees, and power measured becomes: \( P = (V/\sqrt{3}) I \).
5. Testing 437W/437G Series Units (continued)

Important Note: In order to test the drawout units of relays which have an external resistor (per internal connection diagram 16D437B), a resistor must be temporarily be connected between terminals 15 and 16 on the drawout unit. The value of this resistor depends on the control voltage rating of the relay. A 25 watt resistor is sufficient. The value to be used is: 125vdc unit: 2000 ohms; 110vdc unit: 1500 ohms; 220vdc unit: 5000 ohms; 250vdc unit: 6000 ohms.

Figure 8: Typical Test Circuit Without Phase-Shifting Source.

Note: for 437W/437G series units output contact is 11-12.
Connect proper resistor 15-16 if relay is per note at top of this page.

Figure 9: Typical Test Circuit With Phase-Shifting Source.

Note: for 437W/437G series units output contact is 11-12.
Connect proper resistor 15-16 if relay is per note at top of this page.

6. OBSOLETE RELAYS:
Various earlier versions of the type 32R relay are obsolete and have been superseded by the improved series covered by this instruction book. The following is a guide to the replacement of the earlier units. Connections for all of the earlier units are per internal connection diagram 16D237C on page 5, EXCEPT 237C9171.

<table>
<thead>
<tr>
<th>Old Catalog Number</th>
<th>60 Hertz System</th>
<th>50 Hertz System</th>
</tr>
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<tbody>
<tr>
<td>237S4171, 237R4171, 237R9377</td>
<td>437P4671</td>
<td>437F4671</td>
</tr>
<tr>
<td>237S4191, 237R4191, 237R9397</td>
<td>437P4691</td>
<td>437F4691</td>
</tr>
<tr>
<td>237C9171 (change in connections required)</td>
<td>437Wxx70</td>
<td>437Gxx70</td>
</tr>
</tbody>
</table>