

INSTRUCTIONS

Harmonic Restraint Relays

TYPE 50R HARMONIC RESTRAINT UNIT

Catalog Series 420 Drawout Test Case



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INTRODUCTION

These instructions contain the information required to properly install, operate, and test the ABB Circuit-Shield™ Type 50R Harmonic Restraint Unit, Catalog Series 420.

These relays are housed in a case suitable for conventional semi-flush panel mounting. All connections to the relay are made at terminals located on the rear of the case and clearly numbered.

Relays with catalog numbers starting with 420 are similar in function to relays of the earlier 220 series, but offer 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. Units of the 220 series are of partial drawout construction, with the input transformers remaining in the case upon withdrawal of the lower electronic circuit board. See page 13 for information on obsolete versions of the 420 and 220 catalog series units.

No front panel settings are provided with this unit. A target indicator is mounted on the front panel. The target is reset by means of a pushbutton extending through the cover. Control voltage must be present to reset the target.

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 dc control voltage is applied in the correct polarity. Units of the 420 series have different connections compared to the earlier 220 series. Be sure you are using the correct connection diagram for your relay; refer to pages 4 and 13.
2. Apply only the rated dc control voltage marked on the front panel.
3. Certain obsolete units of the 420 catalog series have a movable plug on the vertical rear circuit board to select the form of the contact between terminals 11 and 12. The position of this plug should be inspected before placing the unit into service. Refer to pages 3 and 13.
4. High voltage tests are not recommended. See section on testing for additional information.
5. Removing the drawout assembly in an application that uses the normally closed contact will open that circuit, and may block other protective devices depending on the scheme. Temporarily inserting a test plug, catalog 400X0001, with a jumper across posts 10 and 11 would complete this circuit during the time maintenance was being performed on the 50R relay. (Certain older units would require the jumper across terminals 11 and 12 - be sure to identify the connection diagram for your unit before proceeding.)
6. 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 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 and panel drilling and cutout information is given in Fig. 1.

Connections:

Internal connections and contact logic are shown on page 5. A typical connection diagram is shown in Figure 2.

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

These relays have 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.

A target indicator is provided on the Type 50R. Its use is optional. The operation of the target is based entirely on current flow in the external tripping circuit. On catalog series 420 units the target coil is connected between terminals 13 and 14. A current flow of 1 ampere or higher is required to set the target. (Relays with a catalog number suffix "-ST" have the "sensitive target option" which requires 0.25A or higher to set the target.) Normal dc control voltage must be present for target operation and reset.

Units with catalog number 420T0040 or 420T0041 (obsolete) include a movable link on the vertical rear circuit board (inside surface) which allows you to choose a normally-open (NO) or normally-closed (NC) contact for rear terminals 11-12. The upper and lower circuit board assemblies must be separated to change this selector plug. See procedure on page 8.

Relays with catalog number 420T0040 (obsolete) also include an external resistor which is supplied mounted to the case and wired between terminals 9 and 10. This resistor must be connected for proper operation. Refer to connection diagram 16D420A.

3. SETTINGS

No front panel settings are provided on this relay. An internal potentiometer is provided to allow calibration of the percentage second harmonic that will cause the unit to operate (restrain). See section on testing for setting procedures. The factory setting is approximately 15% which is appropriate for most applications.

4. OPERATION INDICATORS

Pickup LED: this yellow light-emitting-diode indicator lights when sufficient 60 Hertz current is present to place the 50R unit in its operating region. Below this current level the relay will not restrain on the presence of second harmonic.

Restraint LED: this red led lights when sufficient second harmonic is present to cause the relay to restrain and change its contact state.

Target Indicator: this target is provided to give a permanent indication of relay system operation. Its use is optional, and is based entirely on current flow in the tripping circuit. The target must be manually reset by means of the front panel push-button. Control power must be present to set or reset the target.

APPLICATION DATA

The ABB Circuit-Shield™ Type 50R Harmonic Restraint Unit is used to supervise differential, pilot wire, or overcurrent relays in protection schemes which are subject to misoperation on high magnetizing inrush currents.

The Type 50R will detect the presence of second harmonic in the inrush current and will transfer its contacts instantaneously to provide blocking of possible incorrect operation by the other relays in the scheme. The 50R relay must be faster than the relays being supervised for the scheme to be secure. The typical operating time on transformer inrush will be 0.032 sec. The operating time characteristic is shown in Figure 4.

The factory calibration is set for 50R operation at approximately 15% second harmonic. The relay may be adjusted by means of an internal potentiometer over the range of approximately 10% to 20%.

The Type 50R offers low burden and a high continuous current rating. Individual input current coils are provided for each phase, so the relay does not have to be the last relay in the string, an advantage where pilot wire relays are used.

Specifications

Input Circuit: 10 A Continuous
 250 A 1 second

Burden: less than 0.03 ohms resistive, each input.

Harmonic Restraint: Restrain on 2nd harmonic.
 Internally adjustable approximately 10%-20%.
 Factory setting - approximately 15%.

Sensitivity: 60 Hz. pickup circuit factory set for approximately 0.87A, 3 phase.

Operating Time: See Figure 4 for typical operating time.

Output Contact Rating: @ 125vdc
 30A closing/tripping
 5A continuous
 0.3A break

Target Coil (TAR):	Standard Target	Sensitive Target
Operate current minimum:	1 A	0.25 A
Withstand, 1 second:	30 A	10 A
Resistance: negligible		

Operating Temperature Range: -20 to +70°C

Control Voltage: models available for
 125vdc @ 0.030A max. drain
 110vdc @ 0.030A max. drain
 48vdc @ 0.030A max. drain

Tolerances: Factory set points - 2nd harm. restraint 13-17%, for 1A I_{60Hz} 30A.
 - 60 Hz. pickup threshold 0.85-0.89A, 3 phase.
 (both setpoints are field adjustable - see page 9)

CATALOG NUMBERS - COMMON UNITS

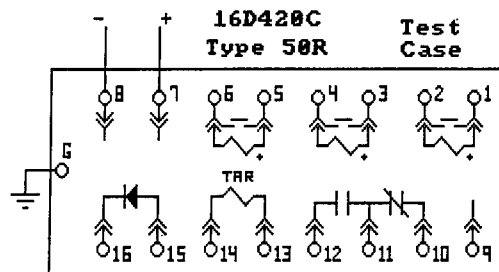
Type	System Freq.	Control Voltage	Internal Connections	Catalog Number
50R	60Hz.	48vdc	16D420C	420T0032
		110vdc		420T0002
		125vdc		420T0042

Contact factory for availability of units for control voltage ratings not listed, or for 50Hz. units.

INTERNAL CONNECTIONS AND OUTPUT CONTACT LOGIC

The following table defines the output contact states in various conditions of the measured input current and the control power supply.

Condition	Output Contact State		LED Indicators	
	Contact 11-12	Contact 10-11	Red	Yellow
No dc control voltage	Open	Closed	Off	Off
Normal dc control voltage, 60 Hertz input current below threshold.	Open	Closed	Off	Off
Normal dc control voltage, 60 Hertz input current above threshold, percentage of 2nd harmonic below set point.	Open	Closed	Off	On
Normal dc control voltage, 60 Hertz input current above threshold, percentage of 2nd harmonic above set point.	Closed	Open	On	On



- Notes: 1. TAR = series target coil.
 2. Internal diode terminals 15-16 for testing use only. See page 9.

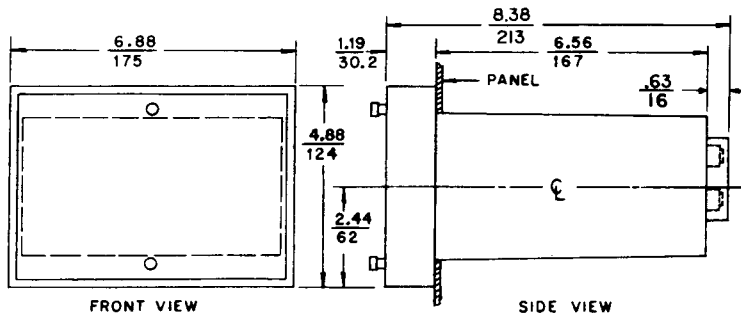
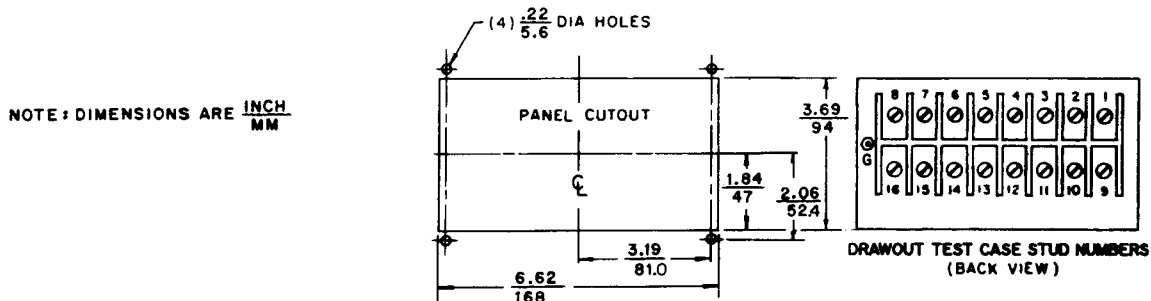


Figure 1: Relay Outline and Panel Drilling



NOTE: DIMENSIONS ARE INCH / MM

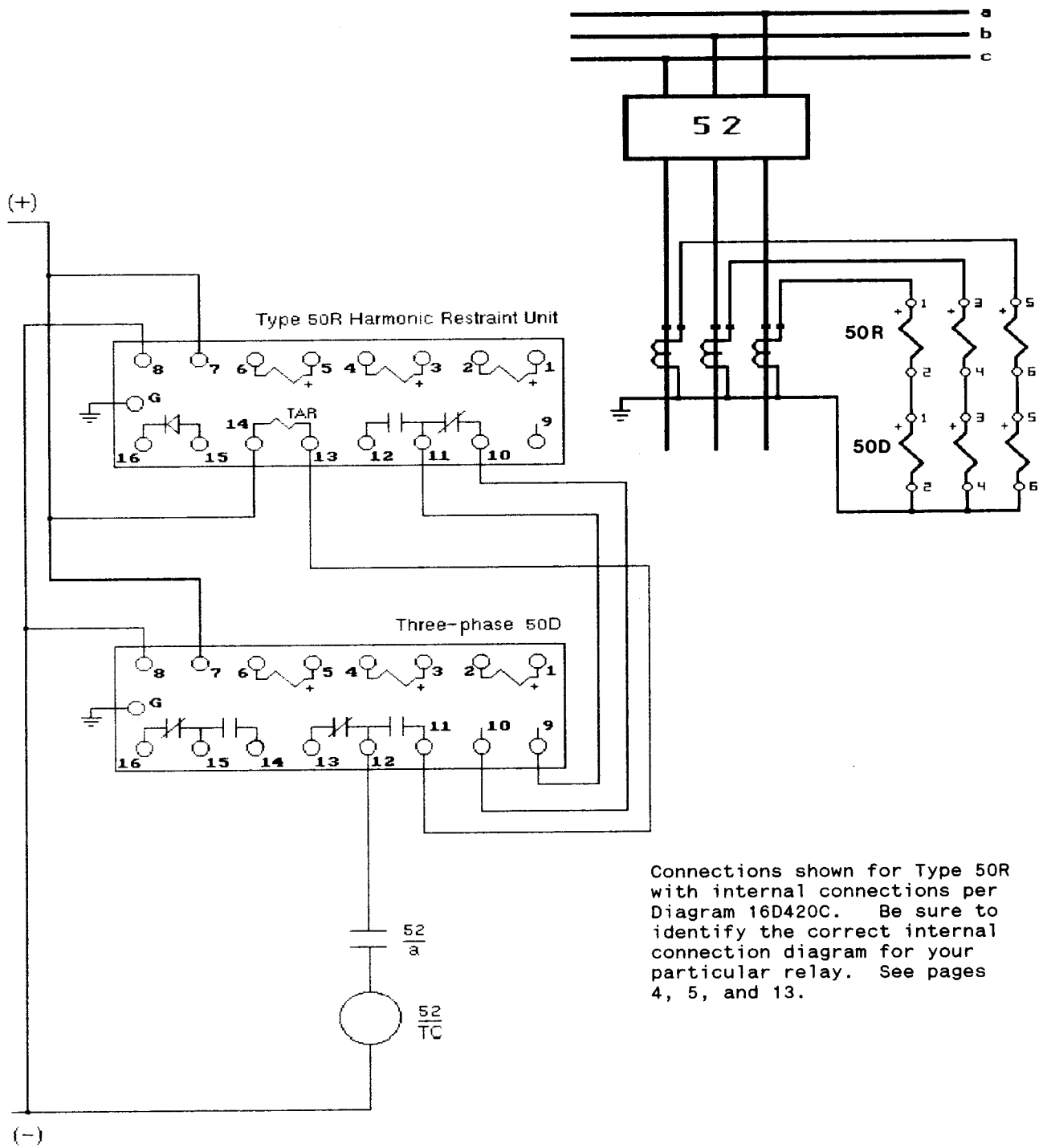


Figure 2: Typical Connections - Type 50R Harmonic Restraint Unit

Notes: In the arrangement shown the Type 50R is used to supervise a Type 50D overcurrent relay by means of the 50D's controlling input, terminals 9-10. The 50D overcurrent relay is blocked from measuring the current when the 50R's contact is open. The contact form selected for the 50R's output contact is normally-closed.

Use of the target indicator on the Type 50R is optional. In the above scheme, the 50R target is set by trip circuit current to 52/TC.

Figure 3:
Lower Circuit
Board Layout
(Typical)

R56:
Harmonic Restraint
Adjustment Pot

R14:
60 Hertz
Threshold
Adjustment

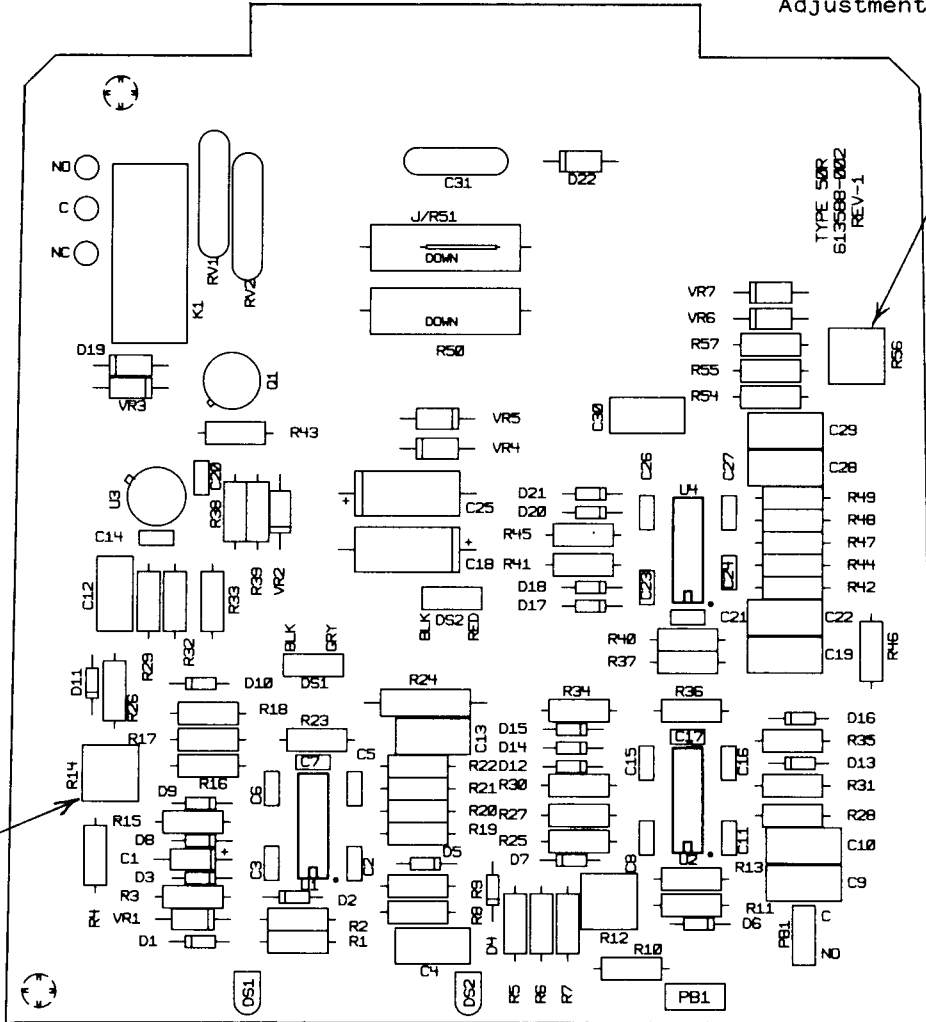
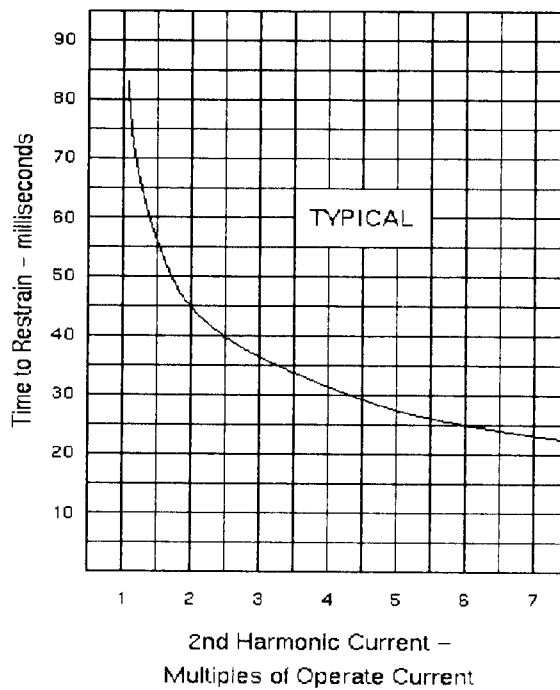


Figure 4:
Operating Time
Characteristic



TESTING

1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on these ABB Circuit-Shield™ solid-state 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.

420 Series Units:

Metal handles provide leverage to withdraw the relay assembly from the case.

Caution: Removing the drawout assembly in an application that uses the normally closed contact will open that circuit.

The assembly is identified by a catalog number stamped on the front panel of the relay and a serial number stamped on the bottom of the circuit 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.

IMPORTANT: in order to test the drawout unit of relays that have an external resistor per internal connection diagram 16D420A, a suitable resistor must be temporarily connected 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. A 25 watt resistor is suitable for testing. If no resistor is readily available, the resistor mounted on the rear of the relay case could be removed and used; however, be sure to remount the resistor on the case at the conclusion of testing.

Disassembly: Should separation of the upper and lower circuit boards be necessary, remove the (2) screws holding the handle assemblies in place. Some units may also require the removal of (2) screws from the underside of the unit near the rear vertical circuit board. Remove the cap from the Reset pushbutton. Carefully move the lower circuit board and front panel assembly forward from the printed circuit board, watching that the target indicator clears the hole in the front panel. An 18 point extender board, catalog 200X0018 is available if access to the lower circuit board is required during testing or troubleshooting.

Test Plug:

A test plug assembly, catalog 400X0001 is available for use with the 420 series units. This device plugs into the relay case on the switchboard and allows access to all the 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, withdraw the drawout element from the case before applying the test voltage.

(Note: a plug-in link on the upper circuit board is temporarily removed when high potential tests are conducted 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 FUNCTION

A built-in test function is provided for convenience in running a test on the relay.

CAUTION: tests should be made with the main circuit de-energized. If tests must be made on an energized circuit, take all necessary precautions.

The test button is labelled TEST. For the Type 50R a restraint condition is simulated when the button is depressed. The red and yellow led indicators should light and the output contacts should transfer to the restraint condition.

4. ACCEPTANCE TESTS

Testing with Conventional Voltage Test Source:

A typical test circuit is shown in Figure 5a. Apply proper control voltage per the nameplate rating of the relay. (Do not use a "modern" electronic-current-source test set for this test method. See the alternate procedure on page 11.)

In this arrangement, the built-in diode between terminals 15 and 16 is used to generate 2nd harmonic content in the current waveform.

Operating Point Tests:

1. Set the Branch B current at zero. Increase the current in branch A with the switch closed across the diode. The 50R should not restrain as the current is all 60Hz. The yellow led should light for branch A current above 0.55 amps. The red led should remain off. Set the current to 1.0 amp.
2. Open the switch across the diode (thus causing a significant 120Hz content in the current waveform). Do not readjust the branch A source. (The apparent current read on the meter will drop, but that is proper.) The relay should restrain (contact transfers, yellow led on, red led on).
3. Raise the current in branch B (increases the 60Hz content). The 50R should return to the non-restraint condition when the percentage of 2nd harmonic falls below the set point. The value may be read from the curve in Fig 5b. Note that since the branch A current was originally set to 1 ampere, the vertical scale may be read as the current in branch B.

The branch B current may be raised and lowered to determine the "restrain" and "reset" values.

Example: assume the relay restrained with a branch B current of 0.92 amps. Reading the curve at 0.92 gives 15% 2nd harmonic on the horizontal scale.

Adjustments: internal potentiometer R56 may be used to adjust the value of 2nd harmonic that causes restraint.

The adjustment of R56 will also affect the 60Hz current threshold level. Once the percent harmonic has been set, close the shorting switch across the test diode, return the Branch B current to zero. Set the Branch A current to 0.50A, and adjust potentiometer R14 so that the yellow led just comes on.

Timing Tests:

1. Set the Branch B current to zero. Set the Branch A current to 2 amps. with the diode shorting switch closed. (Yellow led on, red led off). Operate the diode shorting switch to open up across the diode and to start the timer. The 50R should restrain and stop the timer. (Red led on). The operating time should be less than 0.050 sec. for a 15% second harmonic pickup setting.

Testing with Electronic-Current-Sources:

Modern electronic test sources function as true current sources and can not be used with the relay's built-in test diode to generate 2nd harmonic. Instead, one current source of the test set should be set up to provide the 60Hz fundamental, and a second source to provide a 120Hz 2nd harmonic current. Refer to Fig. 6 for typical connections. Apply proper dc control voltage per the nameplate rating of the relay.

Operating Point Tests:

1. Increase the 60 Hz. current source from zero. The yellow led should light for current above 0.55 amp. The red led should remain off. Set the current to 1.0 amp.
2. Increase the 120 Hz. current source. The red led should come on and the contacts transfer for current 0.13-0.17A (13-17% 2nd harmonic). The 120 Hertz current may be raised and lowered in small increments to determine the restrain and reset values.

Adjustments: internal potentiometer R56 may be used to adjust the value of 2nd harmonic that causes restraint.

The adjustment of R56 will also affect the 60Hz current threshold level. Once the percent harmonic level has been set, return the 120Hz source to zero current; then set the 60Hz source to 0.50 ampere and adjust R14 so that the yellow led just turns on. Repeat the two operating point checks as required.

Timing Tests:

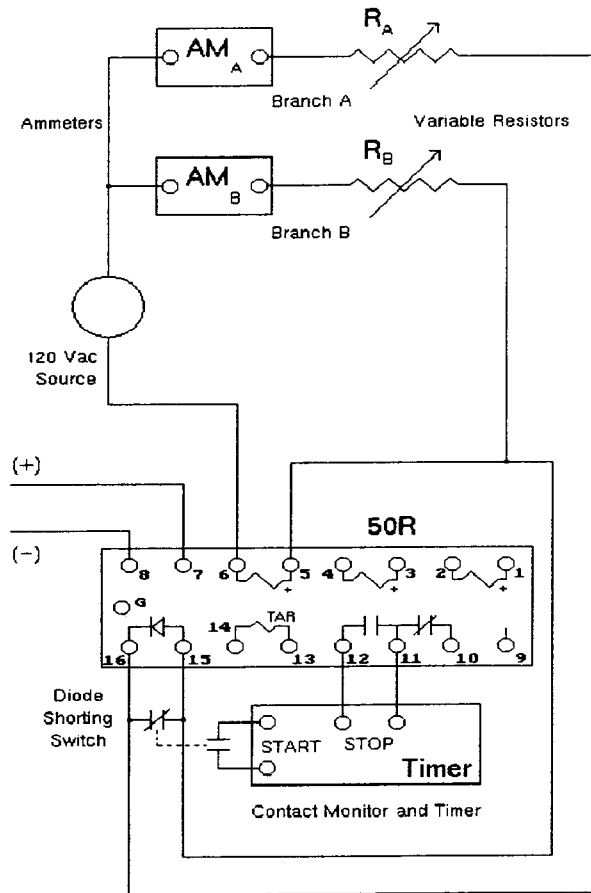
1. Set up the test set so that the timer starts upon application of the 120Hz current. Set-up the 120 Hz source for 1.0 amp. Set the 60 Hz source for 1.0 ampere. The 60Hz current may be applied first, or simultaneously with the 120Hz current. Apply the 120Hz current. The 50R relay should operate (red led on) and stop the timer. The operating time should be less than 0.032 sec.

5. Obsolete Units:

See page 13 for information on obsolete versions of the Type 50R.

Figure 5a: Typical Connections for a Voltage Test Source

Note: for the tests described, the test source must be connected to input terminals 5-6 as shown. Connecting to either of the other inputs will not give the correct results, due to the different winding ratios used for each input of the mixing transformer.



Formulas:

$$H = \frac{0.212I_A}{0.5I_A + I_B}$$

or

$$\frac{I_B}{I_A} = \frac{0.212 - 0.5H}{H}$$

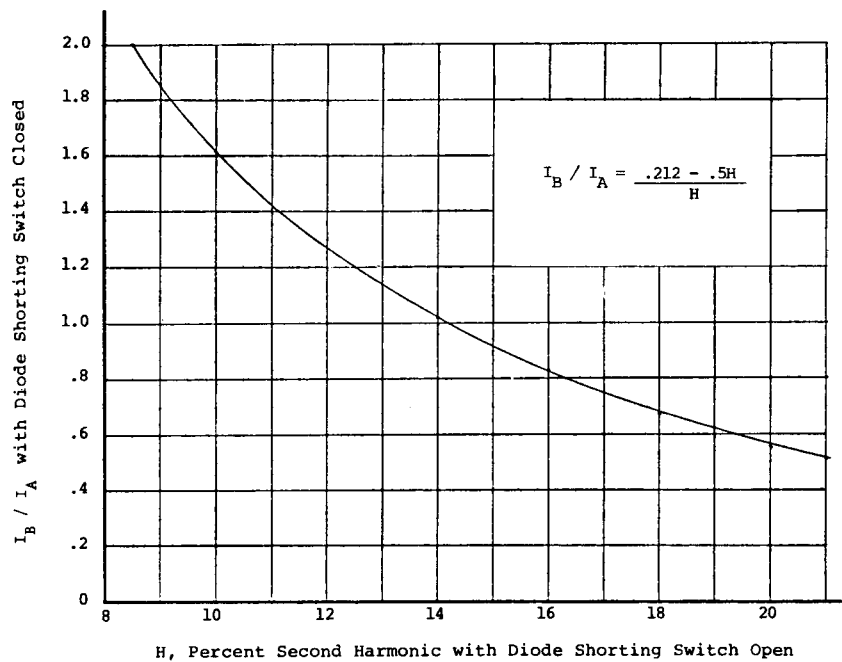


Figure 5b: Percent 2nd Harmonic Content as a Function of I_B/I_A

Note: Set I_A with the Diode Shorting Switch closed. Do not readjust the current I_A after opening the switch. Open switch to obtain the harmonic content indicated on the graph.

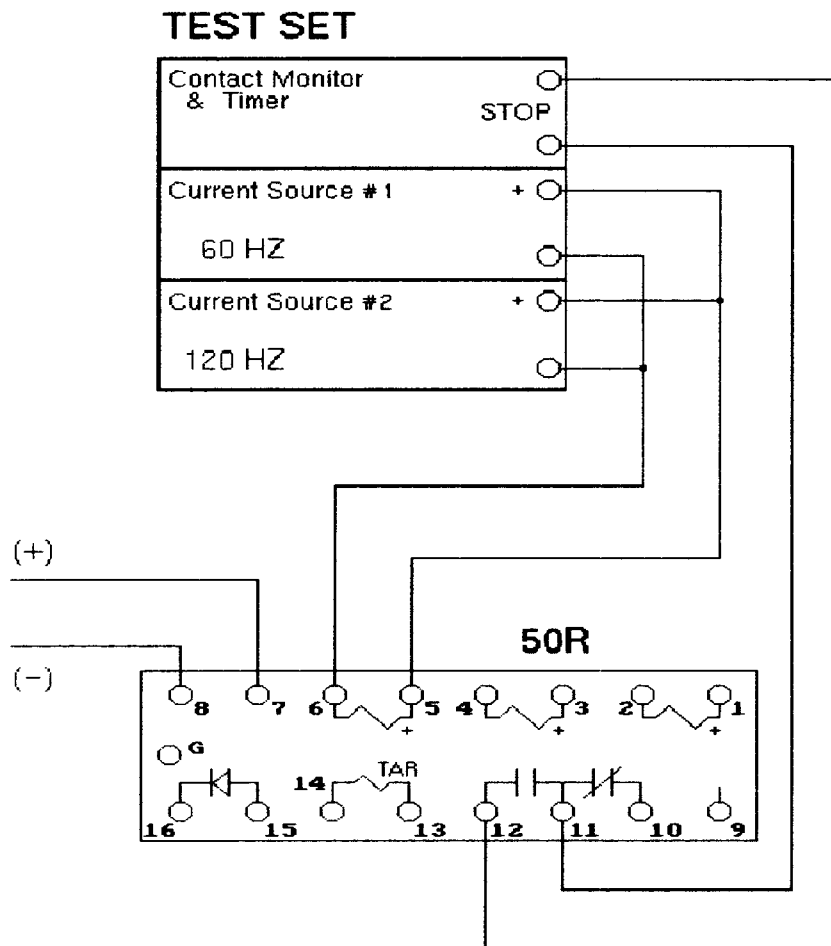


Figure 6: Typical Connections - Electronic Current Sources

Note: for the tests described, the test sources must be connected to input terminals 5-6 as shown. Connecting to either of the other inputs will not give the correct results, due to the different winding ratios used for each input of the mixing transformer.

5. OBSOLETE UNITS

All the obsolete units listed below have the mounting dimensions shown in Figure 1 on page 5. If a replacement unit is required, the equivalent unit should be selected from the table of catalog numbers on page 4. Note that the connections for the various versions are slightly different, and some rewiring may be necessary when replacing an older relay.

Catalog Number 420T0040: this version is in the drawout-test-case and has internal connections per diagram 16D420A. A movable link on the vertical rear circuit board (inside surface) allows you to choose a normally-open (NO) or a normally-closed (NC) contact for terminals 11-12. The external resistor shown between terminals 9-10 is supplied with the relay and must be connected for normal operation.

A red led is provided to indicate the restraint condition.

The external resistor (terminals 9-10) value is 2000 ohms, 25 watts.

The internal calibration potentiometer for 2nd harmonic restraint value is designated R22 on these units. No adjustment is provided for the 60 Hz. threshold value. The 2nd harmonic restraint percentage may be calibrated by generally following the procedures on pages 9 and 10 (ignore references to the yellow led and the 60 Hertz threshold adjustment). Refer to internal connection diagram 16D420A when making test connections.

Note: in order to bench test the drawout unit, a resistor must be connected temporarily between terminals 9 and 10 on the rear vertical circuit board. The resistor value is 2000 ohms, 25 watts.

Catalog Number 420T0041: this version is in the drawout-test-case and has internal connections per diagram 16D420B. A movable link on the vertical rear circuit board (inside surface) allows you to choose a normally-open (NO) or a normally-closed (NC) contact for terminals 11-12. The upper and lower circuit assemblies must be separated to gain access to this selector link.

Both red and yellow led indicators are provided on this model.

Follow the test and calibration procedures given on pages 9 and 10 except: the adjustment potentiometers are labelled R3 for the 2nd harmonic percentage and R31 for the 60 Hz. threshold. Refer to internal connection diagram 16D420B when making test circuit connections.

Catalog Number 220T0040: this version is in the partial-drawout-standard-case and has internal connections per diagram 16D220A. The external resistor shown is supplied with the relay and must be in place for normal operation.

A red led is provided to indicate the restraint condition.

The internal calibration potentiometer for 2nd harmonic restraint value is designated R22 on these units. No adjustment is provided for the 60 Hz. threshold value. The 2nd harmonic restraint percentage may be calibrated by generally following the procedures on pages 9 and 10 (ignore references to the yellow led and the 60Hz threshold adjustment). Refer to internal connection diagram 16D220A when making test circuit connections.

Catalog Number 220T0042: this version is in the partial-drawout-standard-case and has internal connections per diagram 16D220B.

Both red and yellow led indicators are provided on this model.

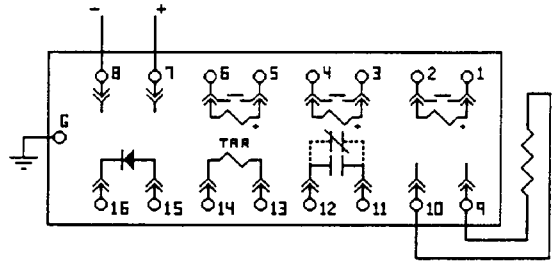
Follow the test and calibration procedures given on pages 9 and 10.

Internal Connections - Obsolete Units (For reference only)

Notes:

- 1. TAR = target coil
- 2. Diode terminals 15-16 for test only.
- 3. Contact 11-12 convertible NO or NC.
- 4. External resistor supplied with relay.

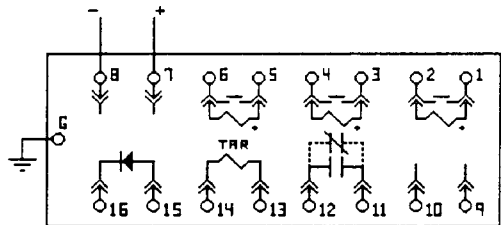
16D420A



Notes:

- 1. TAR = target coil
- 2. Diode terminals 15-16 for test only.
- 3. Contact 11-12 convertible NO or NC.

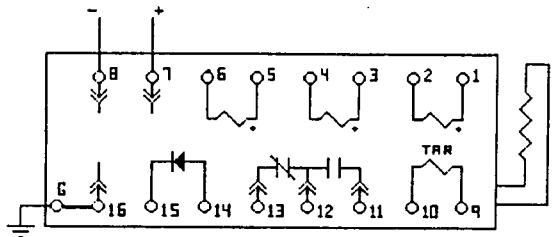
16D420B



Notes:

- 1. TAR = target coil.
- 2. Diode terminals 14-15 for test only.
- 3. Link required terminals 16-G.
- 4. External resistor supplied with relay.

16D220A



Notes:

- 1. TAR = target coil.
- 2. Diode terminals 14-15 for test only.
- 3. Link required terminals 16-G.
- 4. External resistor supplied with relay.

16D220B

