IB 7.4.1.7-2
Issue D

INSTRUCTIONS

Three-Phase Voltage Relay

CIRCUIT SHIELD ®

THREE-PHASE UNDERVOLTAGE AND PHASE-SEQUENCE RELAYS

TYPE 47 Inverse Delay
TYPE 47D Definite Delay
TYPE 47H Instantaneous

Catalog Series 412F/412N Drawout Test Case

Catalog Series 212F/212N Standard Case

TABLE OF CONTENTS

INTRODUCTION

These instructions contain the information required to properly install, operate, and test certain three-phase undervoltage relays, ABB Circuit-Shield™ Types 47, 47D, and 47H, catalog series 212F, 412F, 212N, and 412N. See the section on Testing for reference to earlier models of these relays, catalog series 211F, 411F, 211N, 411N.

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. Relays of the 412F and 412N catalog series are similar to relays of the 212F and 212N series. Both series provide the same basic functions and are of totally drawout construction; however, the 412F and 412N series relays provide integral test facilities, and are preferred for new installations. Also, sequenced disconnects on the 412 series prevent nuisance operation during withdrawal or insertion of the relay if the normally-open contacts are used in the application: (Contacts which are normally open when the voltage is above the set-point).

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 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. *Important: connections for the 412 catalog series units are different from the 211 series units.*

2. Apply only the rated control voltage marked on the relay front panel. The proper polarity must be observed when the dc control power connections are made.

3. For relays with dual-rated control voltage, withdraw the relay from the case and check that the movable link on the printed circuit board is in the correct position for the system control voltage.

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

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

6. On removal of a tap setting pin, the setting automatically switches to the following value/position: Pickup: highest tap; Dropout: highest tap; Time Dial: #6.

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 Asea Brown Boveri. Use normal care in handling to avoid mechanical damage. Keep the relay 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 on page 6. Typical external connections are shown in Figure 2 & 3. *Important: connections are different far 412N and 412F series units compared to older 211N and 211F units. See references in Testing section for rewiring if you are replacing an older unit.*

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.

DC Control power must be connected in the proper polarity. Relays rated for use with 120 vac control power have an internal isolation transformer connected to relay terminals 7 and 8. Polarity of the ac control power to these terminals need not be observed.

Control Voltage Selector Plug;

For relays with dual-rated control voltage: before energizing, withdraw the relay from its case and inspect that the movable link on the lower printed circuit board is in the correct position for the system control voltage. (For units rated 110vdc, the link should be placed in the position marked 125vdc.)

Target Operation Selector Plug:

This plug sets the mode of operation of the target indicator. This is a new feature provided on the 212N/F and 412N/F series units. Setting the plug in the INT position provides for the target to be set electronically at the same time the output relay transfers to the trip condition. With the plug in the EXT position, a trip circuit current of one ampere or more is required through the coil labeled TAR on the internal connection diagram. (The polarity of this current does not matter.) Relays with the catalog number suffix "-st" have more sensitive targets that require 0.25A to set.

3. SETTINGS

PICKUP (Volts)

The pickup taps are labeled by the actual value of the balanced three-phase ac input voltage which will cause the relay contacts to transfer to the "normal" condition. *The relay will not pick up if the phase sequence is incorrect.*

DROPOUT (% of pickup)

The dropout taps are calibrated in percent of the pickup voltage. For example, with a pickup setting of 110 volts and a dropout setting of 80 %, the relay will drop out on balanced three-phase voltage at 110 x .80 = 88 volts.

TIME DIAL

The time dial taps are identified as 1,2,3,4,5,6. Refer to the time-voltage characteristic curves in the Application section. Time dial selection is not provided on Type 47H relays which have an Instantaneous operating characteristic. The maximum operating time for instantaneous relays is 3 cycles.

Note: operating voltage and times other than the specific values provided by the taps can be obtained by means of internal calibration potentiometers. See section on testing for setting procedures.

4. INDICATORS

TARGET:

An operation target is provided. The operating mode of the target can be selected to have it set electronically when the output contacts transfer, or for operation due to the flow of current in the trip circuit. The target will retain its indication on loss of dc control power. In order to reset the target, normal control power must be present and a "normal" ac voltage condition must exist; in other words, the voltage must be higher than the pickup set point and with correct phase sequence.

DROPOUT LED:

A yellow light-emitting-diode is provided to indicate when the ac input voltage has fallen below the dropout setting. This indicator is self-resetting when the ac input voltage rises above the pickup setting.

APPLICATION DATA

Motor Protection and Bus Transfer Schemes:

ABB Circuit-Shield™ Type 47 relays provide three-phase undervoltage and phase-sequence protection for the protection of motors, or for the initiation of bus transfer. A major benefit of this relay is that it is more sensitive to unbalanced voltages ("single-phasing") than many of the comparable electro-mechanical types. In many cases the relay is capable of recognizing a single-phasing condition even though motors may be supplying considerable back emf after having one phase of the supply opened up. See separate discussion of this subject below.

The output circuit of the relay does not require seal – in contacts, allowing simplification of bus transfer schemes.

These relays are available with inverse delay (Type 47), definite-time delay (Type 47D), and instantaneous operation (Type 47H). Types 47 and 47D have a time-dial setting which is set independently of the pickup and dropout voltages. Refer to the time-voltage characteristic curves which follow. Instantaneous relays have a maximum operating time of approximately 3 cycles. The 412F and 412N series relays have instantaneous reset upon return of the ac input voltage to a value above the pickup setting. This is a change over the earlier models, 211 and 411 series, which provided a time delay on reset.

Voltage-Controlled Overcurrent Relay:

The Type 47H is commonly used in conjunction with a type 51 time-overcurrent relay to provide a voltage-controlled overcurrent relay function, device 51V, in generator protection applications. The output contact of the 47H is wired to the torque-control input terminals of the 51 relay. With a normal bus voltage condition, the 47H contact is open and the 51 relay does not measure the current. This allows a normal load current flow equal or greater than the setting of the overcurrent relay. The dropout setting of the 47H is chosen so that on a fault condition, the 47H contact closes instantaneously. This allows the 51 relay to measure the current and to trip the breaker based on its pickup-current and time-dial settings. If the overcurrent relay is equipped with an instantaneous element, it may be controlled by the 47H or left active at all times at the option of the user, simply by the positioning of a wiring jumper on the 51 relay. See Figs. 3a and 3b for the typical connections for this scheme.

Notes on the Use of AC Control Power:

In general the use of a station battery to provide a reliable source of tripping and control power is preferred. However, the Types 47, 47D, and 47H are available for use with 120 vac control power. The output contacts may be used in a 120 vac circuit or in a capacitor trip circuit where the capacitor voltage is no more than 170 vdc nominal. (Consult factory if the higher rating is required.)
The control power for these relays should never be taken from a capacitor trip circuit as the voltage is too high and the relay will drain the capacitor in the event of loss of AC supply.

Types 47 and 47D Undervoltage relays used with 120 vac control power rating in the "self-powered" mode, with both signal and control power taken from the same source, should not have dropout set below 60 vac, since these relays will not maintain published tripping characteristics. In applications where the relay must be used at operating levels below 60 vac, it is recommended that an independent voltage source be used for terminals 7 & 8.

UNBALANCED VOLTAGE SENSITIVITY

Prior State-of-the-Art: when used for motor protection, many mechanical relay types share a common problem in that their response to unbalanced voltages is not sensitive enough. This condition is one well known to relay engineers from their experience in trying to protect motors operating with one phase open. When this situation occurs, the open phase does not collapse, since the back emf of the motor holds up the open phase. As a result, undervoltage relays may not be able to recognize this abnormal condition.

The reason for this lack of sensitivity is that these electromechanical relays commonly used operate on the principle of the "area of the voltage triangle". Another way to express this is that the relay operates on a voltage which is equivalent to:

$$Veq = \sqrt{V_1^2 - V_2^2}$$

This gives an operating characteristic as shown in Figure 4a. For a three-phase low voltage condition, Va equals zero, and the relay operates on the 45° line; that is, for the three voltages each equal to say 80%, Veq is also equal to 80%. This represents the three-phase dropout voltage.

However, for an unbalance on only one phase the relay operates on the curve representing the equation above. With a three-phase dropout setting of 80% the relay will not operate on a phase-to-phase low voltage condition until the voltage drops to 64%.

Figure 4a also shows the positive and negative sequence components of the voltage triangle for a collapse of one phase. Inspection of Figure 4a shows that for the three-phase, 80% dropout case discussed above, the relay will not drop out on a one-phase low basis until the negative-sequence component has reached 18% (corresponding to 64% low-phase voltage).

For a motor, the per unit negative-sequence component of the voltages resulting from an open conductor is equal to the ratio of the running to the starting currents:

$$V_2 = I_R / I_S \text{ (per unit)}$$

For a motor with a starting current of 6 per unit, the negative-sequence voltage is 16% if the motor was running at full load when the fuse blew. The negative-sequence voltage is less if the motor was lightly loaded before the fuse blew. Since the motor with a 6 per unit starting current will yield only 16% negative-sequence on an open conductor situation, the "voltage triangle" type relay will not recognize this condition.

An Improved Characteristic: In contrast, the ABB Type 47 solid-state relay has been designed to operate on the difference between the positive and negative sequence components; that is:

$$Veq = V_1 - V_2$$

Figure 4b shows a plot of this characteristic, which is a 45° line; therefore, the operating characteristic of the Type 47 relay is the same for a phase-to-phase condition as it is for the three-phase low condition.

Returning to the open-conductor situation with the solid-state relay set for 80% dropout, it can detect unbalances of only 10% negative-sequence component. For a starting current of 6 per unit, this relay can protect that motor on an open phase condition.

Inspection of Figure 4b shows that it is possible to adjust the relay for greater sensitivity to unbalance by adjusting the dropout voltage. For example, with a 90% dropout setting, the relay can detect 5% negative-sequence.

Other Relays: Other relays can be considered for phase unbalance protection:

The Type 60Q is a negative-sequence overvoltage relay. It is similar to the Type 47, but offers greater negative-sequence sensitivity. Since it does not include under-voltage protection, it can be set independently just for the unbalance protection. Refer to IB 7.4.1.7-3.

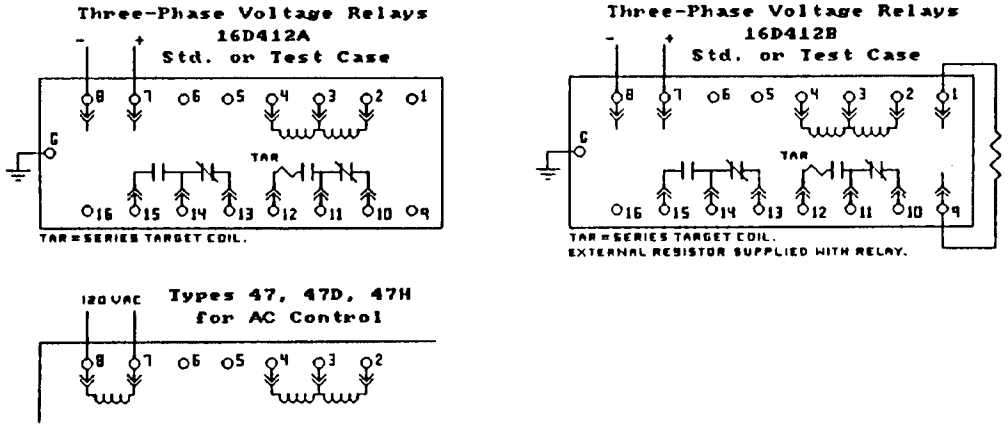
The Type 46D current balance relay, which is a negative-sequence overcurrent relay. The Type 46D would generally be applied to each motor feeder, providing protection against open conductors as well as unbalance in the supply voltage. Refer to instruction book IB 7.6.1.7-2.

INTERNAL CONNECTION DIAGRAMS AND OUTPUT CONTACT LOGIC

The following tables and diagrams define the output contact states under all possible conditions of the measured input voltage and the control power supply. "AS SHOWN" means that the contacts are in the state shown on the internal connection diagram for the relay being considered. "TRANSFERRED" means the contacts are in the opposite state to that shown on the internal connection diagram.

FOR DIAGRAMS 16D412A and 16D412B

Condition	Contact State	
Cat. Series:	412N or 212N	412F or 212F
Normal Control Power AC Input Voltage Below Setting	Transferred	Transferred
Normal Control Power AC Input Voltage Above Setting	As Shown	As Shown
No Control Voltage	As Shown	Transferred



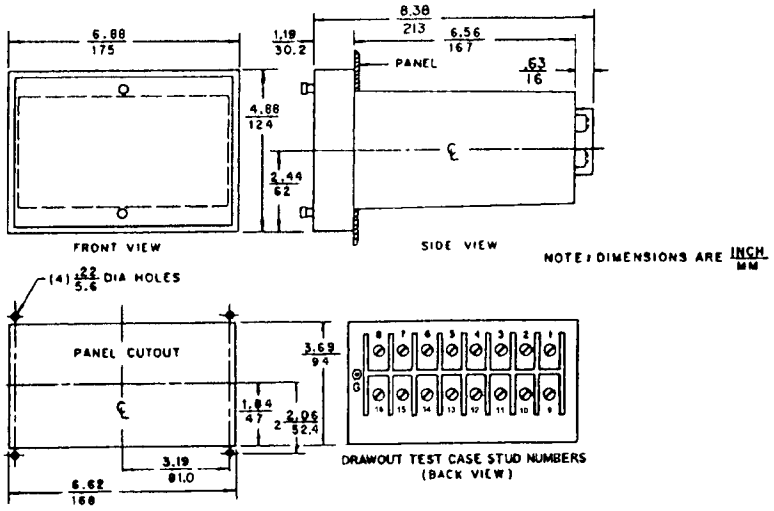


Figure 1: Relay Outline and Panel Drilling

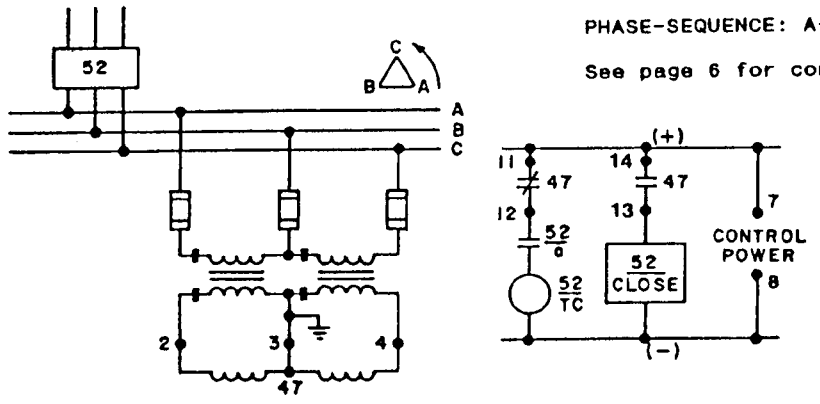


Figure 2: Typical External Connections

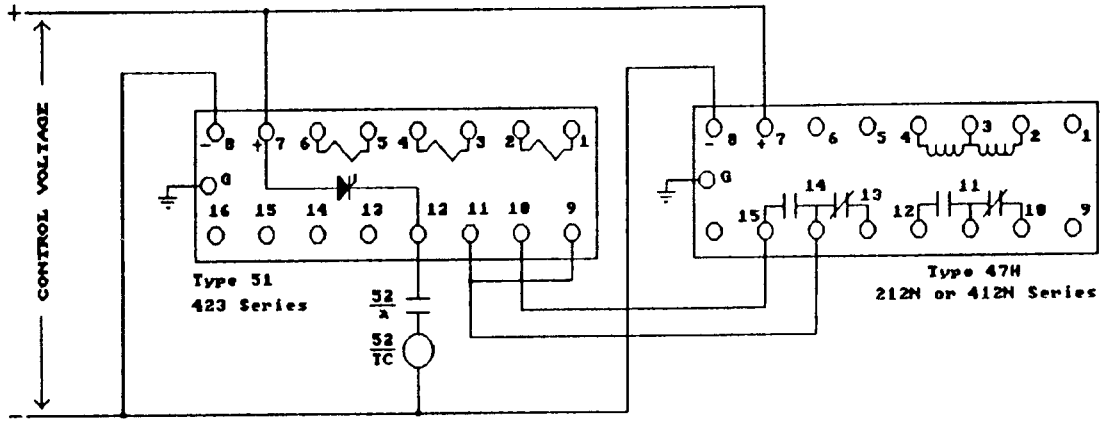


Figure 3a: Typical Control Connections - Voltage Controlled Overcurrent Relay (51V)
Type 51 Catalog Series 423 (3 phase) and Type 47H Catalog Series 412N

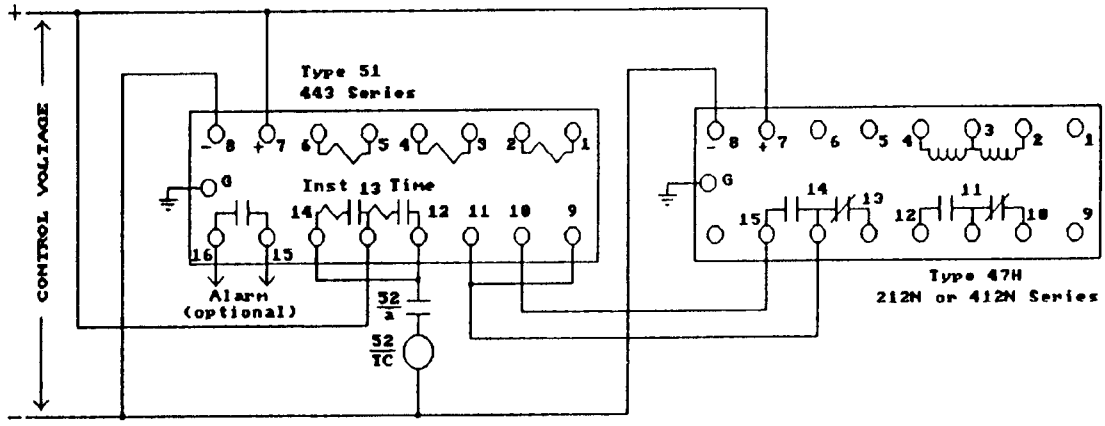


Figure 3b: Typical Control Connections - Voltage Controlled Overcurrent Relay (51V)
Type 51 Catalog Series 443 (3 phase) and Type 47H Catalog Series 412N

Notes to Figs. 3a and 3b:

1. Remove links supplied on type 51 overcurrent relay between terminals 9-10-11.
2. Diagrams shown with type 47 controlling both Time and Inst elements. If Instantaneous is to be non-controlled (active at all times), leave link on between terminals 9-10, and do not connect 9 to 11.

SPECIFICATIONS

Input Circuit:

Rating: 120v models: 160vac, continuous, 50 or 60 Hz.
208v models: 270vac, continuous, 50 or 60 Hz.

Burden: 120v models: less than 1 VA, 1.0 PF at 120 volts.
208v models: less than 1 VA, 1.0 PF at 208 volts.

Taps: available models include:

Types 47, 47D, 47H :	Pickup	90, 100, 110, 120 vac.
	Pickup	155, 175, 190, 208 vac.
	Dropout	70, 80, 90, 98% of pickup.
Types 47D, 47H:	Pickup	90, 100, 110, 120 vac.
	Dropout	30, 40, 50, 60% of pickup.

Operating Time: See Time-Voltage characteristic curves that follow.
Instantaneoue Units (Type 47H): 3 cycles maximum, typical.
Reset Time (all types): less than 150 milliseconds.

Output Circuit: Each contact

@ 125 Vdc:	@ 250 Vdc:	
30 amperes	30 amperes	tripping duty.
5 amperes	5 amperes	continuous.
1 ampere	0.3 ampere	break, resistive.
0.3 ampere	0.1 ampere	break, inductive.

Series Target Coil: 1 ampere or more of trip circuit current will insure target operation.
Withstand: 30 amperes, 1 second.
Coil resistance: negligible.

Operating Temperature Range: -30 to +70 deg. C.

Control Power: Models available for

```
48/125 vdc @ 0.05 A max.
48/110 vdc @ 0.05 A max.
24/ 32 vdc @ 0.08 A max.
   220 vdc @ 0.05 A max.
   250 vdc @ 0.05 A max.
   120 vac 50/60 HZ. @  0.05 A max.
```

Allowable variation:

```
 24 vdc  nominal: 19-29 vdc
 32 vdc      "    25-38
 48 vdc      "    38-58
110 vdc      "    88-125
125 vdc      "    100-140
220 vdc      "    176-246
250 vdc      "    200-280
120 vac      "    95-135 vac
```

Tolerances:

Operating Voltage:	+/- 3% typical +/- 5% max.	These tolerances are based on the printed dial markings. By using the calibration procedures given later in this book, the relay may be set more precisely to the desired values of operating voltage and delay with excellent repeatability.
Operating Time:	+/- 10%	
Repeatability:	variation in operating voltage for a +/- 10% variation in control voltage: +/- 0.25%, typical. variation in operating voltage over the temperature range -20 to + 55 deg C: +/- 2%, typical.	

Dielectric Strength: 2000 vac, 50/60 Hz., all circuits to ground.

Seismic Capability: More that 6g ZPA biaxial broadband multifrequency vibration without damage or malfunction. (ANSI C37.98-1978)

UL Recognized: UL File No. E103204

CHARACTERISTICS OF COMMON UNITS

Type 47, Inverse Delay per TVC-605868

Tap Ranges Pickup	Dropout	Time Delay @ zero volts	Control Voltage	Connection Diagram	Cat. Numbers 60 Hertz	50 Hertz
90-120 vac	70-98%	1-6 sec	see chart	see chart	412N11x5	412N17x5
			120 vac	16D412A	412F1165	412F1765
155-208 vac	70-98%		see chart	see chart	412N14x5	412N19x5

Type 47D, Definite-time Delay per TVC-605869

Tap Ranges Pickup	Dropout	Time Delay (dropout)	Control Voltage	Connection Diagram	Cat. Numbers 60 Hertz	50 Hertz
90-120 vac	70-98%	1-10 sec	see chart	see chart	412N41x5	412N47x5
			120 vac	16D412A	412F4165	412F4765
155-208 vac	70-98%		see chart	see chart	412N44x5	412N49x5
90-120 vac	70-98%	0.1-1 sec	see chart	see chart	412N61x5	412N67x5
			120 vac	16D412A	412F6165	412F6765
90-120 vac	70-98%	0.5-3 sec	125/24 vdc	16D412A	212N5185	---
90-120 vac	30-60%	1-10 sec	see chart	see chart	412N42x5	412N48x5
			120 vac	16D412A	412F4265	412F4865
90-120 vac	30-60%	0.1-1 sec	see chart	see chart	412N62x5	412N68x5
			120 vac	16D412A	412F6265	412F6865

Type 47H, Instantaneous

Tap Ranges Pickup	Dropout	Control Voltage	Connection Diagram	Cat. Numbers 60 Hertz	50 Hertz
90-120 vac	70-98%	see chart	see chart	412N01x5	412N07x5
90-120 vac		120 vac	16D412A	412F0165	412F0765
155-208 vac		see chart	see chart	412N04x5	412N09x5
90-120 vac	30-60%	see chart	see chart	412N02x5	412N08x5
		120 vac	16D412A	412F0265	412F0865

Voltage Digit Selection Chart: (for units with DC control:

** For each of the listed catalog numbers for the types 47, 47D, and 47H relays that contains an "x" for the dc control voltage designation: To complete the catalog number you must replace the "x" with the proper control voltage code digit shown below. The internal connection diagram is related to the control voltage; and is also shown below.
Listed above are characteristics of common units. For other combinations of pickup,dropout ranges and time delay characteristics, contact factory.

Control Voltage	Code Digit for "x-	Internal Connections
24/ 32 vdc	9	16D412A
48/125 vdc	7	16D412A
48/110 vdc	0	16D412A
220 vdc	2	16D412B
250 vdc	5	16D412B

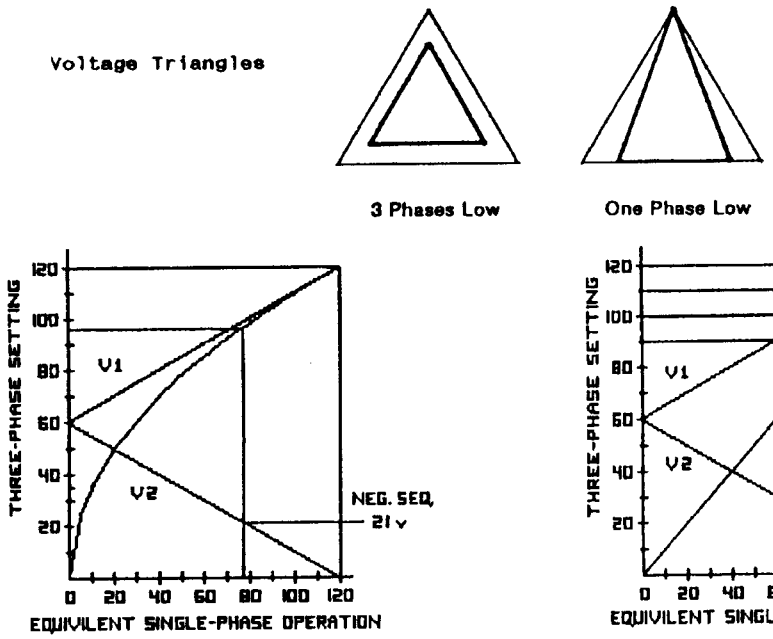


Figure 4A: Operating Characteristic Electromechanical Relay

Figure 4B: Operating Characteristic Type 47 Solid-State Relay

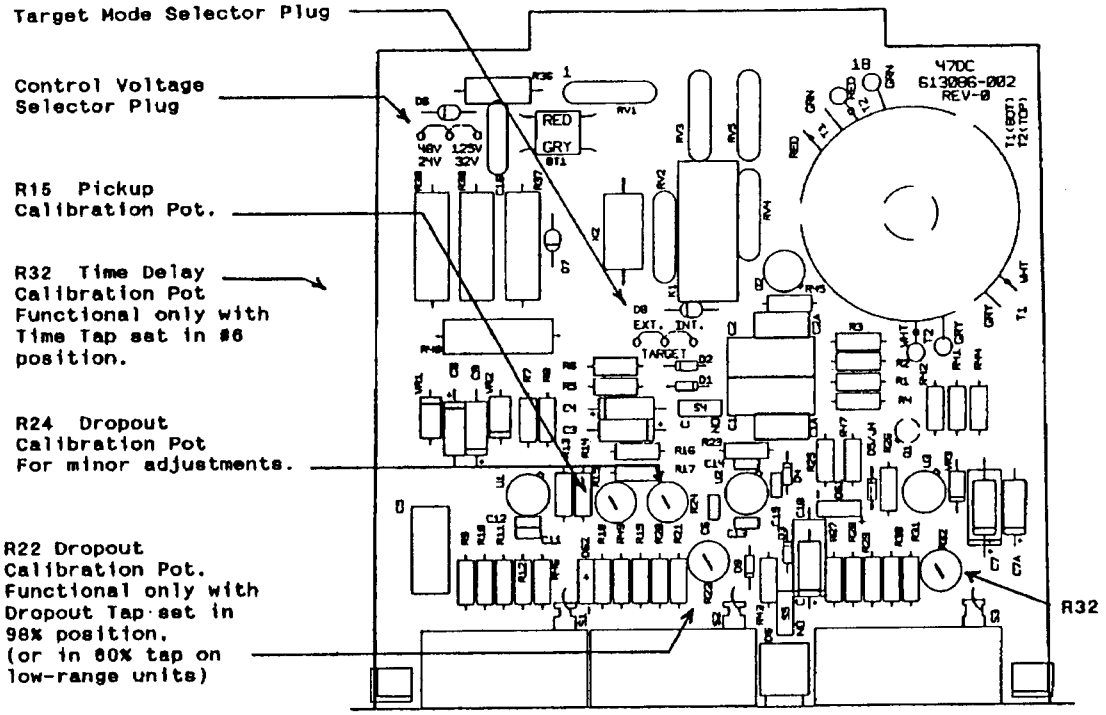
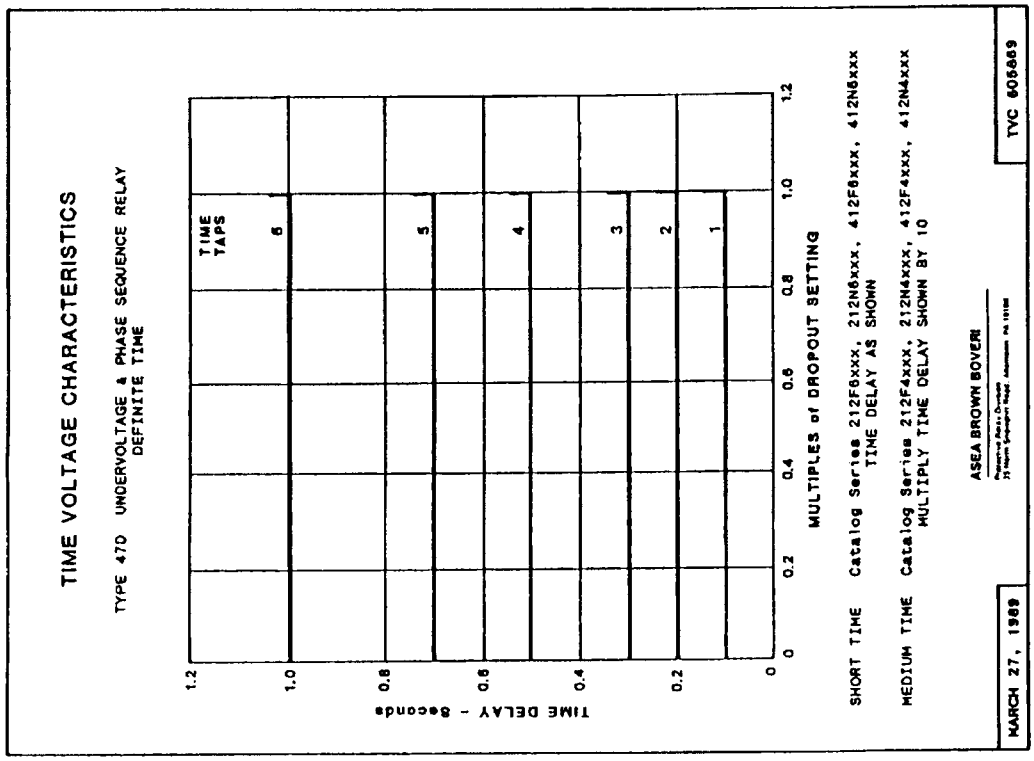
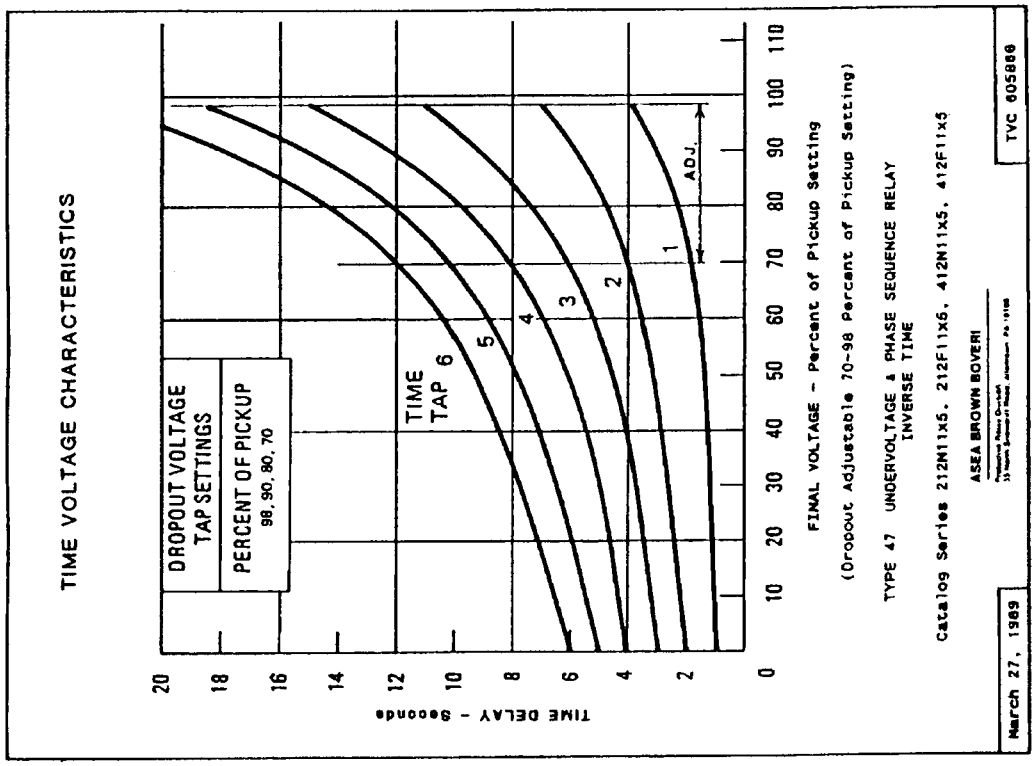


Figure 5: Typical Printed Circuit Board Layout

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


TIME VOLTAGE CHARACTERISTICS
TYPE 47D UNDERVOLTAGE & PHASE SEQUENCE RELAY
DEFINITE TIME
TIME DELAY - Seconds
TIME TAPS
6
5
4
3
2
1
MULTIPLES of DROPOUT SETTING
SHORT TIME Catalog Series 212F6xxx, 212N6xxx, 412F6xxx, 412N6xxx
TIME DELAY AS SHOWN
MEDIUM TIME Catalog Series 212F4xxx, 212N4xxx, 412F4xxx, 412N4xxx
MULTIPLY TIME DELAY SHOWN BY 10
ASEA BROWN BOVERI
MARCH 27, 1989
TVC 605869
For type 47D, Cat.Series 212N5xxx & 412N5xxx, the Time Tap Settings are:
#1: 0.5 sec; #2: 1 sec; #3: 1.5 sec; #4: 2 sec; #5: 2.5 sec; #6: 3 sec.


TIME VOLTAGE CHARACTERISTICS
DROPOUT VOLTAGE TAP SETTINGS
PERCENT OF PICKUP
98, 90, 80, 70
TIME TAP 6
5
4
3
2
1
ADJ.
TIME DELAY - Seconds
FINAL VOLTAGE - Percent of Pickup Setting
(Dropout Adjustable 70-98 Percent of Pickup Setting)
TYPE 47 UNDERVOLTAGE & PHASE SEQUENCE RELAY
INVERSE TIME
Catalog Series 212N11x5, 212F11x6, 412N11x5, 412F11x5
ASEA BROWN BOVERI
March 27, 1989
TVC 605868

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 can be provided on request. Renewal parts will be quoted by the factory on request.

The earlier versions of these three-phase voltage relays, catalog series 211F, 211N, 411F, and 411N are now obsolete and have been superseded by the improved relays described by this book. See paragraph 7 for a reference to these obsolete relays.

412F and 412N Series Units

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

Test connections are readily made to the drawout relay unit by using standard banana plug leads at the rear vertical circuit board. This rear board is marked for easier identification of the connection points.

A test plug assembly, catalog 400X0002 is available for use with the 412 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.

212F and 212N Series Units

Drawout circuit boards of the same catalog number are interchangeable. A unit is identified by the catalog number stamped on the front panel and a 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 with the unit in service may cause an undesired operation.

An 18 point extender board (cat 200X0018) is available for use in troubleshooting and calibration of the relay.

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 its case sufficient to break the rear connections before applying the test voltage.

3. BUILT-IN TEST FUNCTION

Be sure to take all necessary precautions if tests are run with the main circuit energized.

The built-in test is provided as a convenient functional test of the relay and associated circuit. When you depress the button labeled TRIP, the measuring and timing circuits of the relay are actuated. When the relay times out, the output contacts transfer to trip the circuit breaker or other associated circuitry, and the target is displayed. The test button must be held down continuously until operation is obtained. For these Undervoltage relays, the timing is equivalent to that for a complete loss of voltage.

4. ACCEPTANCE TESTS

A typical test circuit is shown in Figure 6, with the ac voltage sources connected in an open delta configuration. Connect the relay to a proper source of control voltage to match its nameplate rating (and internal plug setting for dual-rated units).

For relays rated for 120vac, 70-98% dropout, use the 100v pickup tap, and 80% dropout tap. Increase both sources equally to maintain a balanced three-phase source. Pickup should be obtained at 95-105 volts. Reduce both sources equally in small increments. The dropout led indicator should light at 80 volts (+/-4 volts). Raise the voltage until the relay picks up. Reduce one phase voltage only, holding the other at the pickup level. The dropout indicator should light for a reduced phase voltage of 79 volts (+/-5 volts). (Unbalance test not applicable to type 47H/R).

Check the timing by switching both phase voltage sources suddenly from 120 to zero volts. Refer to the time-voltage curves for the expected operating times. Operating times should be within +/-10% of the expected times.

If the final settings have been selected for the application, the procedures in paragraph 5 can be used to adjust the relay to these values if necessary.

5. CALIBRATION

A typical test circuit is shown in Figure 6 with the ac voltage sources connected in an open delta configuration. Connect the relay to a proper source of control voltage to match its nameplate rating (and internal plug setting for dual-rated units). For 212 series units the 18 point extender board provides easier access to the internal pots. For calibration purposes, the ac sources should be varied equally to provide balanced three-phase voltage.

The pickup voltage may be varied between the fixed tap values by adjusting the internal pickup calibration potentiometer. Place the PICKUP VOLTAGE tap pin in the nearest value and adjust the internal pot R15, repeating the test until the desired operating voltage is obtained. If the internal pot has insufficient range, move the tap pin to the next closest value and try again.

The dropout voltage may be trimmed by using internal calibration potentiometer R24. If a dropout value is significantly different from the fixed taps provided, then the % DROPOUT tap pin must be placed in the rightmost position, and internal calibration potentiometer R22 is used to obtain the desired operating value. R22 has an effective range of the complete range of the % DROPOUT tap selector.

Note: there may be interaction between the adjustment of the pickup and dropout voltages. Check both values and readjust as necessary.

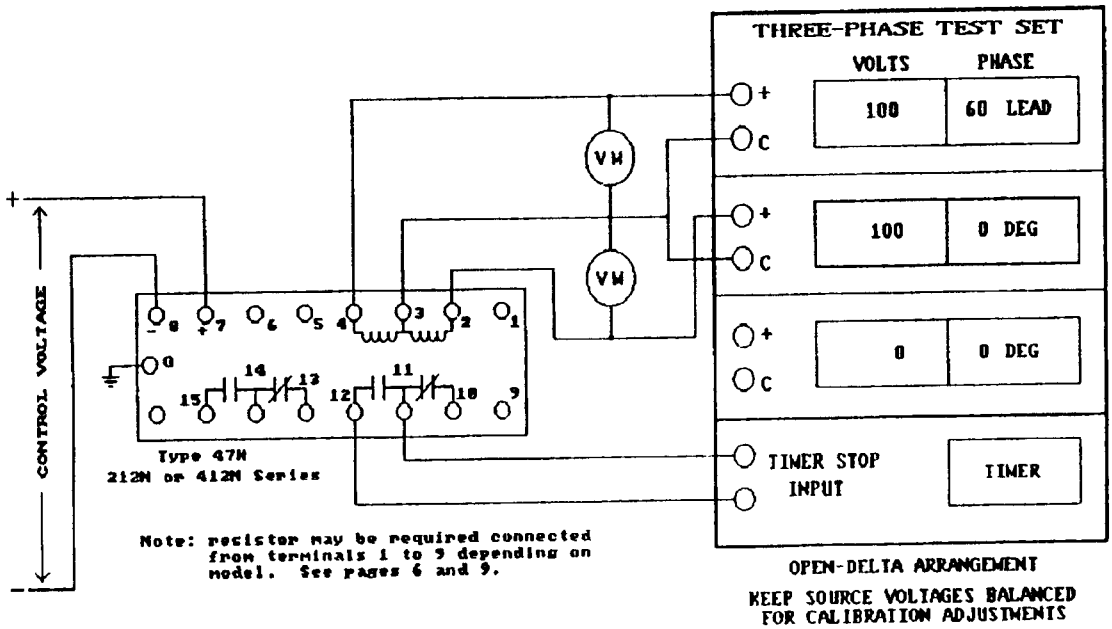
There is no adjustment for making a "minor trim" of the time delay value provided by the fixed taps. If the time delay obtained is not suitable, then move the TIME DIAL tap pin to time dial #6, and use internal pot R32 to set the desired operating time. R32 has an effective range of time dial #1 to somewhat above time dial #6.

We suggest the relay be tagged with the final operating values for reference purposes.

6. IN CASE OF DIFFICULTY

The most common problem experienced with this relay is incorrect wiring, resulting in incorrect phase-sequence being applied to the input terminals 2, 3, and 4. The relay will not pick up with incorrect phase-sequence.

Also, the wiring diagrams in this book are based on A-B-C phase rotation. Some systems operate with A-C-B rotation and the connections to the relay must be modified accordingly: swap the leads to terminals 3 and 4.



7. OBSOLETE UNITS, Catalog Series 211F, 211N, 411F, 411N

The relays referenced here are obsolete and have been superseded by the improved series 412F and 412N 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.

Major Differences:

1. The connections for the older units 211F/211N are different, and a guide to rewiring is given on the next page.

2. The older 211/411 series units provide a time-delay on pickup (reset); the 212 and 412 series units have instantaneous reset.

3. The older units with a medium-definite-time-delay have a range of 1 to 6 seconds on dropout, while the new units provide a range of 1 to 10 seconds.

4. The 211/411 series does not provide a dropout indicating led.

5. The 211/411 series does not provide the option of setting the target by means of the flow of trip circuit current.

The instruction book for the 211F/N and 411F/N series units is IB 7.4.1.7-2 Issue B, which may be requested from the factory.

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

"Old" Catalog Number	Replace with 60 Hertz System	50 Hertz System
211F1171	412N1175	412N1775
211F4171	412N4175	412N4775
211F6171	412N6175	412N6775
211F1174	412N1175	412N1775
211F0171	412N0175	412N0775
211F1161	412F1165	412F1765
211F4161	412F4165	412F4765
211F6161	412F6165	412F6765
211F0161	412F0165	412F0765
211F0271	412N0275	412N0875
211N5181	412N5185	
211N1171, 411N1171	412N1175	412N1775
211N4171, 411N4171	412N4175	412N4775
211N6171, 411N6171	412N6175	412N6775
211N4191, 411N4191	412N4195	412N4795
211N6191, 411N6191	412N6195	412N6795
211N0191, 411N0191	412N0195	412N0795
211N0271, 411N0271	412N0275	412N0875

Refer to the factory for recommended substitution if your relay is not listed above.

Wiring Changes:

Replacement of an older style 211F/211N unit with the 412 series unit requires changing out the entire relay including the case assembly (cases are the same size), and rewiring. The following is a guide to the rewiring required:

Note: where letter "x" is used, it represents any digit.

Replacing a catalog series 211Fxxx1 with the 412 series equivalent:

Wire on 211Fxxx1 terminal moves to terminal on 412 unit	2	3	4	7	8	9	10	11	12	G
	2	3	4	7	8	10	11	14	15	G

Replacing a catalog series 211Fxxx4 with the 412 series equivalent:

Wire on 211Fxxx4 terminal moves to terminal on 412 unit	2	3	4	5	6	7	8	11	12	G
	2	3	4	14	15	7	8	11	12	G

Replacing a catalog series 211Nxxx1 with the 412 series equivalent:

Wire on 211Nxxx1 terminal moves to terminal on 412 unit	1	2	3	4	5	6	7	8	9	10	11	12	G
	12	2	3	4	14	13	7	8	11	10	14	15	G

Replacing a 411 series unit with the 412 series equivalent: no change in wiring;
Drawout relay assembly may be plugged directly into existing case.

Note:
The 412 series units include the option of having the target set by means of the current flowing in the trip circuit. If you want to use this feature, it may be necessary to further rearrange the output contact wiring, since the series target coil is associated with contact 11-12 on the 412 series unit. Refer to the internal connection diagrams on page 6.