



IB 7.4.1.7-5  
Issue C

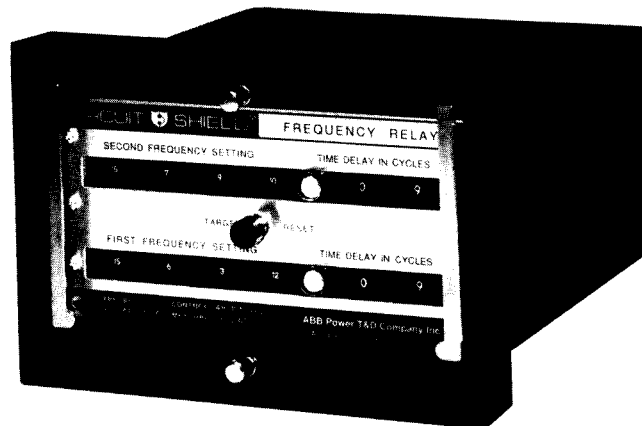
# INSTRUCTIONS

Frequency Relay

CIRCUIT SHIELD<sup>®</sup>

Type 81

Catalog Series 422



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INTRODUCTION

These instructions contain the information required to properly install, operate, and test the ABB Circuit-Shield™ Type 81 Frequency Relay, catalog series 422.

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 422 catalog series are similar to earlier designs of the 222 series. Both series provide the same basic functions and are of totally drawout construction; however, the 422 series relays provide integral test facilities. Also, sequenced disconnects on the 422 series prevent nuisance operation during withdrawal or insertion of the relay if the normally-open contacts are used in the application.

All 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 422 catalog series units are different than the 222 series units.*
2. Apply only the rated 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. Internal movable links are used to set up the mode of operation of the relay. Be sure to inspect and set the links prior to placing the relay in service. See section on connections for more information.
5. High voltage insulation tests are not recommended. See section on testing for additional information.
6. The entire circuit assembly of the relay is removable. The unit should insert smoothly. Do not use excessive force.
7. Follow test instructions to verify that the relay is in proper working order.

**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 clean and dry.

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## 2. INSTALLATION

### Mounting:

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

### Connections:

Internal connections are shown in Figure 2. Typical external connections are shown in Figure 3.

*Important: connections are different for 422 series units compared to 222 series units.*

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.

Internal selector plugs are provided to set up various operating modes. The relay must be withdrawn from its case and the plugs set, properly for the application. See Figure 4 for the locations of the selector plugs.

### Control Power Selector Plug:

Control power must be connected in the proper polarity. For relays with dual-rated control power: 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 plug should be placed in the position marked 125vdc.)

### Operating Mode Selector Plug:

An internal selector plug is provided to choose whether the relay will function as an underfrequency relay or overfrequency relay. If the relay has two stages, a plug will be provided for each stage. The operation of each stage is independently set. In other words, the relay may be set for (2) steps of underfrequency operation, or for (1) step of overfrequency and (1) step of underfrequency operation, or (2) steps of overfrequency operation.

### Target Operation Selector Plug:

This plug sets the mode of operation of the target. This is a new feature not previously available on 222 series units. Setting the plug in the SHUNT or INT position provides for the target to be operated electronically at the same time the output relay is energized. With the plug in the SERIES or EXT position, a trip circuit current of 1 ampere or more is required in the coil labeled TAR on the internal connection diagram. (The polarity of this current does not matter.)

(Note: a number of units, catalog number 422xx1xx have been produced without the trip current operated target feature. Targets on these units are electronically activated when the tripping output is energized.)

## 3. SETTINGS

### Coded Trip Point Frequency Setting

For 60 Hertz models, Table 1 provides setting codes for frequencies between 54 and 63 Hz in steps of 0.05 Hz. Table 2 provides settings for 50 Hz. models for frequencies between 45 and 52 Hz. These tables include the settings commonly used in most applications. Should special settings be required outside these ranges, or between two values given, the codes may be requested from the factory.

Trip point adjustment is accomplished by setting the four thumbwheel switches to the numbers shown in the table which corresponds to the desired trip frequency. Each of the thumbwheel switches is labeled 0 to 15. Settings are shown in the tables in the same arrangement left to right as they are to be made on the relay.

### Time Delay Setting

The time delay thumbwheel switches are labeled directly in cycles. The adjustment range is 1 to 99 cycles. The time delay period will not start until (3) consecutive "bad" cycles have been detected. Therefore the total operating time is the dial setting plus 3 cycles. The timing function will reset upon receiving one "good" cycle. *Do not set the time delay to "00". This will cause a constant trip.*

**IMPORTANT:** THE SETTINGS SHOULD NOT BE CHANGED WITH THE RELAY IN SERVICE. AN INCORRECT OPERATION MAY OCCUR DURING THE TRANSITION FROM ONE SETTING TO ANOTHER.

Undervoltage Cutoff Function

The undervoltage cutoff function will block operation of the frequency relay when the input line voltage drops below its setting. This is an internal adjustment that must be set by test. The factory setting is 60 vac nominal. Refer to the section on testing for re-calibration procedure.

APPLICATION DATA

The ABB Circuit-Shield™ Type 81 Frequency Relay is a reliable solid-state relay designed to provide accurate detection of abnormal frequency conditions on electrical power systems. The Type 81 is available in one-stage and two-stage models. Single – stage models are provided with means to select either underfrequency operation or overfrequency operation. Two-stage models may be set up for either two steps of underfrequency operation as might be found in load-shedding applications; or, for one step of underfrequency and one step of overfrequency operation as would typically be found in generator protection; or, for two steps of overfrequency.

These relays use solid-state technology and digital counting techniques to provide accurate frequency measurement. The time base for measurement is provided by a very stable crystal oscillator. Standard set point accuracy is 0.008 Hz. Models with an accuracy of 0.005 Hz. can be supplied on request. Trip frequency and time delay settings are easily made on the front panel of the relay by means of thumbwheel switches. The timer begins when the relay has detected 3 consecutive "bad" cycles; therefore, the total operating time of the relay is the delay set on the front panel plus 3 cycles. The time delay counter is fully reset if one "good" cycle occurs prior to the relay timing out and tripping.

The Type 81 has operating characteristics which make it ideal for application on closely coordinated system load shedding programs. The accuracy and stability of the relay characteristic permits settings much closer to normal system frequency, and closer steps between settings of relays in a load shedding program than possible with electromechanical relays.

Another application is typical to large industrial plants which have some local generation. Normally they depend on a tie line to a utility for some portion of their power needs. If the breaker at the utility end should open, the generator in the plant would be overloaded, especially if it also attempts to pick up utility load tapped on the tie line. This overload causes an underfrequency condition on the industrial system. The Type 81 can be used to open the tie to the utility system and to drop non-essential loads in the plant. Essential loads can be maintained to the limit of the generator capability.

In DSG applications, typical protection includes a two step Type 81 providing an under and overfrequency window and an ABB Type 27/59 providing an under and overvoltage window. If the frequency or voltage deviates from within either of these windows the tie to the utility system is opened.

CHARACTERISTICS OF COMMON UNITS

Nominal System Frequency	Number of Steps	Output Contacts	Connection Diagram	Control voltage	Catalog Number
60 Hz	1	2 form C	16D422A	48/125 vdc	422B1275
				48/110 vdc	422B1205
				24/32 vdc	422B1295
				24/125 vdc	422B1285
				250 vdc	422B1255
50 Hz	1	2 form C	16D422A	48/125 vdc	422D1275
				48/110 vdc	422D1205
				24/32 vdc	422D1295
				110/220 vdc	422D1225
				250 vdc	422D1255
60 Hz	2	1 form C for each step	16D422B	48/125 vdc	422C1276
				48/110 vdc	422C1206
				24/32 vdc	422C1296
				250 vdc	422C1256
50 Hz	2	1 form C for each step	16D422B	48/125 vdc	422E1276
				48/110 vdc	422E1206
				24/32 vdc	422E1296
				110/220 vdc	422E1226
				250 vdc	422E1256

**SPECIFICATIONS:**

Input Circuit: 60-140 Vac Continuous; 300 Vac for 10 seconds.

Input Burden: 0.7 VA

Undervoltage Cutoff Function: adjustable 60-100 vac, factory setting 60 volts.  
operating time: approximately 30 milliseconds.  
reset time: approximately 65 milliseconds.Trip Point Setting Range: 60 Hz. models – see Table 1 for settings 63.00-54.00 Hz.  
50 Hz. models – see Table 2 for settings 52.00-45.00 Hz. (Settings outside these ranges are possible. Consult factory for feasibility and setting codes.)Trip Point Accuracy and Repeatability: +/- 0.008 Hz., -20 to +55 deg C.  
(+/- 0.005 Hz. available on request)

Time Delay Range: Adjustable 1 to 99 cycles; (add 3 cycles measurement time for total operating time.)

Accuracy and repeatability: typical: +/-1 cycle,  
limits: +3/-2 cycles.

Operating Temperature Range: -30 to +75 deg. C.

Output Circuit: Contact ratings at	<u>125 Vdc</u>	<u>250 Vdc</u>
Tripping	30 amperes	30 amperes
Continuous	5 amperes	5 amperes
Break	0.3 amperes	0.1 amperes

Series Target Coil: 1 ampere or more trip circuit current will insure target operation.

Withstand: 30 amperes, 1 second.

Coil resistance: negligible.

For output circuits with less than 1 ampere current, set relay selector plug for Internal (shunt) operation.

Control Power: models available for

48/125 vdc at 0.03	ampere standby,	0.07 ampere max.
48/110 vdc at 0.03	ampere standby,	0.07 ampere max.
24/ 32 vdc at 0.04	ampere standby,	0.11 ampere max.
24/125 vdc at 0.04	ampere standby,	0.11 ampere max.
110/220 vdc at 0.03	ampere standby,	0.07 ampere max.
250 vdc at 0.03	ampere standby,	0.06 ampere max.
120 vac – consult. factory.		

Allowable variation:	24v nominal:	19– 29 vdc.
	32v nominal:	25– 38 vdc.
	48v nominal:	38– 58 vdc.
	110v nominal:	88–125 vdc.
	125v nominal:	100–140 vdc.
	220v nominal:	175–246 vdc.
	250v nominal:	200–280 vdc.

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

UL Recognized: UL File number E103204

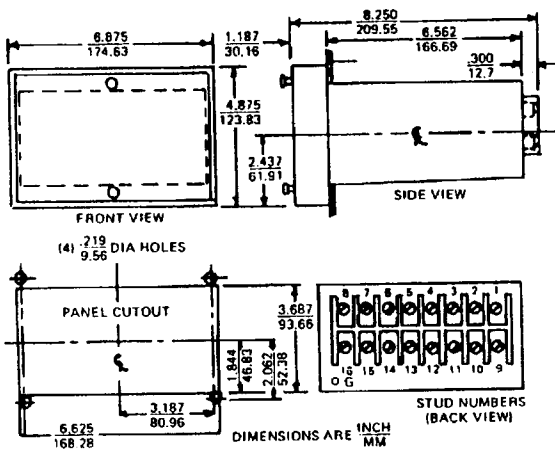


Figure 1: Relay Outline and Drilling

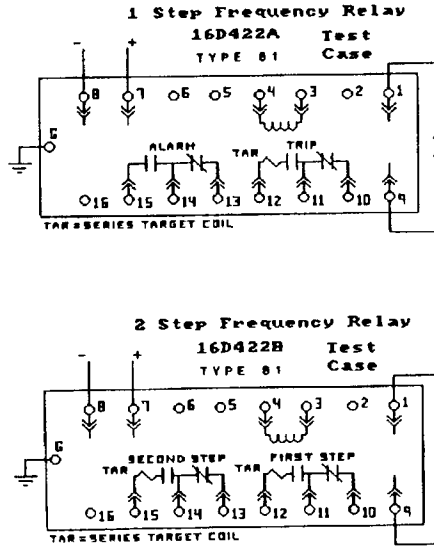


Figure 2: Internal Connections

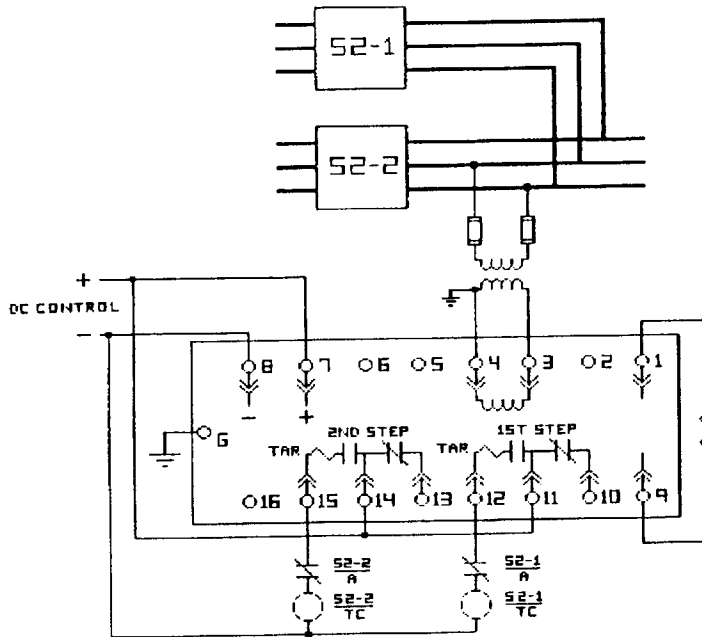


Figure 3a: Typical External Connections

Load Shedding Application  
Relay Set for 2 Steps of Underfrequency

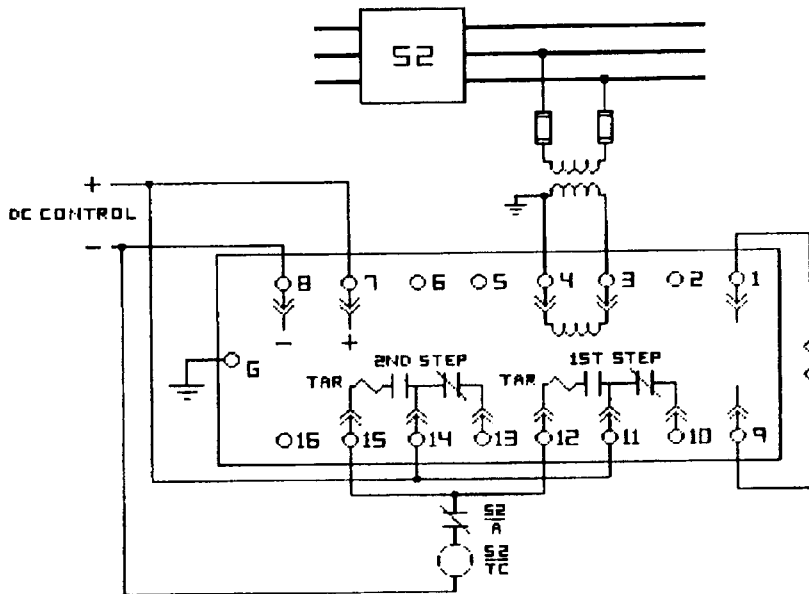


Figure 3b: Typical External Connections

Generator Protection Application  
2 Step Relay Set for Under and Overfrequency Operation

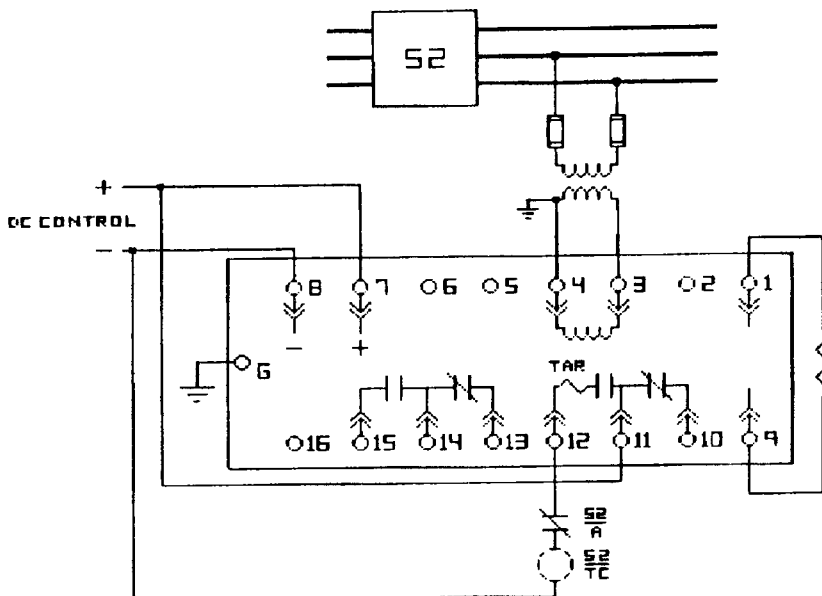


Figure 3c: Typical External Connections

Single Step Relay

**TABLE 1 – TRIP POINT FREQUENCY CODES For 60Hz Units Only**

TRIP POINT FREQ	SWITCH SETTINGS	TRIP POINT FREQ	SWITCH SETTINGS	TRIP POINT FREQ	SWITCH SETTINGS
63.00	15 7 6 9	60.00	13 6 6 11	57.00	14 5 8 13
62.95	12 1 7 9	59.95	15 9 6 11	56.95	13 9 8 13
62.90	12 4 7 9	59.90	12 3 7 11	56.90	13 3 9 13
62.85	13 7 7 9	59.85	14 6 7 11	56.85	12 7 9 13
62.80	14 0 8 9	59.80	12 0 8 11	56.80	12 1 0 14
62.75	14 3 8 9	59.75	14 3 8 11	56.75	15 4 0 14
62.70	15 6 8 9	59.70	12 7 8 11	56.70	15 8 0 14
62.65	12 10 8 9	59.65	14 0 9 11	56.65	14 2 1 14
62.60	12 3 9 9	59.60	13 4 9 11	56.60	14 6 1 14
62.55	13 6 9 9	59.55	15 7 9 11	56.55	13 0 2 14
62.50	14 9 9 9	59.50	13 1 0 12	56.50	13 4 2 14
62.45	15 2 0 10	59.45	15 4 0 12	56.45	13 8 2 14
62.40	12 6 0 10	59.40	13 8 0 12	56.40	12 2 3 14
62.35	12 9 0 10	59.35	15 1 1 12	56.35	12 6 3 14
62.30	13 2 1 10	59.30	13 5 1 12	56.30	12 10 3 14
62.25	14 5 1 10	59.25	12 9 1 12	56.25	12 4 4 14
62.20	15 8 1 10	59.20	14 2 2 12	56.20	12 8 4 14
62.15	12 2 2 10	59.15	12 6 2 12	56.15	15 1 5 14
62.10	13 5 2 10	59.10	14 9 2 12	56.10	15 5 5 14
62.05	14 8 2 10	59.05	13 3 3 12	56.05	15 9 5 14
62.00	15 1 3 10	59.00	15 6 3 12	56.00	15 3 6 14
61.95	12 5 3 10	58.95	14 0 4 12	55.95	15 7 6 14
61.90	13 8 3 10	58.90	12 4 4 12	55.90	15 1 7 14
61.85	14 1 4 10	58.85	14 7 4 12	55.85	15 5 7 14
61.80	15 4 4 10	58.80	13 1 5 12	55.80	15 9 7 14
61.75	12 8 4 10	58.75	15 4 5 12	55.75	15 3 8 14
61.70	13 1 5 10	58.70	14 8 5 12	55.70	15 7 8 14
61.65	15 4 5 10	58.65	12 2 6 12	55.65	15 1 9 14
61.60	12 8 5 10	58.60	15 5 6 12	55.60	12 6 9 14
61.55	13 1 6 10	58.55	13 9 6 12	55.55	12 10 9 14
61.50	14 4 6 10	58.50	12 3 7 12	55.50	12 4 0 15
61.45	15 7 6 10	58.45	15 6 7 12	55.45	12 8 0 15
61.40	13 1 7 10	58.40	13 0 8 12	55.40	13 2 1 15
61.35	14 4 7 10	58.35	12 4 8 12	55.35	13 6 1 15
61.30	15 7 7 10	58.30	15 7 8 12	55.30	13 0 2 15
61.25	13 1 8 10	58.25	13 1 9 12	55.25	14 4 2 15
61.20	14 4 8 10	58.20	12 5 9 12	55.20	14 8 2 15
61.15	15 7 8 10	58.15	15 8 9 12	55.15	14 2 3 15
61.10	13 1 9 10	58.10	14 2 0 13	55.10	15 6 3 15
61.05	14 4 9 10	58.05	13 6 0 13	55.05	15 0 4 15
61.00	15 7 9 10	58.00	15 9 0 13	55.00	12 5 4 15
60.95	13 1 0 11	57.95	14 3 1 13	54.95	12 9 4 15
60.90	14 4 0 11	57.90	13 7 1 13	54.90	13 3 5 15
60.85	12 8 0 11	57.85	12 1 2 13	54.85	14 7 5 15
60.80	13 1 1 11	57.80	15 4 2 13	54.80	14 1 6 15
60.75	15 4 1 11	57.75	14 8 2 13	54.75	15 5 6 15
60.70	12 8 1 11	57.70	13 2 3 13	54.70	12 10 6 15
60.65	14 1 2 11	57.65	12 6 3 13	54.65	12 4 7 15
60.60	12 5 2 11	57.60	15 9 3 13	54.60	13 8 7 15
60.55	13 8 2 11	57.55	14 3 4 13	54.55	14 2 8 15
60.50	15 1 3 11	57.50	13 7 4 13	54.50	15 6 8 15
60.45	13 5 3 11	57.45	12 1 5 13	54.45	15 0 9 15
60.40	14 8 3 11	57.40	12 5 5 13	54.40	12 5 9 15
60.35	12 2 4 11	57.35	15 8 5 13	54.35	13 9 9 15
60.30	14 5 4 11	57.30	14 2 6 13	54.30	14 3 10 15
60.25	12 9 4 11	57.25	13 6 6 13	54.25	15 7 10 15
60.20	13 2 5 11	57.20	13 0 7 13	54.20	12 2 11 15
60.15	15 5 5 11	57.15	12 4 7 13	54.15	13 6 11 15
60.10	13 9 5 11	57.10	15 7 7 13	54.10	14 0 12 15
60.05	15 2 6 11	57.05	14 1 8 13	54.05	15 4 12 15
				54.00	13 9 12 15

DIAL SETTINGS ARE SHOWN IN THE SAME ARRANGEMENT AS THEY ARE TO BE MADE ON THE FRONT PANEL OF THE RELAY



TABLE 2 – TRIP POINT FREQUENCY CODES For 50Hz units only

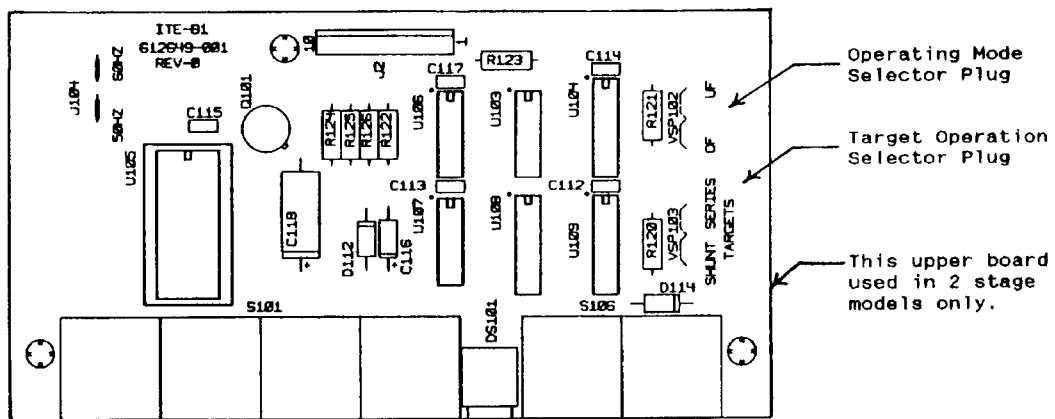
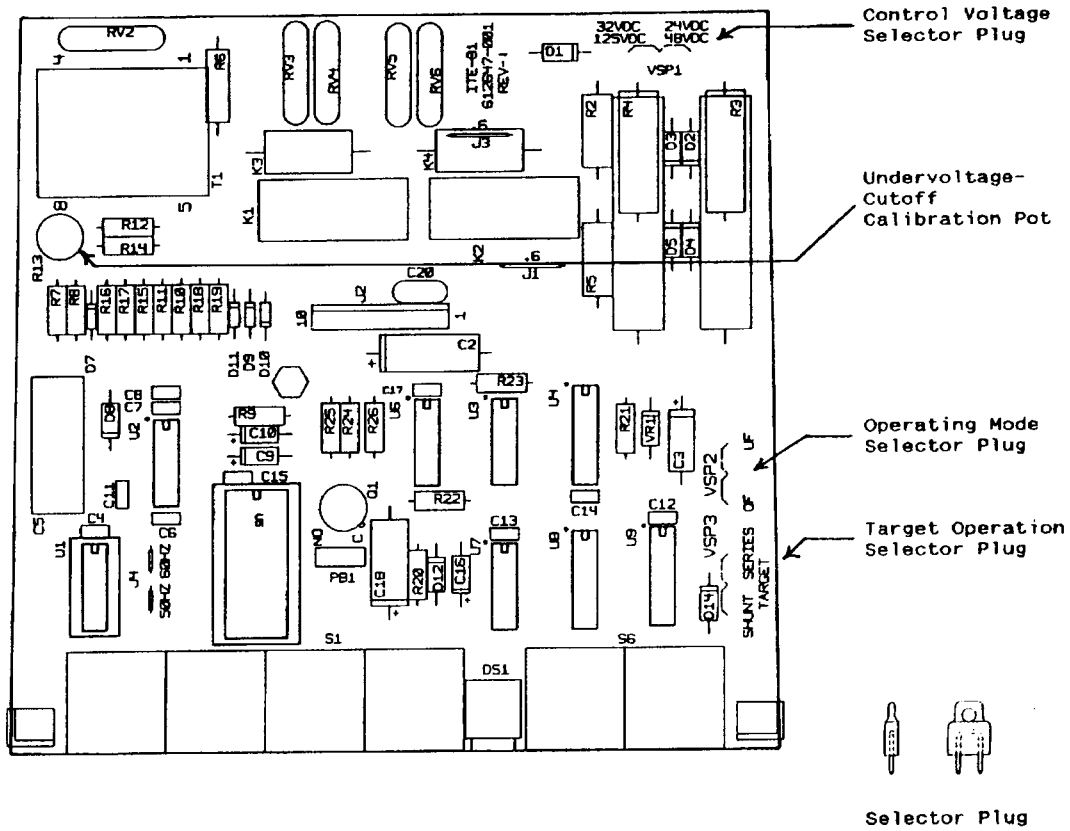
TRIP POINT FREQ	SWITCH SETTINGS	TRIP POINT FREQ	SWITCH SETTINGS	TRIP POINT FREQ	SWITCH SETTINGS
52.00	15 6 4 9	49.75	15 4 3 10	47.25	13 2 4 11
51.95	14 8 4 9	49.70	8 7 3 10	47.20	15 4 4 11
51.90	13 0 5 9	49.65	8 9 3 10	47.15	9 7 4 11
51.85	12 2 5 9	49.60	9 1 4 10	47.10	11 9 4 11
51.80	11 4 5 9	49.55	9 3 4 10	47.05	14 1 5 11
51.75	10 6 5 9	49.50	10 5 4 10	47.00	8 4 5 11
51.70	9 8 5 9	49.45	10 7 4 10	46.95	10 6 5 11
51.65	8 0 6 9	49.40	11 9 4 10	46.90	13 8 5 11
51.60	8 2 6 9	49.35	11 1 5 10	46.85	15 0 6 11
51.55	15 3 6 9	49.30	12 3 5 10	46.80	10 3 6 11
51.50	14 5 6 9	49.25	13 5 5 10	46.75	12 5 6 11
51.45	13 7 6 9	49.20	13 7 5 10	46.70	15 7 6 11
51.40	13 9 6 9	49.15	14 9 5 10	46.65	9 0 7 11
51.35	12 1 7 9	49.10	15 1 6 10	46.60	12 2 7 11
51.30	11 3 7 9	49.05	8 4 6 10	46.55	15 4 7 11
51.25	11 5 7 9	49.00	9 6 6 10	46.50	9 7 7 11
51.20	10 7 7 9	48.95	9 8 6 10	46.45	12 9 7 11
51.15	10 9 7 9	48.90	10 0 7 10	46.40	15 1 8 11
51.10	9 1 8 9	48.85	11 2 7 10	46.35	10 4 8 11
51.05	9 3 8 9	48.80	12 4 7 10	46.30	13 6 8 11
51.00	8 5 8 9	48.75	13 6 7 10	46.25	8 9 8 11
50.95	8 7 8 9	48.70	14 8 7 10	46.20	10 1 9 11
50.90	8 9 8 9	48.65	8 1 8 10	46.15	13 3 9 11
50.85	15 0 9 9	48.60	9 3 8 10	46.10	8 6 9 11
50.80	15 2 9 9	48.55	10 5 8 10	46.05	12 8 9 11
50.75	15 4 9 9	48.50	11 7 8 10	46.00	15 0 0 12
50.70	14 6 9 9	48.45	12 9 8 10	45.95	10 3 0 12
50.65	14 8 9 9	48.40	14 1 9 10	45.90	13 5 0 12
50.60	14 0 0 10	48.35	15 3 9 10	45.85	8 8 0 12
50.55	14 2 0 10	48.30	8 6 9 10	45.80	12 0 1 12
50.50	14 4 0 10	48.25	10 8 9 10	45.75	15 2 1 12
50.45	14 6 0 10	48.20	11 0 0 11	45.70	10 5 1 12
50.40	13 8 0 10	48.15	12 2 0 11	45.65	14 7 1 12
50.35	13 0 1 10	48.10	14 4 0 11	45.60	9 0 2 12
50.30	13 2 1 10	48.05	15 6 0 11	45.55	13 2 2 12
50.25	13 4 1 10	48.00	9 9 0 11	45.50	8 5 2 12
50.20	13 6 1 10	47.95	11 1 1 11	45.45	12 7 2 12
50.15	14 8 1 10	47.90	12 3 1 11	45.40	15 9 2 12
50.10	14 0 2 10	47.85	14 5 1 11	45.35	11 2 3 12
50.05	14 2 2 10	47.80	8 8 1 11	45.30	15 4 3 12
50.00	14 4 2 10	47.75	9 0 2 11	45.25	11 7 3 12
49.95	14 6 2 10	47.70	11 2 2 11	45.20	14 9 3 12
49.90	14 8 2 10	47.65	13 4 2 11	45.15	10 2 4 12
49.85	15 0 3 10	47.60	15 6 2 11	45.10	14 4 4 12
49.80	15 2 3 10	47.55	9 9 2 11	45.05	10 7 4 12
		47.50	11 1 3 11	45.00	14 9 4 12
		47.45	13 3 3 11		
		47.40	15 5 3 11		
		47.35	9 8 3 11		
		47.30	11 0 4 11		

DIAL SETTINGS ARE SHOWN IN THE SAME ARRANGEMENT AS THEY ARE TO BE MADE ON THE FRONT PANEL OF THE RELAY

Note:

The ABB Circuit-Shield Type 81 relay is capable of a setting resolution of 0.01 Hertz. Contact the factory if you need a setting code for a frequency set point not listed in the tables.

Figure 4: Location of Selector Plugs



These drawings represent typical printed circuit board layouts for relays of catalog series 422 units. Variations may exist on board in service. The selector plugs must be positioned properly for the desired modes of operation. Refer to page 3 for a description of plug functions.

Calculation of TIME DELAY switch settings:

If the required operating time of the relay has been given in seconds, this value must be converted to the proper switch settings in cycles. Use the following formula:

$$\text{Setting in cycles} = (t \times f) - 3 \quad \text{where} \quad \begin{array}{l} t = \text{desired operating time in seconds} \\ f = \text{set point frequency} \end{array}$$

For example: with a set point of 58.5 Hz, a total operating time of 0.20 seconds is desired.  
Setting =  $(0.2 \times 58.5) - 3 = 11.7 - 3 = 8.7$  cycles; therefore set the TIME DELAY switches to "09" cycles.

TESTING

1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on the Type 81 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 and circuit description will be provided on request. Renewal parts will be quoted by the factory on request.

See Paragraph 4 for basic information on units of catalog series 222 which are no longer in production.

Drawout Element – Catalog Series 422

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 an operation. The assembly is identified by the catalog number stamped on the front panel of the unit and by a serial number stamped on the bottom of the 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.

Important: in order to test the drawout unit, a resistor must be connected temporarily between terminals 1 and 9 on the rear vertical circuit board. The value of this resistor depends on the control voltage rating of the relay and should be marked on the rear board. A 25 watt resistor is sufficient. If no resistor is available, the resistor assembly mounted on the rear of the relay case could be removed and used. If the resistor from the case is used, be sure to remount it on the case at the conclusion of testing.

*Exception:* for dual rated relays (48/125 vdc, 24/32 vdc, 48/110 vdc, 24/125vdc, 110/220 vdc), the resistor is required only when the relay is set up for the *higher* of the two voltage ratings.

External Resistor Values:

Relay rating:	24/32 vdc	48/125 v	48/110 v	24/125 v	110/220 v	250 vdc
Resistor value:	250 ohm	3500 ohm	3000 ohm	3500 ohm	4500 ohm	8200 ohm

Test Plug.

A test plug assembly, catalog number 400X0002 is available for use with the 422 series unit. 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 of this device.

2. HIGH POTENTIAL TESTS

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

On 422 series units, a link on the rear vertical circuit board is removed temporarily 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. The link is labeled "remove for hipot".

**3. ACCEPTANCE TESTS**

**Functional Test without Variable Frequency Source:**

A typical test circuit is shown in Figure 5. Set the relay for the desired modes of operation. If target operation is to be by trip circuit current, reset the plugs for Series (External) operation, and connect a lockout relay as a load on the output contacts. If a lockout relay is not available, set the target for shunt (Internal) operation at this time. Set the frequency codes and the time delay per the following chart:

Relay Model	Internal Plug Set for	Frequency codes	Time Delay Setting
60 Hz.	Underfrequency	15 1 3 10 (62.00 Hz)	90 cycles
	Overfrequency	15 9 0 13 (58.00 Hz)	90 cycles
50 Hz.	Underfrequency	15 6 4 9 (52.00 Hz)	75 cycles
	Overfrequency	9 9 0 11 (48.00 Hz)	75 cycles

Apply rated dc control voltage to the relay. (Be sure voltage selector plug is in the proper position, Reset the target. Apply a 120 vac 60 Hz input signal for 60 Hz units, or 120 vac 50Hz for 50 Hz. units. After approximately a 1.5 second delay, the relay contacts should transfer to the trip condition and the target should set.

Lower the input voltage. At 66-54 volts input, the contacts should transfer back to the "normal" state as the undervoltage blocking function operates. If a different value is required for the application, adjust internal trimmer potentiometer R13 and repeat the test.

At the conclusion of these tests be sure to reset the relay to the values required for the application. Also recheck the positions of the selector plugs.

**Calibration Tests with Variable Frequency source:**

A typical test circuit is shown in Figure 6. Set the internal plugs for the desired modes of operation and for the dc control voltage. Set the target for internal (Shunt) operation. Follow the same basic procedure given above in "Functional Testing" to confirm basic operation and undervoltage cutoff functions.

**Operating Point Test:** Set the desired frequency codes on the thumbwheel switches. Set the time delay switches to 01 cycle. Apply dc control voltage. Set the level of the variable frequency source to approximately 120 vac. Raise and lower the frequency of the test source slowly to determine the relay's operating point. The operating point should be within +/- 0.008 Hz of the setpoint.

**Time Delay Test:** Set the desired time delay on the thumbwheel switches. Apply rated dc control power. Reset the target. For underfrequency operation, set the variable frequency source to 0.2 Hertz below the relay's frequency setting. For overfrequency operation, set the variable frequency source to 0.2 Hertz above the frequency setting. Set the voltage levels of both sources at approximately 120vac. Switch relay input from the line frequency source to the variable source. Record the operating time of the relay. Compare to the expected delay time.

*For example:* if the time delay switches were set for 20 cycles, and the frequency of the variable source were set to 58.8 Hertz, the total operating time expected would be calculated as follows:

$$1 \text{ cycle of } 58.8 \text{ Hz} = 1/58.8 = 17.0 \text{ milliseconds.}$$

$$\begin{aligned} \text{Total operating time} &= 3 \text{ cycles measurement} + \text{time delay switch setting} \\ &= 3 \text{ cycles measurement} + 20 \text{ cycles timer setting} \\ &= 23 \text{ cycles total} \times 17.0 \text{ milliseconds per cycle} \\ &= 391 \text{ milliseconds} \end{aligned}$$

Allowable tolerance = +3/-2 cycles: which in this example gives 357-442 ms.

Note: for settings below about 6 cycles, point-on-wave switching effects and inherent limitations of the test equipment can make accurate measurement difficult. In such cases, a longer delay setting should be used to confirm basic relay operation.

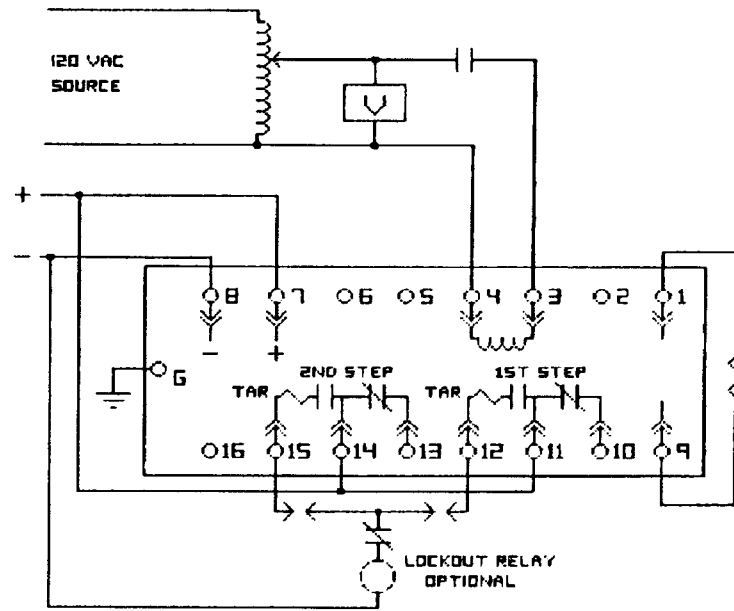


Figure 5: Typical Test Circuit - Functional Test  
(2 Stage Relay Shown)

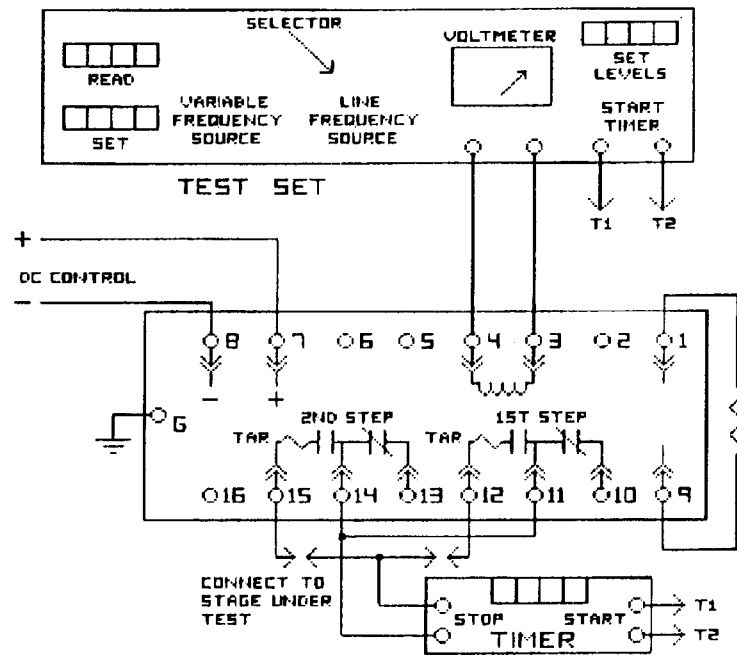


Figure 6: Typical Test Circuit - Calibration Test  
(2 Stage Relay Shown)

**4. OBSOLETE RELAYS – CATALOG SERIES 222**

Type 81 relays of catalog series 222 are no longer in production. The information that follows is a guide to the functions and connections in the event you are setting or testing the older series, or should you need to replace a 222 series with a 422 series unit.

**Connections:** If replacing a 222 series unit with the newer 422 series, note the differences in connections, and rewire accordingly.

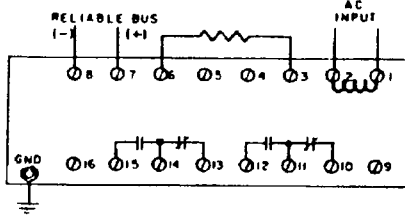
**Settings:** The frequency setting codes given in Tables 1 and 2 apply to both the 222 and 422 series units. The undervoltage cutoff function is adjusted using internal pot R11. Using the 18 point extender board, catalog 200X0018, will make it easier to adjust R11.

**Testing:** Test procedures for the 222 series units are fundamentally the same as those given for the 422 series. Modify the test connections as necessary.

**SUMMARY OF CHARACTERISTICS – CATALOG SERIES 222 (Obsolete)**

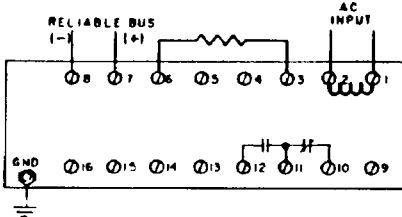
Function	Rated Frequency	Number of Steps	Connection Diagram	Control Voltage	Catalog Number
Underfrequency Only	60 Hz	1	16D222A	48/125 vdc	222A1075 222A1175
				24/125 vdc	222A1085
	50 Hz			48/125 vdc	222F1175
Under or Overfrequency	60 Hz	1	16D222B	48/125 vdc	222B1176
				24/ 32 vdc	222B1196
	50 Hz			48/125 vdc	222D1176
				24/ 32 vdc	222D1196
	60 Hz	1	16D222A	48/125 vdc	222B1175
				24/ 32 vdc	222B1195
	50 Hz			48/125 vdc	222D1175
				48/110 vdc	222D1105
24/ 32 vdc				222D1195	
60 Hz	2	16D222C	48/125 vdc	222C1176	
			24/ 32 vdc	222C1196	
50 Hz			48/125 vdc	222E1176	
			48/110 vdc	222E1106	
			24/ 32 vdc	222E1196	

Internal Connection Diagrams - Catalog Series 222 (obsolete)

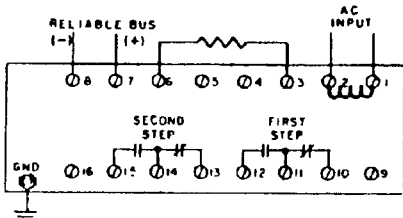


16D222A

Note: the external resistor is not required on catalog numbers 222A1175, 222F1175, and 222A1085.



16D222B



16D222C

Contacts labelled "First Step" are associated with the bottom row of setting switches on the front panel. Contacts labelled "Second Step" are associated with the top row. Contacts shown in "normal" condition. If function set for underfrequency, contacts will transfer when frequency drops below setting. If function set for overfrequency, contacts will transfer when frequency exceeds setting.

Note: Where used, external resistor is supplied mounted and wired on the relay. Resistor must be in place for proper relay operation.