Instruction Leaflet

41-503.21A

Type KF Under-frequency Relay

Class 1E Application

Effective: April 1997
Supersedes I.L. 41-503.21, Dated April 1983

(I) Denotes Changes since previous issue

CAUTION

Before putting the Synchro-Verifier into service, remove all blocking inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely. Inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

1.0 APPLICATION

The Type KF relay is a high-speed under-frequency relay which provides rapid sensing of system overload so that excessive load can be shed. It is particularly suitable for relatively isolated areas where a severe overload (i.e., more than 50%) could occur due to a tie-line trip.

These relays have been specially designed and tested to establish their suitability for Class 1E applications in accordance with the ABB Power T&D Company program for Class 1E Qualification Testing as detailed in bulletin STR-1.

NOTE: The normally closed contact at Terminal #2 should not be used for critical circuits due to a low fragility rating.

"Class 1E" is the safety classification of the electric equipment and systems in nuclear power generating stations that are essential to emergency shutdown of the reactor, containment isolation, cooling of the reactor, and heat removal from the containment and reactor, or otherwise are essential in preventing significant release of radioactive material to the environment.

2.0 CONSTRUCTION & OPERATION

The relay consists of an induction cylinder unit, frequency sensitive components, indicating contactor switch, and auxiliary time delay unit (T). The principal parts of the relay can be seen in Figure 1(page 2).

2.1. INDUCTION CYLINDER UNIT

The induction cylinder unit is a product type unit operating on the interaction between the fluxes that are produced on the four poles. Mechanically, the induction unit is composed of four basic components; a die cast aluminum frame, an electromagnet, moving element assembly and a molded bridge. The frame serves as a mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame. The electromagnet has four coils mounted on the four poles. The coils mounted diametrically opposite each other are connected in series. The locating pins of the electromagnet are used to accurately position the

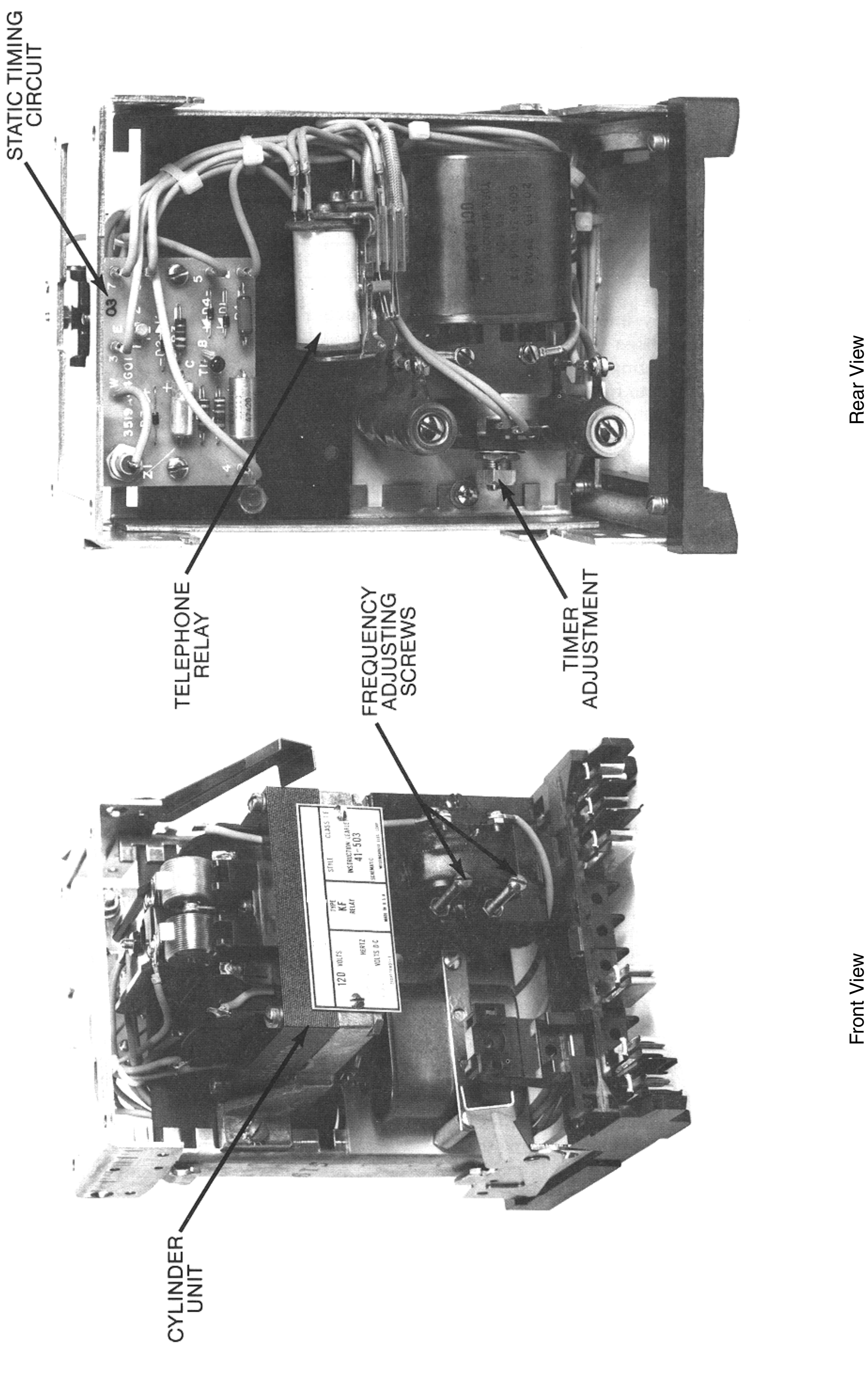

Figure 1: Type KF Relay for 60 Hertz without Case. (Front & Rear View.)

lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core. The stops for the moving element contact arm are an integral part of the bridge.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearing, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp. With the contacts closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

2.2. INDICATING CONTACTOR SWITCH UNIT (ICS)

The indicating contactor switch is a small dc operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

2.3. FREQUENCY SENSITIVE COMPONENTS

The frequency sensitive components consist of capacitors and a variable reactor which is used for setting the relay to trip at the desired frequency.

2.4. AUXILIARY TIME DELAY UNIT

2.4.1. ac Operation – Adjustable

This telephone relay in conjunction with a static timing circuit and full wave bridge provides adjustable time delays (i.e., 6 cycles to 30 cycles) or pickup when the KF relay contacts close. The contacts of the auxiliary time delay unit are connected in the trip circuit.

2.4.2. dc Operation

This telephone relay in conjunction with a static timing circuit provides adjustable time delays (i.e., 6 cycles to 30 cycles) on pickup when the KF relay contacts close. The contacts of the auxiliary time delay unit are connected in the trip circuit.

3.0 CHARACTERISTICS

The KF relay operates to close its contacts when the applied source frequency is below a preset value. The operating characteristic curves for the various auxiliary time delay settings for changing frequency conditions is shown in Figure 4 (page 10).

NOTE: All frequencies in this IL are ±.01 Hz unless otherwise stated.

3.1. RATING

The Type KF under-frequency relay is rated 120 volts at 60 hertz, or 120 volts at 50 hertz. The adjustable range of frequency is 55 to 59.5 hertz for the 60 hertz relay and 44 to 49.5 hertz for the 50 hertz relay.

3.2. TRIP CIRCUIT

The main contacts will close 30 amperes at 250 volts dc and the seal-in contacts of the indicating contactor switch will safely carry this current long enough to trip a circuit breaker.

3.3. TIME DELAY

KF with dc Timer – 6 to 30 cycles (adjustable)
KF with ac Timer – 6 to 30 cycles (adjustable)

3.4. TRIP CIRCUIT CONSTANTS

Indicating Contactor Switch Coil.

Ampere Pickup	Ohms dc Resistance
0.2	8.5
1.0	0.37
2.0	0.10

3.5. ENERGY REQUIREMENTS

Relay Type	Voltage ac 60 Hertz	Timer Condition	Burden
KF with dc Timer	120	N/A	14.7 VA
KF with adjustable ac Timer	120	Energized De-energized	29.4 VA 14.7 VA

4.0 SETTINGS

4.1. FREQUENCY

The relay is set for trip frequency by means of the reactor adjusting screws. The relays are calibrated to trip at 1/2 hertz below rated frequency unless otherwise specified. Turning either of the adjusting screws in a clockwise direction decreases the frequency at which the relay trips. The rate of change of frequency per second versus hertz below trip frequency at contact closure is shown in Figure 4, (page 10) for various time delays.

4.2. INDICATING CONTACTOR SWITCH (ICS)

There are no settings to make on the ICS.

4.3. DC TAP

In the KF relay with dc operated auxiliary time delay unit, selection of the 125 or 48 volt tap must be made on resistor R2 depending on the battery voltage.

5.0 INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the four mounting holes on the flange for the semi-flush type FT case. The mounting screws may be utilized for grounding the relay. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its mounting screws and the relay panel. Ground wires are affixed to the mounting screws as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting.

For detail information on the FT case refer to I.L. 41-076 for semi-flush mounting.

6.0 ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under "SETTINGS" should be required.

6.1. ACCEPTANCE CHECK

The following check is recommended to insure that the relay is in proper working order.

A. Induction Cylinder Unit

Contact Gap – The gap between the stationary contact and the moving contact with the relay in the de-energized position should be approximately 1/16 inch.

B. Frequency Adjusting Reactor

1. Minimum Trip – Using a variable frequency source apply 120V at rated frequency for 1 hour to allow the relay to reach normal operating temperature. Apply 120V at the specified trip frequency to the relay. The contacts

should just close. If no other trip frequency has been specified the relays are calibrated to trip at 59.5 hertz, for the 60 hertz relay and 49.5 hertz for the 50 hertz relay.

2. Reduce the voltage to 60 volts. Check that the relay trips at the calibrated frequency ±.05 Hz. Also verify that the relay does not trip at 0.1 Hz (±.01 Hz) above the calibrated trip frequency.

C. Indicating Contactor Switch

Close the auxiliary time delay unit contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than the rating of the ICS being used. The indicator target should drop freely.

Repeat the above except pass 85% of the rated ICS current. The contacts should not pick up and the target should not drop.

D. Auxiliary Time Delay Unit (T)

1. ac Operation – Adjustable
Block cylinder unit contacts closed. Apply 50 volts ac to terminals 8 and 9 of the KF relay. The T unit should operate. Reduce voltage to approximately 15 volts ac and the T unit should drop out. At rated voltage the time delay obtained should be 6 cycles. The timer can be set to provide up to 30 cycles delay by adjusting the rheostat located on the rear sub base (See Figure 1). Time vs. voltage curves are shown in Figure 8 (page 10).

2. dc Operation
Energize terminals 10 and 4 with rated dc voltage. Place switch across KF relay contacts. Closing the switch will now energize the timing circuit. The time delay obtained from the telephone relay should be 6 cycles. The timer can be set to provide up to 30 cycles delay by adjusting the rheostat located on the real sub base (See Figure 1).

6.2. ROUTINE MAINTENANCE

All relays should be inspected and checked periodically (i.e., once a year) to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

All contacts should be periodically cleaned. A contact burnisher Style #182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

Potentiometers, tantalum capacitors and plastic cased semi-conductors are treated as components that possibly could have a common mode failure characteristic and routine replacement on the following schedule is suggested.

Transistor (T1) - 10 years
Tantalum Capacitors (C1, C2) - - - - - - - - - - 10 years
Potentiometer (Timer Adjustment) - - - - - - - 10 years

Recalibration is necessary whenever any of these components are changed.

6.3. CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order (See “Acceptance Check”).

A. Induction Cylinder Unit

1. The upper pin bearing should be screwed down until there is approximately 0.025” clearance between it and the top of shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

2. The contact gap adjustment for the cylinder unit is made as follows:

   With the moving contact in the normally-opened position, that is, against the right stop on the bridge, screw in the right hand stationary contacts until it just makes with the moving contact. Then advance the stationary contact an additional 1/4 turn. Screw the left-hand stationary contact until it just touches the moving contact then back off the stationary contact two turns for a gap of 1/16 of an inch. The clamp holding the stationary contact need not be loosened for this adjustment, since the clamp utilizes a spring-type action in holding the stationary contact in position.

The set screw in the stationary contacts has been shop adjusted for optimum follow and this adjustment should not be disturbed.

The moving contact assembly has been factory adjusted for low contact bounce performance and should not be changed.

3. The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

   The spring is to be adjusted such that when the relay is de-energized the moving contact just resets. Then move the spring adjuster 3/16 of a turn in the same direction.

B. Frequency Adjusting Reactor

The relay should be preheated for 1 hour with 120 volts and rated frequency before calibration is attempted. A source of variable frequency is required and should be connected to terminals 8 and 9 of the relay.

Set the source frequency to 59.5 hertz and adjust the frequency adjusting screws (See Figure 1) until the cylinder unit contact closes to the left. Reduce voltage to 60 volts and lower the frequency to 59.47 hertz. Adjust control spring so that cylinder unit contact just closes to the left. Raise voltage to 120 volts and recheck 59.5 setting. Adjust frequency adjusting screws if necessary. Recheck 60 volt setting, it should be between 59.42 hertz and 59.52 hertz. Repeat above procedure if necessary until relay contacts are made between the frequency limits.

C. Indicating Contactor Switch (ICS)

Close the auxiliary time delay unit (T) contact and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than the rating of the ICS being used. The indicator target should drop freely.

D. Auxiliary Time Delay Unit

1. **ac Operation – Adjustable**
   Block the KF relay contacts closed. Energize terminals 8 and 9 of the relay with rated voltage and frequency. Time the closing of the telephone relay contacts. This time can be set over the range of 6 to 30 cycles utilizing the rheostat located on the rear sub base. (See Figure 1, page 2.)

2. **dc Operation – Adjustable**
   Energize terminals 10 and 4 with rated dc voltage. Place switch across KF relay contacts. Close switch and time the closing of the telephone relay contacts. Adjust rheostat on rear sub base for desired time delay. This time can be set over the range of 6 to 30 cycles utilizing the rheostat located on the rear sub base. (See Figure 1, page 2.)

7.0 RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data and styles from the Electrical Parts List.

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	REFERENCE	STYLE
FREQUENCY SENSING CIRCUIT – FIGURE 2, 3, 4		
Resistor – R1	750 ohm, 25W, ±5%	1267285
Capacitors – Reactor leg	.225 MFD, 750 VAC, ±3%	606B340H07
Resistor leg	2.0 MFD, 330 VAC, ±3%	606B340H04
Reactor		290B179G04
AC ADJUSTABLE 6 TO 30 CYCLE TIMER – FIGURE 3		
Resistor – (R2)	750 ohm, 25 W, +5%	1267285
Potentiometer	50K ohm	185A067H11
Telephone Relay (T)		541D514H10
CIRCUIT BOARD ASSEMBLY - STYLE 1479B81G02		
Capacitors – C1	47 MFD, 35V, ±20%	184A661H03
C2, C3, C5	6.8 MFD, 35 V, ±5%	184A661H21
C4	0.05 MFD, 50 V, ±20%	184A663H02
Diodes – D1, D2, D3, D4	1N5053	188A342H12
D5, D6, D7, D8, D9	1N645A	837A692H03
Resistors – R1, R11	3.3 K 1/2 W, ±5%	184A763H39
R2	100 ohm, 1/2 W, ±5%	184A763H03
R3	33 ohm, 1/2 W, ±5%	187A290H13
R4	15 K ohm, 1/2 W, ±5%	184A763H55
R5, R6	10 K ohm, 1/2 W, ±5%	184A763H51
R7	470 ohm, 1/2 W, ±5%	184A763H19
Transformer – T1	H62, UTC	629A453H01
Transistors – Q1	2N2647, UJT	629A435H01
Q2	2N3417, NPN	848A851H02
Q3	2N3645, PNP	849A441H01
Zener Diode – Z1	1N2986B, 24 V, ±5%	629A798H03
DC ADJUSTABLE 6 TO 30 CYCLE TIMER – FIGURE 4		
Resistor (R2)	200/1500 ohm	11D9511H06
Potentiometer	10 K ohm, 2 W, ±10%	185A067H02
Telephone Relay (T)		541D514H32
CIRCUIT BOARD ASSEMBLY - STYLE 3519A44G01		
Capacitors – C1	47 MFD, 35 V, ±20%	184A661H03
C2	47 MFD, 35 V, ±5%	862A177H06
Diodes – D1, D2, D3, D4	1N654A	837A692H03
Resistors – R1	10 K ohm, 1/2 W, ±5%	184A763H51
R2	1.2 ohm, 1/2 W, ±5%	184A763H29
R3	680 ohm, 1/2 W, ±5%	184A763H23
R4	700 ohm, 3 W, ±5%	763A127H28
Transistors – Q1	2N4249, PNP	849A441H03
Q2	2N2647, UJT	629A435H01
Zener Diode – Z1	1N2989B, 30 V, ±5%	629A798H01

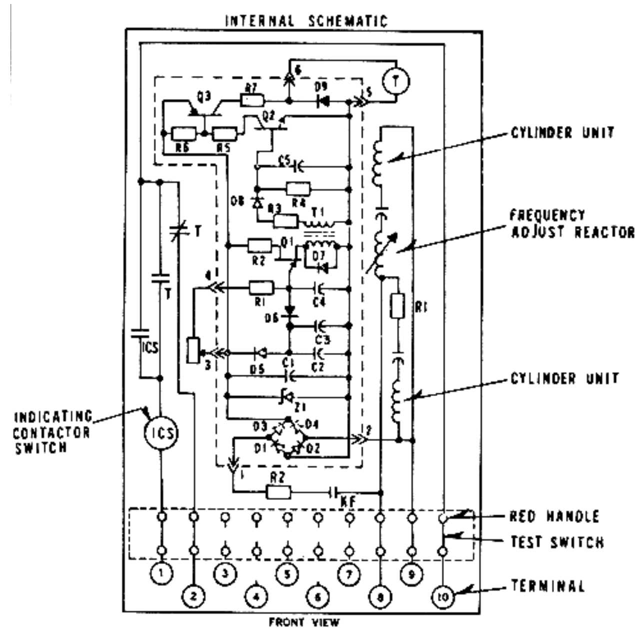

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Figure 2: I internal Schematic of Type KF Relay with ac Operated Adjustable Auxiliary Time Delay Unit.

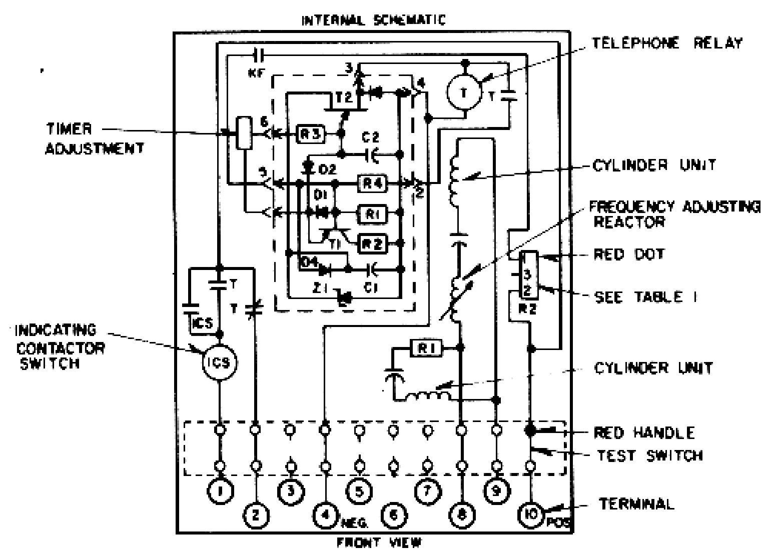

TABLE I

RELAY RATING	TRIP VOLTAGE	LEAD POS	RESIS VALUE
48/125	48	3	200 Ω
	125	2	1500 Ω

Sub 2
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Figure 3:   Internal Schematic of Type KF Relay with dc Operated Adjustable Auxiliary Time Delay Unit.

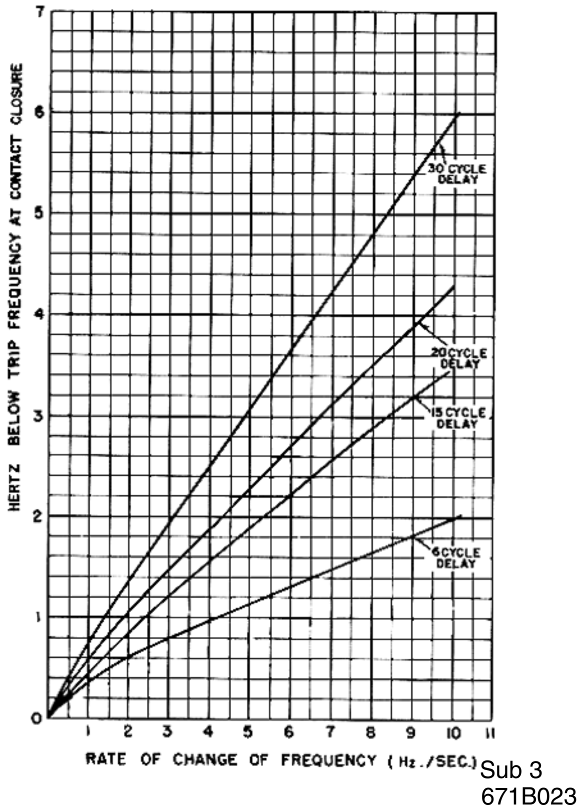

Figure 4: *Operating Characteristics of Type KF Under-frequency Relay for Changing Frequency Conditions.*

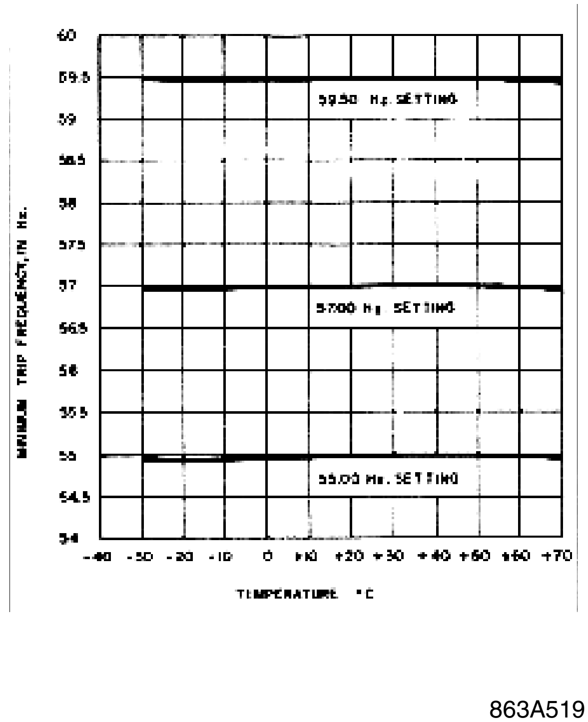

Figure 5: Typical Temperature vs. Minimum Frequency Curves 60 Hertz KF Under-frequency Relay.

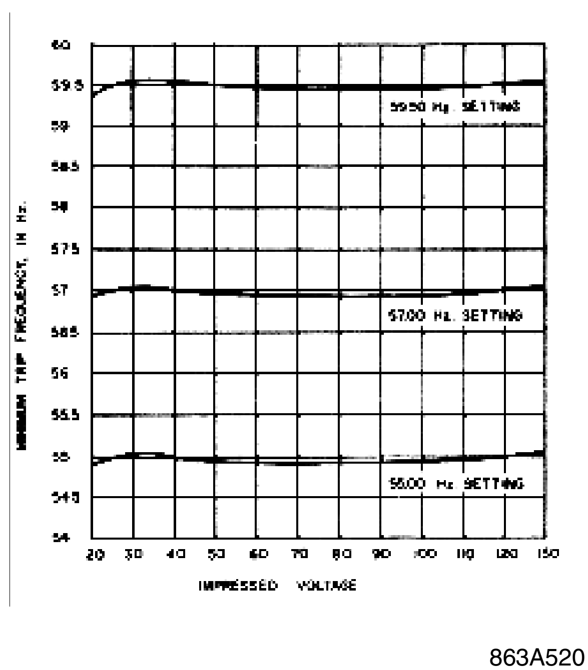

Figure 6: Typical Voltages vs. Minimum Frequency Curves 60 Hertz KF Under-frequency Relay.

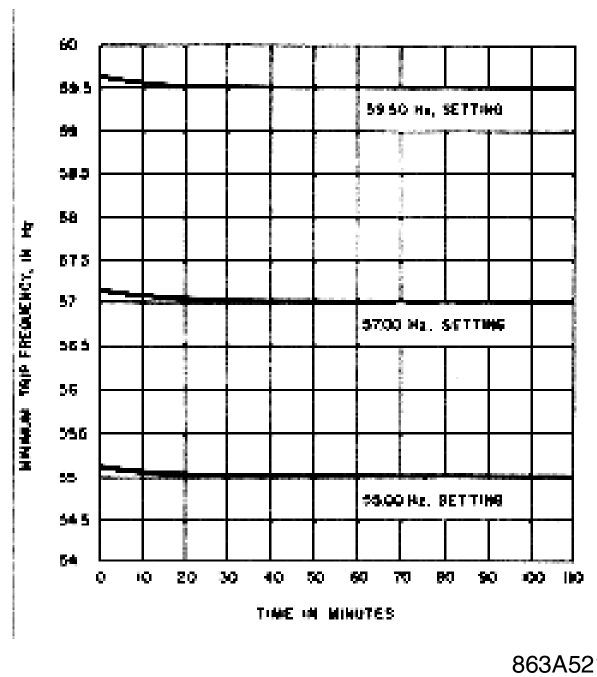

Figure 7: Warm-up curve 60 Hertz Under-frequency Relay.

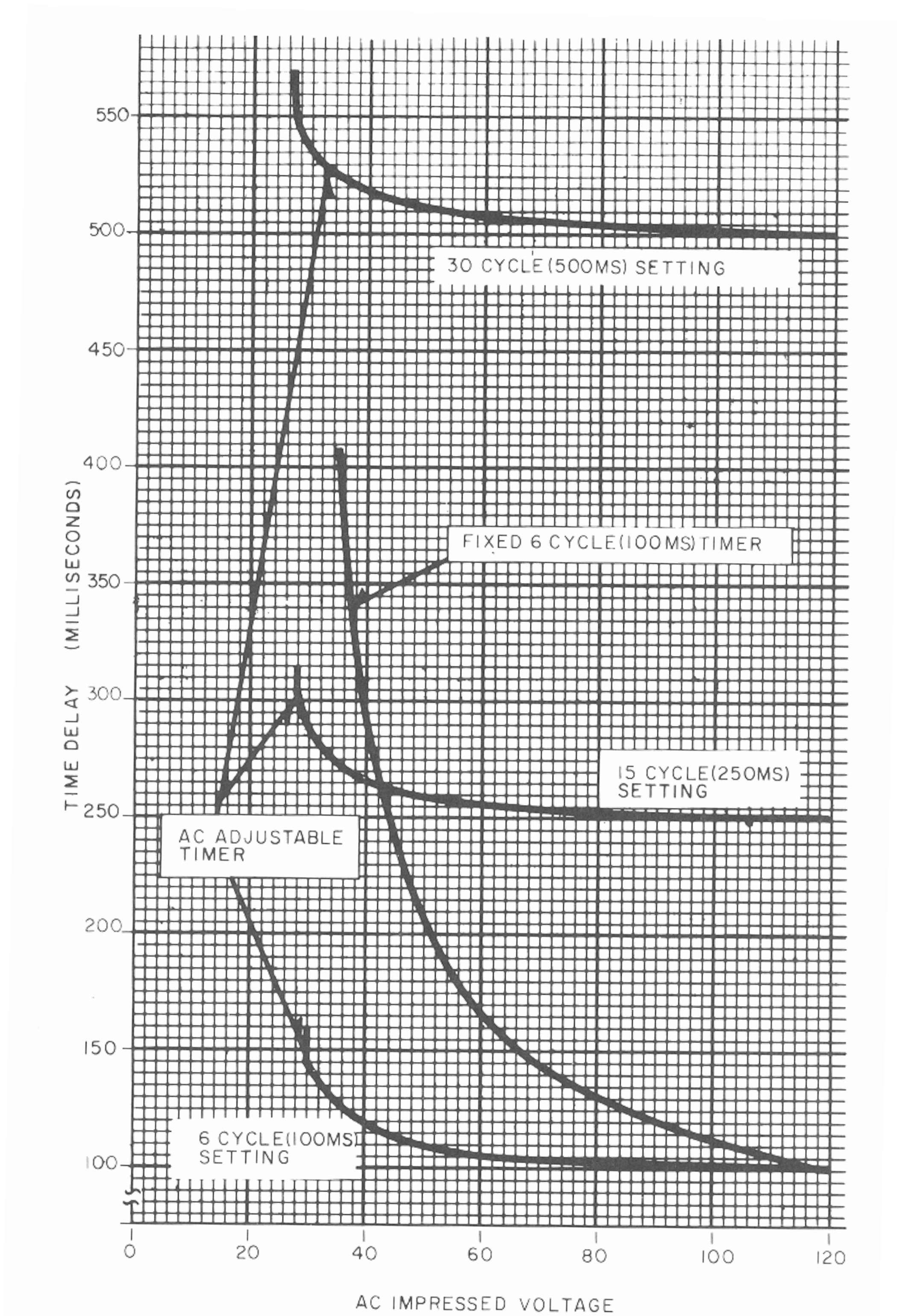

Figure 8: Typical Time Delay vs. Impressed ac Voltage

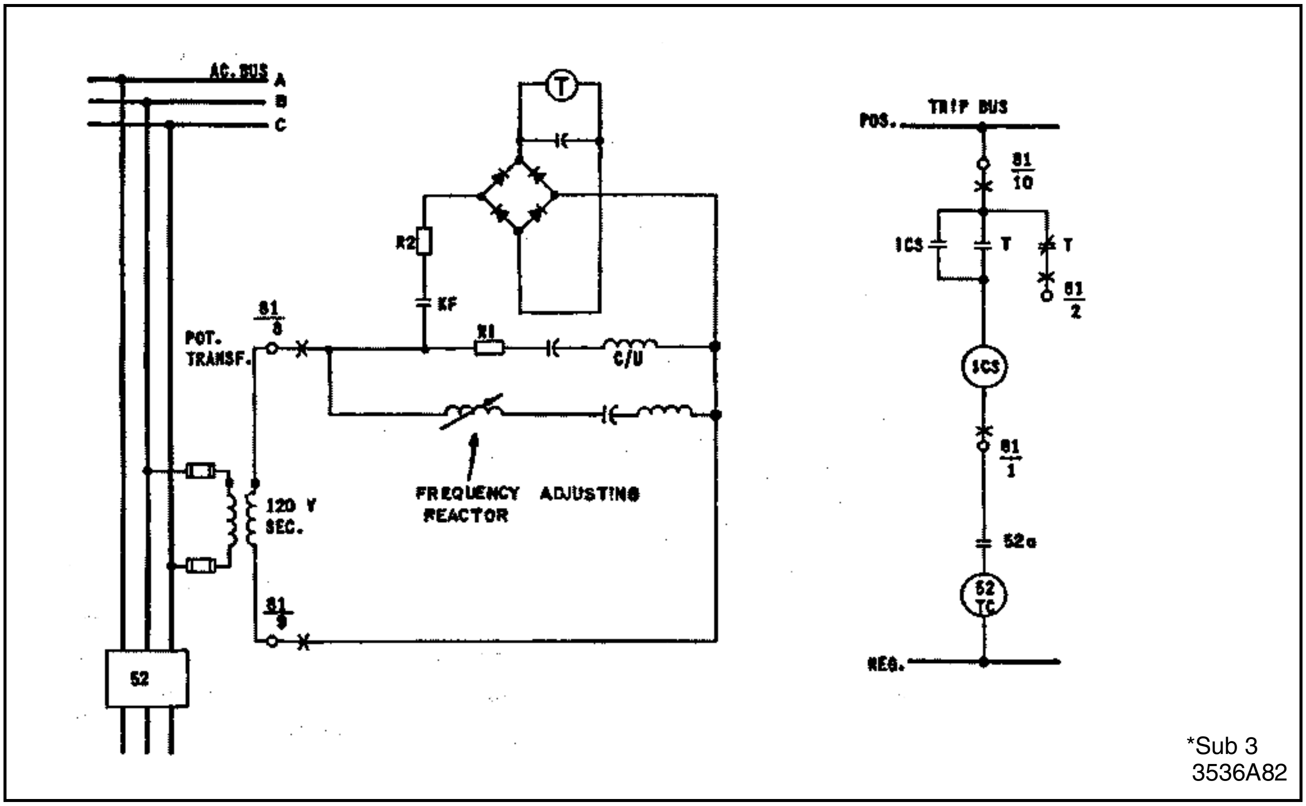

Figure 9: External Connections for the Type KF Under-frequency Relay with ac Operated Auxiliary Time Delay Unit.

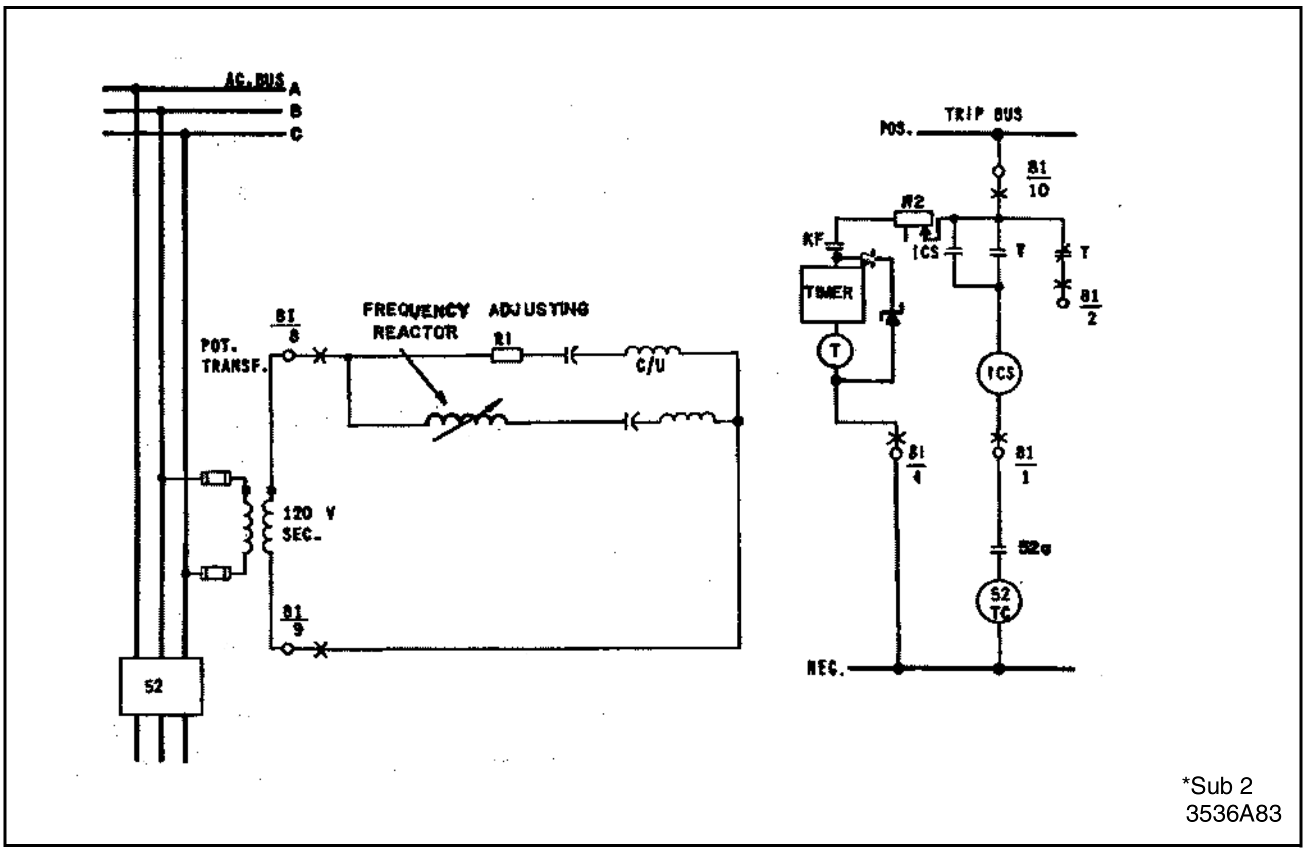

Figure 10: External Connections for the Type KF Under-frequency Relay with dc Operated Auxiliary Time Delay Unit.

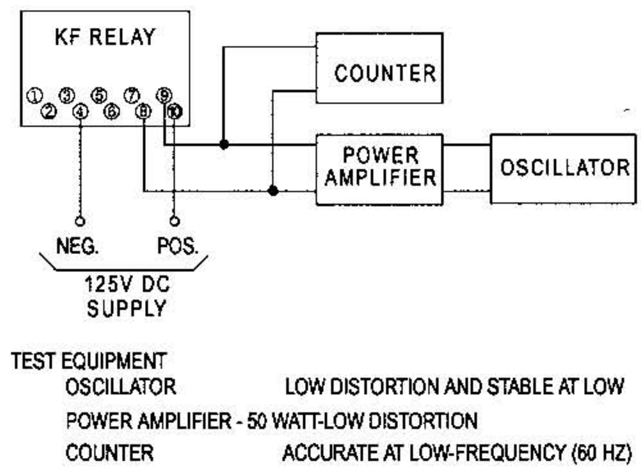

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Figure 11: Diagram of Test Connections for KF Relay with dc Operated Auxiliary Time Delay Unit.

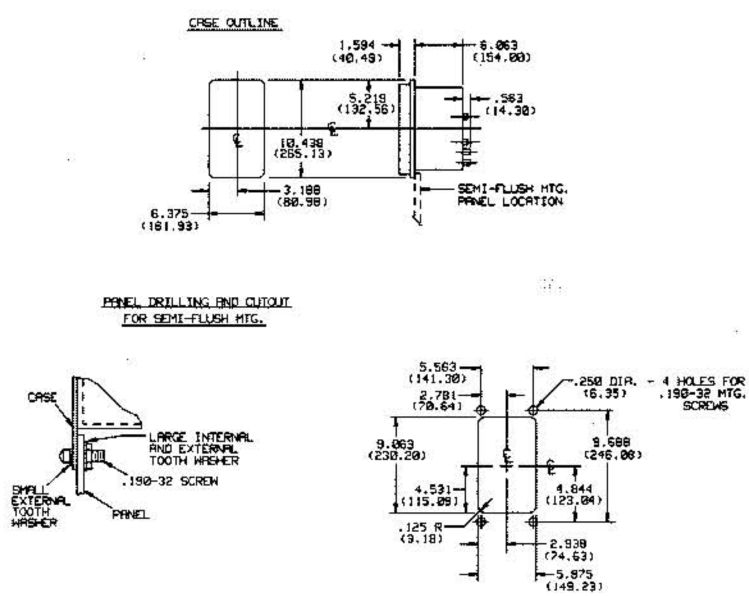

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Figure 12: Outline & Drilling Plan for the Type KF Relay in Type FT 21 Case.

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