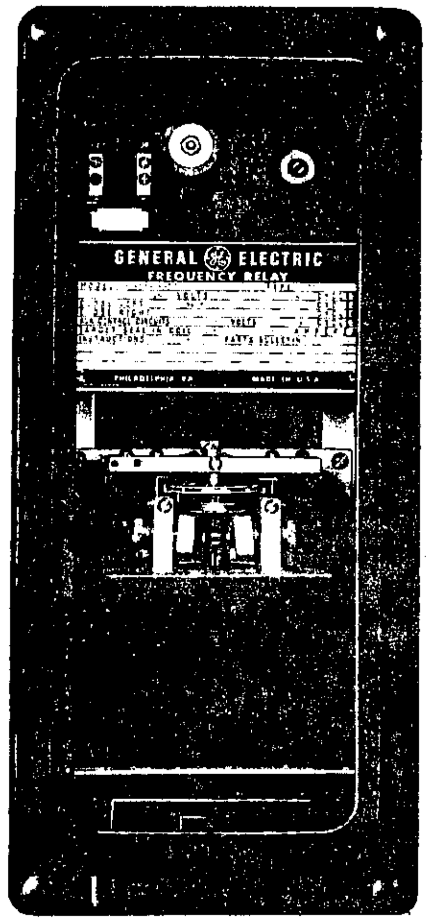
INSTRUCTIONS

GEK-27863

FREQUENCY RELAYS



TYPES

CFF12A47 & UP
CFF12C13 & UP
CFF12E3 & UP
CFF12F1 & UP

POWER SYSTEMS MANAGEMENT DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

CONTENTS

(Cover Photo 8040133)

FREQUENCY RELAYS
TYPE CFF

INTRODUCTION

The CFF12 relays covered by this instruction book are underfrequency devices. All of the relays contain a high speed induction cup unit as the frequency sensing element, but include a six cycle time delay telephone type auxiliary relay.

The frequency sensing unit has both normally open and normally closed contacts. The normally open contact will close on underfrequency to energize the auxiliary relay which will seal-in around the contact that picked it up. When the system returns to normal, the auxiliary relay will be reset by the normally closed contact of the frequency sensing unit.

The CFF12A, CFF12E and the CFF12F use D-C to operate the auxiliary relay and the target seal-in unit. The CFF12C is designed so that all of the auxiliary components function from the same A-C supply that activates the frequency sensing unit.

The relays are contained in the medium size, M-1, drawout case.

Some of the relay models are equipped with zener diodes to improve the operating frequency vs. voltage characteristic.

The following models do not have these zeners:

12CFF12A47A through 12CFF12A60A
12CFF12C13A and 12CFF12C14A
12CFF12E3A and 12CFF12E4A
12CFF12F1A

Those models which are equipped with zeners are:

12CFF12A61A and up
12CFF12C15A and up

APPLICATION

The Type CFF underfrequency relays are applied where high speed detection of underfrequency conditions is required. Specifically they are applied in underfrequency load conservation schemes. If a system disturbance results in some loss of generating capacity such that the load exceeds the generation, the system is in danger of collapse. The underfrequency relay operates to disconnect non-essential load in order to balance load and generation in the affected area. Such action must be taken promptly and must be sufficient magnitude to converve essential load and enable the rest of the system to recover from the underfrequency condition. By preventing a major shutdown, restoration of the entire system to normal operation is greatly facilitated and expedited.

The six cycle auxiliary time delay unit provides security against misoperation due to mechanical shock or the electrical transients which result from switching potentials to the relay or clearing a fault on the system.

Another application of the underfrequency relay is at industrial plants where it is necessary to trip the incoming breaker at the plant when the power company supply is tripped off. This will prevent damage to motors or local generation in the plant that could other wise be incurred if the plant breaker were still closed when the power company automatically reclosed the supply line to the plant.

An overall load conservation scheme can be arranged to trip off non-essential or interruptible load as follows:

a. Trip off blocks of load in several steps with several relays set at successively lower frequency values.

b. Trip off blocks of load in several steps on a time basis at one level of frequency, so that as each time step is reached additional load is dropped.

c. A combination of a and b above.

A tapped subtransmission or distribution substation which has a heavy preponderance of motor load may require special consideration for proper time coordination. If the transmission sources to such a substation were tripped out for any reason, the motor loads would tend to maintain the voltage for a short time while the frequency decreased as the motors were slowing down. It will be necessary to delay the tripping of the underfrequency relay for 15 or more cycles to ride over this condition and avoid tripping breakers needlessly. The type CFF22 relays have a longer time delay feature, ranging from 6 to 60 cycles continuously adjustable.

In applying the underfrequency relay in a system load conservation program, it must be recognized that a low frequency condition does not begin to be corrected until a circuit breaker operation occurs to disconnect some load. The family of curves shown in Fig. 1 are constructed to show frequency vs. time to open the breaker after the disturbance starts for a number of different rates of change of frequency. These curves include:

1. An allowance of six cycles for total breaker clearing time.

2. The frequency relay minimum delay of six cycles.

3. Various frequency pickup settings on the relay.

If any of these factors change, then a new curve should be plotted. The curve can be read directly to determine the system frequency at which the load is actually removed.

Typical external connection diagrams are shown in Figs. 2,3, and Fig. 4.

RATINGS

INDUCTION CUP UNIT

The calibration of this unit is continuously adjustable from rated frequency down to 56 Hz, however, for reasons that will be explained under OPERATING CHARACTERISTICS, underfrequency settings higher than 59.5 Hz should not be used.

The calibration is under the control of a fixed resistor with taps, and a rheostat. Sections of the fixed resistor may be inserted in the circuit when the full value of the rheostat will not lower the operating frequency to the desired value.

The contacts of this unit require no specific rating since they in their function have the capacity to carry the currents called for by the auxiliary relay circuits.

AUXILIARY RELAY A

The coil circuit voltage ratings are on a continuous basis.

The contacts can carry three amperes continuously or 30 amperes for two seconds.

The current interrupting capabilities for either A-C or D-C are shown in Table A.

TABLE A

VOLTS	INDUCTIVE (*)	NON-INDUCTIVE
115 A-C	0.75 amps	2.0 amps
230 A-C	0.5 amps	1.5 amps
48 D-C	1.0 amps	3.0 amps
125 D-C	0.5 amps	1.5 amps
250 D-C	0.25 amps	1.0 amps

* Inductance based on average trip coil

TARGET AND SEAL-IN UNIT

The coil circuit of these assemblies when used in an A-C control circuit, such as the CFF12C, are also on a continuous voltage basis, equal to the voltage rating of the relay.

The D-C control circuits, however, normally use coils with current ratings as shown in Table B.

The contacts in either the A-C or D-C ratings are alike and have a capability of closing 30 amperes for tripping duty.

TABLE B

TARGET SEAL-IN COIL RATINGS		
Conditions	Nominal Tap Rating (Amps)	
	0.2	2.0
Continuous Rating	0.3 Amps	3.5 Amps
DC Resistance	7.0 Ohms	0.13 Ohms
Tripping Duty	5.0 Amps	30.0 Amps

BURDENS

The underfrequency settings on the CFF relays affect the burden imposed on the potential transformer The maximum burden occurs at 59.5 Hz. The operating frequency is lowered by adding more resistance in the calibration control circuit, hence, the burden is reduced with lower frequency settings.

The burden of the CFF12C relay is greater than the CFF12A, CFF12E and CFF12F, because its auxiliary relay and target unit are A-C operated.

The maximum burden for the type CFF relays are listed in Table C.

TABLE C

TOTAL 60 HZ BURDENS				
RELAY TYPE	VOLTAGE RATING	CALIBRATION HZ	WATTS	VOLT AMPERE
CFF12A CFF12E CFF12F	115 AND 230	59.5	9.8	12.4
CFF12C	115 AND 230	59.5	15.3	21.5

CHARACTERISTICS

OPERATING PRINCIPLES

The frequency sensing unit is an eight pole induction cup assembly that responds to the magnitude and phase angle of the fluxes produced by the two sets of coil circuits each occupying 4 of the poles.

When the fluxes are in phase, the unit exhibits zero torque. Under normal conditions of rated voltage and frequency, the phase-displacement between the flux of one circuit with respect to the other produces torque to hold the lefthand (F.V.) contacts open. When an underfrequency condition appears, approaching the calibration frequency, the phase angle first decreases to zero, leaving only spring torque to hold the contact open. As the frequency continues to fall a phase displacement again appears this time to produce contact closing torque. When the frequency reaches the calibrated underfrequency setting, the magnitude of electrical torque is sufficient to overcome the control spring torque closing the left hand contact. The closing of this contact operates the six cycle time delay auxiliary relay called "A" in a so called "PICK UP AND KNOCK DOWN" circuit, that is "A" PICKS UP and seals around the contact that picked it up. The operation of "A" activates the target seal-in unit or the target auxiliary in the case of the CFF12C, if the underfrequency condition persists longer than the six cycle time delay. Should the frequency restore to normal before the prescribed time delay expires, the right hand contact of the sensing unit will close shorting out relay "A" causing it to drop out to normalize the circuit for the next underfrequency condition.

The CFF relays operate to close their contacts when the applied source frequency is below the preset value. An operating frequency vs. voltage characteristic is shown in Fig. 5 . The characteristics are shown with and without the use of zeners in one of the coil circuits. Fig. 6 is also a frequency vs. voltage characteristic combined with ambient temperatures as is Fig. 7 , the latter characteristics are with relays equipped with zeners.

Fig. 8 is a so called "COLD PICKUP" characteristic. This characteristic endeavors to show the change in calibration on a relay de-energized for time long enough to have all its components return to the ambient temperatures indicated. The operating frequency at the first instant power is reapplied to the relay will be higher as shown by the curve, hence, there is the danger of a false trip in setting the calibration to close to the power system frequency.

CONSTRUCTION

The CFF12 frequency sensing unit (see Fig. 9) houses a cup and shaft assembly that carries the moving contact. This assembly is supported on the bottom by a non-magnetic and rust proof pivot resting on a synthetic spring mounted jewel bearing. The compression spring acts to prevent jewel damage should the moving system be subjected to mechanical shock. At the upper end of the shaft, a stainless steel guide pin rides in a polished bronze bushing assembly. This tops bearing serves to keep the cup and shaft assembly properly aligned in the unit as well as controlling the desired end play.

The moving contact assembly is a molded hub, that supports the contacts and a spiral spring. The spiral spring assembly is affixed to an adjustable metal ring, which sets directly above the control spring. The ring, after adjustment may be locked in position in its molded assembly by a hex stud located directly behind the upper pivot.

Barrel type stationary contact assemblies are located on either side of the moving contact. These stationary contacts house a silver contact mounted on a flexible bronze disc which provides for the desired amount of wiping action. The assembly also houses a steel ball that rests against a metal disc, directly behind the contact. The presence of the ball minimizes contact bounce should torque levels exceed the forces to totally compress the flexible contact spring. The stationary contacts are held in position by a screw which holds the barrels secure in the contact support. The entire barrel may be removed by loosening the clamping screw.

The target-seal-in unit is located at the upper left hand side of the relay. It consists of a hinged armature type of assembly operated by either a voltage or current coil depending upon the rating of the relay. The operation of the relay caused the armature and its contact to complete the trip circuit and also to expose the target. The target is reset by a rod assembly located at the lower left hand corner of the cover.

Rheostat R-2 or RH-A are mounted to the right of the target seal-in units. The fixed resistor R-3 or in the case of the CFF12C relays,have leads which may be positioned to select any section of its resistance and is located in the rear of the relay.

These components are identified in the photographs shown in Fig s.11, 12, and 13.

The case is suitable for either surface or semi-flush panel mounting and an assortment of hardware is provided for either mounting. The cover attaches to the case and also carries the reset mechanism. Each cover screw has provision for a sealing wire.

The case has studs or screw connections at the bottom for the external connections. The electrical connections between the relay unit and the case studs are made through spring backed contact fingers mounted in the stationary molded inner and outer blocks between which nests a removable connecting plug which completes the circuits. The outer blocks, attached to the case, carries the studs for the external connections and the inner block carries terminals for the internal connections.

The relay mechanism is mounted in a steel framework called the cradle and is a complete unit with all leads being terminated at the inner block. This cradle is held firmly in the case with a latch at the top and the bottom and by a guide pin at the back of the case. The case and cradle are so constructed that the relay cannot be inserted in the case upside down. The connecting plug, besides making the electrical connections between the blocks of the cradle and case, also locks the latch in place. The cover, which is fastened to the case by thumbscrews, holds the connecting plug in place.

To draw out the relay unit the cover is first removed, and the plug pulled out. The latches are then released, and the relay can be easily drawn out. To replace the relay, the reverse order is followed.

A separate testing plug can be inserted instead of the connecting plug to test the relay in place on the panel either from its own source of voltage, or from other sources. Or, the relay can be drawn out and replaced by another which has been tested in the laboratory.

RECEIVING, HANDLING AND STORAGE

These relays, when not included as a part of a control panel, will be shipped in cartons designed to protect them against damage. Immediately upon receipt of a relay, examine it for any damage sustained in transit. If injury or damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Apparatus Sales Office.

Reasonable care should be exercised in unpacking the relay in order that none of the parts are injured or the adjustments disturbed.

If the relays are not to be installed immediately, they should be stored in their original cartons in a place that is free from moisture, dust and metallic chips. Foreign matter collected on the outside of the case may find its way inside when the cover is removed and cause trouble in the operation of the relay.

ACCEPTANCE TESTS

The following are recommended mechanical checks to insure that the relay is in proper working order.

THE INDUCTION CUP UNIT

The moving contact assembly should be resting against the right hand stationary contact. The contact gap should be approximately 1/16 inch. Each full turn of the contact barrel alters its position by 1/32 of an inch, hence, serves as a convenient means to check or set the contact gap.

The cup-shaft end play has been set to be between 0.015 inches and 0.020 inches. If resetting is necessary,keep the end play within these limits.

Check to see that their is some contact deflection or wipe in the flexible stationary contact. The deflection is in the order of the 0.005 inches to 0.010 inches.

TARGET SEAL-IN UNIT

Operate the armature by hand and note that the bridging contacts make at about the same time with some wiping action before the armature comes to rest against the pole piece. During this operation the target should come into view and latch in before the total travel is exhausted. The reset lever should reset the target.

AUXILIARY TELEPHONE RELAYS "A"

All normally open contacts should have a contact gap of at least 0.010 inches.

Operate the closing armature by hand and note that the closing contact make and deflect at least 0.005 inches before the end of the armature travel.

FREQUENCY CONTROL RHEOSTATS AND SLIDE BAND RESISTORS

The locking nuts for these resistors must be tight.

The following are the general procedures for checking the relay electrically:

TARGET SEAL-IN UNITS

The unit used in the relays with D-C ratings are current operated devices, rated 0.2/2.0 amperes. These seal-in units should pick up at a value equal to or less than the tap rating. Upon picking up, the contacts should wipe fully, and the target should drop. Both tap ratings should be checked. In the process of transferring to the other tap, do not remove the screw from the tap being used first, rather, remove one of the screws from the opposite stationary contact and insert this in the other current tap. Then replace it with the screw used in the first test tap. This procedure keeps the stationary contacts in their original position thereby preserving proper contact alignment.

The unit used in the Model 12CFF12C relays is an A.C. voltage operated device. The pickup voltage of this unit should be 70% or less than the voltage rating.

AUXILIARY UNIT "A"

These relays are voltage operated devices and should pick up at 70% or less than the control circuit voltage rating.

THE INDUCTION CUP UNIT

This frequency sensing unit has been calibrated at the factory to close its trip contact at the frequency stamped on the nameplate.

To check this value apply rated voltage and frequency to the relay as indicated in the Test Diagrams Fig. 13 and Fig. 14.

Permit the relay to heat up for at least one hour with rated voltage and frequency to stabilize the calibration before checking the operating frequency.

In the process of checking or setting the calibration of these relays, be sure that the relay is resting in a level position, i.e. as it will be when mounted on a relay panel.

The frequency setting of the unit is under the control of the rheostat R-2 and the tapped resistor R-3 for all models other than the 12CFF12C. The latter permits additional resistance to be added to the circuit as required, since resistance of R-2 is not sufficient to cover the rated range of frequency settings. In the CFF12C relays there is an additional slide band resistor called RA that works in conjunction with the rheostat called RH-A. The settings are made by placing the rheostat in a mid-position. The calibration is set to approximately the desired frequency by means of the slide band resistor, plus the fixed resistor R-4 if necessary. The calibration may then be set to the desired value by the rheostat. Carefully tighten the slide band and the lock nut on these units and recheck the calibration to be sure it has not changed during these tightening operations.

The test procedure for resetting the calibration should be as follows:

In this case it is assumed that the relay has not been energized for some time, hence, all its components are at room temperature.

1. Set leads on the tapped resistor for zero resistance.

2. Set R-2 or RH-A in its mid-position.

3. Apply rated voltage and frequency for about 10 minutes, then set the calibration to within ±0.1 Hz of the required setting. This preliminary setting will place the calibration control resistance near its final value during the self heating period.

4. Permit the relay to self heat for at least one hour at rated voltage and frequency, then finalize the calibration to the desired value within ±0.02 Hz, and lock the rheostat.

5. Check the operating value at other voltage levels.

   a. The operating frequency on relays without zeners should not fall more than 0.3 Hz at 80 volts. If it does, reduce the control spring setting to just reach this level. The control spring wind-up must be great enough to be sure that the right hand contact will close when no power is applied to the relay, hence, do not weaken it more than necessary.

   b. On relays that use zeners, check the operating frequency down to 60 volts in about 15 volt steps, to determine the flatness of the characteristic. With a minimum wind-up of the control spring the operating frequency will rise as the voltage is reduced due to the zeners. Increasing the control spring tends to flatter the curve. In general, making the 60 volt setting close to the rated voltage should yield a characteristic within +0.05 to -0.1 Hz from 60 to rated volts.

      The control spring settings at 59 Hz calibration will be greater than at 57 Hz, hence, it is adviseable to shoot this voltage characteristic if frequency changes in the order of 0.5 Hz or more is planned to keep the variation of the operating frequency with respect to voltage to a minimum.

INSTALLATION

LOCATION

The location should be clean and dry, free from dust and excessive vibration, and well lighted to facilitate inspection and testing.

MOUNTING

The relay should be mounted on a vertical surface. The outline and panel drilling for either surface or semiflush panel mounting is shown in Fig. 22.

One of the mounting studs or screws should be permanently grounded by a conductor not less than No. 12 B&S gage copper wire or its equivalent.

CONNECTIONS

Internal connection diagrams for the relays are shown in Figs. 15 to 21 inclusive.

ADJUSTMENTS

The relays are calibrated at the factory and should not require any further adjustment. If it is desirable to check the frequency characteristic, follow the procedure outline under MAINTENANCE.

INSPECTION

At the time of installation, the relay should be inspected for tarnished contacts, loose screws, or other inperfections. If any trouble is found, it should be corrected in the manner described under MAINTENANCE.

MAINTENANCE

The relays are adjusted at the factory, and it is advisable not to disturb the adjustments. If for any reason they have been disturbed, the following points should be observed in restoring them.

SHAFT AND BEARINGS

The lower jewel screw can be removed from the unit by means of an offset screw driver or an end wrench. The jewel may be tested for cracks by exploring its surface with the point of a fine needle.

The lower jewel bearing should be screwed all the way in until its head engages the end of the threaded core. The upper bearing should be adjusted to allow about 1/64 inch end play of the shaft.

To check the clearance between the iron core and the inside of the rotor cup, press down on the contact arm near the shaft, and thereby depress the spring mounted jewel until the cup strikes the iron. The shaft and cup should move about 1/6 inch.

CUP AND STATOR

If it is necessary to remove the rotor from the unit, the following procedure should be followed.

The leads should first be removed from the contact structure and tagged for identification in reconnecting. Then remove the three flat head screws which fasten the unit to the mounting plate from the back. Tilt the stator forward and remove the four corner screws which hold the contact head to the stator. The entire top structure with the rotor can then be lifted away from the stator to give access to the assembly. Care should be taken not to strain the leads entering the back of the stator. Unless there is reason for removing the stator from the cradle, these leads need not be disconnected.

To remove the shaft and rotor from the contact head assembly, the spring clip at the top of the shaft must be pulled out, and the clutch adjusting screw and spring taken out of the molded contact arm.

The rotor should be handled carefully while it is out of the unit, and the stator should be protected to keep it free from dust or metallic particles.

In reassembly, the rotor will to into the air gap easily if the parts are held in proper alignment.

CONTACT CLEANING

For cleaning fine silver contacts, a flexible burnishing tool should be used. This consists of a flexible strip of metal with an etched roughened surface, resembling in effect a superfine file. The polishing action is so delicate that no scratches are left, yet corroded material will be removed rapidly and thoroughly. The flexibility of the tool insures the cleaning of the actual points of contact.

Fine silver contacts should not be cleaned with knives, files, or abrasive paper or cloth. Knives or files may leave scratches which increasing arcing and deterioation of the contacts. Abrasive paper or cloth may leave minute particles of insulating abrasive material in the contacts and thus prevent closing.

The burnishing tool described is included in the standard relay tool kit obtainable from the factory.

CONTACT ADJUSTMENT

Should it be necessary to change the stationary contact mounting spring, remove the contact barrel and sleeve as a complete unit after loosening the screw at the front of the contact block. Unscrew the cap. The contact and spring may then be removed.

The moving contact may be removed by loosening the screw which secures it to the contact arm and sliding it from under the screw head.

The contact gap may be adjusted by slightly loosening the screw at the front of the contact block. It should be loose enough only to allow the contact barrel to rotate in its sleeve.

The right contact should hold the moving contact arm in a neutral position, i.e., with it pointing directly forward. Bring the left stationary contact up until it just touches the moving contact by rotating the barrel. Then back it away two full turns to obtain 1/16 inch contact gap. Tighten the screws which secure the contact barrels.

CLUTCH ADJUSTMENT

If for any reason the moving contact arm has been removed or loosened from the rotor shaft, it will be necessary to reset the clutch. The screw on the side of the contact arm should be tightened to bottom of theinternal compression spring, then back off two full turns and with locknut secure.

CALIBRATION PROCEDURE

Refer to section under ACCEPTANCE TESTS.

PERIODIC TESTING

An operational test and inspection of the relay at intervals of six months is recommended. The calibration need not be checked, but operation of the auxiliary circuits should be tested.

In testing relay Types CFF using D-C auxiliary units an adjustable resistor should be substituted for the breaker trip coil. It should be set to draw current equal to 95 per cent of tap setting of the target seal-in unit. When testing relay Types CFF12C an indicating lamp should be used in place of the breaker trip coil.

To check operation of the auxiliary circuits follow the sequence tabulated on Table - D

TABLE - D

RELAY	OPERATE SUCCESSIVELY BY HAND			
	1. Close Left Contacts	2. Open Left Contacts	3. Close Right Contacts	4. Open Trip Circuit
	RESULT			
CFF12A, 12E and 12F	Telephone relay picks up, target seal-in picks up, trip current flows	No Action	Telphone relays drop out.	Target seal-in drops out. Target remains exposed.
CFF12C	Telephone relay picks up, target and auxiliary relay picks up, indicating lamp lights.	No Action	Telephone relay drops out, target and auxiliary relay drops out, target remains exposed indicating lamp extinguishes.	No Action

RENEWAL PARTS

It is recommended that sufficient quantities of renewal parts be carried in stock to enable the prompt replacement of any that are worn, broken, or damaged.

When ordering renewal parts, address the nearest Sales Office of the General Electric Company, specify quantity required, name of part wanted, and give complete nameplate data of the relay. If possible, give the General Electric Company requisition number on which the relay was furnished.

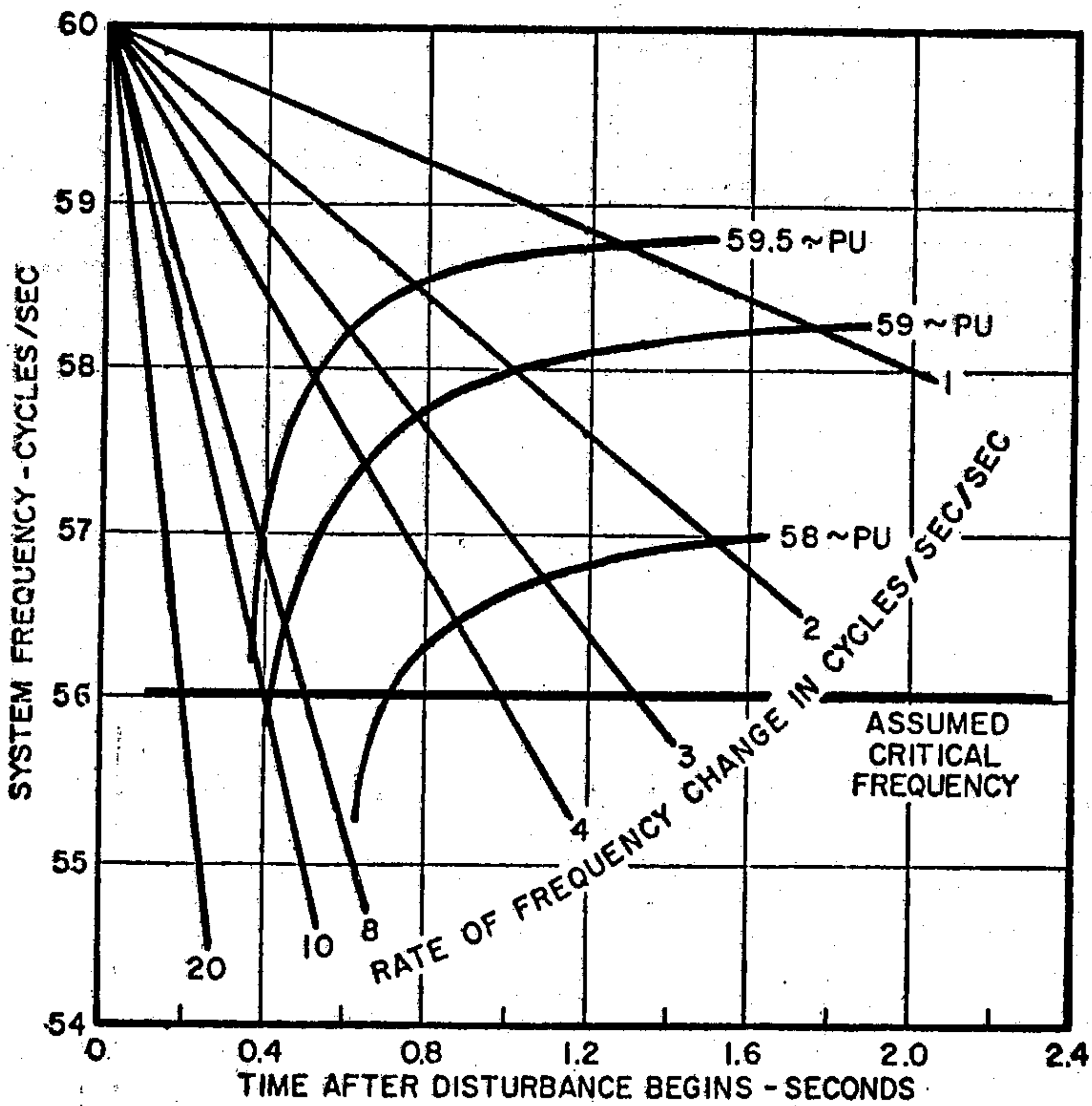
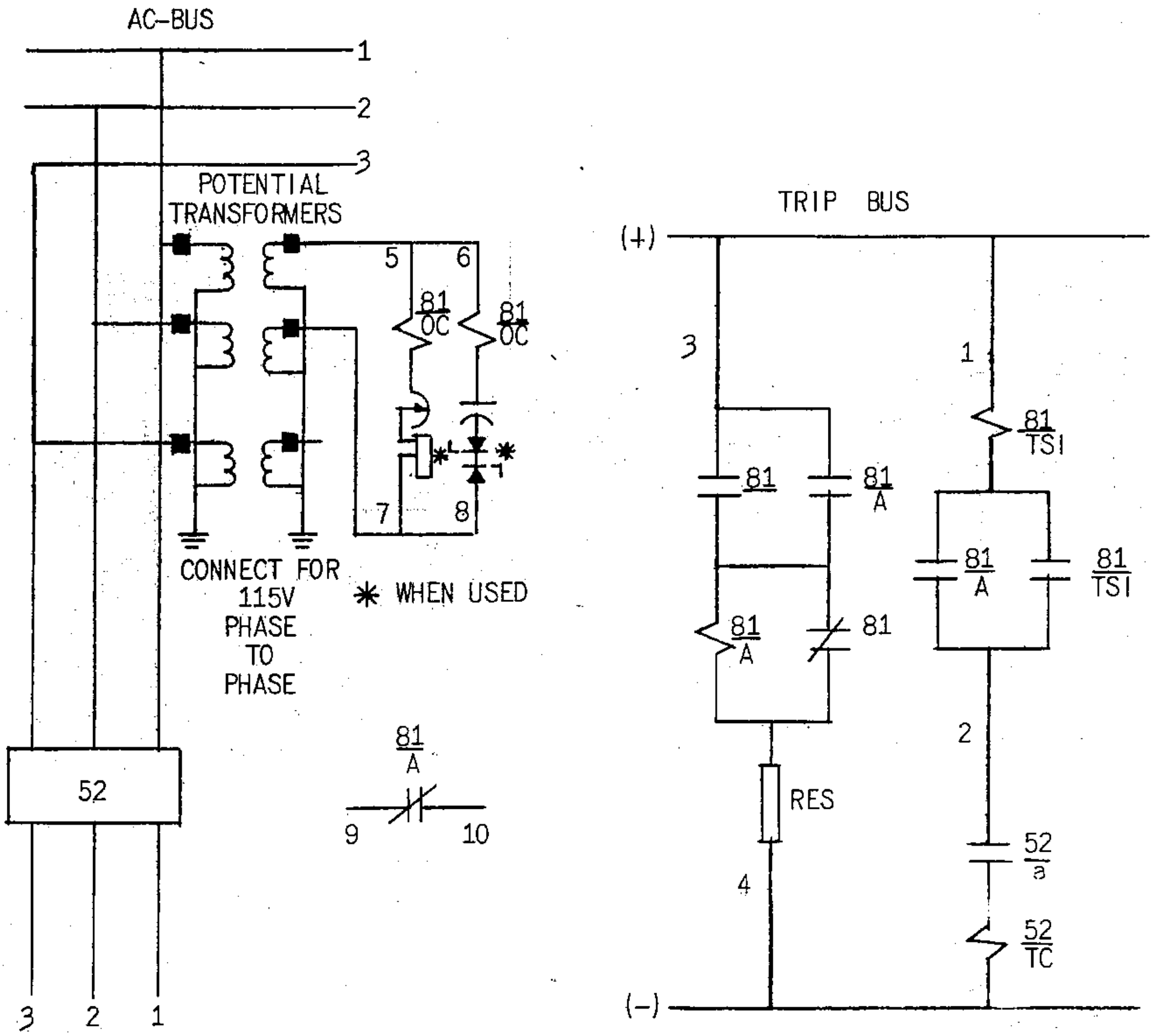


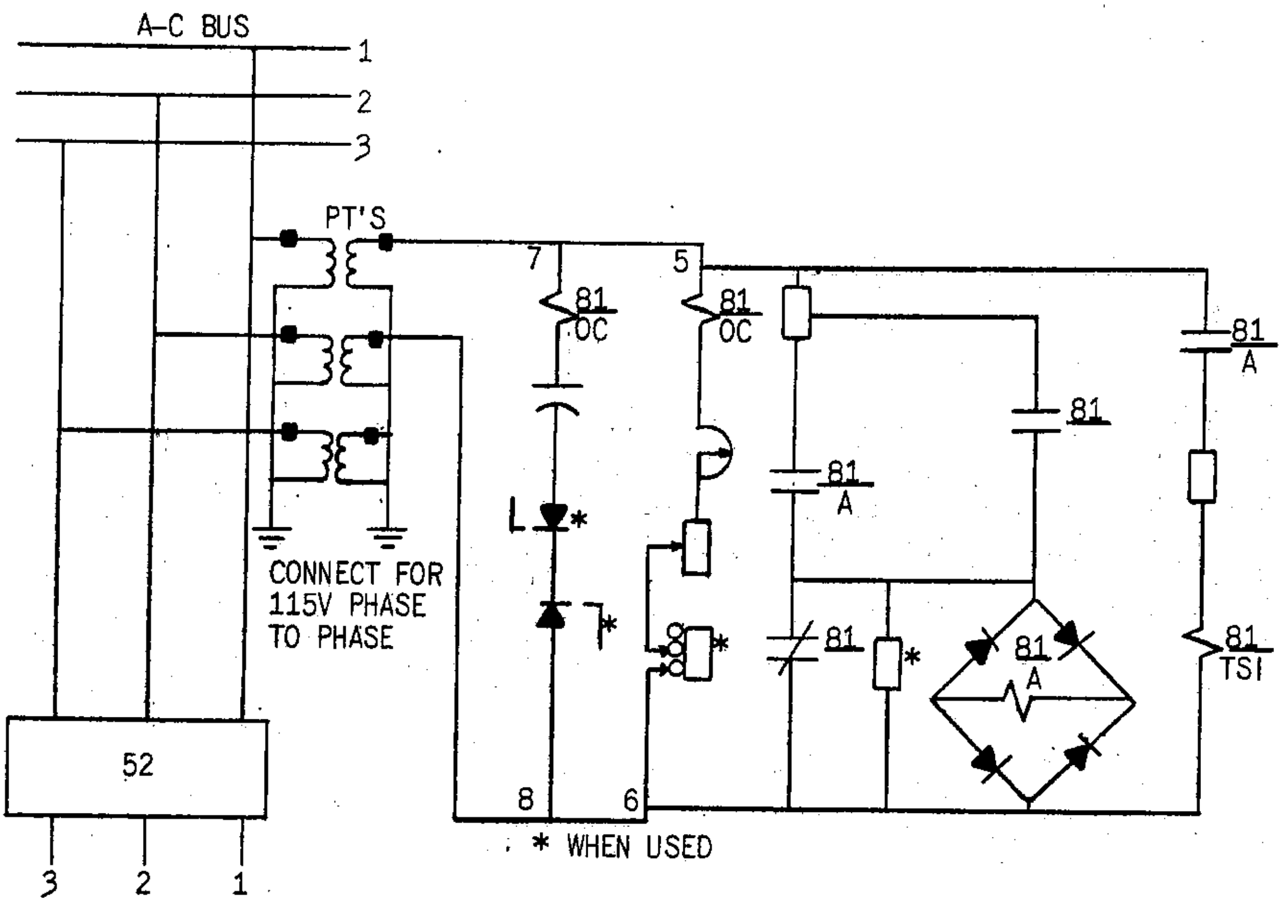
FIG. 1 (0208A2413-0) Frequency VS Time Characteristics For Total Clearing Time For CFF Relays



DEVICE FUNCTION NUMBERS

52 – CIRCUIT BREAKER
81 – FREQUENCY RELAY
TYPE CFF
A – AUXILIARY TELEPHONE RELAY UNIT
52/a – AUXILIARY CONTACT
CLOSED WHEN BREAKER IS CLOSED
OC – OPERATING COIL
TC – TRIP COIL
TSI – TARGET SEAL IN

FIG. 2 (0208A5506-1) External Connections Diagram For Relay Type CFF12A Form 41 And Up



81 – FREQUENCY RELAY TYPE CFF
A – AUXILIARY TELEPHONE RELAY
TSI – TARGET SEAL-IN UNIT
OC – OPERATING COIL
52 – CIRCUIT BREAKER
TC – TRIP COIL

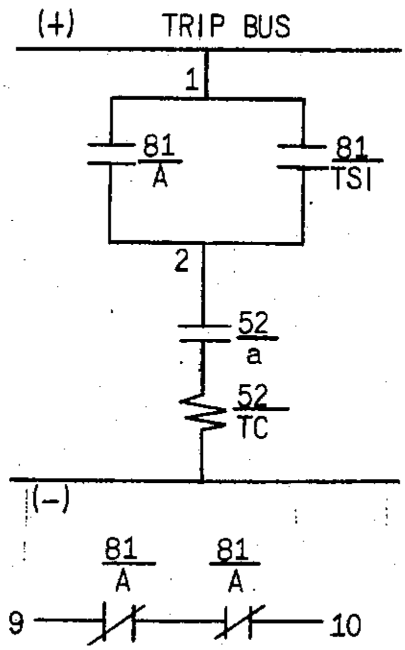
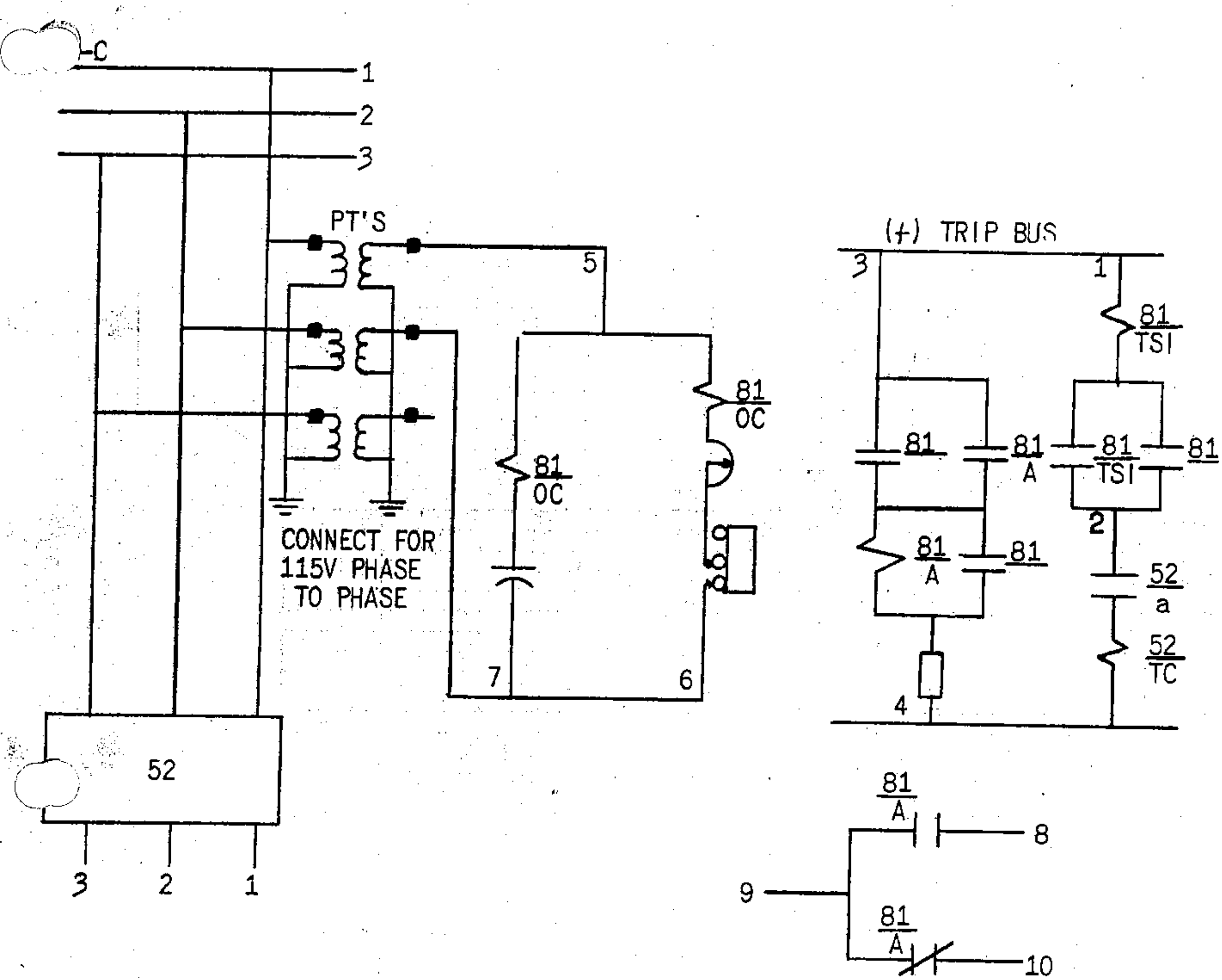


FIG. 3 (0226A7216-1) External Connections Diagram For Relay Type CFF12C



81 – FREQUENCY RELAY TYPE CFF
A – AUXILIARY TELEPHONE RELAY
TSI – TARGET SEAL-IN UNIT
OC – OPERATING COIL
52 – CIRCUIT BREAKER
a – BREAKER AUXILIARY SWITCH
TC – TRIP COIL

FIG. 4 (0226A7215-1) External Connections Diagram For Relay Type CFF12E

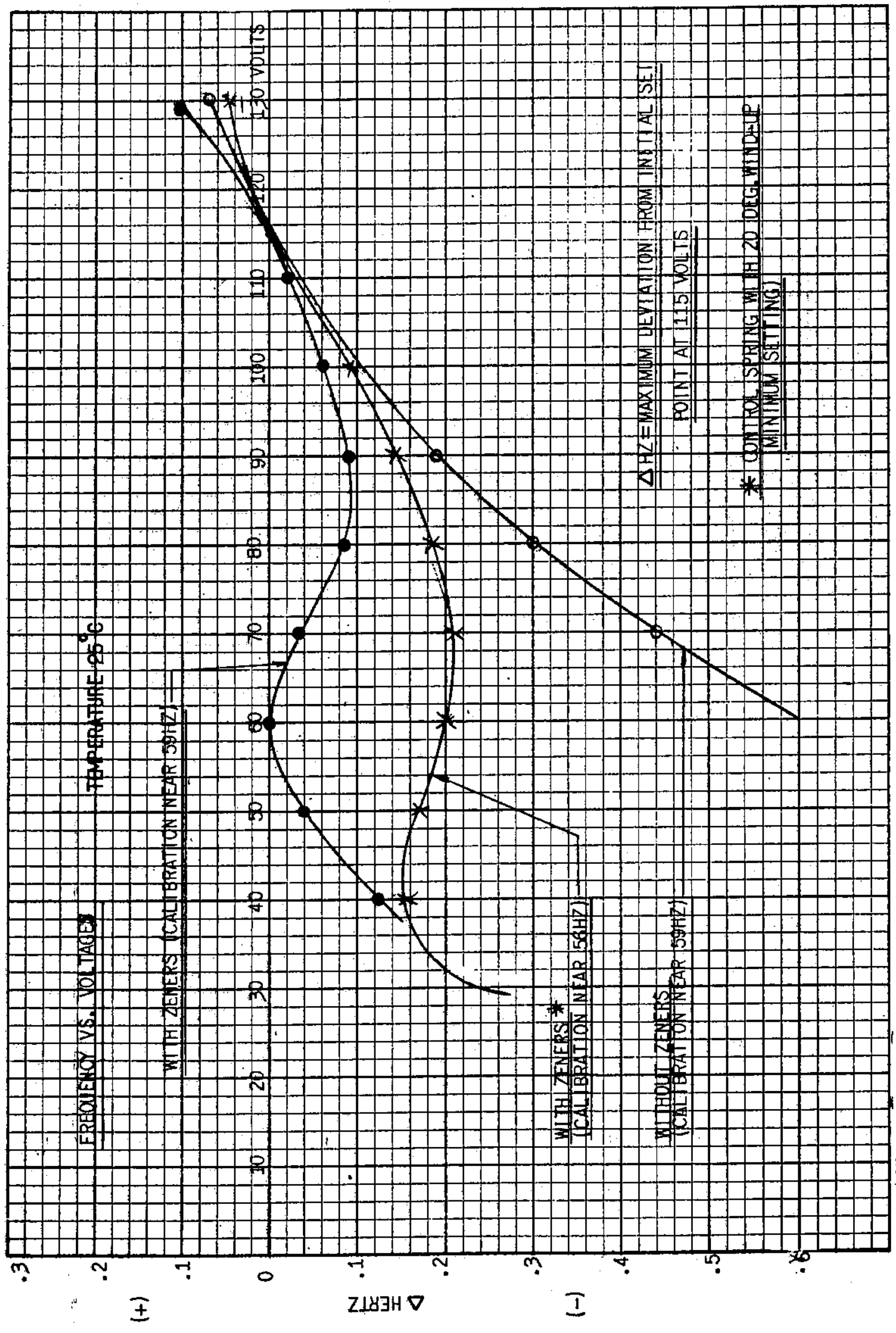


FIG. 5 (0226A6951-0) Typical Operating Characteristics Of Relay Type CFF

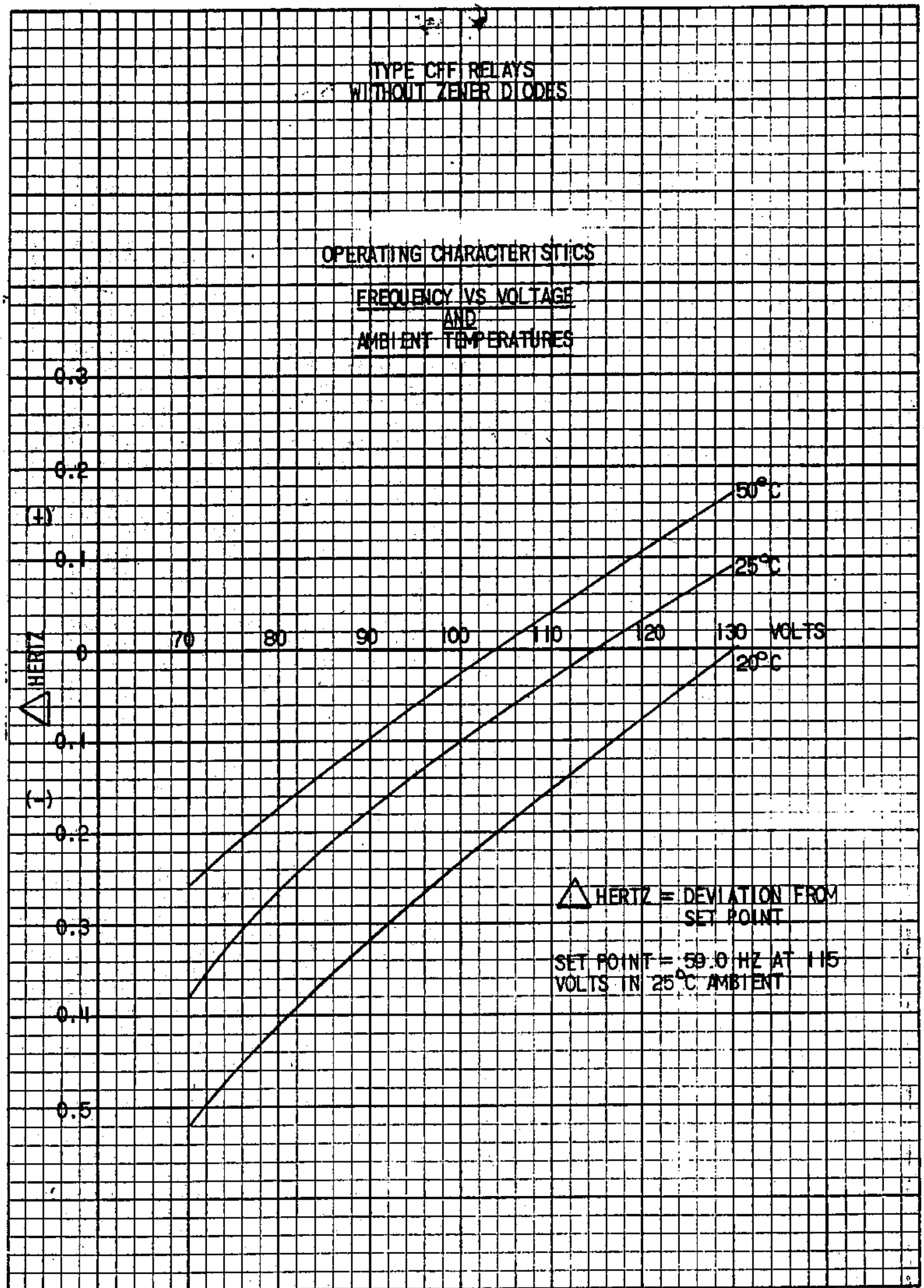


FIG. 6 (0226A6950-1) Typical Operating Characteristics Of Relay Type CFF

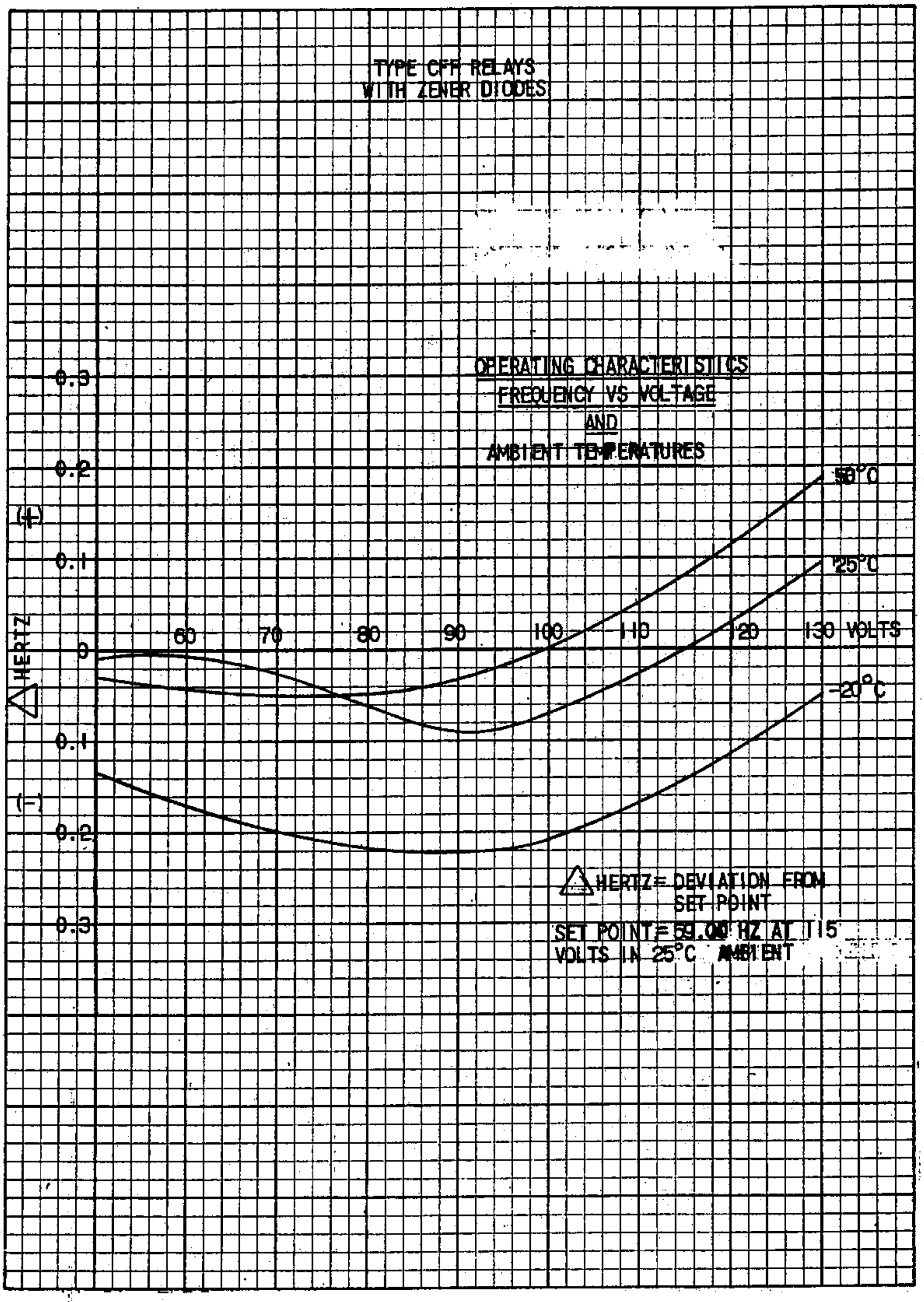


FIG. 7 (0226A6952-1) Typical Operating Characteristics Of Relay Type CFF

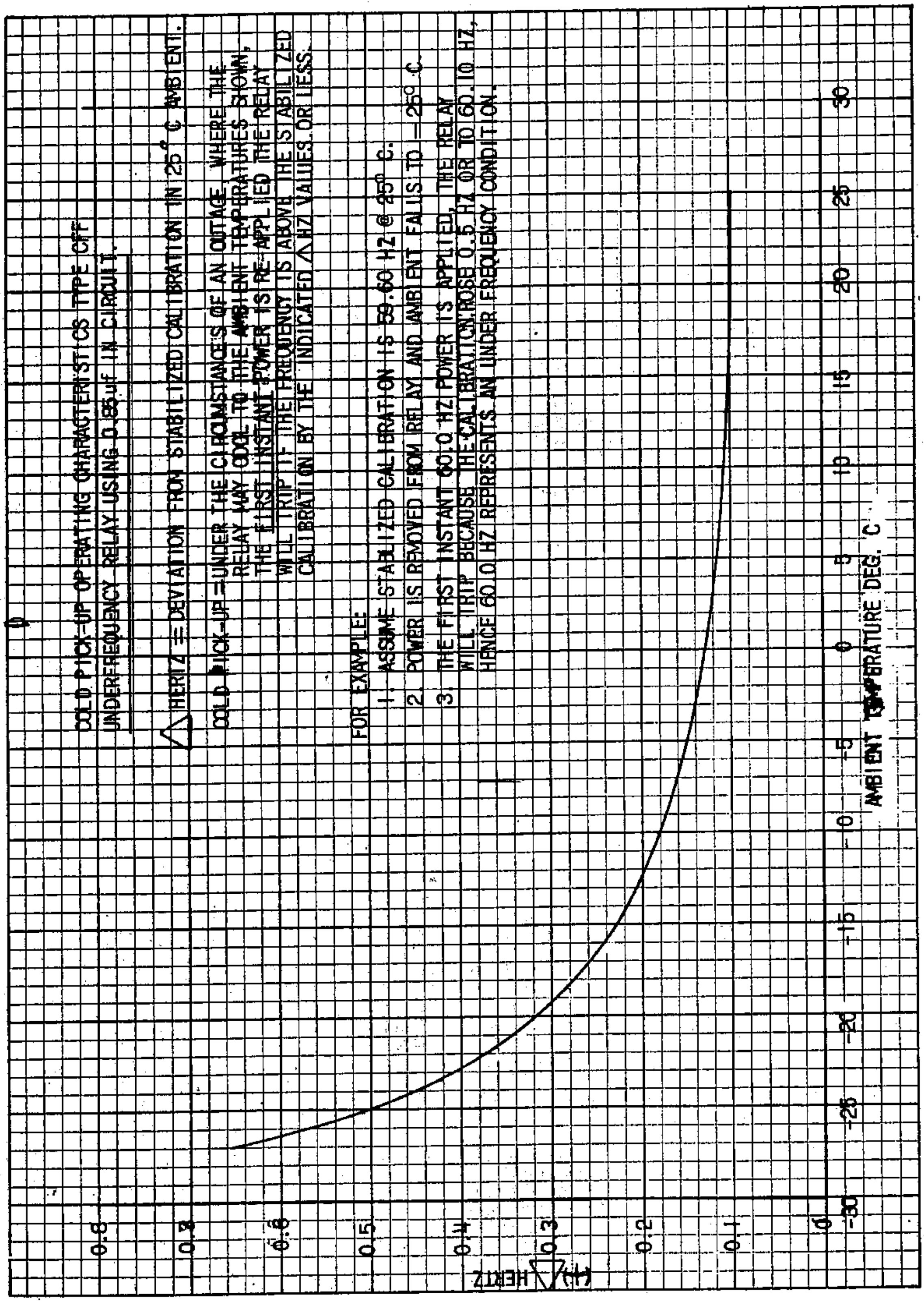


FIG. 8 (0208A5552-1) The Cold Pickup Operating Characteristics Of Relay Type CFF

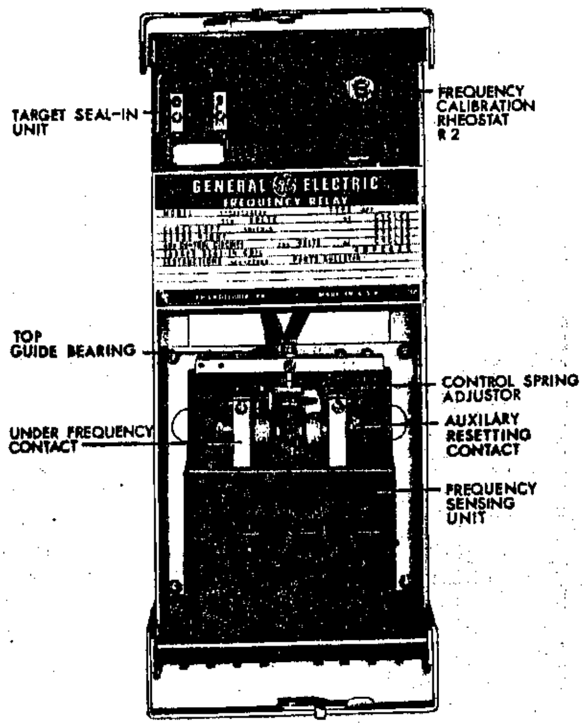


FIG. 9 (8040241) Relay Type CFF12A63A Out Of Case (Front View)

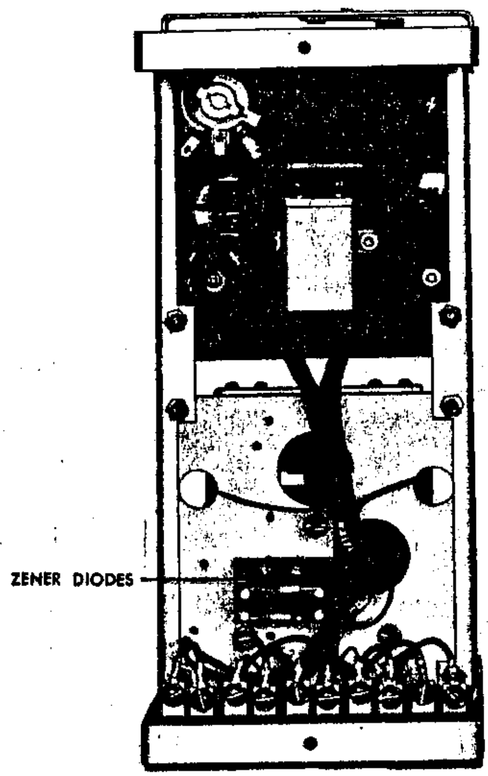


FIG. 10 (8040240) Relay Type CFF12A63A Out Of Case (Rear View)

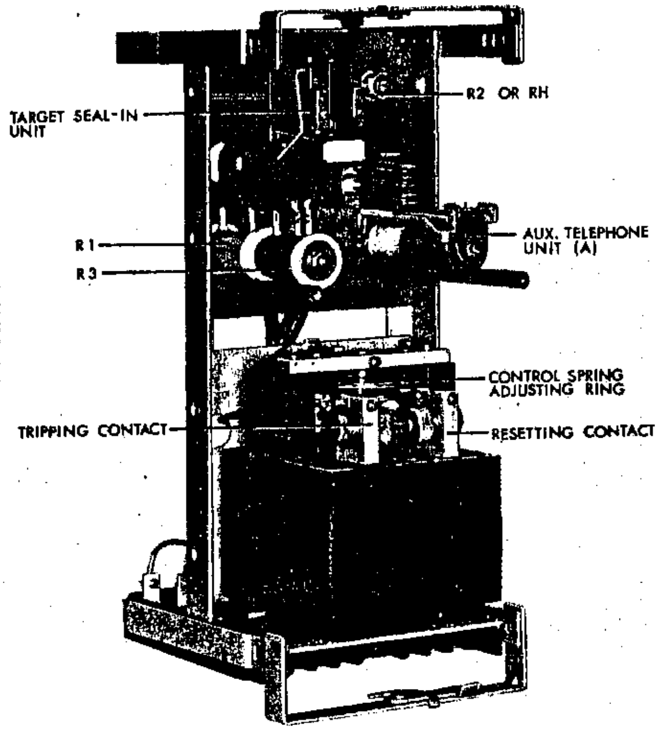


FIG. 11 (8040239) Relay Type CFF12A63A Out Of Case (3/4 Front View)

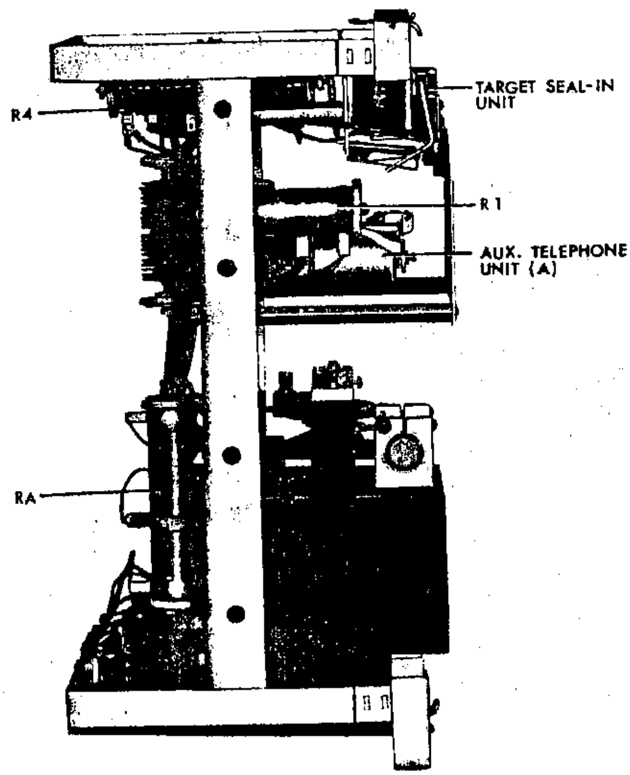


FIG. 12 (8040135) Relay Type CFF12C15A Out Of Case (Side View)

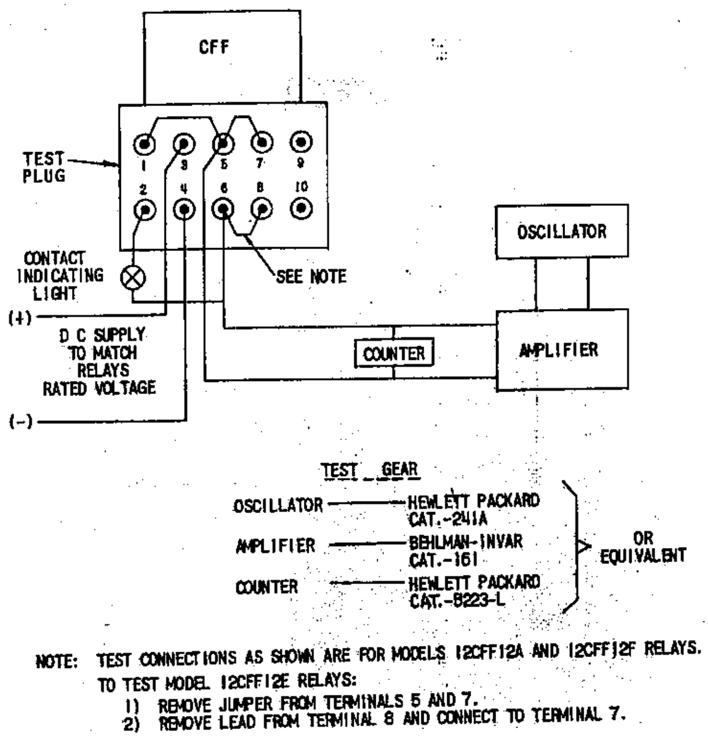


FIG. 13 (0208A5551-0) The Test Diagram For Checking The Frequency Sensing Unit In The CFF12A, CFF12E And CFF12F Relays

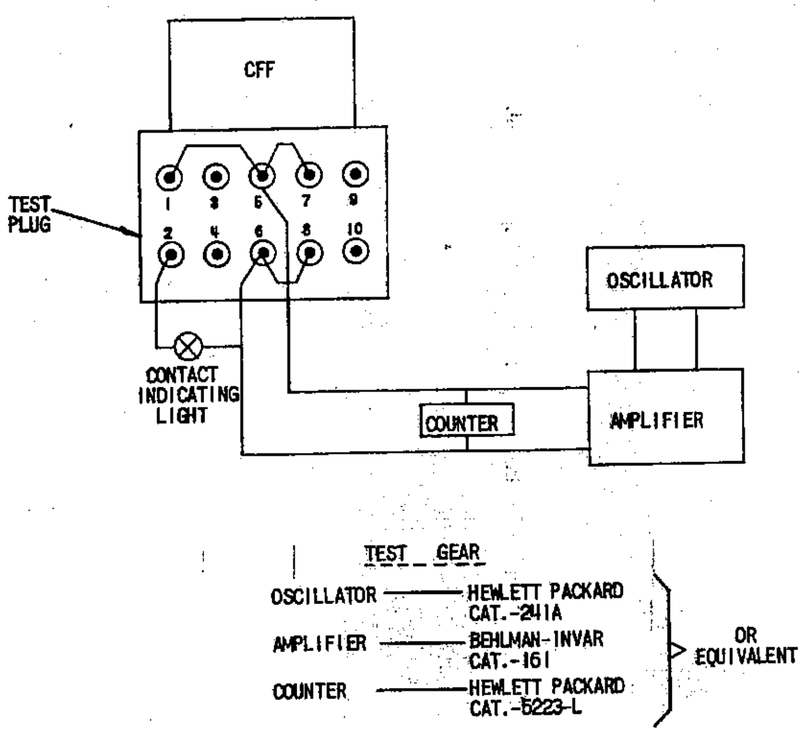


FIG. 14 (0208A5550-0) The Test Diagram For Checking The Frequency Sensing Unit In The CFF12C Relay

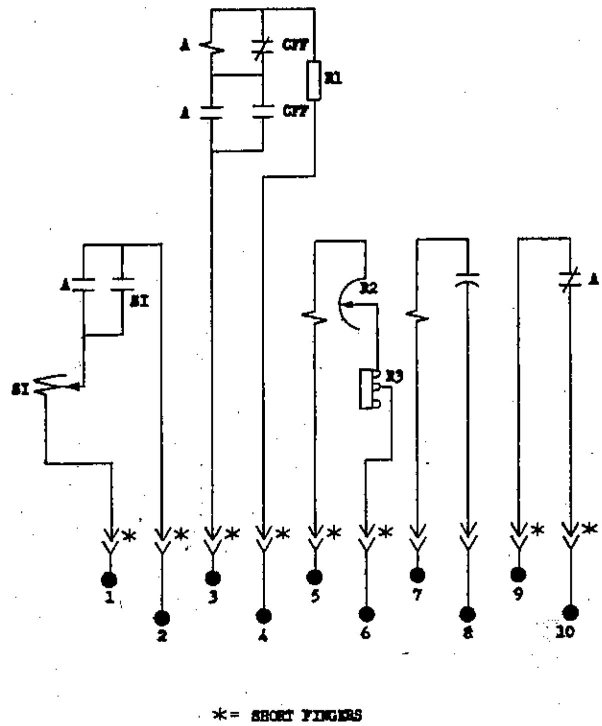


FIG. 15 (0203A8575-1) Internal Connections Diagram For The CFF12A Relay-Form 41 To 60 (Front View)

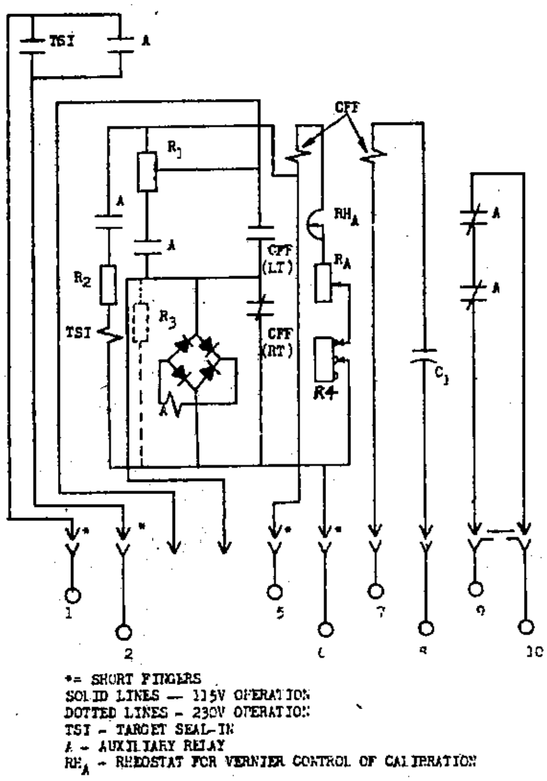
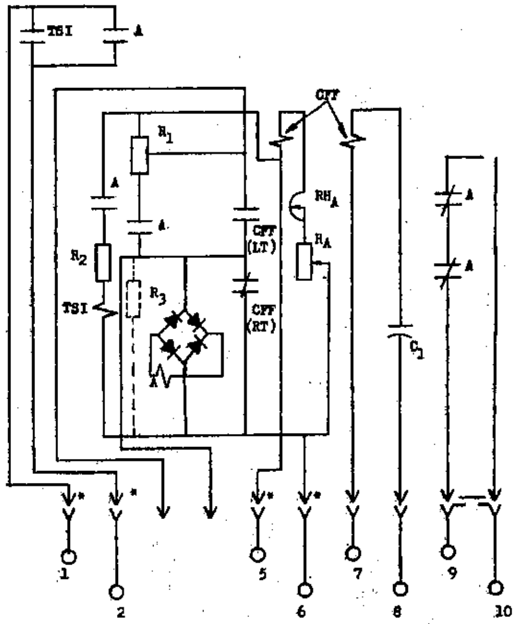
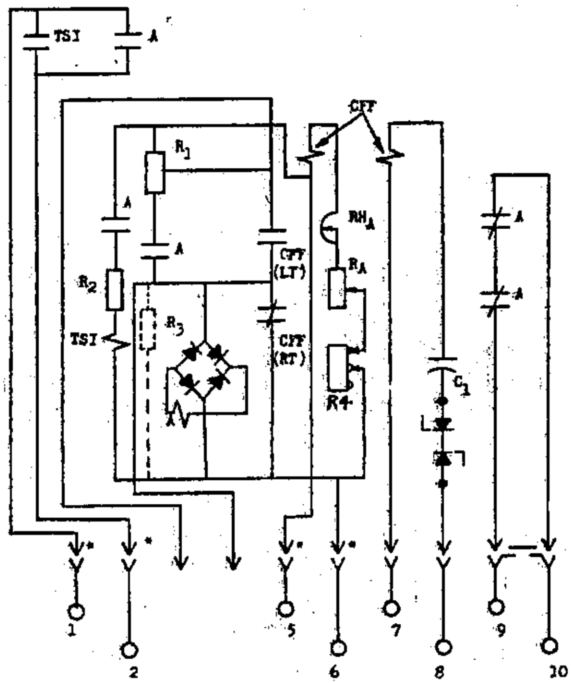


FIG. 16 (0203A8667-1) Internal Connections Diagram For The CFF12C13 Relay (Front View)



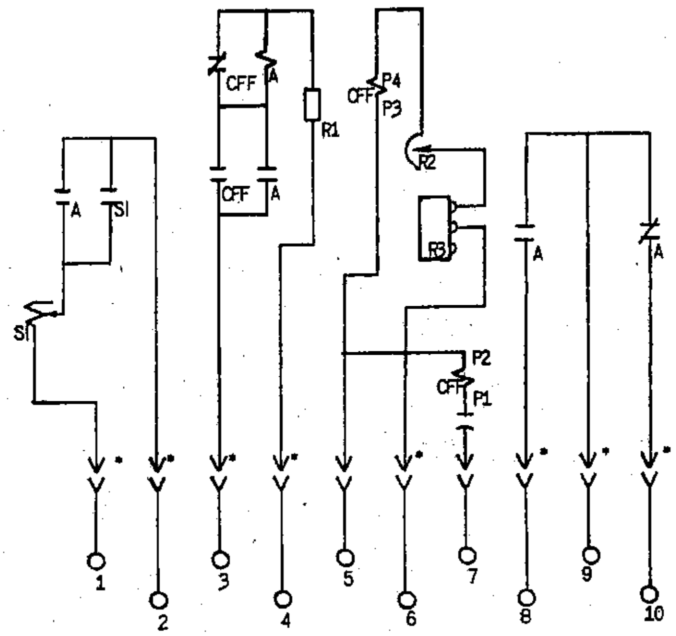
*= SHORT FINGERS
SOLID LINES — 115V OPERATION
DOTTED LINES - 230V OPERATION
TSI - TARGET SEAL-IN
A - AUXILIARY RELAY
RH_A - RHEOSTAT FOR VERNIER CONTROL OF CALIBRATION

FIG. 17 (0195A4964-4) Internal Connections Diagram For The CFF12C14A And CFF12D11 And Up Relays (Front View)



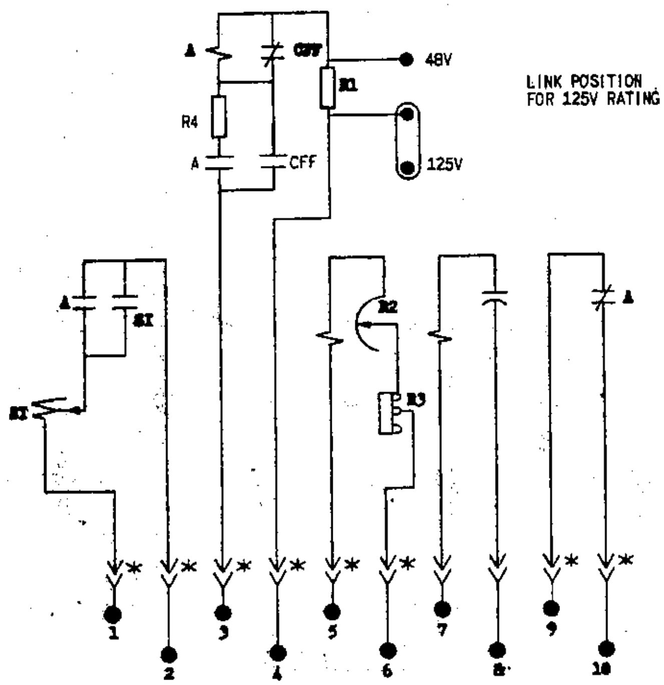
*= SHORT FINGERS
SOLID LINES — 115V OPERATION
DOTTED LINES - 230V OPERATION
TSI - TARGET SEAL-IN
A - AUXILIARY RELAY
RH_A - RHEOSTAT FOR VERNIER CONTROL OF CALIBRATION

FIG. 18 (0208A2356-0) Internal Connections Diagram For The CFF12C15A Relay (Front View)



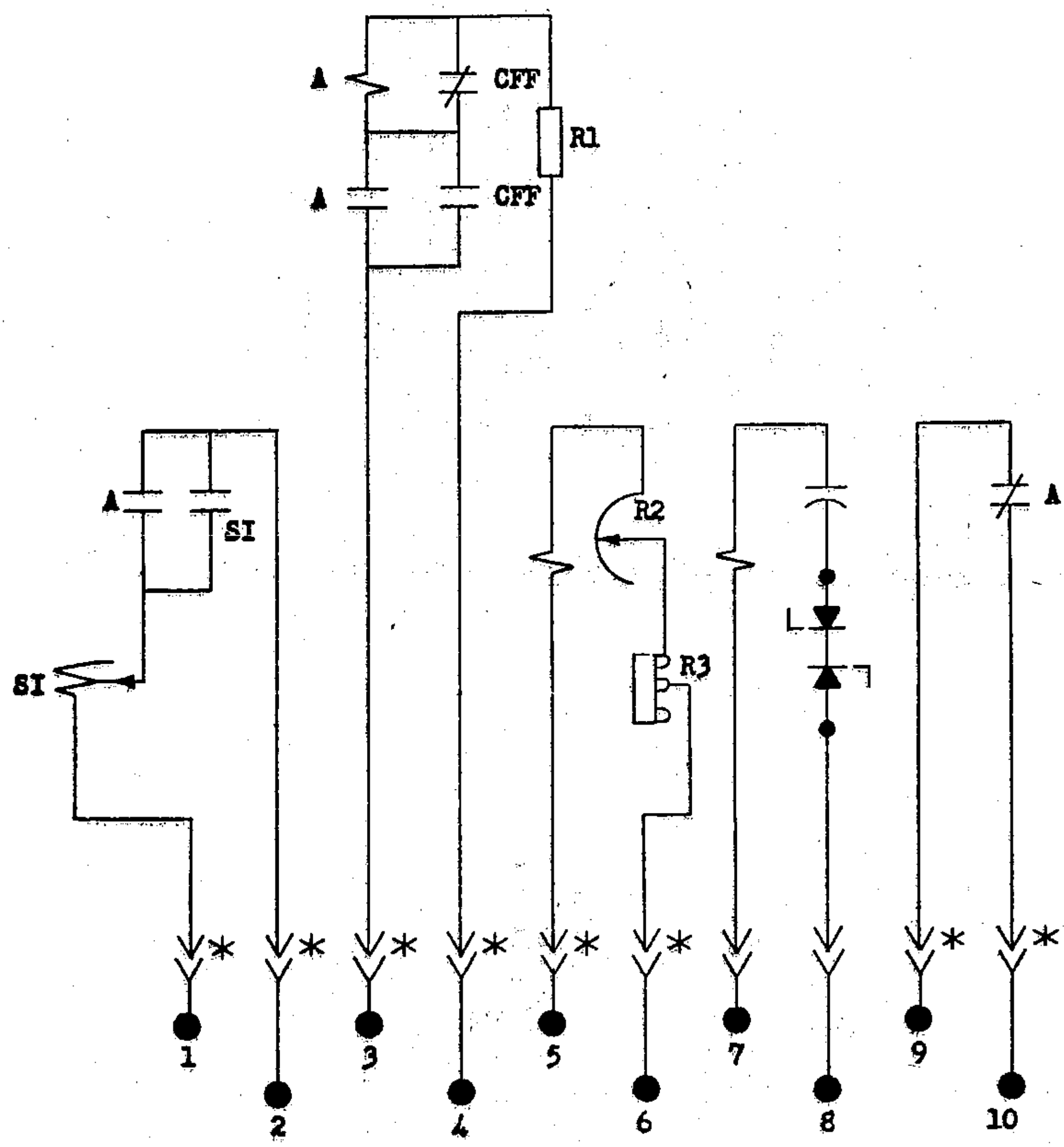
* = SHORT FINGERS

FIG. 19 (0203A8666-0) Internal Connections Diagram For The CFF12E Relay Form 3 & Up (Front View)



* = SHORT FINGERS

FIG. 20 (0207A7866-0) Internal Connections Diagram For The CFF12F Relay (Front View)



*= SHORT FINGERS

FIG. 21 (0208A2357-0) Internal Connections Diagram For The CFF12A Relay - Form 61 & Up (Front View)

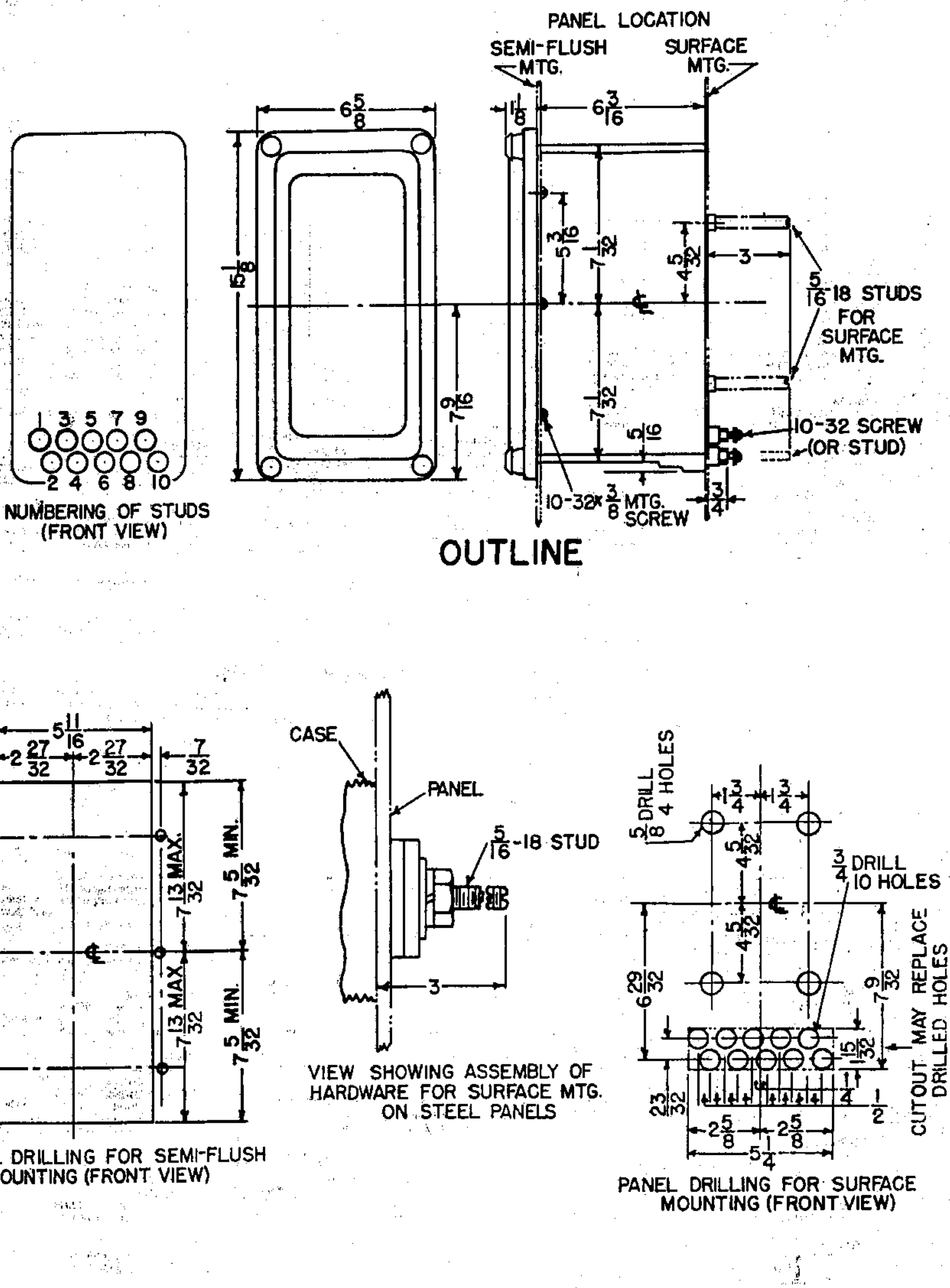


FIG. 22 (K-6209273-2) Outline And Panel Drilling Dimensions For The CFF Type Relays

GENERAL ELECTRIC INSTALLATION AND SERVICE ENGINEERING OFFICES

FIELD SERVICE OFFICE CODE KEY
- * Mechanical & Nuclear Service
- † Electrical & Electronic Service
- ‡ Marine Service
- x Transportation

FOR YOUR LASTING SATISFACTION ... with the performance and availability of your General Electric equipment, GE provides this nationwide network of field service offices, serving utility, industrial, transportation and marine users. Qualified field engineers provide installation, start-up, employee training, engineering maintenance and other services, throughout the productive life of the equipment. For full information, call your nearest Installation & Service Engineering office.

ALABAMA
- † Birmingham 35205 .... 2151 Highland Ave.
- * † ‡ Mobile 36609 .... 1111 S. Beltline Highway

ALASKA
- † Anchorage 99501 .... 115 Whitney Rd.

ARIZONA
- * † Phoenix 85012 ...... 3550 N. Central Ave.
- † Tucson 85716 .... 151 S. Tucson Blvd.

ARKANSAS
- † North Little Rock 72119 ..... 120 Main St.

CALIFORNIA
- * † ‡ Los Angeles 90054 ...... 212 N. Vignes St.
- † Palo Alto 94303 ..... 960 San Antonio Rd.
- † Sacramento 95808 .... 2407 J St.
- † San Diego 92103 .... 2560 First Ave.
- * ‡ San Francisco 94119 .... 55 Hawthorne St.
- * Vernon 90058 .... 3035 E. 46th St.

COLORADO
- * † Denver 80206 .... 201 University Blvd.

CONNECTICUT
- * † Meriden 06450 .... 1 Prestige Dr.

FLORIDA
- † ‡ Jacksonville 32203 .... 4040 Woodcock Dr.
- † ‡ Miami 33134 .... 4100 W. Flagler St.
- * † ‡ Tampa 33609 .... 2106 S. Lois Ave.

GEORGIA
- * † ‡ Atlanta 30309 .... 1860 Peachtree Rd., NW
- † ‡ Savannah 31405 .... 5002 Paulsen St.

HAWAII
- * † ‡ Honolulu 96813 .... 440 Coral St.

ILLINOIS
- * † ‡ x Chicago 60680 .... 840 S. Canal St.

INDIANA
- † Evansville 47705 .... 2709 Washington Ave.
- † Fort Wayne 46807 .... 3606 S. Calhoun St.
- * † Indianapolis 46207 .... 3750 N. Meridian St.

IOWA
- † Davenport 52805 ... P.O. Box 630, 1039 State St., Bettendorf

KENTUCKY
- † Louisville 40218 ...... 2300 Meadow Dr.

LOUISIANA
- † Baton Rouge 70806 .... 8312 Florida Blvd.
- * † ‡ New Orleans 70125 .... 4747 Earhart Blvd.
- * † Shreveport 71104 .... 2620 Centenary Blvd.
- † Monroe 71201 .... 1028 North 6th St.

MARYLAND
- * † ‡ Baltimore 21201 .... 1 N. Charles St.

MASSACHUSETTS
- * † ‡ Wellesley 02181 .... 1 Washington St.

MICHIGAN
- * † ‡ Detroit 48202 .... 700 Antoinette St.
- † Jackson 49201 .... 210 W. Franklin St.
- † Saginaw 48607 .... 1008 Second National Bank Bldg.

MINNESOTA
- † ‡ Duluth 55802 .... 300 W. Superior St.
- * † ‡ Minneapolis 55416 ... 1500 Lilac Drive So.

MISSOURI
- * † Kansas City 64199 .... 911 Main St.
- * † St. Louis 63101 .... 1015 Locust St.

MONTANA
- † Butte 59701 .... 103 N. Wyoming St.

NEBRASKA
- * † Omaha 68102 .... 409 S. 17th St.

NEW JERSEY
- * † Millburn 07041 .... 25 E. Willow St.

NEW YORK
- † Albany 12205 .... 15 Computer Drive, West
- * † ‡ Buffalo 14205 .... 625 Delaware Ave.
- * † ‡ x New York 10022 .... 641 Lexington Ave.
- † Rochester 14604 .... 89 East Ave.
- * † ‡ Syracuse 13206 .... 3532 James St.

NORTH CAROLINA
- * † ‡ Charlotte 28207 .... 141 Providence Rd.
- * Wilmington Reigelwood 28456 .... P.O. Box 186

OHIO
- * † Cincinnati 45206 .... 2621 Victory Pkwy.
- * † ‡ Cleveland 44104 ...... 1000 Lakeside Ave.
- † Columbus 43229 .... 1110 Morse Rd.
- † ‡ Toledo 43606 .... 3125 Douglas Rd.
- † Youngstown 44507 ..... 272 Indianola Ave.

OKLAHOMA
- * † Oklahoma City 73106 ... 2000 Classen Blvd.
- † Tulsa 74105 .. P.O. Box 7646, Southside Sta.

OREGON
- † Eugene 97401 .... 1170 Pearl St.
- * † ‡ Portland 97210 .... 2929 NW 29th Ave.

PENNSYLVANIA
- * Allentown 18102 .... 1444 Hamilton St.
- * † ‡ Philadelphia 19102 ... 3 Penn Center Plaza
- * † Pittsburgh 15222 .... 300 6th Avenue Bldg.

SOUTH CAROLINA
- † ‡ Columbia 29204 ..... 2700 Middleburg Dr.
- † Greenville 29607 .. 41 No. Pleasantburg Dr.

TENNESSEE
- * † Chattanooga 37411 .... 5800 Bldg, Eastgate Center
- † Memphis 38130 .... 3385 Airways Blvd.

TEXAS
- * † Amarillo 79101 .... 303 Polk St.
- * † ‡ Beaumont 77704 .... 1385 Calder Ave.
- * ‡ Corpus Christi 78401 .. 205 N. Chaparral St.
- * † Dallas 75222 .... 8101 Stemmons Freeway
- * † El Paso 79945 .... 215 N. Stanton
- † Fort Worth 76102 .... 408 W. Seventh St.
- * † ‡ Houston 77027 .... 4219 Richmond Ave.
- † San Antonio 78204 .... 434 S. Main St.

UTAH
- † Salt Lake City 84111 .. 431 S. Third East St.

VIRGINIA
- * ‡ Newport News 23601 .... 311 Main St.
- † ‡ Richmond 23230 .... 1508 Willow Lawn Dr.
- † Roanoke 24015 .... 2018 Colonial Ave.

WASHINGTON
- * † ‡ Seattle 98188 .... 112 Andover Park East, Tukwila
- † Spokane 99202 .... E. 1805 Trent Ave.

WEST VIRGINIA
- * † Charleston 25328 .. 306 MacCorkle Ave., SE

WISCONSIN
- * Appleton 54911 .... 3003 West College Dr.
- † ‡ Milwaukee 53202 ..... 615 E. Michigan St.

GENERAL ELECTRIC SERVICE SHOPS

WHEN YOU NEED SERVICE ... These GE Service Shops will repair, recondition, and rebuild your electric apparatus. The facilities are available day and night, seven days a week, for work in the shops or on your premises. Latest factory methods and genuine GE renewal parts are used to maintain performance of your equipment. For full information about these services, contact your nearest service shop or sales office.

ALABAMA
- ● • Birmingham 35211 .. 1500 Mims Ave., S.W.
- ● Mobile 36609 .... 721 Lakeside Dr.

ARIZONA
- ● (Phoenix) Glendale 85019 . 4911 W. Colter St.
- • Phoenix 85019 ..... 3840 W. Clarendon St.
- ● Tucson 85713 .... 2942 So. Palo Verde Ave.

CALIFORNIA
- ● Los Angeles 90301 .... 6900 Stanford Ave.
- ● (Los Angeles) Anaheim 92805 .... 3601 E. LaPalma Ave.
- • (Los Angeles) Inglewood 90301 .... 228 W. Florence Ave.
- ● Sacramento 95814 .... 99 North 17th St.
- ● • (San Francisco) Oakland 94608 .... 1650 34th St.

COLORADO
- ● • Denver 80205 .... 3353 Larimer St.

CONNECTICUT
- ● • (Southington) Plantsville 06479 .... 370 Atwater St.

FLORIDA
- ● • Jacksonville 32203 .... 2020 W. Beaver St.
- ● (Miami) Hialeah 33010 .... 1062 East 28th St.
- ● • Tampa 33601 .... 19th & Grant Sts.

GEORGIA
- ● (Atlanta) ... nbiee 30341 .... 5035 Peachtree Industrial-Blvd.
- • Atlanta .... 2379 John Glenn Dr.

ILLINOIS
- ● • Chicago 60638 .... 6045 S. Nottingham Ave.

INDIANA
- ● Evansville 47711 ... 401 N. Congress Ave.
- ● Ft. Wayne 46803 .... 1731 Edsall Ave.
- ● Hammond 46320 .... 1138 164th Place
- ● • Indianapolis 46222 ... 1740 W. Vermont St.

IOWA
- ● (Davenport) Bettendorf 52722 . 1025 State St.

KENTUCKY
- ● Louisville 40309 .... 3900 Crittenden Drive

LOUISIANA
- ● Baton Rouge 70814 ... 10955 North Dual St.
- ● • New Orleans 70114 ..... 1115 DeArmas St.

MARYLAND
- ● • Baltimore 21230 .... 920 E. Fort Ave.

MASSACHUSETTS
- ● • Δ (Boston) Medford 02155 .... 3960 Mystic Valley Pkwy.

MICHIGAN
- ● • Δ (Detroit) Riverview .... 18075 Krause Ave.
- • Flint 48505 .... 1506 E. Carpenter Rd.

MINNESOTA
- ● Duluth 55807 ... 50th Ave. W & St. Louis Bay
- ● • Minneapolis 55430 .... 2025 49th Ave., N.

MISSOURI
- ● • Kansas City 64120 ..... 3525 Gardner Ave.
- ● • St. Louis 63110 .... 1115 East Rd.

NEW JERSEY
- ● New Brunswick 08902 ..... 3 Lawrence St.

NEW MEXICO
- ● Albuquerque 87109 ... 4420 McLeod Rd. NE

NEW YORK
- ● Albany 12205 .... 1097 Central Ave.
- ● • (Buffalo) Tonawanda 14150 .. 175 Milens Rd.
- ● (Long Island) Old Bethpage 11804 .... 183 Bethpage-Sweet Hollow Rd.
- ● (New York City) North Bergen, N.J. 07012 .... 6001 Tonnelle Ave.
- • (New York City) Clifton, N.J. 07012 .... 9 Brighton Rd.
- • Δ Schenectady 12305 .... 1 River Rd.
- ● Syracuse 13208 ..... 1015 E. Hiawatha Blvd.

NORTH CAROLINA
- ● • Charlotte 28208 .... 2328 Thrift Rd.

OHIO
- ● Akron (Canton) 44720 .... 7900 Whipple Ave. N.W.
- ● • Cincinnati 45202 .... 444 West 3rd St.
- ● • Δ Cleveland 44125 .... 4477 East 49th St.
- ● Columbus 43229 .... 6660 Huntley Rd.
- ● • Toledo 43605 .... 405 Dearborn Ave.
- ● Youngstown 44507 .... 272 E. Indianola Ave.

OKLAHOMA
- ● Tulsa 74145 ...... 5220 S. 100th East Ave.

OREGON
- ● Eugene 97402 .... 570 Wilson St.
- ● • Portland 97210 ...... 2727 NW 29th Ave.

PENNSYLVANIA
- ● Allentown 18103 ...... 668 E. Highland St.
- • (Delaware Valley) Cherry Hill, N.J. .. 08034 .... 1790 E. Marlton Pike
- ● Johnstown 15802 .... 841 Oak St.
- ● Philadelphia 19124 .... 1040 East Erie Ave.
- ● • (Pittsburgh) West Mifflin 15122 .... 4930 Buttermilk Hollow Rd.
- ● York 17403 .... 54 N. Harrison St.

SOUTH CAROLINA
- ● (Charleston) No. Charleston 29401 .... 2490 Debonair St.

TENNESSEE
- ● Knoxville 37914 .... 2621 Governor John Sevier Hwy.
- ● Memphis 38107 .... 708 North Main St.

TEXAS
- ● Beaumont 77705 ..... 1490 W. Cardinal Dr.
- ● Corpus Christi 78401 .... 115 Waco St.
- ● • Dallas 75235 .... 3202 Manor Way
- ● Houston 77036 .... 5534 Harvey Wilson Dr.
- • Houston 77036 .... 6916 Harwin Dr.
- ● Midland 79701 .... 704 S. Johnston St.

UTAH
- ● • Salt Lake City 84110 .... 301 S. 7th West St.

VIRGINIA
- ● • Richmond 23224 .... 1403 Ingram Ave.
- ● Roanoke 24013 .... 1004 River Ave., SE

WASHINGTON
- ● • Seattle 98134 ..... 3422 First Ave., South
- ● Spokane 99211 .... E. 4323 Mission St.

WEST VIRGINIA
- ● • Charleston 25328 .. 306 MacCorkle Ave., SE

WISCONSIN
- ● (Appleton) Menasha 54910 .. 1725 Racine St.
- ● Milwaukee 53207 ... 235 W. Oklahoma Ave.

● Electrical/Mechanical Service Shop • Instrumentation Shop Δ Special Manufacturing Shop