GEK-90636D

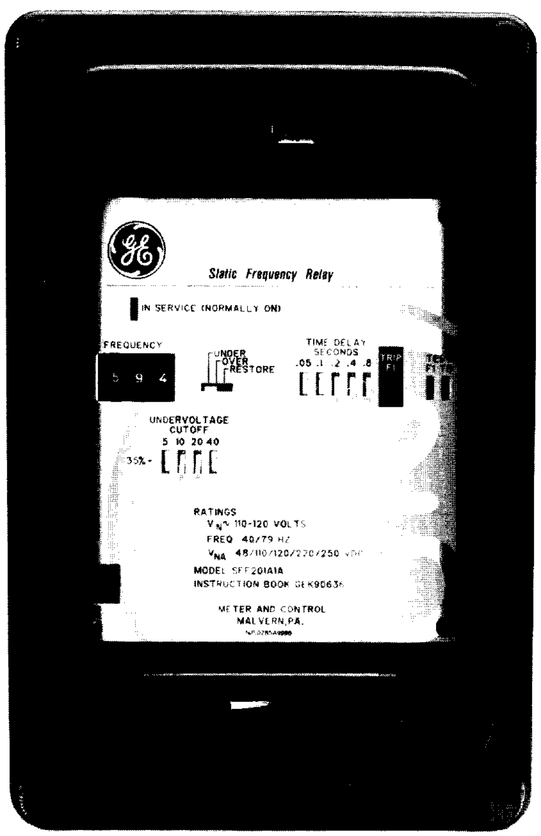
INSTRUCTIONS

Static Frequency Relays

SFF201A, B

SFF202A, B

SFF204A, B



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.... Cover Photo: 8043796

DESCRIPTION

The type SFF relays are digital frequency relays that measure the system frequency. Three versions of the SFF are available providing one, two, or four frequency setpoints. Each of the frequency measuring elements is independent, and can be independently set for under frequency, over frequency, or restore operation, and has 1 form C output contact. Each element may be set for any frequency over the range of 40 to 79.9 Hz in 0.1 Hz steps in the SFF20(-)A and 0.01 Hz steps in the SFF20(-)B. **If a frequency setting outside of the acceptable range is made, that frequency will be prevented from operating.**

A simple rate-of-change (ROC) feature can be enabled on the multi-frequency models. When this feature is enabled, an output will be produced at the higher set frequency if the next lower frequency setpoint is reached before the timer associated with the higher set frequency can time out. For example, assume that a two setpoint relay is set to operate at 59 Hz with an 0.75 second delay, and at 58 Hz with a 1 second delay. If 58 Hz is reached 0.5 seconds after 59 Hz is reached, the output relay associated with the 59 Hz setting will operate at that time rather than waiting until the full 0.75 seconds has expired. Similar performance can be obtained between the second and third setpoints and between the third and fourth setpoints in the four setpoint relay.

The minimum operating time for an under frequency, over frequency, or restore output to occur is 3 cycles. In addition, an adjustable timer is provided for each frequency setpoint wherein a delay can be added to the output. When used in the under frequency or over frequency mode this time is used to delay the output, whereas it is used to prolong the output when the function is used in the restore mode. Timer ranges are shown below:

Model	Timer Range	Steps
SFF20(-)A:	0 to 1.55 seconds	.05 second
SFF20(-)B:	1.0 to 255 milliseconds	1 millisecond
	0.1 to 25.5 seconds	0.1 second

The AC undervoltage cutoff function operates to block all outputs whenever the input voltage is less than the undervoltage cutoff setting. The function has a dropout time of approximately one-half (1/2) cycle and a pickup time of approximately one (1) cycle. The function is adjustable over the range of 35 to 95 percent in 5 percent steps. Note that the percentage is based on 120 volts, the nominal rating of the relay. For example, if the input voltage is 110 volts, and the cutoff level is set to 50 percent, cutoff will occur at 60 volts (50 percent of 120) rather than 55 volts (50 percent of 110).

These instructions do not purport to cover all details or variations in equipment nor to prouide for every possible contingency to be met in connection with installation, operation ***or*** *maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.*

To the extent required the products described herein meet applicable ANSI, IEEE and NEMA standards, but no such assurance is given with respect to local codes and ordinances because they vary greatly.

The relays can be powered from either a DC or AC source.

External connections to the SFF201, SFF202 and SFF204 relays can be seen in Figures 1, 2 and 3, respectively.

Table I summarizes the models available.

Table I

Model SFF	Case Size	Set Points
201	S2	1
202	M2	2
204	M2	4

APPLICATION

The SFF series of frequency relays can be applied wherever an extremely stable device is required for the accurate detection of under frequency or over frequency conditions.

Under Frequency

The under frequency trip feature of the SFF relays may be used in load conservation schemes where accuracy and repeatability of frequency measurement is important. If a system disturbance results in loss of generating capacity such that load exceeds generation, system frequency will start to decay and the system may be in danger of collapsing. Under frequency relays distributed around the system can be used to detect this condition and to disconnect selected system load to compensate for the loss of generation. Sufficient load must be disconnected to enable the remainder of the system to recover to normal, or near normal frequency. In this way, restoration of the entire system will be facilitated.

An overall load conservation scheme can be arranged to trip off selected load in different ways:

a. Disconnect blocks of load in several steps with each step occurring at a successively lower frequency.

b. Disconnect blocks of load in several steps on a time basis at one frequency level so that some load is disconnected as each time step is reached.

c. Any combination of the above.

Each frequency measuring element in the SFF compares the period of each cycle of the voltage wave against a crystal reference and requires three successive cycles of under or over frequency before the delay timer is started. If the input voltage wave is distorted so as to affect the period of the wave, and if this distortion persists for the total time setting, it is possible for the relay to make an incorrect measurement. Longer time delay settings will make this less likely to occur. On the other hand, if the frequency exceeds the setting for at least one cycle after the delay timer is started, and before the time delay is reached, the timer will be immediately reset and a new measurement will be started.

An important consideration in the application of frequency relays is the location of the potential source from which the relay makes its measurement. It is generally not good practice to supply a relay from a potential source that is connected to one bus section and use that relay to disconnect load on another bus section. For example, the voltage and frequency of circuits supplying motor load do not go to zero immediately when the circuits are de-energized. Rather, both the voltage and the frequency decay to zero and often at different rates depending on the characteristics of the circuit and the load. A frequency relay connected to such a circuit could produce an output for this condition if the voltage stays above the voltage cutoff setting for the time delay setting (if any). If the relay is connected to disconnect load on a separate bus section, then this load will be inadvertently disconnected.

A substation which has a large amount of motor load may present a problem of time coordination in load shedding applications. If the transmission sources to the substation are tripped out, the motor load would tend to maintain the voltage while the frequency decreased as the motors were slowing down. This slow decay of voltage combined with a fast operating under frequency relay may cause the motor breakers to trip and lock out unnecessarily. In an unattended station, restoration of the motor load would not then be accomplished by simply reenergizing the transmission sources. This problem could be avoided by coordinating the settings of the time delay of the under frequency trip and the level of the undervoltage cutoff function.

The SFF relay may also be used in an industrial installation that is tapped off of a power company transmission circuit that utilizes high speed automatic reclosing. For faults on the line, both ends of the line will be tripped. This will be followed by a high speed reclose. It is important for the industrial load to be disconnected prior to the reclosure to prevent damage to motors and/or generators that may have slowed down during the interruption. An SFF relay at the plant could be used to detect the drop in frequency that might occur during the time that the transmission line is open. The relay could be used to trip the incoming breaker to the plant to separate it from the power system before reclosing takes place. Each application will have to be analyzed to determine the amount of frequency decay, if any, that will occur during the open circuit period.

Rate of Change

The rate of change feature is available only in multi-setpoint models of the SFF relays, and is usable only between two adjacent setpoints; i.e., F1 and F2, F2 and F3 or F3 and F4. This feature will allow load to be shed faster if the frequency decays at a rate faster than was anticipated when the delay timer settings were determined. The rate of change feature is enabled by setting the appropriate ROC switch to the IN position.

Over Frequency

The over frequency function may be used anywhere that it is desired to detect an over frequency condition. For example, it can be used to protect a generator against operation at frequencies above rated speed that could be caused by an inadvertent load rejection. Another possible application of the over frequency function is in schemes to be used to protect a generator against accidental energization at sub-synchronous speeds or on turning gear. In such schemes the over frequency function would be used to remove supplemental protection that is required to be enabled only during off-line operation.

CAUTION

It should be recognized when applying the over frequency function in this fashion that a loss of DC to the relay will cause the output relay to reset, thus enabling the associated off-line protection.

Load Restoration

If a load shedding program has been successfully implemented, the system frequency will stabilize, and through system control will recover to normal. The recovery to normal is likely to be quite slow and may extend over a period of several minutes. As the frequency approaches normal the restore function in the SFF relay can be used to automatically begin the load restoration process. The amount of load that can be restored is determined by the ability of the system to serve it. The availability of generation, either locally or through system interconnections, determines whether or not the shed load can be successfully restored. A load restoration program usually incorporates substantial time delay, which must be provided by a timer external to the SFF relay. The amount of time delay to use is related to the amount of time required to add generation or to close tie lines during emergency conditions. Also, both the time delay and the restoration frequency setpoints should be staggered so that all of the load is not reconnected at the same time. Reconnecting loads on a distributed basis also minimizes power swings across the system and thereby minimizes the possibility of initiating a new disturbance.

Since the restoration timers will be set for long time delays, it is essential that they do not reset as a result of transient system frequency oscillations that may momentarily reset the restore output function. For this reason, the restore function is provided with an adjustable time delay reset before the contacts change state whenever the function is subjected to a frequency change from above the setpoint to below the setpoint. This delay is adjustable and should be kept very brief, only long enough to ride over momentary under frequency conditions.

The restore frequency setting of the function will most likely be at or very close to rated frequency. If the continuous variations in normal frequency are such that the restore function output relay will pick up and drop out continually, the life of the relay may be shortened. To prevent this, a contact converter designated CC is provided to control the restore output. CC is to be energized by an external device after load shedding has occurred and when it is desired to restore load. CC should be kept energized until all of the load that was shed has been restored at which time it should be de-energized. In this way, the restore output relay will only be operated after an under frequency condition has been detected and until the load that was shed has been restored. During normal frequency conditions, CC will be de-energized and the restore function will not operate due to minor changes in frequency.

SPECIFICATIONS

DC Control Voltage
Nominal 48, 110, 125, 220, 250
Minimum 37 Volts
Maximum 280 Volts

AC Control Voltage
Nominal 110-120 Vrms
Minimum 45 Vrms
Maximum 132 Vrms

AC Measurement Input
Nominal 120 Vrms
Minimum 42 Vrms (35% of nominal)
Maximum 132 Vrms (110% of nominal)

Settings

Frequency
SFF20(-)A: Setpoint 40.0 to 79.9 Hz in 0.1 Hz steps
SFF20(-)B: Setpoint 40.0 to 79.9 Hz in 0.01 Hz steps
Repeatability ±0.002 Hz

Timing
SFF20(-)A: Setpoint 0 to 1.55 seconds in 0.05 second steps
SFF20(-)B: Setpoint 1 to 255 milliseconds in 1 millisecond steps
Setpoint 0.1to 25.5 seconds in 0.1 second steps
Repeatability ±3%

Undervoltage
Setpoint 35% to 95% in 5% steps based on 120Vrms nominal
Setpoint Accuracy ±5%
Repeatability ±3% of setting from 35% to 90%

Rate of change (multi-setpoint models only)
Frequency 1 to frequency 2: IN or OUT
Frequency 2 to frequency 3: IN or OUT
Frequency 3 to frequency 4: IN or OUT

Environmental

Operating
-20°C to +55°C 95% relative humidity (noncondensing). Note that the unit will not malfunction, nor be damaged, in ambient up to +65°C

Storage
-40°C to +75°C 95% relative humidity (noncondensing)

Surge
ANSI C37.90 (SWC and Fast Transient)
IEC 255
GE RFI

RATINGS

Burden

Table II

Model SFF	Case Size	Set Points	Burdens: Power Supply DC WATTS 48	125	250	Power Supply AC VA 120	Measurement AC VA
201	S2	1	3.2	3.5	6.3	8.1	1
202	M2	2	4.9	5.2	8.0	10.6	1
204	M2	4	8.4	8.7	11.5	15.7	1

Contact Ratings

Make and carry 30 amps for 1 second.
DC Break 60 Watts Resistive
Break 25 VA (40 ms L/R)
AC 277 Volts maximum 5 Amperes
Target supervision unit 0.1 amp operate level with less than 0.6 volt drop at 30 amps.

SETTINGS

The following settings, which must be set in each application, are made from the front of the relay without the need for pulling boards or removing the nameplate. It is only necessary to remove the front cover from the relay.

Frequency A three or four digit thumbwheel switch on the front panel allows the frequency of each setpoint to be set. **Note: if a setting is made outside of the stated range, that frequency setpoint will be prevented from operating.**

Function A three position slide switch permits the choice of under, over, or restore modes of operation. When the restore mode is chosen the timer is switched to dropout delay and the contact converter input is enabled.

Rate of Change (Multi frequency models only) A two position recessed switch selects the rate of change function. This function is only valid for under frequency operation. It is disabled when over frequency or restore modes are chosen.

Time Delay An array of two-position toggle switches allows setting the output delay. The setting is equal to the sum of the switches in the UP position.

Voltage Cutoff An array of two-position toggle switches calibrated in 5% steps is used to choose the undervoltage cutoff level. The cutoff setting is equal to the sum of the switches in the UP position.

DISPLAYS

Trip The trip indicators are red LED's which are supervised by the passage of trip current. One is provided for each tripping element.

Table III

Model	Target	Description
201	F1	Frequency 1 output contact operated
202	F1	Frequency 1 output contact operated
	ROC	Rate of change caused F1 contact to operate
	F2	Frequency 2 output contact operated
204	F1	Frequency 1 output contact operated
	ROC	Rate of change caused F1 contact to operate
	F2	Frequency 2 output contact operated
	ROC	Rate of change caused F2 contact to operate
	F3	Frequency 3 output contact operated
	ROC	Rate of change caused F3 contact to operate
	F4	Frequency 4 output contact operated

Test Amber LED's light to indicate when the frequency detection circuit has an output and if an output relay is energized (TB).

In Service A normally lit green LED indicates the regulated DC and start-up circuity are operational.

FUNCTIONAL DESCRIPTION

The potential source connected to studs 5 and 6 is stepped down to 6.9 VRMS filtered and converted to a square wave. It is this square wave that is measured by the frequency element. The frequency measuring circuit compares the period of the incoming square wave against a crystal reference. If the source frequency differs from the setpoint for more than three consecutive periods or cycles the circuit gives an output. If the under voltage supervision has not operated this output starts a time delay (which can be set to 0) which in turn drives the output contact. The rate of change feature if selected will bypass the time delay if the next lower frequency element has operated.

The rate of change path is F4 to F3, F3 to F2, and F2 to F1. Therefore when the frequency settings are made, F4 should be less than F3, etc. This does not preclude setting one element for restore, another for over, and the remaining two for under in a four frequency relay. It is only important that the under frequency elements be adjacent (F1-F2, F2-F3, F3-F4) if rate of change is desired. Block diagrams of each model can be found in Figures 4, 5 and 6. Internal connection diagrams for each model can be found in Figures 10, 11 and 12.

CONSTRUCTION

The components of the relay are mounted on a cradle assembly that can easily be removed from the relay case. The cradle is locked in the case by latches at the top and bottom. The electrical connections between the case blocks and the cradle blocks are completed through removable connection plugs to permit testing the relay in its case. The cover is attached to the front of the case and includes two interlocking arms that prevent the cover from being replaced until the connection plugs have been inserted.

The case is suitable for semi-flush mounting on panels. Hardware is available for all panel thicknesses up to two inches. A panel thickness of 1/8 inch will be assumed unless otherwise specified on the order. Outline and panel drilling dimensions for the SFF201 are shown in figure 8 and for the SFF202 and 204 figure 7.

The printed circuit boards are mounted behind the nameplate and can be accessed by removing the four screws securing the nameplate. The boards are mounted horizontally in guides. Each board is labeled to correspond to a given location. Use GE part number 286A2847P1 card puller or other suitable means to remove the circuit boards. If you do not have a card puller, be careful not to damage or bend any components when removing the boards.

The output relays are mounted in sockets on a board fixed to the back of the cradle. If a relay requires replacement unclip the retaining wire and pull the relay out of the socket.

The input transformer is mounted on the bottom plate of the relay cradle.

RECEIVING, HANDLING AND STORAGE

This relay contains electronic components that could be damaged by electrostatic discharge currents if those currents flow through certain terminals of the components. The main source of electrostatic discharge currents is the human body, and the conditions of low humidity, carpeted floors and isolating shoes are conducive to the generation of electrostatic discharge currents. Where these conditions exist, care should be exercised when removing and handling the modules to make settings on the internal switches. The persons handling the module should make sure that their body has been discharged, by touching some surface at ground potential, before touching any of the components on the modules.

These relays, when not included as 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 damage resulting from handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Sales Office.

The relays should be stored in their original cartons. If the relays are not to be installed immediately, and in a place that is free from moisture, dust and metallic chips.

ACCEPTANCE TESTS

General

The relay should be examined and tested upon delivery to insure that no damage has been sustained in shipment and that the relay is functioning correctly.

Visual

Remove the relay from its case and check for signs of physical damage such as broken or cracked parts.

CAUTION:
Every circuit in the drawout case has an auxiliary brush. It is especially important on circuits with shorting bars that the auxiliary brush be bent high enough to engage the connecting plug or test plug before the main brushes do. This will prevent the secondary circuits from being open-circuited during insertion of the connection plug.

A drawout case relay may be tested without removing it, from the panel, by using a 12XLA13A test plug. This plug makes connection to the relay only and does not disturb any shorting bars in the case. The 12XLA12A test plug may also be used. Although this plug allows greater flexibility, it requires shorting jumpers since connections are made to both the relay and the external circuits.

Test Equipment

1 DC voltage source rated at 48V to 250V with less than 5% ripple
2. Variable frequency generator or line frequency rated at 48 to 120Vrms, 40 to 70 hertz
3. Limiting resistor, or load box for trip target indicator test. Rated from 100Ω-3KΩ, 25 Watts.

General Testing Considerations

The relay can be tested with a variable voltage/frequency generator or with the line frequency. The acceptance test have taken into account both contingencies. Each test has a section for line frequency testing and or for variable frequency generators.

When utilizing variable frequency/voltage generators refer to the test equipment manufactures manual for specific operation instructions of the test apparatus.

Testing with line frequency requires that the frequency setpoints of the relay be set above or below the line frequency depending on the fault being simulated.

Relay Outputs

Test Targets

The test target LEDs are labled Test F1,TB to F4,TB, see figure 17, 19 (front panels). The test targets indicate the status of the output relay (TB) and the frequency measuring element (F-). The "F" test indicator will light when the frequency deviates from the setpoint for 3 consecutive cycles. The "TB" indicator lights when the timer is producing an output to operate the output relay.

Trip Targets

The trip target LEDs are labeled Trip F1,RC to F4,RC. They will latch "on" when the relay trips and there is over 100ma through the normally open contacts. They are reset with the target reset switch or by the removal of the relay power.

Relay Contacts

The relay contacts consist of normally open (NO) and normally closed (NC) contacts for each of the frequency measuring units.

Tests

For the following tests refer to figure 9 for test connections, and to figure 17 and 20 for the front views of the SFF201, and 204 respectively. For the SFF202 refer to the SFF204 front view.

Test the relay in accordance with the function it is set for. Such as Over Frequency, Under Frequency, Rate of Change or Restore.

Note: The trip LEDs will only light and seal in if 100ma of current flows through the output contacts.

Over Frequency Relay Tests

The relay will trip when the frequency under test exceeds the frequency setpoints for more than three cycles.

Table IV

Set Point	Switch Settings				
	† Frequency	Mode	ROC	Time Delay	Under Voltage Cutoff
SFF201					
F1	50 or 60hz	over	-	1.5sec	35%
SFF202					
F1	50 or 60hz	over	out	1.5sec	35%
F2	50 or 60hz	over	-	1.5sec	"
SFF204					
F1	50 or 60hz	over	out	1.5sec	35%
F2	50 or 60hz	over	out	1.5sec	"
F3	50 or 60hz	over	out	1.5sec	"
F4	50 or 60hz	over	-	1.5sec	"

† The relay can be tested at other frequencies if desired. To do so, set the frequency and adjust the inputs based on that setting.

Over Frequency Test With Variable Frequency Generator

1. Apply the rated supply voltage between stud(1) and stud(2) (either polarity).

2. Set the frequency generator at (0.5hz) below the setpoints. For example, set the frequency to 59.5hz for 60hz and 49.5hz for 50hz rated setpoints. Apply the frequency source at 115Vrms between stud(5) and stud(6). Then increase the frequency (0.5hz) above the setpoint. Maintain the frequency at the higher setting for 3 cycles plus 1.5sec to produce an output.

   Verify that the following occurs during the over frequency. The test target LEDs "F1" to "F4" light. The "TB" test targets and the trip target LEDs "F1" to "F4" light after the 1.5 second time delay. And the output relay contacts have tripped, as indicated by the trip targets.

3. Remove the input test frequency, and note that the contacts and LEDs have dropped out.

4. Reset the target LEDs.

5. Remove the supply voltage.

6. Set the undervoltage switch setting to 95%, and repeat the above test starting at step 1. With the undervoltage set at 95% there should be **no trips**, or target LEDs on during the over frequency. The undervoltage cutoff will disable all outputs.

Over Frequency Test With Single or Line Frequency

Before applying the line or single frequency source, set the frequency setpoint(s) (0.5hz) below the frequency input that you use. Such as 59.5hz for 60hz and 49.5hz for 50hz rated line. This simulates an over frequency.

1. Apply rated supply voltage between stud(1) and stud(2), non polarity sensitive.

2. Apply the test line frequency at 115vrms between stud(5) and stud(6). As the line frequency is applied verify that the test target LEDs "F1" to "F4" light, the "TB" test targets and the trip target LEDs "F1" to "F4" light after the 1.5 second time delay setting. And the output relay contacts have tripped, as indicated by the trip targets.

3. Remove the input test frequency, and note that the contacts and test LEDs have dropped out.

4. Reset the targets.

5. Remove the supply voltage

6. Set the undervoltage switch setting to 95%, and repeat the above test starting at step 1. With the undervoltage set at 95% there should be **no trips**, or target LEDs during the over frequency. The undervoltage cutoff will disable all outputs.

Table V

Switch Settings					
Set Point	† Frequency	Mode	ROC	Time Delay	Under Voltage Cutoff
SFF201					
F1	50 or 60hz	under	-	1.5sec	35%
SFF202					
F1	50 or 60hz	under	out	1.5sec	35%
F2	50 or 60hz	under	-	1.5sec	"
SFF204					
F1	50 or 60hz	under	out	1.5sec	35%
F2	50 or 60hz	under	out	1.5sec	"
F3	50 or 60hz	under	out	1.5sec	"
F4	50 or 60hz	under	-	1.5sec	"

† The relay can be tested at other frequencies if desired. To do so, set the frequency and adjust the inputs based on that setting.

Under Frequency Relay Tests

The relay will trip when the frequency under test is below the setpoint(s) for more than three cycles.

Under Frequency Test With Variable Frequency Generator

1. Apply rated supply voltage between stud(1) and stud(2).

2. Set the frequency generator at (0.5hz) above the setpoints. For example, set the frequency to 60.5hz for 60hz and 50.5hz for 50hz rated setpoints. Apply the frequency source at 115Vrms between stud(5) and stud(6). Then decrease the frequency (0.5hz) below the rated setpoints. Maintain the frequency at the lower setting to produce an output.

   Verify that the following occurs during the under frequency. The test target LEDs "F1" to "F4" light. The "TB" test targets and the trip target LEDs "F1" to "F4" light after the 1.5 second time delay. And the output relay contacts have tripped, as indicated by the trip targets.

3. Remove the input test frequency, and note that the contacts and test target LEDs have dropped out.

4. Reset the targets.

5. Remove the supply voltage.

6. Set the undervoltage switch setting to 100%, and repeat the above test starting at step 1. With the undervoltage set at 100% there should be **no trips**, or target LEDs during the under frequency. The undervoltage cutoff will disable all outputs.

Under Frequency Test With Single or Line Frequency

Before applying the line or single frequency source. Set the setpoint(s) (0.5hz) above the frequency input used. This simulates an under frequency.

1. Apply the rated supply voltage between stud(1) and (2).

2. Apply the test or line frequency at 115vrms between stud(5) and stud(6). As the line frequency is applied verify that the test target LEDs "F1" to "F4" light, the "TB" test targets and the trip target LEDs "F1" to "F4" light after the 1.5 second time delay setting. And the output relay contacts have tripped, as indicated by the trip targets.

3. Remove the input test frequency, and note that the contacts and test target LEDs have dropped out.

4. Reset the targets.

5. Remove the supply voltage

6. Set the undervoltage switch setting to 100%, and repeat the above test starting at step 1. With the undervoltage set at 100% there should be no **trips**, or target LEDs during the under frequency. The undervoltage cutoff will disable all outputs.

Rate of Change (ROC) for Multiple Setpoint Models Only

The rate of change feature allows the relay to trip faster than its set time delay if the frequency change is faster and larger in magnitude the limits set on successive frequency setpoints.

Example: F1 is set to 59.8, F2 is set to 58.0, and the time delays on F1 and F2 are 1.5 seconds. If the frequency were to go from 60 to 59.7hz only F1 would trip after a delay of 1.5 seconds. But if the frequency was to change from 60 to 58hz in .25 seconds the relay would trip without waiting for the time delays. The rate of change from F1 to F2 was faster than the time delay of F1.

Table VI

Switch Settings					
Set Point	† Frequency	Mode	ROC	Time Delay	Under Voltage Cutoff
SFF202					
F1	50 or 60hz	under	in	1.5sec	35%
F2	50 or 60hz	under	-	0.0sec	"
SFF204					
F1	50 or 60hz	under	in	1.5sec	35%
F2	50 or 60hz	under	in	1.2sec	"
F3	50 or 60hz	under	in	0.8sec	"
F4	50 or 60hz	under	-	0.0sec	"

† The relay can be tested at other frequencies if desired. To do so, set the frequency and adjust the inputs based on that setting.

It is essential that the trip targets are enabled by the 100ma of current through the normally open relay contacts for this test.

<u>Rate of Change Test for Variable Frequency Generators</u>

1. Apply rated supply voltage between stud(1) and stud(2).

2. Set the frequency generator at (0.5hz) above the setpoints. For example, set the frequency to 60.5hz for 60hz and 50.5hz for 50hz rated setpoints. Apply the frequency source at 115Vrms between stud(5) and stud(6). Then decrease the frequency (0.5hz) below the setpoint with zero time delay.

   When the frequency has been reduced, verify that the following occurs. The test target LEDs "F1" to "F4", and the "TB'"s light with with no time delay. (The rate of change has overridden the set time delays on the TB outputs).

   The "RC" trip targets light with no delay, and the trip target LEDs "F1" to "F4" light in a delayed sequence according to their time delay settings. Note: After 1.5 seconds all LEDs should be lit.

3. Remove the input test frequency, and note that the contacts and test target LEDs have dropped out.

4. Reset the targets.

5. Remove the supply voltage

6. Set the undervoltage switch setting to 100%, and repeat the above test starting at step 1. With the undervoltage set at 100% there should be **no trips** or target LEDs during the under frequency. The undervoltage cutoff will disable all outputs.

Rate of Change Test for Single or Line Frequency

Before applying the line or single frequency source. Set the setpoint(s) (0.5hz) above the frequency input used.

1. Apply rated supply voltage between stud(1) and stud(2), non polarity sensitive.

2. Apply the test line frequency at 115vrms between stud(5) and stud(6). When the frequency has been applied verify that the following occurs. The test target LEDs "F1" to "F4" and the "TB"s light with no time delay. (The rate of change has overridden the set time delays).

   The "RC" trip target LEDs light with no delay, and the trip target LEDs "F1" to "F4" light in delayed sequence according to their time delay settings. Note: After 1.5 seconds all LEDs should be lit.

3. Remove the input test frequency, and note that the contacts and test target LEDs have dropped out.

4. Reset the targets.

5. Remove the supply voltage

6. Set the undervoltage switch setting to 100%, and repeat the above test starting at step 1. With the undervoltage set at 100% there should be **no trips** or target LEDs during the under frequency. The undervoltage cutoff will disable all outputs.

Table VII

Switch Settings					
Set Point	† Frequency	Mode	ROC	Time Delay	Under Voltage Cutoff
SFF201					
F1	50 or 60hz	restore	-	1.5sec	35%
SFF202					
F1	50 or 60hz	restore	out	1.5sec	35%
F2	50 or 60hz	restore	-	1.5sec	"
SFF204					
F1	50 or 60hz	restore	out	1.5sec	35%
F2	50 or 60hz	restore	out	1.5sec	"
F3	50 or 60hz	restore	out	1.5sec	"
F4	50 or 60hz	restore	-	1.5sec	"

† The relay can be tested at other frequencies if desired. To do so, set the frequency and adjust the inputs based on that setting.

Restore Relay Tests

The restore circuit will only produce an output if the contact converter connected to pins 10 and 20 is energized.

Restore Test With Variable Frequency Generator

1. Apply rated supply voltage between stud(1) and stud(2).

2. Connect a DC source rated at 48V to 250V between stud(10) and stud(20). Your power supply voltage will suffice if it is DC.

3. Set the frequency generator at (0.5hz) above the setpoints. For example, set the frequency to 60.5hz for 60hz and 50.5hz for 50hz rated setpoints. Apply the frequency source at 115Vrms between stud(5) and stud(6). And note that the test targets "F1" to "F4" and "TB" LEDs are lit.

   Next, decrease the frequency (0.5hz) below the setpoint. The test target LEDs "F1" to "F4" will go out but the "TB" LEDs will remain lit (output contact(s) are closed) for the 1.5 second delay setting.

4. Remove the input test frequency.

5. Remove the supply voltage

6. Set the undervoltage switch setting to 95%, and repeat the above test starting at step 1. With the undervoltage set at 95% there should be **no trips** or target LEDs during the test. The undervoltage cutoff will disable all outputs.

Restore Test With Single or Line Frequency

1. Before applying the line or single frequency source. Set the frequency setpoints (0.5hz) below the frequency used.

   Apply rated supply voltage between stud(1) and stud(2).

   Connect a DC source rated at 48V to 250V between stud(10) and stud(20). Your power supply voltage will suffice if it is DC.

2. Apply the test line frequency at 115vrms between stud(5) and stud(6). And note that the test targets "F" and "TB" LEDs are lit.

   With the test or line frequency still applied, increase the frequency setpoints to (0.5hz) above the rated line frequency. The test target LEDs "F1" to "F4" will go out but the "TB" LEDs will remain lit and the output contacts will stay closed for the 1.5 second time delay setting.

3. Remove the input test frequency.

4. Remove the supply voltage.

5. Set the undervoltage switch setting to 95%, and repeat the above test starting at step 1. With the undervoltage set at 95% there should be **no trips** or target LEDs during the test. The undervoltage cutoff will disable all outputs.

INSTALLATION PROCEDURE

The relay should be installed in a clean, dry location, free from dust and excessive vibration. It should be mounted on a vertical surface. The outline and panel drilling dimensions are shown in figures 7 and 8.

Surge Ground

The case stud should be permanently connected to ground by a conductor not less than AWG No. 12 copper wire or equivalent. This connection is made to ground the relay case and the surge suppression networks in the relay. The surge ground lead should be as short as possible, preferably 10 inches or less, to provide maximum protection from surges. Figure 23 shows a rear view of an S2 case illustrating the position of the case grounding stud.

Electrical Tests

The test given in the Acceptance Section can be used as a guide in the establishment of your procedure.

Settings

Frequency	Set the desired frequency for each setpoint by pushing the + and - buttons on the switch.
Mode	Choose Under, Over or Restore operation by a recessed three position slide switch.
Rate of Change	ON multi-setpoint models, select IN or OUT by a two position slide switch.
Time Delay	Set the desired time by summing the setting of the toggles in the UP position.
Undervoltage	Set the desired voltage by summing the toggles in the UP position.

TROUBLE SHOOTING

> **CAUTION:**
> **The power supply in this relay is not isolated from the incoming power. The heat sinks are at the incoming potential. Further the common of the regulated DC is at the same potential as the most negative power terminal and SHOULD NOT BE CONNECTED TO GROUND. Make sure that test instruments connected to monitor the signals within the relay are suitably isolated from ground and observe proper techniques to avoid a shock hazard.**

The card extender board part number 0215B8031G1 is required to perform these tests.

> **CAUTION:**
> **REMOVE ALL power from relay before removing or inserting any of the printed circuit boards or output relays. Failure to observe this caution may result in damage to and/or misoperation of the relay.**

The defective circuit may be identified by following the procedures outlined in the following paragraphs. The tests are based on using line frequency as the input and on a set of known settings.

Begin by setting the relay.

TABLE VIII

SFF Model	Line Frequency plus F1	F2	F3	F4	Mode	Rate of Change	Under Voltage	Time Delay
201	0.1				Under		50%	0.1
202	0.2	0.1			Under	Out	50%	0.1
204	0.4	0.3	0.2	0.1	Under	Out	50%	0.1

Refer to figures 17 through 22 for views of the relay with and without a nameplate. The board locations are identified by letters on the right side of the cradle. These letters and the part number of the printed circuit assembly for each location are given on the internal connections diagrams in figures 10, 11 and 12.

The block diagrams in figures 14, 15 and 16 give voltages and waveforms to be found at selected points in the relay. The points are the connector pin numbers on the extender board. The failure of the signal to meet the levels shown on the diagram indicates a failure in that module.

The signals should measured with high input impedance instruments to avoid loading the circuits. Remember the regulated DC is not isolated.

A logic low is a signal with an amplitude of between zero and 20% of the regulated DC voltage, nominally this is 0 to 2.4 volts. A logic high is defined as a signal whose amplitude is between 80 and 100 percent of the regulated DC voltage, nominally this is 9.6 to 12 volts.

SERVICING

CAUTION: REMOVE ALL power from relay before removing or inserting any of the printed circuit boards or output relays. Failure to observe this caution may result in damage to and/or misoperation of the relay.

When replacing a module check the part number and location as shown on the internal connections diagrams in figures 10, 11 and 12 before inserting the module. Perform the acceptance tests before returning the relay to service.

PERIODIC CHECKS AND ROUTINE MAINTENANCE

Considering the vital role of protective relays in the operation of a power system it is important that a periodic test program be followed. It is recognized that the interval between periodic checks will vary depending upon environment, type of relay, and the users experience with periodic testing. Until the user has accumulated enough experience to select the test interval best suited to their individual requirements it is suggested that the points listed under acceptance test be checked at an interval of from one to two years.

RENEWAL PARTS

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

When ordering renewal parts address the nearest Sales Office of the General Electric Company. Specify the quantity required, name of the part wanted, the part number if known, and the complete model number of the relay for which the part is required. Table IX lists the part numbers for the most common replacement parts.

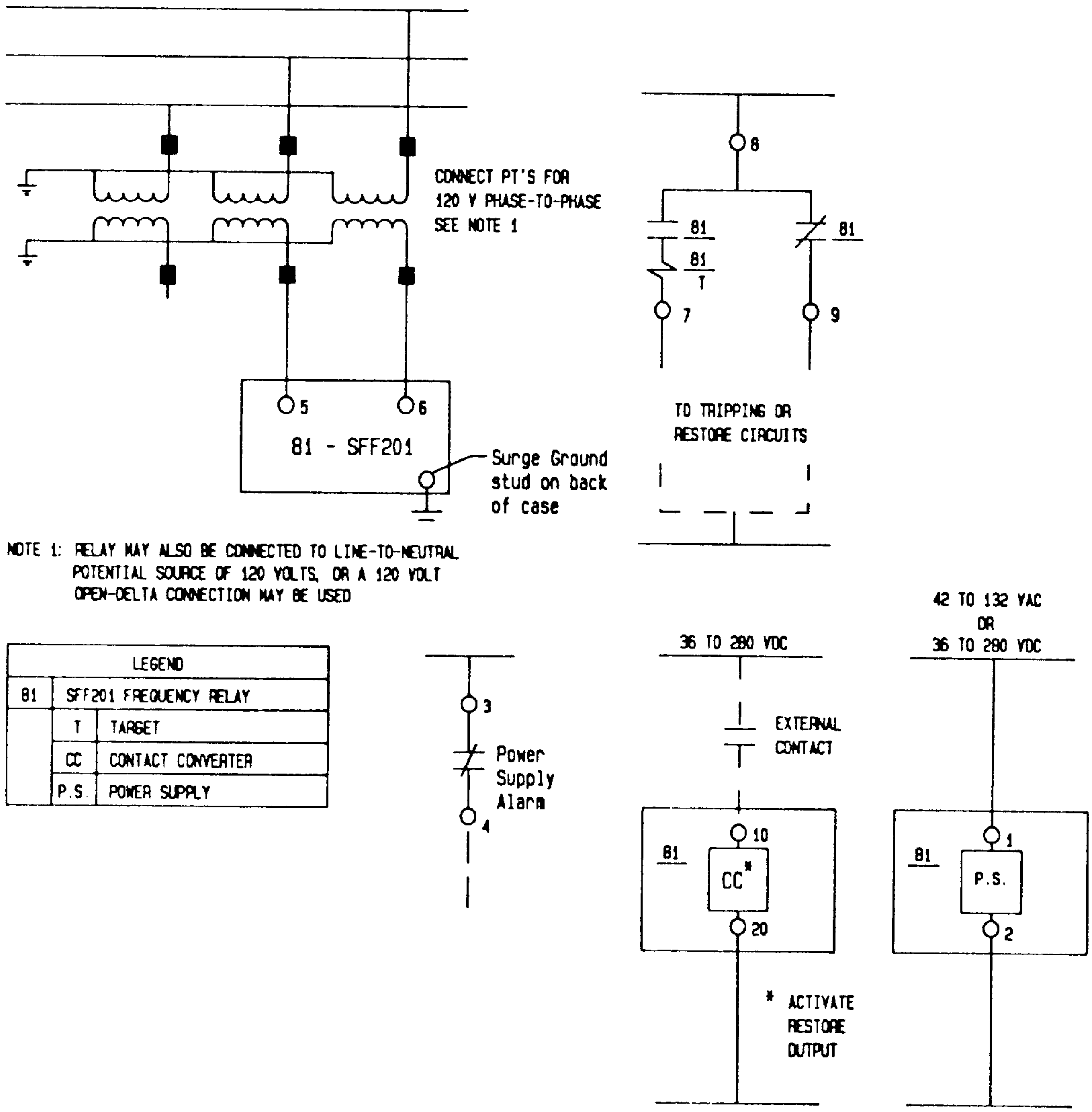
It is recommended that renewal parts only be obtained from the General Electric Company. Should a printed circuit card become inoperative, it is recommended that the card be replaced with a spare.

Since the last edition, changes have been made in the following places:

p.3, AC undervoltage cutoff range, p.7, Undervoltage specifications, p.13, Overfrequency Tests step 6., p.15, Rate of Change, example, p.17, Load Restoration Tests, steps 6 and 5 respectively, p.21, Part number of SFF201 Power Supply.

TABLE IX

Model SFF	Function	Part number
201	Power Supply	0184B6385G-1
202 204	Power Supply	0184B3856G-2 0184B3856G-2
201A 202A 204A	Frequency F1 Frequency F2 Frequency F4	0184B8922G-1
202A 204A	Frequency F1 Frequency F1, F2, F3	0184B8922G-2
201B 202B 204B	Frequency F1 Frequency F2 Frequency F4	0215B8404G-1
202B 204B	Frequency F1 Frequency F1, F2, F3	0215B8404G-2
201 202 204	Undervoltage	0184B8921G-1
201	Mother board	0184B8611G-1
202	Mother board	0184B8925G-1
204	Mother board	0184B8925G-2
201 202 204	Output relay	0246A9826P-3
201 202 204	Target Reset Switch	0246A9920P101
201 202 204	Potential Transformer	0367A0265G79
201 202 204	Lower Cradle Block	0184B8624G1
201 202 204	Lower Case Block	06418058G643
201	Upper Cradle Block	0184B8624G2
202 204	Upper Cradle Block	0184B8624G3
201	Upper Case Block	06418058G644
202 204	Upper Case Block	06418058G645
201	Cover	006229807G59
202 204	Cover	006229807G60



NOTE 1: RELAY MAY ALSO BE CONNECTED TO LINE-TO-NEUTRAL POTENTIAL SOURCE OF 120 VOLTS, OR A 120 VOLT OPEN-DELTA CONNECTION MAY BE USED

LEGEND		
81	SFF201 FREQUENCY RELAY	
	T	TARGET
	CC	CONTACT CONVERTER
	P.S.	POWER SUPPLY

Figure 1 (0286A2808) External connection diagram for the SFF201

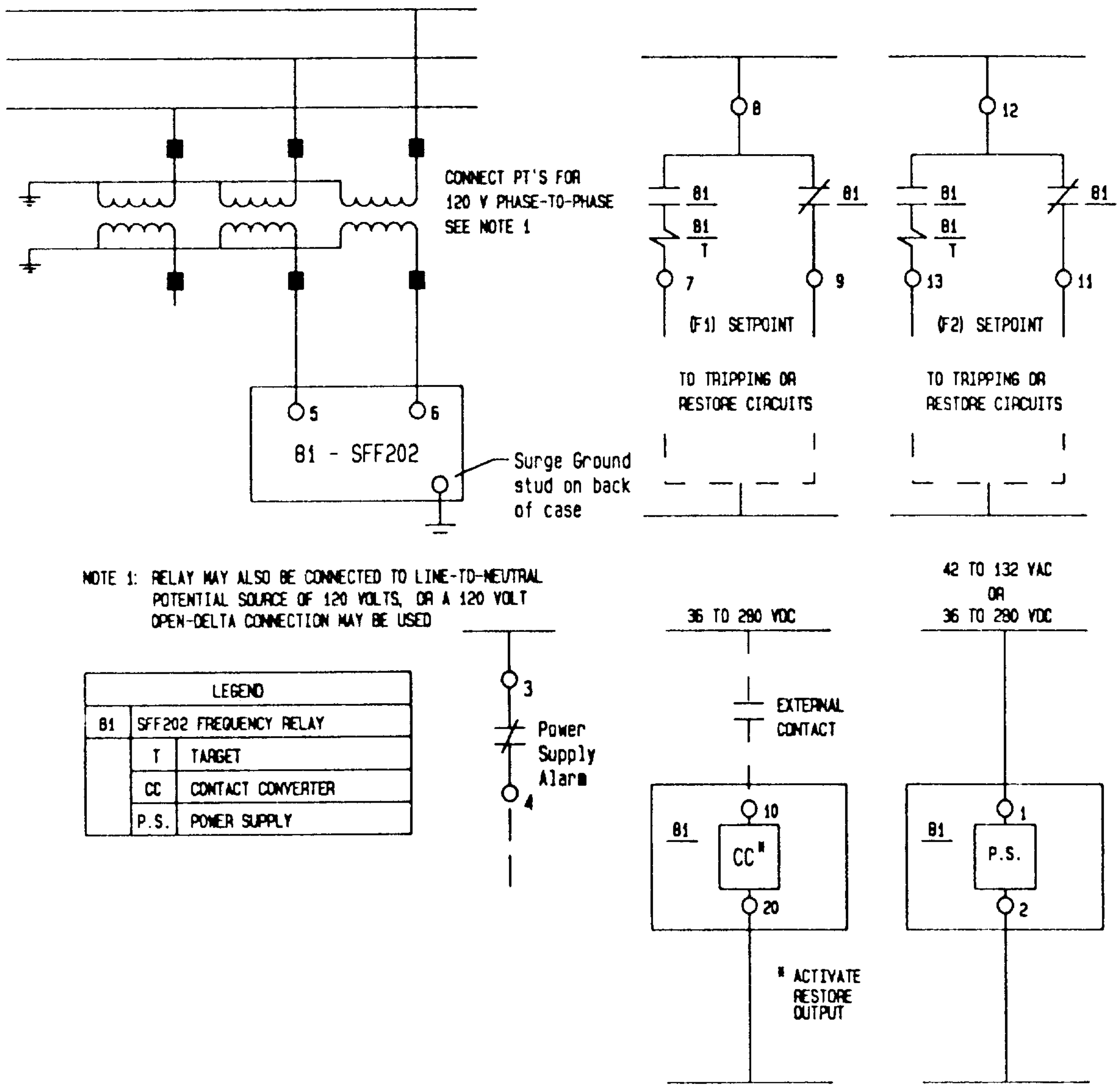


Figure 2 (0286A2809) External connection diagram for the SFF202

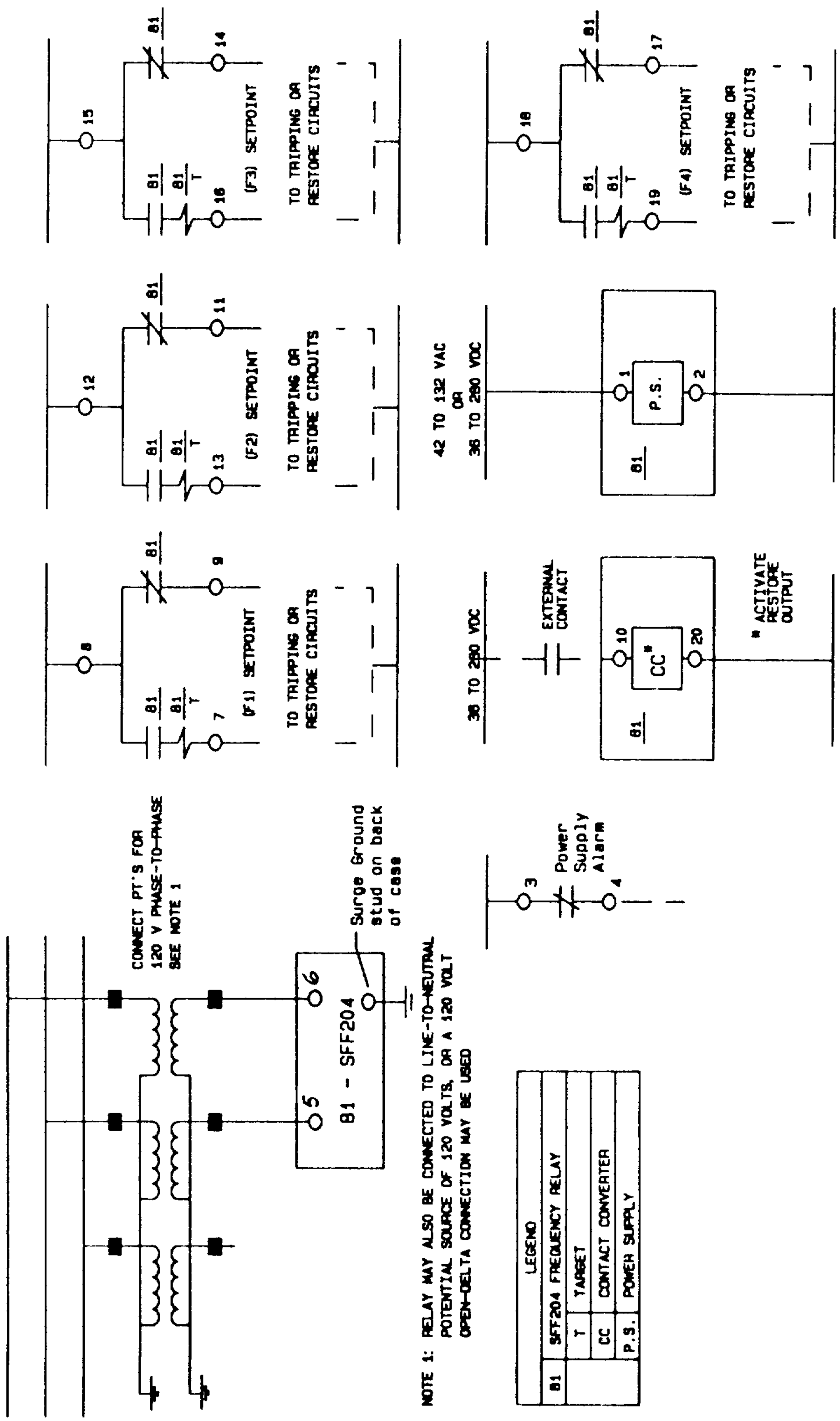


Figure 3 (0286A2810-1) External connection diagram for the SFF204

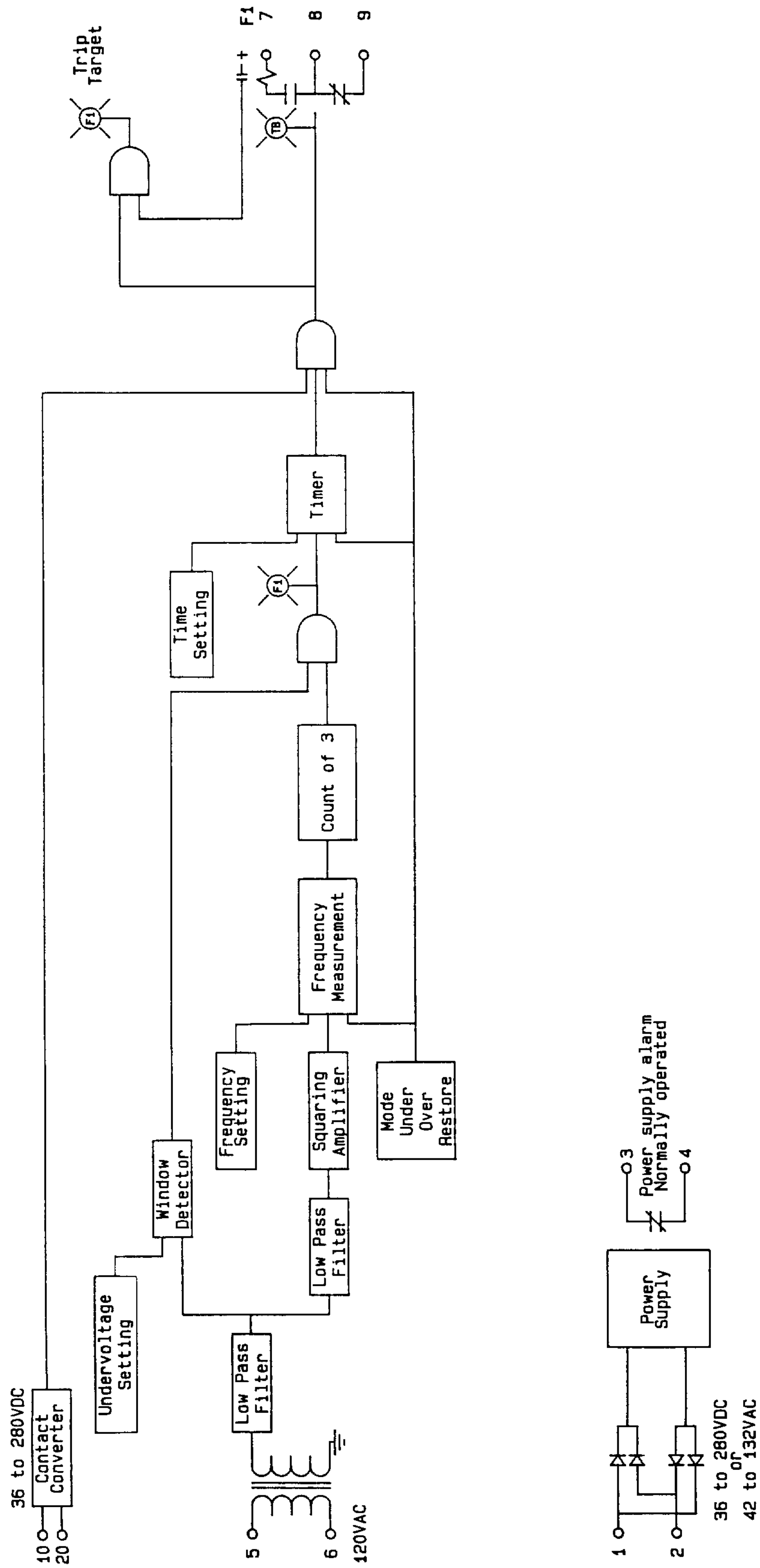


Figure 4 (179C7525 [1]) Block diagram for the SFF201

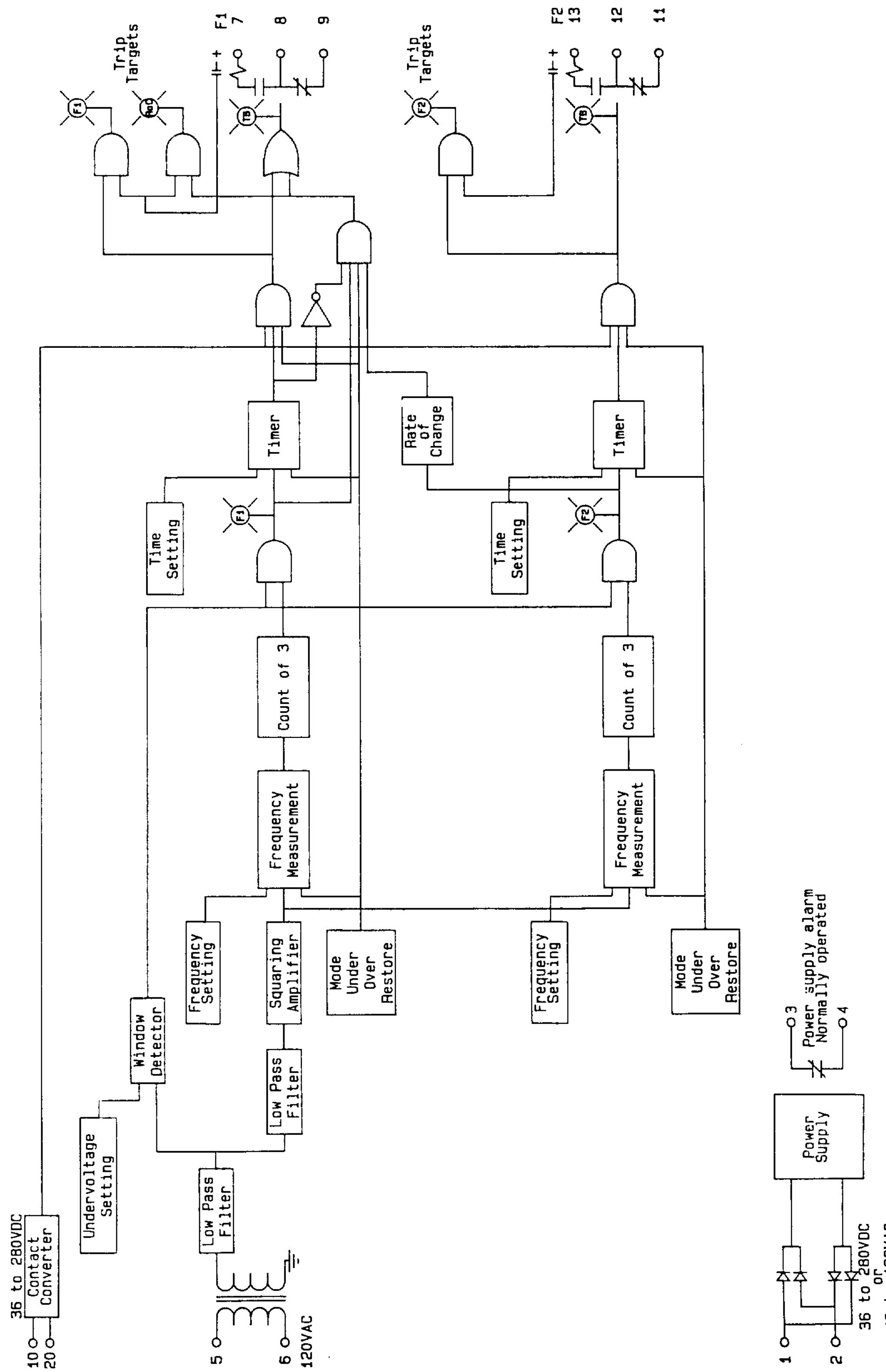


Figure 5 (179C7526 [1]) Block diagram for the SFF202

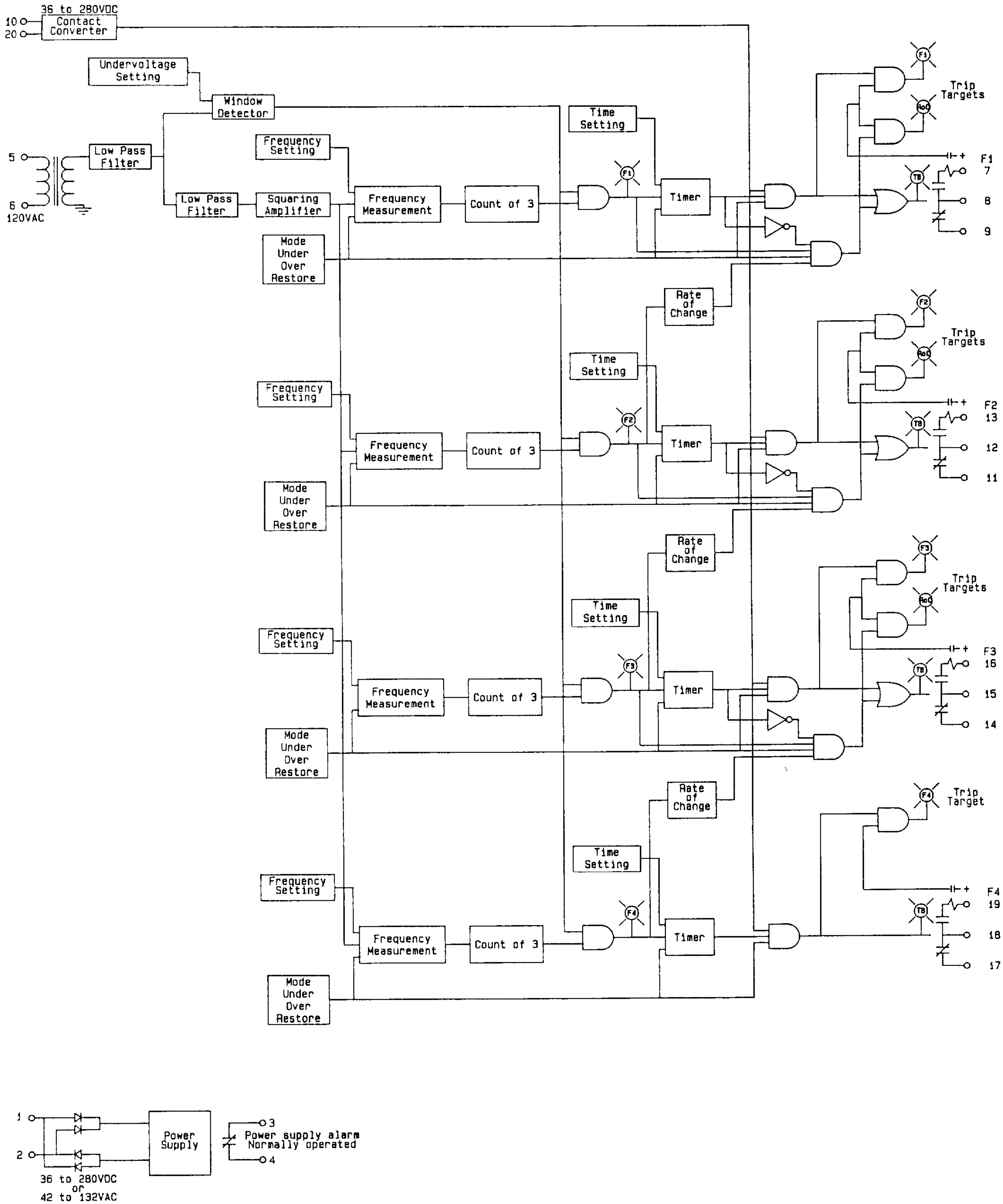


Figure 6 (153D7677 [1]) Block diagram for the SFF204

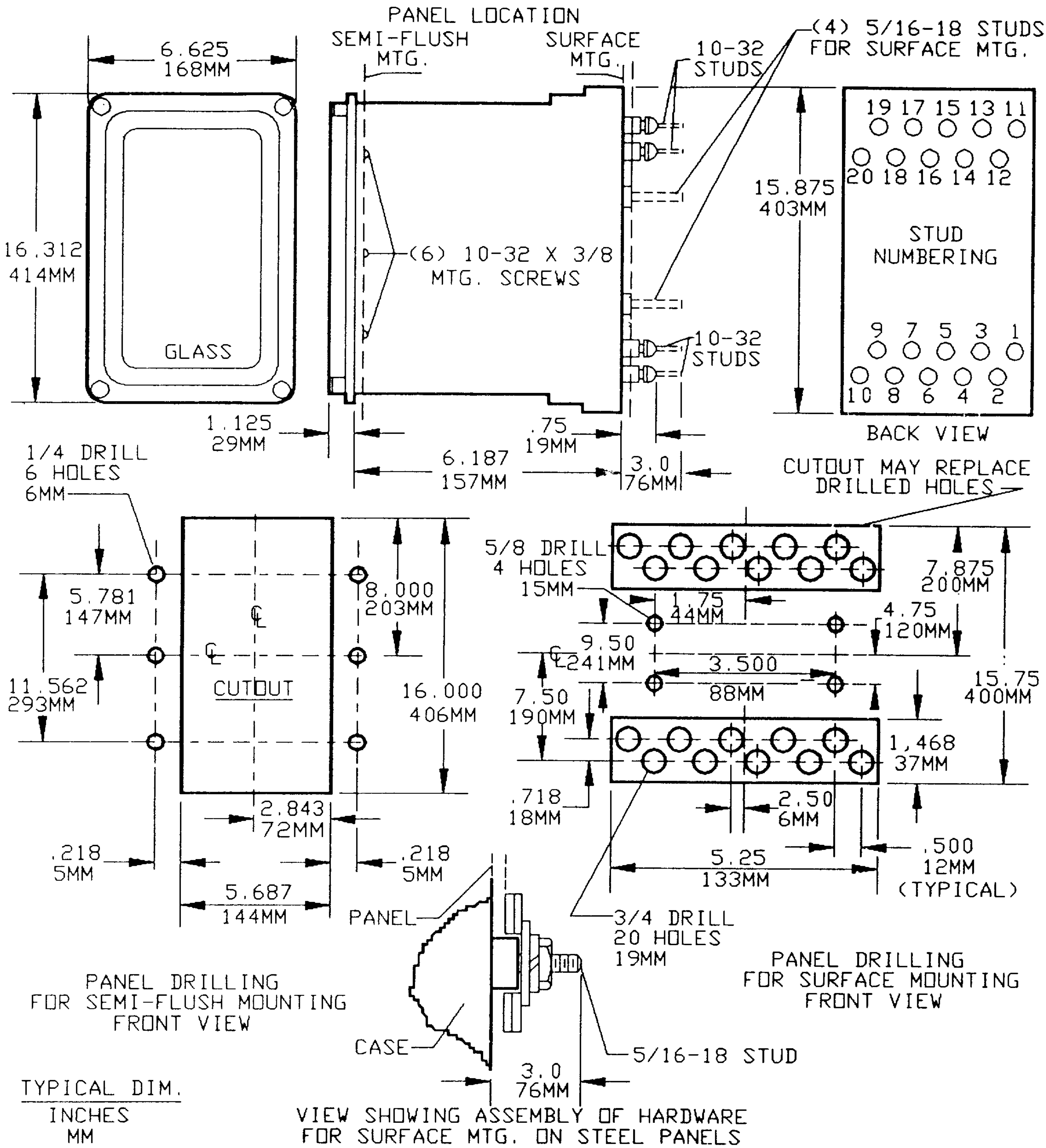


Figure 7 (6209274 [6]) Outline and mounting dimensions for the SFF202 and SFF204

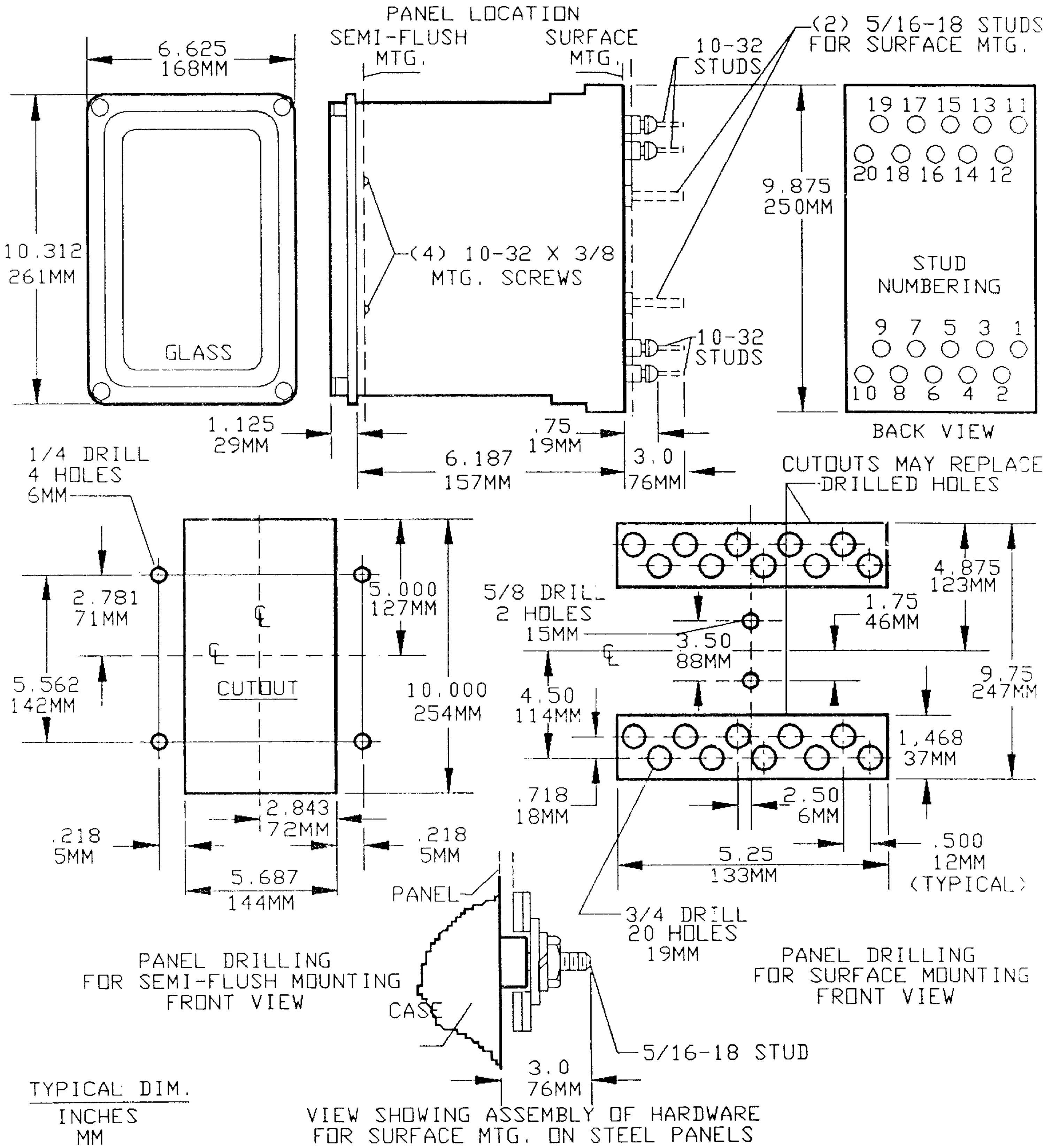


Figure 8 (6209272 [7]) Outline and mounting dimensions for the SFF201

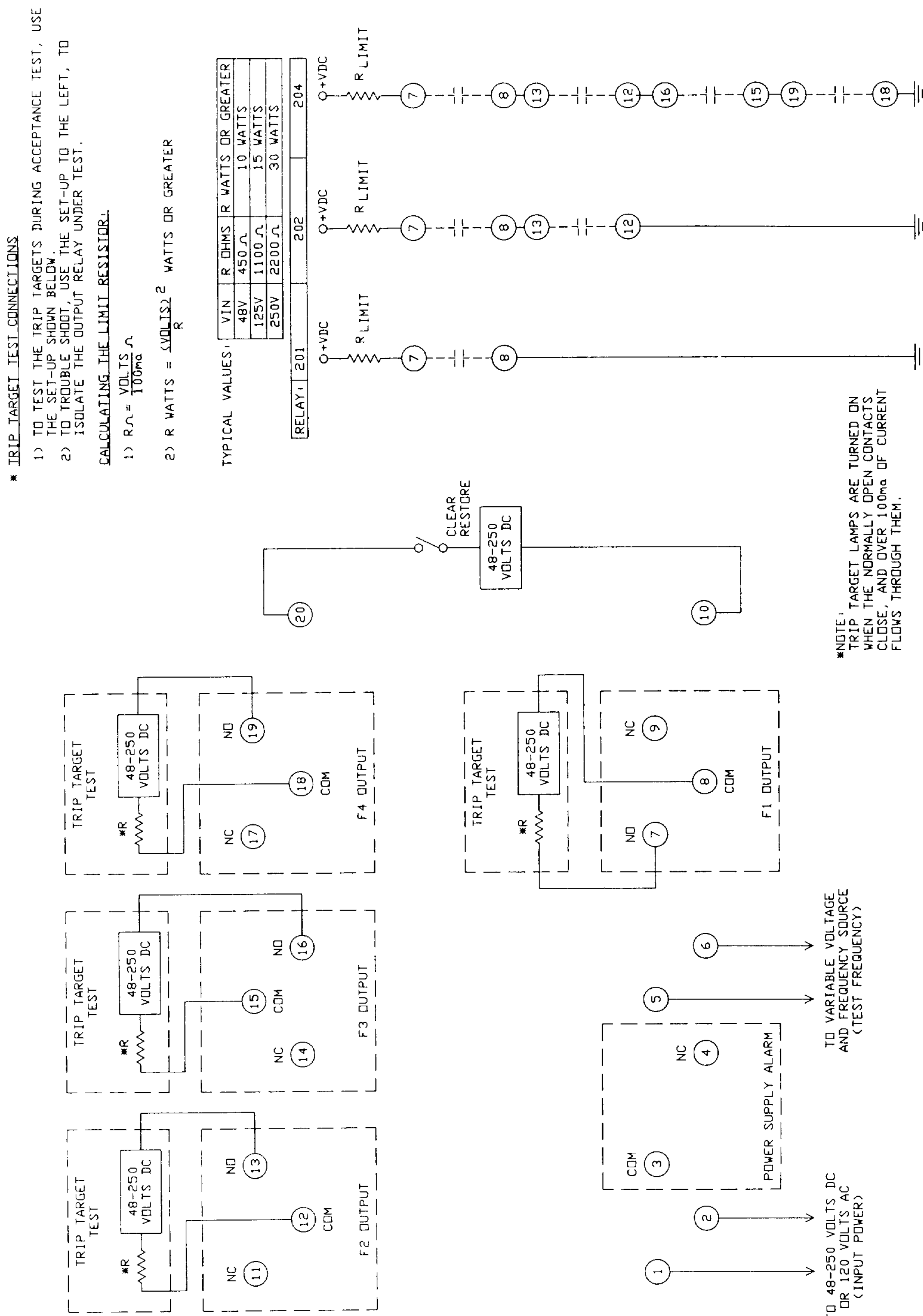


Figure 9 (179C7527-2) Test connections for the SFF

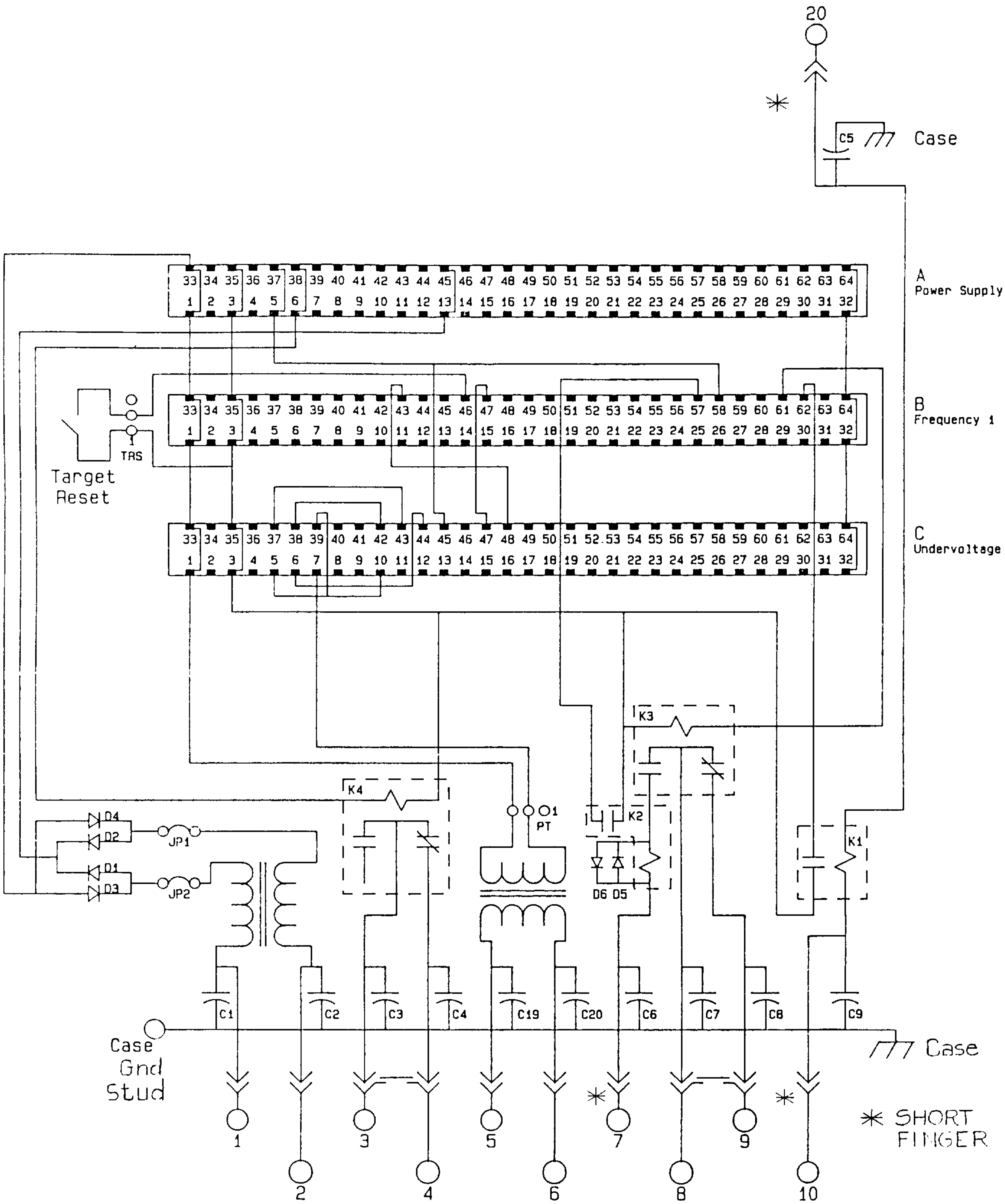


Figure 10 (0183B4489 [6]) Internal connections diagram for the SFF201

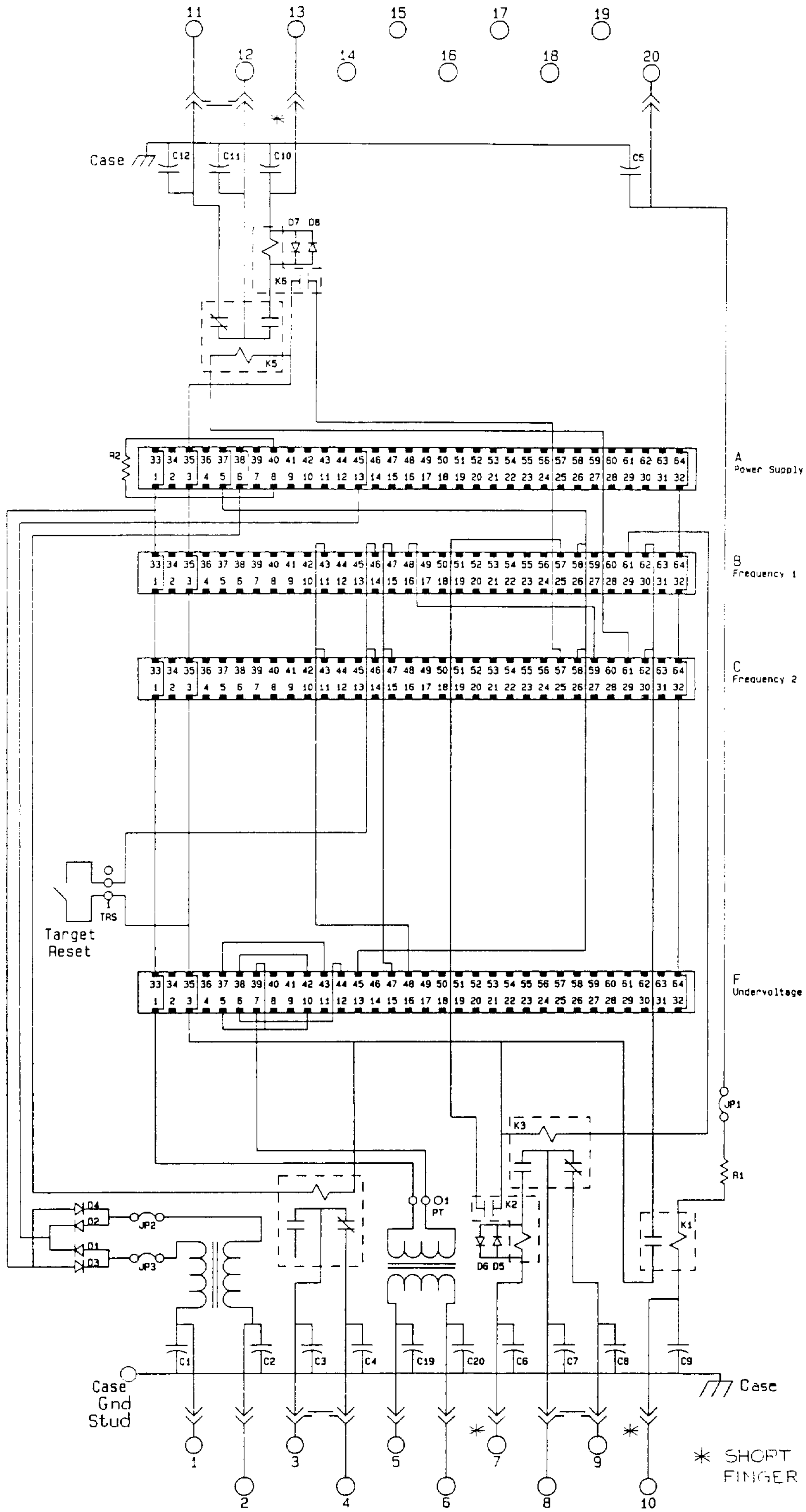


Figure 11 (0183B4490 [4])
Internal connections diagram for the SFF202

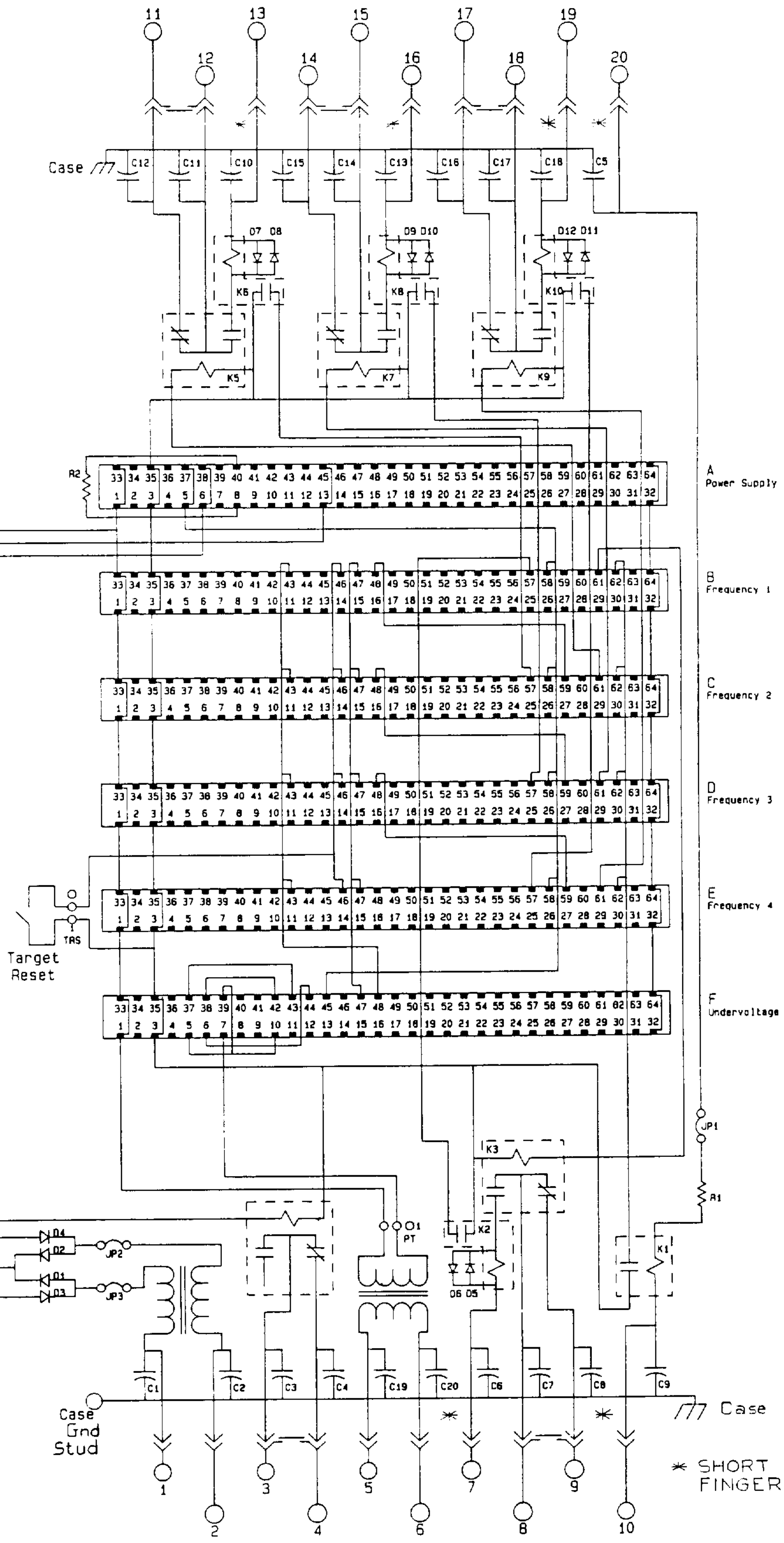


Figure 12 (0183B4491 [5])
Internal connections diagram for the SFF204

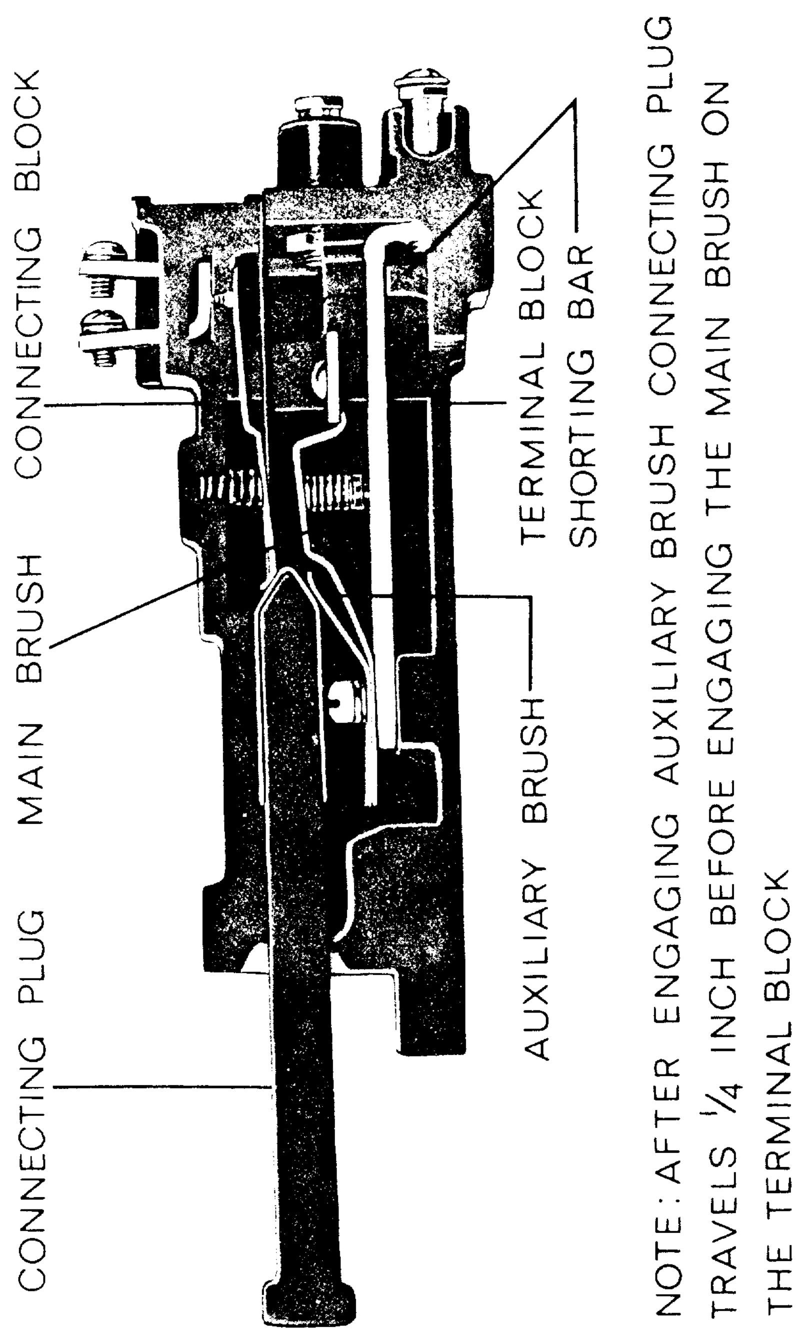


Figure 13 (08025039) Drawout case contact assembly

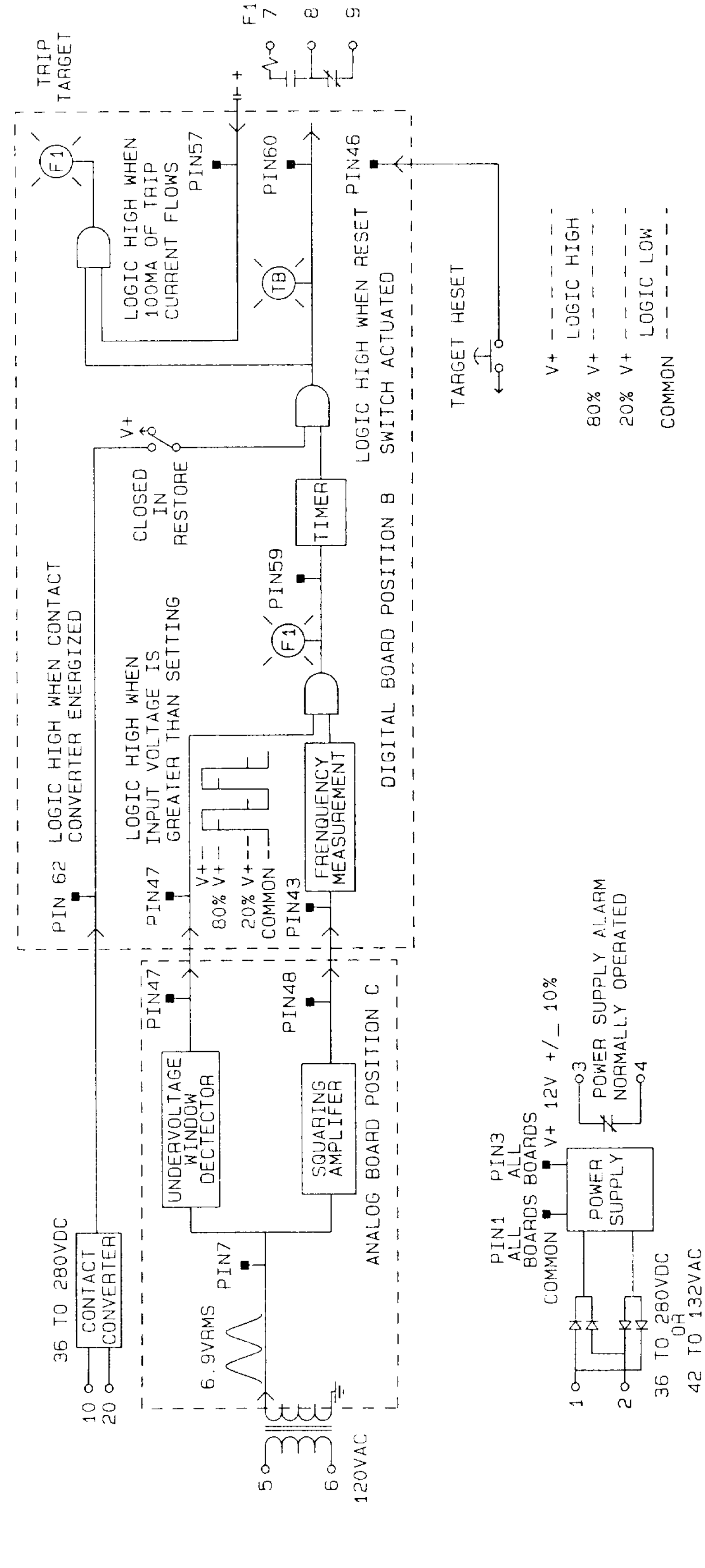


Figure 14 (0179C7782) Trouble shooting diagram for the SFF201

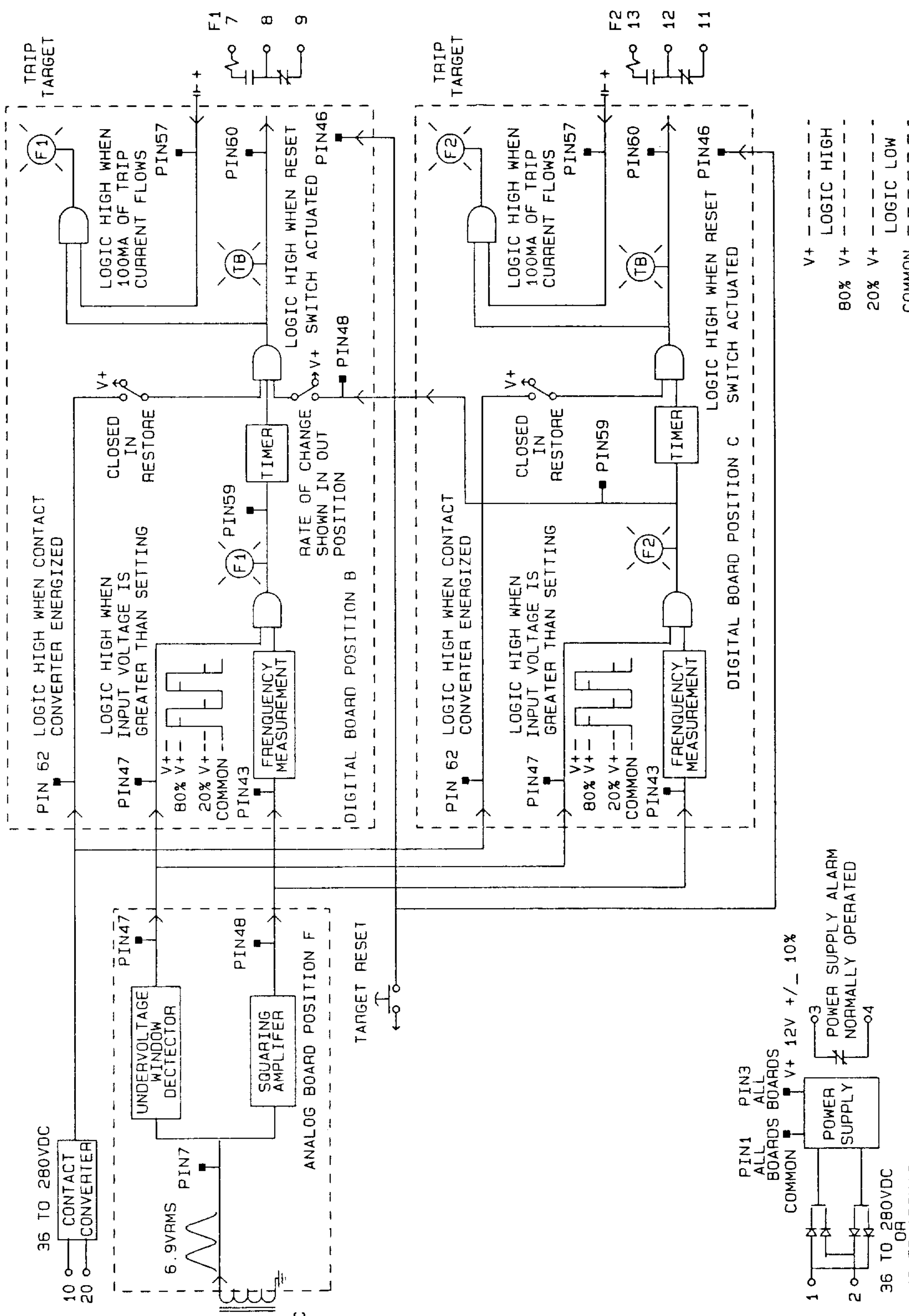


Figure 15 (0179C7783) Trouble shooting diagram for the SFF202

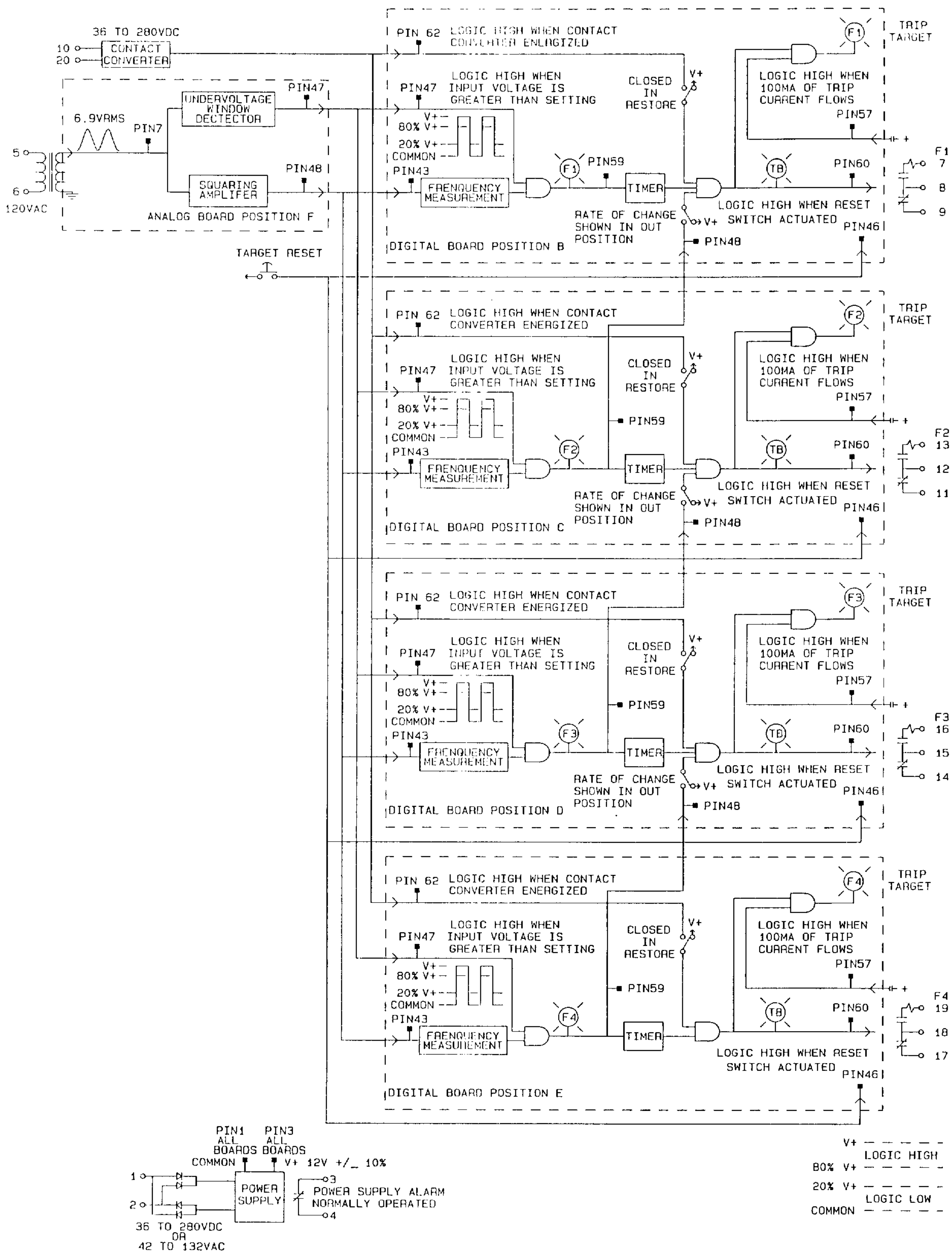


Figure 16 (0153D7720) Trouble shooting diagram for the SFF204

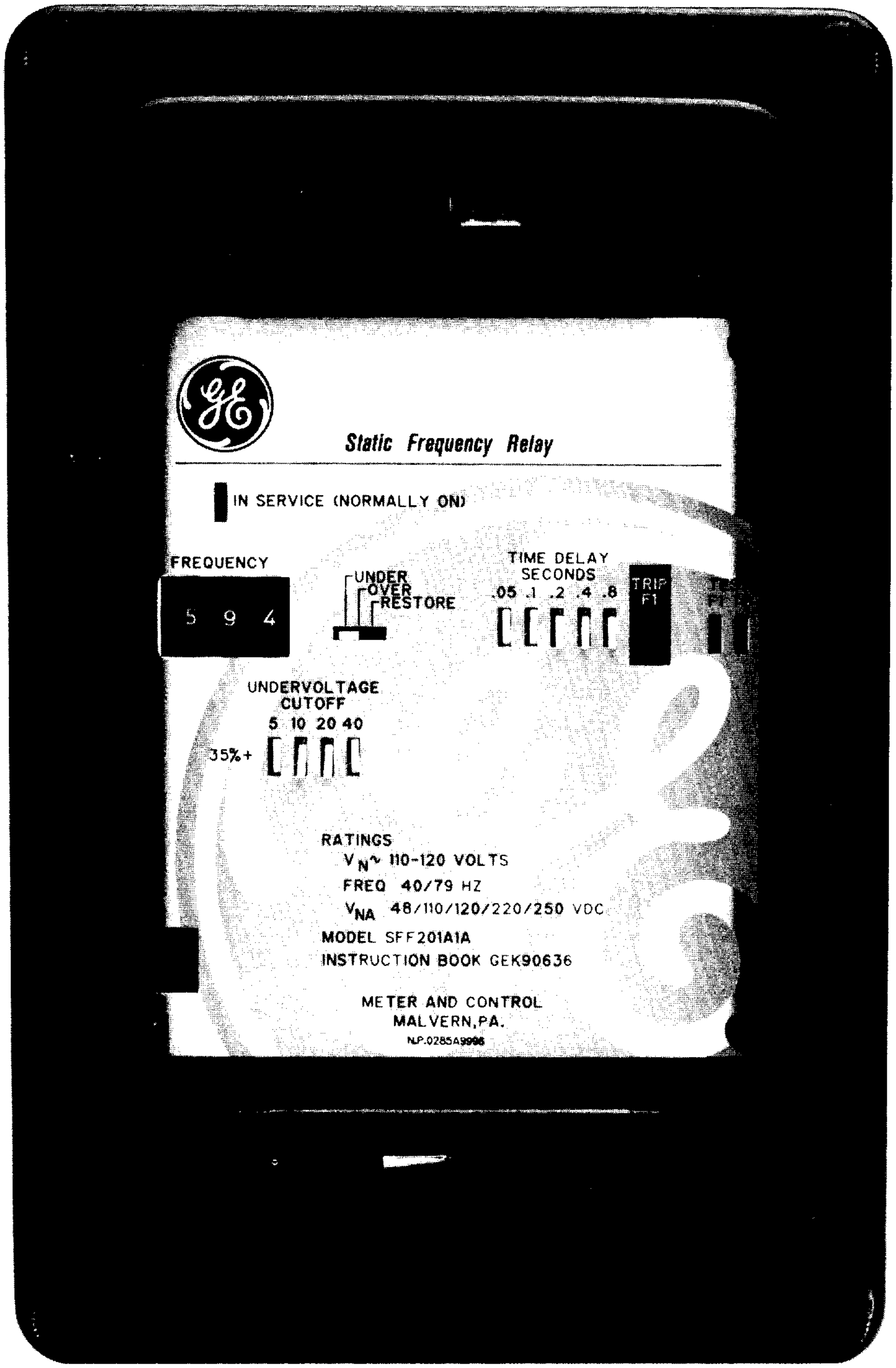


Figure 17 (8043796) Front View of the SFF201A

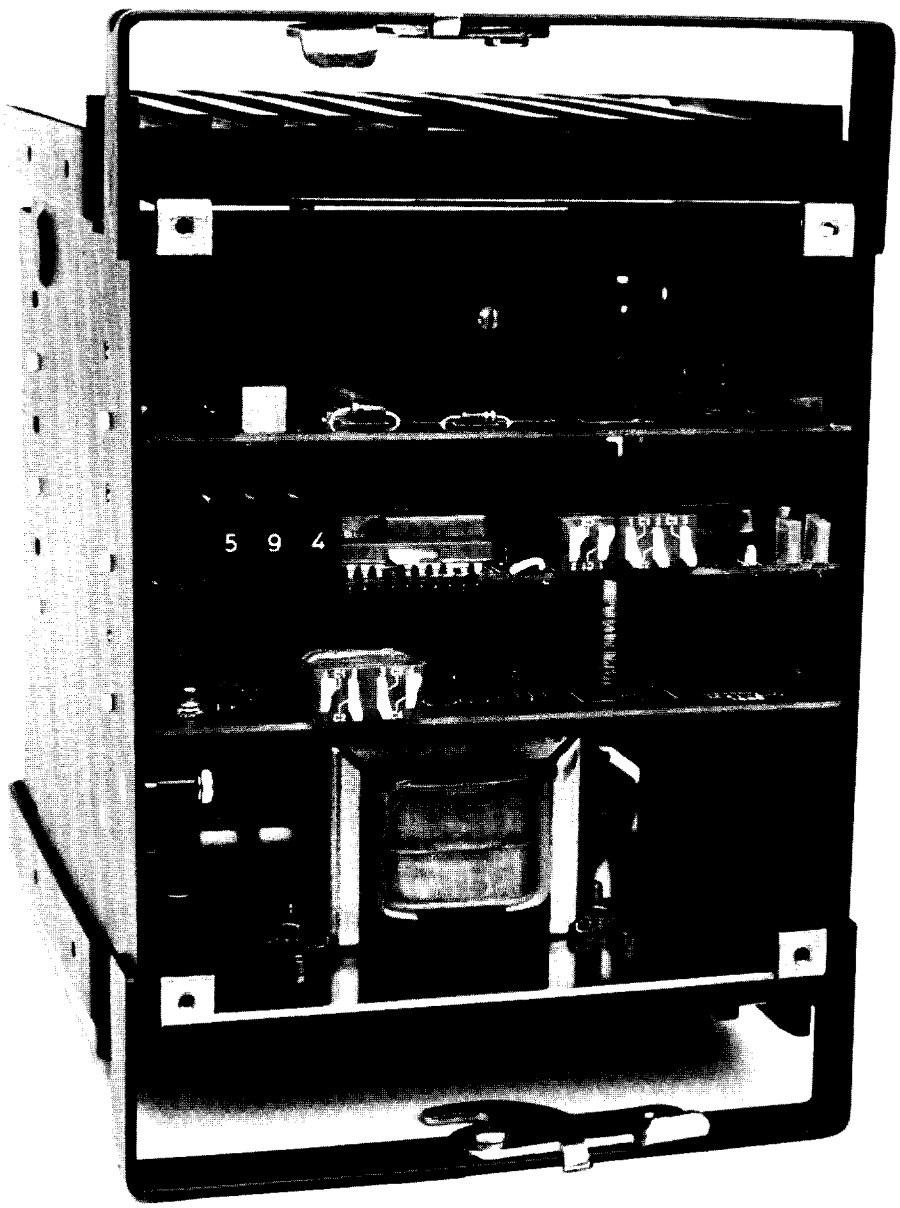


Figure 18 (8043797) Front view of the SFF201A with the nameplate removed

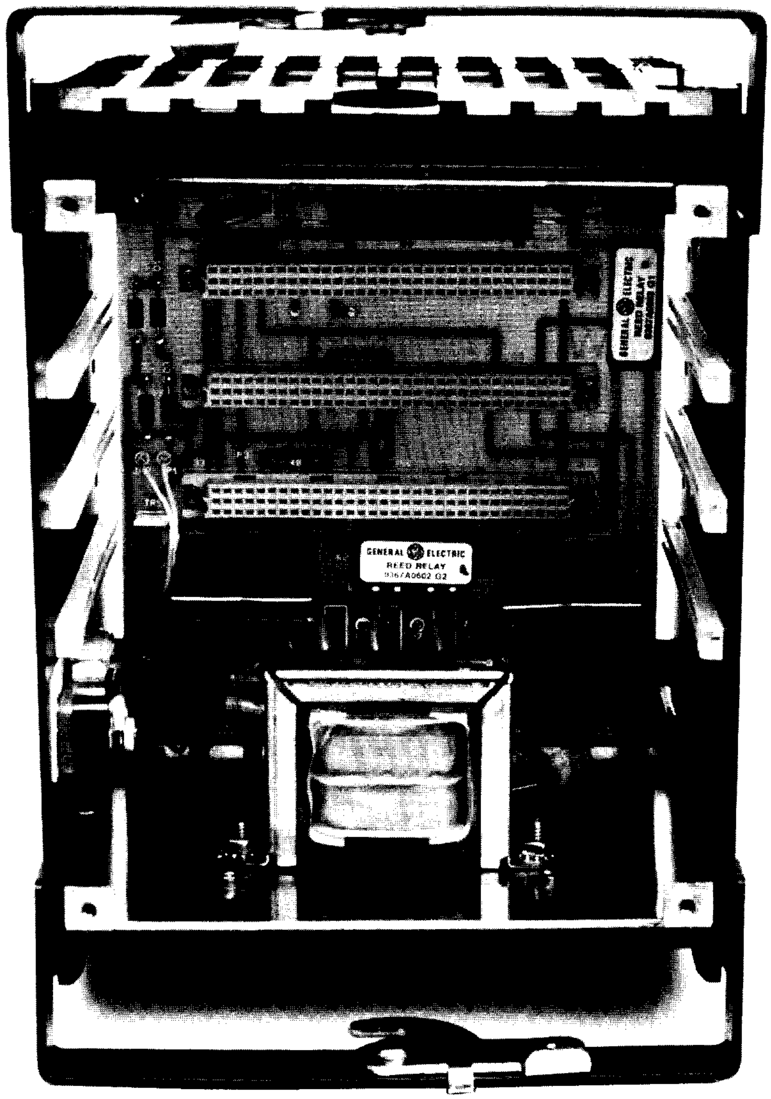


Figure 19 (8043798) Front view of the SFF201A with the circuit boards removed

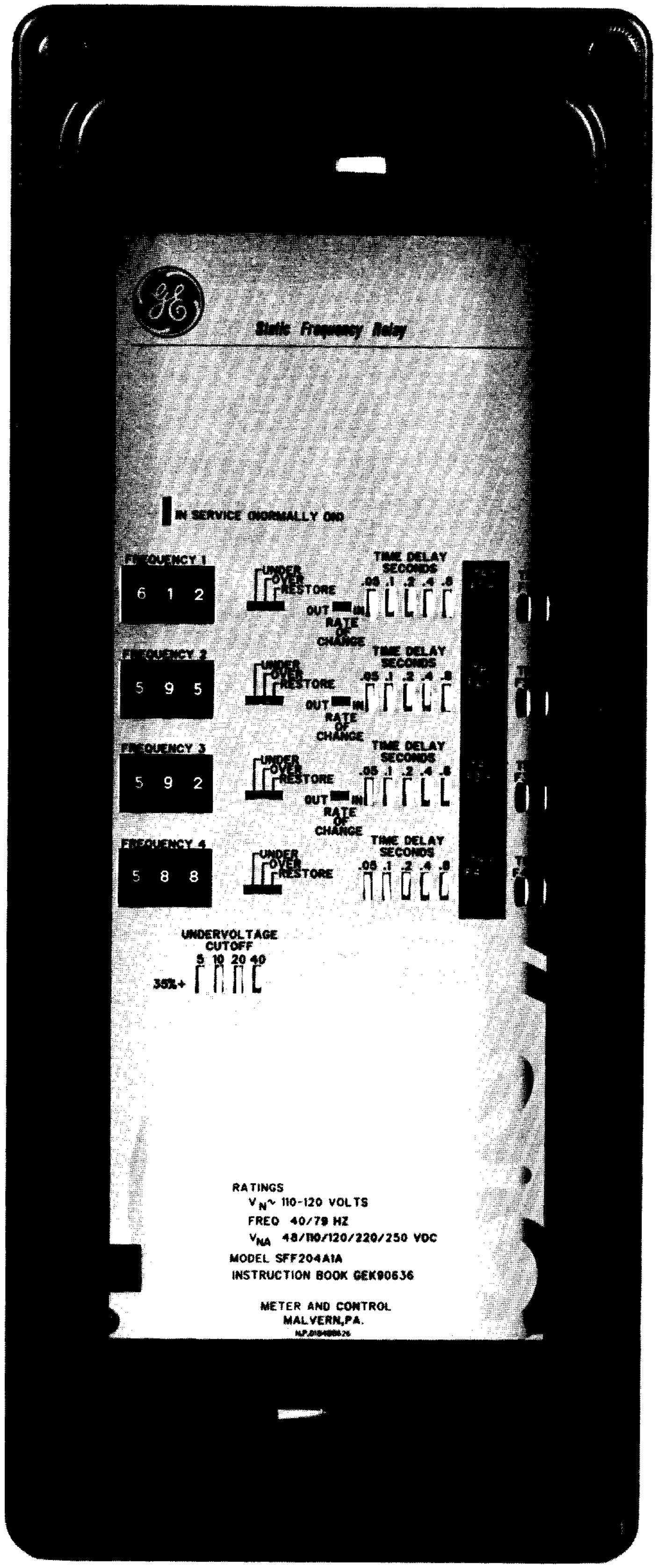


Figure 20 (8043799) Front View of the SFF204A

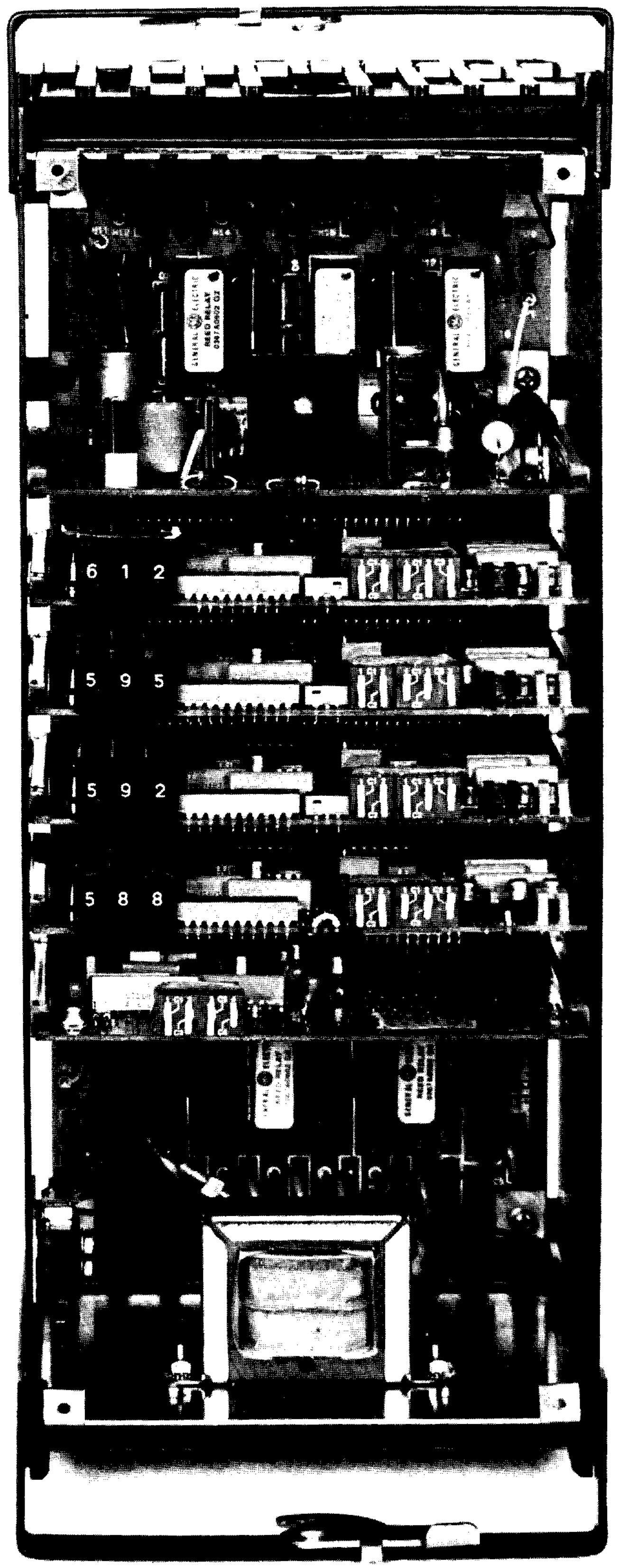


Figure 21 (8043800) Front view of the SFF204A with the nameplate removed

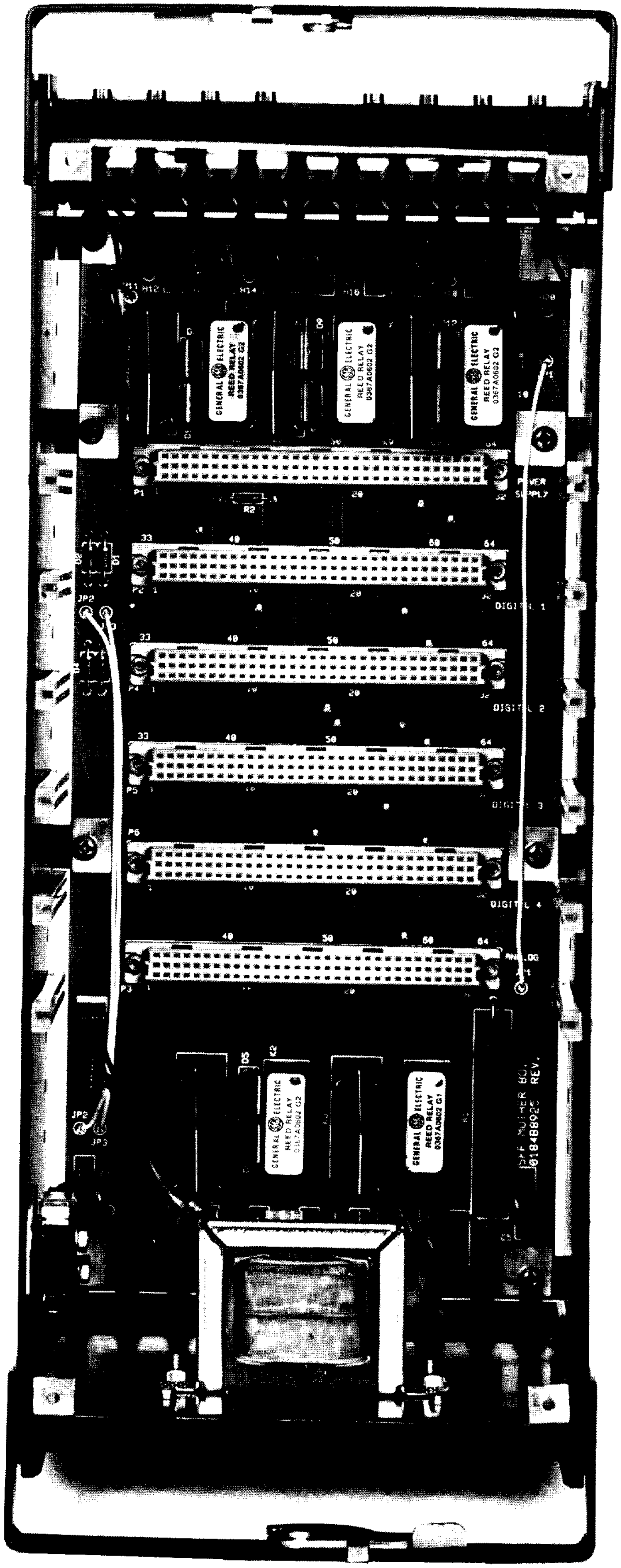


Figure 22 (8043801) Front view of the SFF204A with the circuit boards removed

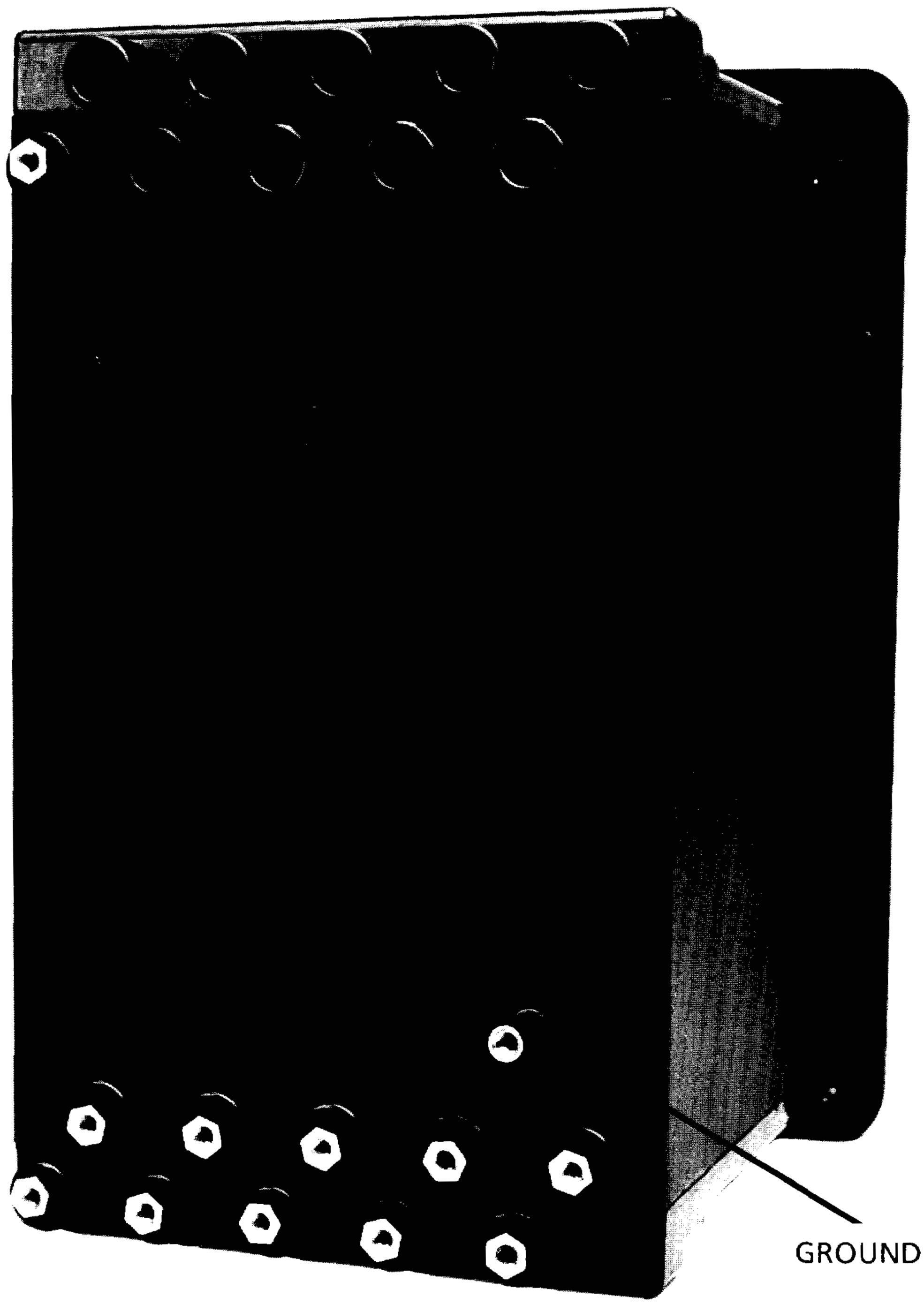


Figure 23 (8043802) Typical surge ground stud location