GE Power Management

Digital Frequency Relay

MFF series 1000

Instructions

GEK 105211B

Anything you can't find?

Anything not clear enough?

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CONTENTS

The information provided herein does not intend to cover all details of the variations of the described equipment nor does it take into account the circumstances that may be present in your installation, operating or maintenance activities.

Should you wish to receive additional information, or for any particular problem which cannot be solved by referring to the information contained herein, please write to:

GENERAL ELECTRIC POWER MANAGEMENT S.A.

1. DESCRIPTION

The MFF type relays are microprocessor based digital relays that provide protection against frequency variation in alternating current systems.

The functions performed by the MFF are:

- Protection against frequency variation.
- Frequency measurement.
- Registering of the frequency and time of the last trip, as well as the setting level that tripped.

The MFF has two settings which may be independently programmed as under or overfrequency, allowing any of the following combinations:

- Two overfrequency settings.
- Two underfrequency settings.
- One overfrequency and one underfrequency setting.

The delay time for each setting may be independently programmed.

In the case of two underfrequency or two overfrequency settings, if the first setting has been reached it will begin to count the delay time, but if the second setting is reached before this time has elapsed, the first setting will trip automatically after three cycles without regard to it's timer.

An AC undervoltage function will cut-off all outputs whenever the input voltage is less than its setting. The function is adjustable in percentage of the rated voltage.

Each setting is provided with its own output relay. Each of these relays contains a normally open contact and a normally close contact in a manner that it may be used for under or overfrequency. Additionally, each setting has an auxiliary alarm relay whose contact is normally closed (see Fig. 1).

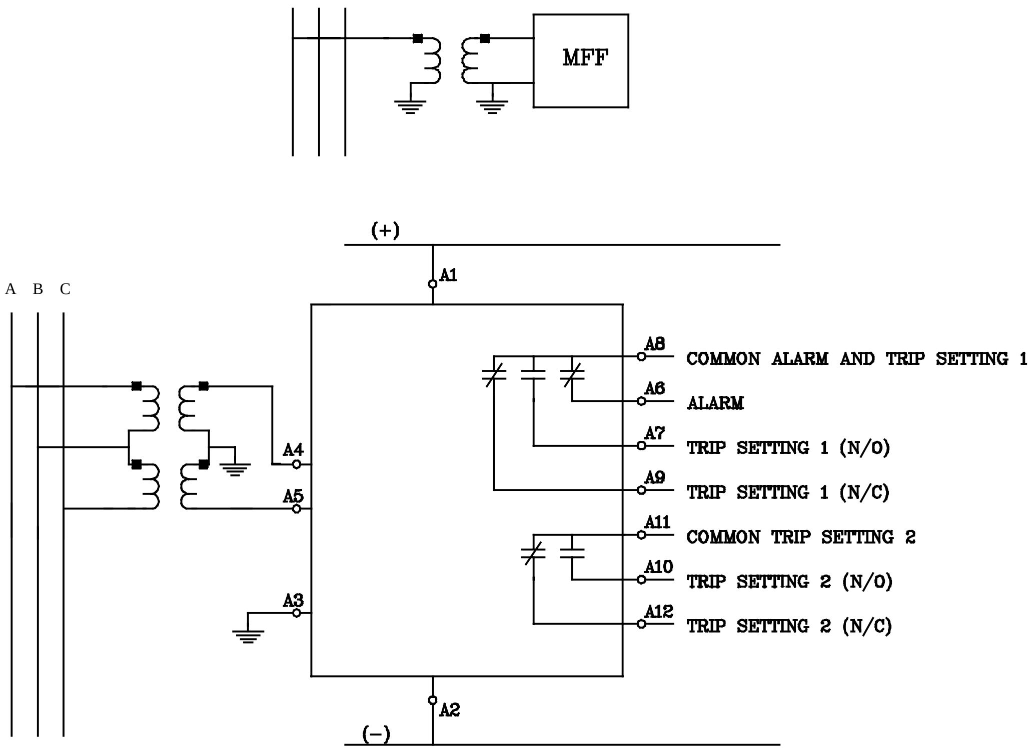


Fig. 1. External connections

2. MODEL SELECTION

The list of available models is as follows:

MFF	1	0	0	0	A	0	0	0	*	0	0	*	DESCRIPTION
													Aux. Voltage
									F				24-48 Vdc/ac
									G				48-125 Vdc/ac
									H				110-240 Vdc 110-220 Vac
													Housing
												C	Individual drawout
												S	Drawout in system

3. BASIC APPLICATION OF FREQUENCY RELAYS

3.1. Load Shedding

The operation of an electrical system will become unstable if load exceeds generation. In this situation generator’s speed will start to decay and the system may be in danger of collapsing due to frequency reduction.

A frequency reduction may damage the generators. While a hydroelectric plant is practically unaffected by a 10% frequency reduction, a thermal plant is quite sensitive to frequency reductions on the order of 5%. The voltage of a thermal plant depends greatly on auxiliary elements such as water supply pumps, coal pulverization equipment, ventilation equipment, etc. When the network frequency decreases, the output power of the thermal generators begins to decrease rapidly, at the same time the input energy to the generator reduces producing a cascading effect. The major danger of this situation is the damage that can occur to the steam turbines due to prolonged operation at reduced frequencies in a severe overload situation.

To prevent the complete collapse of the electrical system, underfrequency relays are used to carry out automatic load shedding, balancing generation with load in the affected area.

3.2. Load Restoration

If the load shedding system has been successfully applied, the electrical system will stabilize and the frequency will once again be set to the rated value. This frequency recovering is produced by the speed regulators of the generators.

It is possible to implement an automatic restoration system for loads that have been disconnected through the use of maximum frequency relays in such a manner that when the network frequency is very close to the rated frequency, you can connect the loads that had been disconnected by the underfrequency relays. This recuperation of loads must be done slowly, in times that may be on the order of several minutes. This is done to avoid producing frequency oscillations when connecting loads, that by their magnitude, may cause significant frequency decreases causing new load shedding.

3.3. Special Problems with Load Shedding

3.3.1. Motor Loads

A substation with a large quantity of motor loads may have time coordination problems when underfrequency relays are used.

In the case of a substation whose feeders have been disconnected on the extreme remote we will notice that the loads generated by motors will tend to maintain the voltage while the frequency will decrease as the motors slow down. This situation will occur when the line capacitance maintains excited the motors. This slow descent of the voltage may be greater than the three or six delay cycles for the rapid trip of the underfrequency relay, thus the relay may trip and block breakers unnecessarily. This situation may be disadvantageous in unattended substations where you do not have remote control of all of the breakers. One solution is to have an additional delay in the operation of the underfrequency relays of around 20 cycles.

3.3.2. High Speed Reclosing

Many large industrial plants have implemented some type of load shedding system When an industrial installation is tapped off a power company transmission circuit that utilizes high speed automatic reclosing, an MFF relay could be used at the industrial location to prevent motor or generator damage which might result from reclosing to the system out of phase. The relay would detect the drop in frequency while the transmission breaker is open and trip the industrial incoming breaker before reclosing could occur.

This is a good application for the MFF relays, which allow the disconnection of the entire plant, or the loads or generators that may be damaged by the reclosing operation.

3.4. Underfrequency Protection of Generators

A steam turbine may suffer extensive damage if it is maintained in operation at reduced frequency for a prolonged period of time during an electrical system overload.

As such, you must take into account that due to the oscillatory nature of frequency variation during electrical system disturbances, it is possible to have frequencies above the rated value (as in the case of a load shedding event). This situation is just as dangerous for the steam turbines as is operation with frequencies below the rated frequency.

In the design of a generator's turbine extreme care is taken so that the resonance frequency of the blades is sufficiently separated from the natural frequency of steam. This avoids vibrations that may damage the turbines' blades. Nevertheless, when the turbine speed changes, the natural frequency of steam may approach the resonance frequency of the blades, producing excessive vibration and the resulting mechanical fatigue. You must take into account that mechanical fatigue is accumulated.

The chart in **figure** 2 represents the curve of the minimum estimated time in function of the operating frequency (may be a frequency under or over to the rated frequency) for damage to any part of the blade structure. The weakest parts are the metal joints between the covers of the blades. The breakage of one of these joints, although not producing severe damage, may change the resonance frequency of the blades bringing it closer to the natural frequency at rated speed, producing mechanical fatigue and a later destruction during normal operation of the turbine.

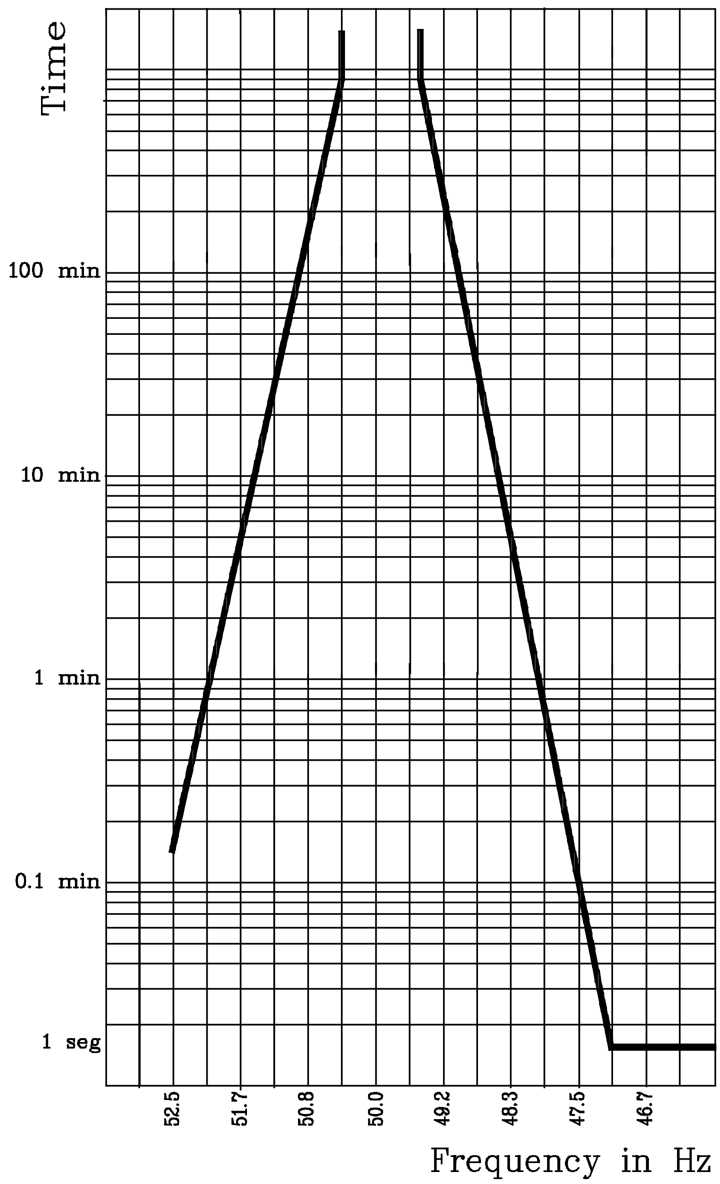


Figure 2. Operating limits for a steam turbine (301A7412F2)

3.4.1. Overfrequency Protection of Turbines

The overfrequency condition most frequently encountered is due to a sudden load loss of a generator when its breaker is tripped. In this situation, the rapid response of the speed regulator avoids overfrequency problems in the turbine.

In case the speed regulator is defective and assuming a partial reduction of the load in the generator of say 50%, and an estatism of 5%, we will have an increase in the frequency of 2.5%. Observing figure 2, you will note that the maximum time that this frequency can be maintained is about 30 minutes, which is sufficient time for the operator to take corrective actions.

A steam turbine operating at low frequency becomes a critical situation because the operator is not able to control the operation.

3.4.2. Underfrequency Protection of Steam Turbines

Establishing an underfrequency protection in a turbine is not simple, therefore it requires extensive knowledge of the electrical system, such as the load shedding philosophy which has been implemented (if existing). The protection procedure requires coordinating a relay characteristic that is essentially a definite time, with a variable curve that refers to the turbine's capacity. Furthermore, since the effects of operation at low frequency are accumulative, this situation introduces another variable that is the history of the turbine. If a machine has been working at low frequency for a considerable amount of time, the operating times of the underfrequency relays will also have to be reduced in accordance with this new situation.

3.4.3. Undefrequency Protection of Other Types of Turbines

As we have previously mentioned, hydraulic turbines are not affected very much by operation at low frequency. In the case of gas turbines, which have blades considerably shorter than those of a steam turbine, the blades are not very sensitive, but it is preferable to consult with the manufacturer of the turbine as to the sensitivity to frequency variations. Diesel motors have no major problems operating at low frequency.

4. CHARACTERISTICS

4.1. General Characteristics

- Accuracy, reliability and low consumption.
- Flush mounting.
- LED indicators for: Trip setting 1.
  Trip setting 2.
  System ready
- Highly legible 7 segment displays.
- Sealable plastic cover, shock resistant and fire-retarding, which permits resetting of the indicators from the exterior.
- Highly reliable solid state components.
- Digital, microprocessor-based system.

4.2. Technical Specifications

Rated frequency:	50 and 60 Hz.
Rated voltage (Vn):	110 VAC.
Auxiliary power:	24 - 48 VDC/AC
	48 - 125 VDC/AC.
	110 - 240 VDC (±20%) or 110 - 220 VAC.
Power consumption:	< 1.5 W in all voltages.
Temperature Range	
Operating:	14° F to 131° F (-10° C to 55° C).
Storage:	-40° F to 149° F (-40° C to 65° C).
Ambient humidity:	Up to 95% without condensation.
Accuracy:	±0.01 Hz.
Repeatability:	0.005 Hz.
Tripping contact ratings	
Make and carry:	3000 W resistive during 0.2 s with a maximum of 30 A and 300 VDC.

Break:	50 W resistive, with a maximum of 2 A and 300 VDC.
Carry continuously	5 A.
<u>Alarm contact ratings</u>	
Make and carry:	5 A DC during 30 seconds and 250 VDC maximum.
Break:	25 W inductive and 250 VDC maximum.
Carry continuously:	3 A.
TYPE TESTS	
Insulation test:	2 kV 50/60 Hz during 1 min (IEC 255-5).
Impulse test:	5 kV peak 1.2/50 ~s, 0.5 J (IEC 255-4).
Interference test:	2.5 kV common mode. 1 kV differential mode. Class III (IEC 255-22-1).
Electrostatic discharge:	Class III (IEC 255-22-2).
Radiointerference:	Class III (IEC 255-22-3).
Fast transient:	Class III (IEC 801-4).

4.3. Settings Ranges and Values

This section lists the corresponding ranges for standard models. Special models with other settings ranges can be supplied on request.

- **Frequency setting** (independent for units 1 and 2):
  Type selection: Over or underfrequency.
  Frequency: 42.0 - 67.5 Hz in 0.1 Hz steps.

- **Timing** (independent for units 1 and 2):
  0.00- 10.0s in 0.05s steps.

- **Undervoltage**:
  40% - 100% of Vn in 10% steps.

5. PRINCIPLES OF OPERATION

5.1. Inputs

Figure 3 represents the block diagram of the MFF relays.

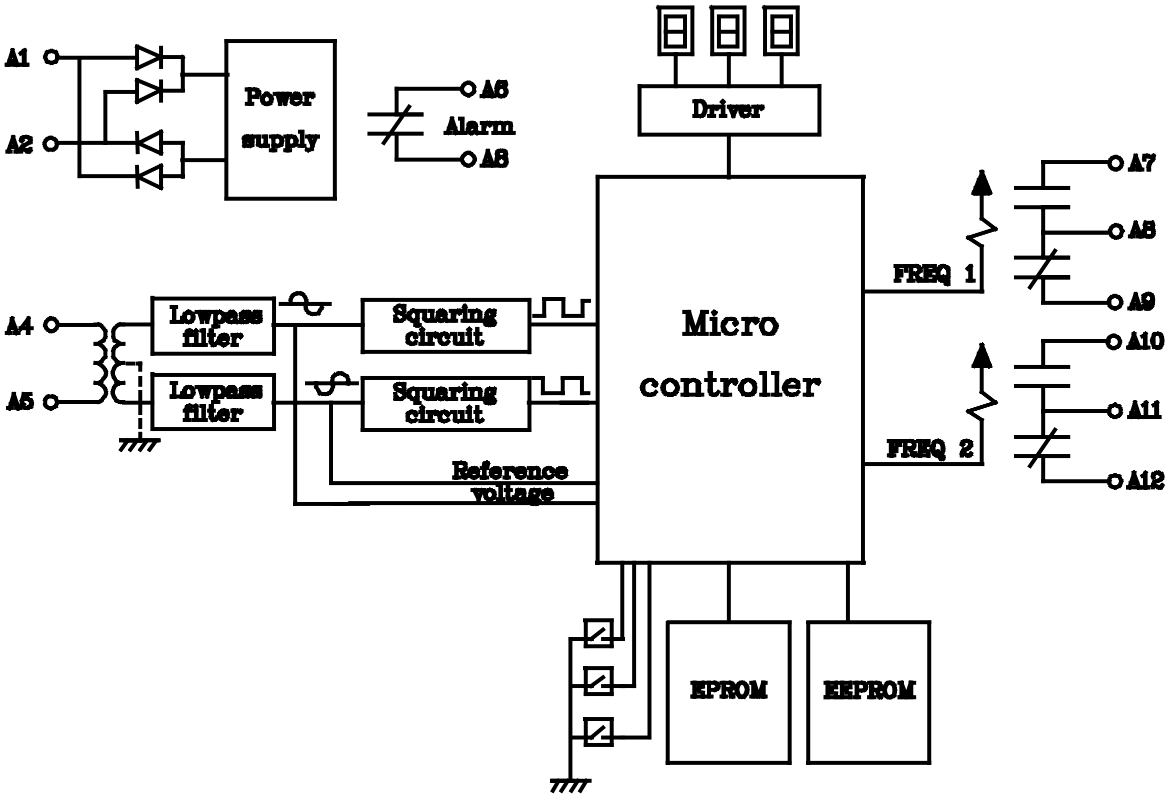


Fig. 3. Block diagram (301A7326F3)

The voltage applied to the relay input is reduced through an internal voltage transformer. This voltage passes through two lowpass filters that convert it into two complementary voltages. These voltages pass through two squaring circuits which convert them into two square waves. These square waves are complementary and are the ones supplied to the microcontroller.

5.2. Measurement

The square waves that arrive at the microcontroller are measured independently. The periods of each wave are measured, and from these values two frequencies are obtained, one for each wave (if the relay is functioning correctly the two frequencies must be identical). The two frequencies are compared with each other to ensure maximum security. The frequencies of each wave are calculated obtaining the average of four cycles in order to obtain a stable measurement.

Once passing the tripping limit for a measured frequency in a wave, the relay waits three cycles before tripping (as long as the frequency does not fall below the limit). The relay alternately samples one wave then the other. When the frequency of the two waves exceeds the limit during three cycles the relay will trip. If there is a failure in the relay and one of the waves is not generated, the relay waits until the frequency of the other wave exceeds the tripping limit for at least four cycles before tripping (if there is no delay time). When the tripping conditions disappear, the MFF takes 3 cycles to drop out.

After having been without input voltage, once it is applied the MFF is unable to trip for a period of 5 cycles to stabilize the frequency measurement.

After the lowpass filters and before the squaring circuits, two voltages proportional to the input voltage are produced. The two voltages are compared with each other to ensure maximum security. If these voltages are less than the undervoltage setting, trips will not be permitted.

5.3. Operation of the MFF

The MFF is controlled through the use of three buttons on the front panel. These buttons are aligned vertically, and starting from the top are:

< ENTER >

< + >

< - >

The two lower buttons are labeled < + > and < - >. The symbol for the <ENTER> button is:

The relay supplies information through three seven segment displays and three led indicators, all situated on the front panel. The leds are aligned vertically, and starting from the top are labeled:

"READY"
"FREQ 1"
"FREQ 2"

With the cover closed, only the < ENTER> button is accessible from the outside.

The MFF may be in one of two states:

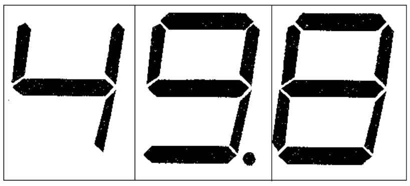
- **Read sequence**: Provides information related to the status of the relay frequency values, records of the last trip, etc. To perform operations in this mode only the < ENTER> button is required.

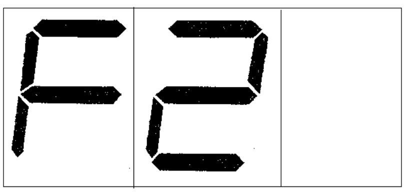
- **Settings sequence**: Permits the inquiry and change of the MFF settings. To perform operations in this mode all three buttons are required.

In addition to these sequences, you may perform another operation from the keyboard: deleting the last trip. This operation will be covered in detail further on in this manual.

5.3.1. Readings

This is the fundamental sequence of the MFF, and is where the MFF is situated when started. It is divided into a series of functions each of which correspond to different information. These functions are numbered from 0 to 4 and are identified by the letter "F" followed by the function number.



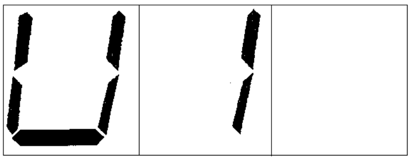


Under normal operations the MFF displays the value of one of the readings on the display. Generally, this reading will be the frequency measurement. Let's suppose, for example, that the value of the frequency is 49.8 Hz, you will see the number 49.8 on the display. If at this moment you press the <ENTER> button and hold it down, you will se an "F" followed by a number, which in this case will be "2".

As long as you keep the button pressed, this code will be maintained in the display.

This indicates that you are in the "Readings sequence" and, upon releasing the <ENTER> button the value of function 2 will be displayed (code of the unit that caused the last trip).

For the Readings sequence, the code that appears when you maintain the < ENTER> button pressed corresponds to the value that is displayed when you release the button. Let's suppose that you have released the < ENTER > button. You will be viewing the code of the unit that caused the last trip. Therefore, if unit 1 tripped, you will see the following on the display:



Pressing the <ENTER> button again will display "F3", the code of the next reading, and upon releasing the <ENTER> button the value for that function will be displayed, which in this case is the frequency that had been reached at the time of the last trip. If you continue pressing and releasing the <ENTER> button in this manner, you will cycle through the remaining readings until reaching reading 4. Pressing <ENTER> at this point will return you to function 0.

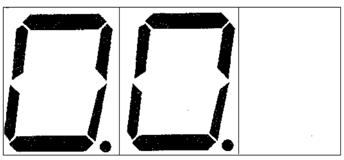
The MFF readings are:

F0: Relay status.
F1: Frequency measurement.
F2: Code of the unit that caused the last trip.
F3: Frequency reached at the time of the last trip.
F4: Operating time of the last trip.

If no buttons are pressed during a period of two minutes, the reading sequence will return to the frequency measurement display. The same occurs if the MFF is in the settings sequence. after 2 minutes it will return to the frequency measurement display.

F0: RELAY STATUS

The status of the MFF is displayed as a two digit code situated on the left of the display. To distinguish the status from other readings, the two corresponding decimal points are illuminated. As such, a status code of 00 (system functioning correctly) would be displayed as:



The status codes of the MFF are:

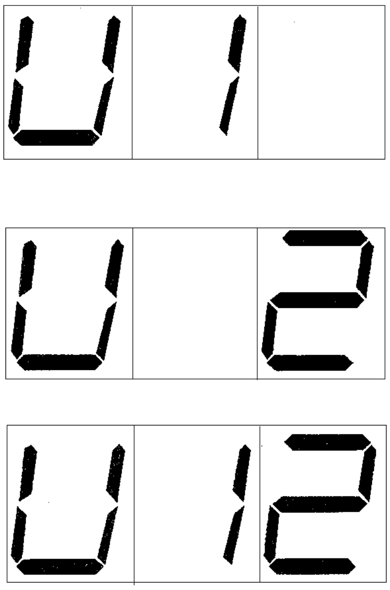
00: System functioning correctly.
01: Settings failure. The stored settings are the default ones.
80: EPROM failure. The program memory has failed.
81: Checksum failure of the settings in EEPROM. Default data may not be saved.
82: Failure saving data in EEPROM during a settings change.
84: System error measuring the input voltage.
85: Failure when attempting to delete the last trip in EEPROM.

The errors with a first digit of zero (0) may be solved by the user. The errors with a first digit of eight (8) indicate an electronic failure in the relay and the MFF requires maintenance. The procedures for error recovery will be discussed in section 4.3.4. ERRORS.

F1: FREQUENCY MEASUREMENT

This reading provides the value of the frequency of the relay's input voltage at the time of the reading. The MFF is capable of measuring from 20 to 99.9 Hz. If this range is exceeded, the overflow indicators "---" will appear on the display.

F2: CODE OF THE UNIT THAT CAUSED THE LAST TRIP



This reading displays the code of the unit that caused the last trip. In the case where both units have caused the trip, both will be recorded.

The following figure shows how this reading will be displayed for a trip caused by unit 1, unit 2, and by both units.

As you can see, the letter "U" (unit) appears on the left, the center digit corresponds to unit 1 and the right digit to unit 2. If no event has been recorded, the letter "U" will appear and the other two digits will be blank. This information is conserved even though the auxiliary voltage has been withdrawn and can be deleted by the user.

F3: FREQUENCY REACHED AT THE TIME OF THE LAST TRIP

This reading displays the frequency reached at the time of the last trip. When a trip is produced, the relay saves the maximum or minimum frequency of the trip. In the case where both settings are adjusted to overfrequency, the MFF will save the maximum frequency measured while the tripping relay is activated. If both settings are adjusted to underfrequency, the MFF will save the minimum frequency measured while the tripping relay is activated. In the case where one setting is over and the other is underfrequency, the relay will save either the maximum or the minimum frequency depending on which unit has been tripped.

This information is conserved even though the auxiliary voltage has been withdrawn from the relay and can be deleted by the user.

F4: OPERATION TIME OF THE LAST TRIP

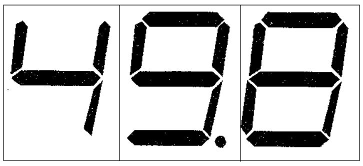
This reading displays the time that has passed from the unit pickup to the time the trip was produced.

Normally, this time will be the set delay time, but the case may arise where both settings are programmed for under or overfrequency and there has been a rapid frequency variation. In this case, if the first setting has been reached it will begin to count the delay time, but if the second setting is reached before this time has elapsed, the first setting will trip automatically after three cycles without regard to it's timer.

This information is conserved even though the auxiliary voltage has been withdrawn from the relay and can be deleted by the user.

5.3.2. Settings

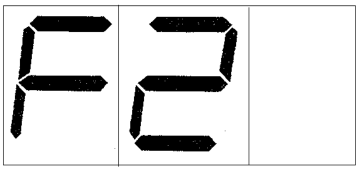
The Settings sequence is the mode in which you can modify the settings of the MFF units. Operations in this mode require the use of all three buttons, therefore you cannot access this sequence with the cover closed.



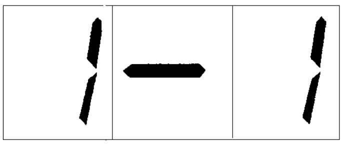
From any point within the Settings sequence, if two minutes pass and no buttons have been pressed, the MFF will return to the frequency measurement function in the Readings sequence.

ENTER

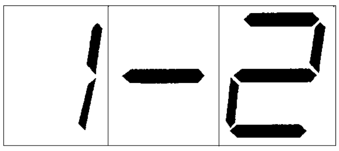
To enter the Settings sequence, the MFF must be in any function within the Readings sequence. Entering the Settings sequence is accomplished by pressing the < - > button while the < ENTER > button is held in. As an example, let's suppose that the reading for F1, the value of the frequency is displayed.

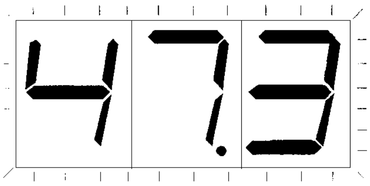


The display shows the frequency value 49.8 Hz. Pressing < ENTER > will display the next function which is F2. Do not forget that any other function is just as valid as this one for entering into the Settings sequence.

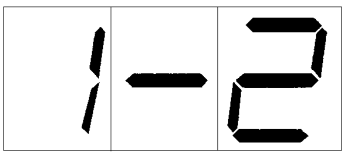


With the < ENTER > button still held in, press the <-> button. The display changes and the reading 1-1 is displayed. This is always the first reading when entering the Settings sequence. The number on the left indicates the unit and the number on the right indicates the setting. In this manner, 1-1 signifies Unit 1 - Setting 1. Unit 1 corresponds to the first frequency setting (FREQ 1) and setting 1 is the selection for under or overfrequency. To view or modify the frequency value for FREQ 1 pressing the < + > button will display 1-2 which corresponds to the frequency value for FREQ 1. Pressing <ENTER> at this point (without the need of holding the button in) will display the current value of the setting, which for now we will suppose is 47.3. Whenever displaying a settings value, the display will blink.

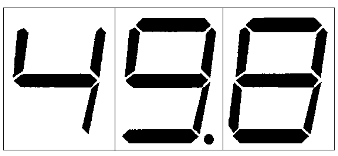




Before continuing on, it would be convenient to understand the relation of the MFF's units and settings. Therefore, let's leave the Settings Sequence for now.



To do this, first press and release the < ENTER > button. This will return the code of the setting (1-2) to the display. To return to the Settings sequence press simultaneously the <+> and the <-> buttons. It does not matter which one is pressed first, only that the two buttons are momentarily pressed in at the same time. This action will return the MFF to the Readings sequence, but not the same point from which you entered into the Settings sequence.



When leaving the Settings sequence, you are always returned to the default relay state, function F1 (frequency measurement).

The MFF includes three protection units:

Unit 1: *Setting for frequency 1*

1-1 Under or overfrequency selection.
Range: under or overfrequency (please see figure 4)
1-2 Tripping frequency.
Range: 42.0 to 67.5 Hz in 0.1 Hz steps.
1-3 Delay time.
Range: 0.00 to 10s in 0.05s steps.

Unit 2: *Setting for frequency 2*

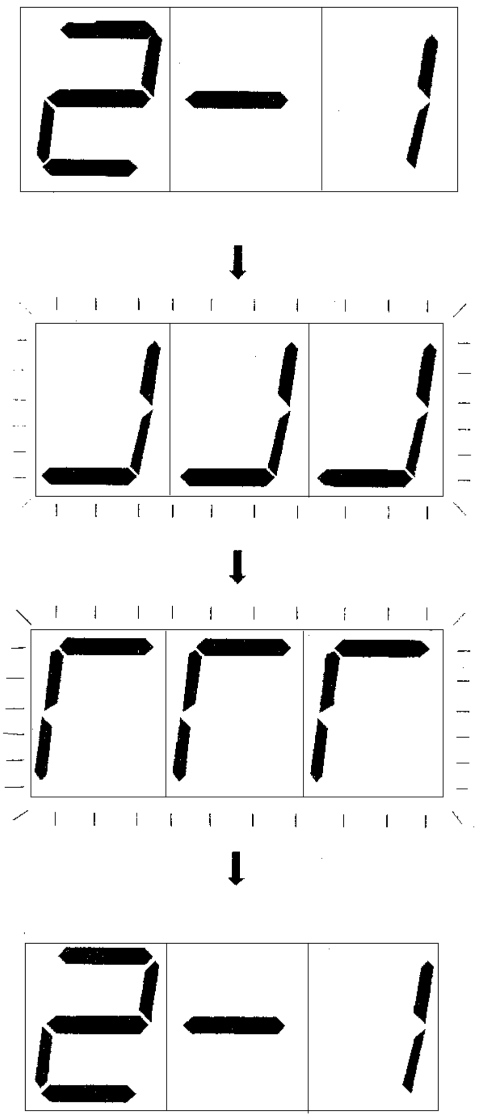
2-1 Under or overfrequency selection.
Range: under or overfrequency (please see figure 4)
2-2 Tripping frequency.
Range: 42.0 to 67.5 Hz in 0.1 Hz steps.
2-3 Delay time.
Range: 0.00 to 10s in 0.05s steps.

Unit 3: *Undervoltage*

3-1 Blocks relay trips if the voltage falls below this setting.
Range: 40% to 100% of Vn in 10% steps.

OVERFREQUENCY **UNDERFREQUENCY**

Figure 4. *Over or Underfrequency selection*



Now that all of the units have been explained, it's time to perform an actual settings change. As an example, let's program the FREQUENCY UNIT 2 for underfrequency, with a value of 46.5 Hz and a delay time of 1.25 s.

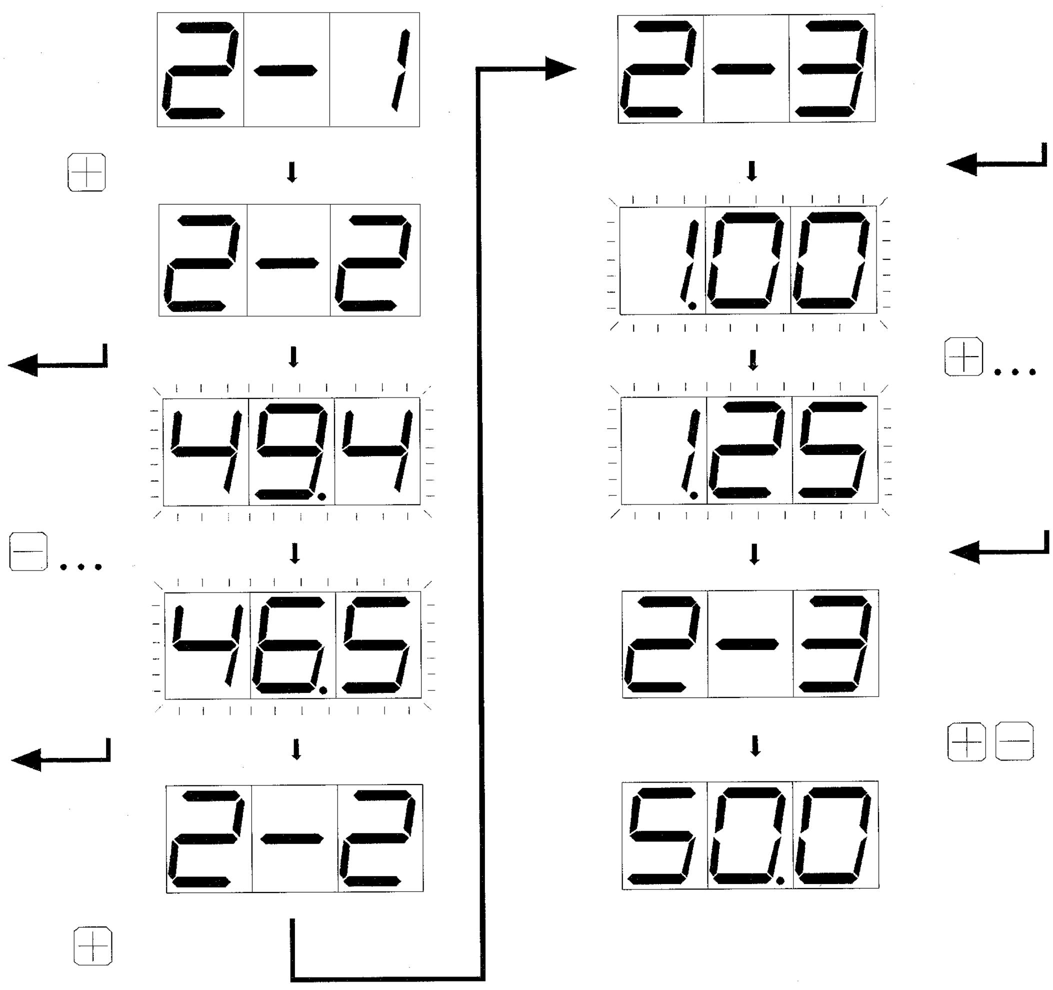
Enter into the Settings sequence in the manner explained earlier, with the code 1-1 appearing on the display. Our example requires that we change the settings 2-1, 2-2, and 2-3. To get to them, press repeatedly <+> and <-> until the desired code appears on the display, in this case 2-1. Selecting the settings is performed circularly in such a manner that pressing <+> when the last setting is displayed will take you to the first setting, and pressing <-> when the first setting is displayed will take you to the last setting.

Once the code 2-1 is displayed on the screen, pressing <ENTER> will display the value of the setting blinking. Supposing that the setting is currently set for maximum frequency, the symbol for maximum will appear on the screen (second figure below). To change it to underfrequency press the <+> button. The symbol for minimum will appear on the screen (third figure below). To accept the change, press <ENTER> and the code 2-1 will once again appear on the display. With this operation the value of setting 2-1 has been changed from over to underfrequency. Here is a graphical representation of this operation.

This process is the same for changing any of the settings. Select the code of the setting you wish to change. When the code appears press <ENTER> and the actual value of the setting will be displayed. The <+> and <-> buttons will increment and decrement the value displayed respectively. Pressing <ENTER> at this point will accept the change for that setting.

If the maximum allowable value for the setting is displayed, pressing <+> will have no effect and the value on the display will not change. The same occurs if the minimum value is displayed. Pressing <-> will have no effect and the value on the display will not change.

If you hold the <+> or <-> button in, the value will increment or decrement automatically at a rate of ten times per second. To avoid undesired changes, there begins to change automatically.



This mechanism only functions when changing the value of a setting and not when selecting the settings codes. For this you must press and release the <+> or <-> button to increment or decrement the code. Let's look at a graphical summary of how to change the other two settings, keeping in mind that the buttons to press are only the above mentioned.

We have assumed that the original value for setting 2-2 was 49.4 Hz, that setting 2-3 was 1.00 and that the value of measured frequency is 50.0 Hz. Had they been others, you would have had to press the <+> and <-> buttons until arriving at the desired valued and then press <ENTER> to accept the change.

After changing a setting, it is updated at the moment you press <ENTER> to accept the change. When a setting changes, the whole unit to which it is related is reinitialized. The rest of the units remain unaffected and continue to function normally. Needless to say, when pressing <ENTER> all of the protections remain "frozen" in their current state until the new setting has been processed (between 0.08 and 0.1 s). Once the corresponding unit has reinitialized, all of them start anew.

If the value of a setting has not changed, the unit will not reinitialize, even though the <+> and <-> buttons had been pressed.

The reinitialization of a unit whose values have changed is complete, including the elimination of the pickup or trip if they had been produced.

5.3.3. Erasure of the Last Trip

The recordings of the last trip, once viewed, can be deleted. To delete them you must be in the Readings sequence. By pressing <ENTER> and <+> at the same time and then releasing them, the frequency and the time of the last trip will appear on the display with values of zero. The indication of the unit that tripped shows a "U" in the left display with the other two displays blank.

5.3.4. Errors

When the MFF detects a failure during operation, two things may happen:

- The failure does not affect the functioning of the relay. It is simply indicated in the status. The status values will have a value beginning with zero.
- The failure affects the functioning of the relay. In this case the corresponding error code is shown on the display, the READY indicator is turned off, and the alarm relay is deactivated. If under these conditions you press the <ENTER> button for a period of five seconds, the relay will proceed to completely reinitialize the software, which will permit the MFF to resume operation if the cause of the error have disappeared.

Let’s take a look at the error codes and their significance.

01- ***Settings error***

At the beginning of the program, the MFF loads the settings from EEPROM. If the stored settings do not pass any of the controls that they are subject to, the default settings are loaded and a code of 01 is indicated in the settings’ status. This error may be solved by the user, by reprogramming all of the relay settings.

This error is always produced when the EEPROM is new and does not have any settings adjusted. By loading the desired settings the MFF will function correctly.

80 - ***ROM Failure***

The contents of the program memory have deteriorated. It will be necessary to replace it.

81- ***Failure writing to EEPROM (Program start)***

Upon starting the program the EEPROM settings have failed their checks. The attempt to load the default setting also failed.

The non-volatile EEPROM has failed and is not capable of storing settings. It will be necessary to replace it.

82 - Failure writing to EEPROM (Settings change)

When attempting to load new settings the EEPROM failed and could not save the changes.

The non-volatile EEPROM has deteriorated and is not capable of storing settings. It will be necessary to replace it.

84 - System failure measuring the input voltage

The measurement of the input voltage is performed by two different routes. If the results differ by a certain value, this indicates that there is an error in one of the measuring system's components.

85 - Failure when attempting to delete the last trip from EEPROM

After a request to delete the last trip from EEPROM, the system verifies that the operation was completed successfully. If the operation was not successful, this error will be produced.

The non-volatile EEPROM has deteriorated and is not capable of deleting settings. It will be necessary to replace it.

5.4. Self Checks and Error Routines

When the MFF detects a critical failure in any of its components it immediately performs a fatal error routine and disables the trips. In this case the relay is left in a program loop from which it cannot exit until the supply voltage has been reset or the <ENTER> button has been pressed for five seconds. For local indication of the error the READY led on the front panel of the relay is turned off and the relay status is shown on the display. The error is also indicated with the alarm relay. Once the <ENTER> button has been held in for five seconds, the led indicators and the display are turned off indicating that the MFF can be reinitialized. If the error is not cleared the fatal error routine will be executed again.

The first thing the MFF does when turned on is perform a complete check of the EPROM. If an error is encountered a fatal error will be returned.

Once the relay is operating, partial checks of the EPROM are performed during the time that the protection functions are free. If an error is detected during these partial checks, a fatal error will be returned

The MFF utilizes a WATCHDOG system to monitor the program.

The input voltage measurement is continually checked to ensure that the input circuit is operating correctly.

6. CONSTRUCTION

6.1. Case

The MFF case is mace of steel. The general dimensions are provided in figure 4.

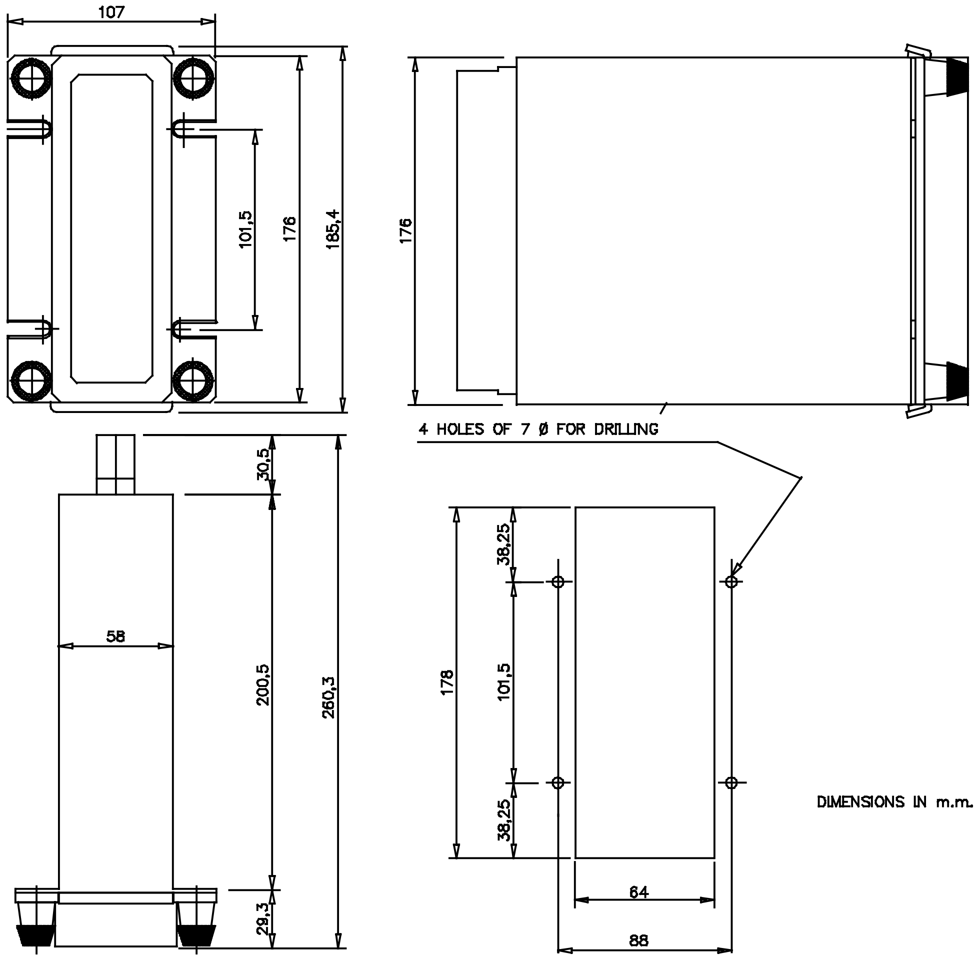


Fig. 5. *Relay case and panel cutout dimension diagram (226B6086F1)*

The front cover is made of plastic and can be fitted to the relay in a manner that produces a dust-proof seal.

6.2. Electrical and Internal Connections

Connection of the external wires is carried out at the terminal block mounted in the rear panel of the relay. This block contains 12 **screw terminals,** each of 3 mm screwed diameter.

The connections are carried out through pressure mounted terminals.

6.3. Identification

The complete relay type data is indicated on the nameplate. Figure 6 shows the front panel of the MFF.

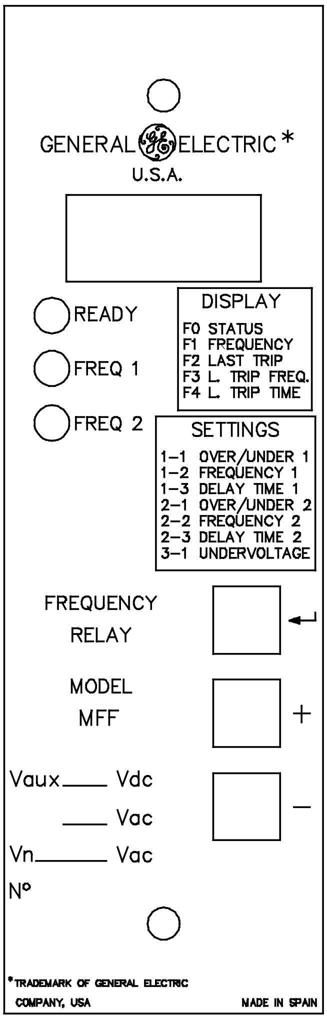


Fig. 6. *Nameplate (301A7412F3)*

6.4. External Signaling

The MFF is provided with three light emitting diode (LED) indicators on the front panel of the relay for signaling the following conditions:

- **READY** : Green LED which indicates that the relay is in operation.
- **FREQ 1**: Red LED which indicates that unit 1 is in tripping condition. The LED will reset as soon as the tripping condition disappears.
- **FREQ 2**: Red LED which indicates that unit 2 is in tripping condition. The LED will reset as soon as the tripping condition disappears.

7. RECEPTION, HANDLING AND STORAGE

This relay is supplied to the customer in a special package, which adequately protects it during transportation, as long as this is performed under normal conditions.

Immediately after receiving the relay, the customer should check whether it shows any signs of transportation damage. If apparently the relay has been damaged due to inappropriate handling, it must be immediately reported in writing to the transportation carrier, and the damage must be reported to the manufacturer.

For unpacking the relay, care should be taken not to lose the screws also supplied in the box.

If you do not intend to install the relay immediately, it is recommended that the relay be stored in its original packaging and kept in a dry, dust-free place.

It is important to check that the data on the identification plate coincides with the data from the order.

8. ACCEPTANCE TESTS

Immediately after receiving the relay, the customer should perform a visual check and perform the acceptance tests in this chapter to ensure the relay has not suffered transportation damage and that the factory calibration has not been altered.

These tests can be performed as installation or acceptance tests in accordance with user criteria. Given that the majority of users utilize different procedures for installation and acceptance tests, this section includes all of the necessary tests that may be performed with these relays.

With the relay disconnected check the alarm and trip relays.

Alarm	A6 - A8	Closed
Relay 1	A7- A8	Open
	A9 - A8	Closed
Relay 2	A10 - A11	Open
	A12 - A11	Closed

Apply auxiliary power to the MFF with a DC voltage connected to terminals A1 and A2 (the voltage depends on the MFF model). Program the MFF with an undervoltage of 60% of the rated voltage, settings 1 and 2 to 59.0 and 58.0 Hz respectively, and any delay time. Apply 110 V with a frequency of 60 Hz. Slowly reduce the frequency until it passes 59.0. At this point the MFF begins to count the delay time and will trip 3 or 4 cycles after the set delay time.

Check that the FREQ 1 led on the front panel of the relay lights up and that the relay contacts are:

Relay 1	A7- A8	Closed
	A9 - A8	Open

Continue reducing the frequency and check that relay 2 trips at the frequency and delay time programmed, lighting the FREQ 2 led on the front panel of the relay and that the relay contacts are:

Relay 2	A10 - A11	Closed
	A12 - A11	Open

Raise the frequency and check that the trips release when they are supposed to.

Repeat the previous steps, but this time do not raise the frequency once the relays have tripped, instead reduce the amplitude of the voltage. Check that the trips release at approximately 60% of the rated voltage. If you increase the amplitude of the voltage the relays will trip again, waiting for the delay time. Once below the undervoltage level the trips are reinitialized.

9. INSTALLATION

9.1. Introduction

The place where the relay is to be installed must be clean, dry, free of dust and vibrations, and well illuminated to facilitate inspection and tests.

The relay must be mounted on a vertical surface. Figure 5 represents the dimensions of the MFF.

The external connection schemes are represented in figure 1.

9.2. Ground Connection for Surge Suppression

The A3 terminal of the relay must be connect to ground so that the disturbance suppression circuits included in the relay may function correctly. This connection must be at least of 2.5 mm diameter wire and be as short as possible to ensure the maximum protection (preferably 25 cm or shorter).

9.3. Tests

Given that the majority of users utilize different procedures for installation tests, the section ACCEPTANCE TESTS includes all of the necessary tests that may be performed as installation tests in accordance with user criteria

If for any reason the tests specified in ACCEPTANCE TESTS **were** not performed, it is recommended that they be performed at the time of installation.

10. PERIODIC TESTS AND MAINTENANCE

Given the important role that protection relays have in any installation, it is recommended that a periodic test program be followed. Given that the intervals between these tests vary for different types of relays and installations as well as the experience of the user performing the tests, it is recommended that the points described in the section INSTALLATION are checked at intervals of 1 to 2 years.