

## GFL-1000 User Manual Ground Fault Locator



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## 1 Declaration of Conformity

This equipment conforms to the relevant requirements of EMC Directive EMC 2004/108/EC. Samples of this equipment have been tested and found to conform to the following standards:

EN50022:2006+A1:2007

EN55024:1998+A1;2001+A2:2003

EN61000-3-2:2006

EN61000-2-3:1995+A1+A2:2005

## 2 Introduction

The GFL – 1000 is designed to locate ground faults in DC bus systems used in a wide variety of applications. The detector works by injecting an AC signal into the bus system with respect to ground using the signal generator. The signal path is then traced using current clamps connected to the signal receiver. The direction of current flow is indicated on the receiver display, enabling the clamps to be moved to another branch or section of wiring. The measurement is repeated, the clamps moved again until the faulty part of the circuit is located. The GFL – 1000 uses sophisticated patented hardware and software measurement and filtering to reduce noise in order to assist and speed up fault tracing, while reducing the possibility of error.

The GFL – 1000 will also detect faults between the bus bars.

The GFL – 1000 will operate at different voltages and frequencies to suit the bus system, and includes self test and calibration system if these are required.



### **Warning!**

Before using Equipment read Safety Precautions carefully.

## 3 Equipment Information

### 3.1 Safety Precautions

The GFL – 1000 generates high voltages and is also connected to high voltage systems. Note the following:

- **When using the equipment Personal Protective Equipment must be worn at all times. In particular, insulating gloves must be worn when connecting test leads. Under no circumstances must test leads, current clamps etc. be handled without insulating gloves.**
- **This equipment must only be used by qualified personnel who must know and comply with all safety and legal regulations related its use. Do not allow children or unqualified personnel to touch or use the equipment.**
  - **A Qualified person is one who is familiar with all aspects of use of the equipment, and understands the relevant safety regulations and requirements. They must be formally qualified to use and carry out work with this equipment.**
- **The equipment (including leads, connection clips, current clamps and other accessories) must not be used if it has been damaged in any way, either by mechanical, electrical or other stress, including environmental such as excessive moisture, temperature extremes etc.**
- **The equipment and its accessories must not be used if they are damp or dirty.**
- **Do not use the equipment in an explosive atmosphere or hazardous area,**
- **There are no user serviceable parts inside the equipment. Opening the equipment will render void any warranty and may render the equipment dangerous and therefore should no longer be used.**
- **The user should become familiar with the equipment and system under test before starting testing.**

### 3.2 Specifications

The GFL – 1000 is designed to work with DC bus systems up to 1000V. Do not connect the equipment to systems with higher voltages.

<b>Output Voltage:</b>	24, 48, 110, 220, 500, 1000 VDC
<b>Output Frequency:</b>	10 Hz
<b>Output Current Limitation:</b>	Selectable between 5 mA and no limit (max: 40 mA)
<b>Fault Location Sensitivity:</b>	$\leq 1 \text{ M}\Omega$
<b>Current Detect Sensitivity:</b>	DC Circuit: $\geq 0.5 \text{ mA}$

<b>Current Clamp:</b>	30 mm (Maximum cable diameter)
<b>Current Sensor:</b>	φ8 and φ20
<b>Jaw Opening:</b>	60 mm (2.36 in)
<b>Display:</b>	Backlit Color LCD
<b>Operating Environment:</b>	Temperature: -5 – 40 °C (23 – 104 °F)
<b>Power Requirements:</b>	Built in Li-ion Batteries with supplied Chargers
<b>Dimensions:</b>	430 x 350 x 135 mm (17 x 13.7 x 5.3 in)
<b>Weight:</b>	7 kg (15.4 lbs)

### 3.3 GFL – 1000 Equipment List

The GFL – 1000 consists of the following parts:

**Carrying Case with built in Signal Generator**

**Signal Receiver**

**Qty. (2) Dual-Range Current Detector**

**Qty. (2) Signal Testing Leads (one black, one red)**

**Qty. (2) Alligator Clips for test leads (one black, one red)**

**Punctuation Clip**

**Qty. (2) 120/220 50/60 Hz Battery Chargers**

**Qty. (2) Supply cables for Chargers**

**Signal Receiver USB Cable (for Firmware update)**

**Memory Stick containing Instructions, Firmware updates etc.**

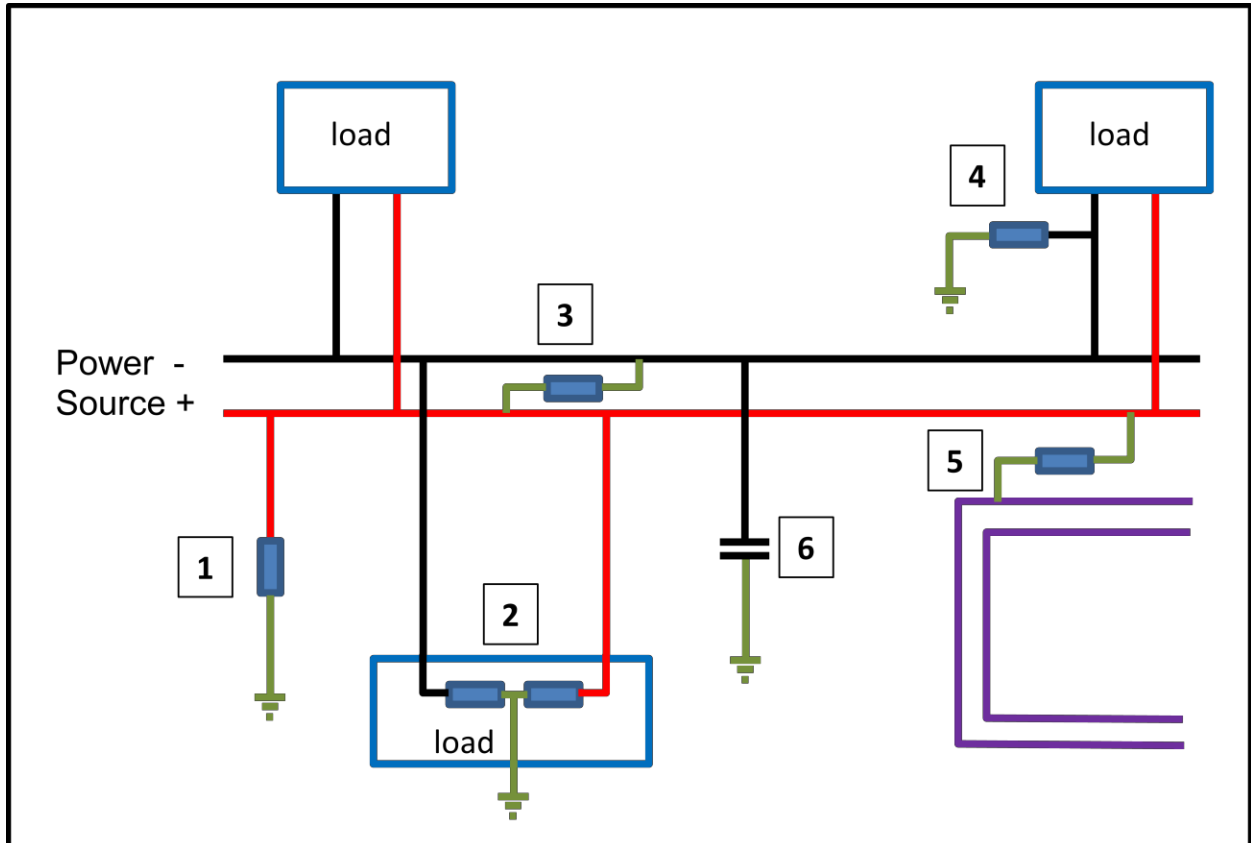
**Carrying strap with two strap adjusters and two fixing plates\***

If any of these parts are missing please contact the supplier of the equipment.

\*The plates slot into positions at the sides of the case to enable the strap to be attached.

### 3.4 Typical Applications

A typical supply to be tested will consist of a main bus connection with many branches to different loads or systems. Figure 3-1 shows a simplified circuit with loads connected via branches. Typical faults are also shown:



**Figure 3-1 Power Circuit showing Possible Faults**

1. Fault from the positive bus to ground.
2. Fault from part of a load to ground
3. Fault between bus bars (partial short circuit)
4. Fault from a branch to ground
5. Fault from bus to a separate circuit ('Wire Mix' connection).

6. Leakage capacitance. This is not a fault, but leakage capacitance may be distributed around the system and will influence measurement (see Section 5.6.1)

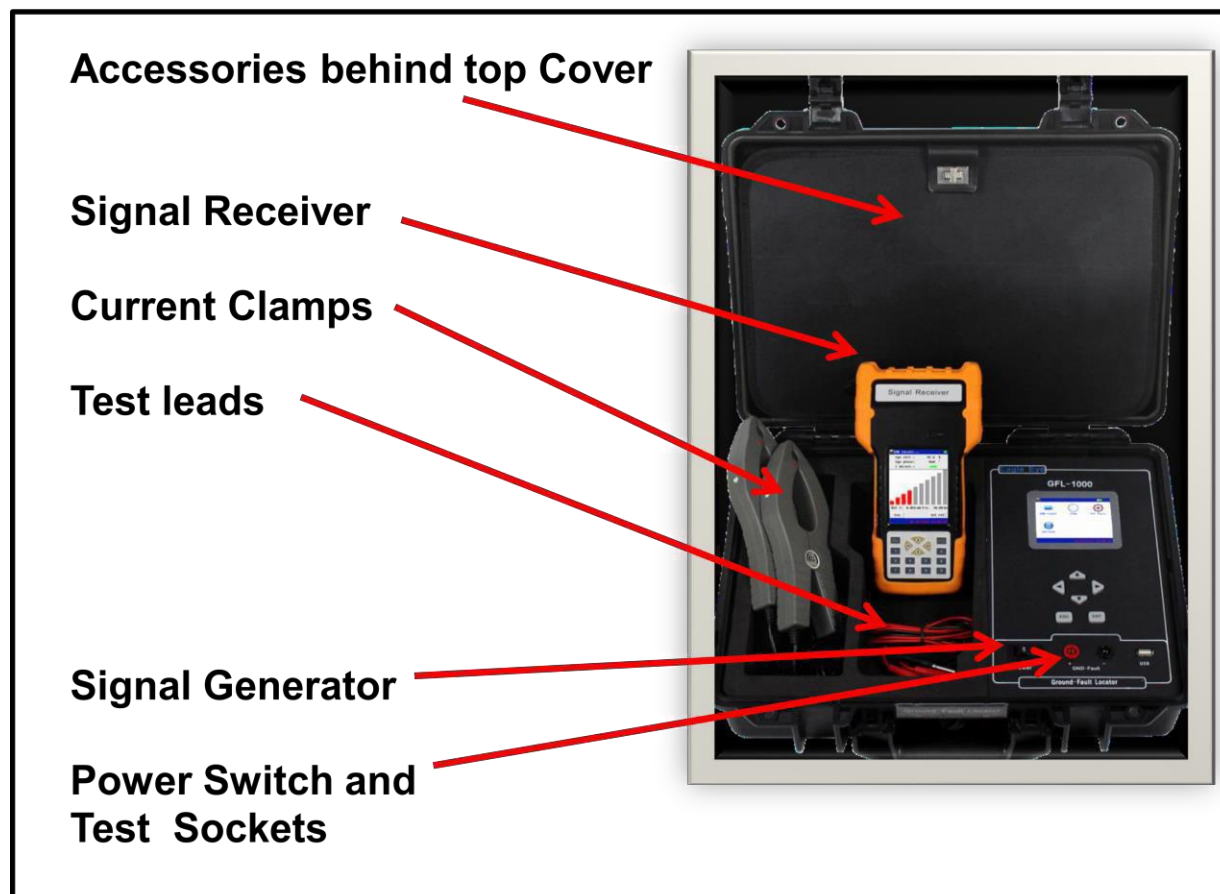
In all cases, the actual impedance (resistance) of the fault may be very high, very low due to a short circuit, or anywhere in between.

## 4 Getting Started



### **Danger!**

High Voltages may be present on System under test. Follow Safety Precautions.



**Figure 4-1 GFL - 1000 Equipment**



Remove the Signal Receiver from the case. Switch it on using the slide switch on the left side of the unit. Check that the display is lights and the battery is charged. The state of charge is indicated by the icon in the top right hand corner of the display. If necessary, charge the battery by connecting the smaller power supply for the Signal Receiver to the DC supply connection at the base of the receiver.

The Signal Generator in the main case can be switched on using the power switch on the front panel. The state of charge is indicated by the icon in the top right hand corner of the display. It may be charged using the larger power supply which plugs into the right hand side of the case.

Both units may be charged while switched off. When the units are fully charged the indicator on the power supply changes from red to green.

The batteries will last for approximately 4 hours in normal use.

## 4.1 Navigation

There are several ways to navigate through the menus. In all cases **Ent** or **Enter** will carry out the action, while **Esc** will go to the previous screen.

On the Signal Generator, use the arrows to move around the screen or change values.

On the Signal Receiver, the screen is touch sensitive and selections may be made using fingers or (more easily) the stylus provided at the top back of the unit. The keypad may also be used, and the buttons at the side duplicate the up, down, enter and escape functions. Be sure to remove the protective transparent screen cover for best visibility and touch performance.



**Figure 4-2 Signal Receiver**

Switch off the unit before making further connections.

Plug in the test leads to the sockets on the front of the Signal Generator. Connect the red lead to the red socket marked (+) and the black lead to the black socket marked (-). Ensure these are correctly connected. Fit the alligator clips to the end of the leads. Note that one of the clips includes an insulation piecing point.

Plug in the current clamps to the connection at the top of Signal Receiver.

## **4.2 Setting Up the Signal Generator**

### **4.2.1 DC Systems**

Determine which bus (i.e. positive or negative) has a fault by connecting a multimeter, set to measure DC volts, between ground and each bus in turn. Generally the fault will be on the bus which gives the lowest voltage reading.

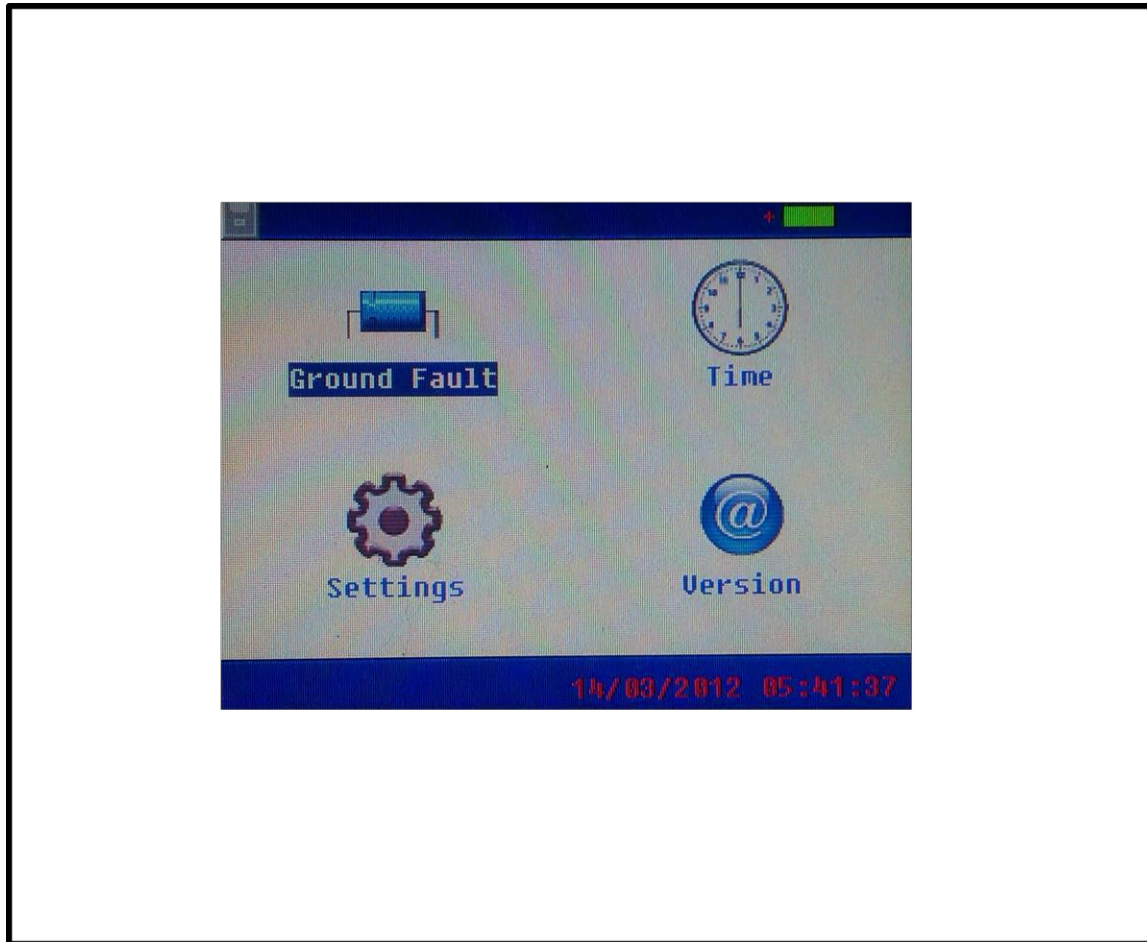
### **4.2.2 Connecting Up**

Now connect the signal generator to the faulty bus.

If the positive bus appears faulty, connect the positive (red lead and connector) to that bus, and the negative (black lead and connector) to ground.

If the negative bus is faulty, connect the negative lead to it, and connect the positive lead to ground.

Switch the unit on at the power switch.



**Figure 4-3 Signal Generator Start up Menu**

On the main screen (see Figure 4-3), select **GND-Fault** using the arrow keys until it is highlighted; then press **ENT**. The next screen will allow the output signal to be adjusted, see Figure 4-4.



**Figure 4-4 Voltage and Current Limit Settings**

#### **4.2.3 Setting the Output Voltage and Current Limit**

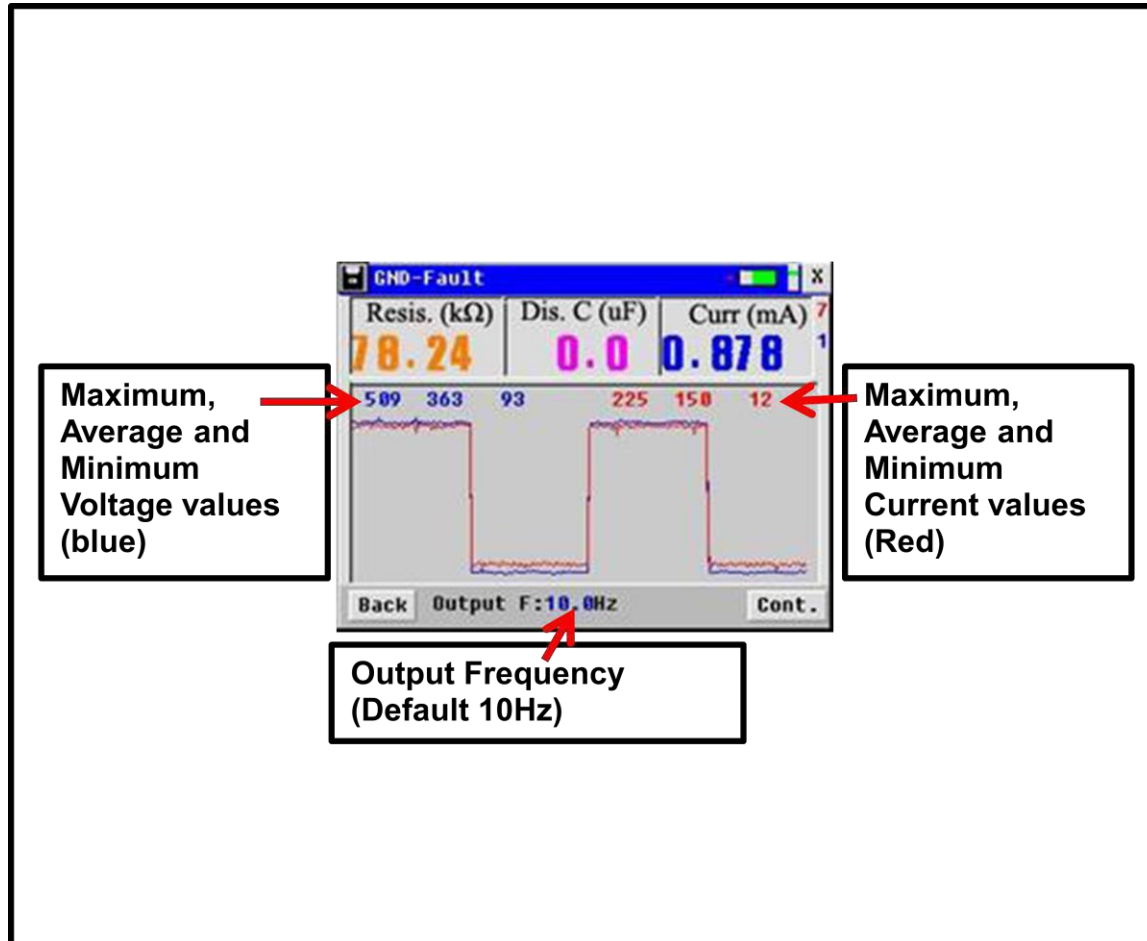
Set the output voltage and current limit by highlighting the appropriate value using the left and right arrow keys, adjusting the value using the up down arrow keys, pressing **ENT** again to save to value. Use the arrow keys to move to the next value, or to the **Back** or **Next** buttons as required.

Select the output voltage to best suit the voltage of the system under test. For example, if the system operates at 100V DC, choose an output voltage of 110V. Settings of 24V, 48V, 110V, 220V, 500V, and 1000V are available.

The current limit should be used only where high levels of current may cause alarms or protection systems to be triggered. For example, railway signaling systems may indicate an alarm if leakage current – or injected current from the signal generator in this case – exceeds 5mA. In this case the current limit should be set to 5mA. If no earth fault

detection systems are present, set the current limit to **UL**, which will in any case limit the output power to about 5W or 40mA, whichever is less.

Select **Next** to continue. The signal generator will operate and a screen similar to that shown in Figure 4-5 will appear. The generator will briefly produce an output in order to measure the system impedance.



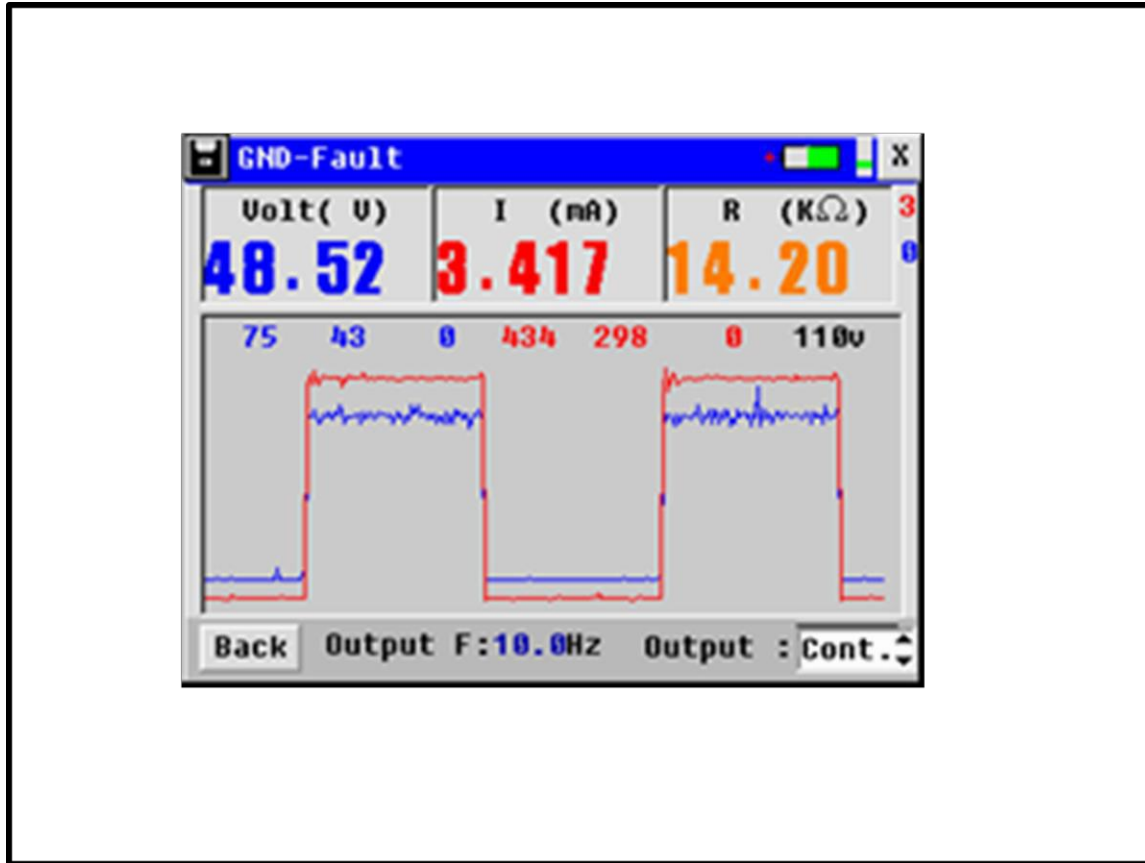
**Figure 4-5 Signal Generator Initial Output**

The display shows the signal generator voltage and current waveforms, together with calculated values of fault current, resistance and leakage capacitance.

Press **Cont.** The screen shown in Figure 4-4 will be shown again.

The output voltage may have been reduced automatically to limit the output current. If the output current is too low, the output voltage may have been increased.

If **Next** is pressed, the generator will produce an output and the screen shown in Figure 4-6 will appear.

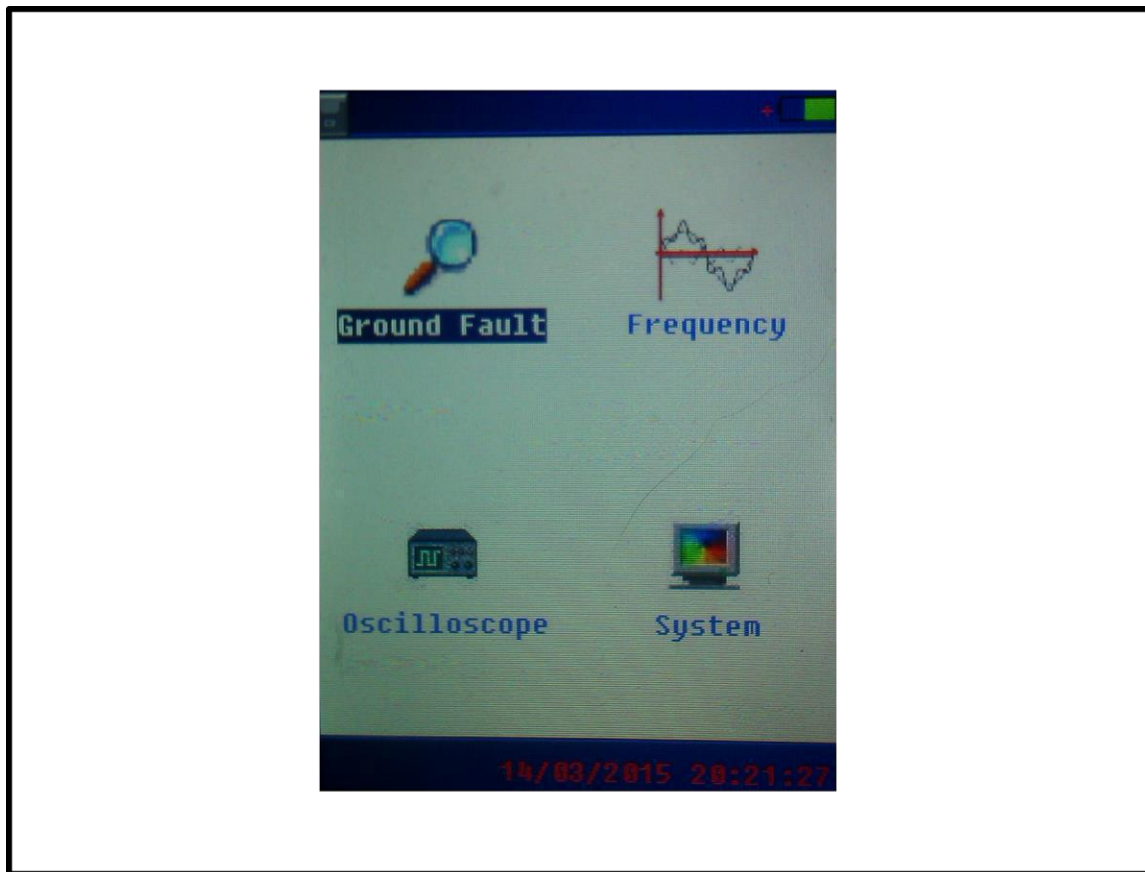


**Figure 4-6 Signal Generator Output**

The signal generator is now producing a continuous output voltage and current which is displayed on the screen. A discontinuous (pulsed) output may be selected if desired by changing the setting **Cont.** in the bottom right hand corner of the screen. If a discontinuous (**Disc.**) output is selected, the output will be pulsed on and off at roughly half second intervals.

### 4.3 Setting up the Signal Receiver

Switch on the unit and select **GND-Fault** from the initial signal receiver screen (Figure 4-7). The green light above the screen should flash every second or so. This indicates normal operation.



**Figure 4-7 Signal Receiver Starting Screen**

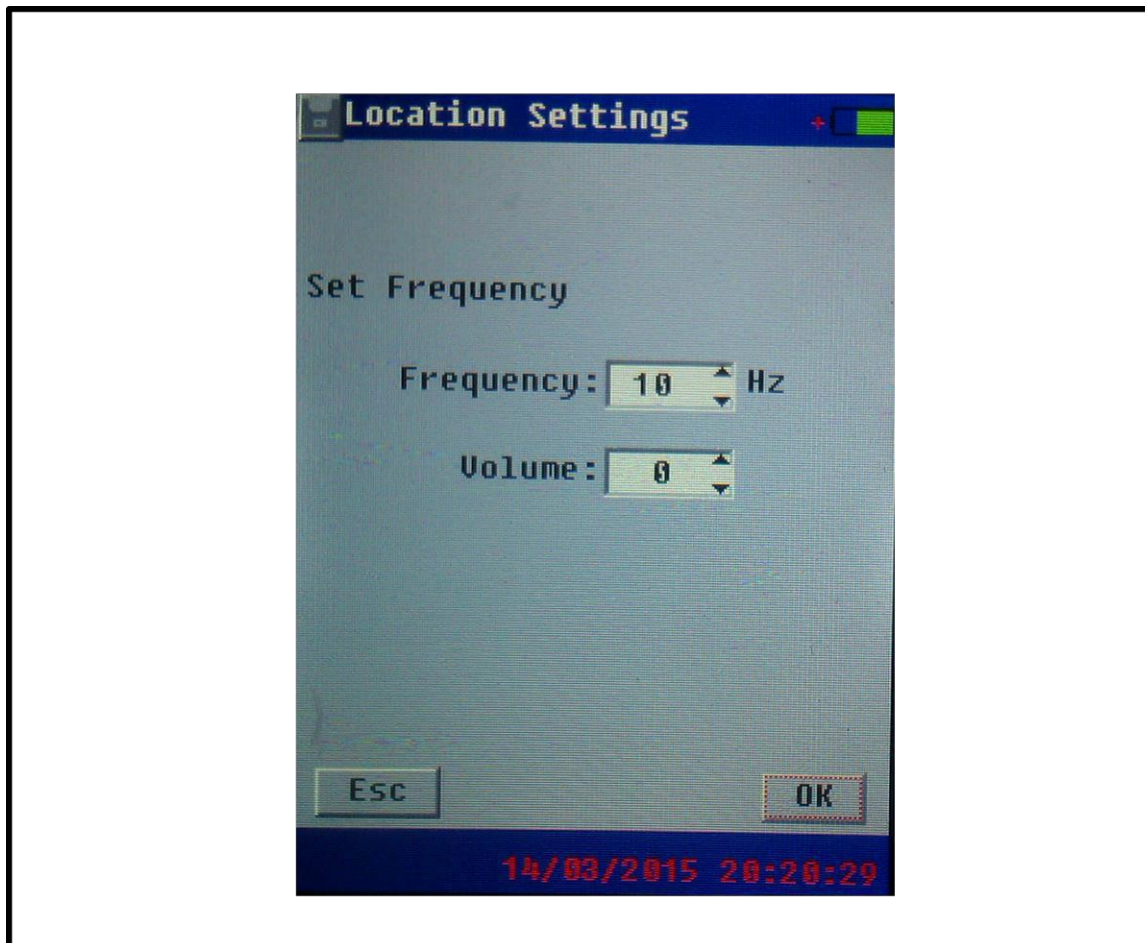
#### **4.3.1 Setting the Frequency and Audio Indicator.**

The screen shown in Figure 4-8 appears when **GND-Fault** is selected in the previous screen. The receiver frequency is fixed at 10Hz, so this cannot be changed

An audio indicator can be set to assist fault tracing. The level at which the audio sounds a 'beep' is set in the location setting screen (Figure 4-8),

If, for example, the Audio indicator is set to 4, the 'beep' will sound if a value above 40% of the reference value is detected. This can be useful during fault tracing. Set the audio values based on experience with the circuit under test, or begin with a value such as 4. Once the Audio value has been set, selecting **OK** on the screen in Figure 4-8.





**Figure 4-8 Location Setting Screen**

#### **4.3.2 Setting the Reference**

Ensure the output of the Signal Generator has been set to continuous (**Cont**). Check that there is current flowing from the signal generator by noting the reading on the screen. A zero current reading indicates an open circuit and will give faulty indication subsequently.

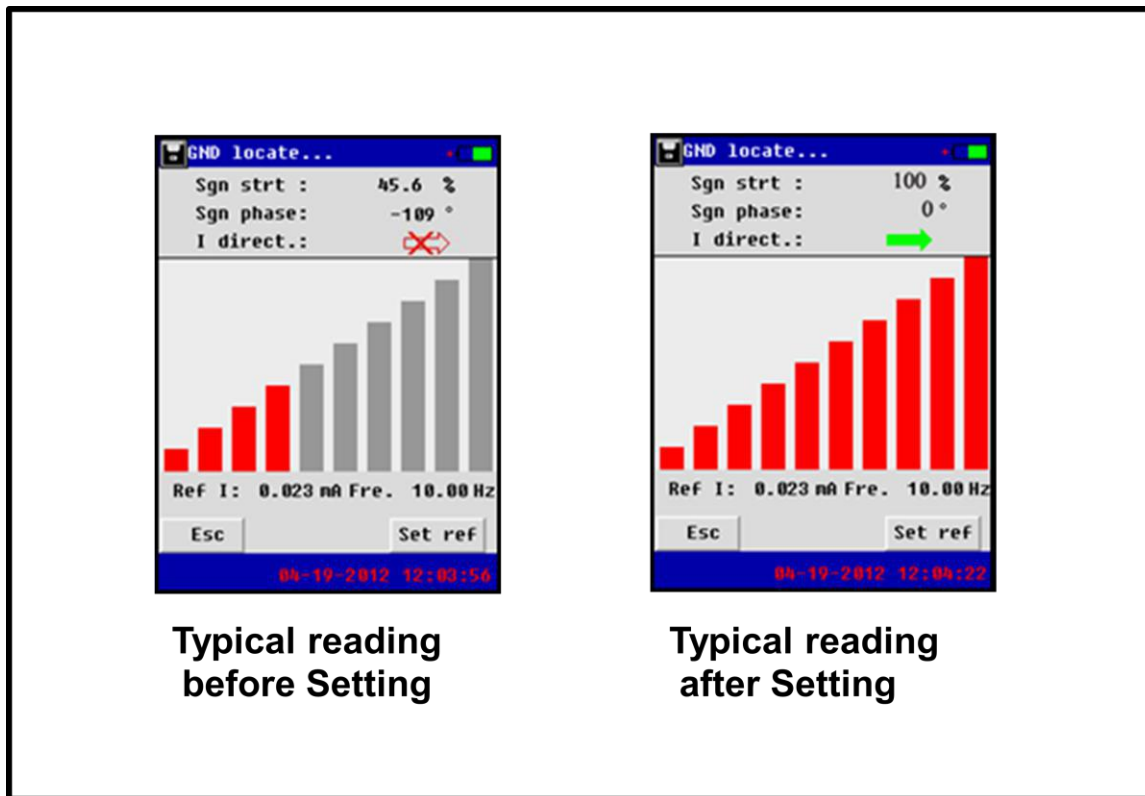
Clip one of the current clamps around the positive voltage lead from the signal generator with the arrow pointing in the direction of current flow; i.e. away from positive as shown in Figure 4-9. The current clamp has large and small positions for large and small cables and bus bars. Use the smaller position where possible to reduce interference.



**Figure 4-9 Current Clamp Position for Reference Calibration**

Allow the measurement to stabilize for five seconds, then select **Set ref** on the signal receiver screen. The display will state **Setting Ref...** and after a few seconds will indicate **Setting Done!** All subsequent measurements will now be referenced to this Signal Generator output value, defined as 100%.

Figure 4-10 shows a typical reading in the signal receiver display before and after the Reference is set. The more red bars, the greater the signal strength. The reference may be reset at any time.



**Figure 4-10 Setting the Reference**

## 5 Tracing the Fault



### **Danger!**

High Voltages may be present on System under test. Follow Safety Precautions.

### 5.1 Basic Principles

The Signal Generator is producing an AC voltage at a frequency that the Signal Receiver is sensitive to. If there is a fault in the circuit, there will be a current flow that will be detected by the current clamp. When two current clamps are used the difference in the current will be measured and displayed. This, in conjunction with built in filtering,

helps to reject noise and interference. Stray capacitance in the system will permit a small current to flow; filtering will also minimize the effect of this.

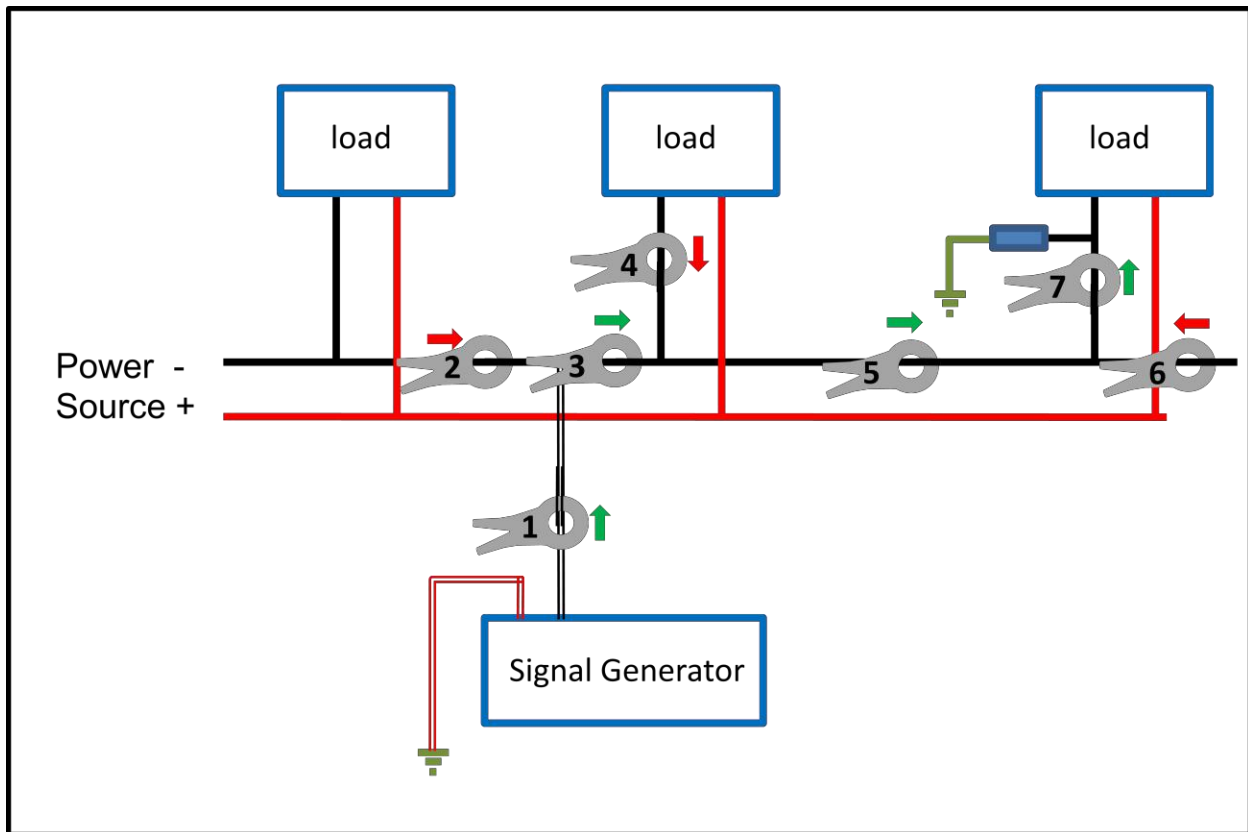
The direction of current flow in Figure 4-10 (**I direct.:**) is shown with reference to the arrow on the current clamp. That is, if the current flow (and therefore the fault current) is in the direction of the arrow on the current clamp, a green arrow pointing to the right will be shown. The red arrow indicates no significant signal is detected. Allow a few seconds for the reading to stabilize after fitting the clamp.

## 5.2 Tracing a ground fault

The Signal Generator should be connected to the system under test as described in Section 4.2.3. The fault is traced by following the current from the signal generator through the wiring system until the faulty branch is located. Figure 5-1 shows how a fault can be traced by moving the clamp by following the green arrow, until the faulty branch is isolated.

In Figure 5-1, the first clamp position (1) the arrow on the display indicates that the current flow – and therefore the fault current, is present in this branch of the circuit. Therefore, the clamp is moved to the next position (2). Here the arrow indicates the fault current isn't present here, so clamp is moved to position (3) and so on until the faulty branch is isolated at position 7.

It is not necessary to separate positive and negative cables; the clamp may be placed around several cables during the fault tracing process.



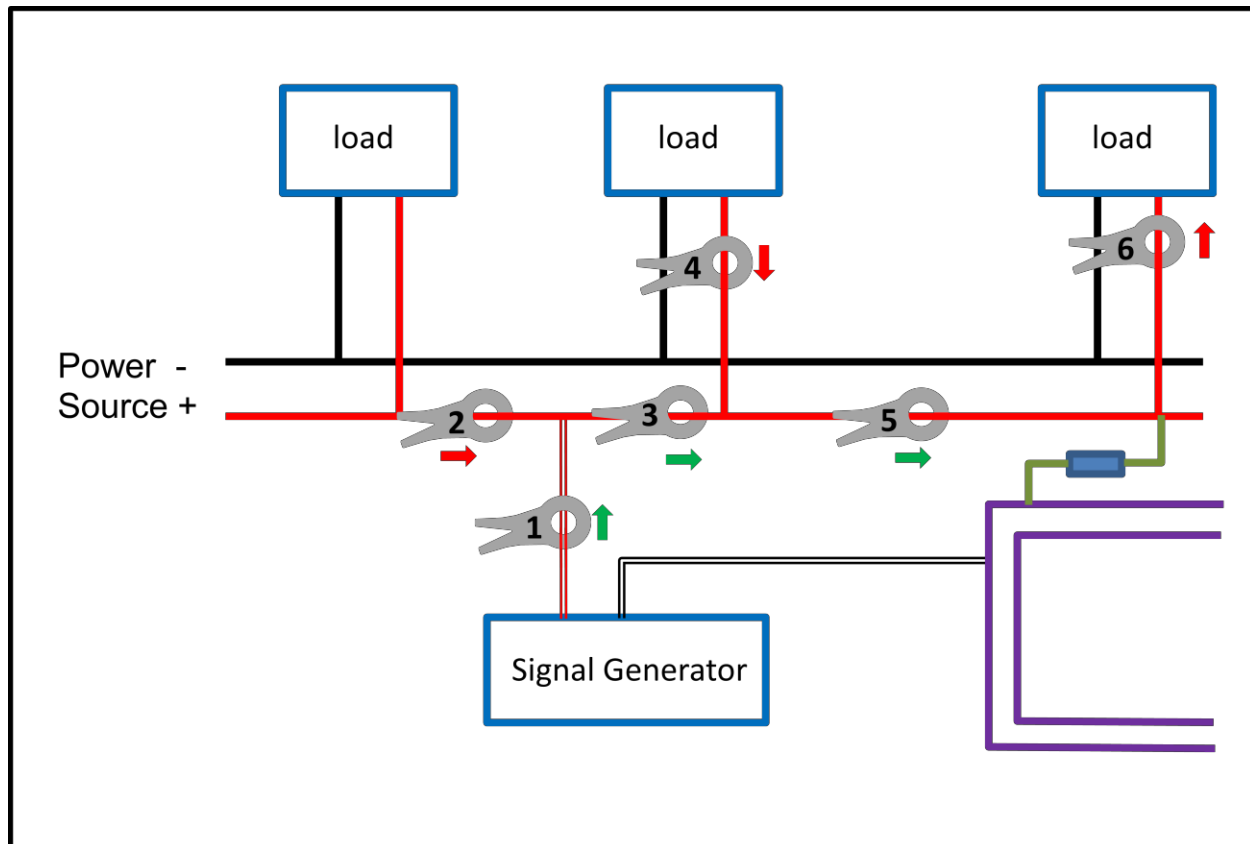
**Figure 5-1 Tracing a Ground Fault**

### 5.3 Tracing 'Wire Mix' faults

Where a fault has occurred between two separate, otherwise isolated circuits, the signal generator may be connected between the two circuits and the fault traced in a similar way to a ground fault.

Use a multimeter as described previously to identify which parts of the circuit have the lowest voltage between them, and connect the signal generator to these two cables.

Figure 5-2 shows the tracing sequence.

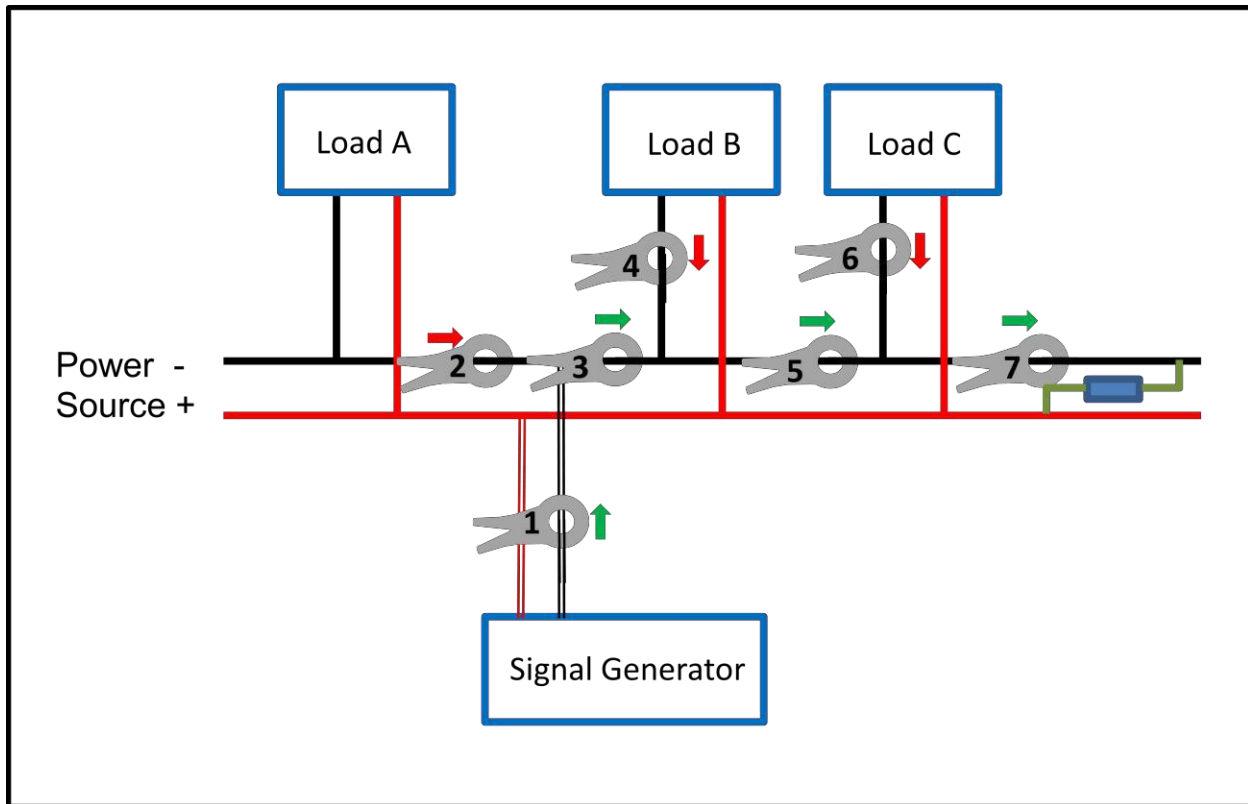


**Figure 5-2 Tracing a 'Wire Mix' Fault**

## 5.4 Tracing Partial Short Circuits

Short circuits between the main power connections will cause protection circuits to open. However, a partial short may cause unwanted battery discharge and other problems. It may be traced in the same way as other faults, but the signal generator must be connected to the two connections that show the partial short. The trace signal will now flow through the partial short circuit, as well as any other existing loads, making tracing difficult if loads cannot be disconnected.

In Figure 5-3, the signal generator has been connected across the main bus bars, and the fault traced as before. However, it will be necessary to disconnect the loads in turn to get a valid reading. That is, load A must be disconnected when reading #2 is made; then the fault at the other end of the bus bar will show accordingly. When readings #4 and #6 are attempted, a red indication, indicating the fault is not in this branch, will only show if Load B and Load C respectively are disconnected.

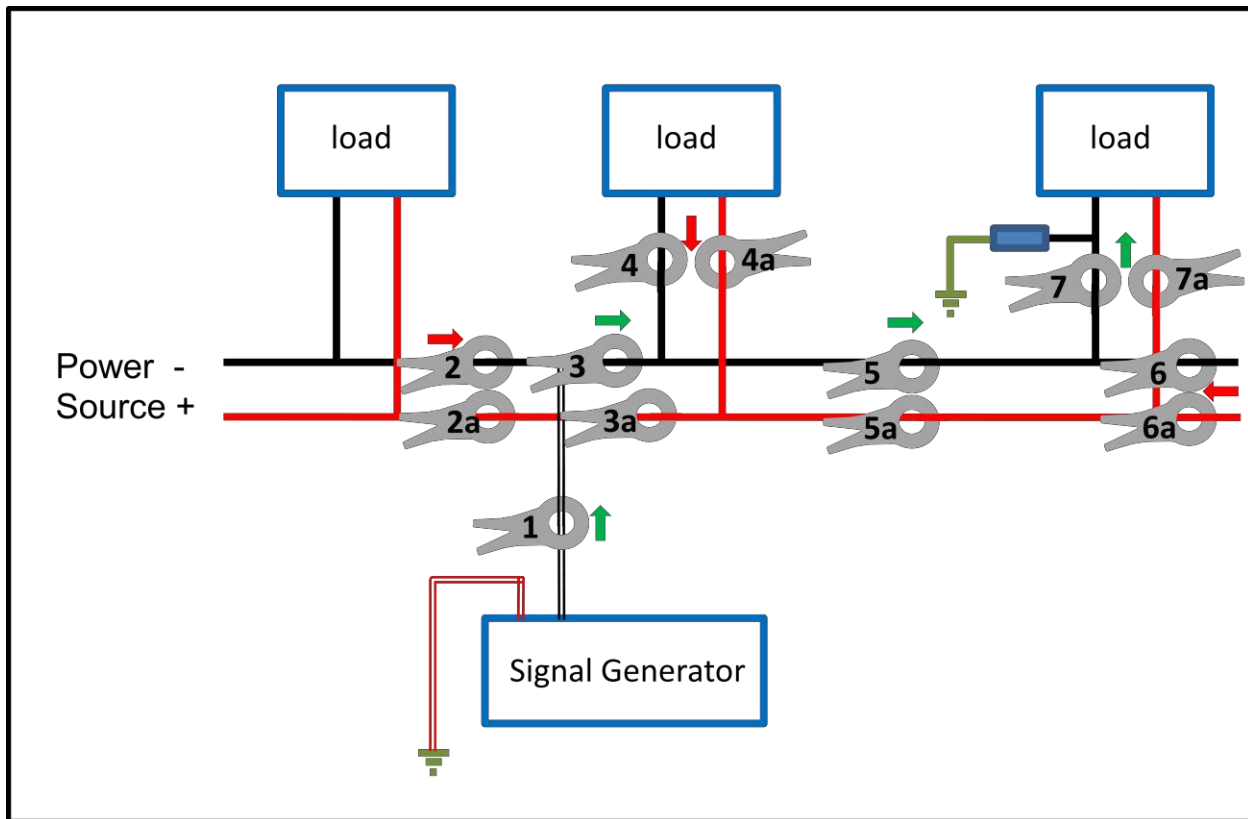


**Figure 5-3 Tracing a Partial Short Circuit**

Note that in all cases it is not necessary to check individual wires. Cable bundles feeding cabinets or equipment may be checked with one measurement and eliminated or traced in more detail as required.

## 5.5 Using Two Current Clamps

The Signal Receiver is provided with two identical current clamps. Either clamp may be used to trace the signal from the Signal Generator by applying the clamp around as many or as few conductors as convenient. However, in systems that exhibit a high level of interference, it is recommended if possible, to either use a single clamp around both main bus bars and cables, or to use both clamps one around each busbar. This will cancel system noise and make tracing the signal from the generator easier. This is shown in Figure 5-4, where two clamps are used (except for the first measurement) and the fault is traced in the same way as before in Figure 5-1.



**Figure 5-4 Tracing a Ground Fault using Two Clamps**

## 5.6 Factors Affecting Fault Tracing.

### 5.6.1 Distributed Capacitance.

Wherever cables run close together there is a significant capacitance which allows a leakage current to flow when AC voltage is present. Leakage capacitance is always present and does not represent a fault condition. The current that flows through the capacitance is out of phase with the resistive (i.e. fault) current and is therefore rejected by the signal receiver. Leakage capacitance is measured by the GFL – 1000 and the value shown in the display.

### 5.6.2 System Noise and Interference

Many systems will contain considerable interference from equipment that is operating. The GFL – 1000 will usually reject this noise by selective filtering. A Spectrum Analyzer is available in the Signal Receiver to help identify levels and frequencies that may cause problems, see Section 7.1.



## 5.7 Hints and Tips

### 5.7.1 Resetting the Reference value

If the signal becomes weaker during tracing, the signal reference can be reset at any point, by setting the reference as described in Section 4.3.2 but with the current clamp at the point of weak signal. That signal will become the new reference value, as shown in Figure 4-10. Ensure however, that the signal at that point is a true signal before resetting the reference.

### 5.7.2 Using more than one Signal Receiver

More than one signal receiver may be used at the same time during tracing. Ensure all Signal Generators have the reference value set (See Section 4.3.2) before starting.

### 5.7.3 Voltage, Current and Selection

As stated in Section 4.2.4, the generator output voltage and current can be changed to facilitate tracing. The voltage may be increased or decreased to vary the output current to improve sensitivity, and the output current limit adjusted as required.

## 6 Signal Generator Additional Functions

### 6.1 Setting the Date and Time

Select **Time** in the main menu. Adjust the date (Day **D** Month **M** Year **Y**) and time (Hours **H** Minutes **M** Seconds **S**) as required. Use the **Ent** button to move from one window to the next and the up and down arrows to change the value. Select **Save** and press **Ent** to confirm.

### 6.2 Settings

The Settings menu allows selection of **Basic** and **Pro** Functions. It is not necessary to select the **Pro** function for normal use.

### 6.3 Version

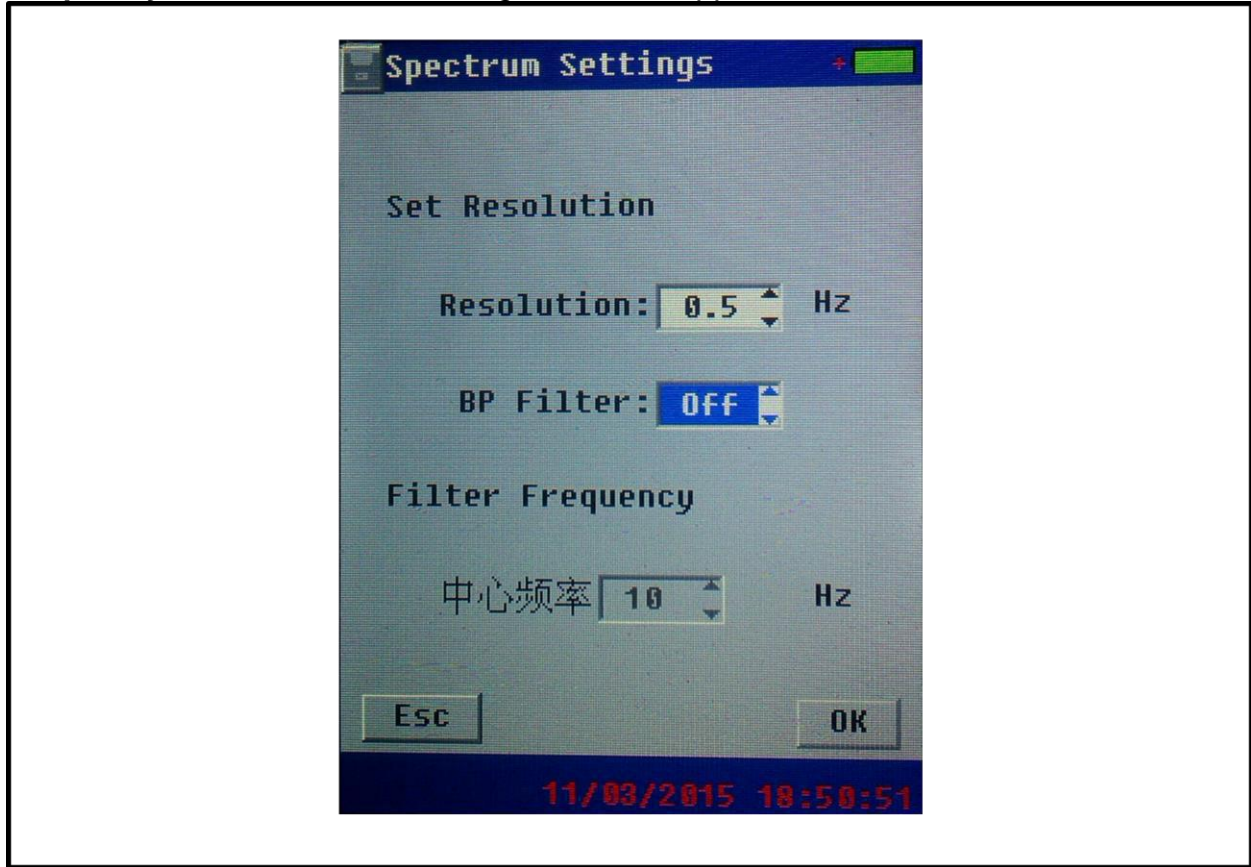
The version of firmware can be read here. Firmware updates can be provided if required. Please contact Eagle Eye for more information.

# 7 Signal Receiver Additional Functions

## 7.1 Spectrum Analyzer

The spectrum analyzer function displays the range and magnitude of the frequencies present in the system under test. It may be used to identify sources of interference, which may then be isolated to facilitate signal tracing.

The Spectrum Analyzer function is selected from the main menu by selecting **Frequency**. The menu shown in Figure 7-1 will appear.



**Figure 7-1 Spectrum Analyzer Settings**

### 7.1.1 Resolution

Setting the resolution of the analyzer also sets the maximum frequency of the analyzer. The maximum frequency is 100 times the resolution setting, that is:

Resolution (Hz)	Maximum Frequency (Hz)
0.5	50
1	100

5	500
10	1000
25	2500

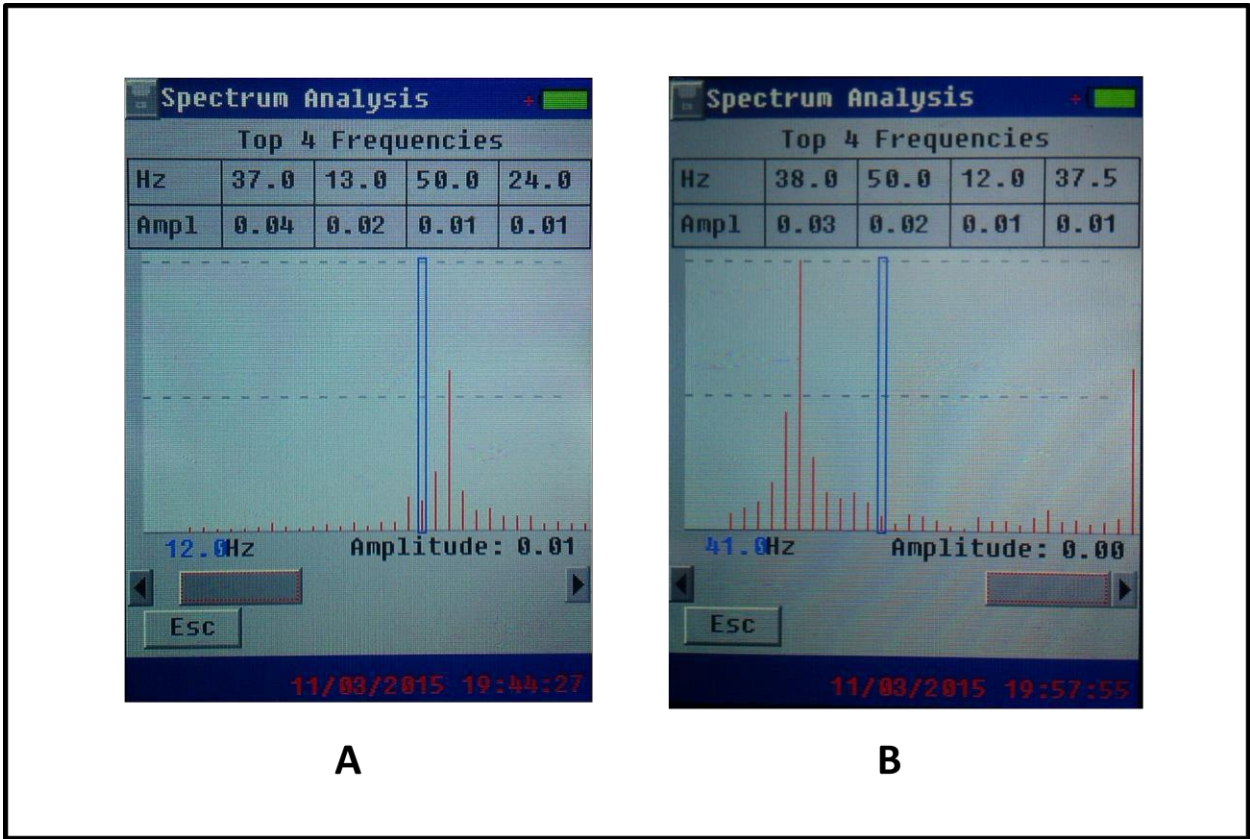
For initial use, use the 0.5Hz setting as this will allow analysis of frequencies around the Signal Generator frequency of 10Hz.

### 7.1.2 BP (Band Pass) Filter

The band pass filter can be enabled to remove interference. The frequency is fixed at 10Hz to suit the Signal Generator frequency. Switch on the band pass filter if there is significant interference when using the Spectrum Analyzer.

### 7.1.3 Spectrum Analysis

Press **OK** and the Spectrum Analysis screen will be displayed, shown in Figure 7-2. The blue cursor on the screen may be moved using the stylus or by touch, and the value of the frequency at the cursor is displayed in blue. The drag bar at the bottom of the screen varies the portion of the full range under analysis to be displayed. At the top of the screen, the four frequencies with the highest amplitude are listed.

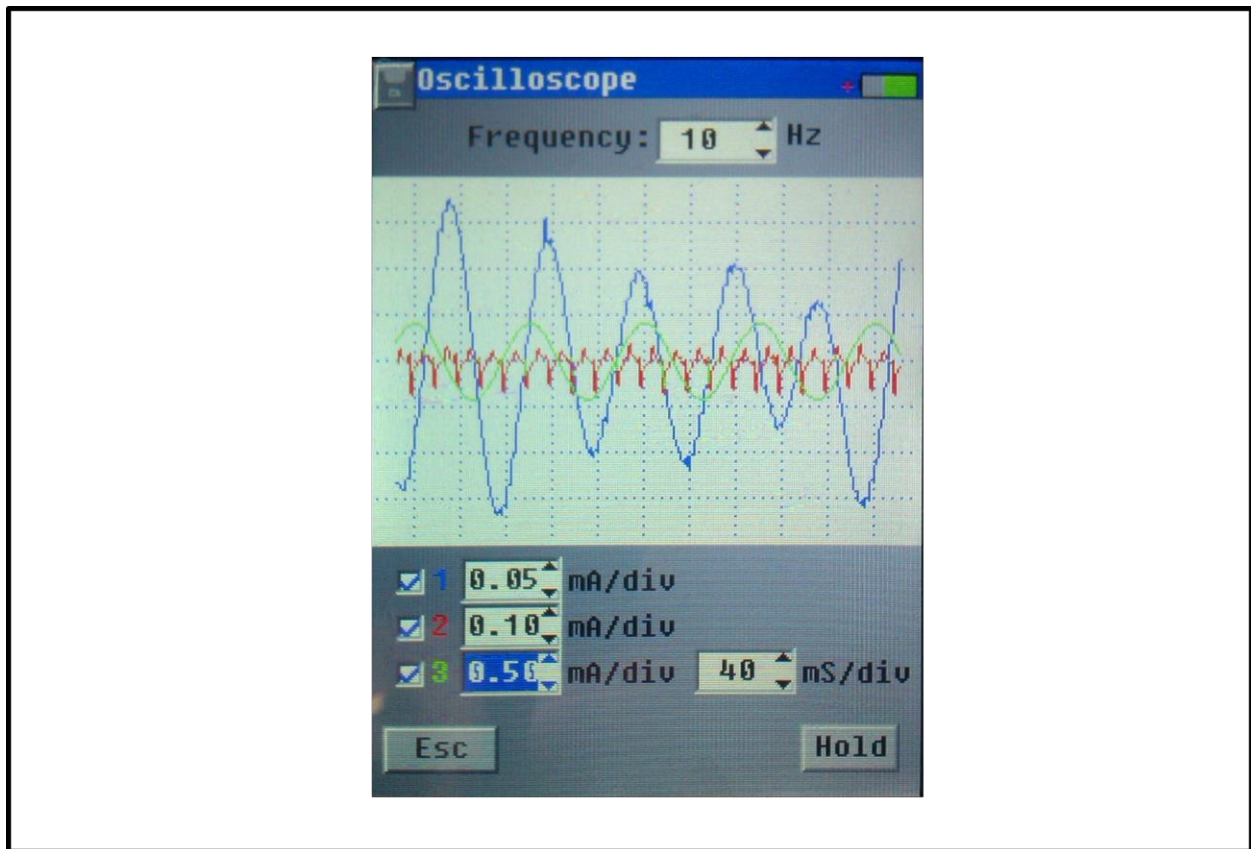


**Figure 7-2 Spectrum Analyzer Displays**

In Figure 7-2A, the cursor is set at 12Hz, and the high value of the 13Hz peak can be seen. The drag bar is showing a frequency range of about 3.5Hz to 17Hz, from full range of 0 to 50Hz. Figure 7-2B, the cursor is set to 41Hz, and the drag bar is displaying 35 to 50 Hz.

## 7.2 Oscilloscope

The oscilloscope function may prove useful for monitoring, measuring, and checking signals on the system under test. Select **Oscilloscope** in the main menu and the screen shown in Figure 7-3 will appear.



**Figure 7-3 Oscilloscope Function**

Three channels are provided. These can be enabled by checking the boxes labelled 1, 2 and 3. The range of each channel can be changed in the boxes to the right of the channel numbers. The time per division can be changed in the same way.

Channel 1 (blue) displays the signal filtered by the band pass filter.

Channel 2 (red) displays the unfiltered signal

Channel 3 (green) displays the synchronization signal.

The **Hold** button will capture the display as viewed, and **Run** will release the hold function.

The frequency indicated above the display shows the frequency of the Signal Receiver and cannot be changed.

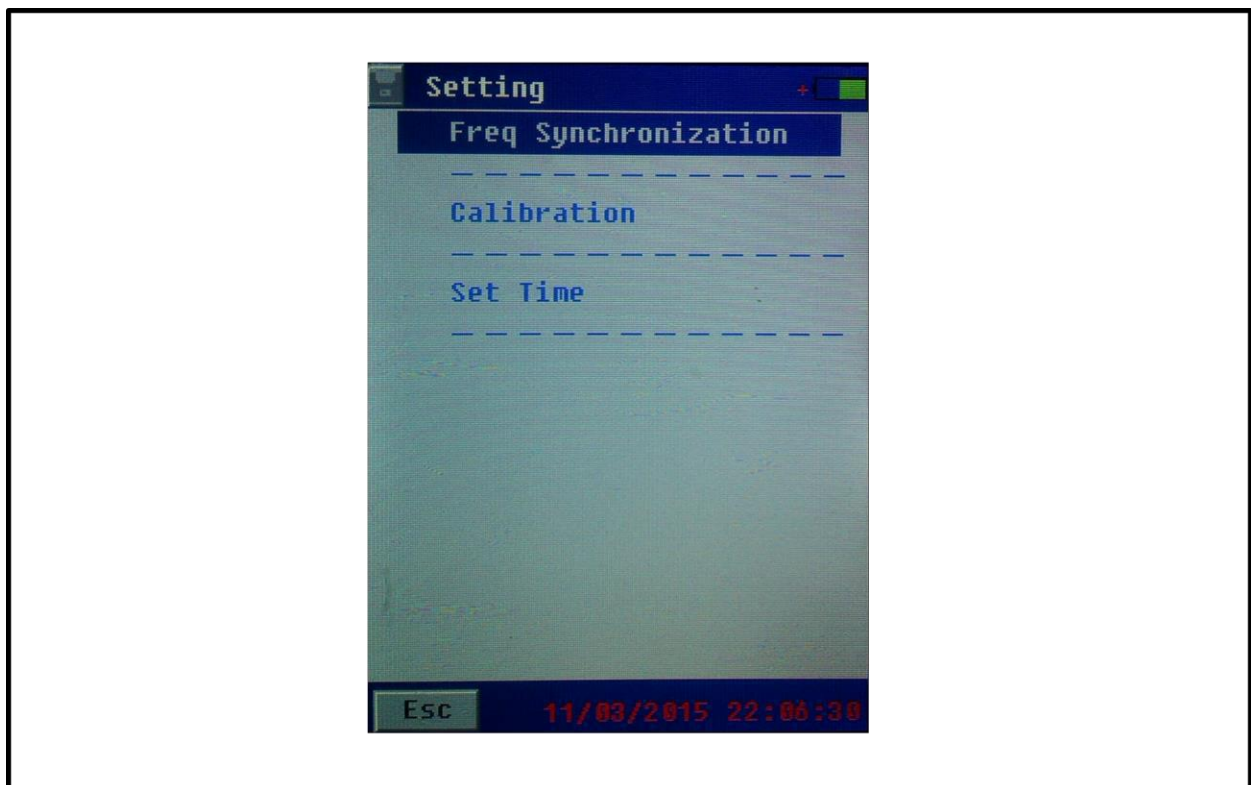
## 7.3 System

Selecting System in the main menu will lead to a second screen with the choice of **Setting** or **Version**.

### 7.3.1 Version

The version of firmware can be read here. Firmware updates can be provided if required. Please contact Eagle Eye for more information.

Selecting **Setting** will lead to the screen shown in Figure 7-4.



**Figure 7-4 Setting Screen**

### 7.3.2 Calibration

Calibration requires a code to enter and additional information to use. Please contact Eagle Eye if you believe your Signal Receiver requires calibration.

### 7.3.3 Set Time

The time and date can be set in the Signal Receiver in a similar way to the settings in the Signal Generator as described in Section 6.1.



### 7.3.4 Frequency Synchronization

The Signal Receiver is synchronized to the Generator during factory set up, so it should not be necessary to carry out synchronization in normal use. However, this can be carried out if exceptional phase shift is noted, which will affect the sensitivity of the measurements.

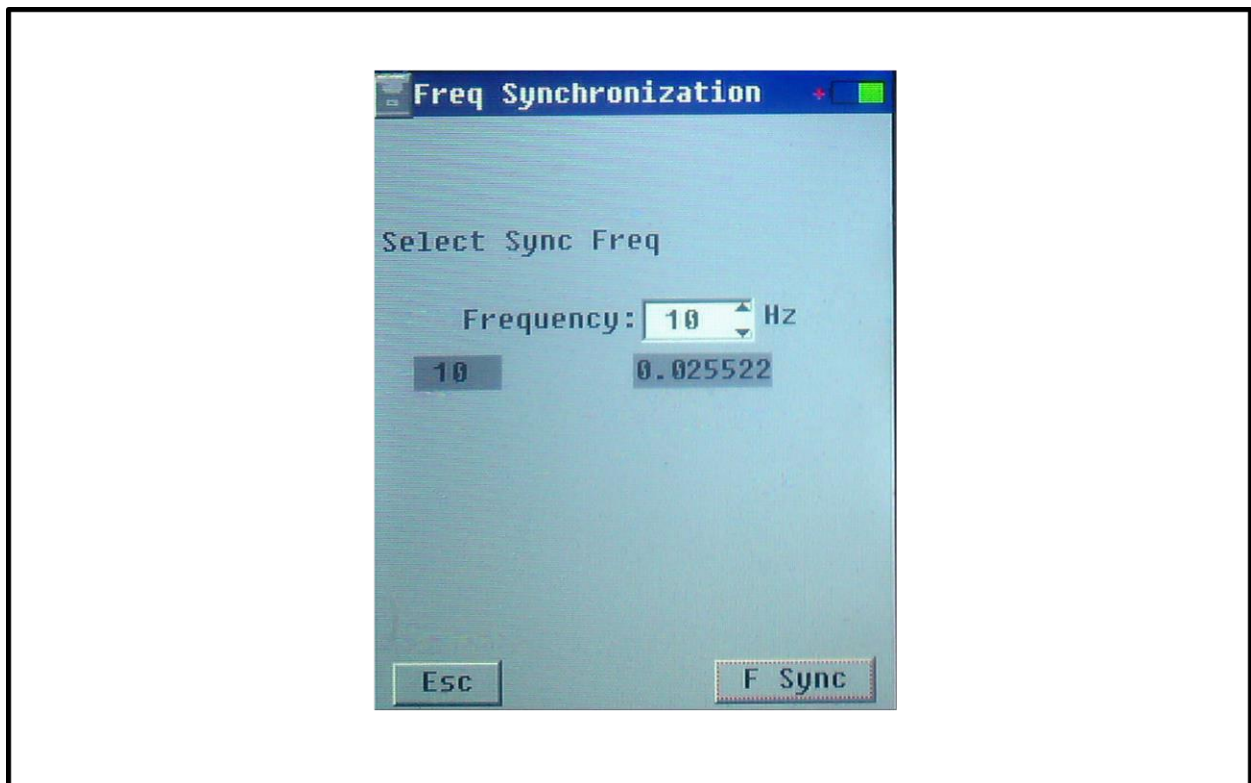
To synchronize the generator and receiver, switch on both units and allow them to stabilize. This should take about 20 minutes.

Connect the Signal Generator outputs together, and select an output voltage of 48V (see Section 4.2.4). Do not set a higher voltage as this may damage the generator.

Clamp the current clamp around the cable as shown in Figure 4-9 . Avoid moving the clamp during synchronization.

From the main screen of the Signal Generator, select **System**, then **Setting**, then **Freq Synchronization**

The screen shown in Figure 7-5 will appear.



**Figure 7-5 Synchronization Screen**

The frequency of 10Hz is not adjustable on this variant, so press **F Sync** to start synchronization. The Receiver will step through several screens, (see Figure 7-6) including a 240 second synchronization process. The final screen will show **Syn Done!**, (not **Setting Done**) indicating that synchronization is complete.



**Figure 7-6 Synchronization Steps**

## 8 Troubleshooting

Always check first that the batteries are fully charged and the units are switched on.



## 8.1 Checking the Signal Generator

The Signal Generator can be checked by repeating the steps described in Section 4.2. If the Generator is functioning correctly, a display similar to that shown in Figure 4-6 will indicate a square waveform. The current will be limited to about 6.5mA if a 5mA current limit is set.

## 8.2 Checking the Signal Receiver

The signal receiver can be checked in a similar manner. With the Signal Generator operating as described in Section 4.3, fit the current clamp around the cable as shown in Figure 4-9. If the receiver operating correctly, it will detect and display the signals (using ground fault, Spectrum Analyzer or Oscilloscope functions) produced by the generator.

## 8.3 Problems during Use

The following table describes problems encountered in general use. Possible Causes and Solutions are indicated.

Description	Causes	Solutions
Signal strength and phase angle in signal receiver periodically displays high or low.	Signal display of signal generator is set to "Discontinuous" mode.	Change to "Continuous" mode.
	Signal is too weak	Increase output voltage
	The current clamp is not properly closed	Check the clamp is closed by pressing the jaws together; check that the mating faces are clean.
	The reference value has been set when no current is flowing or the clamp is not properly closed.	Clamp the current detector in the circuit and make sure that the signal generator is transmitting signal properly, then set the reference point.
The phase angle is continuously changing	1. Generator and Receiver frequencies are not synchronized. 2. Current detector is not kept stable during frequency synchronization.	Carry out Frequency Synchronisation as described in Section 7.3.4
System Earth fault relay operates	1. Excessive Signal Generator output. 2. Incorrect connection to bus bar; no ground fault present	1. Reduce output current as described in Section 4.2.4 2. Check bus-bar connections.
GFL-1000 operates for a short amount of time then the equipment powers off.	Unit not fully charged before operation	1. Fully charge signal generator and receiver before using. 2. For long term operation, connect the AC power adapter to the signal generator.

## 8.4 Cleaning, Storage, and Maintenance

Ensure the units are switched off and disconnected from power sources. Clean all units with a soft damp cloth. Do not immerse in liquid. Do not use abrasives, solvents, or alcohol.

Store the unit in the case provided in a dry area, protected from condensation and direct sunlight. Store at a temperature between: -5 and + 40 °C (23 – 104 °F). If the unit is not used for some time, recharge the batteries to maintain their performance.

The equipment requires no regular maintenance. There are no user maintainable parts inside the unit.

## 8.5 Help and Support

For help and support, please contact Eagle Eye:

Call: 1-414-962-EEPS (3377)

Toll Free: 1-877-805-EEPS (3377)

[info@eepowersolutions.com](mailto:info@eepowersolutions.com)