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IGS-2/IPRF-3 FREQUENCY DOMAIN INDUCED POLARIZATION RECEIVER

OPERATION MANUAL

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PRELIMINARY
NOT TO BE USED

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ABOUT THIS MANUAL

This manual describes the operation of the IGS-2/IPRF-3 Frequency Domain Induced Polarization Receiver. It is a complementary sensor for the IGS-2 Integrated Geophysical System. The IGS-2/IPRF-3 Frequency Domain Induced Polarization Receiver is designed to be used with the TSQ-2E, TSQ-3 and TSQ-4 Time and Frequency Domain IP and Resistivity Transmitters.

Information pertaining to the IGS-2 System Control Console, or the TSQ series of complementary transmitters can be found in operation manuals dedicated to these various instruments.

If the operator is not familiar with the "IGS-2 Integrated Geophysical System - Operation Manual", then it is highly recommended that the operator begin by becoming familiar with it.

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Induced Polarization Method

Induced polarization is the only method presently available which has general application to the direct detection of disseminated sulphide deposits such as 'porphyry type' or bedded copper deposits, and bedded lead-zinc deposits in carbonate rocks.

Until 1971 all measurements of the induced polarization effect were made using the voltages observed at surface or in drillholes due to the time varying currents flowing from overvoltage effects. This method is now called Electrical Induced Polarization (EIP). In 1971 Scintrex introduced the Magnetic Induced Polarization (MIP) Method which measures the magnetic fields associated with these current flows. The MIP method uses the Scintrex MFM-3 High Sensitivity Vector Fluxgate Magnetometer to feed signals to an IGS-2/IPRF-3 Receiver.

In practice, two different field techniques (time domain and frequency domain) have been employed to execute EIP and MIP surveys. These techniques can yield essentially equivalent information but do not always do so. Instrumentation and field procedures using both techniques have been employed considerably over the past three decades. Much theoretical information for quantitative interpretation has been accumulated.

Recently there has been much interest in making broadband measurements in order to remove EM coupling effects and study IP responses with varying frequency. These 'spectral' measurements can be made with the IGS-2/IPRF-3 Receiver in the frequency domain.

In addition to receivers and transmitters, Scintrex provides all the accessories necessary for IP surveying. These include: The DHIP-2 Drillhole Logging Option, simulator networks for testing receivers, field wire, wire reels, porous pot electrodes, copper sulphate, angle-iron stake electrodes, stainless steel stake electrodes, plugs and alligator clips, walkie-talkie radios, tool boxes and spare parts.

1.2 IGS-2/IPRF-3 Frequency Domain Induced Polarization Receiver Option

The IPRF-3 Frequency Domain Induced Polarization Receiver Option is an adjunct sensor package designed for use with the Scintrex IGS-2 Integrated Geophysical System Control Console. When the IPRF-3 Receiver Option is used in conjunction with a Scintrex IGS-2 System Control Console, the result is the IGS-2/IPRF-3 Frequency Domain Induced Polarization Receiver.

The IGS-2/IPRF-3 Receiver incorporates the latest advances in frequency domain induced polarization receivers. The instrument extracts over two channels simultaneously the fundamental and third harmonic amplitude and phase information contained in the transmission of a single repetitive square wave.

This receiver is very simple to operate, typically requiring only a few keystrokes to take a measurement, store information in the solid-state memory and automatically advance the station coordinates.

The 32 character LCD display of the IGS-2 System Control Console uses full words. This aids the operator because there is no ambiguity about the meaning of the display and no confusing codes to memorize. The two line display lets the operator compare the present measurement, which is always in the upper line, with the previous value or any other measurement saved in memory, shown in the lower line.

By using the IGS-2/IPRF-3 combination, all of the circuit board slots in the IGS-2 are used for IP boards so that it is not possible to use the MP-4 Proton Magnetometer Sensor Option, the VLF-4 VLF Electromagnetic Sensor Option or the EM-4 GENIE/Horizontal Loop Electromagnetic Sensor Option concomitantly. However, since the IGS-2 can record ancillary information, additional data from independent instruments can be stored along with the IGS-2/IPRF-3.

Figure IPRF:1
IPRF-3 Receiver Option

The IPRF-3 Frequency Domain Induced Polarization Receiver Option consists of the following:

1) An IPRF-3 Receiver Console that accommodates the IGS-2 System Control Console,
2) Three IP electronic circuit boards that are installed inside the IGS-2 System Control Console,
3) A program EPROM for mounting on Memory Board #1 inside of the IGS-2 System Control Console,
4) A Battery Charger.

IPRF-3 Receiver Console:

The IPRF-3 Receiver Console is a rugged case that houses the operational controls of the receiver; two analog monitoring meters, input and output receptacles, an oven-controlled crystal clock, a rechargeable battery pack and a slot that accommodates the IGS-2 System Control Console.

Electronic Circuit Boards:

The three IP Electronic Circuit Boards provide input amplification and signal processing of the received signals before these signals are utilized by the IGS-2 System Control Console for final data processing.

Program EPROM:

The Program EPROM (Electrically Programmable Read-Only Memory) contains the recorded instructions necessary for the correct computations to be performed by the IGS-2 System Control Console's microprocessor.

Battery Charger:

The Battery Charger provides a charging current for the internal battery pack of the IPRF-3 Console, as well as the battery pack of the optional HSC-2 High Stability Clock.

Advantages of the IGS-2/IPRF-3 Receiver:

EIP and MIP Measurements: Both electrical (EIP) and magnetic (MIP) induced polarization measurements can be performed with use of the appropriate sensors. MIP measurements offer the facility of measuring IP effects in the earth without the need for ground contact by the detector system.

Frequencies: Five operating frequencies ranging from 0.033 to 3.0 Hz are keyboard selectable via the IGS-2 System Control Console.

RPS and PFE Parameters: Simultaneous, automatic measurement of RPS and PFE quantities. The RPS parameter provides IP information automatically corrected for first order inductive coupling and the PFE parameter can provide an accuracy of 0.1% even with transmitters that are not current stabilized.

High Stability Clocks:

The use of synchronized oven-controlled crystal clocks at both the transmitter and receiver permits measurements to be made much more rapidly and accurately than if a feedback loop design were used. Also, the absolute phase shift at a given frequency can be measured, without the need of a radio link or cable connecting the transmitter and receiver.

Dual Inputs: The choice of performing single channel measurements, or simultaneous dual channel measurements employing a common centre electrode, is available depending upon the survey requirements.

Ohmmeter: The built-in ohmmeter provides a convenient means of checking the electrical resistance of electrodes and the continuity of field cables.

Signal Generator for Calibration: The operating frequencies of the receiver can be regularly calibrated by means of the internal signal generator.

Transmitter Current Recording: The value of the output current from the transmitter can be recorded in memory along with the other measurement parameters for later data retrieval.

Averaging of Readings: Individual measurement readings can be averaged to improve the accuracy of the measurement values.

Noise Spike Rejection: Deviations of more than four standard deviations from the averaged readings during a measurement can be automatically rejected on a cycle-by-cycle basis.

1.3 Measurement Methods

The Scintrex TSQ Series of IP Transmitters can be used in conjunction with the IGS-2/IPRF-3 Receiver to perform IP measurements in two separate methods - EIP and MIP. The MFM-3 High Sensitivity Vector Fluxgate Magnetometer is required for MIP measurements.

Electrical Induced Polarization Method

In the Electrical Induced Polarization (EIP) method the IGS-2/IPRF-3 Receiver derives information relating to the induced polarization characteristics of the earth through the standard measurement of voltages observed at surface due to the frequency varying currents flowing from overvoltage effects.

The EIP method is the conventional way of measuring induced polarization effects in the earth by employing potential electrodes as detectors. It has general application in the direct detection of disseminated sulphide deposits such as porphyry type or bedded copper deposits, and bedded lead-zinc deposits in carbonate rocks.

Magnetic Induced Polarization Method

In the Magnetic Induced Polarization (MIP) method The MFM-3 High Sensitivity Vector Fluxgate Magnetometer replaces the potential electrodes normally employed in the EIP method. The MIP method derives information relating to the induced polarization characteristics of the earth through measurements of the magnetic fields associated with galvanic current flow.

The MIP method is a viable, novel way of measuring induced polarization effects in the earth without the necessity of ground contact by the detector system. It is equally applicable to the detection of disseminated and massive sulphide bodies and offers some possibility of differentiating between these two broad types. As well, the MIP method offers the potential of detecting IP responses through even highly (ionic) conductive overburden and of rapid reconnaissance, coupled with excellent depth penetration.

1.4 The IGS-2/IPRF-3 Parameters

1.4.1 Parameters Recorded and Measured

The IGS-2/IPRF-3 Receiver operates on the principle of the simultaneous determination of amplitude and phase of two or more harmonically related components transmitted simultaneously in a single square wave. Signals received on two inputs are processed simultaneously.

The IGS-2/IPRF-3 measures the following quantities per input:

AMP.1 = Amplitude of first harmonic
AMP.3 = Amplitude of third harmonic
PHS.1 = Phase shift of the first harmonic relative to the transmitted waveform
PHS.3 = Phase shift of the third harmonic relative to the transmitted waveform
PFE = Percent Frequency Effect between the fundamental and third harmonic
RPS = Relative Phase Shift between the fundamental and third harmonic
SD.1 = Standard Deviation of first harmonic
SD.3 = Standard Deviation of third harmonic

where $$PFE = \left(\frac{AMP.1 - 3\ AMP.3}{3\ AMP.\ 3}\right) 100\% \quad - 4\%$$

$$RPS = 3\ PHS.1 - PHS.3$$

For a pure square wave:

3 AMP.3 = AMP.1 and PFE = 0
3 PHS.1 = PHS.1 and RSP = 0

1.4.2 The PFE Parameter

The PFE measurement is the classical frequency domain IP measurement, over a frequency difference of a factor of three rather than the more typical factor of ten. Since the relation of IP amplitude to frequency is logarithmic, the resultant PFE's are therefore about one half of those observed over a decade change in frequency. However, because of the precision of the IGS-2/IPRF-3 measurement there is no loss of measurement accuracy compared to measurements taken using the classical frequency domain technique of sequential transmission of frequencies.

The decrease in the PFE parameter is more than justified by the basic instrumental noise levels (less than 0.05% PFE and 0.05 degrees RPS), and the fact that measurements are made simultaneously on the components of one transmitted square wave. Since, these components largely increase or decrease proportionately when the ground load changes, their ratio as measured by the IGS-2/IPRF-3 will remain stable. Measurements of PFE are thus largely unaffected by moderate ground load changes and, in fact, accuracies of 0.1% PFE are often obtainable with transmitters that are not current stabilized.

1.4.3 The RPS Parameter

The advantage of recording the RPS parameter lies in the fact that, to a first order approximation, it is free of error due to electromagnetic coupling. This is easily seen from the following discussion. The Relative Phase Shift (RPS) as measured, calculated and output by the IGS-2/IPRF-3 is defined as:

$$RPS = 3PHS.1 - PHS.3$$

The phase shift at any frequency (PHS.i) is a function of contributions from electromagnetic (EM) induction and from induced polarization (IP) effects. The EM coupling contribution is "noise" and must be removed in order that the true value of the IP effect can be observed. As is shown in Figure IPRF:2, for the frequency range used in IP measurements, the phase shift due to EM induction is almost proportional to the frequency while the phase shift due to IP effects is relatively constant over the range. Thus we have:

$$PHS.i = EMi + IP.i$$

and $$RPS = 3PHS.1 - PHS.3$$

thus $$RPS = 3EM.1 + 3IP.1 - EM.3 - IP.3$$

but $$3EM.1 = EM.3$$

and $$IP.1 = IP.3$$

thus $$RPS = 2IP.i$$

Figure IPRF:2
Phase Angle versus Frequency

Thus we come to the interesting conclusion that the RPS parameter output by the IGS-2/IPRF-3 Receiver automatically eliminates EM coupling noise, at least to a first approximation. Results from actual field cases published by Hallof (1974) and Wynn and Zonge (1975) demonstrate that EM coupling is effectively removed by this means. If however, higher order corrections are desired, they can be made using the RPS parameters measured by the IGS-2/IPRF-3 at several frequencies.

So far we have mentioned only the operation of the IGS-2/IPRF-3 on the fundamental and third harmonic of a single transmitted waveform. Since the square wave transmitted has many more harmonics than these, higher frequency measurements are possible, providing that signal strength is adequate. For example, the third harmonic may be used as a false fundamental in which case the ninth harmonic becomes a false third. Further, if both PFE and RPS measurements are made using the fundamental, third and ninth harmonics, then additional information becomes available for use in EM coupling elimination and discrimination between different sources of IP response.

For example, it can be shown that the quadratic frequency terms in the EM coupling in both the PFE and RPS parameters may be removed using their values obtained by emplying the original fundamental and then the third harmonic as a second fundamental. To be specific, if PFE.1, PFE.3, RPS.1 and RPS.3 are the measured values, then the EM quadratic-stripped values become:

$$\text{PFE} = \frac{(9\ (\text{PFE.1}) - \text{PFE.3})}{8}$$

$$\text{RPS} = \frac{(9\ (\text{RPS.1}) - \text{RPS.3})}{8}$$

When measurements are made at more than one fundamental frequency, then one can use the results to obtain a better approximation to actual phase angles, rather than RPS. For example, if f and 3f are used sequentially as fundamental frequencies, then:

$$\text{RPS.1} = 3\text{PHS.1} - \text{PHS.3}$$

and $$\text{RPS.2} = 3\text{PHS.3} - \text{PHS.9}$$

thus $$\text{RPS.1} + \frac{\text{RPS.2}}{3} = 3\text{PHS.1} - \frac{\text{PHS.9}}{3}$$

$$= \frac{8\text{PHS.1}}{3}$$

Since RPS.1 and RPS.3 are measured, PHS.1, the phase angle at the lowest frequency, stripped of EM induction effects, may be calculated.

Based upon a large number of field experimental results (i.e. Scott 1971) the normal equivalence between the two parameters output by the IGS-2/IPRF-3 should be approximately given by:

RPS (degrees) = 1.6 PFE (percent) (±10%)

Any major departure from this equivalence would signify anomlous ground response, EM coupling, measuring error, etc.

1.5 IPRF-3 Receiver Console

The IPRF-3 Receiver Console is a rugged case that houses the operational controls of the receiver; two analog monitoring meters, input and output receptacles, an oven-controlled crystal clock, a rechargeable battery pack and a slot that accommodates the IGS-2 System Control Console.

The IPRF-3 Receiver Console is briefly described below:

Figure IPRF:3
IPRF-3 Receiver Console Control Panel

1. **IGS-2 Control Console**
An opening is provided for the insertion of the IGS-2 System Control Console into the IPRF-3 Receiver Console Control Panel.

2. **IGS-2 Interconnect**
The IGS-2 Interconnect is a cable with plug used to input signals into the IGS-2 System Control Console for signal processing and data storage.

3. **Signal Input Binding Posts**
Three Signal Input Binding Posts are provided to attach the field cables from the potential electrodes to the IPRF-3 Receiver Console. The black binding post is common to both input channels.

4. **Analog Meters**
The main purpose of the Analog Meters is to allow the operator to observe the incoming signals. For proper operation, the needle deflection should be symmetrical and remain within the solid green area. However, operation in the green outlined area is permissible. The other use of the Analog Meters is as a readout device for electrode resistance checks.

5. **Data Output Receptacle**
The Data Output Receptacle provides a RS-232C serial interface to a printer or other peripheral device external to the IGS-2/IPRF-3 Receiver.

6. **Reset Button**
Under certain conditions the IGS-2 System Control Console will not respond regardless of which key is pressed. The Reset Button is pressed to restore the instrument to normal operation. The recorded data are not affected by pressing this button.

7. **Synch. Output Receptacle**
The Synch. Output Receptacle is used to connect the HSC-2 High Stability Clock to the IGS-2/IPRF-3 Receiver for synchronization purposes.

8. **Freq. Trim Potentiometer**
The Freq. Trim Potentiometer is used to adjust the frequency of the IGS-2/IPRF-3 Receiver's crystal clock to the frequency of the HSC-2 High Stability Clock.

1.6 IGS-2/IPRF-3 Accessories

1.6.1 HSC-2 High Stability Clock

The HSC-2 High Stability Clock is used to assure precise timing of the TSQ Series IP Transmitter and to synchronize the transmitter and receiver.

The HSC-2 Control Panel is briefly described below:

Figure IPRF-5
HSC-2 Control Panel

1. **To Transmitter**
   This cable and plug assembly is used to connect the HSC-2 Clock to a TSQ Transmitter Console or to the IGS-2/IPRF-3 Receiver Console.

2. **Battery Charger Receptacle**
   The Battery Charger Receptacle is used to connect the Battery Charger to the HSC-2 High Stability Clock's battery pack.

3. **Analog Meter**
   The Analog Meter is used to display either the beat frequency of the HSC-2 Clock combined with the internal clock of the IGS-2/IPRF-3 Receiver or the battery level of the HSC-2 Clock's battery pack.

4. **Domain Switch**
   The Domain Switch is used to select either the time or frequency domains of operation.

5. **Function Switch**
The three-position Function Switch selects the HSC-2 Clock's mode of operation. The three possible selections are:

1) OFF — Disables the HSC-2 High Stability Clock.

2) BATTERY — Enables the analog meter to read the present state of charge of the battery pack.

3) SYNCH. — Enables the analog meter to read the beat frequency of the HSC-2 Clock combined with the internal clock of the IGS-2/IPRF-3 Receiver.

1.6.2 Battery Charger

The Battery Charger is used to provide a charging current for the internal battery pack of the IPRF-3 Console, as well as the battery pack of the optional HSC-2 High Stability Clock.

The Battery Charger is briefly described below:

Figure IPRF:6
Battery Charger Front Panel

1. **Power Cable**
The Power Cable is a three-conductor cord terminating in a standard moulded grounding plug that supplies the main power to the instrument.

2. **Power Indicator**
The green LED Power Indicator is illuminated when the Battery Charger is on.

3. **Charging Cables**
The Charging Cables are two cords terminating in four-pin plugs that mate with the Battery Charger Receptacles on the IGS-2/IPRF-3 Receiver Console and the HSC-2 Clock Control Panel.

4. **Charge Indicators**
A Charge Indicator will light up when the Battery Charger is powered up and an intact battery pack is connected to its respective Charging Cable.

Figure IPRF:7
Battery Charger Rear Panel

5. **Battery Voltage Selector**
The Battery Voltage Selector is a slide switch that can be actuated with a small screwdriver.

IMPORTANT: The voltage indicated on the switch must correspond to the line voltage before operating the Battery Charger.

6. **Fuse Holder**
The Fuse Holder contains a fuse to protect the Battery Charger circuitry in the event of an overload, malfunction or wrong input voltage selection.

IMPORTANT: Do no substitute fuses of a higher rating than indicated below. The fuse must be changed depending upon the supply voltage.

115 V AC = 0.5 A Slow-Blow Fuse
230 V AC = 0.25 A Slow-Blow Fuse

1.7 IPRF-3 Setup Menus

The IPRF-3 Setup Menus are presented on the next page for easy reference as you read the next chapter, entitled "Enabling the Survey Method".

Figure IPRF:8
IPRF Setup Menus

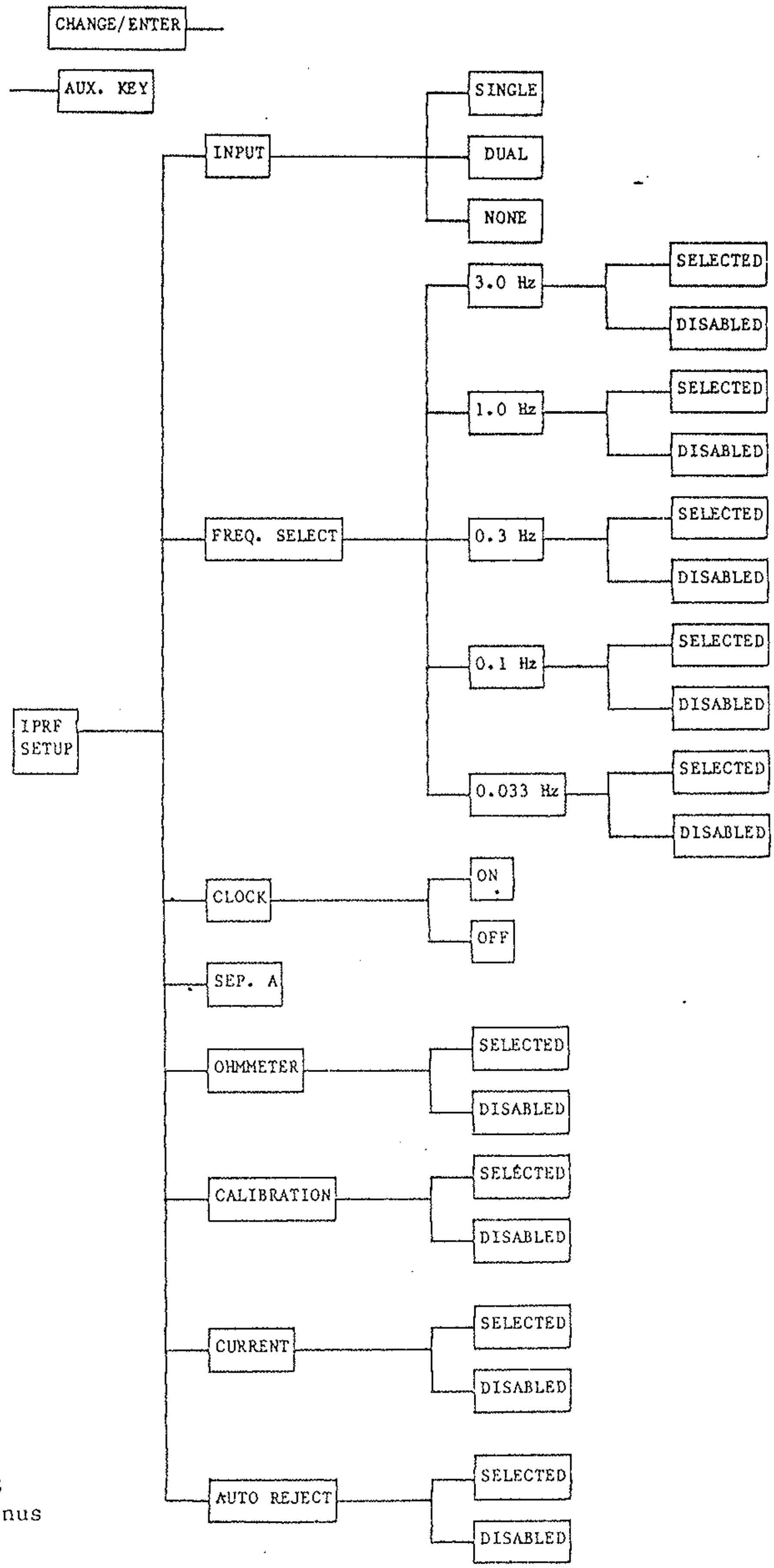

Figure IPRF:8
IPRF Setup Menus

2.0 ENABLING THE SURVEY METHODS

2.1 Introduction

Two modes of operation are available with the IGS-2/IPRF-3 Receiver. They are:

1. Single Channel Input
2. Dual Channel Input

2.2 Selecting the Survey Parameters

The IGS-2/IPRF-3 Receiver can perform measurements on two separate channels simultaneously. In the EIP method this is accomplished by two adjacent dipoles sharing a common centre electrode. In the MIP method two Fluxgate Magnetometers can be utilized, one per dipole position.

Selecting the input is performed in the following manner:

1. In the AUX. mode, scroll to find: IPRF SETUP.

2. Press CHANGE/ENTER to enter this item and scroll to find: INPUT.

3. One of the following will appear beside INPUT:

SINGLE	Single Channel
DUAL	Dual Channel
NONE	Disables the IPRF Receiver

4. Press CHANGE/ENTER in order to change a selection.

5. Scroll until the required input appears in the display.

6. Press CHANGE/ENTER to complete the entry.

7. Scroll down to see the next item in the menu: FREQ. SELECT.

8. The frequency select feature is entered by means of the CHANGE/ENTER key. (See 2.3.1 Frequency Select for details.)

9. Press AUX. to complete the selection(s) and to return to the previous menu.

10. Scroll down to the next item: CLOCK.

11. Press CHANGE/ENTER and scroll until the appropriate option appears. (See 2.3.2 Clock for details.)

12. Press CHANGE/ENTER to complete the entry.

13. Scroll down to the next item: SEP.A.

14. Press CHANGE/ENTER and enter the SEP.A value. (See 2.3.3 Dipole Separation for details.)

15. Press CHANGE/ENTER to complete the entry.

16. Scroll down to the next item: OHMMETER.

17. The ohmmeter feature is enabled/disabled by means of the CHANGE/ENTER key. (See 2.3.4 Ohmmeter for details.)

18. Scroll down to the next item: CALIBRATION.

19. The calibration feature is enabled/disabled by means of the CHANGE/ENTER key. (See 2.3.5 Calibration for details.)

20. Scroll down to the next item: CURRENT.

21. The current entry option is enabled/disabled by means of the CHANGE/ENTER key. (See 2.3.6 Current Entry Option for details.)

22. Scroll down to the next item: AUTO REJECT.

23. The automatic rejection feature is enabled/disabled by means of the CHANGE/ENTER key. (See 2.3.7 Automatic Rejection for details.)

2.3 IPRF-3 Survey Parameters

2.3.1 Frequency Select

There are five frequencies that can be selected for use in measurements. They are:

3.0 Hz
1.0 Hz
0.3 Hz
0.1 Hz
0.033 Hz

The frequencies are enabled/disabled as follows:

1. Press the CHANGE/ENTER key.

2. Scroll through the frequencies to check their status.

3. Press the CHANGE/ENTER key while viewing a frequency to either select or disable it.

4. Press the AUX. key to return to the previous menu.

Note: If all of the frequencies are disabled then the IPRF method is effectively disabled, regardless of the mode selection.

2.3.2 Clock

The IGS-2/IPRF-3 Receiver is equipped with an oven-controlled crystal clock that can be synchronized with the clock used by the transmitter. Once the transmitter and receiver clocks have been synchronized, it is necessary to keep the clocks running in order to maintain synchronization.

The clock is enabled/disabled as follows:

1. Press the CHANGE/ENTER key.

2. Scroll until the appropriate condition appears (i.e. ON or OFF).

3. Press the CHANGE/ENTER key a second time to complete the entry.

2.3.3 Dipole Separation

The dipole separation value (SEP.A) is the distance between potential electrodes (EIP method), or magnetometers (MIP method). The SEP.A value can be any five digit number up to 99999 with a floating decimal point for better resolution. It can be recorded as a survey parameter for later use, though it is not utilized for any calculations by the IGS-2 System Control Console's microprocessor.

The dipole separation value is entered as follows:

1. Press the CHANGE/ENTER key.

2. Enter through the keyboard the correct SEP.A value.

3. Press the CHANGE/ENTER a second time to complete the entry.

2.3.4 Ohmmeter

The IGS-2/IPRF-3 Receiver is equipped with a built-in ohmmeter for electrode resistance checks. Accurate IP measurements should be possible with up to 25 kilohms of resistance at the electrodes. However, it is strongly recommended that the resistance be kept at the lowest possible level in order to minimize possible noise pick-up on the field cables.

The ohmmeter is enabled/disabled as follows:

1. Press the CHANGE/ENTER key once to select the ohmmeter, if it is currently disabled, or

2. Press the CHANGE/ENTER key once to disable the ohmmeter, if it is currently selected.

Note: The ohmmeter is normally disabled when using MFM-3 Magnetometers rather than electrodes for measurements. However, it may be useful to enable the ohmmeter to check the magnetometer connecting cable when a cable fault is suspected.

2.3.5 Calibration

The IGS-2/IPRF-3 Receiver has a built-in signal generator that is used to calibrate the instrument.

The calibration feature is enabled/disabled as follows:

1. Press the CHANGE/ENTER key once to select the calibration feature, if it is currently disabled, or

2. Press the CHANGE/ENTER key once to disable the calibration feature, if it is currently selected.

Note: Calibration is performed like any other measurement by pressing the START key. After the START key has been pressed a message will appear in the display "CALIBRATION ON, START OR AUX?". Calibration can be disabled at this point by pressing the AUX. key. See Section 3.1.2 for further details.

2.3.6 Current Entry Option

The IGS-2/IPRF-3 Receiver is equipped with an option to enter manually the value of the transmitter output current every time a measurement is started.

The current option is enabled/disabled as follows:

1. Press the CHANGE/ENTER key once to select the current parameter, if it is presently disabled, or

2. Press the CHANGE/ENTER key once to disable the current parameter, if it is presently selected.

2.3.7 Automatic Rejection

The IGS-2/IPRF-3 Receiver is equipped with an automatic noise rejection feature. This feature, if selected, eliminates readings whose noise levels exceed 4 standard deviations (SD), or 4% of the respective amplitude. No readings are eliminated until the first five reading periods are averaged together to establish a reasonable estimate of the SD value.

The automatic rejection feature is enabled/disabled as follows:

1. Press the CHANGE/ENTER key once to select the automatic rejection feature, if it is currently disabled, or

2. Press the CHANGE/ENTER key once to disable the automatic rejection feature, if it is currently selected.

2.4 Disabling the IPRF-3 Receiver

In order to disable the IGS-2/IPRF-3 Receiver, do the following:

1. In IPRF SETUP, press CHANGE/ENTER and scroll to find: INPUT.

2. Press CHANGE/ENTER and scroll until NONE appears.

3. Press CHANGE/ENTER to complete the selection.

The message in the auxiliary mode will now read IPRF DISABLED.

Note: If all of the frequencies are disabled then the IPRF method is effectively disabled, regardless of the mode selection.

3.0 PERFORMING A MEASUREMENT

3.1 Preliminary Procedures

At the start of a survey day there are a series of preliminary procedures that must be performed in order to initialize the IGS-2/IPRF-3 Receiver. These procedures are outlined below:

3.1.1 Power to the IPRF-3 Console and Check the Dessicant

1. **Check the Power Switch:** If the main power switch of the IPRF-3 Console has been turned off it is necessary to remove the Dessicant and Main Power Cover to gain access to the power switch. Once the cover has been removed the main power can be switched on by setting the toggle switch to the ON position.

2. **Check the Dessicant:** With the Dessicant and Main Power Cover removed to check the main power switch the dessicant container can be examined. A dry dessicant pack is blue; a moist exhausted packed is pink or translucent.

   If the silica pack indicates that it is moist, remove the silica pack from the dessicant container. Gently heat the pack to dry the silica gel, being careful not to melt the nylon bag.

3.1.2 Calibration

The IGS-2/IPRF-3 has a built-in signal generator that is used to calibrate the instrument. It is recommended that the calibration be conducted at the start of a survey day. In the event that there is a substantial temperature change during the day, it is also recommended that the instrument be calibrated again.

In order to calibrate the IGS-2/IPRF-3 Receiver, do the following:

1. **Disconnect the Cables:** All cables must be disconnected from the signal inputs.

2. **Enable the Calibration:** The IGS-2/IPRF-3 is enabled as it would normally be for the survey day. Ensure that the calibration selection in the IPRF-3 setup menu has been selected and that all of the required frequencies have been selected. Refer to Section 2.2 "Selecting the Survey Parameters" for complete details.

3. **Initiate the Calibration:** By pressing the START/STOP key once, the prompt "CALIBRATION ON, START OR AUX?" will appear in the display of the IGS-2 System Control Console.

Pressing the START/STOP key once will initiate the calibration of the instrument.

Pressing the AUX. key once will automatically disable the calibration feature.

4. **Enter Dipole #:** The "DIPOLE #" prompt will appear after pressing the START/STOP key. It is recommended that the operator enter "0" as the dipole number so that if data is later dumped it will clearly indicate which measurements were used to calibrate the instrument.

If a change in the dipole number value is required, then a new value (i.e. "0") can be entered by pressing the CHANGE/ENTER key and entering the new value.

5. **Start the Calibration:** By pressing the START/STOP key once, the instrument will synchronize itself to the selected frequencies, set the gain controls, measure the internal offsets and commence reading. The message "READING" will be displayed and individual unaveraged readings will be indicated.

By pressing the START/STOP key a second time, the subsequent samples will be averaged together. The message "DUR xxxx" will be displayed indicating the present number of cycles incorporated into the averaging process.

6. **Record the Calibration:** By pressing the START/STOP key once during the averaging of samples, the averaging will be terminated. This measurement can then be recorded by pressing the RECORD key once.

7. **Subsequent Frequencies:** After recording the previous frequency calibration, the instrument will automatically sequence itself in descending order through the remaining frequencies that were initially selected when the IPRF-3 Setup Menu was enabled.

NOTE: Between frequency measurements the message "PLEASE WAIT 30 SECONDS" will appear. During this period the instrument is initializing itself for the subsequent frequency.

3.1.3 Clock Synchronization

The IGS-2/IPRF-3 has an internal oven-controlled clock that can be synchronized with the HSC-2 High Stability Clock which is utilized by a Scintrex TSQ Series IP Transmitter. This feature permits measurement of the absolute phase shift at a given frequency without the need of a radio link or cable connecting transmitter with receiver.

1. **Warmup the Clocks:** Both the HSC-2 Clock and the Internal Clock of the IGS-2/IPRF-3 Receiver must be turned on at least 1/2 hour prior to synchronization in order for the temperature of the clock ovens to stabilize.

   The HSC-2 Clock is turned on by selecting the SYNCH. mode of operation on the Function Switch.

   The Clock of the IGS-2/IPRF-3 Receiver is turned on by selecting the appropriate selection in the IPRF Setup Menu of the IGS-2 System Control Console. Refer to Section 2.2 "Selecting the Survey Parameters" for further details.

2. **Connect the Clocks:** Connect the To Transmitter cable and plug assembly of the HSC-2 Clock to the Synch. Output Receptacle on the IPRF-3 Console.

   Select the SYNCH. mode of operation on the Function Switch of the HSC-2 Clock.

   Select the Frequency Domain on the Domain Switch of the HSC-2 Clock.

3. **Adjust the IPRF-3 Clock:** The Freq. Trim Potentiometer on the IPRF-3 Console is used to adjust the frequency of the IGS-2/IPRF-3 clock to that of the HSC-2. Unlock the Freq. Trim Potentiometer by pushing the locking tab counter-clockwise.

   The Analog Meter of the HSC-2 Console will display the beat frequency of the IGS-2/IPRF-3 clock combined with the HSC-2 Clock. By adjusting the Freq. Trim Potentiometer the needle of the meter will come to a complete rest indicating that the frequency of the two clocks are matched.

   NOTE: 1) The needle should stop between 0.3 and 0.7 of the meter's full scale.

2) There should not be any noticeable drift of the needle during an observation period of one minute.

3) If the needle is motionless in the centre of the meter, not responding to the Freq. Trim adjustment, check to see if the cable is not connected or if the IPRF-3 clock is not turned on.

4. **Lock the Clock:** Lock the Freq. Trim Potentiometer of the IPRF-3 when finished by pushing the locking tab clockwise.

3.1.4 Check the Battery, Memory and Time

Examine the contents of the IGS-2 System Control Console INFO menu to ensure that the survey can proceed.

Press INFO and scroll to confirm the following conditions:

1. Memory is free 100%;

2. Battery level is sufficiently high;

3. Time and date are correct;

4. Grid number is correct.
   Grid number can be changed here if necessary without going through the Initialise mode by pressing the CHANGE/ENTER key, changing the number, and pressing the CHANGE/ENTER key once again.

The items labelled INFO A - INFO H will appear next. They are used to store ancillary information, such as evaluation, along with a measurement. The use of this feature is described in Chapter 4.0 of the IGS-2 Operation Manual in the section entitled "Adding Ancillary Data".

3.1.5 Transmitter Setup

The appropriate transmitter is set up as per the instructions contained within its respective operation manual.

3.2 Setting Up the Equipment

3.2.1 Setup for EIP Measurements

The IGS-2/IPRF-3 Receiver can employ either porous pots or stainless steel stakes as electrodes when performing EIP measurements.

The steps outlined below should be followed in setting up the IGS-2/IPRF-3 for EIP measurements.

1. **Connect the Electrodes:** Connect the potential electrodes to the free ends of the field cables by splicing and insulating the contact between the conductor wire (centre wire) of the cable with the potential pot or stake.

2. **Connect the Receiver:** Attach the other end of the cable to either the P1 or P3 Signal Input Connector on the IPRF-3 Console.

   NOTE: P1 corresponds to channel "A"
   P2 is common to both channels
   P3 corresponds to channel "B"

3.2.2 Setup for MIP Measurements

The MFM-3 High Sensitivity Vector Fluxgate Magnetometer is used as a sensor for MIP measurements. Please refer to the "MFM-3 Operation Manual" for complete setup and operational procedures.

The steps outlined below should be followed in setting up the IGS-2/IPRF-3 Receiver for MIP measurements:

1. **Connect the Magnetometer:** Connect one end of the field cable to the Output Connector on the front panel of the MFM-3 Console.

2. **Connect the Receiver:** Attach the other end of the cable to either the P1 or P2 Signal Input Connector of the IPRF-3 Console.

   NOTE: P1 corresponds to channel "A"
   P2 corresponds to channel "B"

3.3 EIP and MIP Measurements

Before starting a survey, ensure that the present line and station positions of the instrument correspond to the required survey location. To do this, press the Line key, then the Station key and change the entries if necessary.

A typical measurement would follow the sequence as outlined below:

1. **Check the Method:** Before starting a measurement the METHOD key can be pressed to see what method or frequency is about to be measured.

2. **Enter the Dipole #:** The "DIPOLE #" prompt will appear after pressing the START/STOP key. If a change in the dipole number value(s) is required at this particular station, then a new value(s) can be entered by pressing the CHANGE/ENTER key and entering a new value(s).

   NOTE: 1) DIPOLE # is a single digit value that represents a particular dipole position in an IGS-2/IPRF-3 survey.

   2) When operating in the Dual Channel Input mode, two single digit values are entered consecutively representing channels "A" and "B" respectively.

   3) In order to maintain a coherent listing of data when printed, it is recommended that dipole measurements proceed from the first to the "n"th dipole at every station. Channel "A" should represent the odd dipole numbers (1, 3, and 5) and channel "B" should represent the even dipole numbers (2, 4, and 6).

3. **Check the Electrode Resistance:** If the Ohmmeter has been enabled then the resistance of the electrodes, in an EIP measurement, can be checked. The electrode resistances are displayed on the analog meters while the IGS-2 System Control Console displays the "DIPOLE #" prompt.

   NOTE: The displayed resistances of the electrodes should be less than 25 kilohms in order to achieve high quality measurements.

4. **Enter the Transmitter Current:** If the Current Entry Option has been selected, a prompt "CURRENT" will now appear in the IGS-2 display. The output current of the transmitter can now be keyed into the instrument for later retrieval when data is dumped. It is recommended that the current be entered in milliamperes (mA).

5. **Start the Reading:** By pressing the START/STOP key once, the instrument will synchronize itself to the selected frequency, set the gain controls and commence reading. The message "READING" will be displayed and individual unaveraged readings will be indicated. These readings are not recorded.

   IMPORTANT: Ensure that the transmitter is ON before starting the reading sequence.

6. **Start the Averaging:** By pressing the START/STOP key once, the subsequent sample readings will be averaged together. The message "DUR xxxx" will be displayed indicating the present number of cycles incorporated into the averaging process.

   IMPORTANT: The electrodes, or magnetometers, must not be disturbed during the averaging process because motion noise will corrupt the measurement.

7. **Record the Measurement:** By pressing the START/STOP key once during the averaging of samples, the averaging process will be terminated. If the measurement is to be recorded, the RECORD key is pressed once. If the operator prefers to disregard that particular measurement, the START/STOP key can be pressed twice to repeat the measurement at that particular station location.

8. **Subsequent Measurements:** If more than one frequency has been selected for measurement, the instrument will, upon recording the present measurement, automatically sequence itself through those selected measurements before automatically incrementing to the next Station Number.

   If a measurement at a previous frequency needs to be repeated, after the instrument has automatically sequenced itself, the operator should re-select the required frequency by scrolling back to it, after the present measurement data has been recorded.

9. **Incrementing to the Next Station:** If Auto Station Incrementation has been selected, the instrument will automatically increment the Station Number by the value entered as Station Separation. Otherwise, station incrementation must be done manually by the operator. Please refer to Section 4.3.11 Station Incrementation in the "IGS-2 Operation Manual" for further details.

10. **Setup for Next Measurement:** The complete transmitter-receiver array is transferred to the next station to proceed with the survey.

3.4 Common Operating Procedures

3.4.1 Aborting A Measurement

By pressing the AUX. key once during an IGS-2/IPRF-3 measurement, that particular measurement will be aborted. This is particularly useful for immediate termination during either the reading or averaging of the received signals.

3.4.2 Viewing Data

To view data that has been stored for the measurement just completed, press the DATA key. The recorded data is listed in order and may be viewed sequentially by scrolling through the list. The sequence of data is as follows:

For Both Channels:

1.	DIPOLE #	(Dipole Numbers(s))
2.	CURRENT	(Transmitter Current Output)

For Channel "A":

3.	A:PFE	(Percent Frequency Effect)
4.	A:RPS	(Relative Phase Shift)
5.	A:PHS.1	(Phase Shift of the First Harmonic relative to the transmitted waveform)
6.	A:AMP.1	(Amplitude of First Harmonic)
7.	A:SD.1	(Standard Deviation of First Harmonic)
8.	A.SD.3	(Standard Deviation of Third Harmonic)

For Channel "B":

9.	B:PFE	(Percent Frequency Effect)
10.	B:RPS	(Relative Phase Shift)
11.	B:PHS.1	(Phase Shift of the First Harmonic relative to the transmitted waveform)
12.	B:AMP.1	(Amplitude of First Harmonic)
13.	B:SD.1	(Standard Deviation of First Harmonic)
14.	B:SD.3	(Standard Deviation of Third Harmonic)

For Both Channels:

15.	DUR	(Duration of Cycles)
16.	TIME	(Time of Measurement)

NOTES:

1) "A:" refers to Channel A.
   "B:" refers to Channel B.

2) Data can be viewed during a measurement, as well as after a measurement, by pressing the SCROLL key. It may take a few seconds for the display to change after the SCROLL key is pressed.

3) During a measurement TIME is not displayed, as it is of not particular interest at that moment. The Duration of Cycles (DUR) is displayed during a measurement on the lower display line, along with the other data parameters.

3.4.3 Ancillary Data

The IGS-2 System Control Console has a data storage capacity for eight pieces of coded information (INFO A - INFO H) to be recorded with each measurement that is performed.

The use of this feature is fully discussed in the "IGS-2 Operation Manual", Chapter 4.0, under "Adding Ancillary Data".

4.0 IPRF-3 WARNING MESSAGES

Display	Meaning
OVERLOAD	A condition where the signal in one or both channels exceeds the dynamic range of the instrument. By observing the analog meters one should be able to diagnose the problem. The probable causes are: 1) 2) Pressing the AUX. key will return the receiver back to the start of measurement procedures.
WEAK SIGNAL	A condition where the signal in one or both channels is below the minimum value for obtaining accurate readings. By observing the analog meters one should be able to diagnose the problem. The probable causes are: 1) Signal Inputs are not connected properly. 2) Calibration is not enabled. Pressing the AUX. key will return the receiver back to the start of measurement procedures.

5.0 OPERATIONAL NOTES

5.1 Battery Charger Operation

The battery packs of the IPRF-3 Console and the HSC-2 Clock can be recharged by following the steps outlined below:

1. **Select the Voltage:** Select the correct input voltage (115 V AC or 230 V AC) with the rear panel Battery Voltage Selector slide switch. The voltage on the switch must correspond to the line voltage before operating the battery charger.

   If the Battery Charger is connected to 230 V AC with the Voltage Slide Switch in the 115 V position, the fuse will blow. If the situation is reversed (i.e. line voltage is 115 V AC and the Voltage Slide Switch shows 230 V AC) the charger will not operate properly.

2. **Check the Fuse:** Ensure that the correct fuse has been inserted into the fuse holder.

   IMPORTANT: Do not substitute fuses of a higher rating than indicated below. The fuse must be changed depending upon the supply voltage.

   115 V AC = 0.5 A Slow-Blow Fuse
   230 V AC = 0.25 A Slow-Blow Fuse

3. **Power the Charger:** Connect the Battery Charger to the line voltage. The green LED Power Indicator should be illuminated. If it is not illuminated, check the following:

   a) Power plug is correctly connected to the power output and power is available.
   b) Correct fuse is inserted in the fuse holder properly and the fuse is in good condition.
   c) Correct input voltage has been selected.

   NOTE: 1) If a partially discharged battery pack has been exposed to cold temperatures, it should be permitted to stand at room temperature for about 1/2 hour before charging commences.

   2) If a partially discharged battery pack has been exposed to very warm temperatures and is then placed on charge, it may take about 1/2 hour for the battery pack to cool off before the battery starts to charge.

4. **Connect the Battery Pack:** Attach a Charging Cable to the Battery Charging Receptacle of the IPRF-3 Console and/or the HSC-2 Clock. Both of these battery packs can be charged simultaneously.

A Charger Indicator should become illuminated for each Charging Cable when the powered up Battery Charger is connected to an intact battery pack. The Charge Indicator will go out when the internal thermal sensor of the battery pack senses that it has received a full charge. While the battery pack remains attached to the operational Battery Charger it will be supplied with a trickle charging current to maintain full capacity. Full charging can normally be completed by leaving the battery charger operating overnight.

One of the Charging Cables has a temperature sensor in its length to measure the ambient temperature. This information is used to help prevent overcharging of the battery packs.

IMPORTANT: Ensure that the temperature sensor in the Charging Cable is kept at ambient temperature and that it is not placed near some heat generating equipment such as the Battery Charger itself.

5.2 Electromagnetic Noise

When the IGS-2/IPRF-3 Receiver is in the reading mode, the individual readings of the observed parameter will be seen to vary randomly about some constant value. This random fluctuation is due to electromagnetic noise.

During the averaging mode, for both the fundamental and third harmonics of each channel, all electromagnetic parameters are computed from the average value of "n" individual readings of the received signal, where "n" is the displayed Duration of Cycling (DUR). The received signal is resolved into two orthogonal components that are measured. The standard deviation (SD) of the "n" individual readings of both of these components are computed for each harmonic. As statistically, the standard deviation of these two components should not differ greatly, standard deviation of one component for each harmonic (SD.1, SD.3) is displayed. However, they are both used in determining whether a reading is to be rejected if the automatic rejection feature is enabled.

$$SD = \left(\frac{\sum_{i-1}^{n} (Xi - \overline{X}n)^2}{n-1} \right)^{\frac{1}{2}}$$

where Xi = an individual reading of one field component, for the "i"th cycle.

$\overline{X}n$ = average of Xi for an averaging of "n" cycles

For a given frequency and separation, the standard deviation is proportional to atmospheric noise. Standard deviation is a measure of the signal-to-noise ratio and it quantitatively describes the signal quality. Smaller SD values correspond to signals with less noise. An increase in SD values indicate a deterioration of the signal due to local storms (lightning discharges) or gusting winds. Large variations in atmospheric noise are possible, depending upon season, latitude and local thunderstorm activity.

From the measured SD values, the standard deviation of the individual readings of any IGS-2/IPRF-3 parameter can be determined:

SD (AMP.1) = SD1%
SD (AMP.2) = SD2%
SD (PHS.1) = 0.57 SD.1 degrees
SD (PHS.3) = 0.57 SD 3 degrees
SD (PFE) =
SD (RPS) =

The importance of knowing the SD values is that the SD values determine the standard error of a measurement consisting of a "n" cycle average of the parameters of interest:

$$ERROR = \frac{SD}{(n)^{\frac{1}{2}}} = \frac{SD}{(DUR)^{\frac{1}{2}}}$$

If one were to keep repeating the measurements while remaining at the same station, 68% of the readings averaged over "n" cycles would in the limits of ±ERROR around the true value. 95% of the readings would be in the limits of ±2 ERROR.

Also, the averaging time required to reduce the measurement error to a desired value can be determined:

$$DUR = \left(\frac{SD}{ERROR} \right)^2$$

5.3 Noise Spike Rejection Filter

Atmospheric electromagnetic noise is caused mainly by electrical activity in storms. Distant lightning discharges occurring worldwide generates a steady background noise. Electromagnetic impulses (spikes) due to lightning in nearby storms can cause deviations in the individual amplitude readings of much greater magnitude than the standard deviation (SD) due to background noise.

When the noise spike rejection algorithm is enabled (see Section 2.3.7), the magnitudes of the difference between each individual reading's signal components, over each channel, and their running averages are computed. If any one of these four magnitudes is greater than,

4SD + 0.3 AMP.

where SD = standard deviation
AMP. = computed amplitude value for channel A or B.

then the reading of both signal components, for both channels, is rejected.

The addition of the term 0.03 AMP. to the rejection criteria is needed to prevent the rejection of readings due to changes in receiver or transmitter electrode orientation when the SD values are close to zero, as they may be at short separations.

Any rejected reading is excluded from the computation of running averages for all measurement parameters and the Duration of Cycles (DUR) is not incremented until the next reading is accepted. The total number of rejected readings is displayed as # REJECTED, at the completion of a measurement.

No readings are rejected during the first five cycles of averaging. This is because a reasonable estimate of the SD value must be established before any rejection criteria can be applied. The occurrence of a large noise spike during the first five cycles of averaging will increase the SD value considerably and prevent the rejection of subsequent noise spikes. It is therefore suggested that the operator monitor the SD.3 value which is usually more affected by the lightning discharges. If a large SD.3 value is observed during the first five cycles of averaging, it is suggested that the measurement be aborted and restarted.

5.4 Outputting Data

Complete information regarding the outputting of data is presented in Section 4.10 of the "IGS-2 Operation Manual".

6.0 ADDING THE IPRF-3 OPTION TO THE IGS-2 SYSTEM

7.0 MAINTENANCE AND REPAIR

7.1 Field Maintenance

Little maintenance should be necessary as the IGS-2/IPRF-3 Receiver uses solid-state circuits throughout, with the exception of some manually operated front panel controls. A good life expectancy can be expected from the controls and the well sealed case should keep water and other contamination out.

To maintain the high input impedance of the IGS-2/IPRF-3 Receiver particular care should be taken to keep the connectors clean and dry. Periodic washing of the connectors with a mild solvent is recommended. Suitable solvents are methyl hydrate, freon or naptha gas (purified gasoline). Hot water and mild soap may be substituted followed by a thorough rinse in clear water. The connectors MUST be thoroughly dried for a few hours at elevated temperatures.

WARNING: Solvents such as automotive gasoline, paint thinner, acetone, etc. should not be used.

7.2 Troubleshooting

Most apparent troubles are caused by leakages or open circuits in the field cables or by improper ground contact when using potential electrodes in the EIP method.

Complex solid-state circuitry such as in the IGS-2/IPRF-3 Receiver is fairly difficult to repair in the field, as sophisticated test equipment is necessary, however, because of its rugged construction, the frequency of repair should be low.

8.0 SPECIFICATIONS

Channels	Single channel measurements, or simultaneous dual channel measurements employing a common centre electrode.
Impedance	3.65 M ohm
Protection	Resistor and zener diode protection up to 50 V.
Input Voltage Range	50 uV to 12 V
SP Cancellation	Removed by high pass filter. SP not measured.
External Electrical Resistance Check	Analog meter for each channel. Stimulus is a 27 Hz square wave current.
Synchronization	Oven controlled crystal clocks in receiver and transmitters. Clock stability 5.10^{-10}/day, 3.10^{-9} over -40°C to 50°C.
Frequencies	0.033, 0.1, 0.3, 1.0 and 3.0 Hz.
Analog Filtering	Active analog filters with cutoff frequencies changed automatically when operating frequencies are selected. Provides a minimum of 50 db attenuation at 50 Hz and its harmonic frequencies and negates the influence of fifth and higher harmonics of the signal frequencies.
Signal Detection	Four phase sensitive synchronous detectors per channel for in-phase and quadrature components at the fundamental and third harmonics.
Signal Processing	Continuous averaging of in-phase and quadrature components for f_0 and $3f_0$. Calculation of standard deviation for signal amplitudes.
Noise Spike Rejection	Deviations of more than three standard deviations from the average are rejected on a cycle-by-cycle basis.

Displayed Data	PFE, RPS, PHS.1, AMP.1, SD.1, SD.3 per channel and averaging duration.
Measurement Resolution	10 uV for amplitudes. 0.01 degrees for phase angles.
Absolute Accuracy	±3% of observed values for AMP.1, PFE and RPS. 0.1 degrees for phase angle.
Additional Data Storage	AMP.3, PHS.3, current (in mA), dipole spacing, dipole number, and time at start of measurement.
Analog Meters	Two, used for signal monitoring and resistance check.
Clock Frequency Adjustment	Set manually using front panel control.
Frequency Selection	Selected via IGS-2 System Control Console keyboard.
Operating Time	6 hours at -40C.
Operating Temperature	-40°C to 50°C.

9.0 IPRF-3 PARTS LIST

PART	PART NUMBER

10.0 WARRANTY AND REPAIR

10.1 General Warranty

All Scintrex equipment, with the exception of consumable items, is warranted against defects in materials and workmanship for a period of one year from the date of shipment from our plant. Should any defects become evident under normal use during this warranty period, Scintrex will make the necessary repairs free of charge.

This warranty does not cover damage due to misuse or accident and may be voided if the instrument consoles are opened or tampered with by persons not authorized by Scintrex Limited.

To validate the warranty, the warranty card supplied with the instrument must be returned to Scintrex within 30 days of shipment from our plant.

Instruments shipped for repair from outside Canada should be addressed to Scintrex Limited, care of: Murray and Robinson, Customs Brokers, Lester B. Pearson International Airport, Canada. Since Scintrex instruments are manufactured in Canada there is no customer delay or duty payable in Canada. It is advisable to state on customs documents "Canadian Goods Returned to Canada for Repair". Shipments should be made by air. Within Canada, ship by air directly to Scintrex Limited, 222 Snidercroft Road, Concord, Ontario, Canada, L4K 1B5. No instrument will be accepted for repair unless it is shipped prepaid. After repair it will be returned collect.

Scintrex Limited
222 Snidercroft Road
Concord, Ontario
Canada, L4K 1B5

Telephone: (416)669-2280
Telex: 06-964570
Telefax: (416)669-5132
Cable: Geoscint Toronto

10.2 Special Warranty for the Rechargeable Battery Pack

The Scintrex general warranty of one year from the date of shipment on its products applies to the instrument described in this manual with the exception of the rechargeable battery pack. Because of the nature of this item, it is expected to have a limited lifetime and is, therefore, classed as a "consumable" item.

Therefore, the following special terms apply to the rechargeable battery pack only:

a) The Scintrex rechargeable battery pack is warranted to the original purchaser for a period of six months from the date of shipment. The warranty is limited to repair or replacement of a pack due to defects in workmanship or materials used in manufacture. Should there be any defect due to manufacture within the first thirty days after shipment, the pack will be replaced free of charge. After 30 days, the pack will be replaced with the cost prorated on the basis of six months.

b) In order to warrant replacement, the function of the component must deteriorate below the normal useful operating limits as described in this instruction manual.

c) Customers must test the rechargeable battery pack within thirty days after shipment. The return of the warranty card will be taken to indicate that this test has taken place.

d) No credit will be issued for a pack which, in the judgement of Scintrex, has been damaged, abused, modified or on which the serial number or the type number has been obliterated or defaced.

e) No pack will be accepted for return credit unless permission has been obtained from Scintrex in writing, the shipment has been returned prepaid and insured, the component is packed in its original box or the equivalent, and a full written explanation of the reason for the rejection of the component is enclosed.

f) Whenever a replacement pack is supplied under this warranty, it will be covered by a fresh warranty hereunder.

g) To exercise the battery pack warranty, the following steps should be taken.

   - Scintrex will reply to the purchaser confirming that a replacement component will be sent. The date of failure will be taken to be the date that Scintrex is apprised of the failure. Scintrex' reply will also indicate the appropriate charge to be made for the replacement component and the credit that may be granted, based on item a) above, on receipt of the defective part. Where some doubt exists at Scintrex that a correct technical diagnosis of failure has been made, some test procedures may be suggested for fault confirmation.

- On receipt of the purchaser's order, Scintrex will send the replacement component as requested. The purchaser will be charged the full value of the replacement component, but subject to a credit on receipt of the defective item. The purchase order should provide full shipping instructions for the replacement component.

- The purchaser will carefully pack and remit the faulty component via prepaid airfreight to Scintrex Limited, 222 Snidercroft Road, Concord, Ontario, Canada, L4K 1B5 or for clients outside Canada to Scintrex Limited, in care of Murray and Robinson, Customs Brokers, Lester B. Pearson International Airport, marked "Defective Part - Returned to Manufacturer".

- Upon receipt of the defective part, Scintrex will inspect it and confirm that the failure thereof falls within the terms of this warranty. If this is confirmed, Scintrex will then issue an appropriate refund to the purchaser. Unless the defective component is returned to Scintrex for inspection and confirmation of the nature of the failure, no credit can be given thereon. A component which is found not to be defective on receipt will be returned to the purchaser.

h) Scintrex undertakes to keep on hand a reasonable stock of these rechargeable battery packs in order to supply a rapid replacement thereof when required.