IPR-12 Time Domain

IP/Resistivity Receiver

Operator's Manual

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ABOUT THIS MANUAL

This manual contains 10 sections:

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IMPORTANT NOTICE

There's an old phrase:
If all else fails, read the manual.

Dear User,

If you are reading the manual due to the fact that you have encountered a problem, please read **'First Time Operation'** in **Section 4, SETTING UP THE IPR-12**. Your solution to the problem may be as simple as a Cold Boot.

First time operation is not only applicable when you use the instrument for the first time, it also applies after the battery has been removed for more than a few minutes.

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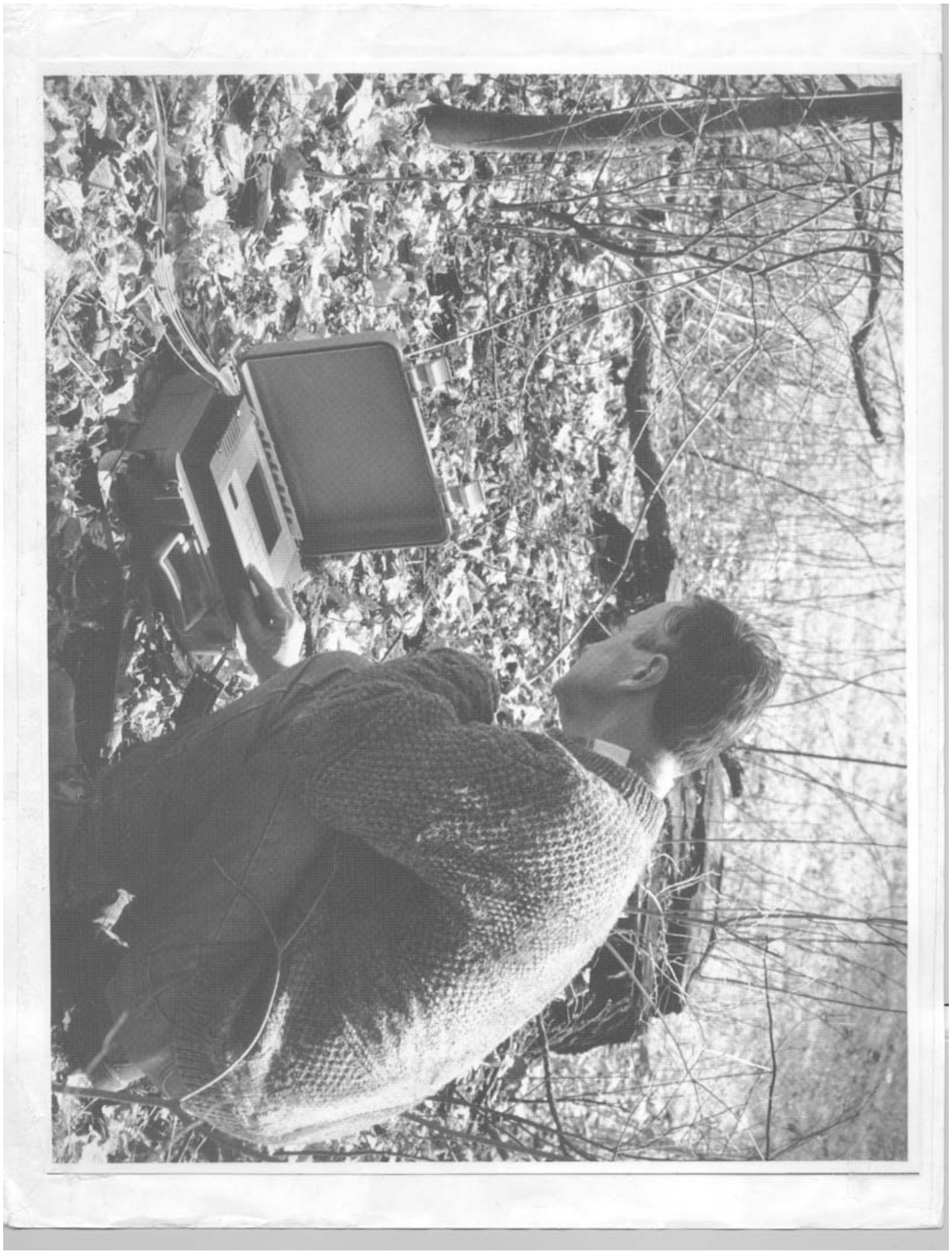


INSTRUMENT OVERVIEW

The IPR-12 Time Domain Induced Polarization/Resistivity Receiver is primarily used for precious and base metal mineral deposit exploration as well as geoelectrical surveying for groundwater or geothermal resources. For these latter targets, the induced polarization method can be very useful since geological materials often have IP constants when resistivity differences are absent.

The IPR-12 accepts signals from up to eight potential dipoles simultaneously which are then recorded in solid-state memory along with automatically calculated parameters. It is compatible with transmitters that output square waves with equal on and off periods and polarity changes each half cycle. These periods can vary in duration from 1 to 32 seconds with the IPR-12 measuring the primary voltage (Vp), self potential (SP) and time domain induced polarization (Mi) characteristics of the received waveform. The primary voltage, self potential and individual transient windows are continuously averaged and updated every cycle. Normally, depending on the receive time, 10 to 14 predetermined windows are measured simultaneously for each dipole. In addition to these, a user selectable window is also available. In addition, it is possible for the user to select up to 14 slices instead of the pre-defined settings. The total receive time is selectable from 1, 2, 4, 8, 16 and 32 seconds. K-factors, resistivity, statistical and Cole-Cole parameters are calculated and recorded in memory with the measured data and time. The Cole-Cole parameters; true chargeability (M") and time constant (Tau) for a fixed C of 0.25 can be used to distinguish between different chargeable sources based mainly on textural differences. The IPR-12 automatically calculates the geometrical (K) factors for the standard arrays that appear on the Info screen. This is particularly useful for arrays such as the Gradient or Schlumberger in which the K-factors change for every station. Then using the measured primary voltages with operator-entered current values, the receiver calculates and records apparent resistivity values.

All of the system parameters can be selected via the 17-key keypad. The large 16 line by 40 character backlit super twist liquid crystal display enables you to view any one of the 12 different graphic display screens during or after a measurement. The high quality data can easily be output serially to a digital printer to printout listings of data recorded in memory or transferred to a computer.

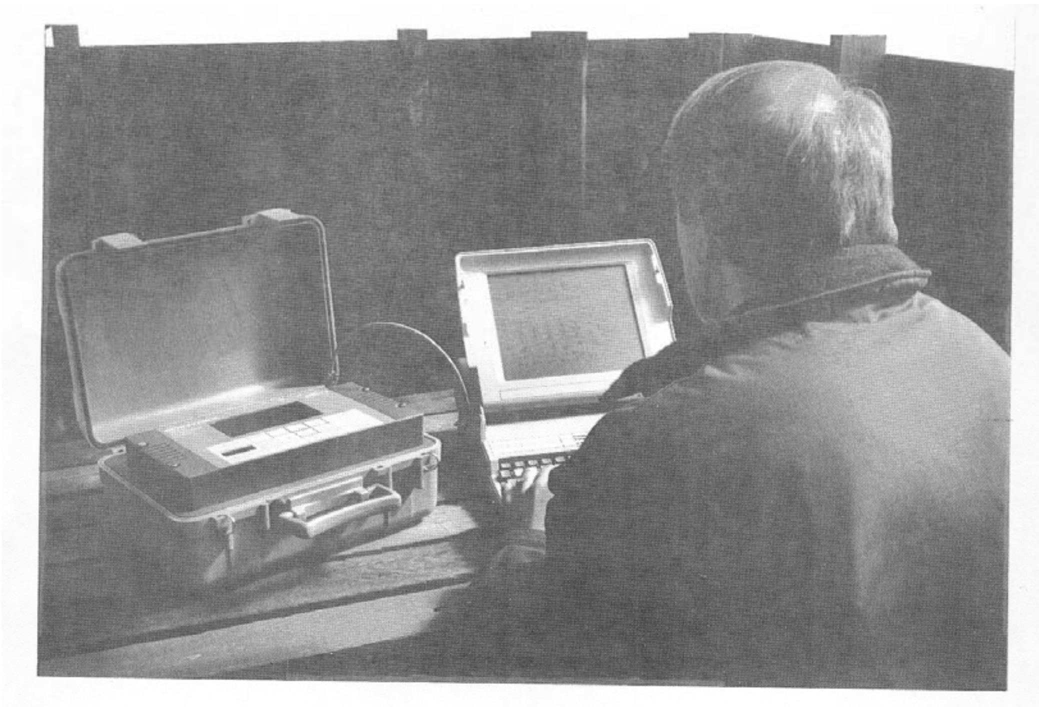


Figure 1: Analyzing Data Collected By The IPR-12 Receiver

SYSTEM COMPONENTS

The IPR-12 consists of the following components:

- Large 17-key keypad
- Liquid crystal display
- Eight differential analog inputs
- Data output connector
- Analog meter
- Internal power supply
- Charger connectors
- Desiccant compartment
- Tie down rings

Figure 2: IPR-12 System Components

Keypad

The easily readable, 17-key keypad enables you to access all of the IPR-12 functions usually with one key press.

Liquid Crystal Display

The large 16 line by 40 character (128 x 240 dots) liquid crystal display (LCD) presents the status and data of the IPR-12 during and after a reading in an alphanumeric and/or in a graphic format.

Analog Inputs

The eight identical differential inputs simultaneously accept signals from up to eight individual potential dipoles.

Data Output Connector

The RS-232C interface enables you to output data to a personal computer or a printer for archiving or processing information. The baud rate is keypad selectable between 300 baud up to 57.6k baud. The pin designations are shown below for the RS-232C connector on the IPR-12.

Signal	**Pin**
Ground	A
Transmitted Data	B
Received Data	C
+5Volt	D

Analog Meter

The analog meter which is embedded within the keypad allows you to monitor a particular dipole and is easily switchable from dipole to dipole. This is particularly useful during noisy conditions.

Battery Compartment

The IPR-12 requires eight, 4 Ah D cell batteries for normal instrument operation. Additional eight batteries are required for the display heater when required at low temperature. Scintrex recommends NiCad rechargeable batteries.

Charger Connectors

Two Charger connectors are located on the side of the case which enables the operator to recharge the internal batteries.

Desiccant Compartment

The IPR-12 requires an internal desiccant pack to prevent the build-up of moisture inside the instrument.

Tie Down Rings

The tie down rings are on the side of the IPR-12 case to enable you to secure the IPR-12 field wires in order to prevent strain on the connections. They also enable you to safely attach the IPR-12 onto a packframe.

INSPECTING YOUR IPR-12

The IPR-12 is contained within a rugged, waterproof housing.

1. Lift up the two tabs that secure the lid of the case to the instrument housing.

2. Inspect the IPR-12 for any physical damage.
Note: Contact Scintrex or your authorized agent immediately if there is any evidence that the unit was damaged during shipment.

3. Compare the contents of the shipping container with the packing slip.

Notes:
Contact Scintrex or your authorized agent if the contents of the container do not correspond with the packing slip.

The lid of the case can be removed by removing the hinge pin. Refer to the Maintenance Section - 'Removing The Lid'

INSTALLING THE BATTERIES

The IPR-12 requires two sets of batteries. One set is to power the instrument while the other set is to power the display heater. Scintrex supplies Nickel-Cadmium (Ni-Cad) batteries with a 4Ah capacity. Other batteries such as the Alkaline type can be used when you are not able to re-charge the batteries. In an emergency, it is also possible to use Carbon-Zinc flashlight batteries.

WARNING: Great care must be taken when handling and storing NiCad batteries as shorting out a cell may result in an explosion or fire.
Notes:

- Sets of batteries should not be mixed as a weak battery may imply that the batteries are discharged and excessive charging decreases the lifespan of a battery.
- Scintrex recommends rechargeable NiCad batteries with a 4Ah capacity or greater.
- Alkaline batteries can be used where charging facilities are not available.
- In an emergency, carbon-zinc flashlight batteries can be used.

Figure 3: Installing The Batteries

1. On the front panel, remove the five battery compartment screws on each side of the panel. (See figure 3).

2. Lift the cover off of each compartment to expose the battery tubes.

Note: The batteries located on either side of the display are the IPR-12 main batteries while, the batteries on either side of the keypad are for the display heater.

3. The polarity of the batteries are shown inside each tube. Install the D-cell batteries inside the tubes ensuring that the polarity is correct.

Note: Incorrect polarity does not damage the instrument or the batteries, however, the instrument does not work.

4. Re-install the battery compartment covers. Tighten the screws (do not overtighten).
Notes:
If you are replacing the batteries, measured data and setup parameters are retained in the memory during this procedure. If the batteries are fully discharged, they still provide enough power for a couple of days to the memory. Do not remove the main batteries for an extended period of time when there is valuable data stored in memory.

WARNING - During shipment or if the unit is being stored, to prevent damage to the instrument from leaking electrolyte, remove the batteries.

THE KEYPAD

Comment [c1]:

The keypad consists of 17 keys. Some of the keys have up to three functions. The response of the key press depends on the current display and/or action. The function keys have precedence over the numeric or alphabetized keys. If there is no reading in progress and a key press is not detected within a one minute period, the IPR-12 turns off to conserve battery power.

Note: Key conflicts exist between the Record Next Directn, Recall 7 and Info 8 keys. See 'Operating Procedures' for more detail.

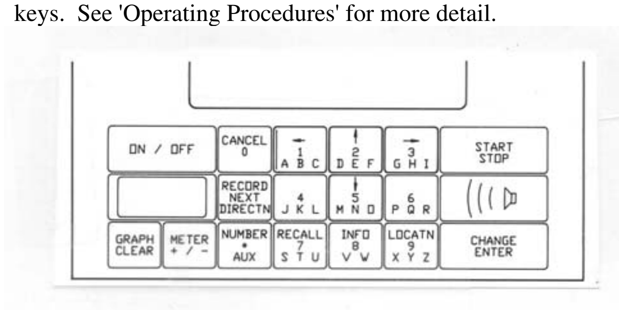


Figure 4: The IPR-12 Keypad

KEY FUNCTIONS

On/Off — This key powers the instrument On and Off. Turning the power off during a reading abruptly terminates the operation with loss of the current data.

Aux — Accesses the Main Menu.

Change/Enter — Enables you to select a parameter to change the value and to enter the changed value into memory. It is also used to toggle parameters.

Start/Stop — Starts a measurement, advances further into a measurement and stops it. It can also be used as a Pause key to stop and start a data dump.

Alphabetized Keys — Assigns letters to the display in the Notes feature and operator name. The Z key has the following additional functions:

- re-scale the Graph Display (zoom)
- re-scale and re-zero the Meter Display and the Analog Meter
- re-zero the Signal-Noise Monitor

Cancel — The cancel key can do the following:

- stop a reading of which no data is to be saved
- discard data of a properly terminated reading
- stop the Signal-Noise monitor operation
- stop the recall function
- abort the dumping of data

Clear Enables the operator to do the following:

- clear incorrect data entry
- initiate a 'cold boot'
- reduce the full scale value for the Signal-Noise Monitor

Cursor Keys ↑↓ Accesses the parameter boxes in the Setup displays. Scrolls through pages of numeric data in the Off-Line display.

←→ Accesses individual parameters within the parameter boxes in the Setup display to enable you to change the values. Changes the LCD intensity in the Main Menu.

Directn Sets the line direction of the electrode placements in the Location display.

Graph Accesses the Graph display which represents the IP decay.

Info Accesses the Information display which shows the selected array and K factors as well as other information.

Locatn Accesses the Location display which shows the current, station number, attribute, station separation, C-line, direction, current electrode location, P-line and potential electrode location.

Meter Accesses the Meter display which simulates the needle position of up to 8 edgewise meters where it would normally rest during the different phases of the IP signal.

Next Advances the cursor to the next character location when entering notes in the Information display or to advance to the next station in the recall operation. Also advances the full scale range of the Signal-Noise Monitor to the next range.

Number Accesses the Number display which shows the value of the electrode resistance, self potential, primary voltage, chargeability, the error value, the dipole from which synchronization occurs and the analog meter selection.

Numeric Keys 1-9, +/-, .	Enters numeric data, designates +/-, adds a decimal point to data in the Setup displays. Numbers 1-8 select the dipole number for the Graph or Signal-Noise Monitor displays or for the Analog meter. +/- toggles between data of the present and the previously measured and entered data.
Recall	Enables you to access previously recorded data.
Record	Records data in memory.
Beeper Port	This is not a key. The port enables the sound of the beeper to emit from the unit whenever a key is pressed.

THE DISPLAYS

There are three types of displays:

• Setup Displays
• On-line Displays
• Off-line Displays

All of the displays have a basic setup for easy viewing:

X		**X**
	X	
X		**X**
AAA	**BBB**	**CCC**

X - specific display information which varies from display to display. The operator entered data or the measured data are always presented in lower case numbers (or letters) while the parameter labels are in upper case.

A - the action prompt on all of the displays which tells the user to select a key to perform a certain action. For example, 'Change'.

B - reserved on all of the displays for messages. This area is usually blank.

C - the main battery voltage for the instrument is displayed in this area on all of the displays. When the battery voltage value drops to 100 the main batteries need to be recharged. The instrument turns off without any warning if the level drops to below approximately 100 and will not allow you to perform a measurement.

Setup Displays

The Setup displays enable you to enter all system parameters to prepare your IPR-12 for a survey. The following Setup displays are available on the LCD and are accessed via the keypad.

- Cold Boot display
- Main Menu display
- Initialization display
- Custom slice setup display
- Output display
- Locations display
- Info display

If the previous data has been recorded, the Locations display appears when you turn on the IPR-12. If the previous data has not been recorded, the Off-Line display - Numeric Slices (Dipole 1 - 4) appears.

Cold Boot Display

This display allows the partial or complete basic initialization of the receiver. This display appears if the CLEAR key and the ON/OFF keys are pressed simultaneously.

Cold Boot (N, Y, 1) ?

Warning !

N: No Cold Boot
Y: Setup param. & data will be erased
1: Setup param. ONLY will be erased

N: This option does nothing. This is a way out, if you reached this display inadvertently.

Y: You use this option to begin first time operation, to set up basic house-keeping parameters for proper instrument operation. Note that all survey data will be lost!

1: This option allows you to re-initialize the instrument even if there is data in the instrument. This option is normally not used, but may be useful in cases of operational difficulties.

The Locations Display normally follows this display upon key press.

Main Menu

The Main Menu enables you to do the following:

- select the Initialization display
- select the Output display
- select the Signal-Noise monitor
- set the intensity of the liquid crystal display

Note: This menu can be selected with the Aux key, except during a measurement.

```
****SCINTREX****

INDUCED POLARIZATION RECEIVER

IPR-12   3.0

(0)     INITIALIZATION
(2)     OUTPUT
(4)       SIGNAL-NOISE MONITOR
(< >)     LCD INTENSITY

Select ?                      BAT1:  bbb
```

Initialization Display

The Initialization display enables you to set specific parameters for the survey to select an instrument self test. This display is accessible from the Main Menu.

```
                    HH:MM:SS    12:00:00
                    YY/MM/DD  91/06/24

JOB #:              1024        COLE-COLE:
OPERATOR:   R. MILLER      OMIT# SLICES:       0
SERIAL #:     9105002
                                       TIMING:              2
TEST:               YES         UNITS:          METRE
HEATER:               NO
DURATION:             10
SYNC. CHANL:           1
AUTO. REJ.:           NO        VAR. SLICES:        NO
FULL SAT. DET.      YES         SLICE WIDTHS:       ->
Mx            340-520

 Change ?                              BAT1:   bbb
```

HH:MM:SS - It is the time of day in a 24 hour format. The actual time that the synchronization phase begins, is recorded with the data of each measurement.

YY/MM/DD - It is the date which is recorded in the header of the data dump. A new date generates a new header.

JOB # - Is the number of the current survey project. It accepts up to 6 digits.

OPERATOR - The operator's name or number. This parameter accepts up to 9 characters.

SERIAL # - It is the instrument serial number or any other identification number with a maximum of 9 digits.

TEST - Enables or disables the internal test generator. See the Specifications section for the nominal values.

HEATER - Enables or disables the display heater however, if the temperature is above -15°C, enabling this parameter has no effect.

DURATION - Is the number of IP cycles to be measured before the Auto-termination (maximum 999 cycles).

SYNC. CHANL. - This is the signal input which is used for synchronization. It is normally assigned to the input with the strongest signal.

AUTO REJ. - Enables or disables the automatic rejection of IP cycles contaminated by occasional noise spikes that occur during the measurement period.

FULL SAT. DET. - Allows you to fully or partially observe saturation conditions in the internal signal path. With "Not Full", observation is available only during the measurement period for example, while measuring all the slices. With "Full" observation, the times of signal transition are included, for example, between the end of the Vp period and the start of the first M-slice. "Full" is normally used, however, with large EM transients at the signal transitions, it may be required to use partial saturation detection (Not Full).

Mx - This indicates the beginning and the end of the user defined Chargeability Slice. This slice can be placed anywhere within the realm of the normal chargeability slices for the selected timing. The minimum width is 10ms, the step size is also 10ms. For one second timing (See Appendix E), the boundaries are on ..5ms and on ..10ms for other timings. For example, 1 sec. timing - 465, 4 sec. timing - 460

↑ must end in ↑ must end in

OMIT # (OF) SLICES - Defines the number of slices to be omitted for the Cole-Cole calculation, in excess of the ones which are automatically omitted at short timings. You are able to omit only 3 slices. The instrument maintains a minimum of 5 slices, regardless of the number of slices that the operator omits.

TIMING - This is the setting of the receiver time of either 1, 2, 4, 8, 16 or 32 seconds. Transmitter and Receiver timing must be identical.

UNIT - Enables you to enter metre or feet for the electrode locations. The apparent resistivity always appears in ohm metre.

VARIABLE SLICES - Enables or disables the use of variable slices.

SLICE WIDTHS - This leads to another menu in which the slice widths can be defined.

Custom Slice Width Setup Display

DELAY BY:	**40**
SLICE #1:	**10**
SLICE #2:	**10**
SLICE #3:	**10**
SLICE #4:	**10**
SLICE #5:	**20**
SLICE #6:	**20**
SLICE #7:	**20**
SLICE #8:	**40**
SLICE #9:	**40**
SLICE #10:	**80**
SLICE #11:	**80**
SLICE #12:	**160**
SLICE #13:	**160**
SLICE #14:	**320**

Change?

The following should be observed when entering variable slices:

- the slice widths are entered at 10 ms increments
- the slice windows must be contiguous
- if less than 14 windows are to be used, the remaining windows should be defined with 0 width
- the windows cannot start before 40 ms (hardware limitations due to the filter response)
- delay by parameter should be used to avoid the filter sponse (min. 40 ms)
- the last window has to end in Tx-115 ms
- COLE-COLE - parameters will not be computed
- if delay by + slices widths exceed Tx -115 ms, the following error message will appear: Err! reduce delay + slice Tsum by xxx
- when entering slice widths, use appendix G as a guide to slice width limits

DELAY BY: Initial delay which can be used to bypass the filter response.

SLICE #n: #1 - #14 slice widths

Output Display

The Output display enables you to select specific parameters for outputting data to a peripheral device. This display is accessible from the Main Menu.

```
DUMP PARAMETERS:          BAUD RATE: r

DATA BITS:          j          300    (1)
CR DELAY:            c          600    (2)
                               1200 (3)
DUMP ONE LINE     ?            2400  (4)
DUMP ALL DATA:     ?            4800  (5)
                               600    (6)
CLEAR MEMORY:      ?            19200 (7)
                               38400 (8)
                                57600 (9)


Change ?                                BAT1: bbb
```

DATA BITS - This is the number of data bits output during the data dump. You can select either 7 or 8 data bits. These must be selected according to your external device. This is usually achieved by experimenting with each data bit selection.

BAUD RATE - This is the speed at which the data is sent to the external device. This rate must correspond to the rate at which your external device can accept data. The current baud rate setting is shown after the prompt (r) while the selections that are available are shown below.

CR DELAY - This delay slows down the carriage return signal for slow printers so the data of the next line is not sent prematurely. The range is from 0 to 999ms and depends on your printer. The delay is usually established by experimenting. Computers usually accept a delay of 0.

DUMP ONE LINE - This selection enables you to dump the data one line at a time. The line that you are dumping is shown in the Locations display under Recall. If you want to dump the next line in the sequence, you do not have to return to the Locations display to change the line, you can just press the Enter key. The IPR-12 will automatically advance to the next line number and dump the data.

DUMP ALL DATA - This parameter is selected to start the data dump. It outputs all of the data at one time, possibly into a very large file.

CLEAR MEMORY - This parameter is selected to clear the memory and requires a (Y)es or (N)o answer. Once you clear the memory by selecting 'Y' all of the data is lost, except for the setup parameters.

Signal-Noise Monitor Display

The Signal-Noise Monitor display shows the signal of a selected dipole in order to help you troubleshoot if you encounter a problem. This display is available from the Main Menu.

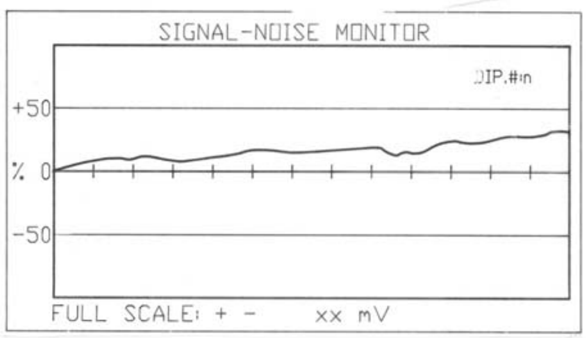


Figure 5: Example of Signal-Noise Display

Notes:

- The input signals are sampled at 50ms intervals and the data value of the selected dipole displayed as a pixel on the display. This enables you to observe signal, noise and SP drift for up to approximately 12 seconds at a time. The full scale value can be changed in 1-2-5 steps. The SP can also be removed in order to observe the small noise on top of a large SP.

DIP. # - This is the number of the selected dipole for which the display applies.

Full Scale - The full scale value (±xx) is the - vertical value of the box outline. You can adjust the value to between ±1mV to ±14V.

Locations Display

The Locations display enables you to enter the electrode location for the next reading and the location of the data of a previous reading prior to recording. If the previous data has been recorded, the display will automatically appear when you turn on the instrument . This display is also accessible from the LOCATN key if the IPR-12 is not taking a measurement.

CURRENT: rrrrr		**MOVE: i**	
STAT #:	**sss.ssd A: a**	**ST. SEP.: +nnn.nn**	
C-LINE#:	**lll.lld**	**C1: ccc.ccd**	**A: a**
		C2: ccc.ccd	**A: a**
P-LINE 3:	**lll.lld**	**P1: ppp.ppd**	**A: a**
		P2: ppp.ppd	**A: a**
		P3: ppp.ppd	**A: a**
		P4: ppp.ppd	**A: a**
RECALL:		**P5: ppp.ppd**	**A: a**
STAT.#:	**sss.ssd**	**P6: ppp.ppd**	**A: a**
P-LINE #:	**lll.lld**	**P7: ppp.ppd**	**A: a**
		P8: ppp.ppd	**A: a**
		P9: ppp.ppd	**A: a**

CURRENT - This is the transmitter current in milliamperes (mA). The range is 1 to 99999mA (99.999Amp).

STAT. # - The station number for this measurement which consists of the numeric part (sss.ss) and the direction part (d). The range is from 0 to 99999 with a decimal point as required. The direction allows entry of the geographical direction or Cartesian co-ordinates and is one of N, S, E, W, - or +.

Note: The station number does not have to coincide with an electrode location as no calculation is based on this designation.

STAT.SEP - This is the station separation. It indicates how far the array is moved. The range is from 0 to 99999 with a decimal point as required. It can be either positive (+) or negative (-). See the descriptions of 'MOVE' and 'C1, C2, P1...' and 'A'.

MOVE - There are no entries in this field. You select this parameter to alter the electrode locations: C1, C2 P1...P9 and station number. This feature changes all the selected electrode locations with a single keystroke, by the Station Separation. See also 'C1, C2, P1...' and 'A'.

C-LINE #- Is the line number of the current electrodes. It follows the same format at Station Number.

P-LINE # - Is the line number on which the potential electrodes are placed. It usually is the same as C-Line # but is different in arrays such as the Gradient Array. It follows the same format as Station Number.

C1, C2 - This is the location of the current electrodes. The format is the same as for Station Number. It does not matter which electrode is chosen as C1.

P1 - P9 - These are the locations of the potential electrodes. The format is the same as for Station Number.

A: - Is called the attribute to the station number and electrode locations. The result of the attribute affects how the station number or the electrode locations are changed by 'MOVE'. It is also used to determine how many dipoles are measured.

It can have the following entries and meanings:

+ - increments the respective value if 'Stat.Sep.' is +
decrements the respective value is 'Stat.Sep is -

- - increments the respective value if 'Stat.Sep' is -
decrements the respective value if 'Stat.Sep is +

0 - does not change the respective value. Can be used for a fixed
current electrode, for instance an infinity electrode

x - this electrode is not connected. Do not measure the adjacent
dipoles.

RECALL - Used to point to the line number and station number for the recall function. These parameters can be set here for any valid location, provided the respective data is in memory. This value is automatically updated to the latest location every time data is recorded. This makes it simple to recall the previous data once the reading is recorded. If you are dumping data one line at a time (Output Display), you select the line number on this display, return to the Output display and select the DUMP ONE LINE parameter. If you want to dump the next line in the sequence you just press the Enter key from the Output display and the IPR-12 will automatically advance to the next line and dump the data.

Info Display

The Info display shows you the array and K-factors as well as a Notebook feature and instrument house keeping information. This display is accessible with the INFO key but cannot be accessed during a measurement.

```
ARRAY SELECTED: a
1-Dip.Dip          2-Pol.Dip          3-Schlumb
4-Wenner           5-Gradient         6-Pol.Pol.
7-Other

K - FACTORS
K1:xxxx.xxx        K2:xxxx.xxx        K3:xxxx.xxx
K4:xxxx.xxx        K5:xxxx.xxx        K6:xxxx.xxx

NOTES:

tttttttttttttttttttttttttttttttttttttt.....

MEM. FREE (%):  fff

                                           BAT2: bbb
Change ?                                BAT1: bbb
```

ARRAY SELECTED - Displays the selected array and also shows the arrays that are available to you. Resistivity K-factors are automatically calculated for all arrays accept 'Other'.

K-FACTORS - Calculated automatically when a specific array is selected, based on the information in the Locations display and the 'Units' parameter in the Initialization display. No manual entries are allowed except if the operator selects 'Other' in the Array Selected parameter. If invalid electrode locations are chosen the word 'ERR' appears instead of a numeric value. For example, two equal potential electrode locations.

NOTES - Allows the entry of alpha-numeric notes to each reading. It accepts up to 38 characters.

MEM.FREE (%) - Indicates in percent the amount of memory for data storage that is still available. If this number is unrealistic, on start up, a cold boot was likely not performed correctly.

BAT1 - Indicates the status of the main batteries. Any value above 100 is acceptable however, when the battery level drops below approximately 100, the unit shuts off without any warning and does not allow any readings to take place. The battery status is measured at certain times and the same status is displayed until the next possible update. No updates take place during a measurement so this could give the operator a false impression of the battery strength as the highest demands on the battery is during a reading. The most accurate battery level is the level that is displayed immediately after a reading when the battery level is re-measured.

BAT2 - This is the status of the Display Heater battery. The heater turns off automatically without warning if the level drops below approximately 100.

On-Line Displays

The On-Line displays show the actual data either in numeric or graphical format during a measurement. The following On-Line displays are available and are accessed via the keypad.

- Electrode Resistance display
- Meter display
- Graph display
- Numeric display
- Analog meter

The On-Line displays have a variety of common error messages such as:

- OVERLOAD AT INPUT
- LOW SIGNAL ON 'nnn'
- OVERL.CH. ON 'nnn'
- SYNCH PROBLEM ...

See the Troubleshooting section on how to correct these errors if they appear in the messages area of the display.

Electrode Resistance Display

The Electrode Resistance display enables you to view specific parameters during a survey. This display appears after you press the START key the first time.

DIP	RES	SP	VP	Mx	S.D.
1	rrrr.r				
2	rrrr.r				
3					
4					
5	rrrr.r				
6	rrrr.r				
7	rrrr.r				
8	rrrr.r				
Resistivity Phase..				BAT1: bbb	

Notes:

Only the dipoles that are used are shown in this display and in later displays.

RES - The range is 0 to 1999.9k? with 0.1k? resolution. This data is not averaged. Each dipole is measured individually and the value shown is therefore for the respective dipole pair.

Meter Display

The Meter display shows you the 8 edgewise meters that simulate the different phases of the IP signal. This display appears after you press the START key a second time or it is accessible during a measurement via the METER key.

```
          _          _          _
1
          _          _          _
2

          _          _          _
3
          _          _          _
4

          _          _          _
5
          _          _          _
6

          _          _          _
7
          _          _          _
8


  DUR ddd                          BAT1:  bbb
```

Notes:

This is a simulation of up to eight edgewise meters. The bars represent the needles where they would normally rest during the different phases of the IP signal. The left hand position indicates the -Vp, the centre position represents -/+Mx and the right hand position is +Vp. The data is updated once a cycle, and indicates non-averaged data.

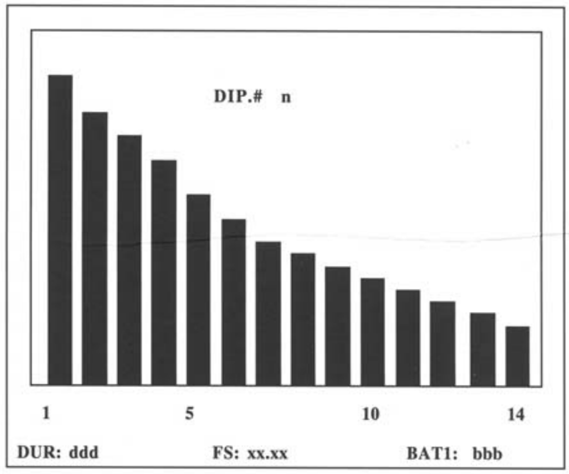
The Vp deflection is set to 75% of Full Scale from the Vp obtained during the first cycle and SP is initially bucked out. On-going changes in amplitudes or SP drift are made with reference to those values.

If considerable changes take place during a measurement, it is possible to re-zero and re-scale the display (zoom in) with the “z” key.

DUR - This is the number of cycles averaged of the dipole with the most rejections which could be due to internal saturation, or with low signal. Other dipoles may have more cycles. If there were no rejections this represents the number of cycles for all the dipoles. This parameter appears on all On-Line displays.

Graph Display

The graph display shows you the decay in a graphical format. This display is accessible via the GRAPH key followed by a numeric key (1-8) while a measurement is in progress or before recording the data.



Notes:

This graph represents the IP decay of the selected dipole. The negative sign (-) at the foot of some bars indicate that these bars are actually negative, however due to display constraints they cannot actually be shown below the horizontal base line. Up to four bars on the left hand side of the display may be missing. Refer to the Specifications section - 'IP Transient Program' for further details.

DIP # - This is the number of the selected dipole to which the graph applies. The default dipole is the dipole with the highest selected dipole number which normally has the lowest signal.

FS - xx.xx - Is the vertical full scale value (F.S.) of the bars. The size of the highest bar is set to 95% of F.S. of the values obtained during the synchronization cycle. On-going changes in amplitude are made with reference to those values. This enables you to observe changes that take place during the measurement. If considerable changes take place during a measurement, it is possible to re-zero and re-scale the display (zoom in) with the “z” key.

Numeric Display

The Numeric display shows you the numeric data of the measurement. This display is accessible during a measurement or thereafter, but before the data is recorded via the RECORD key.

DIP	RES	SP	VP	Mx	S.D.
1s	**rrrr.r**	**ssss**	**vvvv.vv**	**mmm.mm**	**e.ee**
2	**rrrr.r**	**ssss**	**vvvv.vv**	**mmm.mm**	**e.ee**
3					
4					
5	**rrrr.r**	**ssss**	**vvv.vv**	**mmm.mm**	**e.ee**
6	**rrrr.r**	**ssss**	**vvv.vv**	**mmm.mm**	**e.ee**
7	**rrrr.r**	**ssss**	**vvv.vv**	**mmm.mm**	**e.ee**
8m	**rrrr.r**	**ssss**	**vvv.vv**	**mmm.mm**	**e.ee**
DUR:ddd					**BAT1: bbb**

s - indicates the dipole which is used for synchronization as chosen in the instrument set up.

m - is the dipole to which the analog meter is connected. “m” has precedence over “s” in the case of conflict.

SP - Self Potential in mV, 1mV resolution

VP - Primary voltage in mV with 10uV resolution

Mx - Chargeability of the user defined
Chargeability slice in mV/V with 0.01mV/V resolution

S.D. - Standard Deviation of data in Mx

Analog Meter

The analog meter displays the signal of the default dipole which is the dipole with the highest number, or the signal of the operator-selected dipole during a measurement.

The analog meter is updated continuously and displays the noisiness of the signal. The scale factors for SP and Vp are obtained during the first cycle for each dipole. Any changes thereafter are displayed with reference to the initial conditions. It is possible to re-scale (zoom) the value if changes have become excessive and forced the display too far off scale.

The Off-Line displays show the numeric slice, calculated data, numeric and graph displays after a measurement is terminated. The following are Off-Line displays:

- Numeric Slice displays
- Calculated Data display

Note: The On-line numeric and graph displays are also available.

Numeric Slice Display

This display shows the chargeability slices in numeric form in mV/V. This is the first display to appear when you turn on your instrument if the previous data was not recorded. This display normally appears after a reading is terminated or it can be selected before the data is recorded with the NUMBER key followed by a vertical scroll.

	DIP 1	DIP 2	DIP 3	DIP 4
M1	mmm.mm	mmm.mm		
M2	mmm.mm	mmm.mm		
M3	mmm.mm	mmm.mm		
M4	mmm.mm	mmm.mm		
M5	mmm.mm	mmm.mm		
M6	mmm.mm	mmm.mm		
M7	mmm.mm	mmm.mm		
M8	mmm.mm	mmm.mm		
M9	mmm.mm	mmm.mm		
M10	mmm.mm	mmm.mm		
M11	mmm.mm	mmm.mm		
M12	mmm.mm	mmm.mm		
M13	mmm.mm	mmm.mm		
M14	mmm.mm	mmm.mm		
				BAT1: bbb

Notes:

Shows the chargeability slices in numeric form in mV/V for dipoles 1 to 4 **(DIP1 - DIP 4)** while another page shows the data for dipoles 5 to 8.

M1..M14 are the slice numbers. Up to four slices may be missing from the top. See the Specifications section - 'IP Transient Program' for further information.

Calculated Data Display

Presents the calculated data for each dipole. This display is accessible after a measurement is terminated but before the data is recorded via the NUMBER key followed by a vertical scroll.

DIP	RHO	DUR	M"	TAU	RMS%	Wi
1	**mmm.mm**	**ddd**	**nnn.nn**	**ttt.tt**	**r.rrr**	**w**
2	**mmm.mm**	**ddd**	**nnn.nn**	**ttt.tt**	**r.rrr**	**w**
3						
4						
5	**mmm.mm**	**ddd**	**nnn.nn**	**ttt.tt**	**r.rrr**	**w**
6	**mmm.mm**	**ddd**	**nnn.nn**	**ttt.tt**	**r.rrr**	**w**
7	**mmm.mm**	**ddd**	**nnn.nn**	**ttt.tt**	**r.rrr**	**w**
8	**mmm.mm**	**ddd**	**nnn.nn**	**ttt.tt**	**r.rrr**	**w**
						BAT1:
bbb						

Notes:

This display shows the calculated data versus the dipole number **(DIP n).**

RHO - is the apparent resistivity in ohm-meter.

DUR - is the actual number of cycles measured for each dipole. The durations differ if a low signal or internal saturation occurred during the measurement.

M" - This is the Cole-Cole Chargeability in mV/V.

TAU - The Cole-Cole time constant, expressed in seconds.

RMS - The root mean square (rms) error between the actual decay curve and the theoretical decay curve with a 'C' of 0.25 stored in memory.

Wi - The number of slices retained for the Cole-Cole calculations.

Occasionally, it may not be possible to establish the Cole-Cole parameters due to poor signal or due to other factors. In these cases, TAU and RMS will be blank and the following Error Codes will appear under Wi instead of the number of slides used:

99	Poor S.D. or slices < 5
98	Negative Slices
97	Test Generator (Cole-Cole Disabled)
96	Variable Slices (Cole-Cole Disabled)

SET-UP PROCEDURES

The section, Setting-Up The IPR-12, enables you to program the IPR-12 to do specific tasks. If you follow these instructions, the steps result in a setup to perform a self test using the internal test generator as a signal source for a 6 dipole, Pole-Dipole array. This procedure does not require (or allow) any external connections so that you can perform the test in the office.

Note: You cannot access the setup parameters during a measurement.

First Time Operation

When you are operating the instrument for the first time, the unit requires a 'Cold Boot' (complete microprocessor initialization). To do this procedure, follow these steps:

1. The unit must be turned off. While pressing and holding the Clear key, press the On/Off key. Two beeps emit from the IPR-12 and the cold boot display is presented.

Cold Boot (N, Y, 1) ?

Warning!

N: No Cold Boot
Y: Setup param. & data will be erased
1: Setup param. ONLY will be erased

2. Press Y to erase the parameters and the data. The Locations display will appear. All internal parameters have now been initialized and the instrument is ready to be set-up.

Accessing The Parameter Fields

To access the parameter fields, move the vertical cursor until the cursor rests on the first parameter field within the box that you require.

Accessing The Parameters Within The Fields

To access the parameters once you have selected the specific parameter box, move the horizontal cursor until the cursor rests on the parameter that you want to change.

Changing Parameters

There are three types of prompts that appear on the displays. The way that you change a parameter depends on the type of prompt that is shown on the screen. These prompts are located on the lower left hand side of the screen and tells you what action to perform. Changing the parameter consists essentially of the following:

- filling in the parameter fields via the keypad (*Enter*)
- toggling between two given designations (*Toggle*)
- selecting an item from a given list (*Select*)

Since most of the entries require the same steps, they are explained here in detail but the sequence of steps will be substituted with the following single words (*Enter, Toggle, Select*) in this section.

Enter

In the following sections, when a parameter box requires a value the word *Enter* followed by a value will appear in the given steps in this manual. When this word appears, the following steps are required to change the parameter:

1. Press CHANGE to change the parameter. The prompt in the left hand bottom corner changes to Enter>, opening the data entry field.
2. If the entry requires a sign, press the +/- key until the correct sign appears.
3. Key-in the desired numerical value. If you enter an incorrect value, press the CLEAR key and repeat steps 2 and 3.
4. Press ENTER to store that parameter with the new value. The new value moves into the parameter box and the prompt changes back to 'Change?'.

Toggle

If the parameter gives you a choice between two values, the word *Toggle* will appear and requests the following action:

1. Press the Change/Enter key until the desired value appears. Allow about 1 second between key strokes otherwise a keystroke may be ignored.

Select

If the parameter gives you various selections to choose from, the word *Select* will appear and the following steps will be required:

1. Press CHANGE to enable you to change the parameter. The prompt at the bottom changes to Select >

2. Choose the appropriate selection by pressing the key that is designated to that selection.

3. Press ENTER to store that parameter with the new selection. The new selection moves into the parameter box and the prompt changes back to 'Change?'

Main Menu

Setting The LCD Intensity

1. Press the Aux key to view the Main Menu.

2. Press the ← or → key to decrease or increase the intensity and the viewing angle of the screen. → increases the intensity while ← decreases the intensity. There are 60 key strokes required to go from end to end.

Initialization Display

Setting The Time and Date

1. From the Main Menu, select 0 for the Initialization display. On first power-up, the cursor (rectangular block) should be in the 'HH' field.

2. *Enter* the hours in a 24 hour format.

3. Press the → key to move the cursor to 'MM'.

4. *Enter* the minutes.

5. Press the → key to move the cursor to 'SS'.

6. *Enter* the seconds.

7. Press the → key to move the cursor to 'YY'.

8. *Enter* the year.

9. Press the → key to move the cursor to 'MM'.

10. *Enter* the month.
11. Press the → key to move the cursor to 'DD'.

12. *Enter* the day.

Setting Job #

13. Press the → or ↑ key to move the cursor to JOB #.

14. *Enter* the job number.

Setting The Operator

15. Move the cursor to OPERATOR.

16. Push Change. The following prompt appears along the bottom line of the display:

    Enter name (9 ch)>

17. Push the first letter or number key of the operator until the desired character appears to the right of the prompt.

    Note: If you press a wrong key, push the Clear key and re-enter the correct number or letter.

18. Press the Next key.

19. Push the second letter or number key of the operator as in step 17.

20. Press the Next key.

21. Repeat steps 21 and 22 until the Operator designation is complete.

22. Press Enter.

Setting The Serial Number

23. Move the cursor to SERIAL #.

24. *Enter* the serial number or any identification number.

Selecting Test

25. Move the cursor to TEST

26. *Toggle* until Yes appears.

Selecting The Heater

27. Move the cursor to HEATER.

28. *Toggle* until No appears.

Setting The Duration

29. Move the cursor to DURATION.

30. *Enter* 10.

Setting The Sync. Channel

31. Move the cursor to SYNC. CHANL.

32. *Enter* 1.

Setting The Auto Rejection

33. Move the cursor to AUTO REJ..

34. *Toggle* until No appears.

Selecting The Full Saturation Detection

35. Move the cursor to FULL SAT. DET.

36. *Toggle* until Yes appears.

Setting The Timing

37. Move the cursor to TIMING.

38. *Select* 2.

Setting Mx

39. Move the cursor to Mx.

40. *Enter* 340.

41. Press the → key.

42. *Enter* 520.

Setting Cole-Cole Slices

43. Move the cursor to OMIT # SLICES.

44. *Enter* 0.

Setting The Unit

45. Move the cursor to UNIT.

46. *Toggle* until Metre appears.

The following is a typical Initialization Display:

Initialization Display

HH:MM:SS 12:00:00
YY/MM/DD 91/06/24

JOB #:	**1024**	**COLE-COLE:**	
OPERATOR:	**R. MILLER**	**OMIT # SLICES:**	**0**
SERIAL #:	**9105002**		
		TIMING:	**2**
TEST:	**YES**	**UNITS:**	**Metre**
HEATER:	**NO**		
DURATION:	**10**		
SYNC. CHANL.:	**1**		
AUTO REJ.:	**NO**	**VAR. SLICES:**	**No**
FULL SAT. DET.	**YES**	**SLICE WIDTHS:**	**-->**
Mx	**340 - 520**		

Change ? **BAT: bbb**

Custom Slice Width Setup Display

47. Move the cursor to Variable Slices

48. *Toggle* YES to use Variable Slices or NO to use Slice Width.

49. Move the cursor to Slice Widths

50. Press *enter* to open the new menu.

The following is a typical Custom Slice Width Display:

Custom Slice Width Display

DELAY BY:	**40**
SLICE #1:	**10**
SLICE #2:	**10**
SLICE #3:	**10**
SLICE #4:	**10**
SLICE #5:	**20**
SLICE #6:	**20**
SLICE #7:	**20**
SLICE #8:	**40**
SLICE #9:	**40**
SLICE #10:	**80**
SLICE #11:	**80**
SLICE #12:	**160**
SLICE #13:	**160**
SLICE #14:	**320**
Change?	

Output Display

1. Press the Aux key to view the Main Menu.

2. *Select* 2 for the Output display.

Setting The Data Bits

3. Move the cursor to DATA BITS.

4. *Toggle* until the required number is shown on the display (7 or 8). If the wrong data bit is selected, the data may be not be presented correctly on the printout. Scintrex recommends selecting 8 bits first.

Setting The Baud Rate

5. Press the ←key to move the cursor to BAUD RATE.

6. *Select* the appropriate baud rate. The baud rates of the IPR-12 and your external device must be identical. Use the highest possible baud rate to minimize the dumping time.

Setting The CR Delay

7. Move the cursor to CR DELAY.

8. *Enter* the required Carriage Return Delay.

Note: 0 is usually acceptable for a dump to a computer. When dumping to a printer a longer delay may be necessary. If portions of data are lost when printing, it may be necessary to increase the CR Delay.

Dumping one line of data at a time

9. Go to the LOCATIONS display and move the cursor to the P-LINE parameter in the RECALL area.

10. *Enter* in the line number and line direction of the data that you want to dump.

11. Return to the Output display and move the cursor to DUMP ONE LINE.

12. Press the Change/Enter key.

13. The IPR-12 will output the data for the line that you selected from the Recall feature in the Locations display.

14. To dump the data of the next line in the sequence, press the Change/Enter key. The IPR-12 automatically advances to the next line number and dumps the data for this line.

Dumping all of the data

15. Move the cursor to DUMP ALL DATA?

16. To initiate the dumping of data, push the Change/Enter key.

Notes: To pause the dumping, push Stop. To resume the data dump, press Start. To terminate the dumping, press Cancel.

Erasing The Memory

17. Move the cursor to CLEAR MEMORY?

18. Press the Change/Enter key.

19. The Erase Memory Warning prompt appears:

Are you sure? (Y/N)

Note: If you press Y, all data will be lost.

20. Press the N key to retain the data, press the Y key to erase the data from memory.

Note: The Setup parameters remain unchanged.

Locations Display

1. Press the LOCATN key.

Setting The Current

2. Move the cursor to CURRENT.

3. *Enter* 555.

Setting The Station Number

4. Move the cursor to STAT.#.

5. *Enter* 0.

6. Press the DIRECTN key.

7. *Select* E.

Selecting The Attribute

8. Move the - cursor once to A:

9. *Select* +

Setting The Station Separation

10. Move the cursor to STAT.SEP.:

11. *Enter* 25.

Setting C-Line

12. Move the cursor to C-LINE.

13. *Enter* 1200

Selecting Direction

14. Press the DIRECTN key.

15. *Select* N.

Setting The Current Electrode Location

16. Move the cursor to C1:

17. *Enter* 1200.

18. Press the DIRECTN key.

19. *Select* W.

20. Move the - cursor key once to A:

21. *Select* 0.

22. Move the cursor to C2:

23. *Enter* 25

24. Press the DIRECTN key.

25. *Select* W

Note: C1 and C2 may be interchanged. However, the convention in dipole-dipole and pole-dipole is that C1 is closest to P1.

26. Move the - cursor key once to A:

27. *Select* +

Setting P-Line

28. Move the cursor to P-LINE.

29. *Enter* 1200

30. Press the DIRECTN key.

31. *Select* N.

Setting Potential Electrode Location

32. Move the cursor to P1:

33. *Enter* 0.

34. Press the DIRECTN key.

35. *Select* E.

36. Press the - cursor key once to A:

37. *Select* +

38. Repeat steps 34 through 39 and enter the following data:
P2: 25 E +
P3: 50 E +
P4: 75 E +
P5: 100 E +
P6: 125 E +
P7: 150 E +
P8: 0 E x
P9: 0 E x

Setting The Recall

39. *Enter* the data into the Recall field in the same manner if required.

Note: The Locations display is now ready for an imaginary survey. This is a good time for you to become familiar with the Move feature. The following steps enable you to familiarize yourself with this feature.

40. Move the cursor key with the + and - keys to MOVE. (Usually you would use the - cursor key twice.)
41. Select MOVE by pressing the Change Enter key a few times. Notice how the numbers with the + attribute increment by 25.

42. *Enter* as 'STAT.SEP:' the value of your present station number but proceeded by a minus sign (-). For example, the station number is 175, enter -175 as the station separation.

43. Select MOVE by pressing the Change Enter key. The station number should be 0 and all other numbers at their original value.

44. *Enter* 25 for STAT.SEP.: The instrument is ready again for the imaginary survey. The display should be as follows:

```
CURRENT:  555                  MOVE:
STAT #:    0E        A: +      ST.  SEP.:  25

C-LINE#:          1200N        C1:1200W          A: 0
                                  C2:25W            A: +

P-LINE 3:         1200N        P1: 0E               A: +
                                  P2: 25E              A: +
                                  P3: 50E              A: +
                                  P4: 75E              A: +
RECALL:                           P5: 100E            A: +
STAT.#:             0E          P6: 125E            A: +
P-LINE #:         1200N        P7: 150E           A: +
                                  P8: 0E               A: X
                                  P9: 0E               A: X

Change  ?                                          BAT1: bbb
```

Information Display

1. Press the INFO key.

Selecting The Array

2. Move the cursor key to ARRAY SELECTED.

3. *Enter* 2 (for Pole-Dipole).

The K-Factors

The K-Factors appear as the electrode locations are already entered and an array was chosen with known geometry. K8 shows ERR because of equal locations of P8 and P9. If you select OTHER in the array area, you must enter the K-Factor that you have calculated for yourself. Note that the K-Factor must be entered in the proper form when using 'Feet' for spacing to obtain the apparent resistivity in ohm-eter. To enter the K-factors move the cursor to K1 and *Enter* the calculated value, repeat for all of the K-factors.

Making Notes

4. Move the cursor to NOTES:. A faint cursor in the form of an underline character appears below the N of NOTES:.

5. Press the T key until T appears in the first character position.

6. Press Next.

Note: If you enter an incorrect character, press the Clear key and enter the correct character.

7. Press the H key until H appears in the second character position.

8. Press Next.

9. Press the I key until I appears in the third character position.

10. Press Next.

11. Press the S key until S appears in the fourth character position.

12. Press Next twice to leave a space in between S and the next character.

13. Press the key and Next combinations to enter in the following: IS MY FIRST TEST

Characters 0-9, A-Z, ., +, - can be entered in the Notes area.

Note: If you want to delete (or overwrite) text, place the cursor after the character that you want to delete (by pressing the Next key) and press the Clear key. The Clear key acts as a backspace key and deletes the character. To delete an entire line, move the Cursor to the end of the line and press the Clear key until all of the characters are erased.

The display should look like the following, however the battery level may show a different value:

```
ARRAY SELECTED:     2
1-Dip.Dip          2-Pol.Dip          3-Schlumb
4-Wenner         5-Gradient          6-Pol.Pol.
7-Other

K-FACTORS
K1:314.3             K2:943.3             K3:1888.3
K4:3150.6            K5:4732.3            K6:6635.5
K7:183.4

NOTES:
THIS IS MY FIRST TEST

MEM. FREE (%):  100

Change ?                                  BAT2:   0
                                            BAT1:   144
```

The instrument is now ready for an imaginary survey using the self test. If you are using the IPR-12 for the first time you may want to proceed to the Operating Procedures - 'Testing The IPR-12' to become familiar with the operation (page 5-5).

OPERATING PROCEDURES

On/Off Procedures

The On/Off key alternately turns the instrument On and Off. If you turn the unit off while a reading is in progress, the reading is automatically terminated and the current data is lost.

Notes:

- If a reading is not in progress, the IPR-12 turns off automatically after one minute if no key is pressed. This is to conserve battery power.

- The unit also turns off without any warning when the main battery level drops below approximately 100.

The first display to appear is the Locations Display unless the previous data was not recorded, in which case the Numeric Slice display appears. This still enables you to record the data.

Setting Up a Measurement

Entering The Current

1. On the Locations display, move the cursor to CURRENT:.

2. *Enter* the transmitter current.

   Note: The current can also be entered after a measurement, or while the measurement is in progress (see "Note:" at end of on-line procedures at the bottom of the next page).

Advancing The Locations

3. Move the cursor to MOVE:.

4. Press CHANGE ENTER.

5. Verify that the locations are correct.

Measuring The Electrode Resistance

6. Press START.

7. Inspect the electrode resistances.

8. If the resistances are within acceptable limits, press START to initiate a reading.

   Notes:

Synchronization and Gain Setting

- The IPR-12 now proceeds to obtain initial synchronization and to set the gain. (Bucking out of the SP is not necessary with the IPR-12). This process lasts for about 1.5 to 2 cycles.

- Occasionally, the transmitter may not be On. When this occurs, the gain cannot be set and the unit cannot synchronize which results in the message 'Sync. Problem...'. If this occurs, do the following:

  1. Wait until the transmitter is On which is indicated by distinct meter movements and press START to re-start the gain setting and synchronization phase.

- If you want to view the noise of a specific dipole on the analog meter see 'Observing Noise on a Selected Dipole' that is later on in this section.

On-Line Procedures

These are the procedures that you perform during a measurement.

Inspecting The Meter Display

9. Inspect the Meter display for a few cycles and verify that all dipoles have a stable signal. It is unlikely that good data can be obtained if large SP drift is present or by the presence of noise. Large SP drift is indicated by the shifting of the bars sideways while the presence of noise is indicated by random shifts.

10. If the bars drift off scale, push Z (zoom) to re-scale the display.

11. Observe the analog meter if there seems to be any problem as it provides you with more information.

Changing The Analog Meter To Another Dipole

12. Press an appropriate Number key (1-8) to switch the analog meter to any valid dipole.

Observing The Bar Graph

13. Press GRAPH. The bar graph of the dipole with the highest dipole number appears. If the graph is too small or is over-flowing the top, press Z (zoom) to re-scale.

14. Press an appropriate Number key (1-8) to view the Graph of the desired dipole.

15. Press NUMBER. The Numeric display appears.

Inspecting The Data Numerically

16. Inspect and monitor the data while the reading progresses. Closely monitor the Mx and S.D. of the dipoles with the weakest signal (Vp) to ensure good quality data.

17. Wait until the reading is automatically terminated (number of selected cycles) or manually terminate the measurement by pressing STOP.

Note: Error messages may appear along the bottom of the display accompanied by a Beep. See the Troubleshooting section.

Note: Instruments with software Version l.3 and later allow the current to be entered while a measurement is in progress as follows: press CHANGE and enter the current after the prompt at the bottom left hand corner of the display. When finished, press ENTER. The instrument response to keystrokes is somewhat slow as the microprocessor is carrying out other tasks at the same time.

Off-Line Procedures

These are the procedures that you perform after a measurement:

18. Inspect the following displays by scrolling with the Up or Down cursor key:

Numeric Slices, dipole 1..4
Numeric Slices, dipole 5..8
Numeric data (as on-line)
Calculated data

Note: Some Cole-Cole data may be missing if no satisfactory curve match could be obtained. A typical case for this is 'TEST'data.

19. Push either:

LOCATN to enter the current if it wasn't done already or to review the electrode locations etc. or
INFO to enter or add to a note or
CANCEL if you want to discard the data and return to the Locations display or
RECORD if you want to record the data in memory or
GRAPH if you want to inspect the graphs by following the procedures outlined in the On-Line procedures.
Note: Due to a function conflict of two keys, it is not possible to exit from graph to 'RECALL' and INFO. Push 'NUMBER' first and then branch out from there.

Entering Notes

20. Push INFO and move the cursor to 'NOTES'.

21. Follow the steps outlined under INFO display in the Setting-Up the IPR-12 Display. To add to or change an existing note use the NEXT key and move the cursor to the desired place and enter new text. To delete text use the CLEAR key to backspace over the text.

Comparing Data

22. To compare the data between the data last recorded and the present data, press the +/- key to toggle between the two data sets.

Recording Data

23. To record the data, press RECORD.
Notes:

- This records the data and NOTES:.. in memory. The notes are cleared from the NOTES field and cannot be repeated for later measurements.
- Recording cannot occur if the Locations Display is on the screen due to a function conflict with the Next key function. Switch to another display such as Number and then press the RECORD key.

- This completes the measurement process.

Recall Previous Data

1. In the Locations Display, set the P-LINE# and the STAT.#: parameters (below the word “RECALL”).

2. Press RECALL.

3. Inspect the data by scrolling through the four data displays.

4. Press NEXT to view the data of the next station. By pressing the NEXT key you can scan through all of the data in the order that the data was collected.

5. Press CANCEL to stop the Recall function.

Testing The IPR-12

The IPR-12 uses an internal test generator when you select the 'TEST' parameter from the Initialization Display (see Setting Up the IPR-12). For first time users, if you have followed the steps outlined in the previous section, proceed to step 7. To perform a self test do the following:

1. Ensure that there are no input wires connected to the signal input terminals on the IPR-12.

2. If the unit is Off, press the ON/OFF key.

3. Press START.

4. Inspect the electrode resistances. They should all show 'OVERL'.

5. Short out one dipole input at a time in sequence and check if the corresponding displayed value drops below 0.3k?.

6. Remove the short when all of the dipoles are tested.

7. Press START and take a reading for about 10 cycles.

   Notes:

   - The IPR-12 parameters should already be set-up if you have followed the procedures in the previous section, 'Setting Up The IPR-12'.

   - After the measurement is complete, all measured data is automatically analyzed to ensure that the data meets the specifications. If there is a problem, the following message appears, 'Test Failure: Channel n' (see the specifications section for nominal values).

8. When the test is complete, disable TEST in the Initialization Display.

Observing The Noise At The Input

There are two methods to observe noise:

- on the analog meter
- on the signal-noise monitor display

Observing Noise Of a Selected Dipole on The Analog Meter

To observe noise on a selected dipole do the following:

1. Select the desired dipole by selecting the 'SYNC CHANL:' on the Initialization Display.

2. With the transmitter Off, attempt to take a reading. The IPR-12 should display 'Synch Problem...'.

Notes:

- Noise may let the IPR-12 try to take a reading which would be indicated by displaying the duration. If this occurs, press START to re-start the process.

- The meter needle may be off-scale, press Z (zoom) to set it to mid-scale.

3. Observe the Analog Meter for SP drift and noise. The Full Scale value for the analog meter is displayed on the bottom of the LC display. The highest sensitivity is $\pm$50mV.

4. If the needle drifts off scale, re-zero it be pressing Z (zoom).

5. Press CANCEL and reset the 'SYNC CHANL:' when you are finished.

Observing Noise Of a Selected Dipole on The Signal-Noise Monitor Display

1. With the transmitter off, select the Signal-Noise Monitor option from the Main Menu by pressing 4.

2. Press the appropriate number key (1-8) to view the data of the desired dipole.

3. Press Z (zoom) to re-zero the display in order to bring the trace into the center of the screen.

4. Press either NEXT to increase the full scale value, or CLEAR to decrease the full scale value to obtain a meaningful display.

5. Press Cancel when you are finished.

The Display Heater

The display becomes sluggish if the ambient temperature is very low. A thermostatically controlled heater limits the operating temperature to
-15°C. Scintrex suggests that the display heater only be enabled (Initialization Display) when needed to conserve battery power. For example, if the unit is not going to be used for a couple of hours during a survey day, the heater should be disabled and re-enabled about 15 minutes prior to resuming the survey. If the display heater is enabled and the ambient temperature is above -15°C, the display heater is automatically turned off. To enable the display heater do the following:

1. Ensure that the heater batteries are installed. (See Getting Started Section).

2. From the Initialization Display, move the cursor to HEATER.

3. Toggle to select YES.

Note: If the battery level of the display heater (BAT2:bbb) drops below approximately 100 the heater is automatically turned off.

Outputting Data

Exact instructions on how to dump data cannot be given as it depends on the equipment that you have available. To verify that the data is on the disk, Scintrex recommends that you first dump the data to a computer and then from the computer, dump the data to a printer, or inspect it by other means, such as the LIST.COM program.

There are two programs supplied with the IPR-12:

• DOWNLOAD.EXE
• LIST.COM

DOWNLOAD.EXE is a communications program that is specifically designed for dumping IPR-12 data. Other commercially available programs may also be used, when properly configured. See Appendix C for operating instructions.

LIST.COM is a program which enables you to inspect the dumped data. However, you cannot edit the data. This program is licensed to Scintrex by its author for distribution with the IPR-12. See Appendix D for operating instructions.

Connecting An External Device

The RS-232C serial port can be interfaced with any compatible external device for outputting data from the IPR-12. It has a 7 or 8 bit ASCII, one start, one stop bit, no parity format and the baud rate is keypad selectable for standard rates between 300 to 57.6k (See Section 3.2 OUTPUT). To accommodate slow peripherals, a selectable carriage return delay is also available and handshaking is done by X-on/X-off.

1. Unscrew the Data Output connector cap and connect the RS-232C cable (P/N 745081) between the external device to the Data Output connector.

Dumping Data

1. Either turn the printer On or execute the DOWNLOAD.EXE program.

2. Select OUTPUT on the Main Menu and verify the dump parameters.

3. Move the cursor to DUMP DATA: and press the Change Enter key.

Note: See Appendix C for DOWNLOAD.EXE operating manual.

Viewing Dumped Data

1. Execute the LIST.COM program to view the dumped data on a computer.

Note: See Appendix D for LIST.COM operating manual.

EXAMPLE OF A DATA DUMP

Job #: 1 — Date: 91/05/14
Operator: R. MILLER — SERIAL #: 002

P-Line: 1200E — Units: Metre
Array: Dipole-Dipole — Mx From:670ms to 850ms

Station	P1	P2	P3	P4	P5	P6	P7	P8	P9
	C-Line	CI	C2	Curr.	Timing	Time	:		
D:	VP	SP	Mx	S.D.	Res.		Dur. : K-Fact.		Rho
	M1	M2	M3	M4	M5	M6	M7 : M"		Tau
	M8	M9	M10	M11	M12	M13	M14: RMS		#Wi
275N	275N	287.5N	300N	312.5N	325N	337.5N	350N	362.5N	375N
	1200E	250N	512.5N	205	2	13:37:41:			
1:	2248.69	-6	13.11	0.02	11.0		17:	235.6	2585
				42.13	36.83	32.19	27.66	182.74	0.50
	23.56	19.86	16.63	13.80	11.38	9.31	7.57	0.850	11
2:	828.29	-12	15.85	0.04	16.2		17:	942.5	3808
				49.22	43.28	38.00	32.82:	210.54	1.00
	28.08	23.78	20.00	16.66	13.79	11.32	9.25:	0.762	11
3:	330.80	-5	21.59	0.07	14.0		17:	2356.2	3802
				64.65	57.14	50.39	43.74:	270.94	2.00
	37.61	32.01	27.07	22.67	18.85	15.55	12.77:	0.730	11
4:	128.60	3	18.84	0.36	18.7		17:	4712.4	2956
				54.43	48.34	42.87	37.44:	239.78	4.00
	32.37	27.69	23.52	19.76	16.49	13.65	11.23:	0.545	11
5:	56.31	1	19.48	0.82	24.7		17:	8246.7	2265
				55.32	49.18	43.65	38.22	250.07	8.00
	33.09	28.39	24.18	20.41	17.09	14.24	11.79:	0.781	11
6:	35.42	-20	24.16	0.41	12.4		17:	13194.7	2280
				70.41	62.44	55.25	48.22	296.54	4.00
	41.58	35.53	30.14	25.33	21.12	17.51	14.44:	0.725	11
7:	28.25	-28	30.19	0.60	8.2		17:	19792.0	2727
				88.96	78.80	69.58	60.60:	356.40	4.00
	52.14	44.50	37.72	31.66	26.38	21.87	18.05:	0.982	11
8:	14.06	47	37:31	1.02	3.8		17:	28274.3	1939
				103.63	92.49	82.32	72.35:	425.03	16.00
	62.79	54.04	46.19	39.04	32.78	27.40	22.81:	0.811	11

Notes: P9 ABOUT 100M FROM POWER LINE

Note: The maximum value of Rho is 9999999. If the Rho is larger than the maximum, it is clipped to 9999999.

Note: Occasionally, TAU and RMS will be blank and Wi will contain an Error Code. These codes are explained in Section: Calculated Data Display.

CONNECTING THE ELECTRODES

The following information tells how to connect the electrodes for common arrays such as Pole-Dipole etc. Two methods are commonly used;

• Snake method - for short spacings.
• Multiconductor cables - for longer spacing where dragging of a Snake becomes difficult.

Using The Snake

The Snake is a bundle of wires of different lengths jacketed to connect each electrode to the IPR-12. The Field Wire Terminator allows for easy and quick connection and disconnection from the instrument. A re-inforcement plate in the instrument lid enables a cut-out to be made for wire entry. Survey procedures can result in that the potential electrode array leads or lags the current electrodes. This results in that either the longest, or alternately the shortest wires are connected to Dipole 1. Dipole 1 should be connected to P1 and P2. Connecting the Field Wire Terminator to the IPR-12 as shown below results in proper connections.

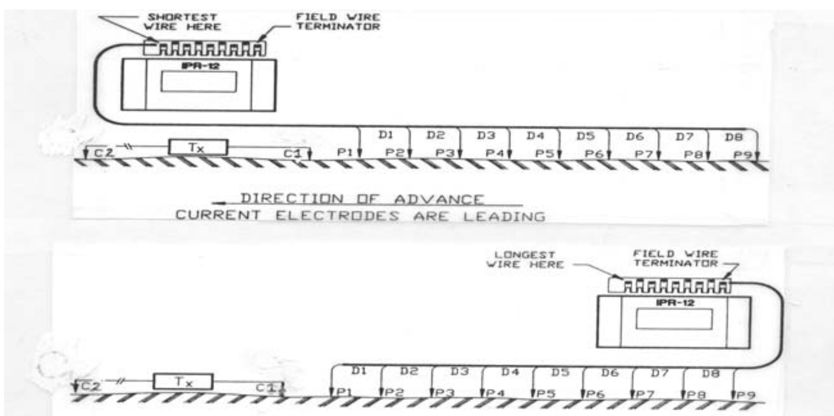


Figure 6: Connecting The Electrodes With The Snake

Connecting The Wire To The Field Wire Terminator

To connect the wires to the IPR-12 via the field wire terminator, do the following steps:

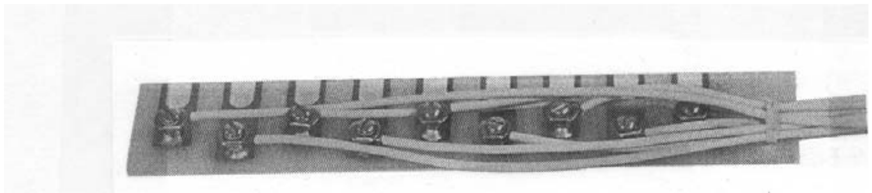


Figure 7: The Field Wire Terminator

1. Using a wire stripper, strip approximately 10mm of the protective insulation off of the end of the wire.

2. Loosen the appropriate screw on the terminator, pull up the desired U-shaped clip and insert the stripped end of the wire underneath the clip.

   Ensure that the selected electrode corresponds to the appropriate binding post on the input module of the IPR-12.

3. Firmly tighten the screw to secure the wire underneath the clip.

4. Follow steps 1 to 3 for each connection that you require.

5. Using string, tie the wire bundle to the terminator plate.

6. Connect the field wire terminator to the input module of the IPR-12 by loosening each binding post and inserting the indented side of the field wire terminator underneath the posts.

7. Tighten each binding post to ensure that the field wire terminator is well connected and secure.

8. Connect the wire bundle to the D-Ring at the side of the instrument case with a cord to prevent stressing the connections.

Using The Multiconductor Cable

The Multiconductor Cable Adaptor (P/N 745 031) must first be connected to the IPR-12 before the Multiconductor Cables can be connected.

Note: The Multiconductor cables are not suitable for dragging to a new location as is done with a Snake. The normal procedure is to move the array by moving the cable which becomes free to the front of the other cables.

1. Clean and dry the terminals free from dust and dirt.

2. Tighten the binding posts.

3. Install the adapter and secure the two screws.

The figure shown below shows how to position the cables to a maximum of six dipoles. P1 is connected to the binding post at the right hand side of the adaptor. Proper connection of the other electrodes is automatically assured by connecting the cables in series. A takeout via a binding post at the end of each cable allows connection to the respective electrode. Cables of a particular length may be used for shorter separations, but are cannot be connected in series for greater spacings.

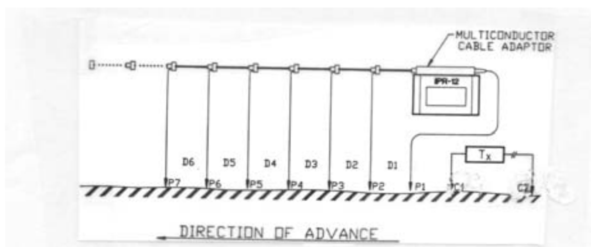


Figure 8: Connecting The Multiconductor Cable

It is not necessary to lock the connectors together with the locking nut, if the plug is fully inserted.

Additional cables may be positioned beyond the last dipole in use but care must be taken not to disturb other cables while a measurement is in progress.

Precautions

Actual contact to the ground is normally made with Stainless Steel electrodes or with Non-polarizing Porous Pots which are filled with Copper Sulphate solution. The latter method is the preferred way, due to the much lower drift produced compared with the ST.ST. electrodes.

In either case, it is important to keep the electrode resistance as low as practical. High electrode resistance and poor quality wire to electrode connections may result in noisy data. The electrode resistances should be kept in the low k?. This may not always be possible and a few tens of k? may have to be accepted.

As most of the measurements are done with a 2 second or longer timing, effects of the cable insulation are minimal. Hidden problems which may result in altered data for the dipoles with the lowest Vp may arise with 1 second timing, cable length in excess of 200m, unsuitable cable insulation and large differences in the Vp between the first and the last dipoles. Under these conditions it is very important to keep the electrode resistance low. The choice of the material of the Multiconductor Cables by Scintrex is such to minimize the material's effect.

Electrical leakage is the common cause of poor data in IP surveys. The problem is the worst between the first and the last dipole due to the large difference in signal amplitude. The wide spacing of the binding posts and the Teflon insert in the multi-pin connector, minimizes this effect, nevertheless it is important to keep the input area clean. Scintrex suggests that the wires be terminated directly to the binding posts if leakage is suspected in rainy areas.

IPR-12 MEASUREMENTS AND CALCULATIONS

Introduction

The IPR-12 measures the following parameters for each dipole

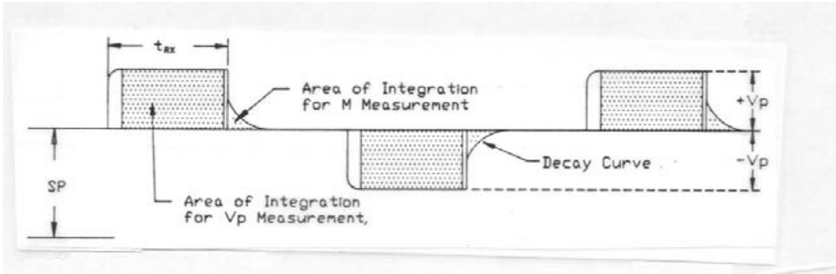


Figure 9: Waveform at the Input Terminals of the IPR-12

There are three additional parameters that the IPR-12 measures and records:

• electrode resistance
• starting time of the reading
• duration of the measurement in IP cycles

In addition, the IPR-12 calculates the following parameters:

• K-Factors for the apparent resistivity calculations
• apparent resistivity
• Cole-Cole data

Electrode Resistance Measurement

The electrode resistance is measured sequentially in a repeating manner,
dipole after dipole. This results in the true resistance value which each dipole poses. The data displayed is not averaged, therefore changes in resistance are updated fully at each resistance scan. The final values prior to the second 'START' key press are retained and stored with other data in memory. The measuring stimulus is a 10Hz squarewave AC signal which does not cause electrode polarization.

Time and Duration

The 'TIME' parameter represents the time of day at the start of the IP measurement (subsequent to the second 'START' key press). The 'DURATION' is the number of cycles averaged on a dipole by dipole basis.

Self Potential (SP) Measurement

The Self Potential displayed and recorded is the average of the DC voltage present across the respective input terminals during the course of the measurement. It consists of the actual SP and the DC voltage due to the polarization on the electrodes (negligible for porous pots).

Primary Voltage (VP) Measurement

The Primary Voltage is integrated between 10% and 80% of the current on time, to account for deformation of the primary pulse due to large chargeability, transmitter instability or noise. Vp is continuously averaged (stacked) to enhance the signal quality.

Chargeability (M,Mx) Measurement

Several phenomena can alter the shape of the time domain induced polarization decay curve such as the following:

• electromagnetic (EM) coupling
• interline coupling
• variation of the average size of metallic particles
• degree of interconnection of metallic particles
• other IP sources.

The figure shown below illustrates these effects:

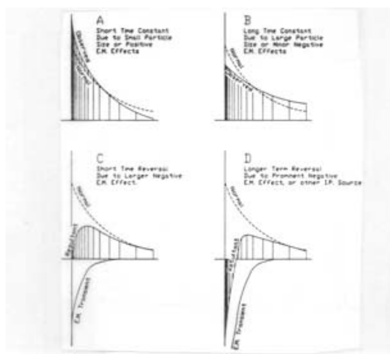


Figure 10: Decay Curve Shape and How it is Affected by Various Phenomena

Positive electromagnetic coupling effects or small particle size may give rise to an abnormally fast decay (Case A). Case B may imply a slower decay due to a minor negative transient or IP responses from large metallic particles and other various causes. Cases C and D, where the values of the initial slices are considerably reduced or are even negative, show the effect of electromagnetic transients of increasing amplitude or effects of other nearby IP anomalies.

Slice Timing - Breaking the current off time into multiple time windows (slices) resolves complicated decays. The slice widths are chosen so that the closely spaced samples are taken at the initial portion where the change in the rate of decay is the greatest. This technique applies the most when Cases C and D occur.

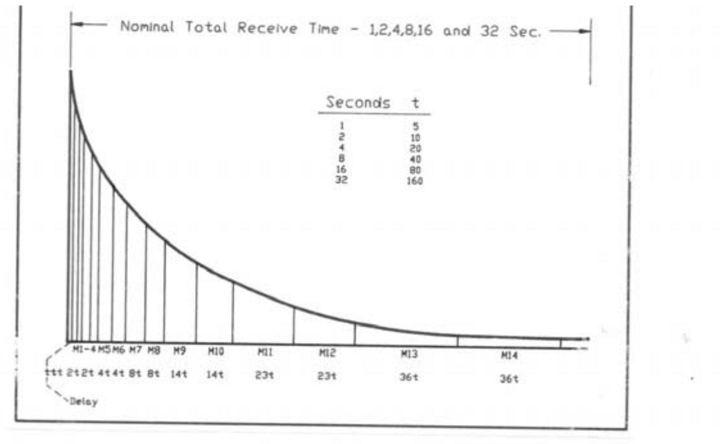


Figure 11: IPR-12 Timing for the Slices of an IP Decay Curve, Where t depends on t_{TX}.

The figure shown above generally illustrates these arrangements. The table shown in Appendix G, gives the slice width, slice start and end times as well as the mid-point for each slice with reference to the current Off transition.

Secondary Voltage (Vs) - To improve the quality of the measured data, the secondary voltage (Vs) measurement is averaged separately for each slice by integration. The Vs integration takes place over the times shown in the table in Appendix G. In addition to integration, the signal quality is enhanced by the Vs data being continuously averaged (stacked) and then used in the chargeability (M) calculation (Vs is not displayed or recorded).

Chargeability Calculations

Chargeability (M) Calculation - The chargeability is defined in the following calculations:

$$M = \frac{Vs * 1000}{\quad} \text{ in mV/V}$$

Vp

Where:

$$V_s = \frac{\int_{t1}^{t2} Vs * dt}{t_r}$$

t_1 = time at beginning of slice
t_2 = time at end of slice
$t_r = t_1 - t_2$ (integrating period)
V_p = voltage during the current On time
V_s = voltage measured by the receiver during the integrating period with the current off.

K-Factor Calculations

The K-factor calculations are based on the general formula for the calculation of the potential distribution in a current dipole.

$$\Delta V = \frac{I\rho}{2\pi} \quad \frac{1}{C_1P_1} - \frac{1}{C_1P_2} - \frac{1}{C_2P_1} + \frac{1}{C_2P_2}$$

The K-factor calculations take the position information of C1, C2 and P1, P2 etc. from the Locations Display and the Units from the Info Display to obtain a value which results in ohmmeter for the resistivity calculations. Note that it does not matter which electrode is C1 or C2.

Apparent Resistivity Calculation

The apparent resistivity is defined as:

$$RHO = K * \frac{V}{I}$$

Where, Vp is the Primary Voltage of the respective dipole, I is the transmitter current and K is the K-factor.

Cole-Cole Calculations

True **Chargeability (M")** - is the ration of voltage immediately after, to the voltage immediately before an infinitely long charging current turn off. It is expressed in mV/V.
Time Constant (TAU) - is expressed in seconds. The following are the allowed values for the time constants:

2^{-14} = 0.00006, 2^{-13} = 0.00012, 2^{-12} = 0.00024, 2^{-11} = 0.00048,

$2^{-10} = 0.0009765$, $2^{-9} = 0.001953$, $2^{-8} = 0.003906$, $2^{-7} = 0.00781$, $2^{-6} = 0.0156$, $2^{-5} = 0.0312$, $2^{-4} = 0.0625$, $2^{-3} = 0.125$, $2^{-2} = 0.250$, $2^{-1} = 0.5$, $2^{0} = 1$, $2^{1} = 2$, $2^{2} = 4$, $2^{3} = 8$, $2^{4} = 16$, $2^{5} = 32$, $2^{6} = 64$, $2^{7} = 128$, $2^{8} = 256$, $2^{9} = 512$, $2^{10} = 1024$, $2^{11} = 2048$

Note that the value of exponent (frequency dependence) parameter, c, is not displayed as it is fixed at c = 0.25. For more information on the Cole-Cole parameter, see Appendix B.

Root - Mean - Square - Deviation , RMS - is expressed in % and is calculated according to the following formula:

Where:

$$RMS\% = \left\{ \frac{1}{\#W_i} \sum_{1}^{\#W_i} \left(1 - \frac{M_i}{M_{ic}} \right)^2 10^4 \right\}^{1/2}$$

W_i = number of slices which are included in Cole-Cole parameter calculation.

M_i = values of measured chargeabilities.

M_{ic} = corresponding values of the 'best fit' master curve chargeabilities.

The value of the RMS quantifies the goodness of the fit between the measured decay curve and the 'best fit' master curve, which is selected from the set of master curves with parameters c = 0.25 and 26 time constant values in the range of 2^{-14} to 2^{11} (in binary increments).

Notes: A number of slices are excluded automatically from the Cole-Cole calculations due to the slow filter response. The following is a list of slices included and excluded:

Timing	**Slices Excluded**	**Slices Included (Wi)**
1 second	first 4	10
2 second	first 3	11
3 second	first 1	13

All slices are used for 8 seconds and longer. However, more slices can be excluded regardless of the timing selected with the setting "OMIT # SLICES:" in the Initialization Display. This omits slices which could be contaminated by an inductive coupling effect which can interfere with the IPR-12 determining the Cole-Cole parameters. For more information about the Cole-Cole parameters, see Appendix B.

Note: Slices with excessive noise are automatically excluded from calculation as well. The criteria used is that the chargeability value of the excluded slice is less than five times the value of S.D. This will affect the late slices. If the number of slices, W_i, that qualify for the calculation is less than five, the Cole-Cole parameter determination will not be performed resulting in blank characters on the display and also in the dump.

Statistical Calculation (S.D.)

The error (S.D.) is the standard deviation of Mx for each dipole, which is a standard method of defining data quality in statistics. Note that the surveys which are solely based on resistivity, where the chargeability is not measured, statistical information based on Mx is still a useful tool in assessing the noisiness of a measurement.

Rejection

The rejection algorithm rejects the data in cycles which have been disturbed by an occasional noise spike, as is frequently encountered due to distant thunderstorm activity or cultural noise.

Rejection, if enabled, operates on Vp and on each M-slice of each dipole including Mx. Once a minimum of three cycles has been acquired, data is continuously analyzed by a proprietary algorithm, which rejects bad data. The remaining good data is used in the continuous averaging process to obtain the displayed and recorded data.

MAINTENANCE

Charging The Batteries

Important: For longer battery life, avoid overcharging. Batteries should not be charged over night if the unit was used for a short period of time. Ideally, the batteries should be completely discharged before recharging however, since this is not always possible, re-charge the batteries approximately 11/2 times the time period that the instrument was used. For example, if the IPR-12 was turned on for 2 hours, recharge the batteries for 3 hours.

The battery charger (P/N 738 019)that is supplied with the IPR-12 can charge one set of Ni-Cad batteries in 15 hours. Two chargers are needed to charge the main batteries and the heater batteries simultaneously. If possible, the batteries should be charged between 0 - 50°C.

1. Place the line voltage selector switch on the charger in the position according to your line voltage (115V or 230V)

2. Unscrew the charger connector cover(s) from the side panel of the IPR-12.

3. Connect the charger cable(s) connector to the IPR-12 connector(s).

4. Plug the charger(s) into the AC outlet.

Important: Remove batteries during shipment and storage

Checking The Desiccant Pack

The IPR-12 requires an internal desiccant pack
to prevent the build-up of moisture inside of the IPR-12.

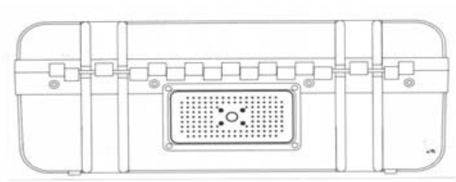


Figure 12: The IPR-12 Back Panel

1. Remove the four thumb screws from the cover of the desiccant compartment located on the back panel of the IPR-12.

2. Remove the desiccant pack that is inside the compartment.

3. Check the colour of the granules. Pink granules indicate that the desiccant requires drying out. Refer to the Basic Maintenance procedures outlined below.

Basic Maintenance

The IPR-12 requires the following basic maintenance.

1. Clean the area around the input terminals, the field wire terminator and the connectors of the Multiconductor cables by using soap, water and tissue paper to remove all dirt.

2. Rinse the devices with clean water. Do not immerse the connectors in water.

WARNING: Do not use strong solvents to remove dirt as it may damage the finish on the instrument.

3. Dry thoroughly.

4. Check the insulation around the potential electrode wires. Poor insulation is the most frequent source of trouble.

5. Periodically dry out the desiccant pack by placing it near a heat source such as a hair dryer. The granules inside the pack indicate if a drying out period is required. Deep blue indicates that the desiccant is dry while pink granules indicate that drying out is necessary.

Important: Scintrex recommends that you periodically dry out the desiccant pack even if the instrument is in storage. This is particularly critical if the instrument is stored at an elevated temperature and high humidity.

Replacing the Fuses

There are two types of fuses used in the IPR-12. One type of fuse is for the battery supplies while the other type is for the input signals.

The battery fuses are the standard, clip-in fuses and the input fuses are the type with attached leads, soldered to the back of the motherboard. To replace either type of fuse do the following:

1. Remove the 16, 6-32 self-sealing screws that surround the IPR-12 front panel.

2. Carefully lift the main unit out of the case ensuring that the cables are safe.

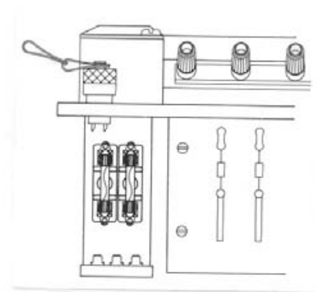


Figure 13: The Rear Panel View With Cover Removed

3. From the rear of the unit, view the input fuses on the Motherboard and the two battery fuses.

4a. The battery fuses snap in and out of the connectors. Both batteries are quick acting, 1 Amp glass fuses.

4b. To replace an input fuse, de-solder the damaged fuse and re-solder a new fuse.

CAUTION: When testing the fuses, use the high range on the Ohm meter to prevent the fuses from blowing by the meter current.

5. Re-install the unit into the case ensuring that the cables are not between the bottom of the chassis and the case.

6. Re-install the 16 screws to secure the unit to the IPR-12 case.

Multiconductor Cable

The insulating material of the Multiconductor cables minimizes the effects of dielectric absorption. The effect which is similar to Chargeability causes trouble with large spacings, large potential electrode resistances and short timing. This should be kept in mind when replacing the cables. Scintrex strongly recommends that you obtain replacement cables from Scintrex (P/N 738 080).

The figure shown below is the wiring diagram for the cables:

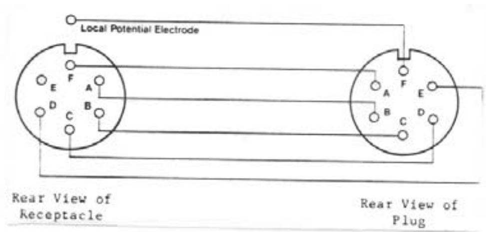


Figure 14: Wiring of the Multiconductor Cable

Note: Do not use acid type fluxes when resoldering the connections as this may lead to electrical leakage and corrosion.

Removing The Lid

To remove the lid you must remove the hinge pin:

1. There is a diamond knurl on each end of the hinge pin.

2. One knurl unscrews, remove this knurl and slide the hinge pin out to remove the lid.

3. Screw the knurl onto the hinge pin to ensure that it does not get misplaced.

TROUBLESHOOTING

Problems	**Possible Causes**	**Possible Solutions**
ON/OFF key does not respond (no beep)	No batteries	**1.** Install batteries
	Batteries installed incorrectly	**1.** Ensure that each battery is in the correct polarity as shown on the inside of each tube and that the IPR-12 instrument batteries are installed as opposed to the heater batteries. See Getting Started section.
	Discharged batteries	**1.** Recharge batteries as outlined in the Maintenance section.
	Corroded contacts	**1.** Clean the battery contacts
	Blown power fuse	**1.** Replace fuse.
Display is invisible	Incorrect screen intensity	**1.** Push the ON key ensuring that the unit beeps. **2.** Press the AUX key. **3.** Press the ← or → key until the display appears (up to 60 times).
Instrument immediately shuts off	Low main battery level	**4.** Recharge or replace main batteries.
Error message for Sync. Chanl.	Numeric entry not within the range.	**1.** Enter a valid Sync. Chanl. number
ERR message for K-factor	Invalid electrode locations	**1.** Electrode locations must not overlap.
OVERL message in E1. Res.test	Disconnected electrode	**1.** Connect electrode **2.** Repair wire
	Blown input fuse	**1.** Do steps 1 to 6 in Testing The IPR-12 **2.** Replace input fuse.

Overload At Input	Excessive input signal	**1.** Reduce transmitter current . See also Appendix A.
	Spikes at signal transitions	**1.** Set the Full Sat. Det. to NO. This problem may occur with Gradient, Schlumberger or Wenner arrays. Since the IPR-12 is not detecting saturation over the full IP cycle, pay more attention to the quality of the data. Use porous pots as potential electrodes.
Low Signal Ch:n	Insufficient signal on one or more dipoles indicated by n	**1.** Increase the transmitter current. If at maximum, continue and measure only other dipoles.
Overl Ch: n	Internal saturation on one or more dipoles indicated by nnnn due to SP drift of increase in signal.	**1.** If persistent during reading, Cancel and Restart, or continue and measure only other dipoles.
Sync. Problem	Missing input signal	**1.** Turn on transmitter.
	Incompatible timing	**1.** Select proper timing.
	Transmitter timing out of tolerance.	**1.** Use crystal controlled transmitter.
	Missing Sync. dipole.	**1.** Select the proper dipole for synch. It may have been deleted when an electrode was disabled.
	Internal and external signal present	**1.** Disable test generator or disconnect input wires as required.
	Too much noise	**1.** Reduce noise. Synchronize from the dipole with the largest signal.
	Input fuse blown	**1.** Do the steps outlined in the Testing the IPR-12.
		2. Replace fuse.

Heater does not come on	Heater parameter not selected	**1.** Ensure that the Heater parameter from the Initialization display is enabled.
	Batteries not installed.	**1.** Install heater batteries - see the Getting Started section.
	Discharged batteries.	**1.** Charge heater batteries.

Note: Additional messages may appear on the display, these messages are self explanatory.

SPECIFICATIONS

Inputs:	Multiple inputs, allowing from one to eight simultaneous dipole measurements. Nine binding posts mounted in a single row for easy reversal of the connection of the dipole array.
Input Impedance:	16M?
Input Voltage Range:	50µV to 14V
Sum Vp2..Vp8:	14V
SP Bucking Range:	±10V. Automatic, linear slope correction operating on a cycle by cycle basis.
Chargeability Range:	0 to 300mV/V
Tau Range:	2^{-14} to 2^{11}s
Reading Resolution of Vp, SP and M:	Vp - 10µV, SP - 1mV, M - 0.01mV/V
Absolute Accuracy:	Better than 1%
Common Mode Rejection:	>100db
Vp Integration Time:	10% to 80% of the current on time.
IP Transient Program:	Total measuring time keyboard selectable at 1, 2, 4, 8, 16 or 32 seconds. Normally 14 windows except that the first four are not measured on the 1 second timing, the first three are not measured on the 2 second timing and the first is not measured on the 4 second timing. See diagram in the Measurement and Calculation section. An additional transient slice of minimum 10ms width, and 10ms steps, with delay of at least 40ms is keyboard selectable.
User Selectable IP Transient Program	The user is allowed to program the transient slice widths of up to 14 slices. The minimum slice width is 10ms and initial delay cannot be less than 40ms. The user can choose to program less than 14 slices, however, the remaining slices must be initialized with 0ms. Programmed slices must be contiguous.

Transmitter Timing:	Equal on and off times with polarity reversal each half cycle. On/Off times keyboard selectable at 1, 2, 4, 8, 16, 32 s. Timing accuracy of transmitter better than ±100ppm required.
External Circuit Test:	All dipoles are measured individually in sequence, using a 10Hz square wave. Range is 0 to 2 M? with 0.1k? resolution. The resistance is displayed on the LCD and is also recorded.
Synchronization:	Self synchronizes on the signal received at a keyboard selected dipole. Time limited to avoid mistriggering.
Filtering:	RF filter, anti-aliasing filter, 10Hz 6 pole lowpass filter, statistical noise spike removal, linear drift correction, operating on a cycle by cycle basis.
Internal Test Generator:	SP = 1200mV, Vp = 807mV, M = 30.28mV/V
Analog Meter:	For monitoring input signals; switchable to any dipole via keyboard.
Keyboard:	17 key keypad with direct access to the most frequently used functions.
Display:	16 line by 40 characters, 240 x 128 dot graphics liquid crystal display. Displays instrument status during and after the reading.
Display Heater:	Used in below -15°C operation. Thermostatically controlled. Requires separate rechargeable batteries for heater display only.
Memory Capacity:	Stores information for approximately 400 readings when 8 dipoles are used, more with fewer dipoles.
Real Time Clock:	Data is time stamped with year, month, day, hour, minute and second.
Digital Output:	Formatted serial data output to printer or computer etc. Data output in 7 or 8 bit ASCII, one start, stop bits, no parity format. Baud rate is keyboard selectable for standard rates between 300 baud and 57.6k Baud. Selectable carriage return delay to accommodate slow peripherals. Handshaking is done by X-on/X-off.
Standard Rechargeable Batteries:	Eight rechargeable Ni-Cad D cells. Supplied with a charger, suitable for 115/230V, 50 to 60Hz, 10W. More than 20 hours service at +25°C, more than 8 hours at -30°C.

Ancillary Rechargeable Batteries:	An additional eight rechargeable Ni-Cad D cells may be installed in the console along with the Standard Rechargeable Batteries. Used to power the Display Heater or as back up power. Supplied with a second charger. More than 6 hours service at -30°C.
Use of Non-Rechargeable Batteries:	Can be powered by D size Alcaline batteries, but rechargeable batteries are recommended for longer life and lower cost over time.
Field Wire Terminator:	Used to custom make cables for up to eight dipoles, using ordinary field wire.
Optional Multi-Conductor Cable Adapter	When installed on the binding posts, permits connection of the Multidipole Potential Cables.
Operating and Storage: Temperature Range	-30°C to +50°C
Dimensions:	Console; 355 x 270 x 165mm Charger; 120 x 95 x 55mm
Weight:	Console; 5.8kg Standard or Ancillary Rechargeable Batteries; 1.3kg Charger; 1.1 kg

APPENDIX A: NOISE SOURCES AND EXCEEDING LIMITS

Noise Sources

Noise is any undesired electrical signal that is superimposed onto the received IP signal. The effect of noise are more predominant with low input signals and will eventually render accurate measurements impossible. It is therefore important to minimize noise as much as possible.

There are two types of noise sources:
- natural noise sources.
- man made noise sources.

Natural Noise Sources

There are various sources of noise that occur naturally.

• instrumental noise.
• telluric noise that the wires and electrodes pick up.
• noise produced by the wire insulation.

The IPR-12 instrumental noise level generally is lower than other ambient noises that you encounter in a field survey.

Telluric noise is present everywhere but may vary from place to place and from time to time. It is dependent to a great extent by solar activity.

Noise that is produced by wire insulation is not a noise in the true sense but the result is field data that contains noise. It is caused by dielectric absorption in the wire insulation, which results in an apparent IP decay where there is no chargeability in the ground. The errors caused by dielectric absorption are dependent on the wire insulation, the length of the wire and the electrode resistance. The insulation capacity must not be confused with dielectric absorption as it results in decays in the hundreds of microsecond range and is therefore unimportant.

Man Made Noise Sources

Many man made noise sources can interfere with obtaining good quality data.

• power line and radio interference.

- noise produced by operator's clothing particularly nylon and/or rubber boots worn during the winter.
- noise produced by disturbing the wires.
- self potential drift produced by the polarization of metal electrodes.
- electrical leakage due to faulty insulation.

An operator can cause noise in a variety of ways. If an operator wears nylon clothing or rubber boots in the winter it can cause a tremendous amount of noise especially if the electrode resistances are high.
For best results, do not move around or touch the console unnecessarily. If an operator disturbs the wires while a measurement is in progress, the insulation of the wire may deform and cause noise.

Self potential drift may create data that contains noise due to polarization that takes place at the surface of recently placed or disturbed metal electrodes.

Exceeding Limits

Whereas the lower limit of the IPR-12 is restricted by noise, the upper limit is restricted by internal power supplies, in that the signal may drive amplifiers into saturation. Supervisory circuits monitor critical signals and invoke appropriate alarm signals.

Internal saturation can take place if the received signal increased after the gain was set, or if there was considerable SP drift.

Saturation at the input is the effect of large signal between the reference electrode and any other electrode. The electrode which is the reference depends on which dipole was selected for synchronization, usually it is dipole 1. The following short list shows the relation between synchronization dipole and reference electrode:

Synch. Dipole	**Ref. Electrode**
1	P2
2	P3
etc.	etc.

The reference electrode can be visualized as the pivoting point of a see-saw (balance). Let us look as an example for the case where 8 dipoles are used:

- P2 is the reference
- P1 swings about P2 by Vp of dipole 1. P9 swings about P2 by the sum of Vp2 + Vp3 + ...+ Vp8.

Usually, the sum of Vp2 .. Vp8 is less than Vp1, and therefore Vp1 is the critical parameter. There are occasions where this is not the case, and the sum is becoming the critical parameter. Under these conditions, it may be advantageous to change the synchronization to for instance dipole two or three, therefore changing the pivoting point to P3 or P4 respectively.

Saturation at input may take place even though the voltages just described are well below the 14 volt upper limit of the instrument. The reason for this is that the current on-pulse from the transmitter is not necessarily a nice square pulse of the duration of the transmitter timing, but a train of narrow pulses which may result in an average value (measured by the IPR-12) below their peak value. The input protection of the IPR-12 responds to the critical peak value. Transmitters which use phase control for the current regulation, such as the TSQ family have this characteristic. If saturation at the input occurs, reducing the current with the current stabilization, will not solve the problem as the peak value is not changed, just the average. The proper method of correction is to use a lower voltage setting.

APPENDIX B: COLE-COLE SPECTRAL PARAMETER ESTIMATION

1.0 Introduction

The IPR-12 time domain receiver is capable of estimating on line, immediately following the measurement of IP transient, the values of spectral parameters m, and tau (τ) although it uses the fixed value of 0.25 for the parameter c. In the following sections we will explain how this is done, and what are the benefits for the users. In Section 2. a short overview of Cole-Cole parameter estimation techniques in both time and frequency domains is presented. Following this is the description of the difficulties which in many field situations decrease the

reliability of the spectral parameter estimation. Last but not least is a problem caused by an inadequate timing accuracy of the receiver discussed in section 3.4. The effective solution to these various problems is presented through fixing the parameter c. The technique of Cole-Cole parameter estimation in the IPR-12 receiver is presented in Section 3. In particular, the use of the weighing factors, and their use in reducing the effects of the inductive coupling (IC) is discussed in Sections 3.2 and 3.3. The topic most important for the user, of how to make best use of the estimated spectral parameters, is presented in Section 3.1. In addition to the obvious direct use of the spectral parameters, the less obvious application of the IPR-12 receiver to measure phase characteristics cost efficiently is presented in Sections 3.1.2 and 3.1.4. The means of approximately estimating the value of the parameter c are explained in Section 3.1.3. The process of spectral parameter estimation is a data smoothing process, and the factor which determines the confidence of the estimate of spectral parameters is a valuable factor in estimating the overall quality of measurement of the IP transient itself as explained in Section 3.5.

2.0 Cole-Cole Parameter Estimation in Frequency and Time Domain IP

Extensive field measurements have confirmed that the Cole-Cole dispersion in the form of the equation

$$Z(\omega)= R_0 \ (l\text{-}m[l\text{-}l/[l+(iw\tau)^c]]) \qquad (1)$$

will conveniently describe all spectral IP responses over a wide range of angular frequencies ω=2 f (Pelton et al, 1978). Four parameters:

R_0 - the d.c. resistivity of the rocks
m - chargeability amplitude (true chargeability)
c - the exponent (or frequency dependence)
τ - the time constant (tau)

can be used to accurately describe measured IP effects. For real rocks, Pelton et al (1978) showed by in-situ measurements that c ranges from about 0.1 to 0.5, with 0.25 the most typical value. By definition (Seigel, 1959) the chargeability m ranges from 0 to lV/V (or l000mV/V). In practice, it seldom exceeds 500mV/V. The time constant tau ranges from 10^{-3} sec to 10^4 sec. R_0 is highly variable. These parameters form a basis which appears most useful and convenient for mineral discrimination.

In the frequency domain (FD) the IP complex impedance is measured directly. In order to reliably determine IP spectral parameters magnitude and phase spectra have to be accurately measured over a wide range of frequencies. If the distortions of the field data due to inductive coupling effects are properly removed by a computer inversion program (Hallof and Pelton, 1980), the spectral IP response can be determined. Computer inversion is then used to obtain the apparent values of the Cole-Cole parameters. If required, the effects of dilution of the response of the target body by the host rock (Pelton et al, 1978) could be corrected to obtain true values of the parameters that describe the source of the IP effect.

Cole-Cole spectral parameters may also be extracted from time domain (TD) IP measurements (Johnson, 1984). An indirect approach is used. Measured decays are compared with a set of master decay curves which are precalculated for a large number of c and tau values. Parameters c and tau of the "best fit" master curve are declared preferred estimated values for the measured data, and the chargeability m is calculated. The determination of Cole-Cole parameters is performed off line on IBM PC or a compatible computer, to which the IP decay data measured by the Scintrex IPR-ll time domain IP receiver are transferred.

The Scintrex IPR-12 time domain IP receiver estimates the value of Cole-Cole parameters immediately following the completion of the IP decay curve measurements. The frequency dependence parameter c is fixed at 0.25. The Cole-Cole parameters m, and tau are computed, displayed, stored and dumped, along with the original data, in the form of normalized magnitude of the IP decay in 14 time windows (slices Ml to M14).

2.1 Difficulty in Resolving FD or TD Responses

The phase angle may be calculated from the complex impedance equation (1). Phase is a rather complicated function of frequency and spectral parameters m, c and tau:

$$\varphi = \operatorname{arctg} \frac{m(\omega\tau)^c \sin(\pi c/2)}{(1-m)(\omega\tau)^{2c} + (2-m)(\omega\tau)^c \cos\pi c/2) + 1} \quad (2)$$

The phase maximum occurs at frequency

$$fc = \frac{1}{2\tau\pi\,(1-m)^{1/2c}} \quad (3)$$

Computer programs like "123" spreadsheet or MathCAD may be conveniently used to numerically solve both equations. The phase spectra, i.e. the variation of the phase vs. the frequency, are often plotted on a double logarithmic scale. On such a double logarithmic plot, the phase is symmetric about fc. At low frequencies the phase has slope of +c, and at high frequencies it has a slope of -c. Therefore the phase angle curves with larger c (0.4 to 0.5) are more peaked, whereas the curves with low value of c (0.1 to 0.2) are shallow and broader. The main effect of increasing the chargeability m is to increase the phase angles. The time constant tau in equations (1) and (2) is associated with the angular frequency ω in the form of the product ωt. Hence, if tau is increased by a factor and ω decreased by the same factor, the amplitude and the phase angle are unchanged. The net effect is as if both amplitude and phase spectra are shifted horizontally to the left.

In the frequency domain, phase angles, measured in milliradians (mrad), are very often not larger than few tens of milliradians, and they change slowly, over several decades of frequency, by an even smaller amount. Over a restricted frequency range of one to two decades the phase spectra of dispersions with different parameters may be adjusted to be almost identical. Therefore reliable discrimination between phase curves with different m, c and tau is possible only if the phase spectra is accurately measured over a wide range of frequencies which starts at 0.01 Hz and extends over several decades. This is often difficult to do in practice.
The accuracy of the frequency domain IP spectral measurements is restricted at both the high and the low ends of the required frequency range. Unless a short potential electrode separation is used or a remote reference is employed for noise cancellation, IP measurements at low frequencies are time consuming and signal stacking becomes less effective in removing the measurement errors (San Filipo and Hohmann, 1983) caused by presence of telluric noise. For this reason phase angles are not routinely measured at frequencies below 0.01 Hz.

At higher frequencies, inductive coupling (IC) effects may corrupt the IP phase measurement. Stripping of the inductive coupling effects in order to obtain phase characteristics which include only IP effects is not without problems. Major and Silic (1981) have demonstrated that small changes in the parameters used to approximate inductive coupling by a Cole-Cole dispersion can produce very large changes in the calculated value of tau. In addition, the interaction between induced polarization and inductive coupling effects is, in general, more complex than a simple multiplication of two Cole-Cole dispersions representing IP and IC effects, as used by Hallof and Pelton (1980).

We shall demonstrate by the following numerical example that, if the frequency range is, for practical reasons, limited to about two decades of frequency starting at about 0.03 Hz, the phase angle differences between IP responses with different values of the parameter c may be made small by adjusting parameters m and tau. These small differences may be obscured by the measurement errors, leading to erroneous estimation of spectral parameters.

The parameter which is most affected by this problem is tau. However the chargeability m may change considerably, as well.

In Example 1 it is assumed that a Cole-Cole dispersion with parameters m=185.94mV/V, c=0.22 and tau=1.5sec represents the IP response of the ground. In Table 1 its phase is tabulated for different frequencies. The phase angle difference between the phase angle of this dispersion and four dispersions with different set of spectral parameters is tabulated as well. The criterion for selecting these dispersions was that, in addition to being a good fit, dispersions #2, #3 and #4 are included in the master curve set used by Johnson (1984), and dispersion #5 is included in the master curve set of the IPR-12 receiver. The phase differences are small (less than 1 mrad or about 4%) over a range of almost two decades of frequencies, even for the dispersion #2, for which tau differs from the assumed correct dispersion #1 by factor of 67.

The overlap is wider and values for tau differ less for dispersions #3 and #5, as the differences in c parameter are smaller. Dispersion #2, with the smallest c, has f_c furthest away from the range of overlap, to bring the rate of phase change vs. frequency close to the rate of other dispersions with higher frequency dependence c. This shift is achieved mainly by adjusting tau, whereas the phase magnitude adjustment is achieved mainly by adjusting the chargeability m. A receiver with the resolution of 0.1 mrad or better is required, and the measurement errors, including the errors due to the imperfect IC stripping, have to be very small, in order to differentiate between different spectra during the process of estimation of the spectral parameters.

As the phase angles measured in FD and the time decay of chargeability measured in TD are different manifestation of the same physical phenomenon, it follows that the differences between chargeability vs. time readings for these four dispersions must be small. The chargeability readings for the dispersion #1 and the chargeability differences between #1 and other four dispersions for a 2 sec time sequence (T_{on}=T_{off}=2sec with polarity reverse following each T_{off}) are tabulated in Table 2. Note that the fundamental harmonic component of the excitation waveform is 1/8 Hz and that the harmonic components with a significant amplitude extend to about 3 Hz, which coincides with the range over which the phase angle curves overlap. The root mean square error of the relative differences (RMS%dev), and the root mean square error of the differences (RMSdev) are tabulated as well. If the chargeability magnitude m of the assumed ground response changes, the differences and RMSdev will change proportionally, but RMS%dev will remain constant.

The chargeability readings in this example are reasonably large, but the differences of chargeability readings between different dispersions are below lmV/V. A receiver with a resolution of 0.lmV/V or better (the IPR-12 receiver has a resolution of 0.0lmV/V) is required for measuring the chargeabilities, if one is to assure a good fit. All other measurement errors have to be low as well. This includes the timing accuracy of the receiver as explained in Section 3.4.

The example shown is not an isolated occurrence. Look-alike FD or TD responses shown on Tables 1 and 2 are not limited to the range of tau>l or to smaller values of c; they are present throughout the whole range of tau and c.

The fact that difficulties exist in inverting real FD field measurements corrupted by noise and inductive coupling effects is overcome by fixing the value for frequency dependence c during the process of stripping the IC effects and subsequent determination of the IP dispersion parameters (Hallof and Pelton, 1980). The reason for fixing c during the dispersion parameter determination process in the IPR-12 receiver is similar. In many field situations, the required accuracy for reliable, unambiguous estimation of dispersion parameters is just not easily achievable. Consequently the estimated value of m may change considerably and the estimated value of tau may change by more than one order of magnitude, for repeated measurements at the same station, in the presence of a small amount of noise in the chargeability readings. Users of the IPR-12 may find such jumps in the values of m and tau disturbing. An effective solution for this problem is to fix the frequency dependence parameter c. This, in fact, is not as restrictive as it appears at first. In the next section we shall explain how to make good use of the information obtained from the Cole-Cole parameters m and tau, and how the limitation of a fixed c may be overcome by a second TD measurement at a different timing sequence.

3.0 Cole-Cole Parameter Estimation in the IPR-12 Receiver

The approach used in the IPR-12 receiver for spectral parameter estimation through "best-fit" curve matching is, in principle, identical to the method used by Johnson (1984) with the following differences:

a) The value of the frequency dependence c is fixed at c=0.25 while the time constant tau is allowed 21 discrete binary (power of 2) values in the range 2^{-14} to 2^{11} for 2 sec timing sequence. At other timing sequences this range is scaled by the factor T_{on}/2sec, e.g. 2^{-10} to 2^{15} for T_{on}=32 sec.

b) Weighing factors wi in the curve fitting algorithm do not bias the curve fitting to late decay times. They are allowed values of either 1 (used for curve fitting) or 0 (ignored for curve fitting).

c) The effects of inductive coupling can be reduced by setting 0 weighing factors for up to three early slices and thereby removing them from the curve fitting algorithm. No other technique has been provided to strip the inductive coupling effect from IP the decays.

The reason for the difference a) was given in section 2.1. The reasons for differences b) and c) will be explained in sections 3.2 and 3.3.

3.1 Use Of Cole-Cole Parameters with Fixed C

3.1.1 Direct Use of the Parameters m and tau

The frequency dependence parameter c contains information on the grain-size distribution of the metallic mineral particles that are the source of IP anomalies (Pelton et al, 1978). The maximum theoretical value expected is c=0.5 in the case of a unique grain-size. If a broad, non-unique distribution is present, c is usually in the range of 0.25 to 0.35. Most responses fall into this range and for this reason c is, during process of spectral parameter estimation in the IPR-12, fixed at 0.25. In the case of two overlapping distributions of grain-size, or in case of a very broad continuous distribution, c is in the range of 0.1 to 0.2. Obviously, if c is fixed at 0.25, the information about grain-size distribution is lost. We shall later in this section explain how one may overcome this limitation.

Increased polarizable mineral concentration increases value of the chargeability parameter m. This information is, of course, readily available in the IPR-12 receiver and it may be plotted and interpreted directly.

There is a plenty of evidence that the time constant tau is directly dependent upon the grain-size of the mineralization that is the source of the IP effect. For fine grained mineralization f_c from equ. (3) is at high frequencies and tau is small. For coarse grained mineralization the opposite is true. One may directly interpret the change in time constant to the change in grain-size of the mineral particles. This information is, of course, readily available in the IPR-12 receiver and it may be plotted and interpreted directly.

We have demonstrated in section 2.1. that the differences between TD decays (or phase angle spectra) for Cole-Cole dispersions with different values of the parameter c may be made small, if m and tau are properly adjusted. For 2 sec timing sequence a good match may be achieved between a set of master curves with fixed c=0.25 and dispersions having the parameters c and tau in following ranges:

c=0.l0, tau range: far in excess of 0.001 to 1000 sec
c=0.20, tau range: in excess of 0.001 to 1000 sec
c=0.25, tau range: 0.001 to 1000 sec

c=0.30, tau range: 0.003 to 300 sec
c=0.40, tau range: 0.1 to 10 sec

The time constant tau of the master curves is allowed 26 discrete binary (power of 2) values in the range of 2^{-14} to 2^{11}. The upper limit in the range of tau could be increased up to 16 times by using longer transmitter time sequences.

3.1.2 Indirect Measurement of Phase Characteristics

If the IP ground response is in the indicated range of c and tau, a TD IP measurement at a single time sequence may be used to indirectly measure phase angles (spectra) over about one and a half decades of frequency, i.e. the estimated values of m, and tau may be used in equation (2) to calculate phase spectra in the frequency range starting at about 1/3 or 1/2 of the fundamental excitation frequency f_0 (f_0 =1/2pT , T=4T_{on}) and extending for almost two decades. By performing the measurement at two different time sequences, which are spaced by factor of 8 or 16, the range in which phase data fit well may be further extended.

Example II will illustrate this: If the ground IP response is m=610.03mV/V, c=0.l, tau=0.0l sec, a good fit will be achieved by the IPR-12 receiver at a 32 sec transmitter timing sequence with the dispersion m=244.23mV/V, c=0.25, tau=4sec. The phase differences between the two dispersions, as shown in Table 3, are small in the range of 0.003 to 0.03 Hz. The estimate m=274.38mV/V, c=0.25, tau=0.25sec at 2 sec timing is a good fit in the frequency range 0.1 to 3 Hz. The agreement in phase angle over the range of three decades of frequencies is better than 5% and it has been obtained by IP TD measurements at only two timing sequences. It is interesting to note that the good phase fit extends below the fundamental excitation frequency: one is therefore spared the time consuming measurement at 1/3 of f_0 . In the FD, measurement of phase at seven frequencies (sequence 1-3-10) is required to obtain similar information. This is rather slow procedure, compared to the TD.

Table 4 demonstrates the same for a dispersion with m=217.75mV/V, c=0.4, tau=3sec, which at 2 sec timing sequence matches the master curve m=368.10mV/V, c=0.25, tau=64sec, and at 32 sec timing sequence matches with m=397.06mV/V, c=0.25, tau=0.25sec. A good phase agreement is obtained over almost three decades of frequency. Note that the difference in parameter c for both examples from c=0.25 is relatively large, which makes both the decay curve fit and the phase fit poorer. In the case of a smaller difference in c between the measured response and c=0.25 of the master curve set, the decay curve fit would be better, and the phase agreement more accurate over an even wider frequency range. The extended information contained in the time domain measurements at two timing sequences cannot be handled by the IPR-12, but it could be used by an off line inversion program to obtain a more accurate estimate of spectral parameters without placing any restriction on the value of the parameter c. However, many users may be fully satisfied with the expedient and reliable estimates obtained at a single timing sequence.

3.1.3 Evaluation of the Parameter c

The last two examples demonstrate a technique to better evaluate c the from Cole-Cole parameter estimation at two different timing sequences:

a) If the estimates of the parameter tau at two time sequences do not differ much (factor of two or less), then the actual value of the parameter c is close to the fixed value of 0.25 used in the IPR-12. E.g. the dispersion m=302.38mV/V, c=0.22, tau=0.3 sec matches with m=265.75mV/V, c=0.25, tau=0.5sec at a 2 sec timing sequence, and with m=267.75mV/V, c=0.25, tau=0.5sec at a timing sequence of 32 sec.

b) If the estimate of tau at longer timing sequence increases substantially, c is smaller than 0.25. E.g. for the dispersion m=610.03mV/V, c=0.l, tau=0.0lsec a good fit will be achieved by the IPR-12 receiver at a 32 sec timing sequence with the dispersion m=244.23mV/V, c=0.25, tau=4sec (Table 3). The estimate m=274.38mV/V, c=0.25, tau=0.25sec is a good fit at a 2 sec timing.

c) If the estimate of tau at a longer timing sequence decreases substantially, c is larger than 0.25. E.g. for the dispersion m=217.75mV/V, c=0.4, tau=3sec good fit will be achieved by IPR-12 receiver at a 32 sec timing sequence with dispersion m=397.06mV/V, c=0.25, tau=0.25sec (Table 4). The estimate m=368.10 V/V, c=0.25, tau=64sec is a good fit at a 2 sec timing.

The same rules apply for combinations of timing sequences other than 2 and 32 sec. In order to increase confidence of the assessment the ratio of the T_{on} times used should preferably be 8 or larger.

3.1.4 Indirect Measurement of Phase Ratio

The ratio of phase angles at frequencies usually separated by a factor of 10 may be used in reconnaissance FD surveys to determine whether the frequency at which the phase maximum occurs, fc, is below or above the investigation frequency range. If this ratio is less than 1, the phase is decreasing and the fc is lower than the investigation frequency. If the ratio is larger than 1, the f_{max} is larger than investigation frequency. This information is used in mineral discrimination (e.g. graphite vs. massive sulphides). The same information could be easily obtained from spectral parameters estimated by IPR-12 receiver. To determine the phase ratio between 3 and 0.3 Hz, $R_{3/0.3}$, it is best to use a 1 sec timing sequence. The value of the time constant tau for which $R_{3/0.3}$=1.0 varies from 0.25 (if m=l00mV/V) to 1.0 (if m=600mV/V). For larger values of tau the phase ratio is $R_{3/0.3}$<1, reaching 0.63 at tau=1024, m=l00mV/V. For smaller values of tau the phase ratio is $R_{3/0.3}$>1, reaching 1.5 at tau=1/1024, m=600mV/V. A good estimate of the value of the phase ratio $R_{3/0.3}$ may be determined by calculating the phases at 0.3 and 3 Hz from equation (2). An approximate formula, with an accuracy of better than 10%, limited by linear approximation, be used to relate $R_{3/0.3}$ with the parameters m in mV/V and tau = 2^N in seconds:

$$R_{3/0.3}=-0.04*N+0.00015*m+0.95 \quad (4)$$

To determine the phase ratio between 1 and 0.1 Hz, $R_{1/0.1}$, it is best to use a 2 sec timing. The value of the time constant tau for which $R_{1/0.1}$=1.0 varies from 0.5 (if m=l00mV/V) to 2.0 (if m=600mV/V). For larger values of tau the phase ratio is $R_{1/0.1}$<l, reaching 0.65 at tau=1024, m=l00mV/V. For smaller values of tau the phase ratio is $R_{1/0.1}$>1, reaching 1.55 at tau=1/1024, m=600mV/V. A good estimate of the value of the phase ratio $R_{1/0.1}$ may be determined by calculating phases at 0.1 and 1 Hz from equation (2). An approximate formula (accuracy better then 8%) may be used to relate $R_{1/0.1}$ with the parameters m in mV/V and tau = 2^N in seconds:

$$R_{1/0.1}=-0.04*N+0.00015*m+1.0 \quad (5)$$

Only one TD decay curve measurement is required to measure the phase ratio whereas in FD two phase measurements are required to obtain the same information.

3.2 Weighing Factors In The Curve Fitting Algorithm

A minor difference from the approach employed by Johnson (1984) is that the weighing factors w_i in equations (9) and (10), Johnson (1984), are either 1 or 0 in the IPR-12 receiver algorithm and consequently do not bias (emphasize) the decay at late times. The reason for this is that there may not be much difference in the magnitude of the noise contamination between the early (narrow) and late (wide) slices (integration windows), if the noise is predominately at low frequencies. Telluric noise, which is normally the main source of noise affecting IP measurements, has a spectrum which rapidly increases below 0.1 Hz. Noise reduction algorithms, like linear drift correction, are not effective enough to adequately eliminate these low frequency noise contributions. In addition, the signal to noise ratio may be lower in the late slices, as the IP signal decays quite rapidly (the ratio of chargeability readings for latest and earliest slice is M_l/M_{14}=7.2 for Newmont standard 2 sec IP decay which fits well c=0.25, tau=lsec).

Therefore, one might be tempted to bias the decay to the early times, where the signals are strongest. However, it has been felt that it is best to leave the decay unbiased. The exception to this is the elimination of slices from the curve matching process (weighing factor w_i=0 means that the corresponding slice is ignored) which is used under the following circumstances:

a) The decay transient caused by the filter extends into some early slices. It contaminates the IP decays rendering them unsuitable for IP spectral parameter estimation. In the 1 sec timing sequence, for example, the four earliest slices are not used. In the 2 sec timing sequence,
three slices are not used. In the 4 sec timing sequence one slice is not used. In all other timing sequences, all 14 slices are used.

b) Analogous to the need for high accuracy in the measurement of phase angles in the FD, is the need to precisely measure the IP decay in TD if spectral parameters are to be accurately determined. In helping to achieve this goal the resolution of the chargeability measurement has been increased 10 fold in the IPR-12 receiver, to 0.01mV/V. In addition, the slices for which the ratio of chargeability reading to the measurement error S.D. (for the definition S.D. see section 3.0 of the IPR-12 receiver manual) is less than 5, are automatically eliminated from the curve matching process by setting their weighing factors to 0. This feature prevents the late slices with low ratio of signal to noise from appreciably affecting the outcome of the curve fitting process, which is performed by minimizing the percent difference (log ratio) between the measured IP decay and the scaled master curves. Even a small amount of noise may produce a large percentage error, if the chargeability values are small, which normally occurs at late times. Noise induced small negative values of late-time chargeability readings for fast IP decays are eliminated by this criterion as well.

The effect of a +10% error in the last slice on the spectral parameter estimation is demonstrated in the following example: It is assumed that the IP dispersion is m=185.94mV/V, c=0.22, tau=1.5sec(dispersion #1 from Table 1 and 2). The IPR-12 spectral parameter estimate of the undistorted decay is m=165.66mV/V, tau=lsec, with RMS%dev=0.62%. The estimate from
the set of curves with c not fixed (0.1 increments, starting at c=0.l) is m=368.06mV/V, c=0.l, tau=l0sec with RMS%dev=0.42%. The measured, and now slightly distorted in M14, decay curve is compared with the master curve set. The IPR-12 estimate is now m=167.63mV/V, tau=4sec with RMS%dev=2.58%. Note that if c were not fixed, the best estimate of the spectral parameters is m=383.72mV/V, tau=l000sec, c=0.l with RMS%dev=2.18%. The estimate with the fixed c is less affected by this kind of error. In addition, the fixed c estimate of the undistorted decay is closer to the assumed IP dispersion.

3.3 Reducing The Effects of Inductive Coupling

No attempts have been made to remove (strip) inductive coupling effects by a spectral parameter estimation program in IPR-12. The reasons for this will be given after the examination of Tables 5 and 6, in which the chargeability readings of a broadband TD IP receiver (say the IPR-12 could measure all early slices) are shown for the assumed positive IC effects, with time constants 10 and 5msec, m=l V/V, c=l.0 (exponential decay). Note, that according to Major and Silic (1981) the inductive coupling time constant may range from 10 msec for strong coupling to 0.001 msec for weak coupling. Even if the simple exponential model for IC were acceptable, several conditions have to be fulfilled for the stripping to be successful:

a) The stripping program would have to take into the account combinations of positive or negative IP effect and positive or negative IC effect. This would be a rather complicated task for the IPR-12s resident microprocessor, but can be accomplished off line using a microcomputer.

b) The receiver should be broadband in order to measure several slices contaminated with the IC effect, in order to successfully separate the IC effect from the IP effect. One can see from the tables that only at the shortest timing sequence does a strong IC have significant readings in several of the early slices. The proper determination of IC parameters is therefore difficult. There is nothing basically wrong about this: TD IP is, indeed, used to reduce IC effects relative to IP effects, not to measure them.

c) An external synchronization would have to be used. The delay to the 50% point of the exponential decay is t_d =0.693*(time constant) i.e. 7 msec if the time constant is 10 msec. The receiver timing sequence for
the measurement of decays in 14 time windows which starts (in the self trigger mode) at 50% point is delayed by 7 ms resulting in an extremely large error in measuring the fast exponential IC decay. A much smaller error is caused by the timing error in measuring the IP decay, provided c is fixed. This will be detailed in the next section.

As explained in Section 3.2.,four early slices are automatically ignored in the spectral parameter estimation algorithm for the 1 sec timing sequence, three for the 2 sec timing sequence, and one for the 4 sec timing sequence. By examining the Tables 5 and 6 again one can see that, in case of strong coupling, two additional slices are contaminated by IC effects in the 1 sec timing sequence, and only one additional slice in 2, 4 and 8 sec sequences. Consequently, the approach taken in the IPR-12 in dealing with IC effects is to allow the operator to remove up to three slices, if they are suspected to be contaminated with IC, from the spectral parameter estimation program. These operator selected slices will be removed in addition to those automatically rendered useless by the filter response. If a 2 sec sequence is used only one slice has to be removed, in the case of strong coupling. If strong coupling effects are not expected, then the time to achieve required measurement accuracy by signal averaging (stacking) may be reduced by more than one half by using 1 sec transmitter timing sequence. The only penalty is that the range of evaluated time constants tau is shifted downward by a factor of two.

The adverse effects of eliminating a number of early slices from the curve matching process is a loss of equivalent investigation frequency bandwidth, as the early slices contain information on the higher frequencies. The differences between similar decay curves become smaller as indicated by smaller RMS %difference and

RMS difference values. Without fixing c the outcome of the spectral parameter estimation would become more ambiguous.

The effect of a +10% error (simulating an IC effect) in the fourth slice, M4, on the spectral parameter estimation is demonstrated in the following example:
It is assumed that the IP dispersion is m=185.94mV/V, c=0.22, tau=1.5sec(dispersion #1 from Table 1 and 2). It is also assumed that the 2 second mode is used with the 3 early slices missing. The IPR-12 spectral parameter estimate of the undistorted decay is m=165.66mV/V, tau=lsec, with RMS%dev=0.62%. The estimate from
the set of curves with c not fixed (0.1 increments, starting at c=0.l) is m=368.06mV/V, c=0.l, tau=l0sec with RMS%dev=0.42%. The measured, and now slightly distorted in M4, decay curve is compared with the master curve set. The IPR-12 estimate is now m=170.38mV/V, tau=0.5sec with RMS%dev=2.56%. Note that if c were not fixed, the best estimate of the spectral parameters is m=389.17mV/V, tau=0.lsec, c=0.l with RMS%dev=2.15%. The estimate with the fixed c is less affected by this kind of error. In addition, the fixed c estimate of the undistorted decay is closer to the assumed IP dispersion.

3.4 Importance of Accurate Timing Measurements In TD IP Spectral

The effects of a timing error on the IP spectral parameter estimation are demonstrated in the following example:
It is assumed that a decay transient from a strong IC coupling has shifted the receiver window times by 7msec toward the late times. It is assumed that the IP dispersion is m=185.94mV/V, c=0.22, tau=1.5sec(dispersion #1 from Table 1 and 2). It is also assumed that the 2 second mode is used with the 3 early slices missing. In addition, it is assumed that one more slice has been removed by the operator to eliminate IC contamination. The IPR-12 spectral parameter estimate of the undistorded decay is m=165.77mV/V, tau=lsec, with RMS%dev=0.61%. The estimate from the set of curves with c not fixed (0.1 increments, starting at c=0.l) is m=369.92mV/V, c=0.l, tau=l0sec with RMS%dev=0.34%. The measured, and now because of the timing error slightly distorted, decay curve is compared with the master curve set. The IPR-12 estimate is now m=162.22mV/V, tau=4sec with RMS%dev=0.08%. Note that if c were not fixed, the best estimate of the spectral parameters is m=200.93mV/V, tau=3sec, c=0.2 with RMS%dev=0.23%. The estimate with the fixed c is less

affected by this kind of error. In addition, the fixed c estimate of the undistorted decay is closer to the assumed IP dispersion.

The timing error was in our example introduced by a strong IC decay. Normally this is not a common occurrence. The IPR-12 uses the electronic trigger circuits monitored by the resident microprocessor for self synchronization at the 50% point of the decay. This approach produces low timing errors (about 0.25msec) which is important for the accurate spectral parameter estimation, especially if the spectral estimates are obtained without fixing the parameter c. Some receivers which use software based self synchronization algorithms have maximum timing errors equal to the sampling time, which may be l0msec.

3.5 Reasons For A Poor Curve Fit

The following observations should help in determining the reasons for poor curve fit, indicated by a large value of RMS% deviation reading (RMS% on IPR-12 display and printout):

If IP decays are free of noise and IC, and the estimated time constant tau is not at either end of the range for the timing employed, than RMS%dev<2.5% if all 14 slices are used, and RMS%dev<1.5% if only 11 slices are used. RMS%dev is a measure of the mismatch between the measured decay and the master curve set with the fixed value of c=0.25. The closer the value of the frequency dependence parameter c is to c=0.25 the better the fit and the lower is the value of RMS%dev. If the value of c of the ground response is exactly 0.25, then the maximum value of RMS%dev<0.6% in the case of matching all 14 slices (note that this is caused by the time constant tau being allowed to assume only discrete values).

If the RMS%dev readings are larger than the above values, the reasons could be following:

a) The time constant is at the end of the range: remedial action is to change timing sequence, i.e. to longer T_{on} times if tau=1024 (upper end of the range), or to shorter if tau=1/1024 (lower end of the range). Sometimes this may not help if the actual value of c is larger than 0.3 and the time constants are either much larger or much smaller than 1. Some useful information is obtained by knowing that the limit in tau is reached.

b) Excessive noise contamination, which could be assessed by observing the value of the error of the measurement, S.D., and comparing it with the chargeability readings in the late slices to obtain an estimate of the relative errors. The remedial action is to average more readings or to increase the signal amplitude by pumping more current into the ground. Normally the noise sources are telluric noise and man-made noise, but sometimes a possible source of noise could be a receiver electrode problem such as high contact resistance or electrode polarization changes (metal electrodes only).

c) IC contamination which generally increases with wider electrode separation and higher ground conductivity. In the case of strong IC coupling the operator could, by removing even one slice from the curve matching algorithm, substantially improve the goodness of the decay curve fit.

An important note: it takes time to "charge" the ground, especially if time constants tau are large, i.e. the excitation has to be present for many periods before the IP decays reach a steady state. If accurate spectral IP measurement are desired, turn on the transmitter as soon possible and wait for at least 10 periods. This settling phenomenon affects the late slices proportionally much more than the early slices. The resultant effect is that the value of the time constant estimate is smaller if the steady state has not been reached. The same problem exists in FD when measuring phase angles at low frequencies.

References

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-Cole-Cole Dispersion--				phase vs. frequency						
#	m[mV/V]	c	t [sec]	f [Hz]	0.01	0.03	0.1	0.3	1	3	10
1	185.94	0.22	1.5	ph1[mrad]	16.26	17.28	17.87	17.86	17.25	16.21	14.69
2	370.84	0.10	100.0	ph1-ph2	-1.88	-0.85	-0.13	0.09	-0.16	-0.76	-1.72
3	203.48	0.20	3.0	ph1-ph3	-0.84	-0.48	-0.12	0.11	0.25	0.26	0.17
4	139.27	0.30	1.0	ph1-ph4	1.65	0.77	0.10	-0.07	0.29	0.98	1.86
5	165.48	0.25	1.0	ph1-ph5	0.86	0.45	0.09	-0.09	-0.11	0.03	0.30

TABLE 1

-Cole-Cole Dispersion--				chargability vs. time at Toff=2sec															
#	m[mV/V]	c	t[sec]	slice	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	RMS%dev	RMSdev [mV/V]
1	185.94	0.22	1.5	ch1 [mV/V]	50.59	45.63	41.04	36.89	32.79	28.98	25.17	21.63	18.37	15.49	12.91	10.68	8.76	7.14		
2	370.84	0.10	100.0	cg1-cg2	-0.38	-0.11	0.11	0.21	0.25	0.24	0.21	0.16	0.09	0.03	-0.02	-0.07	-0.10	-0.13	0.8%	0.18
3	203.48	0.20	3.0	cg1-cg3	0.53	0.41	0.35	0.27	0.20	0.13	0.07	0.01	-0.03	-0.06	-0.08	-0.10	-0.11	-0.11	0.81%	0.23
4	139.27	0.30	1.0	cg1-cg4	0.77	0.32	0.05	-0.12	-0.21	-0.24	-0.23	-0.19	-0.14	-0.08	-0.02	0.03	0.07	0.11	0.83	0.26
5	165.48	0.25	1.0	cg1-cg5	-0.16	-0.23	-0.22	-0.21	-0.18	-0.14	-0.09	-0.05	-0.01	0.02	0.05	0.07	0.09	0.10	0.60%	0.13

TABLE 2

-Cole-Cole Dispersion--				phase vs. frequency							
#	m[mV/V]	c	t [sec]	f [Hz]	0.003	0.01	0.03	0.1	0.3	1	3	10
6	610.03	0.10	0.01	ph6 [mrad]	24.49	26.14	27.62	29.19	30.55	31.93	33.07	34.16
7	274.38	0.25	0.25	ph6-ph7	5.75	3.69	1.88	0.35	-0.30	0.12	1.66	4.52

INDUCTIVE COUPLING EFFECT, TIME CONSTANT 0.01 SEC

TIMING Toff(sec)	CHARGABILITIES (mV/V) M1	M2	M3	M4	M5	M6	M7
1	477.30	289.50	141.05	51.89	13.06	-1.77	0.14
2	232.54	85.55	21.52	2.91	0.22	0.00	0.00
4	58.51	7.92	0.61	0.01	0.00	0.00	0.00
8	4.50	0.08	0.00	0.00	0.00	0.00	0.00
16	0.04	0.00	0.00	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 5

INDUCTIVE COUPLING EFFECT, TIME CONSTANT 0.005 SEC

TIMING Toff(sec)	CHARGABILITIES (mV/V) M1	M2	M3	M4	M5	M6	M7
1	232.54	85.55	21.52	2.91	0.22	0.00	0.00

APPENDIX C: DOWNLOAD OPERATING INSTRUCTIONS

The DOWNLOAD.EXE program is an IBM-PC® compatible program comparable to Crosstalk or Procomm and has been provided for your convenience. If DOWNLOAD does not meet your requirements, for example if you have a computer which is not IBM® compatible, please ask your Scintrex representative for advice on what would be a suitable replacement.

What is DOWNLOAD?

DOWNLOAD is a serial communications program that allows you to transmit the data stored in your IPR-12 to an IBM-PC® or compatible computer. Data will be displayed on your computer screen and if you want, simultaneously stored in a file.

Will DOWNLOAD run on my computer?

If you have a 486 based computer with EGA graphics, DOWNLOAD should run on your computer. We also cannot guarantee that DOWNLOAD will run concurrently with other programs such as TSR (Terminate and Stay Resident) programs and Windows. DOWNLOAD was developed as a free standing program and is not meant to run in conjunction with other programs.

When I run DOWNLOAD, a box appears on my screen What do I do next?

The box that you initially see has two smaller boxes in it, one with the word **Continue** and one with the word **Exit** in it. If you want to continue, you may press **C** for continue or press **E** to exit the program. You may also use the left or right arrow keys to select your choice. When you press the arrow keys, the selected item will have a double line border. If you press the **Enter** key, the program executes the item that you selected.

Now I see two bars, one at the top of my screen and one at the bottom. What next?

DOWNLOAD uses what are called "Pull-Down Menus". The top bar contains the menu headings (Parameters, Files etc.) and the bottom bar is a message bar. To "pull down" the menu associated with each heading, press the first key (Hotkey) of the menu heading. Press **H** to get the menu for **Help**. You can now use the up and down arrow keys of your computer to point to a menu item. You can use the left and right arrow keys to move across the top bar menu headings. To execute a menu item function, you can highlight it using the up and down arrows and press enter or you may simply press the item's first letter.

How can I find out what a menu item does?

Many menu items have built in help files. Go to the **Screen** menu by leaving your current menu (press **ESC** key) and then pressing the **S** key. Now press the **F1** key. This gives you help on the **Mono reset** menu item. Press any key (such as ESC) to exit Help. Now move to **Color Reset** by using the down arrow and press **F1**. As before, press any key to leave the Help menu. It is advisable at this time to read the Help files of all menu items prior to executing them. You only need to use the arrow keys and F1 keys to read all Help files.

How do I change DOWNLOAD from color to monochrome and vice versa?

Go to the **Screen** menu and reset to either **Mono** or **Color**, and then save this as default by executing **Save as Default**.

What does Alt-X mean?

You have selected **Get Data** in the DOWNLOAD menu. To exit this screen you must press the **Alt** key and while keeping it depressed, press the **X** key.

Can I save the data I have seen on the Screen?

Yes, but only if a file was opened prior to receiving data. Do this by selecting and executing **Open file** in the **File** menu. Note that the file status is shown on the bottom of your screen.

What are the default Communication settings for the IPR-12?

57,600 baud, No parity, 8 data bits, 1 stop bit, Com 1.

What happens if I save the communication parameters?

A file named DOWNLOAD.--1 is created in your current directory containing your customized communication parameters. If you delete the file DOWNLOAD.--1, the default IPR-12 communication parameters given above will be used.

What happens if I Execute the "Save As Default" item in the Screen Menu ?

A file named DOWNLOAD.--2 is created in your current directory. This file contains the screen color (mono) settings selected by Scintrex.
If you delete this file, every time you run DOWNLOAD you will be asked if you have a color or mono monitor. This step can be avoided if you **Save as Default** the screen setting of your choice.

How do I download data to a file?

Read the Help file for **Get Data**. You must:

1. Open a file (See File Menu)
2. Select and execute **Get Data**
3. Use the keypad of the IPR-12 to start a dump of serial data from the IPR-12.

Can I use more than one File?

Yes, but before opening a new file, the old one must be closed. (When opening a new file, DOWNLOAD will prompt you to close your old file.)

After I download the data, what do I do next?

Exit the **Get Data** screen (**Alt-X**) and then press **E** to exit DOWNLOAD. Your file will be automatically closed (saved).

APPENDIX D:

LIST

A File and Browsing Utility

Version 7 October, 1989

Command key summary

Cursor keys
Cursor key Function

Command key summary

Letter keys
The letter key commands are mnemonic.
That is, the letter in some way, indicates

left arrow	scroll left 10 columns
right arrow	scroll right 10 columns
up arrow	up one (previous) line
down arrow	down one (next) line
Enter	continue to next page
END	position to end of file (bottom)
ESCape	Exit program unconditionally
HOME	restart from first line (top)
PgUp	scroll up one page, 23 lines
PgDn	scroll down one page, 23 lines

F-function keys

Function key	Function
F1	Displays the HELP screen
F3	Find NEXT occurrence of text after Scan or Find
F9	Find the PREVIOUS occurrence of text
F10	Exit to DOS

For changing display colors:

F2	Change background color for Find/Scan text
F4	Change foreground color for Find/Scan text
F5	Change background colore for main body of display
F6	Change foreground color for main body of display
F7	Change background color for top and bottom lines
F8	Change foreground color for top and bottom lines

what the command does.

Letter	Function
A	Find next occurrence of 'text' (Again)
B	Skip to end of file (Bottom)
C	Toggles Continuous scrolling
D	Scroll Dwon one page
F	Find 'text' regardless of case
G	Get new filename/filespec (also Alt-F)
H	Display the Help screen
K	Toggles keyboard key-ahead
L	Scroll LEFT 10 columns
M	Toggles Monitor retrace testing to eliminate snow
N	Down one (Next) line
P	Toggles the printing of displayed lines
Q	Quits current file and displays next file, if any
R	Scroll Right 10 clmns. command the 'R' command
S	Scan for exact text match, case dependent
T	Restart from first line (Top)
U	Scroll Up one page (23 lines)
W	Toggles the Wrap option for displaying long lines
X	Terminate, clear screen and exit do DOS
Z	Display the previous file

Letter keys

7	Toggles the 7-bit filter
8	Toggles the 8-bit filter

Control-keys

The Ctrl-key commands are entered by pressing Ctrl at the same time as you press one of the following letter keys:

*	Toggles the start filer
+	Position a given number of lines forwards
-	Position a given number of lines backwards
?	Dispalys the Help screen
space	Scrolls down one page
\text	Find any case ‘text’ going forwards
/text	Scan exact case ‘text’ going forwards
` or ↑	Find any case ‘text’ going backwards
‘ or ↓	Find exact case ‘text’ going backwards

Control key		Function
Ctrl-HOME		Position to a specific line by number
Ctrl-PgDn		Display next file
Ctrl-PgUp		Display previous file
Ctrl-left		Reset display to column 1, ie: scroll full left
Ctrl-A		Scroll full left
Ctrl-C		Display next page, scroll down
Ctrl-D		Scroll right 10 columns
Ctrl-E		Display previous line, scroll up 1 line
Ctrl-F		Send a formfeed control character to the printer
Ctrl-H	**	Hang up the telephone
Ctrl-N		Display previous file
Ctrl-P		Print the entire file
Ctrl-R		Display previous page, scroll up
Ctrl-S		Scroll left 10 columns
Ctrl-T	**	Dial a telephone number
Ctrl-U		Display previous file
Ctrl-V	**	Switch display windows
Ctrl-W		Display previous line, scroll up one line
Ctrl-X		Display next line, scroll down one line

Alt-keys

The Alt-key commands are entered by pressing the Alt key at the same time as you press one of the following letter keys:

Alt-letter		Function
Alt-A		Search for next occurrence of text, continue to next file until found
Alt-B		Mark bottom line of display
Alt-C		Copy options and setting to LIST.COM
Alt-E		Toggle 25 or 43/50 line display with EGA or VGA
Alt-F		Enter additional filenames to display
Alt-G		Goto DOS temporarily to enter DOS commands
Alt-I	**	Insert a filespec from the screen display
Alt-H		Toggle Hex display mode
Alt-J		Toggle the “junk” filter
Alt-L		Toggle preloading of files
Alt-M		Mark the line at the top of the display
Alt-N		Toggle the Alt-X screen saving feature
Alt-O		Write marked lines to the same file used by Alt-D
Alt-R		Toggle the display of a ruler line on top line
Alt-S		Toggle the file Sharing option
Alt-T		Toggle the TAB control character filter
Alt-U		Unmark lines marked by Alt-M and Alt-B
Alt-V	**	Invoke the File Selection Menu
Alt-W		Toggle split screen
Alt-X		Exit to DOS and display the original screen
Alt-Y		Reposition to the last “active” line (bookmark)
Alt-Z		Toggles the status display in the bottom line. The default is to display the cursor key useage. Using Alt-Z changes the bottom line to show the option switches “Toggles:” settings.

APPENDIX E: INSTRUMENT PARTS LIST

Description	Part No.
IPR-12 Console	745 010
Battery Charger	738 019
Field Wire Terminator	745 056
RS-232C Cable	745 081
Minor Spare Parts Kit	745 030
Desiccant Pack	160 325
Battery Fuse 1A (Littel Fuse 312001)	512 017
Input Fuse (Buss GFA 1/20)	512 010

Options

Multi-conductor cable adapter	745 031
Multi-conductor cable	738 080

APPENDIX F: WARRANTY AND REPAIR

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 console is 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.

Repair

All shipments require a concise and clear invoice accompanying the shipment, showing:

1. Consigned to SCINTREX LTD.
2. Description of Goods
3. Value of Customs Purposes
4. Reason of Shipment is REPAIR OF CANADIAN MADE GOODS
5. Serial Numbers

One copy inside and one copy outside the container

A copy of the Original Invoice from Scintrex should be included if at all possible, as this will expedite Customs clearance.

Shipments should be addressed to:

SCINTREX LTD.
c/o DANZAS Customs Brokers
1600 Drew Road
Mississauga, Ontario, Canada
L5S 1S5
Attn: Deborah Perotta
Tel: (905) 405-9300

Please note: All equipment must be shipped prepaid by the customer. Shipments will not be accepted on a Collect Basis unless prior arrangements have been made. In order to minimize delays, a RETURN AUTHORIZATION NUMBER should be obtained prior to the return of the equipment (see attached pre-printed form).

SCINTREX Customer Service

222 Snidercroft Road
Concord, Ontario
Canada L4K 1B5

Tel: (905) 669-2280
Fax: (905) 669-9899
E-mail: 104511.600@compuserve.com

REPAIR RETURN AUTHORIZATION FORM

Dated: _____/_____/_____

Return Authorization Number: ____

Company Name: ____

Customer Number: ____________________ Account Status: Net 30 _________ Prepayment ______

Repair Type: Geophysical ___________ Analytical ____________ Warranty _______________

Company Address: ____

____

Ship To Address: ____

____

Specified Return Carrier: ____

Ship Prepaid And Invoice (Net 30 Customers Only): Yes: ______ No: _______

Client Contact: ____

Telephone Number: _____________________________ Fax Number: ________________________

Purchase Order Number: ___________________________ Verbal Sign: _______________________

Estimate Required: Yes ______ No ______ Cost Estimate: _____________________________

Pre-authorized Repair Cost Amount: $_______________ maximum

Estimated Customer Ship Date: _____/_____/_____ Carrier Type: _________ Waybill: __________

Description of Main Instrument Being Returned:

Item 1: ___________________________________ Serial Number: __________________________
Item 2: ___________________________________ Serial Number: __________________________
Item 3: ___________________________________ Serial Number: __________________________

Description of Problem: ____
____
____

APPENDIX G: TIMING SLICES

Receive Time = 1 second

Slice #	Width (ms)	Start	Mid-Point	End
5	20	35	45.0	55
6	20	55	65.0	75
7	40	75	95.0	115
8	40	115	135.0	155
9	70	155	190.0	225
10	70	225	260.0	295
11	110	295	350.0	405
12	120	405	465.0	525
13	180	525	615.0	705
14	180	705	795.0	885

Receive Time = 2 seconds

Slice #	Width (ms)	Start	Mid-Point	End
4	20	50	60.0	70
5	40	70	90.0	110
6	40	110	130.0	150
7	80	150	190.0	230

8	80	230	270.0	310
9	140	310	380.0	450
10	140	450	520.0	590
11	230	590	705.0	820
12	230	820	935.0	1050
13	360	1050	1230.0	1410
14	360	1410	1590.0	1770

Receive Time = 4 seconds

Slice #	Width (ms)	Start	Mid-Point	End
2	20	40	50.0	60
3	40	60	80.0	100
4	40	100	120.0	140
5	80	140	180.0	220
6	80	220	260.0	300
7	160	300	380.0	460
8	160	460	540.0	620
9	280	620	760.0	900
10	280	900	1040.0	1180
11	460	1180	1410.0	1640
12	460	1640	1870.0	2100
13	720	2100	2460.0	2820
14	720	2820	3180.0	3540

Receive Time = 8 seconds

Slice #	Width (ms)	Start	Mid-Point	End
1	40	40	60.0	80
2	40	80	100.0	120
3	80	120	160.0	200
4	80	200	240.0	280
5	160	280	360.0	440
6	160	440	520.0	600
7	320	600	760.0	920
8	320	920	1080.0	1240
9	560	1240	1520.0	1800
10	560	1800	2080.0	2360
11	920	2360	2820.0	3280
12	920	3280	3740.0	4200
13	1440	4200	4920.0	5640
14	1440	5640	6360.0	7080

Receive Time = 16 seconds

Slice #	Width (ms)	Start	Mid-Point	End
1	80	80	120.0	160
2	80	160	200.0	240
3	160	240	320.0	400
4	160	400	480.0	560
5	320	560	720.0	880
6	320	880	1040.0	1200
7	640	1200	1520.0	1840
8	640	1840	2160.0	2480
9	1120	2480	3040.0	3600
10	1120	3600	4160.0	4720
11	1840	4720	5640.0	6560
12	1840	6560	7480.0	8400
13	2880	8400	9840.0	11280
14	2880	11280	12720.0	14160

Receive Time = 32 seconds

Slice #	Width (ms)	Start	Mid-Point	End
1	160	160	240.0	320
2	160	320	400.0	480
3	320	480	640.0	800
4	320	800	960.0	1120
5	640	1120	1440.0	1760
6	640	1760	2080.0	2400
7	1280	2400	3040.0	3680
8	1280	3680	4320.0	4960
9	2240	4960	6080.0	7200
10	2240	7200	8320.0	9440
11	3680	9440	11280.0	13120
12	3680	13120	14960.0	16800
13	5760	16800	19680.0	22560
14	5760	22560	25440.0	28320

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