Documentation for MPT DAS-1

Electrical Impedance Tomography System

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PC software version 11.x or later System software version 9.x or later

DAS-1 User Manual Table of Contents

Section 1.0 System Overview

1.1 Unpacking and Packing

The DAS-1 System comes in a molded ATA reusable shipping case. Your system will include the following:

- Two (2) Micro SD cards
- Battery charger
- RS232 cable
- USB cable
- External Power cable
- Cables for
  - 1) an external battery (alligator clips) and
  - 2) a high current external power supply (banana plugs) to power the system transmitter

If your system includes additional multiplexers, it will include:

- External Multiplexer cable
- External Tx Cable
- A Battery charger for each multiplexer
- External Power Cable for each multiplexer

1.2 Operation Modes

The DAS-1 can be operated as a stand-alone unit with only its internal multiplexer or with one or more external multiplexers. Internal multiplexer and receivers can be powered entirely from internal batteries or from external 12 volt or 6 amp sources. However, the transmitters must be powered by an external battery supply. If a transmitter battery is included with the DAS-1, then the transmitters can be powered internally.

The system can be operated in one of three different modes:

1) Operation using the internal interface and data storage;
2) Real-time operation using an external computer and;
3) Autonomous system operation using an external computer and internet connection.

1.3 Data Modes

Data can be collected in one of five modes: Time Domain, Frequency Domain Data Stream, Self-Potential and Spectral IP. The data are stored in ASCII format on micro SD cards in standard FAT32 format allowing easy storage and transfer of up to 8 gigabytes of data. All of the data modes and system functions can be operated under PC control or autonomously.

Time Domain

In Time domain mode the system collects IP data using 1 to 35 user assignable windows at base frequencies from 1/64 Hz to 13.5 Hz.

Frequency Domain

In Frequency domain mode the system can acquire phase and amplitude data from 1/64 Hz to 5 Hz.

Data Stream

The Data Stream mode allows the user to store incoming data streams of up to 128 points and then apply their own data averaging and noise rejection methods.

Self-Potential

The Self Potential mode allows the system to measure the self-potential value at one or more receiver pairs without transmitting current.

Spectral IP

The Spectral IP data mode allows the user to collect frequency domain spectral IP data. The DAS-1 will make measurements at one or more of seventeen pre-assigned frequencies.

1.4 Connectors and Associated Cables

The following is a description of the receptacles for each connection on the DAS-1 receiver:

- Batt 1 – 5-pin Mil Spec connects to system internal power source using either:
  - Mil Spec connector to banana plugs for external power supply
  - Mil Spec connector to battery charger

- Batt 2 (on systems with internal TX battery Option)
  - Mil Spec connector to banana plugs for external power supply
  - Mil Spec connector to battery charger
- RS232/USB – 6-pin Mil Spec connects to PC using either:
  - Mil Spec connector to serial port connector
  - Mil Spec connector to USB connector

- Ground – Green banana plug (no cable included)

Figure 1.4.1 DAS-1 connector panel

- External Battery - Black & red banana plug sockets connect to external power source for System Transmitter using either:
    - Banana plugs to alligator clips for external 12V battery
    - Banana plugs to banana plugs for external 13.8V power source

- Cable 1 to 4 – 16-pin Mil Spec connect to ERT cables or converter box (for optional system configured with two 32-pin Mil Spec connectors, information found in Appendix C)

- Ext Mux - 24-pin Mil Spec connects to additional multiplexer using:
    - Mil Spec to Mil Spec connector
    - TX Out – Blue & yellow banana plug sockets connect to additional multiplexer using:
        - Banana plugs to banana plugs

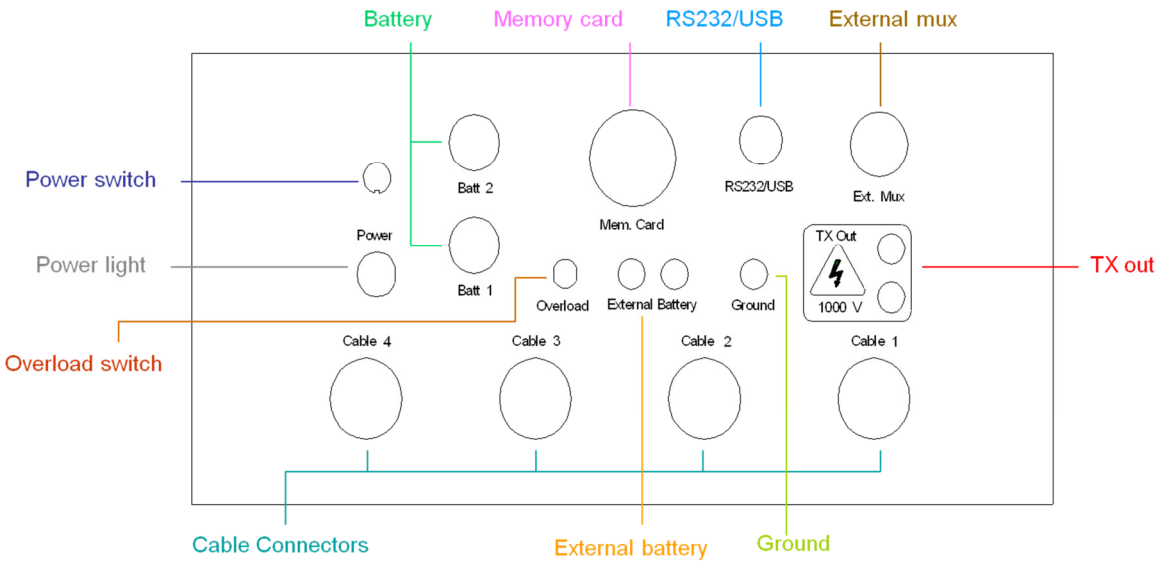


Figure 1.4.2 DAS-1 connector panel layout

1.5 Keypad

The DAS-1 keypad uses electronic proximity sensors and thus is extremely rugged and has no moving parts to wear out. The keypad detects the presence of a conductive object, generally a finger. Releasing a key may require the user to lift his/her finger some distance above the keypad. Also it is important not to leave a conductive object on or near the keypad. The sensitivity of the keypad can be adjusted (see Section 6).

Arrow keys are used to navigate through the software menus (see Section 6). The left and right keys are used to move between various menus and the up and down arrows to select items to edit within a menu. Keypad numbers are configured the same as a telephone number pad and text can be entered by hitting the same key several times.

Figure 1.5.1 DAS-1 keypad

1.6 LCD Display

The DAS-1 console uses a 40 character by 16 line LCD display. As with all LCD displays it is temperature sensitive. The system remembers its previous contrast settings so if there is a large temperature change between one field session and the next, the screen contrast may need to be adjusted. At high temperatures the LCD will tend to darken; for displays which are too dark press the **Contrast Down** key several times. For low temperatures the contrast decreases and the screen may appear blank at startup. To increase contrast on the LCD display, use the **Contrast Up** key on the keypad.

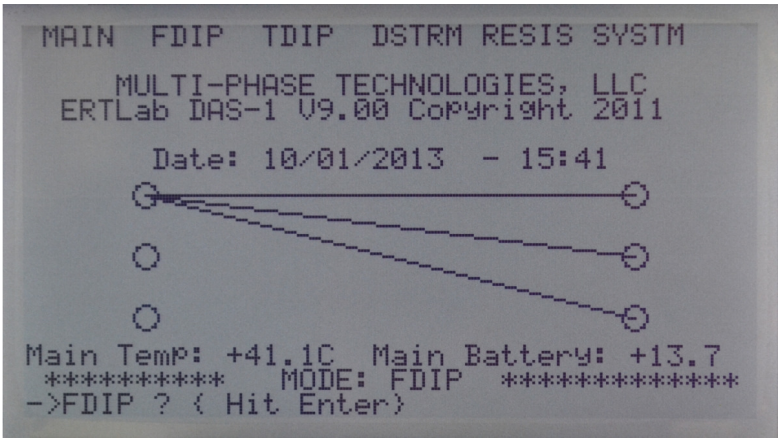


Figure 1.6.1 DAS-1 LCD start display

DAS-1 console menus are discussed further in Section 5.

Section 2.0 System Safety and Warnings

2.1 Shock and Electrocution Hazards

The DAS-1 system is capable of creating voltages in excess of 480 volts (960 volts peak to peak) and currents as high as 2.5 amperes. These voltages can be fatal if they pass through the body. Under normal conditions, these voltages can be present on any of the Well/Cable connectors on the Main Unit or Multiplexer, the External Tx (Tx Out) banana plugs or sockets, any cables or wire connected to these connectors or sockets and the electrodes themselves. Under normal circumstances, the communication circuits, battery connectors and instrument cases are electrically isolated from the high voltage transmitter circuits. However, if the system is damaged or if water is present inside the equipment cases, then the high voltage isolation will be compromised. The most critical safety issue is that all operators and their assistants must have sufficient training to understand the dangers created by these high voltages, where they are located on the system, and precautions to be taken against accidental electric shock. Precautions should include:

1) Never operate the system if there is any evidence that it has been damaged or if water of other liquids may have leaked into the equipment case;
2) Inspect cables and electrodes and do not use cables or connectors that show signs of physical damage;
3) Periodically test the system isolation using the procedure outlined in Appendix A.
4) Do not handle cables or electrodes while the system is operating;
5) Survey lines and electrode locations should be clearly marked with appropriate warning signs;
6) Operators should maintain a clear line of sight of the electrodes and should discontinue operations immediately if personnel approach the electrodes or cables. Shutting the system down using the system menus may take several seconds: in emergency situations turn the power off to the main unit and disconnect the TX power source although this may result in corruption of data files and/or loss of data;
7) Always work as though the system is operating at maximum voltage. Even if the operator has chosen a lower *Target Voltage*, there are a number of circumstances that would cause the system to operate at a higher voltage:
    a. when the transmitter first turns off, inductive effects within the wires and cables can create voltage pulses that are much higher than the operating voltage;
    b. if a wire, cable or electrode becomes disconnected during operation, there will be a rise in transmitter voltage before the transmitter can sense the problem and shut down or reduce its output power; and
    c. physical damage to the internal transmitter during shipping or field work could have unpredictable effects on its operation.

2.2 Internal Batteries

The system uses Nickel Metal Hydride (NMH) batteries. Although generally safe, under some circumstances these batteries can release gasses which cause pressure to build up in the

equipment cases. Other manufacturers have had actual explosions from overcharging batteries. At least in some cases these problems occurred when connecting external power supplies in place of the manufacturer's battery chargers. It is important to note the differences in battery chargers and power supplies. Power supplies produce a constant voltage under a broad range of current flows. Battery chargers use either constant current or current pulses and allow wide variations of voltage. For this reason NEVER RUN THE DAS-1 WITH THE CHARGERS CONNECTED as the resulting voltages can damage system electronics. Also the battery chargers have a number of safety features including a timer that prevent overcharging and damaging batteries. Because of this the DAS-1 has separate circuits for the batteries and power supplies. . Please take the following precautions:

1) Do not leave battery chargers permanently connected to systems;
2) For long-term use (such as monitoring systems) use an external 13.8 V power source connected to the bypass terminals in the system. NEVER CONNECT AN EXTERNAL POWER SUPPLY DIRECTLY TO THE BATTERY!
3) Do not operate the system with the battery chargers connected!

2.3 External Batteries

When using an external battery as power source (i.e. 12V marine battery), please remember that:

1) Hydrogen gas may be produced by lead-acid batteries, and may explode if ignited. Use adequate ventilation; avoid open flames, sparks, or other sources of ignition;
2) Contact with combustibles and organic materials may cause fire and explosion;
3) Do not allow metallic materials to simultaneously contact both terminals;
4) Turn the system power off prior to connecting or disconnecting the battery terminals;
5) Follow the manufacturer's instructions for the battery charger; do not overcharge the battery;
6) Only use external batteries with the transmitter which are specified by the manufacturer to have a continuous discharge rate of at least 25 amperes;
7) Wear ANSI Z87.1 approved safety glasses when connecting the battery charger to the battery; and
8) The battery should be kept in a non-conductive carrying case designed to hold the size and type of battery in order to reduce the chance of accidentally short circuiting the output terminals.

2.4 Physical Hazards

2.4.1 Lifting

Always use caution when lifting/carrying the instrument, use proper lifting techniques:

- Lift close to your body
- Feet placed shoulder width apart
- Bend your knees and keep your back straight
- Lift with your legs

2.4.2 Cables and trip hazards

- If possible, run cables and wires so they do not stretch across walkways and create a tripping hazard.
- Mark cables, wires and electrodes for easy visibility.
- Position instrument cases so they are out of pedestrian routes.

Quick Start Guide to the DAS-1

The DAS-1 can be operated with either using the internal interface and data storage or an external PC. The following instructions will address the operation of both options.

In order to collect data in either mode it is necessary to create a command file using the PC software (DasAcquisition). A command file stores all of the system settings and the data "schedule" for a given data run. You will need to create a command file prior to performing a survey.

To use the internal interface, the PC software allows you to upload command files to the DAS-1 system's micro SD card. At present only the TDIP, FDIP and Stream data modes can be run using the DAS-1 internal interface. Spectral IP or Self Potential (SP) data modes can only be run under PC control.

This Quick Start Guide may be useful in using the DAS-1 system for the first time, but should not replace the full manual as a reference tool. When in doubt of a setting or function, consult the full user manual which follows immediately after the Quick Start Guide. Be sure to read Section 2 "System Safety and Warnings" before operating the DAS-1 system.

Quick Start using the DAS-1 console interface

In order to operate the DAS-1 using the console internal interface, follow each of the subsequent steps which are discussed in further detail below:

1) **System Setup** – connect the DAS-1 (and multiplexers) to power supplies
2) **Main Menu & System Menu** - Configure settings on the DAS-1 console software

System Setup

The DAS-1 comes with all the necessary connection cables. Using the configuration shown in Figure 1, the transmitter (**External Battery**) will be run from an external 12V battery (or 13.8V power source).

The internal system battery that runs the processor, switches and receivers (**BATT 1**) will be connected to either a 6 amp power supply or a 12 V battery (If the internal system battery is fully charged the system can run approximately 8 hours without either of these external power sources.)

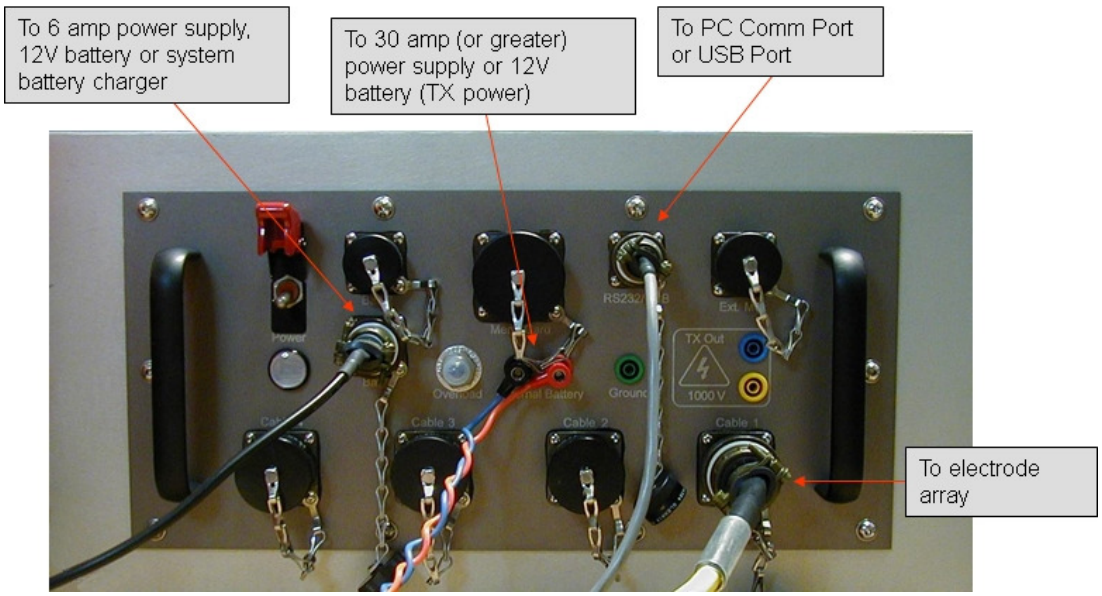


Figure 1. DAS-1 System setup

(Note: If an external multiplexer is needed (>64 electrodes), connect the **Ext. Mux** connector on the DAS-1 main unit to one of the two **Mux Comm** connectors on the multiplexer. A transmitter cable must also be connected between the DAS-1 and external multiplexer (blue

and yellow banana plugs). At the multiplexer, make certain to connect the blue and yellow plugs to the sockets of the same color, otherwise the output of the transmitter will short circuit. If the multiplexer's internal battery is fully charged the multiplexer can run approximately 8 hours without an external power source. If an external power supply is used, it can be connected to the same one as the main unit.

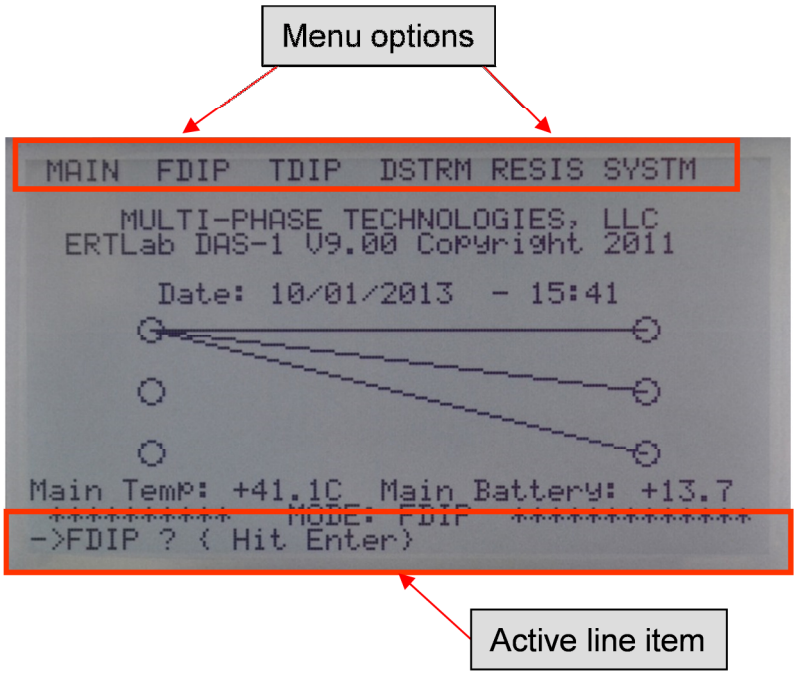


Figure 2. Main menu

Main Menu

Once you have the system set up, toggle the DAS-1 Power Switch **ON**. You will see the Main Menu as shown in Figure 2. On the DAS-1 Keypad (Figure 3), use the **horizontal arrows** to scroll through the menu options until **SYSTM** appears as the active line item at the bottom of the Main Menu (Figure 2). Select the **SYSTM** menu by hitting the **ENTER** key on the keypad.

Figure 3. DAS-1 Keypad

System Menu

This will bring up the **SYSTM** menu (Figure 4). There are three important parameters that must be entered in order to begin successful data collection:

1) **Use USB Port**; if using the USB port on an external PC set this to **TRUE**; if using a RS232 comm cable or running the system independent of a PC, set to **FALSE;**
2) **Enable PC Comm**; if using an external PC set this to **TRUE** (this is the default setting), setting this to **FALSE** disables the Comm Port; and
3) **Use Int. Batt**. (for use only on systems with an optional internal transmitter battery); set to **TRUE** to use the internal Tx battery, **FALSE** when using external Tx power.

To edit these settings, use the **UP/DOWN** arrows on the keypad to scroll through the options in the menu. The active option will appear at the bottom of the LCD display. Use the **SPACE** key on the keypad to toggle the selection between **TRUE** and **FALSE**. Select **ENTER** to complete your selection (Note: Be sure to hit **ENTER** or your selection will not be completed).

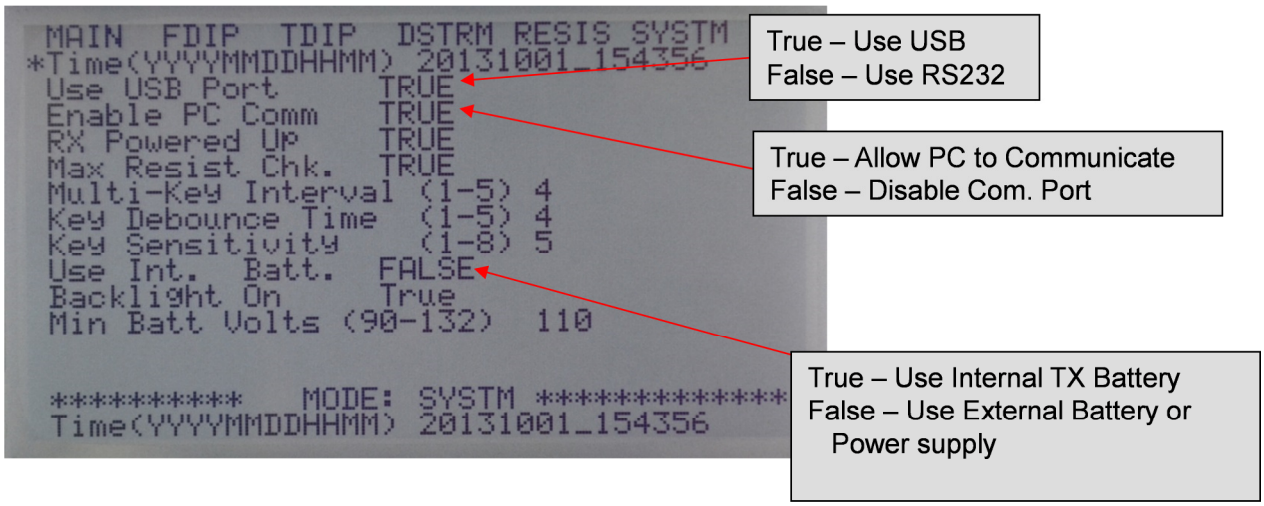


Figure 4. DAS-1 System Menu

To return to the Main Menu, use the horizontal arrows on the keypad and hit **ENTER** when the menu selection shows **MAIN**.

Detailed instructions on additional keypad commands, LCD settings and menu options can be found in Sections 1 and 6 in the DAS-1 User Manual.

Command (CMND) Files

You are provided with two generic command files that are available in the FDIP, TDIP and the DSTRM options. Figure 5 shows the FDIP option. The command file contains electrode locations and a sequential list of arrays that use those locations (i.e. dipole-dipole). If alternate or additional electrode configurations are required, you will need to create a schedule using ERTLab™ inversion software and place the command files on the DAS-1 (see the ERTLab™ manual for further information).

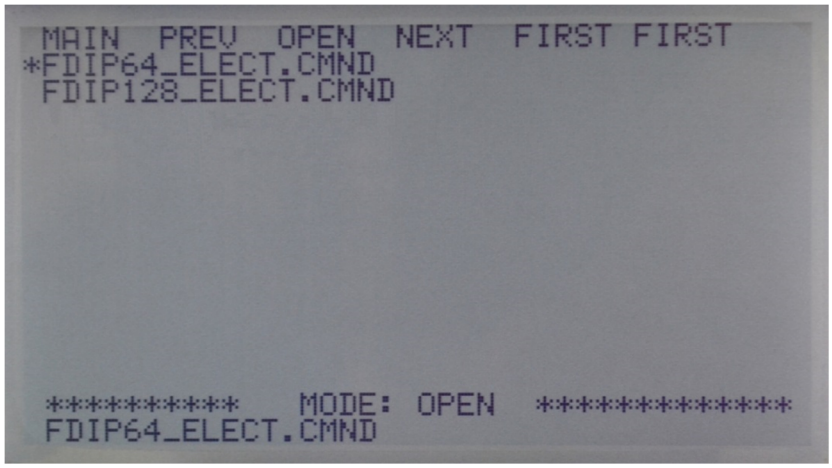


Figure 5. Two generic FDIP command files

Select either command file then press **ENTER** on the keypad. You will see a set of changeable menu options. Figure 6 shows the FDIP menu options. One of the most important options is the **50Hz Noise Rej**. Select **TRUE** if the system is used in Europe and **FALSE** if the system is used in the United States and Canada. Modify any of the options as needed. Once the file is setup to your specifications, use the right **ARROW** key to select **RUN**, and then **ENTER** to start the data run.

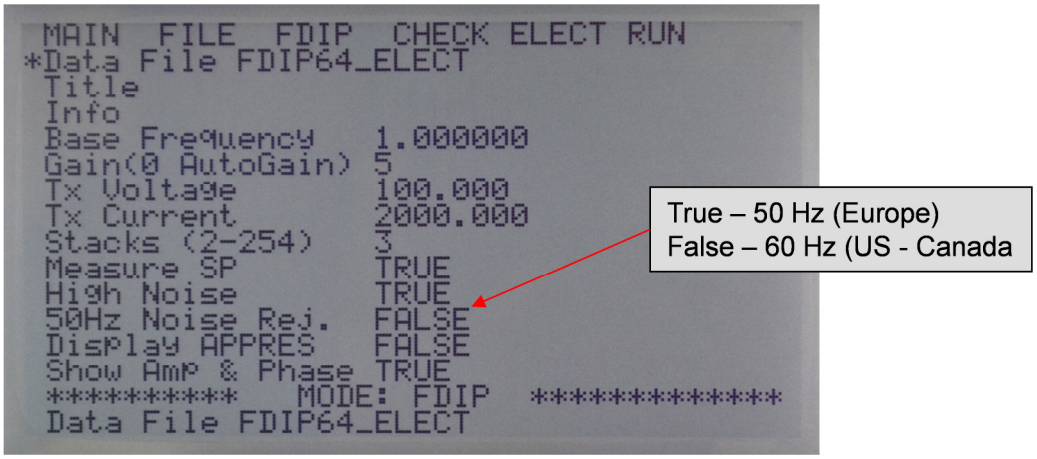


Figure 6. FDIP menu options

While the DAS-1 is collecting data the progress is displayed on the window (Figure 7). An explanation of the additional information on the progress window is explained in Section 6.

At any time, you can press and hold **STOP** on the keypad to stop the collection. In the active line item, the word **`QUIT?`** will appear; press **ENTER** to confirm stopping the run. Once the progress has ended, the display will show the menu options and another run can be started.

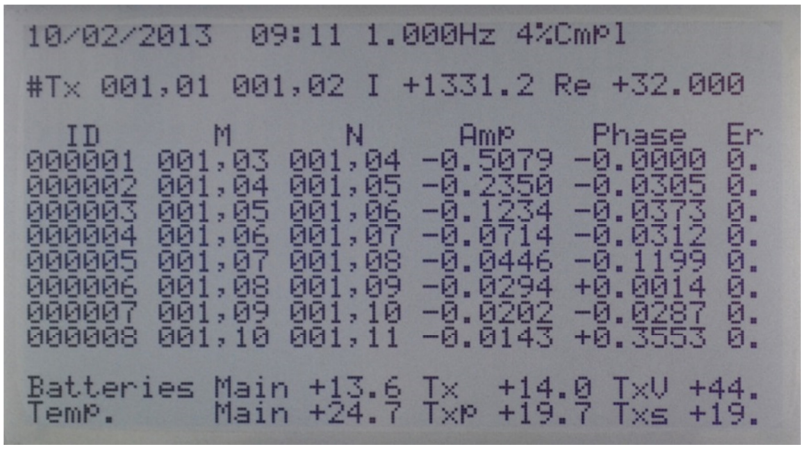


Figure 7. FDIP data collection progress

To collect the data, either remove the SD card and place into an SD card reader (not included) or connect to a PC and download the files directly off the SD card.

Quick Start Guide to the DAS-1 Using a PC

In order to operate the DAS-1 under PC control, these steps must be followed:

1) **Setup the DAS-1 System to a Personal or Laptop Computer**
2) **Setup the DAS-1 for PC communication**
3) **Install and Setup PC DAS Acquisition Software**
4) **Run a Command File**

Setup the DAS-1 System to a Personal or Laptop Computer

The DAS-1 comes with all the necessary communication connection cables. Using the configuration shown in Figure 1, the transmitter (**External Battery**) will be run from an external 12V battery (or 13.8V power source).

The internal system battery that runs the processor, switches, and receivers (**Batt 1**) must be connected to either a 6 amp power supply or a 12 V battery. (Note: If the internal system battery is fully charged the system can run approximately 8 hours without either of these external power sources.)

The RS232/USB connector must be attached in order to communicate between the PC and the DAS-1. The cables are included for both options.

If an additional external multiplexer (MUX) is required (>64 electrodes), connect the **Ext. Mux** connector on the DAS-1 main unit to one of the two **Mux Comm** connectors on the MUX. A transmitter cable (blue and yellow banana plugs) must also be connected between the DAS-1 and external MUX. At the MUX, make certain to connect the blue and yellow plugs to the sockets of the same color, otherwise the output of the transmitter will short circuit. If the MUX's internal battery is fully charged, it can run approximately 8 hours without an external power source. If an external power supply is used, it can be connected to the same one as the main unit.

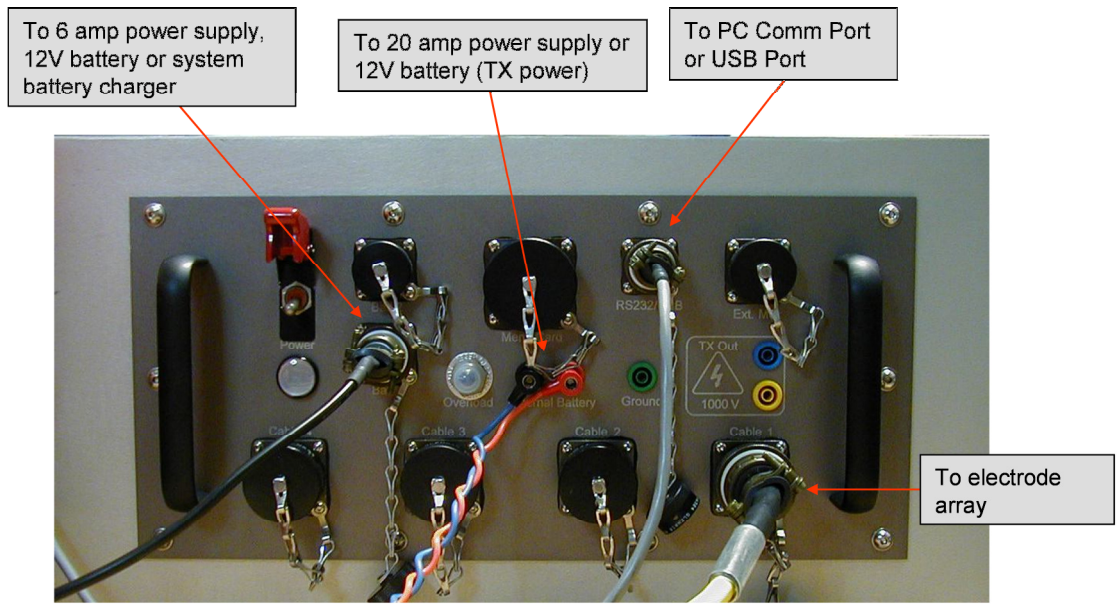


Figure 1. DAS-1 System setup

Setup the DAS-1 for PC Communication

DAS-1 Menu

Once you have the system set up, turn on the PC, ensure that the DAS-1 is connected, and then toggle the DAS-1 Power Switch **ON**. You will see the System Main Menu (Figure 2). On the DAS-1 keypad (Figure 3), use the **LEFT/RIGHT** arrows to scroll through the menu options until **SYSTM** appears as the active line item at the bottom of the Main Menu (Figure 2). Select the **SYSTM** menu by hitting the **ENTER** key on the keypad.

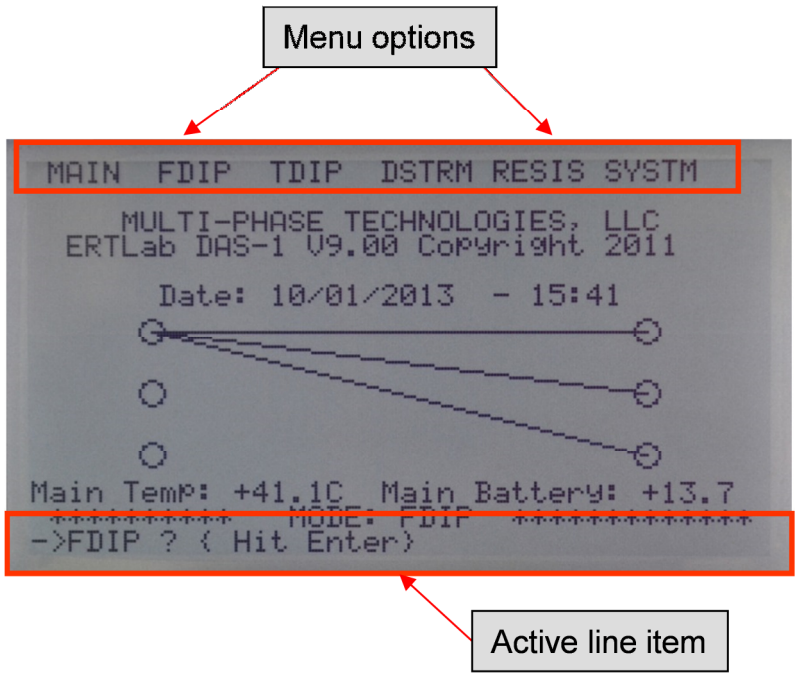


Figure 2. System Main menu

Figure 3. DAS-1 Keypad

System Menu

This will bring up the **SYSTM** menu (Figure 4). There are three important parameters that must be entered in order to begin successful data collection:

1) **Use USB Port**; if using the USB port on an external PC set this to **TRUE**; if using a RS232 comm cable or running the system independent of a PC, set to **FALSE;**
2) **Enable PC Comm**; if using an external PC set this to **TRUE** (this is the default setting), setting this to **FALSE** disables the Comm Port; and
3) **Use Int. Batt**. (only for use on systems with an optional internal transmitter battery); set to **TRUE** to use the internal Tx, **FALSE** when using an external Tx power.

To edit these settings, use the **UP/DOWN** arrows on the keypad to scroll through the options in the menu. Use the **SPACE** key on the keypad to toggle the selection between **TRUE** and **FALSE**. Select **ENTER** to complete your selection (Note: Be sure to hit **ENTER** or your selection will not be completed).

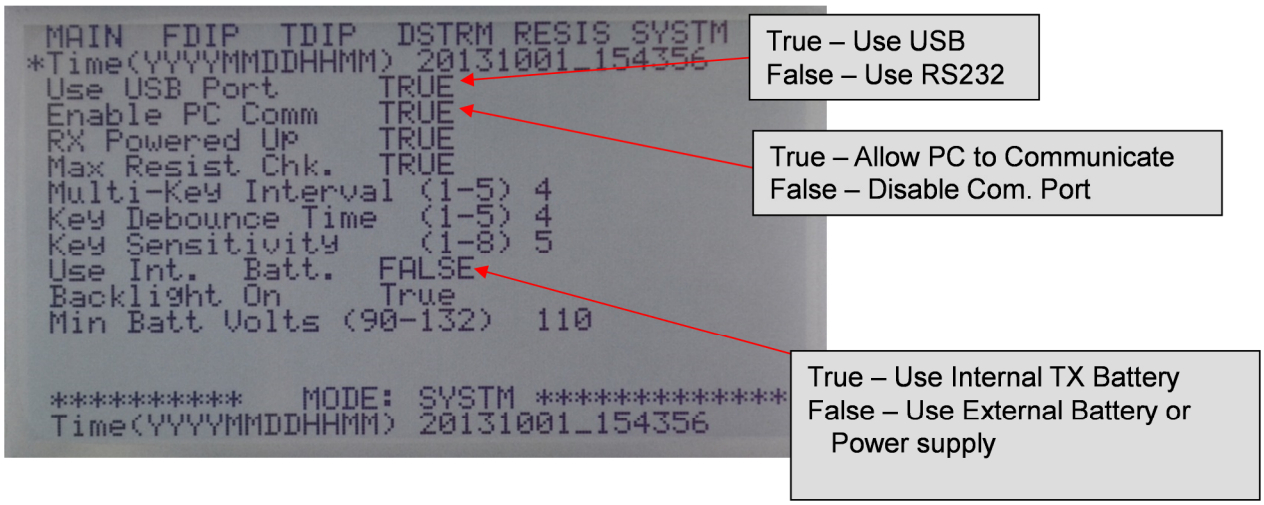


Figure 4. DAS-1 System Menu

To return to the Main System Menu, use the **LEFT/RIGHT** arrows and press **ENTER** when the menu selection shows **MAIN**.

More detailed instructions on keypad commands, LCD settings and menu options can be found in Sections 1 and 6 in the DAS-1 User Manual.

PC Software

Load DAS Acquisition software

Insert the DAS-1 operating software CD into your PC and follow the installation instructions: it will create a directory structure on your local hard drive (unless otherwise specified during installation).

1) In the **CMND and SCHD** folder on the CD there will be six command files and two schedule files. Place the command files in the appropriate PC folders (i.e. the FDIP64_ELECT.CMND and FDIP128_ELECT.CMND files will be placed into the \MPTERTField\FDIP\ folder on the PC, etc.) then place the two schedule files into the \MPTERTField\Schedule\ folder on the PC.
2) In the \MPTERTField\System_Config\ directory, open DASAcquisition.exe. You will see the DAS Acquisition Main menu (Figure 5).

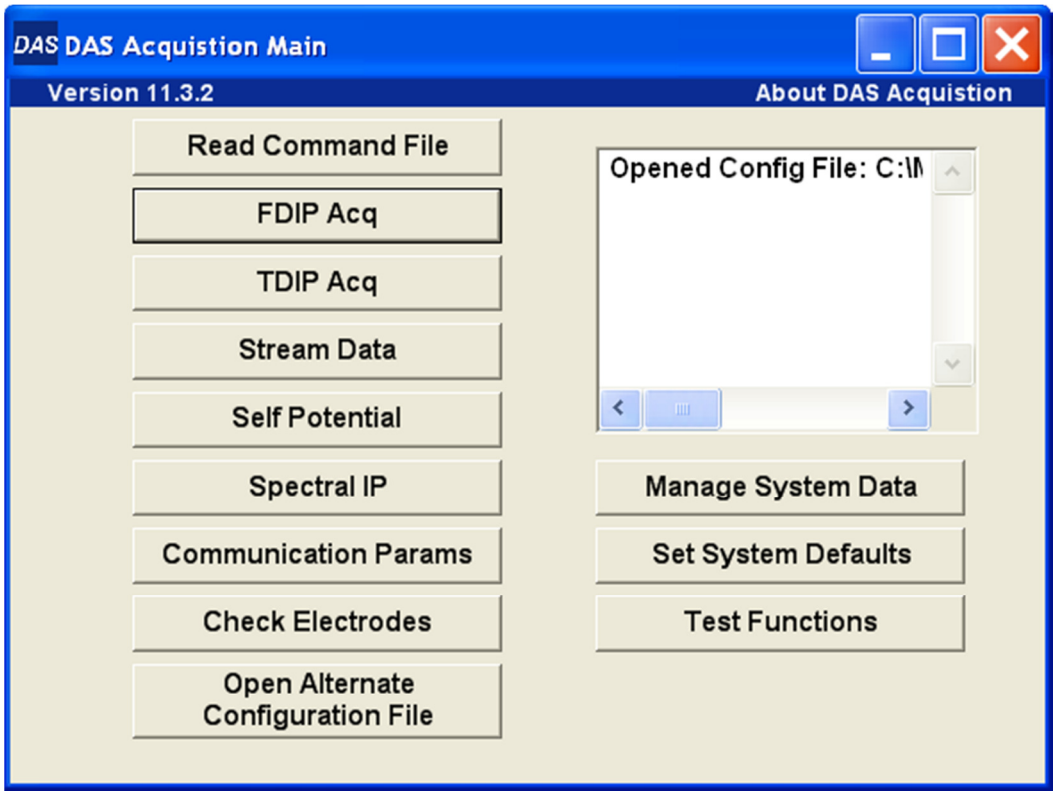


Figure 5. DAS Acquisition Main menu

Set up the Communication between the DAS-1 and Computer

1) With the **DAS Acquisition Main** window open click on **Communication Params**. This will open up the **CommSettings** window (Figure 6).

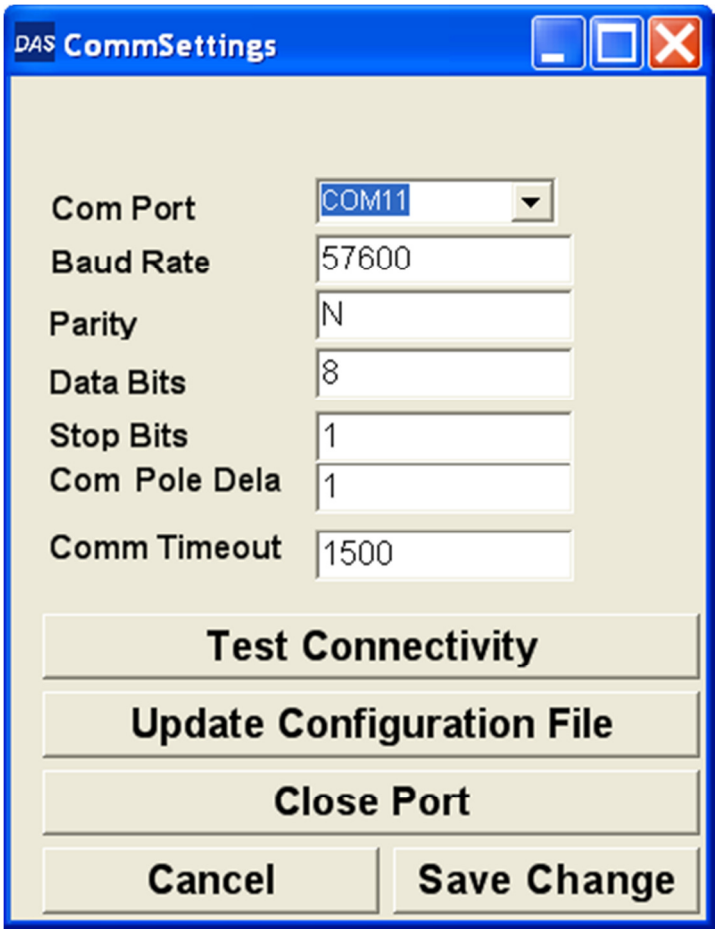


Figure 6. Communication Settings Menu

2) Ensure that the DAS-1 is on and the cable setup is correct. Determine the appropriate port by choosing from the drop down list under **Com Port** then click on **Test Connectivity**. Once the connection is established, click on **Save Change**.

   The port number for this port can be any valid, unused port number from 1 to 255. For the USB port this can be different for different systems or change with time. Typically for actual serial ports the values are 1, 2 or 3. For the USB Port they are typically (but not always) 4 or greater. The **CommSettings** window will list all available communication ports.

Run a Command File

Command and Schedule Files

If you placed the command and schedule files into the proper directories, you will now be able to conduct a test run.

The schedule file contains electrode locations and a sequential list of arrays that use those locations (i.e. dipole-dipole). If you require (or desire) alternate or additional electrode configurations, you will need to create a schedule using ERTLab™ inversion software.

Revise or Create a Command file and begin data collection:

1) On the PC, open **DASAcquisition**
2) Select a data collection mode (FDIP, TDIP, Stream, SP or Spectral. Note: SP and Spectral files were not created for this quick start guide.). Figure 7 shows the Frequency Domain Acquisition window.

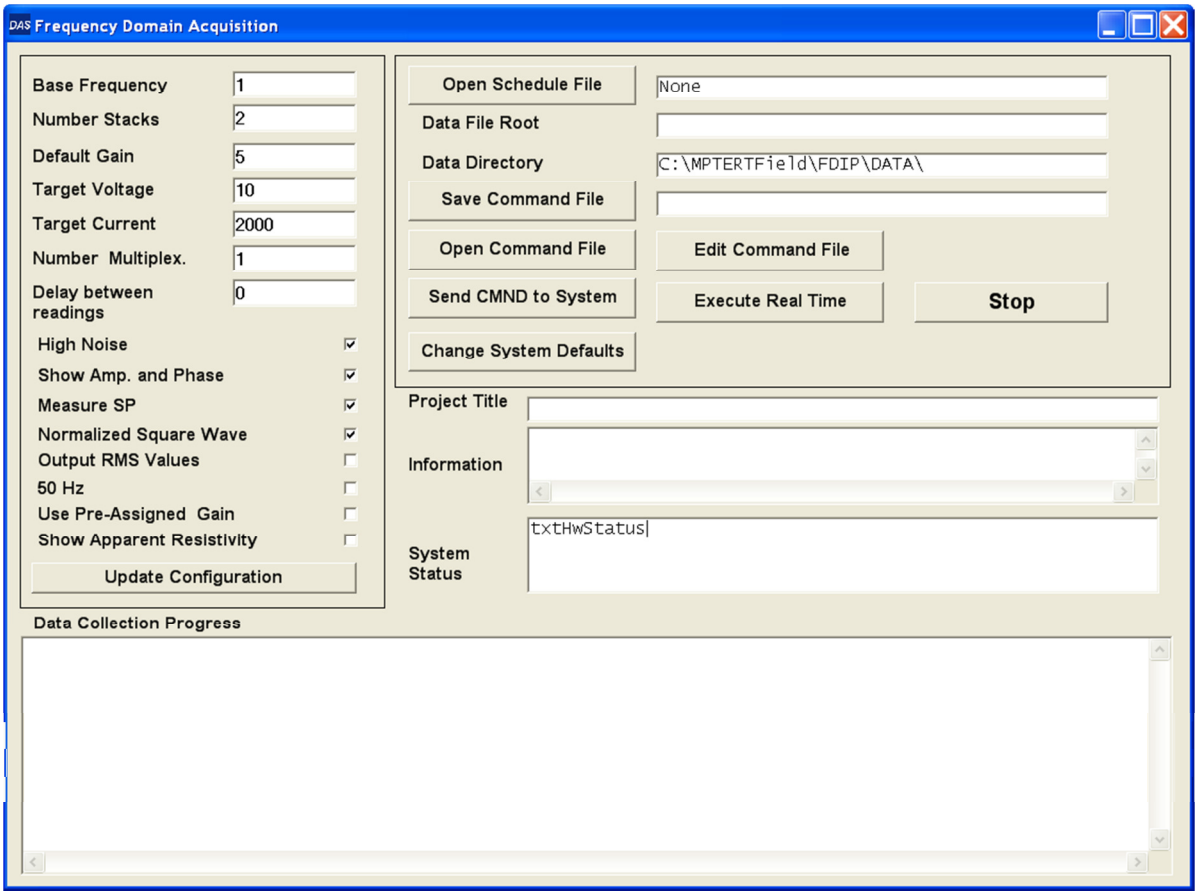


Figure 7. Configuration menu for Command File in FDIP Acquisition Mode

3) Select **Open Schedule File** and open the desired schedule file. If you are revising an

existing command file, select **Open Command File**.

4) Change configuration parameters as desired by clicking on **Edit Command File**. A new window entitled **Edit Command** will open (Figure 8). Read Section 5.13 in the Das-1 User's Manual for more information on editing a command file.

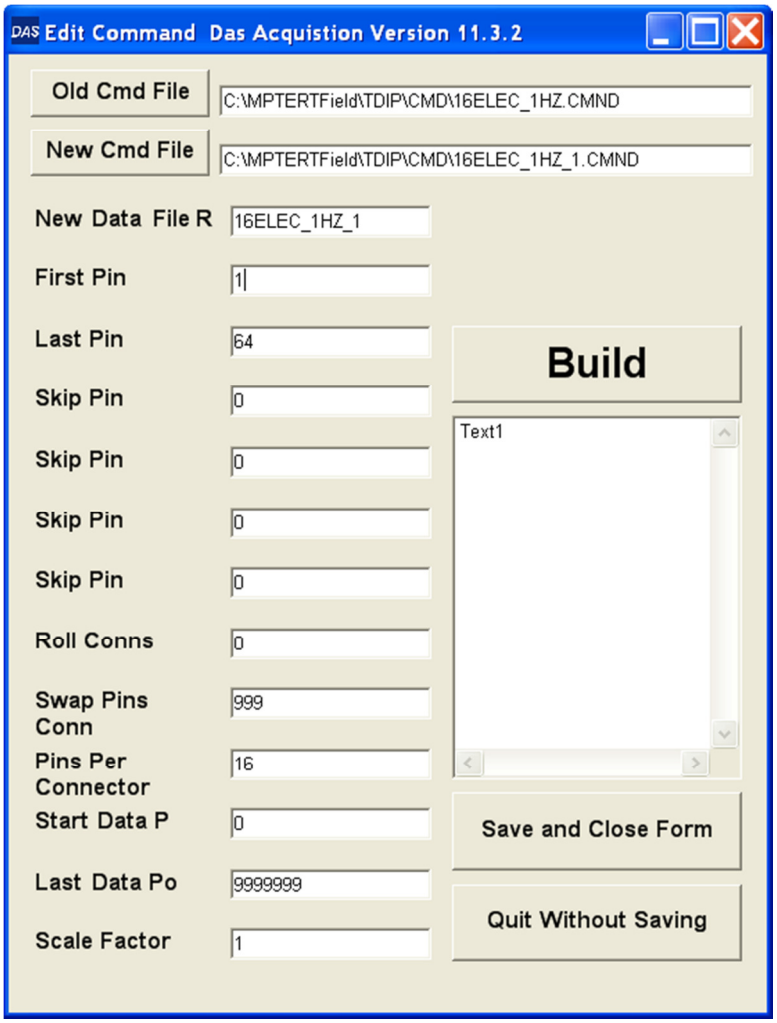


Figure 8. Initial Edit Command Menu

5) Once the edits are complete click on **Build** then click on **Save and Close Form** this will direct you back to the data collection window (Figure 7).

6) Additional changes can be made to the configuration including changes to the frequency, number of stacks, etc. (The user can enter almost any value for a parameter including invalid values. Because many of the parameters interact with each other, the code does not check the values until either the user tries to save the file or clicks the **Update Configuration** button).

7) Once the command is set up to your specific requirements click on **Execute Real Time** and click on **Open** to run the data collection.

8) The file will be saved in the specified Data Directory.

Section 3.0 System Setup

3.1 Short-term field use

A simplified diagram of the connections for standard, short-term field use of the DAS-1 is shown in Figure 3.1.1. The system is operated by using the internal interface software and does not need to be connected to an external computer. Data is stored directly on its internal micro SD card.

The DAS-1 has an internal battery that runs the processor, receiver, and internal multiplexer. The system can be run as shown in Figure 3.1.1 using the internal battery to run the processor and an external 12 Volt battery to run the transmitter. This configuration allows the system to be run at full power, 250 watts.

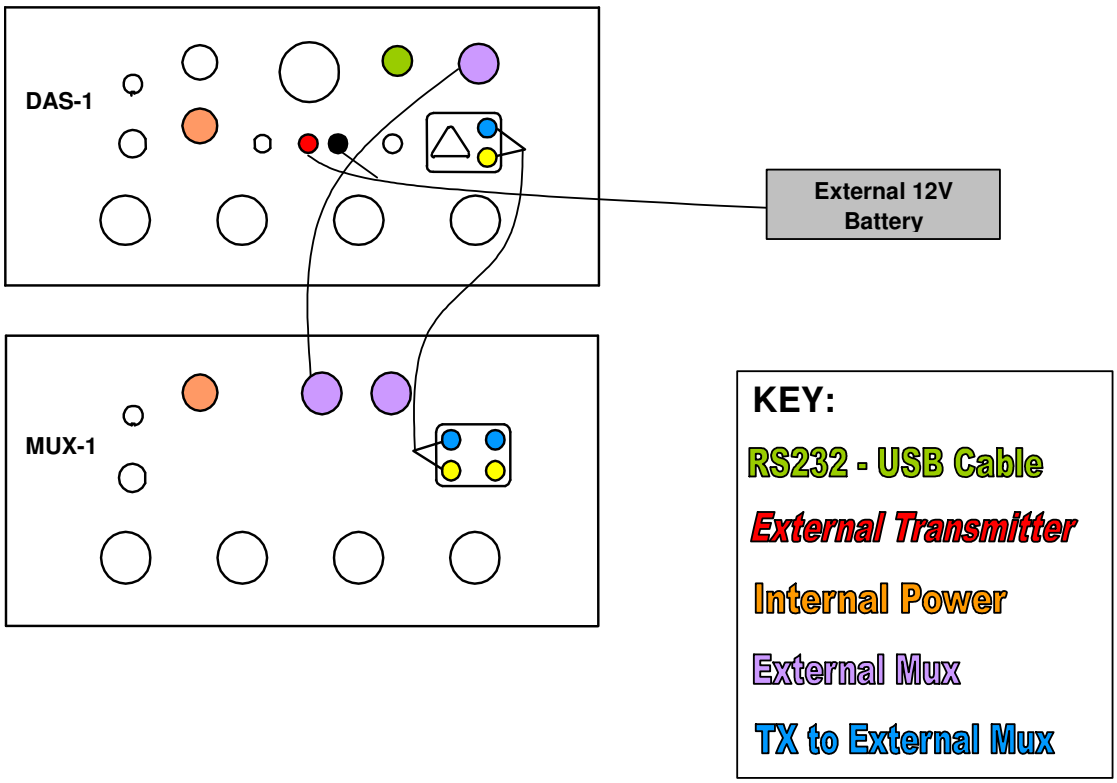


Figure 3.1.1 DAS-1 system setup for short term data collection, under system control (no external PC).

To connect more than 64 electrodes to the system at one time will require using an external multiplexer. The external multiplexer can operate off its own internal battery. Two types of cables are needed to connect the external multiplexer: a heavy gray External Multiplexer Cable with 26 pin circular mil-spec connectors that link the **Ext. Mux** connector on the DAS-1 main unit to one of the two **Mux Comm** connectors on the multiplexers. The second connector on the external multiplexer can be used to connect to additional multiplexers. In addition to the External Multiplexer Cable a transmitter cable must be connected between the DAS-1 and external multiplexer. This cable has blue and yellow banana plugs. At the multiplexer, make

certain to connect the blue and yellow plugs to the sockets of the same color otherwise the output of the transmitter will short circuit

3.2 Long-term monitoring and Autonomous Monitoring

For long-term monitoring applications the DAS-1 system is designed so that it can be powered using external 13.8 V power supplies and operated by an external desktop or laptop computer. Using an external power supply allows the system to be operated continuously for long periods of time without the difficulty of keeping the batteries charged.

Although it is possible to operate the system for short periods of time with the battery chargers connected, MPT does not recommend leaving the system connected to the battery chargers for long periods of time. The nickel metal hydride "smart" chargers supplied with the system are designed as battery chargers that adapt to the peculiarities of the charge-voltage cycle of the batteries and are not designed to act as power supplies. Furthermore, it is also not advisable to connect batteries to a power supply that is not designed to charge NiMh batteries. MPT supplies external power cables that bypass the battery and can be used to power the system without risk of damaging the system. The system requires an average current of roughly 1 ampere during operations, with peak currents of about 2 amperes. It is possible to power the main unit processor (**Batt 1**) and the external multiplexers (but not the transmitter) from the same supply as long as the average and peak power is sufficient. Each external multiplexer requires about .3 amps. A typical 3 to 5 amp rated supply will easily power the system. We recommend that **the DAS-1 processor and/or external multiplexers should not be powered from the same power supply or battery as the transmitter.** The unit that is used to power the transmitter must have an average current of at least 30 amperes and a surge current of at least 35 amperes. Because of these large surge currents, connecting the processor and transmitter circuits together will increase the noise levels on the data. In addition, the noise can interfere with communications between the computer and the DAS-1. In certain circumstances noise can cause the USB port to "latch." Under these circumstances either the controlling computer must be rebooted or the system power cycled to restore communications. To avoid these issues we recommend:

1) Use separate power supplies for the processor and transmitter circuits,
2) If possible use a serial port instead of a USB,
3) Avoid using switching power supplies or use additional power conditioning to reduce electromagnetic interference,
4) Consider fully isolating the computer from the DAS-1 using commercially available serial or USB port isolators,
5) For non-isolated system try grounding the negative (black) lead of the processor to the power ground of the controlling computer, and
6) If necessary add additional ferrite EMI suppression beads to the power and communication cables.

Using an external computer allows control options not available directly from the internal interface software on the DAS-1. These include automatically executing command files according to a pre-assigned schedule and automatic upload of data files to an FTP server.

Figure 3.2.2 shows a typical setup for long-term monitoring applications. Note that external multiplexers are daisy chained together using *External Multiplexer* and *Transmitter*

cables. As before note the importance of connecting the banana plugs of the transmitter cables to sockets with the same color as the plugs to avoid short circuiting the transmitter.

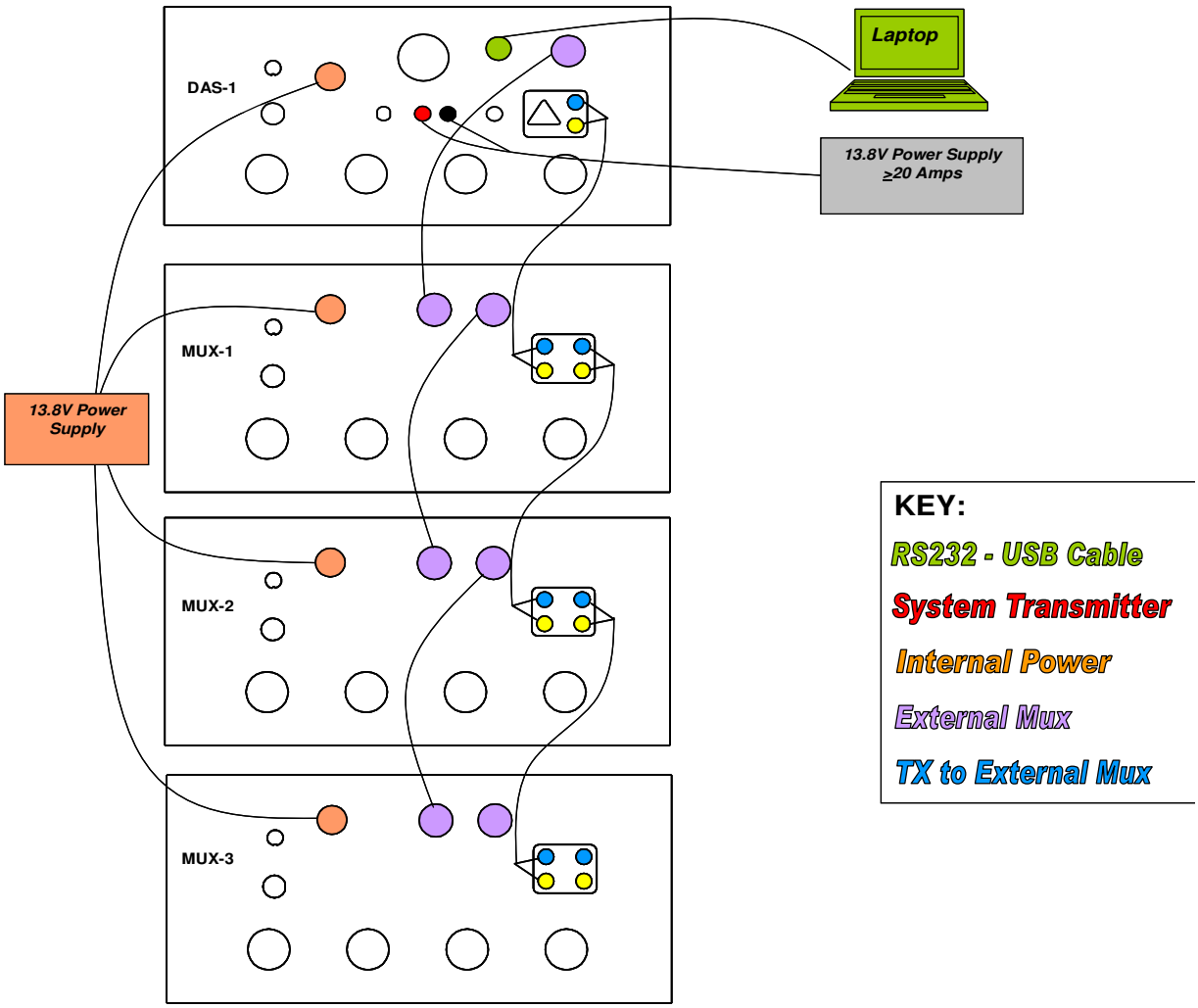


Figure 3.2.2. System configuration for long-term/autonomous monitoring, using external power supplies and external multiplexers.

3.3 Batteries and chargers

The DAS-1 and Mux-1 come with a 12.0 V 10000 mAh (120Wh) NiMH Battery pack. The battery pack should provide 8 to 10 hours of run time.

- Connect battery charger to the **Batt 1** (and **Batt 2** connector if present) connector(s) and plug into an AC power source.
- The charger will detect the battery voltage automatically. A red LED light will be on during charging.
- The battery will be charged at 1.8A constant current.
- When the battery is fully charged, current will be reduce to a trickle charge and at 100mA, a green LED will indicate a full charge.
- Charging time is approximately 2 - 4 hrs.

Caution

- The charger is designed for indoor use only.
- The charger should be positioned horizontally and work in well ventilated conditions, avoid water and keep it away from flammable materials.
- Don't cover the charger when charging.
- The ambient temperature should not be more than 40 C. Note that each battery pack has an integrated temperature sensor as a safety feature. The batteries will not be charged if the temperature of the pack exceeds 40 C.
- Don't touch the plug.
- Turn the system **OFF** before connecting the charger.
- Do not turn the system on or run the system while the charger is connected.
- Don't try to disassemble the charger.

Section 4.0 File Structure

4.1 Overview

As noted in the previous section, the system can run either under internal control using its micro-secure digital card for command and data storage or it can run under the control of an external computer in which case the data are stored on the local computer. In terms of file structures, the primary difference between the control modes is that **when the system is run under internal control the file conventions below must be rigidly followed** whereas under external PC control we recommend that users follow the structure but there is some flexibility in file names and locations.

Both the data and command files are written using ASCII characters using Microsoft formatting conventions. In this manual, we will indicate specific ASCII character code using a pair of brackets with a decimal number; for example the code for the number "1" is {49}. System commands and data records are written on lines with each line terminated by a carriage return {13} then a line feed {10}. Most files use spaces {32} and/or tab characters {9}. On the micro SD card, these files are written in FAT32 format that can be read or written by most laptop or desktop computers.

****Note regarding naming conventions for Data Files: Due to a limitation in the Microsoft software, the first 6 characters of any Data File will only be repeated 36 times for a given calendar date. If you are collecting numerous data files in one day (>36) it will be necessary to rename the Data Files or the system will slow significantly.**

***** Note on micro SD cards: Micro SD cards wear out! Issues have arisen with writing to older micro SD cards, particularly older cards used in other devices such as phones or cameras. Micro SD cards have a limited life for read/write cycles. For this reason we strongly advice users to:**

1) **Always keep a spare formatted Micro SD card with the field system,**
2) **Do not recycle micro SD cards from older devices,**
3) **Cards should be replaced if the system console displays errors accessing the card or if the system appears to takes a very long time (tens of seconds) to start data collection,**
4) **Backup data every day,**
5) **Avoid powering down the system during a data run as this can corrupt the micro SD card (note that forcing a power down by turning off the switch should only be used for emergency situations, instead use the keypad shutdown procedure), and**
6) **Use smaller capacity cards (16 Gigabytes or less) for the DAS-1.**

4.2 Schedule Files

*Schedule file*s contain the list of arrays used for each data point in a sequence. They are only used on the personal computer to create *Command Files* which are discussed in the next section. The naming of schedule files is not critical since they are only used on the PC. However, in the DAS_Acquisition software the default name for the *Command File* is derived from the *Schedule File* name. Therefore it is best to follow the DAS-1 file conventions for filenames: **25 characters including upper case text characters, numbers and the underscore character** {95}.

The Schedule File uses the ERTLab™ structure. Files use standard ASCII characters in Microsoft Windows format. Commands and data fields each occupy a single line of the file with

one command or one data field per line. All lines are terminated by a carriage return character and line feed character {13} {10}. Commands consist of a keyword that begins with a "#" {35} character. Most keywords are followed by a delimiter r (space, comma or tab) then one or more data values each separated by delimiters. Any line that begins with a "!" {33} is assumed to be a comment line and the contents of the line are ignored.

In the schedule file, the commands/data occur in three blocks: the Translation block, the Electrode Block and the Schedule Block. An example is shown in Figure 4.2.1.

Translation Block

The translation block tells the system how to translate from multiplexer pins to field line-electrode designations. The translation block starts with the keyword: **#trans_start** placed on a line by itself. This is followed by one or more lines each containing 3 integer values which are:

Pin number, Line Number, Electrode Number

The pin number should be between 1 and number of "pins" in the multiplexer. The standard DAS-1 main unit has 64 pins divided between 4 connectors. Internally, these pins are numbered sequentially starting with pin 1 on Connector 1 through pin 16 on Connector 1 then continuing with pin 1 on Connector 2 through pin 16 on Connector 2 and so on. When additional multiplexers are used, each multiplexer is given an internal address that ranges from 1 to 255 (address zero is always reserved for the main unit). For multiplexer address 1, the pins are numbered from 65 to 128, for the multiplexer with address 2 they are numbered from 129 to 192 and so on.

The user may choose to designate all the pins as a single "Line/Well" or split them into multiple Line/Wells each with different numbers of electrodes. Line and electrode numbers must be greater than zero. Zero is reserved for the remote pole locations for pole-pole or pole-dipole. The maximum size of the line number is 999. There are limits on the line and electrode numbers imposed by the limited space in the system file format, there are 6 available positions (including 1 space) for line and electrode numbers: For line numbers 1- 99, the maximum electrode number is 999; for line numbers 100 - 999 the maximum electrode number is 99. For example:

Line Electrode

9 9 _ 9 9 9

-or-

9 9 9 _ 9 9

The final line of the translation block must be the keyword: **#trans_end** placed on a line by itself. An example is shown on Figure 4.2.1. Note that unused pins may be left out of the table.

Electrode Block

The electrode block gives the system the location of the electrodes. In data acquisition, the primary use is to allow the system to calculate the geometry factors for calculating apparent resistivities. **If the electrode locations are not correct the apparent resistivities will not be correct.** The electrode block allows the data file to be self-documenting and provides electrode locations for data modeling.

The electrode block begins with the keyword **#elec_start** on a single line. This is followed by one line for each electrode in the translation section above. The following lines contain two integers followed by at least three floating point numbers and optionally a fourth floating point number and an integer. The integers give the line and electrode designation for electrodes listed in the Translation Block discussed earlier. This is followed by the X, Y, and Z coordinates of the electrode. The final line of the electrode block must be the keyword **#elec_end** placed on a line by itself.

Schedule Block

The final section of the schedule file is the schedule block. It contains a list of all of the arrays that the system will measure. The schedule block starts with the keyword: **#data_start** on a line preceding the first schedule line. The schedule block ends with the keyword **#data_end** on a line following the last line of the schedule. This should be followed by a blank line or comment. Each line of the schedule file contains nine integer values:

1) The data point number, this value must be present but does not need to be sequential and is not actually used by the program,
2) Cable/Well designation for the A (+ Tx) electrode,
3) Electrode Number for the A (+Tx) electrode,
4) Cable/Well designation for the B (- Tx) electrode,
5) Electrode Number for the B (-Tx) electrode,
6) Line/Well designation for the M (+ Rx) electrode,
7) Electrode Number for the M (+Rx) electrode,
8) Line/Well designation for the N (- Rx) electrode.
9) Electrode Number for the N (-Rx) electrode.

All of these numbers must be included on each line. Additional numbers on the line will be ignored by the program. Any Line/Well – Electrode pair must match one declared electrode in the Translation and Electrode blocks. For efficient field operation it is important that the schedule is sorted by the Tx electrodes. The DAS-Acquisition software looks at successive data points to see if it can allocate multiple receiver channels. For example, the first line of the schedule file is always set as Receiver (Rx) Channel 1. The software then looks to see if the second line of the schedule file uses the same transmitter electrodes. If both lines use the same transmitting electrodes, then the second line will be set as Rx Channel 2. This will continue until either all eight channels are allocated or a line is found that has different transmitting electrodes. The software does not reorder the schedule lines and does not exchange the A and B electrodes so the user must provide an ordered schedule file. For ordered files, the system will be able to allocate most of its Rx channels most of the time and thus will collect data eight times as fast as a single channel system. For unordered schedules, the system will operate essentially as a single channel system. Note that there can be a disadvantage to collecting data with multiple channels. If during data collection the

received voltage exceeds 10 volts on any Rx channel, the DAS-1 will reduce the Tx current to reduce the voltage to an acceptable level on that channel. Unfortunately, this can reduce the signal to noise levels on the other channels. This problem occurs only for cases with short electrode separations and a wide range of received voltages. Often this problem can be detected by calculating the Geometric Factors used for apparent resistivity values. Ideally, arrays with very small Geometric Factors (~10) should not be collected at the same time as arrays with large Geometric Factors (>1000).

```
!Translation Block
#trans_start
!Pin   Line    Electrode
1       1       1
2       1       2
3       1       3
4       1       4
5       1       5
6       1       6
7       1       7
8       1       8
9       1       9
10      1       10
#trans_end

! Electrode Block
#elec_start
!cable   elec     x              y          elec elev        surf elev
1        1       0.085          0.230          0                0
1        2       0.230          0.175          0                0
1        3       0.230          0.010          0                0
1        4       0.230          -0.170         0                0
1        5       0.110          -0.220         0                0
1        6       -0.055         -0.220         0                0
1        7       -0.220         -0.165         0                0
1        8       -0.220         0.000          0                0
1        9       -0.220         0.155          0                0
1        10      -0.075         0.230          0                0
#elec_end
!Schedule Block
#data_start
!Num cable_A  elec_A  cable_B  elec_B cable_M elec_M  cable_N elec_N

1       1       1       1       2       1       3       1       4
2       1       1       1       2       1       4       1       5
3       1       1       1       2       1       5       1       6
4       1       1       1       2       1       6       1       7
5       1       1       1       2       1       7       1       8
#data_end
```

Figure 4.2.1 Example Schedule File

4.3 Command Files

Command files contain all of the information needed to conduct a data run including the system configuration and schedule information. They are created on a personal computer using the DAS_Acquisition software and either executed directly from the PC (Section 5; PC Software) or downloaded onto the DAS-1 system (see Section 5.10). Command files can be edited/reconfigured using the Edit Command function on the PC software (see Section 5.13) or the **ELECT** menu on the DAS-1 console software (see Section 6.7). The following is an overview of the command files. **Users are strongly discouraged from directly editing in the Command File.**

The Command File should follow the DAS-1 filename conventions. The file root should be no more than 25 characters and must end with a four letter extension CMND (for example: 5Hz_SKIP0_1_4.CMND). The characters can include upper case letters, numbers and the underscore character, "_" {95}.

The Command File is written in ASCII text format. Commands consist of a "#" followed by two or more text characters. The files begin with system configuration information including the Target current and Voltage (Figure 4.3.1). Specific configuration information and explanations can be found in Appendix B.

The second section of the command file contains information on the electrode configuration (Figure 4.3.2) taken from the Electrode Block of the Schedule file. Electrodes are designated by cable ID and electrode ID (i.e. 001, 01) and are given location and elevation values such as X, Y, Z, and Terrain (z) in meters. Additionally, this section contains translation information that gives ID numbers to cable/electrode orientations.

The final section of the command file contains information that allows the system to run the schedule (Figure 4.3.3). This section is created in the command file using information from the schedule file, and is not generally edited outside of the schedule file. To edit or create a new command file, we recommend doing so with the DAS-1 PC software.

```
! Command File written by ERTLab DACQ
#IVersion                    9.010
#IDate       Date: 20100510_1043

! ----------------------------------------------------!
#ST
! ----------------------------------------------------!
#ITitle                      ""
#SName                       "TESTBOX_2"
#SDirc                      "C:\MPTERTField\TDIP\DATA\"
#SR50Hz
#SHiNse
#SGDflt                       5
#SMuxN                        1
#SCltSP      !TX Section
#XMXVlt                      480
#XCurMx                      2500
#XPowMx                      250
#XVTrgt                      10
#XITrgt                      2000
#XBtVmn                      11
#XTmpMx                      70
#XLrRes                      1
#XUpRes                      1000000
!Time Domain IP Section
#TFrequ                      01.00000
#TStcks                      3
#TRDely                      100
#TLngtR                      100.000
#TIPDly                      100
#TChrg
#TW01                        100.000
!
```

Figure 4.3.1. Example of the system configuration section of the command file

```
!Elec Trans Section
#ENum        000064
#ELectrd 001,01 +0.0000 +0.0000 +0.0000 +0.0000 001
#ELectrd 001,02 +0.0000 +1.0000 +0.0000 +0.0000 002
#ELectrd 001,03 +0.0000 +2.0000 +0.0000 +0.0000 003
#ELectrd 001,04 +0.0000 +3.0000 +0.0000 +0.0000 004
#ELectrd 001,05 +0.0000 +4.0000 +0.0000 +0.0000 005
#ELectrd 001,06 +0.0000 +5.0000 +0.0000 +0.0000 006
#ELectrd 001,07 +0.0000 +6.0000 +0.0000 +0.0000 007
#ELectrd 001,08 +0.0000 +7.0000 +0.0000 +0.0000 008
#ELectrd 001,09 +0.0000 +8.0000 +0.0000 +0.0000 009
#ELectrd 001,10 +0.0000 +9.0000 +0.0000 +0.0000 010
#ELectrd 001,11 +0.0000 +10.000 +0.0000 +0.0000 011
#ELectrd 001,12 +0.0000 +11.000 +0.0000 +0.0000 012
#ELectrd 001,13 +0.0000 +12.000 +0.0000 +0.0000 013
#ELectrd 001,14 +0.0000 +13.000 +0.0000 +0.0000 014
#ELectrd 001,15 +0.0000 +14.000 +0.0000 +0.0000 015
#ELectrd 001,16 +0.0000 +15.000 +0.0000 +0.0000 016
#ELectrd 002,01 +1.0000 +16.000 +0.0000 +0.0000 017
#ELectrd 002,02 +2.0000 +16.000 +0.0000 +0.0000 018
#ELectrd 002,03 +3.0000 +16.000 +0.0000 +0.0000 019
#ELectrd 002,04 +4.0000 +16.000 +0.0000 +0.0000 020
#ELectrd 002,05 +5.0000 +16.000 +0.0000 +0.0000 021
#ELectrd 002,06 +6.0000 +16.000 +0.0000 +0.0000 022
#ELectrd 002,07 +7.0000 +16.000 +0.0000 +0.0000 023
#ELectrd 002,08 +8.0000 +16.000 +0.0000 +0.0000 024
#ELectrd 002,09 +9.0000 +16.000 +0.0000 +0.0000 025
#ELectrd 002,10 +10.000 +16.000 +0.0000 +0.0000 026
#ELectrd 002,11 +11.000 +16.000 +0.0000 +0.0000 027
#ELectrd 002,12 +12.000 +16.000 +0.0000 +0.0000 028
#ELectrd 002,13 +13.000 +16.000 +0.0000 +0.0000 029
#ELectrd 002,14 +14.000 +16.000 +0.0000 +0.0000 030
#ELectrd 002,15 +15.000 +16.000 +0.0000 +0.0000 031
#ELectrd 002,16 +16.000 +16.000 +0.0000 +0.0000 032
#ELectrd 003,01 +16.000 +15.000 +0.0000 +0.0000 033
#ELectrd 003,02 +16.000 +14.000 +0.0000 +0.0000 034
#ELectrd 003,03 +16.000 +13.000 +0.0000 +0.0000 035
#ELectrd 003,04 +16.000 +12.000 +0.0000 +0.0000 036
```

Figure 4.3.2. Example of the electrode configuration section of the command file

```
!
!Mux-RxSection
#MA      08          00C00010305070608070908 0A090B0A0C0B0D393B98
#MT      000001 001,01 001,03
#MR1 001,05 001,07  -37.69913
#MR2 001,06 001,08  -82.46685
#MR3 001,07 001,09  -150.7966
#MR4 001,08 001,10  -247.4007
#MR5 001,09 001,11  -376.9912
#MR6 001,10 001,12  -544.2809
#MR7 001,11 001,13  -753.9828
#MR8 004,09 004,11  -713.3441
#MA      02          00C0001033A3C3B3D9F
#MT      000002 001,01 001,03
#MR1 004,10 004,12  -352.1885
#MR2 004,11 004,13  -150.7534
#MA      08          00C00013E0406050706083436353736383739383A73
#MT      000003 001,01 004,14
#MR1 001,04 001,06  +150.7534
#MR2 001,05 001,07  +352.1885
#MR3 001,06 001,08  +713.3441
#MR4 004,04 004,06  +753.9828
#MR5 004,05 004,07  +544.2809
#MR6 004,06 004,08  +376.9912
#MR7 004,07 004,09  +247.4007
#MR8 004,08 004,10  +150.7966
#MA      02          00C00013E393B3A3CA9
#MT      000004 001,01 004,14
#MR1 004,09 004,11  +82.46685
#MR2 004,10 004,12  +37.69913
#MA      08          00C00020406080709080A090B0A0C0B0D0C0E383AB4
#MT      000005 001,02 001,04
#MR1 001,06 001,08  -37.69913
#MR2 001,07 001,09  -82.46685
#MR3 001,08 001,10  -150.7966
#MR4 001,09 001,11  -247.4007
#MR5 001,10 001,12  -376.9912
#MR6 001,11 001,13  -544.2809
#MR7 001,12 001,14  -753.9828
#MR8 004,08 004,10  -753.9046
#MA      03          00C000204393B3A3C3B3D83
#MT      000006 001,02 001,04
#MR1 004,09 004,11  -433.2448
#MR2 004,10 004,12  -230.9331
#MR3 004,11 004,13  -112.3845
…

#Run_End
```

Figure 4.3.3. Example of the multiplexer configuration section of the command file

4.4 Data Files

The DAS-1 creates the data file names by appending the date, time and a four letter extension "DATA" onto a file name root parameter in the command file. The default file root name is derived from the schedule file name. A typical data file name is SANDTANK_20090313_1334.Data. Note that the year is first followed by the month, day then an underscore followed by the time in hours and minutes.

Data files are written directly in ERTLab™ format. Descriptions of this format are given in the Appendix B at the end of the manual.

4.5 Directory Structure

For PC Control Mode it is strongly recommended that the default directory structure is followed (this structure is REQUIRED for use with the micro SD card; see below). The DAS-1 installation software will create a directory named MPTERTField on the hard drive of the PC. This directory contains the following six subdirectories:

1) **STREAM**,
2) **FDIP**,
3) **SCHED,**
4) **TDIP**,
5) **SP,** and
6) **SPECTRAL**

The DSTREAM, FDIP, TDIP, SP, and SPECTRAL directories each contain two subdirectories:

1. **CMD** and
2. **DATA**

which contain the Command Files and Data Files respectively. The **SCHED** directory contains a list of schedule files that can be used to create command files for any of the data modes.

The **CMD** directory contains the command files created by the PC program and data files are placed directly in the **DATA** directory of the appropriate acquisition type. For example, data from the TDIP acquisition mode will save into the C:\MPTERTField\TDIP\DATA\ directory. Note that **only the appropriate Command files for a specific Data Mode can be placed in a given subdirectory**. For example, only Data Stream Command Files can be placed in the DSTREAM\CMD\ directory. Trying to make a data run using a TDIP or FDIP command file in the DSTREAM directory will cause a run-time error or erratic results. When the operator opens a command file, the system reads the configuration information which is held in memory then closes the file. When the user then starts a data run, the program looks for the command file in the correct directory to read the schedule information. If the file is in the wrong directory, the run will terminate with an error. If there happens to be a file of the same name in the correct directory the program will execute using that schedule information; this may lead to unexpected results.

The micro SD Card REQUIRES the following three directories to be listed directly in the root (uppermost) directory:

1) **STREAM**,
2) **FDIP** and
3) **TDIP**.

Additional directories can be present but are not used or read by the DAS-1. Each of these directories contains two subdirectories:

1) **CMD** and
2) **DATA**.

Section 5.0 PC Software

5.1 Introduction

This section discusses the DAS-1 Acquisition Software that is used to create command files, configure the system, and operate the system under control of a laptop or desktop computer. In addition, the MPT_Office software can be used to create command files and program them to run autonomously using the MPT_Scheduler routine. Autonomous operation software is covered in a separate manual. This section contains a listing of the Commands (buttons) available in the various menus.

5.2 Main System Menu

At startup, the software displays the **Main System Menu** shown in Figure 5.2.1. Following is a description of Main System Menu Commands.

Read Command File

Read Command File allows the user to open any existing command file for any of the five Data Modes. After a file is opened the software will determine the type of *Data Mode* and will jump to the appropriate *Data Mode* menu and load the configuration information.

FDIP Acq

The FDIP Acq command opens the FDIP Menu which allows the user to build an FDIP Command File using an existing schedule.

TDIP Acq

This command opens the TDIP Menu which allows the user to build a TDIP Command File using an existing schedule.

Stream Data

The Stream Data command opens the Stream Data Menu which allows the user to build a Stream Data Command File using an existing schedule.

Self-Potential

The Self Potential command opens the SP Menu which allows the user to build a SP Command File using an existing schedule.

Spectral IP

The Spectral command opens the SPECTRAL Menu which allows the user to build a SPECTRAL Command File using an existing schedule.

Communication Params

This opens the **Communications Menu**. This allows the user to change the settings for communication between the PC and DAS-1. It also allows the PC to automatically search for the correct communication settings. See Section 5.8.

Check Electrodes

This selection allows the user to perform a quick resistance check on adjacent electrode pairs (See section 5.12).

Open Alternate Configuration File

This allows the users to change the default directory structure.

Manage System Data

Manage System Data provides access to the command and data files on the SD card in the DAS-1 system through the serial or USB port. It also allows the user to synchronize the system time between the PC and DAS-1.

Set System Defaults

Set System Defaults allows the user to set the overall limits for transmitter voltage, current, battery voltage etc. It also allows the user to replace the system calibration settings.

Test Functions

This opens the **Test Function Menu** which provides an interface to low level communication with the DAS-1.

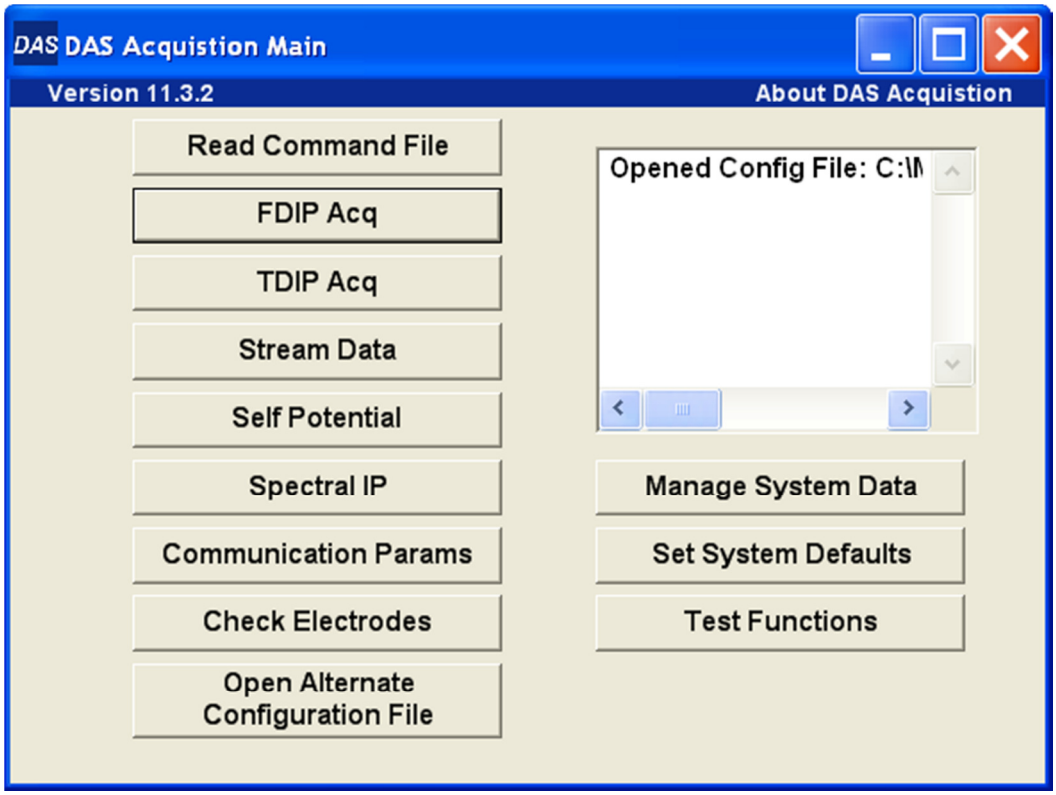


Figure 5.2.1 Main System Menu.

5.3 FDIP Menu

5.3.1 Introduction

In Frequency Domain Induced Polarization (FDIP) Data Mode, the system collects IP data using the frequency domain method and reports the data as amplitude and phase or real and imaginary values. In essence, the system is doing a real-time Fourier Transform of data values collected at even intervals throughout the waveform. The DAS-1 uses a set of filter functions that are specially designed to reject low frequency noise thus making the results fairly immune to electrode polarization errors. The filter functions are also designed to reject power line noise and therefore different filters functions are used for North America (60 Hz) and Europe (50Hz). For both filters, the maximum frequency is 5 Hz. Acquisition is restricted to fractions of 5 Hz i.e. 5/2 Hz, 5/3 Hz, 5/4 Hz, 1 Hz and so on.

The filter also requires two full waveforms so a ***stack*** in this case is two full waveforms and the minimum number of stacks is 2. Therefore, the fastest acquisition would be for four waveforms at 5 Hz which would require about 0.8 seconds for the actual data collection. Some time is required to set the multiplexer and to process and transfer data so the fastest acquisition rate for frequency domain is about 1 data point per receiver channel per second. Acquisition times increase proportionally to the number of stacks and inversely with the frequency.

The transmitted waveform is a near square wave. That is, the current is turned on in the positive direction for a duration that is just slightly half the period (the period is 1/Frequency), turns off for approximately 2 ms, turns on with the reverse sense of current flow for slightly less than half the period, then the current is turned off for 2 ms and the sequence is repeated.

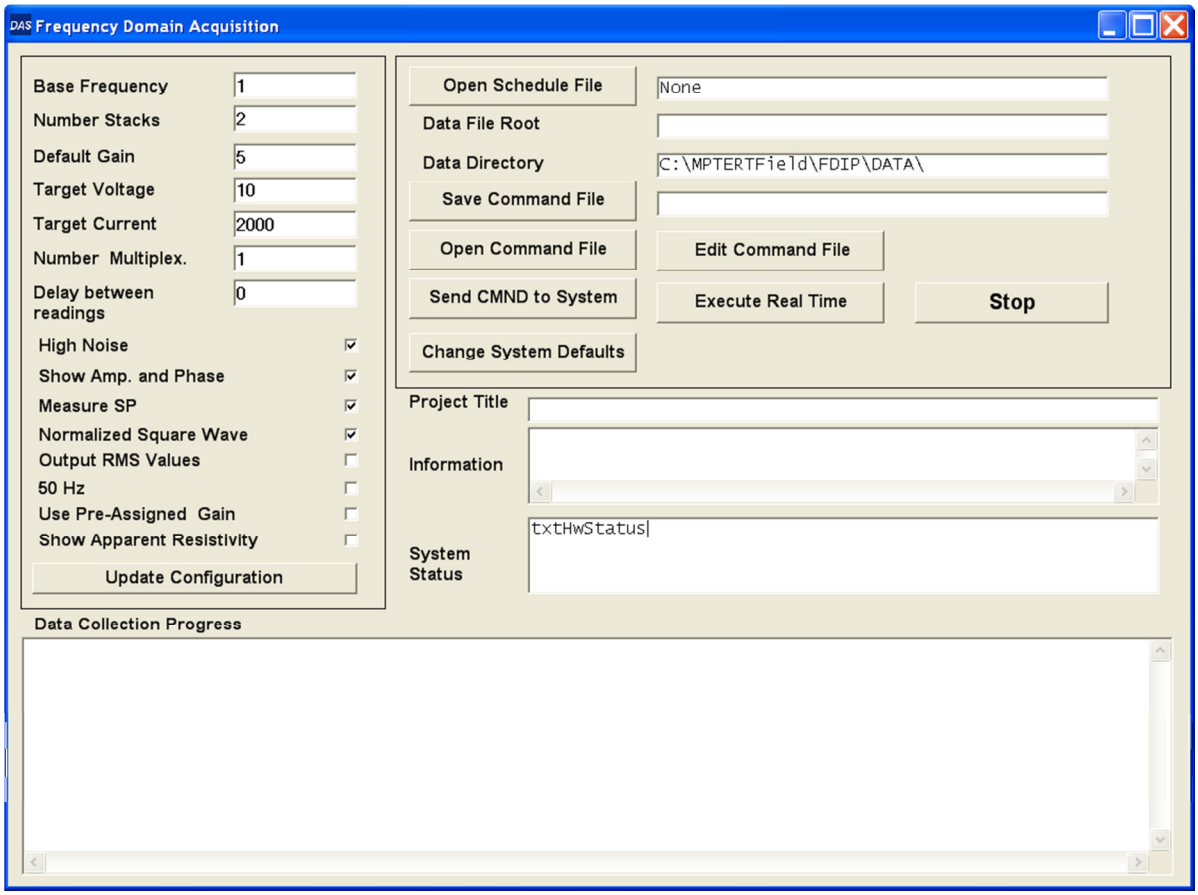


Figure 5.3.1 FDIP Menu

The **FDIP Menu** (Figure 5.3.1) allows the user to build an FDIP Command File using an existing schedule or modify an existing command file. To create a new command file, begin by opening either a schedule file (see Section 4.1) or existing FDIP command file, change Configuration parameters as needed, test the configuration using the Update Configuration button, then save the file. After the command file is saved, it can be uploaded to the DAS-1 system or executed directly from the PC.

5.3.2 FDIP Menu Commands

Open Schedule File

This opens an existing schedule file in DAS-1/ERTLab™ format.

Save Command File

This saves the command file onto the PC. The Save Command File does not directly transfer the file to the DAS-1 system, use the **Send CMND to System** option instead.

Open Command File

The command opens an existing command file. The command file includes schedule information and parameters. At present, there is no method to convert a different data acquisition mode command file (i.e. TDIP, SPECTRAL) into an FDIP command file. If the user opens a TDIP or SPECTRAL command file using this command, the FDIP menu will close and the program will open the appropriate menu for either TDIP or SPECTRAL.

Send CMND to System

This command allows the user to send a command file to the DAS-1 system. To use this command the system must be connected using either a USB or serial (RS232) cable and turned on. Also, the correct communication parameters must be set using the **Communications Menu** accessible from the **Main Menu** (Section 5.8).

Edit Command File

This selection opens the Edit Command File menu that allows the user to select data points and shift connectors and pin numbers for existing command files without entering a new schedule file. See Section 5.13.

Execute Real Time

After a command file is saved, it can be executed directly under PC control using this command.

Stop

This command stops the execution of a data run that was started using the **Execute Real Time** command. When you issue this command, the system will generally not stop immediately but waits to complete the data point that is currently being collected. ***In an emergency situation where the system must be shut down immediately regardless of the consequences to data collection, shut down the power switch on the system. However, shutting the power down in the middle of a data run may cause the system to lose part of all of the current data run and/or corrupt the micro-SD card.***

Change System Defaults

This command can reset the limits of the system. See Section 5.9.3 for more information.

Update Configuration

Note that the user can enter almost any value for a parameter (below, section 5.3.3) including invalid values. Because many of the parameters interact with each other, the code does not check the values until either the user tries to save the file or clicks the **Update Configuration** button. If any value is out of range, the system will replace the value with the nearest valid one.

5.3.3 FDIP Menu Parameters

Data File Root

Unique data file names are created for each run by appending the date and time to the end of the data file root. Data file roots are restricted to no more than 20 characters long. Data file names can have only numbers, capital letters, and the underscore symbol "_". The date and time are given as year then month, then day, followed by an underscore "_" then time. An example file name is *TESTSCHED20090328_1826.Data*

Data Directory

The data directory is the location where the data files will be placed during a data run. It is used only for the PC as the DAS-1 console software has a more rigid directory structure than the PC (see Section 4.4)

Project Title

The project title is any line of text included for information. It is included in the data file but is not used for any data process. For Command files to be downloaded to the DAS-1 this should be 35 characters or less.

Information

On the PC, the user can add any number of lines of text that will be included as documentation in the data file. For files downloaded to the DAS-1 only one line of 35 characters is allowed.

System Status

The **System Status** box shows system status during data runs and any warnings and error messages, when a command is executed. Users can clear any messages in the system status box by double clicking on the **System Status** caption next to the box.

Base Frequency

The maximum frequency is 5 Hz. Acquisition is restricted to fractions of 5 Hz i.e. 5/2 Hz, 5/3 Hz, 5/4 Hz, 1 Hz and so on.

Number Stacks

A Stack is the number of values averaged to create the final data and noise estimates. In the DAS-1 in FDIP Mode, two full waveforms are used for each stack. The minimum number of stacks is 2.

Default Gain

The default gain is an integer from 0 to 5 giving the index of the gain/range settings. The default is 5 which allows the system to use Auto-Gain settings and should be used except for very unusual circumstances. Using values along with setting the **Use Pre-Assigned Gain** checkbox will force the system to use that specified gain/range value for all data. If the data values are too large for the range the system will produce erroneous results or may fail to collect one or more data. The table below gives the gain and range settings.

Table 5.3.1

Gain Index	Gain	Max Voltage
0	Auto Range	10
1	1	10
2	5	2
3	25	0.4
4	125	0.08
5	**Auto Range**	**10**

Target Voltage

This is the approximate transmitter voltage in volts used for the data series. The actual voltage may vary from this somewhat and is typically smaller than this voltage but depends on load conditions. For typical transmitter contact resistances (a few hundred to a few thousand Ohms) the system will choose a transmitter and will seek to find an optimal voltage which is at or slightly below this value but still has a high efficiency and is unlikely to exceed the transmitter current, power, and voltage limits. For very high contact resistances (tens of thousands of Ohms) the transmitter has a minimum output voltage of about 25 volts. Typical values range from 20 volts to 480 volts. It is again important to note that **operators should never assume that the voltage is necessarily limited to this voltage and data should never be collected if humans or animals may be in contact with exposed metal on cables, connectors or electrodes**. However, lower voltages are in general safer than higher voltages. Also higher voltages do not necessarily result in better signal to noise values. We recommend running preliminary tests and using the lowest target voltage that provides adequate data values. Ideally this voltage should be under 100 volts.

Target Current

This is the approximate transmitter current limit in milliamps for a data series. For each set of readings the transmitter will try to limit the current flow to approximately this value. Typically this is set at or near the system limit of 2500 milliamps.

Number Multiplexers

For systems with only a Main Unit this should equal 1. The **Number Multiplexers** value should equal the total number of multiplexers (the number of multiplexers includes the main unit plus external multiplexers) connected to the system even if those multiplexers are not used for a given schedule. **All of the multiplexers connected to the system must have sequential addresses and must be turned on during data collection.** For example, if a given Schedule/Command file only uses the cables connected to Multiplexer Address 3, you must also have external multiplexers 1 and 2 connected to the system and turned on even though they are not used for the current command file. If in this same example there are additional multiplexers (for example Multiplexer addresses 4 and 5 connected to the system) they must also be turned on and the number of Multiplexers set to 5.

High Noise

Selecting the high noise value by checking the box changes the auto gain values generally causing the system to choose a gain setting with a higher voltage range.

Show Amp. and Phase

Setting this value causes amplitude and phase to be displayed in the status box during a data run. The default is **TRUE**.

Measure SP

When this value is checked the DAS-1 measures the self-potential prior to starting the normal data collection. Therefore setting this value does increase run times slightly.

Normalized Square Wave

Setting this value causes the system to apply a correction factor so the raw values of current and voltage are approximately the same as the average value for a square wave. In other words the voltages should be the same as those measured using a voltmeter or oscilloscope. This does not change the V/I value or phase values. Selecting the RMS parameter (below) overrides this value. If either the Normalized Square Wave or Output RMS parameters are chosen the raw values from filter function are output.

Output RMS Values

Setting this value causes the system to apply a correction factor to output RMS values for raw voltages and current. This does not change the V/I value or phase values. Setting the RMS parameter overrides Normalized Square Wave parameter. If neither the Normalized Square Wave nor Output RMS parameters are chosen, the raw values from the filter function will be the output.

50 Hz

This parameter should not be checked (default) in North America and other parts of the world that use 60 Hz power and should be checked in Europe and parts of the world with 50 Hz power.

Use Pre-Assigned Gain

As discussed above, the parameter overrides the Auto-Gain range of the system. This should be used only in very unusual circumstances.

Show Apparent Resistivity

Checking this option causes the system to display apparent resistivity instead of amplitude and write apparent resistivity values into the data file.

5.4 TDIP Menu

5.4.1 Introduction

This menu is used for Time Domain Induced Polarization or resistivity –only data collection modes. In TDIP Data Mode, the system uses a standard TDIP current waveform as shown in Figure 5.4.2. To collect IP data, the system begins by transmitting current on for a period of 1/ (4 *Base Frequency). The system waits a length of time given by the Resistivity Time Delay (TRDely), then measures the On-Time Voltage averaged over a period given by Resistivity Measurement Time (TlngthR). The current is then turned off for the same length of period, 1/(4 * Base Frequency). During this time the TDIP decay waveform is measured during 1 or more Windows. The system then transmits current with opposite polarity and repeats the sequence.

The DAS-1 uses a proprietary algorithm to Stack the data over several waveforms. In this system the first stack requires 2 complete waveforms and each subsequent stack 1.5 waveforms. The fastest data acquisition would be for 7.5 Hz with 2 Stacks and requires roughly 0.5 seconds to collect data on 1 to 8 channels.

In resistivity only mode, the system uses a square wave and has a maximum frequency of 13.5 Hz. The system should collect about 3 x [number of channels] data points per second.

Acquisition times increase proportionally to the number of stacks and inversely with the frequency.

The **TDIP Menu** (Figure 5.4.1) allows the user to build a TDIP Command File using an existing schedule or modify an existing command file. To create a new Command File, begin by opening either a Schedule File (see Section 4.1) or existing TDIP Command File, change parameters as needed, test the configuration using the Update Configuration button then save the file. After the command file is saved, it can be uploaded to the system or executed directly from the PC.

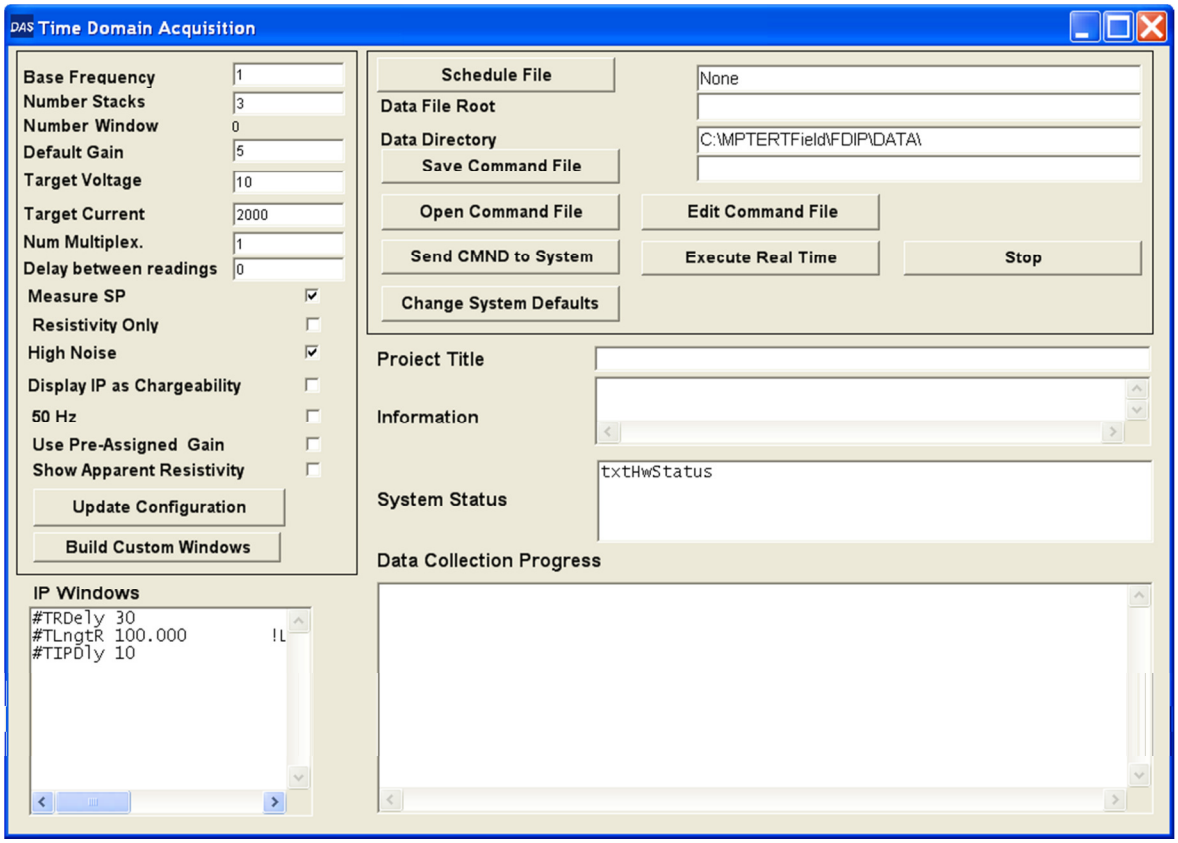


Figure 5.4.1 TDIP Menu

5.4.2 TDIP Menu Commands

Schedule File

This opens an existing schedule file in DAS-1/ERTLab™ format.

Save Command File

Saves the command file on the PC. The Save Command File does not directly transfer the file to the DAS-1 system, use the Send CMND to System option instead.

Open Command File

The command opens an existing command file. The command file includes schedule information and parameters. At present, there is no method to convert a Stream Data or FDIP command file into a TDIP command file. If the user opens a Stream Data or FDIP command file using this command, the TDIP menu will close and the program will open the appropriate menu for either FDIP or Stream Data.

Send CMND To System

This command allows the user to send a command file to the DAS-1 system. To use this command the system must be connected using either a USB or serial (RS232) cable and turned

on. Also, the correct communication parameters must be set using the **Communications Menu** accessible from the **Main Menu**.

Edit Command File

This selection opens the **Edit Command File** menu that allows the user to select data points and shift connectors and pin numbers for existing command files without entering a new schedule file. See Section 5.13

Execute Real Time

After a schedule file is saved, it can be executed directly under PC control using this command.

Stop

This command stops the execution of a data run that was started using the **Execute Real Time** command. When you issue this command, the system will generally not stop immediately but waits to complete the data point that is currently being collected. ***In an emergency situation where the system must be shut down immediately regardless of the consequences to data collection, shut down the power switch on the system. However, shutting the power down in the middle of a data run may cause the system to lose part of all of the current data run!***

Change System Defaults

This command can reset the limits of the system. See Section 5.9.3 for more information.

Update Configuration

Note that the user can enter almost any value for a parameter including invalid values. Because many of the parameters interact with each other, the code does not check the values until either the user tries to save the file or clicks the **Update Configuration** button. If any value is out of range, the system will replace the value with the nearest valid one.

Build Custom Windows

The Build Custom Windows Command displays the Build Custom Windows submenu shown in Figure 5.4.2. In this menu the user can either add additional windows or clear all of the windows and build a new set from scratch. Building a new set of windows starts with picking the delay time between when the transmitter is turned on and when the system begins recording the voltage used for the on-time, resistivity part of the measurement. The time delay can be set in multiples of 10 milliseconds. This delay is used to reduce the effects of electromagnetic coupling and induced polarization on the resistivity values. Longer times reduce these effects but will reduce the length of time available to measure resistivity. Typical values range from 10 ms for high speed acquisition to a few hundred milliseconds.

When the user enters the delay time, the software displays the minimum and maximum time available for the next window or delay time. The resistivity window and IP windows are allocated in either 16.67 ms increments for 60 Hz power line noise rejection or 20 ms increments for 50 Hz power line noise rejection. Typically the longest possible window is chosen that will fit in the remaining time. If too long of a window is chosen, the window will be trimmed to the maximum length the next time the **Update Configuration** command is applied.

After assigning the resistivity measurement window, the next step is to assign the IP delay, the time between the turnoff of the transmitter and the first IP measurement window. Again this delay is assigned in 10 ms increments. Users can then assign from 1 to 35 IP windows depending on the time available and the power-line rejection frequency.

Note that if the base frequency is increased the time period is reduced and the system will remove any windows that exceed the available time period. It will retain at least one IP window; if necessary trimming the window length and initial IP delay. When the base frequency is reduced the windows are retained but windows are not automatically added. For this reason, it is often easier to modify an existing low frequency configuration and increase the frequency than to modify a high frequency one and reduce the frequency.

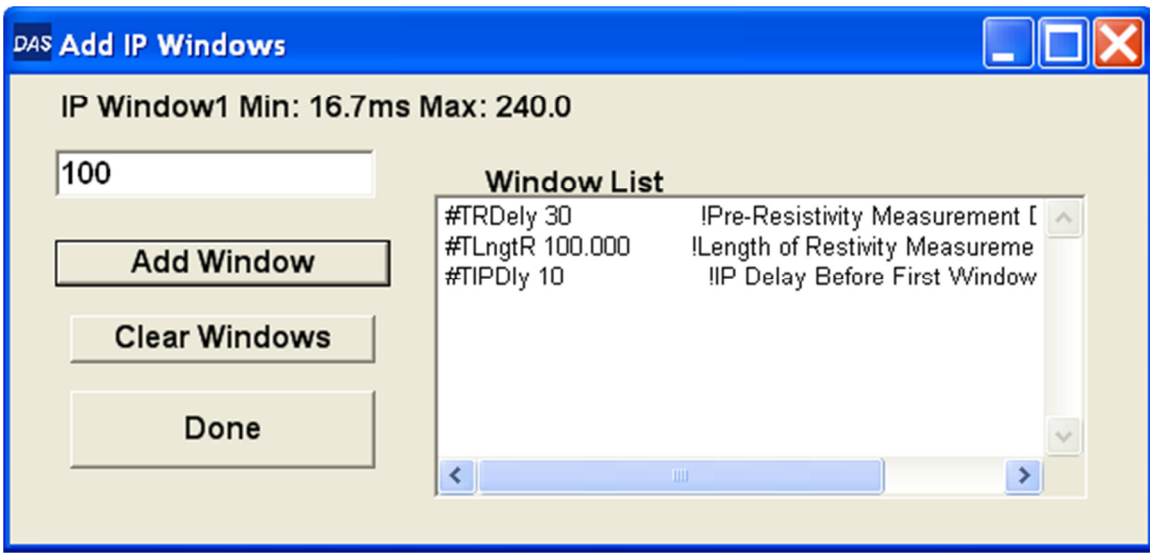


Figure 5.4.2. Build Custom Window menu

5.4.3 TDIP Menu Parameters

Data File Root

Unique data file names are created for each run by appending the date and time to the end of the data file root. Data file roots are restricted to no more than 20 characters long. Data file names can have only numbers, capital letters, and the underscore symbol "_". The date and time are given as year then month, then data, followed by an underscore "_" then time. An example file name is *TESTSCHED20090328_1826.Data*

Data Directory

The data directory is the location where the data files will be placed during a data run. It is used only for the PC as the DAS-1 has a more rigid directory structure than the PC (see Section 4.4).

Project Title

The project title is any line of text included for information. It is included in the data file but is not used. For Command files to be downloaded to the DAS-1 this should be 35 characters or less.

Information

On the PC the user can add any number of lines of text that will be included as documentation in the data file. For files downloaded to the DAS-1 only one line of 35 characters is allowed.

System Status

The **System Status** box shows system status during data runs and any warnings and error messages, when a command is executed. Users can clear any messages in the system status box by double clicking on the **System Status** caption next to the box.

Base Frequency

The maximum frequency is 9 Hz for 60 Hz power line noise rejection and 8 Hz for 50 Hz power line noise rejection.

Number Stacks

A Stack is the number of values averaged to create the final data and noise estimates. In the DAS-1 in TDIP Mode, two full waveforms are used for each stack. The minimum number of stacks is 2.

Number of Windows

This shows the number of windows used to collect TDIP data. The number of windows is actually set below using the IP Windows box or Build Custom Windows submenu.

Default Gain

The default gain is an integer from 0 to 5 giving the index of the gain/range settings. The default is 5 which allows the system to use Auto-Gain settings and should be used except for very unusual circumstances. Using values along with setting the *Use Pre-Assigned Gain* checkbox will force the system to use that gain/range value for all data. If the data values are too large for the range, the system will produce erroneous results or may fail to collect one or more data. See Table 5.3.1 (in Section 5.3) for the gain and range settings.

Target Voltage

This is the approximate transmitter voltage in volts used for the data series. The actual voltage may vary from this somewhat and is typically smaller that this voltage but depends on load conditions. For typical transmitter contact resistances (a few hundred to a few thousand Ohms) the system will choose a transmitter and will seek to find an optimal voltage which is at or slightly below this value but still has a high efficiency and is unlikely to exceed the transmitter current, power, and voltage limits. For very high contact resistances (tens of thousands of Ohms) the transmitter has a minimum output voltage of about 25 volts. Typical values range from 20 volts to 480 volts. ***It is again important to note that operators should never assume***

that the voltage is necessarily limited to this voltage and data should never be collected if humans or animals may be in contact with exposed metal on cables, connectors or electrodes. However, lower voltages are in general safer than higher voltages. Also, higher voltages do not necessarily result in better signal to noise values. We recommend running preliminary tests and using the lowest target voltage that provides adequate data values. Ideally this voltage should be under 100 volts.

Target Current

This is the approximate transmitter current limit in milliamps for a data series. For each set of readings the transmitter will try to limit the current flow to approximately this value. Typically this is set at or near the system limit of 2500 milliamps.

Number Multiplexers

For systems with only a main unit this should equal 1. The Number Multiplexers should equal the total number of multiplexers (the number of multiplexers includes the main unit plus external multiplexers) connected to the system even if those multiplexers are not used for a given schedule. ***All of the multiplexers connected to the system must have sequential addresses and must be turned on during data collection.*** For example, if a given Schedule/Command file only uses the cables connected to Multiplexer Address 3, you must also have external multiplexers 1 and 2 connected to the system and turned on even though they are not used for the current command file. If in this same example there are additional multiplexers, for example Multiplexer addresses 4 and 5 connected to the system they must also be turned on and the number of Multiplexers set to 5.

Measure SP

When this value is set the DAS-1 measures the self-potential prior to starting the normal data collection. Therefore, setting this value does increase run times slightly.

Resistivity Only

Setting this value will set the number of IP Windows to zero and the change the waveform from an IP-Type waveform to a square wave. No IP data will be collected and the acquisition frequency can be increased to as high as 16 Hz.

High Noise

Selecting the high noise value by checking the box changes the auto gain values generally causing the system to choose a gain setting with a higher voltage range.

Display IP as Chargeability

When **Display IP as Chargeability** is selected**,** the IP values are displayed as Chargeability, milliVolts per Volt on-time (resistivity) voltages. Otherwise, the IP values are given in Ohms as off-time voltage over current.

50 Hz

This parameter should not be checked (default) in North America and other parts of the world that use 60 Hz power and should be checked in Europe and parts of the world with 50 Hz power.

Use Pre-Assigned Gain

As discussed above the parameter overrides the Auto-Gain range of the system. This should be used only in very unusual circumstances.

Show Apparent Resistivity

Checking this option causes the system to display apparent resistivity instead of amplitude and write apparent resistivity values into the data file.

5.5 Stream Data Menu

5.5.1 Introduction

The Stream Data mode allows the user to collect raw current or voltage values in up to 128 windows. These data can then be plotted or processed using user created software. The user then chooses frequency, the number of half-waveforms (see below) and the window length. The Stream Data Mode is set up in terms of Half Waveforms. A half-waveform has a period of 1.0 / (2 * Frequency) and begins when the transmitter current is turned on (see Figure 5.5.1). The system transmits a TDIP style waveform. The first half-waveform and thus the first window begins when the transmitter is turned on. The code chooses the number of windows that will fit within the Half-Waveform. Each half waveform has the same number of windows and there may be gaps after the last window in one Half-Waveform and the first window in the next. Note that some windows can span the time when the transmitter is turned off.

The **Stream Data Menu** (Figure 5.5.2) allows the user to build a Stream Data Command File using an existing schedule or modify an existing command file. To create a new Command File, begin by opening either a Schedule File (see Section 4.1) or existing Stream Data Command File, change parameters as needed, test the configuration using the Update Configuration button then save the file. After the command file is saved, it can be uploaded to the system or executed directly from the PC.

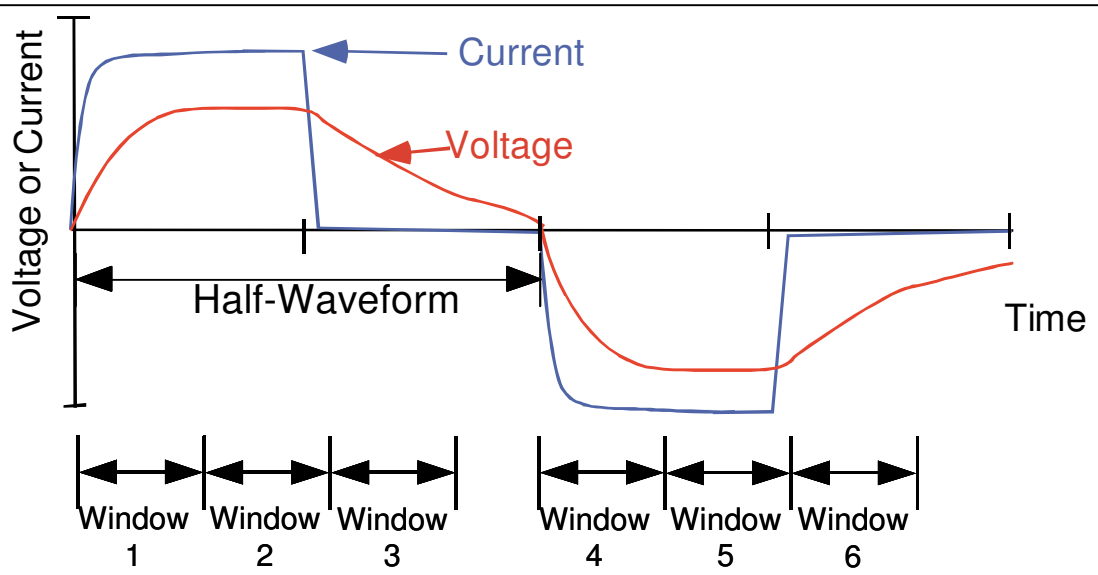


Figure 5.5.1 Typical Stream Data Waveform showing timing of windows with respect to Half Waveforms.

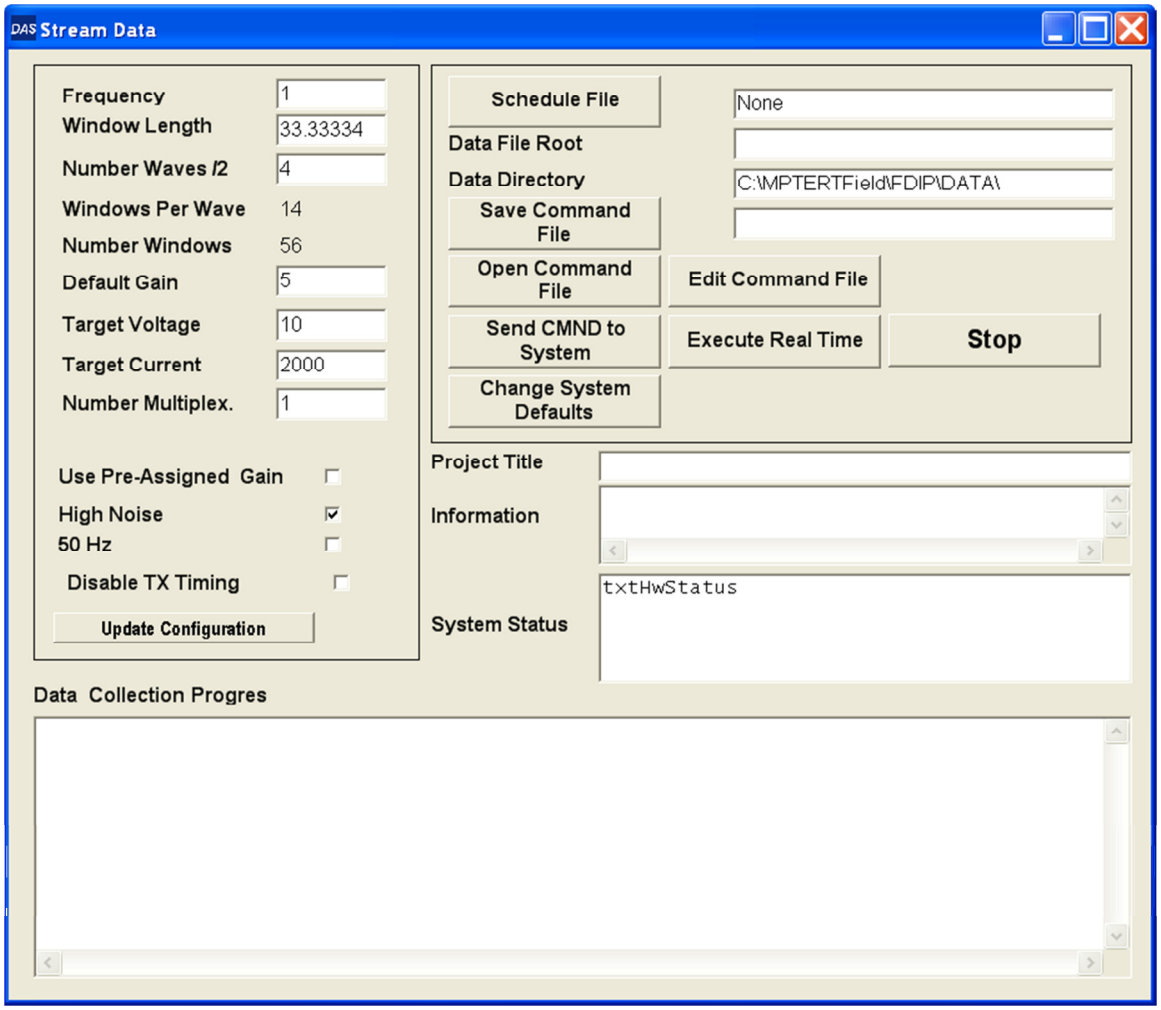


Figure 5.5.2. Stream Data Menu

5.5.2 Stream Data Menu Commands

Schedule File

This opens an existing schedule file in DAS-1/ERTLab™ format.

Save Command File

This saves the command file onto the PC. The Save Command File does not directly transfer the file to the DAS-1 system, use the **Send CMND to System** option instead.

Open Command File

The command opens an existing command file. The command file includes schedule information and parameters. At present, there is no method to convert a TDIP or FDIP command file into a Stream command file. If the user opens a FDIP or TDIP command file using this command, the Stream menu will close and the program will open the appropriate menu for either FDIP or TDIP Data.

Send CMND to System

This command allows the user to send a command file to the DAS-1 system. To use this command the system must be connected using either a USB or serial (RS232) cable and turned on. Also, the correct communication parameters must be set using the **Communications Menu** accessible from the **Main Menu.**

Edit Command File

This selection opens the **Edit Command File** menu that allows the user to select data points and shift connectors and pin numbers for existing command files without entering a new schedule file. See Section 5.13.

Execute Real Time

After a schedule file is saved, it can be executed directly under PC control using this command.

Stop

This command stops the execution of a data run that was started using the **Execute Real Time** command. When you issue this command, the system will generally not stop immediately but waits to complete the data point that is currently being collected. ***In an emergency situation where the system must be shut down immediately regardless of the consequences to data collection, shut down the power switch on the system. However, shutting the power down in the middle of a data run may cause the system to lose part of all of the current data run!***

Change System Defaults

This command can reset the limits of the system. See Section 5.9.3 for more information.

Update Configuration

Note that the user can enter almost any value for a parameter including invalid values. Because many of the parameters interact with each other, the code does not check the values until either the user tries to save the file or clicks the **Update Configuration** button. If any value is out of range, the system will replace the value with the nearest valid one.

5.5.3 Stream Data Menu Parameters

Data File Root

Unique data file names are created for each run by appending the date and time to the end of the data file root. Data file roots are restricted to no more than 20 characters long. Data file names can have only numbers, capital letters, and the underscore symbol "_" . The date and time are given as year then month, then data, followed by an underscore "_" then time. An example file name is *TESTSCHED20090328_1826.Data*

Data Directory

The data directory is the location where the data files will be placed during a data run. It is used only for the PC as the DAS-1 has a more rigid directory structure than the PC (see Section 4.4).

Project Title

The project title is any line of text included for information. It is included in the data file but is not used. For Command files to be downloaded to the DAS-1 this should be 35 characters or less.

Information

On the PC the user can add any number of lines of text that will be included as documentation in the data file. For files downloaded to the DAS-1 only one line of 35 characters is allowed.

System Status

The **System Status** box shows system status during data runs and any warnings and error messages, when a command is executed. Users can clear any messages in the system status box by double clicking on the **System Status** caption next to the box.

Frequency

The maximum frequency is 9 Hz for 60 Hz powerline noise rejection and 8 Hz for 50 Hz powerline noise rejection.

Window Length

Voltages collected in Stream Data Mode are averaged over windows that are integer multiples of 16.67 milliseconds per window for 60 Hz powerline noise rejection and 20 milliseconds for 50 Hz powerline noise rejection. There must be at least one window per data half-waveform.

Number of Waves/2

These are the number of Half-Waveforms collected during a data run.

Windows Per Wave

This shows the number of windows per half-wave. The code chooses the number of windows that will fit within the time period of the Half-Waveform.

Number of Windows

This shows total number of windows collected.

Default Gain

The default gain is an integer from 0 to 5 giving the index of the gain/range settings. The default is 5 which allows the system to use Auto-Gain settings and should be used except for very unusual circumstances. Using values along with setting the Use Pre-Assigned Gain checkbox will force the system to use that gain/range value for all data. If the data values are too large for the range the system will produce erroneous results or may fail to collect one or more data. See table 5.3.1 (in Section 5.3) for the gain and range settings.

Target Voltage

This is the approximate transmitter voltage in volts used for the data series. The actual voltage may vary from this somewhat and is typically smaller that this voltage but depends on load conditions. For typical transmitter contact resistances (a few hundred to a few thousand Ohms) the system will choose a transmitter and will seek to find an optimal voltage which is at or slightly below this value but still has a high efficiency and is unlikely to exceed the transmitter current, power, and voltage limits. For very high contact resistances (tens of thousands of Ohms) the transmitter has a minimum output voltage of about 25 volts. Typical values range from 20 volts to 480 volts. ***It is again important to note that operators should never assume that the voltage is necessarily limited to this voltage and data should never be collected if humans or animals may be in contact with exposed metal on cables, connectors or electrodes***. However, lower voltages are in general safer than higher voltages. Also, higher voltages do not necessarily result in better signal to noise values. We recommend running preliminary tests and using the lowest target voltage that provides adequate data values. Ideally this voltage should be under 100 volts.

Target Current

This is the approximate transmitter current limit in milliamps for a data series. For each set of readings the transmitter will try to limit the current flow to approximately this value. Typically this is set at or near the system limit of 2500 milliamps.

Number Multiplexers

For systems with only a main unit this should equal 1. The Number Multiplexers should equal the total number of multiplexers (the number of multiplexers includes the main unit plus external multiplexers) connected to the system even if those multiplexers are not used for a given schedule. ***All of the multiplexers connected to the system must have sequential addresses and must be turned on during data collection.*** For example, if a given Schedule/Command file only uses the cables connected to Multiplexer Address 3, you must also have external multiplexers 1 and 2 connected to the system and turned on even though they are not used for the current command file. If in this same example there are additional multiplexers, for example Multiplexer addresses 4 and 5, connected to the system they must also be turned on and the number of Multiplexers set to 5.

Use Pre-Assigned Gain

As discussed earlier the parameter overrides the Auto-Gain range of the system. This should be used only in very unusual circumstances.

High Noise

Selecting the high noise value by checking the box changes the auto gain values generally causing the system to choose a gain setting with a higher voltage range.

50 Hz

This parameter should not be checked (default) in North America and other parts of the world that use 60 Hz power and should be checked in Europe and parts of the world with 50 Hz power.

Disable TX Timing

This parameter disables the synchronization between the transmitter and Stream Data windows. If this value is set, the system will collect a continuous series of data windows starting slightly before the transmitter is turned on. Often windows will span the turn-on times of the transmitter and the data sequence will likely complete before the transmitter is finished. This mode is primarily for diagnostic purposes. Normally the data collection is synchronized with the Transmitter.

5.6 Self Potential Menu

5.6.1 Introduction

The Self Potential method allows the system to measure the self-potential value at one or more receiver pairs without transmitting current. For consistency, the SP routine uses a schedule file with same format as the other data acquisition modes so values must be supplied for the transmitter electrode locations even though they are not used. It is suggested the transmitter cable and electrode values are set to zero. Note that one known issue is that the system will not allow the receiving locations to be the same as the transmitting locations for even though the transmitter is not actually used.

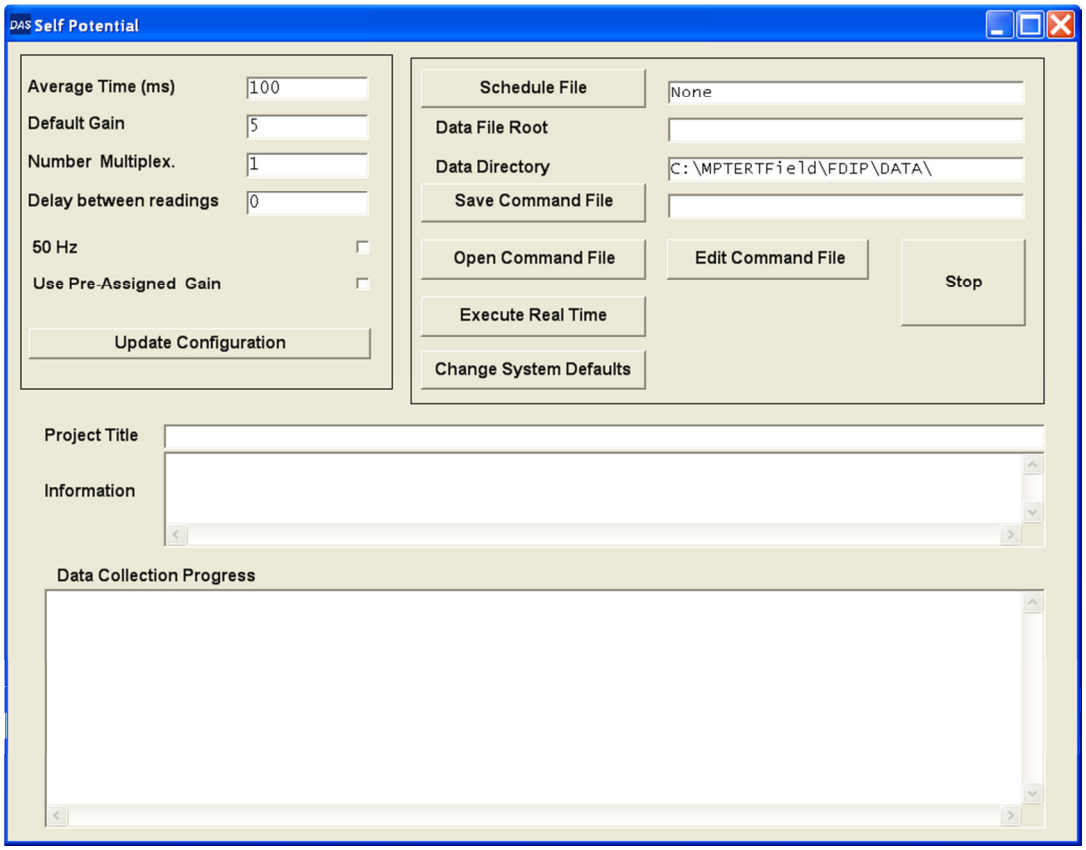


Figure 5.6.1 Self Potential Menu

5.6.2 Self Potential Menu Commands

Schedule File

This opens an existing schedule file in DAS-1/ERTLab™ format.

Save Command File

This saves the command file onto the PC. The Save Command File does not directly transfer the file to the DAS-1 system, use the **Send CMND to System** option instead.

Open Command File

The command opens an existing command file. The command file includes schedule information and parameters. At present, there is no method to convert other types of command files into a Self-Potential command file. If the user opens a different type of command file using this command, the Self Potential menu will close and the program will open the appropriate menu.

Edit Command File

This selection opens the **Edit Command File** menu that allows the user to select data points and shift connectors and pin numbers for existing command files without entering a new schedule file. See Section 5.13

Execute Real Time

After a command file is saved, it can be executed directly under PC control using this command.

Stop

This command stops the execution of a data run that was started using the **Execute Real Time** command. When you issue this command, the system will generally not stop immediately but waits to complete the data point that is currently being collected. ***In an emergency situation where the system must be shut down immediately regardless of the consequences to data collection, shut down the power switch on the system. However, shutting the power down in the middle of a data run may cause the system to lose part of all of the current data run!***

Change System Defaults

This command can reset the limits of the system. See Section 5.9.3 for more information.

Update Configuration

Note that the user can enter almost any value for a parameter including invalid values. Because many of the parameters interact with each other, the code does not check the values until either the user tries to save the file or clicks the **Update Configuration** button. If any value is out of range, the system will replace the value with the nearest valid one.

5.6.3 Self Potential Menu Parameters

Data File Root

Unique data file names are created for each run by appending the date and time to the end of the data file root. Data file roots are restricted to no more than 20 characters long. Data file names can have only numbers, capital letters, and the underscore symbol "_". The date and time are given as year then month, then data, followed by an underscore "_" then time. An example file name is *TESTSCHED20090328_1826.Data*

Data Directory

The data directory is the location where the data files will be placed during a data run. It is used only for the PC as the DAS-1 has a more rigid directory structure than the PC (see Section 4.4).

Project Title

The project title is any line of text included for information. It is included in the data file but is not used. For Command files to be downloaded to the DAS-1 this should be 35 characters or less.

Information

On the PC the user can add any number of lines of text that will be included as documentation in the data file. For files downloaded to the DAS-1 only one line of 35 characters is allowed.

System Status

The status window shows system status during data runs and shows warnings and error messages if any when a command is executed. Users can clear any messages in the status box by double clicking on the Status caption above the box.

Average Time (ms)

This is the length of time used to average the self-potential measurements. The shortest time is 16.7 ms for 60 Hz data acquisition. Longer times will generally provide better noise rejection.

Default Gain

The default gain is an integer from 0 to 5 giving the index of the gain/range settings. The default is 5 which allows the system to use Auto-Gain settings and should be used except for very unusual circumstances. Using values along with setting the Use Pre-Assigned Gain checkbox will force the system to use that gain/range value for all data. If the data values are too large for the range the system will produce erroneous results or may fail to collect one or more data. See table 5.3.1 (in Section 5.3) for the gain and range settings.

Number Multiplexers

For a system with only a main unit this should equal 1. The Number Multiplexers should equal the total number of multiplexers (the number of multiplexers includes the main unit plus external multiplexers) connected to the system even if those multiplexers are not used for a given schedule. ***All of the multiplexers connected to the system must have sequential addresses and must be turned on during data collection.*** For example, if a given Schedule/Command file only uses the cables connected to Multiplexer Address 3, you must also have external multiplexers 1 and 2 connected to the system and turned on even though they are not used for the current command file. If in this same example there are additional multiplexers, for example Multiplexer addresses 4 and 5, connected to the system they must also be turned on and the number of Multiplexers set to 5.

50 Hz

This parameter should be set to **FALSE**(default) in North America and other parts of the world that use 60 Hz power and **TRUE** in Europe and parts of the world with 50 Hz power.

Use Pre-Assigned Gains

As discussed earlier the parameter overrides the Auto-Gain range of the system. This should be used only in very unusual circumstances.

5.7 Spectral IP Menu

5.7.1 Introduction

The Spectral IP data mode allows the user to collect frequency domain spectral IP data. The DAS-1 will make measurements at one or more of seventeen pre-assigned frequencies. The frequencies are: 225, 112.5, 75, 37.5, 25, 15, 7.5, 5, 2.5, 1.667, 1, 0.5, 0.25, 0.125, 0.0625, 0.03125 and 0.015625 Hz. The high frequency data are collected using a special filter that averages the signal over four full waveforms. Below 7.5 Hz, the system uses the same filters and stacking methods described in the FDIP section.

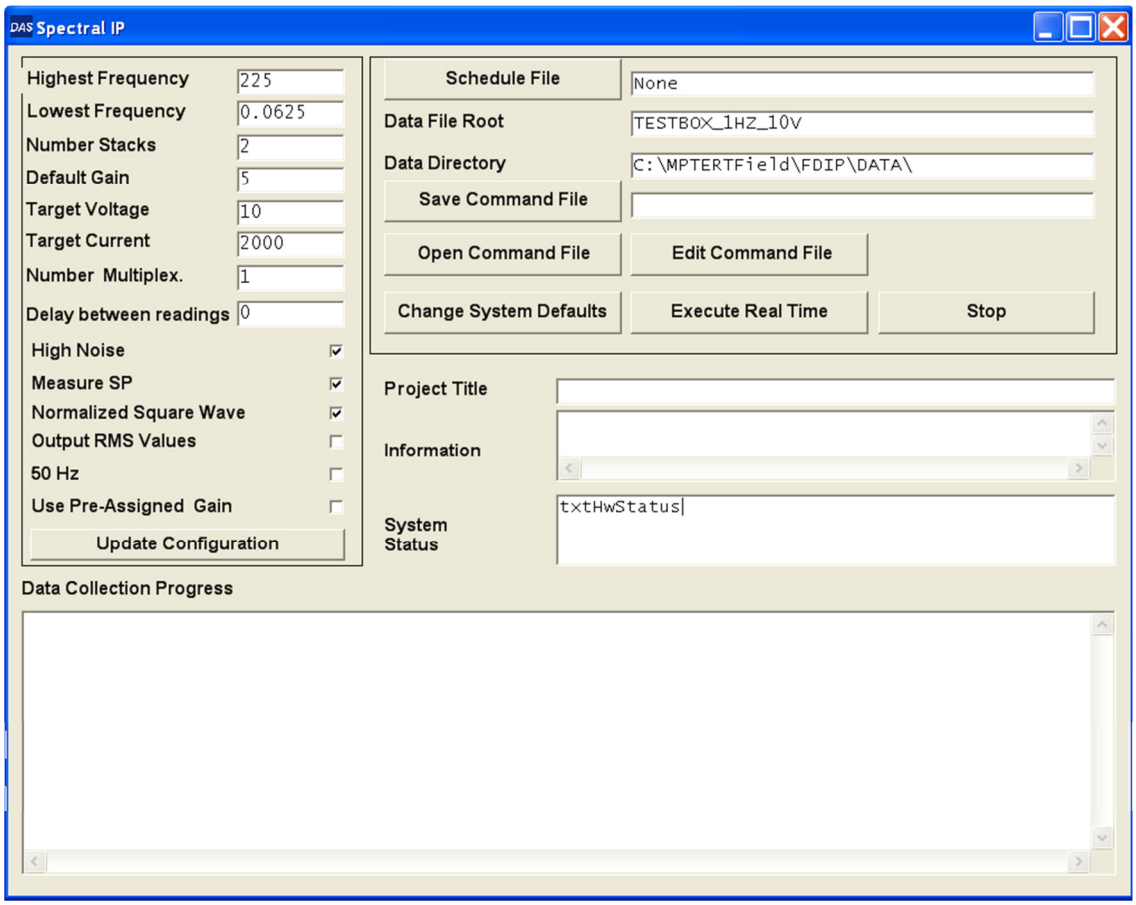


Figure 5.7.1 Spectral IP Menu

The **Spectral IP Menu** (Figure 5.7.1) allows the user to build a Spectral IP Command File using an existing schedule or modify an existing command file. To create a new Command File, begin by opening either a Schedule File (see Section 4.1) or existing Spectral IP Command File, change parameters as needed, test the configuration using the Update Configuration button then save the file. After the command file is saved, it can be uploaded to the system or executed.

5.7.2 Spectral IP Menu Commands

Schedule File

This opens an existing schedule file in DAS-1/ERTLab™ format.

Save Command File

This saves the command file onto the PC. The Save Command File does not directly transfer the file to the DAS-1 system, use the **Send CMND to System** option instead.

Open Command File

The command opens an existing command file. The command file includes schedule information and parameters. At present, there is no method to convert other types of command files into a Spectral command file. If the user opens a different type of command file using this command, the Spectral menu will close and the program will open the appropriate menu.

Edit Command File

This selection opens the **Edit Command File** menu that allows the user to select data points and shift connectors and pin numbers for existing command files without entering a new schedule file. See Section 5.13

Execute Real Time

After a command file is saved, it can be executed directly under PC control using this command.

Stop

This command stops the execution of a data run that was started using the **Execute Real Time** command. When you issue this command, the system will generally not stop immediately but waits to complete the data point that is currently being collected. ***In an emergency situation where the system must be shut down immediately regardless of the consequences to data collection, shut down the power switch on the system. However, shutting the power down in the middle of a data run may cause the system to lose part of all of the current data run!***

Change System Defaults

This command can reset the limits of the system. See Section 5.9.3 for more information.

Update Configuration

Note that the user can enter almost any value for a parameter including invalid values. Because many of the parameters interact with each other, the code does not check the values until either the user tries to save the file or clicks the **Update Configuration** button. If any value is out of range, the system will replace the value with the nearest valid one.

5.7.3 Spectral IP Menu Parameters

Data File Root

Unique data file names are created for each run by appending the date and time to the end of the data file root. Data file roots are restricted to no more than 20 characters long. Data file names can have only numbers, capital letters, and the underscore symbol "_". The date and time are given as year then month, then data, followed by an underscore "_" then time. An example file name is *TESTSCHED20090328_1826.Data*

Data Directory

The data directory is the location where the data files will be placed during a data run. It is used only for the PC as the DAS-1 has a more rigid directory structure than the PC (see Section 4.4).

Project Title

The project title is any line of text included for information. It is included in the data file but is not used. For Command files to be downloaded to the DAS-1 this should be 35 characters or less.

Information

On the PC the user can add any number of lines of text that will be included as documentation in the data file. For files downloaded to the DAS-1 only one line of 35 characters is allowed.

System Status

The status window shows system status during data runs and shows warnings and error messages if any when a command is executed. Users can clear any messages in the status box by double clicking on the Status caption above the box.

Highest Frequency

This parameter sets the highest frequency the system will collect. For example, if the highest frequency is set to 100, the system will begin collecting data at 75 Hz, the highest, pre-assigned value below 100 Hz.

Lowest Frequency

This is the minimum frequency collected during a spectral IP data run. Note that the lowest frequency is 1/64 Hz. Acquiring 4 stacks will require about 10 minutes per data point at this frequency. A full spectral sweep from 225 to 1/64 Hz will take 30 minutes or more.

Number Stacks

A Stack is the number of values averaged to create the final data and noise estimates. In the DAS-1 in Spectral IP Mode, two full waveforms are used for each stack below 7.5 Hz and four full waveforms for frequencies over 5 Hz. The minimum number of stacks is 2.

Default Gain

The default gain is an integer from 0 to 5 giving the index of the gain/range settings. The default is 5 which allows the system to use Auto-Gain settings and should be used except for very unusual circumstances. Using values along with setting the Use Pre-Assigned Gain checkbox will force the system to use that gain/range value for all data. If the data values are too large for the range the system will produce erroneous results or may fail to collect one or more data. See table 5.3.1 (in Section 5.3) for the gain and range settings.

Target Voltage

This is the approximate transmitter voltage in volts used for the data series. The actual voltage may vary from this somewhat and is typically smaller that this voltage but depends on load conditions. For typical transmitter contact resistances (a few hundred to a few thousand Ohms) the system will choose a transmitter and will seek to find an optimal voltage which is at or slightly below this value but still has a high efficiency and is unlikely to exceed the transmitter current, power, and voltage limits. For very high contact resistances (tens of thousands of Ohms) the transmitter has a minimum output voltage of about 25 volts. Typical values range from 20 volts to 480 volts. ***It is again important to note that operators should never assume that the voltage is necessarily limited to this voltage and data should never be collected if humans or animals may be in contact with exposed metal on cables, connectors or electrodes***. However, lower voltages are in general safer than higher voltages. Also, higher voltages do not necessarily result in better signal to noise values. We recommend running preliminary tests and using the lowest target voltage that provides adequate data values. Ideally this voltage should be under 100 volts.

Target Current

This is the approximate transmitter current limit in milliamps for a data series. For each set of readings the transmitter will try to limit the current flow to approximately this value. Typically this is set at or near the system limit of 2500 milliamps.

Number Multiplexers

For a system with only a main unit, this should equal 1. The Number Multiplexers should equal the total number of multiplexers (the number of multiplexers includes the main unit plus external multiplexers) connected to the system even if those multiplexers are not used for a given schedule. ***All of the multiplexers connected to the system must have sequential addresses and must be turned on during data collection.*** For example, if a given Schedule/Command file only uses the cables connected to Multiplexer Address 3, you must also have external multiplexers 1 and 2 connected to the system and turned on even though they are not used for the current command file. If in this same example there are additional multiplexers, for example Multiplexer addresses 4 and 5, connected to the system they must also be turned on and the number of Multiplexers set to 5.

High Noise

Setting the high noise value to **TRUE** by checking the box changes the auto gain values generally causing the system to choose a gain setting with a higher voltage range.

Measure SP

When this value is set the DAS-1 measures the self-potential prior to starting the normal data collection. Therefore setting this value does increase run times slightly.

Normalized Square Wave

The normalize to square wave effects only the reporting of the raw data values for voltage and current. For the DAS-1 the source wave for FDIP is a square wave. Choosing the Normalized to Square Wave option causes the raw amplitude, real and imaginary component values to be reported at the peak amplitude of the square wave.

Output RMS Values

The Output RMS values effects only the reporting of the raw data values for voltage and current. This parameter overrides the Normalize to Square Wave parameter causes the raw amplitude, real and imaginary component values to be reported as root-mean-square (RMS) values.

50 Hz

This parameter should be set to **false** (default) in North America and other parts of the world that use 60 Hz power and **true** in Europe and parts of the world with 50 Hz power.

Use Pre-Assigned Gains

As discussed earlier the parameter overrides the Auto-Gain range of the system. This should be used only in very unusual circumstances.

5.8 Communication Parameters Menu

5.8.1 Introduction

Selecting the Communication Params button will bring up the CommSettings Menu (Figure 5.8.1). This menu is used to set the communication parameters between the DAS-1 and a Windows Compatible personal computer. The DAS-1 can communicate using either a standard serial port or using a USB cable with a virtual serial port. The communications settings vary depending on which method of communication is used.

In order to communicate with the DAS-1 via PC, the PC and DAS-1 must be connected and the DAS-1 must be on. Depending on whether you are using a serial or USB port you must set the adjust the DAS-1 accordingly. Under the **SYSTM** menu on the DAS-1 select the option **Use USB Port** and set the option to TRUE if using a USB port or FALSE if using a RS232 port. You cannot communicate with the DAS-1 using the serial port if the **Use USB Port** option is set to **TRUE**, it must be set at **FALSE**.

5.8.2 CommSettings Menu Commands

Test Connectivity

The **Test Connectivity** button will check to see if the Com Port is the correct port for the DAS-1 and that communication is established. A message will appear above the Com Port text indicating whether it has established connection. An error will be displayed if no connection is established.

Update Configuration File

The **Update Configuration File** button will open the configuration file (MPtFieldMonitor.cfg) located in the \MPTERTField\System_Config\ directory and update this file. A message indicating a successful update will be displayed.

Close Port

This closes the communications port so another program can access it.

Cancel

This closes the CommSettings window and does not save any changes made to the settings.

Save Changes

This selection saves the most recent changes to the communication settings and will close the CommSettings window.

5.8.2 CommSettings Menu Parameters

The CommSettings menu will find all available communication ports and will list them under the Com Port drop down menu.

Com Port

The port number for this port can be any valid, unused port number from 1 to 255. For the USB port this can be different for different systems or change with time. Typically for actual serial ports the values are 1, 2 or 3. For the USB Port they are typically (but not always) 4 or greater. The CommSettings window will list all available communication ports. You will be able to select from the drop down menu and click on the **Test Connectivity** button until the correct port is located.

Com Port Settings

The following **Baud Rate, Parity, Data Bits,** and **Stop Bits** values depend on whether the DAS-1 is using its internal serial port or a USB connection. For the serial port the valid settings are: 57600,N,8,1 and for the USB cable the valid settings are: 115200,N,8,1.

Baud Rate

Shows the current Baud Rate for a serial port (57600).

Parity

This option defaults to N.

Data Bits

This option defaults to 8.

Stop Bits

This option defaults to 1.

Com Pole Delay

The Com Pole Delay is the interval in milliseconds (ms) at which the system checks the serial port for incoming data. Generally 1 ms is adequate. However some systems or serial port adapters will lock up if they are polled too many times per second.

Comm Timeout

This is the length of time in milliseconds that the personal computer waits for a response from the DAS-1. 1500 milliseconds is usually sufficient, occasionally longer times may be needed. Going to shorter times will likely cause the system to timeout during communications.

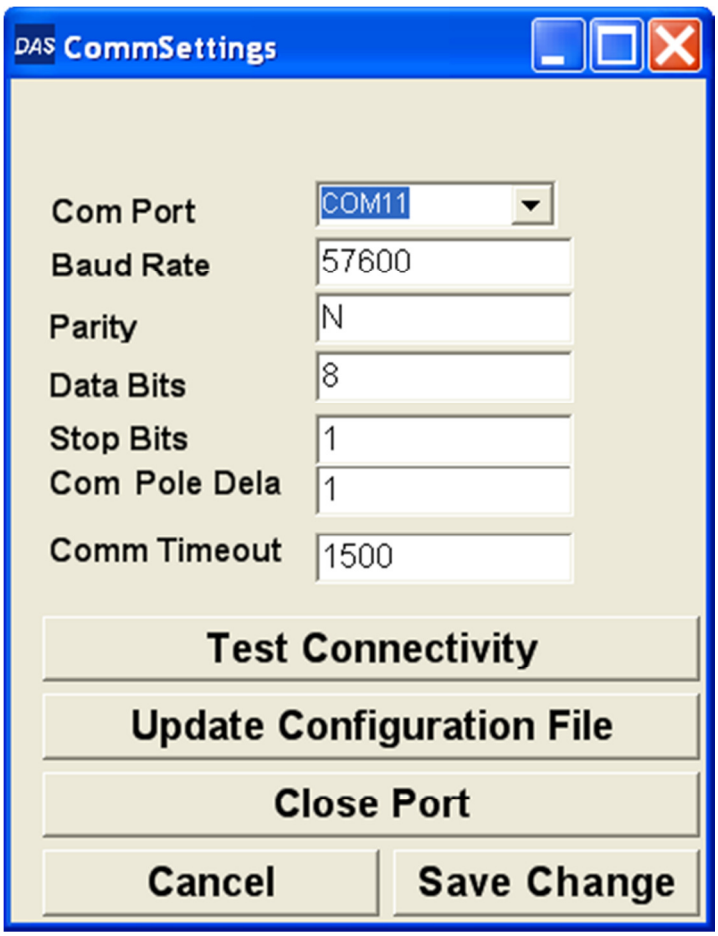


Figure 5.8.1 Communication Settings Menu

5.9 Set System Defaults Menu

5.9.1 Introduction

Most users will never need to access the Manage System Defaults menu (Figure 5.9.1). This menu allows the user to reset system limits and to change the internal calibration values of the system. Note that changing these values is generally done by MPT after system repairs or updates. Changes made to the system configuration are written into the Command Files and are implemented when those command files are executed.

5.9.2 Manage System Defaults Menu Commands

Update System Gains

It is recommended that the user not alter the gain settings. The gain settings are designed such that the system gives the correct voltage values. Putting incorrect values into the gain settings will not only cause incorrect results but may interfere with the Auto-Gain setting functions inside the system. Thus gains should not be used to compensate for errors outside the DAS-1 or to apply arbitrary factors to data values.

To reset gains the user must first reset the gains correction factors to the default values. This can be done by selecting the Update System Gains button and choosing the Use Default Gains instead of opening a gains file. Then collect a series of data at each of the gains settings on each of the receiver channels plus the transmitter monitor (Channel 0) using a calibration bridge with known values. A table of values is constructed and placed in a text file. The table must have four columns where the first column is the correction factors for the gain = 1 and the last column for the gain = 125. There must also be 9 rows where the first row is the gain correction for the Current Monitor (Channel 0) and the last for receiver Channel 8. The gains corrections are given as: (Measured Value) / (Correct Value). Also the settings for the current monitor must be determined first and then the values for the remaining receiver channels determined. Table 5.7.1 shows and example gain file. The gain file can contain comment lines.

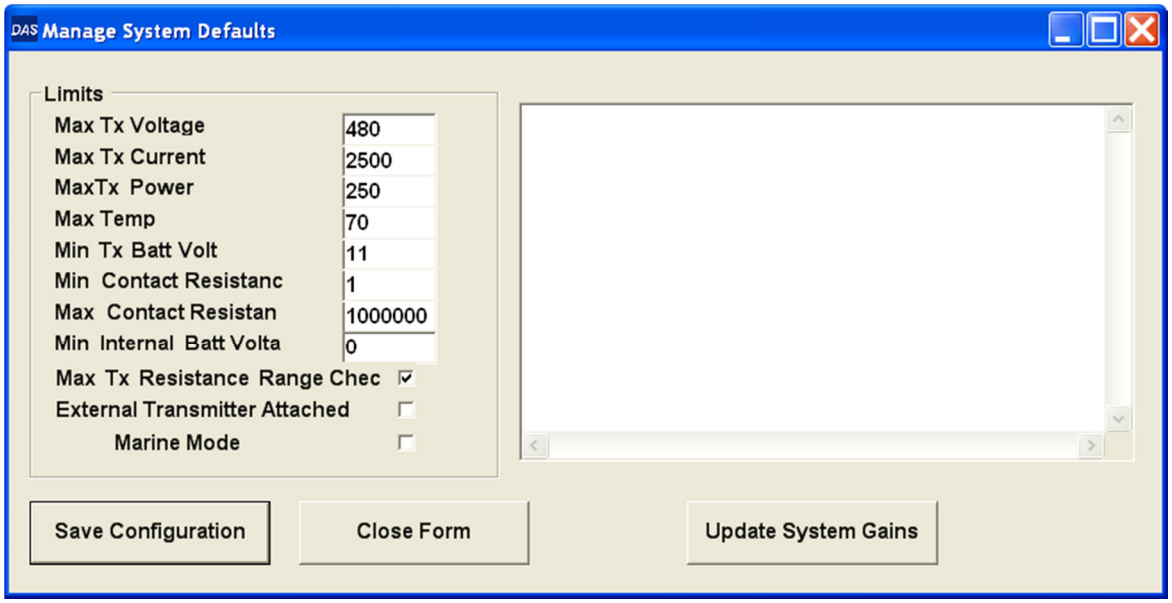


Figure 5.9.1 Example Table of Gain Correction Factors in System Defaults Menu

5.9.3 Manage System Defaults Menu Parameters

The user can reset the maximum transmitter voltage, current, power, temperature and contact resistance values to ones lower than the maximum values of 480 Volts, 2500 milliamps, 250 Watts, 70 C and 1 million Ohms respectively. The minimum values for Battery Voltage, and Contact resistance can be increased from the default values of 11 Volts and 1 Ohm respectively.

5.10 Manage System Data Menu

5.10.1 Overview

The Data Management menu (Figure 5.10.1) allows the user to copy command files from the PC onto the DAS-1 system and copy Data files from the DAS-1 system onto the PC. To use this menu, the DAS-1 must be connected to a Personal computer, the power must be turned on and the correct communications parameters must be set (see Section 5.6). Users should note that this is a fairly slow method to move files to and from the system. Typical transfer rates are about 200 kilobytes per minute using the serial cable and about 500 kilobytes per minute using the USB cable. Much faster transfers can be accomplished by removing the micro SD card from the DAS-1 and reading it using an internal or USB based card reader. However when uploading files to the DAS-1 using this method, users must be careful to follow file naming conventions and place files in the correct locations on the micro SD card.

5.10.2 Data Management Menu Commands

To download data or command files from the DAS-1, begin by selecting either the Data or Command option for the correct data mode, Stream Data, FDIP, or TDIP. The Spectral IP and Self Potential modes are not available on the DAS-1 system software.

List Files

This option provides a directory listing of all of the files in the DAS-1 data directory for a specific data mode. If there are large numbers of files in the directory it can take several seconds to list all of the files. Next, use the mouse to select one of the files. This will open a second menu, the View Data Files Menu (Figure 5.10.2). The file name, completion date and size are listed in the uppermost window on the menu.

Load PC File on the Field System

When the user selects this option, a dialog box will appear from the PC with a list of available command files. Select the command file you want to upload; the status box at the bottom of the menu will indicate the status of the upload (i.e. beginning upload; file upload successful). As previously noted, *never place a command file for one data mode in the command directory for a different data mode*. This will result in an error when the user tries to execute the file.

The software will not upload a command file to the DAS-1 if there is already a command file with the same name in the same data mode directory. To replace an existing file the user must list the files using the **List Files** button then **DELETE** the file as described in the previous section.

Initialize New SD Card in DAS1

This command allows the user to insert a new blank micro SD card into the DAS-1 and prepare it for use by creating a directory structure. (see Section 4)

Set System Time

This command will set the time of the DAS-1 to the PC clock time.

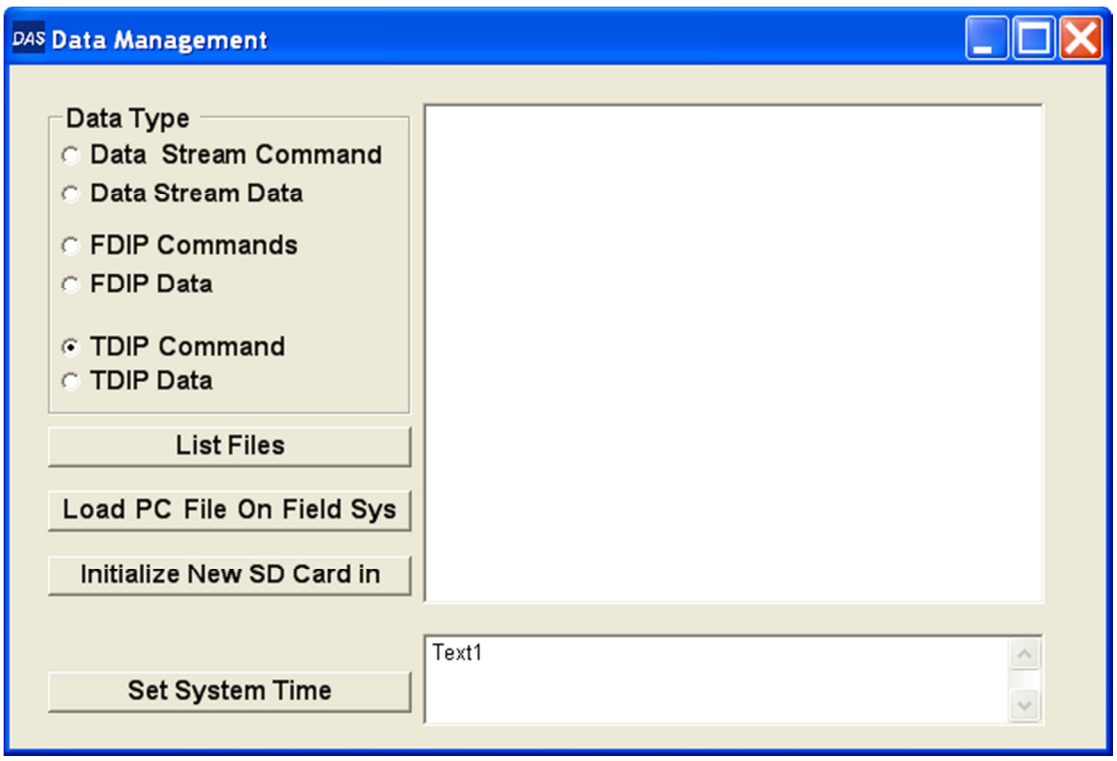


Figure 5.10.1 Manage System Data Menu

The **View Data Files Window** will open when the **List Files** option is selected. It has its own set of menu commands listed below.

Previous File in List

Users can use this option to navigate through the list of files. This option can only view the files in the active directory.

Next File in List

Users can use this option to navigate through the list of files. This option can only view the files in the active directory.

Get File from Field System

This option will open a dialog box that lets the user decide where the file should be stored on the PC. Note that the present version of the code does not prevent the user from overwriting existing files, but will give a warning message. After a file location is chosen the system starts the download process.

Stop File Load

The **Stop File Load** option will stop any data file being downloaded to the PC. A message will indicate that the download was halted.

Update File Window

If the **Show File Contents** box was checked before starting the download, a copy of the file's current contents are placed in a buffer which is viewed by selecting this option. The window is only updated each time the user selects this button. This allows the user to view an upload in progress without the window constantly updating.

Clear Window

The buffer is cleared whenever a new upload is started or the user selects this button.

Delete File on Field System

The user can remove a file from the field system using the Delete File on Field System. There is no undo command and the file is removed permanently. However, you will be given a warning message whether you wish to delete the file.

Show File Contents

The user can check the box before downloading in order to copy the current file. The contents are placed in a buffer and allow the user to view the contents of the file. This is not recommended for large files.

Wrap Lines in Window

By checking this box will allow the file to wrap in the window should the user want to view the entire line of data.

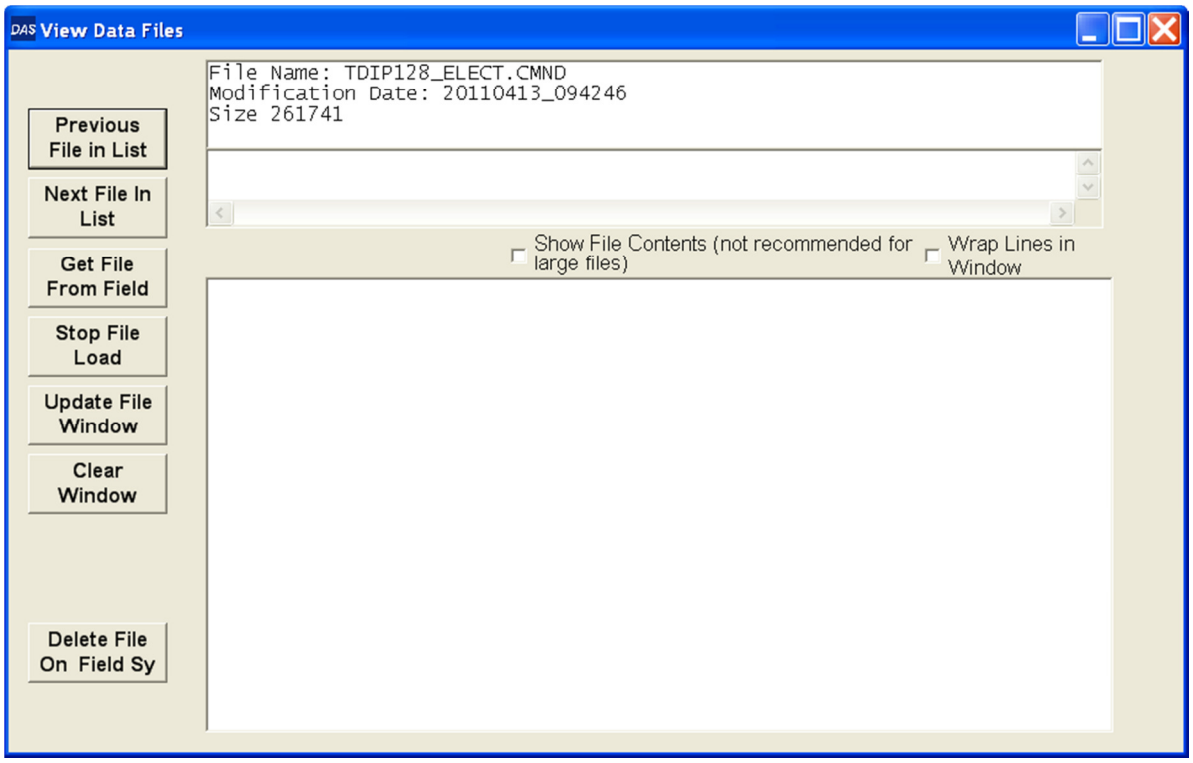


Figure 5.10.2 View Data Files Menu

5.11 TEST Functions Menu

It is recommended that this menu be used only under the supervision of MPT Technical Support. This menu is not required for normal system operations and <u>can actually interfere</u> with some of the functions of the DAS-1.

The TEST Functions menu (Figure 5.11.1) is used to send low-level commands directly to the various boards inside the DAS-1. When the menu is opened copies of all of the low-level commands from the personal computer are written in the Command (uppermost) box. Responses from the system boards are copied to the All Incoming (bottom) box. The Response and ErrorList boxes list the most resent system response and error messages respectively. Selecting the No Timing or CR box adds system time stamps to the All Incoming Box and the Expect Checksum checks the incoming commands to see if they have the correct Checksum (a method of error checking serial communications). Finally, selecting the Save to File checkbox causes this same information to be saved to a series of files that can be evaluated later.

To re-emphasize, this menu is not required for normal system operations and <u>can actually interfere</u> with some of the functions of the DAS-1. In particular writing all of this information to the various boxes and files can slow down communications considerably. Therefore, it is important to keep this menu **closed** unless it is needed to troubleshoot the system.

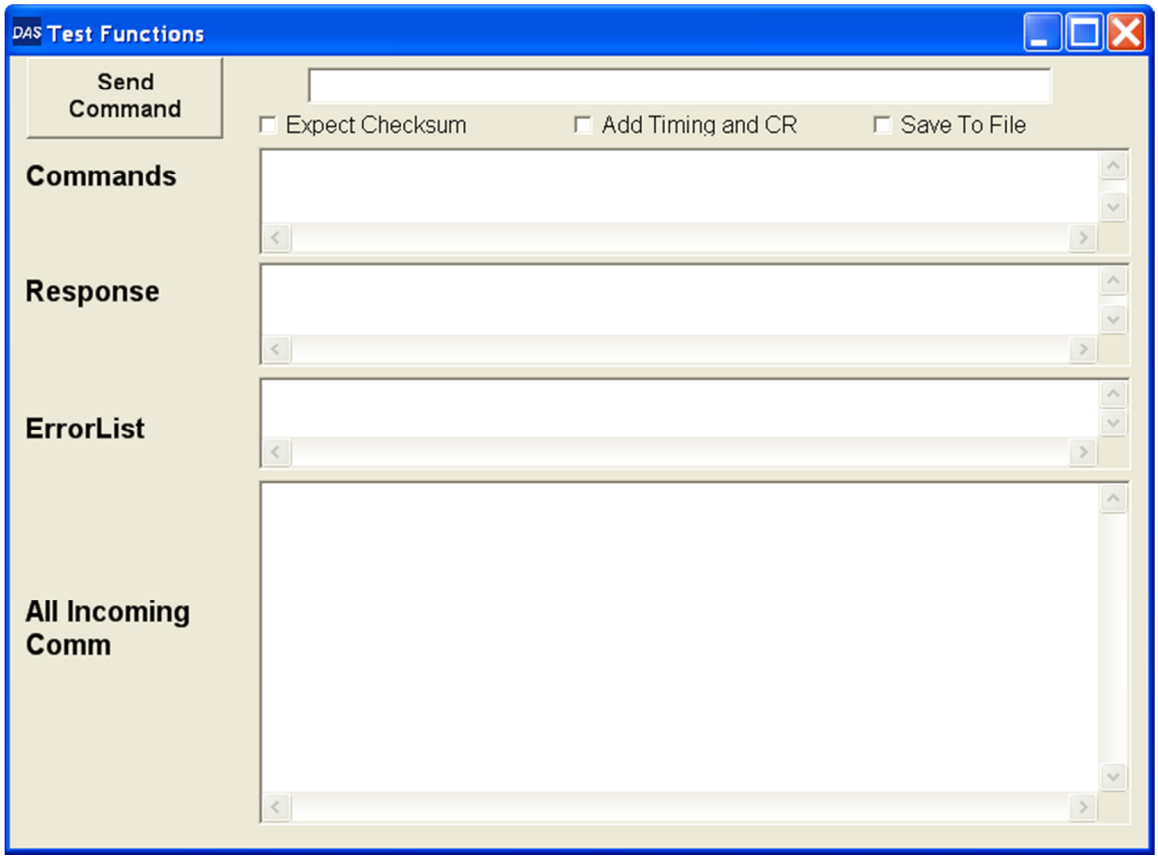


Figure 5.11.1 Test Functions Menu

5.12 Test Electrodes Menu

5.12.1 Overview

This selection allows the user to perform a quick resistance check on adjacent electrode pairs. We recommend using this function after electrodes are in place and prior to initial data collection. It is not necessary to perform this test before each data run.

This procedure performs an estimate of contact resistance. The highest reading for this method is limited to approximately 300,000 ohms; thus any reading greater than 200,000 Ohms should be considered an open circuit.

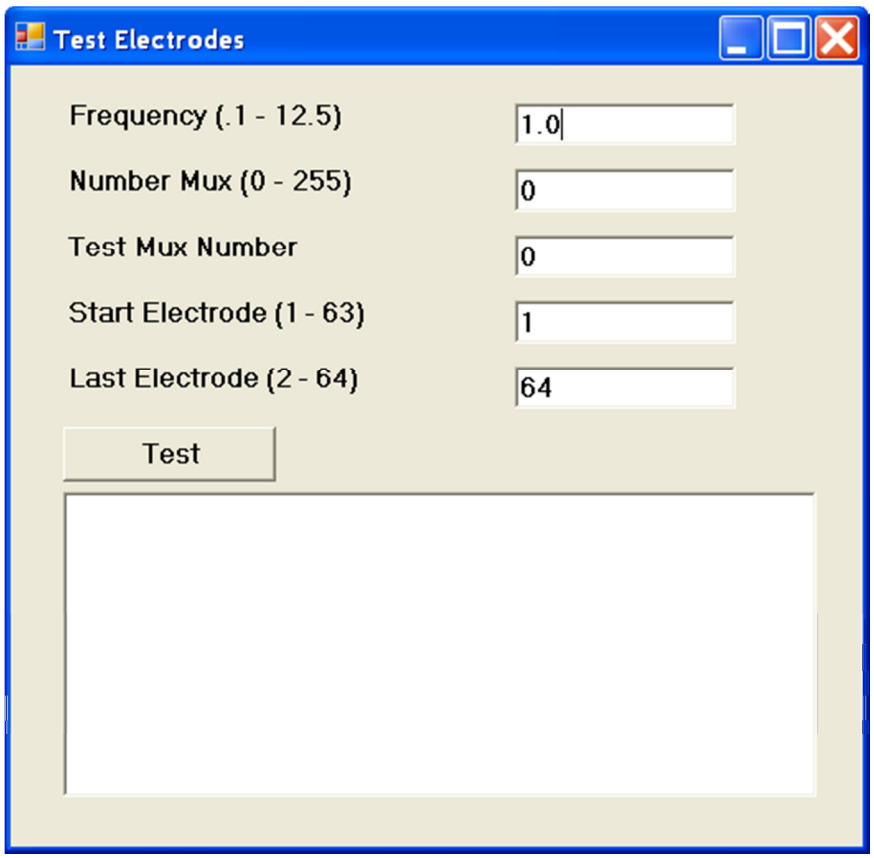


Figure 5.12.1 Test Electrodes Menu

5.12.2 Test Electrodes Menu Parameters

Frequency

Enter the frequency desired (0.1 Hz to 12.5 Hz) for testing contact resistance between electrodes. The default is 1.0 Hz.

Number Mux

This is the total number of units being tested, the DAS-1 Main unit is considered as 1. For example, to test the DAS-1 Main Unit only, enter 1. For the DAS-1 and one external multiplexer (MUX), enter 2, for two external multiplexers enter 3, etc.

Test Mux Number

Enter the MUX you want to test. For testing the DAS-1 Main unit only, use 0 (this is the default). To test the first external multiplexer, enter 1; for the second multiplexer, enter 2, etc.

Start Electrode

Enter the range of electrodes you want to test (the default is 1-63).

Last Electrode

Enter the range of electrodes you want to test (the default is 2-64). There needs to be at least two electrodes selected to conduct a check electrodes test.

Test

Press the **Test** button to run the test electrodes. You will need to press **Test** for each electrode pair.

5.13 Edit Command Menu

5.13.1 Introduction

The Edit Command Menu is a valuable tool in editing previously created command files (i.e. *.CMND). This menu will allow the user to do the following: skip pins, limit the number of pins to use, limit the number of data points, scale the spacing between pins, reverse the order of the pins on a cable, and skip or shift lines.

When editing a command file for any of the data acquisition modes - such as FDIP, TDIP, Stream, Self-Potential, or Spectral IP - the Edit Command Menu interface in Figure 5.13.1 will be shown. However, your text field in the **Old Cmd File** and **New Cmd File** will be different than in the figure.

5.13.2 Edit Command Menu Commands

Old Cmd File

This shows the original name of the command file that will be edited. This must be an existing command file.

New Cmd File

This shows the name of the new command file that will be created. By default, this new command file name is the same name as the old command file name appended with an underscore and a number (i.e. "old_command_file_name_**1**.CMND").

Change the name of the edited command file on this line. The command file name may be a maximum size of 32 characters long.

New Data File Root

This is the name of the data file that will be created when running the newly edited command file. The new data file name may be a maximum size of 20 characters long.

First Pin

The first pin default number is one (1) in the command builder. If you wish to edit the number of the first pin, you may enter the number you require. The values must be between 1 and 16316 (this is the maximum number allowed and can accommodate 255 multiplexers with 64 pins each).

Last Pin

The last pin default number is sixty-four (64) in the command builder. If you wish to edit the number of the last pin, you may enter the number you require. Ensure that the last pin is a larger value than the first pin by at least four. The pvalues for the text field must be between 4 and 16320.

Skip Pin

There are four Skip Pin boxes; only one pin number may be entered each box. If multiple pins need to be skipped, use the additional Skip Pin text boxes. This must be a value between the First and Last pin. The minimum total number of pins is four.

Roll Conns

This will shift or "roll" the pins on the line. The values do not have to be whole numbers and decimals may be used if you wish to shift a fraction of a line. For instance, to shift a quarter of a line on a 16 electrode line enter, "0.25" and the command file will shift down four electrodes to line 001, electrode 05. To shift the entire line, enter "1" and the command file will shift past the entire line. The values must be between 0 and 1023.

When editing the Roll Conns with a multiplexer attached to the DAS-1, and you roll the connectors so that only the DAS-1 is used, it is advisable to disconnect the multiplexer before data collection.

Swap Pins Conn

This will place the order of the pins in reverse order. When entering either "0" or "1" all of the lines in use will be set in reverse order. For lines 2 and greater, the line number entered and all lines greater than that value will be reversed. For instance, entering "3" will keep lines 1 and 2 in normal order and reverse lines 3 and greater. The values must be between 0 and 1023.

Pins per Connector

This must match the system connector configuration in use. Enter either the value 16 or 32.

Start Data Point

This will change the initial starting data point on the data collection schedule. Any starting data point may be used.

Last Data Point

This is the last data point that will be collected. The number of allowable data points may vary since each data point is collected in blocks while using the same transmitter. This number must be greater than the Start Data point.

Scale Factor

This option allows for the distance between electrodes to be scaled. The scale factor must be between 0.001 and 1000.

<u>Warnings</u>

Warning: It is not advisable to edit a previously edited command file. Please edit the original command file only.

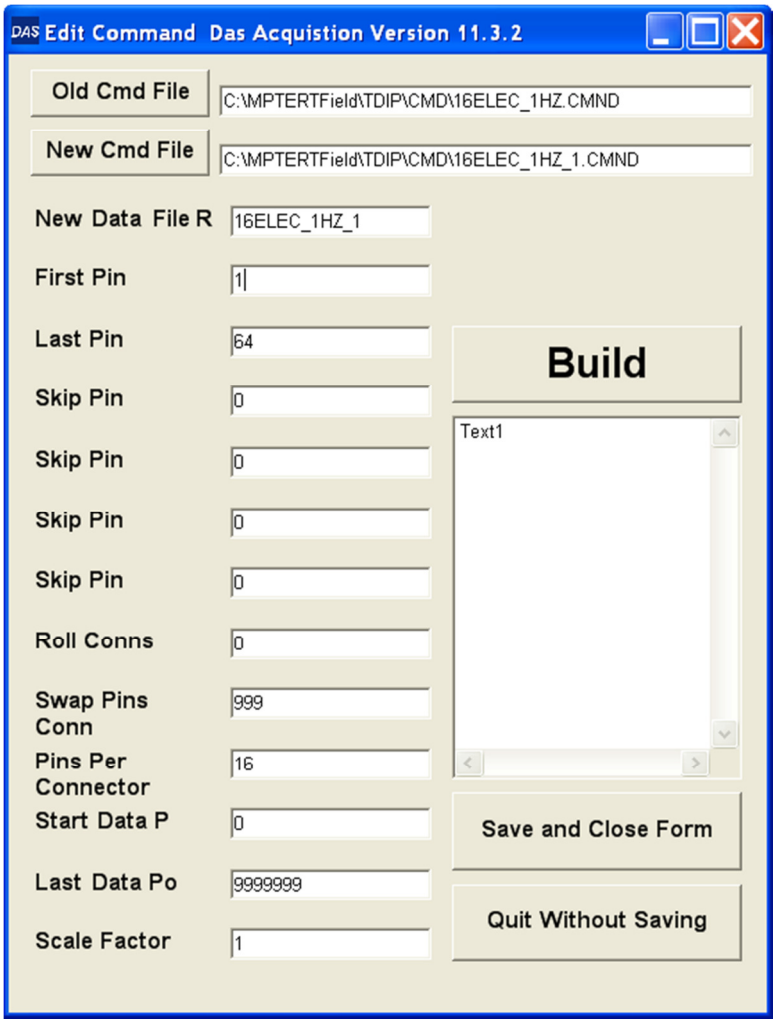


Figure 5.13.1. Initial Edit Command Menu

Section 6.0 Console System Menus

6.1 Introduction

This section discusses the DAS-1 Acquisition Software that is used to create command files, configure the system, and can be used to operate the system without a laptop or desktop computer. Autonomous operation software is covered in a different manual. This section contains a listing of menus found on the DAS-1 system.

6.2 Main Menu

On DAS-1 startup, the system LCD displays the **Main Menu** shown in Figure 6.2.1. Use the **LEFT/RIGHT** arrows on the keypad to toggle between the submenus: FDIP, TDIP, DSTRM, RESIS and SYSTM. The bottom line on the LCD indicates which menu option is selected. Select **ENTER** on the keypad to complete your menu selection.

The DAS-1 startup displays the company name, the console software version, copyright, date and time. It also includes the temperature of the main receiver and receiver battery voltage.

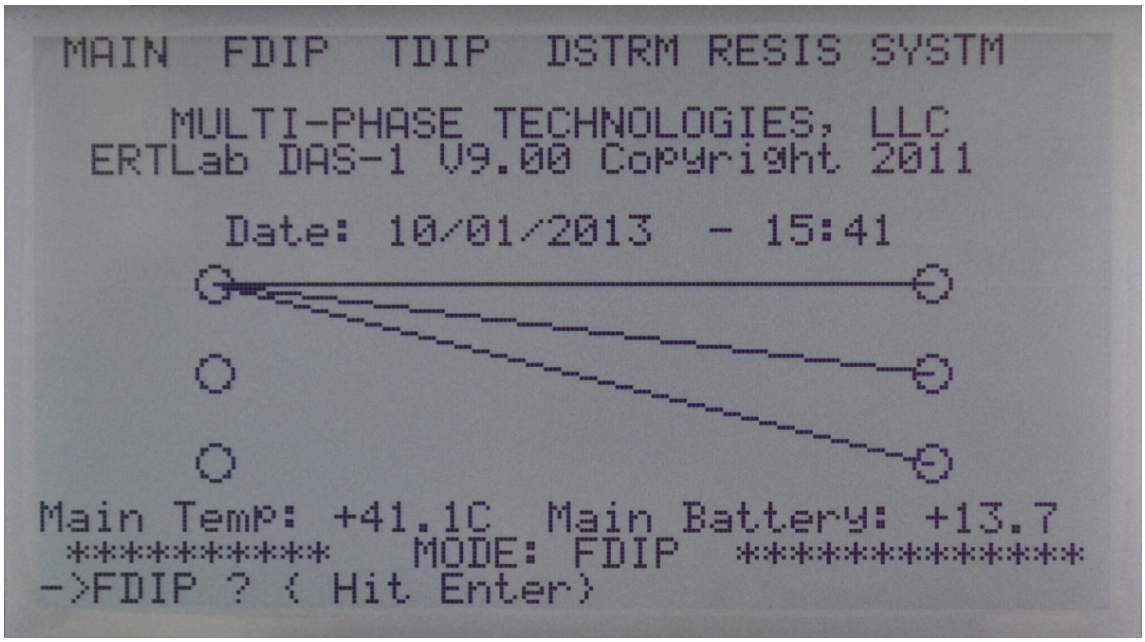


Figure 6.2.1 Main Menu.

6.2.1 System Menu

By selecting the System option (use the right arrow key until the **SYSTM** option is shown in the active line and press **ENTER** in the keypad) from the Main menu, you will be directed to the System menu (Figure 6.2.2).

This menu allows the user to configure system settings. Use the **UP/DOWN** arrows to move between the options on the screen and the **LEFT/RIGHT** arrows to toggle between the various menus located at the top of the display. Use the **SPACE** button on the keypad to toggle between **TRUE** and **FALSE**. Select **ENTER** on the keypad to complete your selection.

(The lines at the bottom of the screen indicate the active mode and line item)

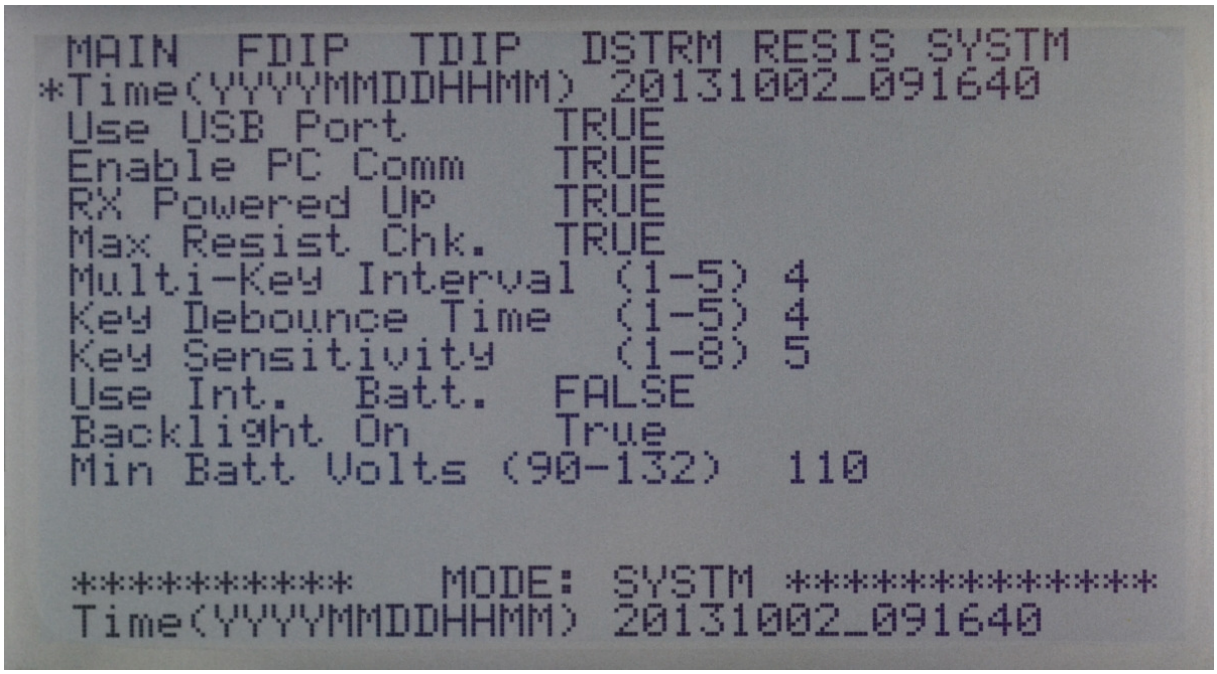


Figure 6.2.2 System Menu

Time

Enter the time and date in the format shown (YYYYMMDDHHMM). It is necessary to have correct date/time in order to have correct data file names.

Use USB port

Set this to **TRUE** to connect to an external computer using a USB port (cable is included with system). Set this to **FALSE** when using a serial port or when not connected to an external computer.

Enable PC comms

Set to **TRUE** when connected to an external desktop or laptop computer.

Rx Powered Up

Set to **TRUE** to keep the receivers on all of the time. This can improve data quality as it can take time for the receiver boards to stabilize after power up. However, this can substantially reduce the battery life for the internal battery. Therefore, when running on the internal battery we recommend setting this to **FALSE**.

Max Resist Chk.

Setting this to **TRUE** will reject resistivity values greater than the user specified value during data collection. The default value is set at 1,000,000 ohms.

Multi-Key Interval (1-5)

Selecting the **Multi-Key Interval** customizes the wait time between selecting text keys; the shorter the interval, the sooner the last key selection is entered (milliseconds).

Key Debounce Time (1-5)

Minimum time between touching any key twice, only one digital signal can be registered within the space of a given time (milliseconds).

Key Sensitivity (1-8)

The sensitivity of the key to your finger**;** how close your finger needs to be to activate any key; 1= less sensitive 8 = most sensitive (i.e. when wearing gloves).

Use Int. Batt.

Set to **TRUE** to use the internal Tx power, **FALSE** when using external Tx power. **(**For use on systems with an <u>optional internal transmitter battery</u>).

Backlight On

Set to **TRUE** to enable LCD backlight.

Min Batt Volts (90-132)

This allows the user to override the minimum battery voltage setting (embedded in the command file) by this amount. **Warning:** the system will not operate properly under 11 volts.

6.3 FDIP Menu

6.3.1 Introduction

In Frequency Domain Induced Polarization (FDIP) Data Mode the system collects IP data using the frequency domain method and reports the data as amplitude and phase or real and imaginary values. In essence, the system is doing a real-time Fourier Transform of data values collected at even intervals throughout the waveform. The DAS-1 uses a set of filter functions that are specially designed to reject low frequency noise thus making the results fairly immune to electrode polarization errors. The filter functions are also designed to reject power line noise and therefore different filters functions are used for North America (60 Hz) and Europe (50Hz). For both filters, the maximum frequency is 5 Hz. Acquisition is restricted to fractions of 5 Hz i.e. 5/2 Hz, 5/3 Hz, 5/4 Hz, 1 Hz and so on.

The filter also requires two full waveforms so a *Stack* in this case is two full waveforms and the minimum number of stacks is 2. Therefore, the fastest acquisition would be for four waveforms at 5 Hz which would require about 0.8 seconds for the actual data collection. Some time is required to set the multiplexer and to process and transfer data so the fastest acquisition rate for frequency domain is about 1 data point per receiver channel per second. Acquisition times increase proportionally to the number of stacks and inversely with the frequency.

The transmitted waveform is a near square wave. That is, the current is turned on in the positive direction for a duration that is just slightly half the period (the period is 1/Frequency) , turns off for approximately 2 ms, turns on with the reverse sense of current flow for slightly less than half the period, then the current is turned off for 2 ms and the sequence is repeated.

The **FDIP Menu** (Figure 6.3.1) allows the user to modify certain parameters of an already created FDIP Command File. Once the parameters are changed (as discussed above in section 6.2), test the configuration by pressing the right arrow button on the keypad until **CHECK** is selected (note: this process is similar to using the Update Configuration button in the PC Software). The file can then be run by pressing the right arrow button until **RUN** is selected. The **ELECT** option allows the user to edit the command file on the console, see Section 6.7 below.

6.3.2 FDIP Menu Commands

Data File

Displays the name of the open command file.

Title

The project title is any line of text included for information. It is included in the data file but is not used. For command files to be downloaded to the DAS-1 this should be 35 characters or less.

Info

For files downloaded to the DAS-1 only one line of 35 characters is allowed to include documentation to the data file.

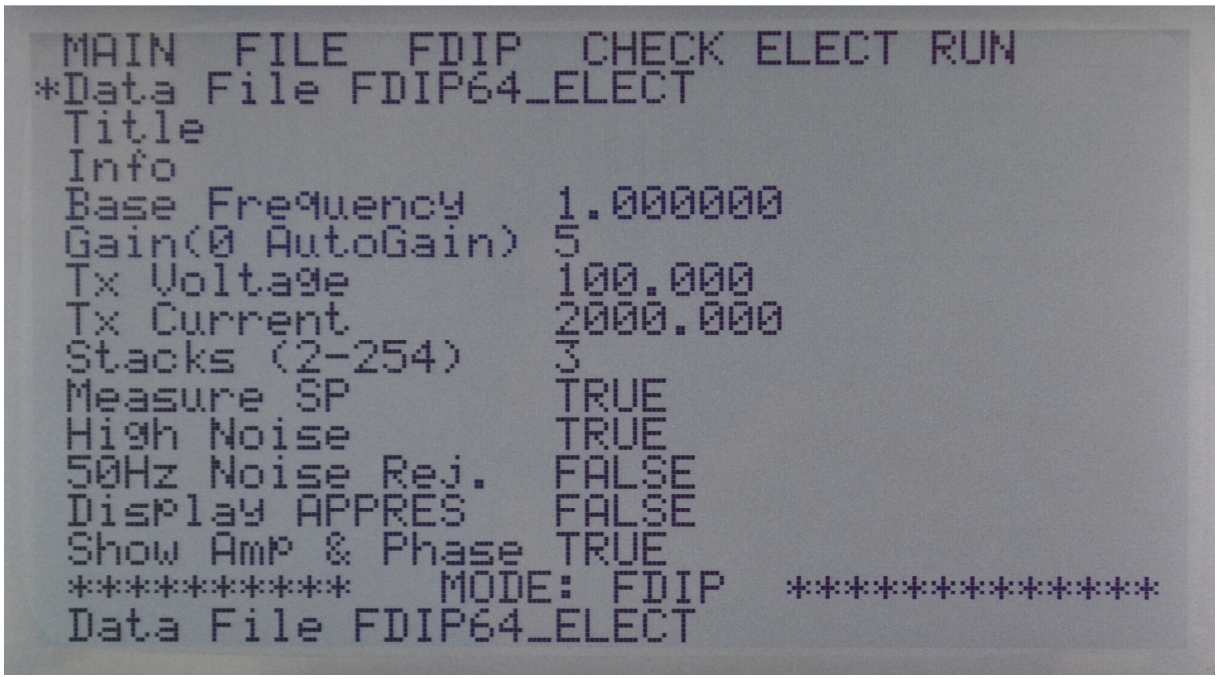


Figure 6.3.1. FDIP system menu

Base Frequency

The maximum frequency is 5 Hz. Acquisition is restricted to fractions of 5 Hz i.e. 5/2 Hz, 5/3 Hz, 5/4 Hz, 1 Hz and so on.

Gain (0 AutoGain)

The default gain is an integer from 0 to 5 giving the index of the gain/range settings. The default is 5 which allows the system to use Auto-Gain settings and should be used except for very unusual circumstances. If the data values are too large for the range the system will produce erroneous results or may fail to collect one or more data. Table 6.3.1 lists the gain and range settings.

Table 6.3.1

Gain Index	Gain	Max Voltage
0	Auto Range	10
1	1	10
2	5	2
3	25	0.4
4	125	0.08
5	**Auto Range**	**10**

Tx Voltage

This is the approximate transmitter voltage in volts used for the data series. The actual voltage may vary from this somewhat and is typically smaller than this voltage but depends on load conditions. For typical transmitter contact resistances (a few hundred to a few thousand Ohms) the system will choose a transmitter and will seek to find an optimal voltage which is at or slightly below this value but still has a high efficiency and is unlikely to exceed the transmitter current, power, and voltage limits. For very high contact resistances (tens of thousands of Ohms) the transmitter has a minimum output voltage of about 25 volts. Typical values range from 20 volts to 480 volts. ***Operators should never assume that the voltage is necessarily limited to this voltage and data should never be collected if humans or animals may be in contact with exposed metal on cables, connectors or electrodes***. However, lower voltages are in general safer than higher voltages. Also higher voltages do not necessarily result in better signal to noise values. We recommend running preliminary tests and using the lowest target voltage that provides adequate data values. Ideally this voltage should be under 100 volts.

Tx Current

This is the approximate transmitter current limit in milliamps for a data series. For each set of readings the transmitter will try to limit the current flow to approximately this value. Typically this is set at or near the system limit of 2500 milliamps.

Stacks (2-254)

A stack is the number of values averaged to create the final data and noise estimates. In the DAS-1 in FDIP Mode, two full waveforms are used for each stack. The minimum number of stacks is 2, maximum is 254.

Measure SP

When this value is set to **TRUE** the DAS-1 measures the self-potential prior to starting the normal data collection. Therefore setting this value does increase run times slightly.

High Noise

Setting the high noise value to **TRUE** changes the auto gain values generally causing the system to choose a gain setting with a higher voltage range.

50Hz Noise Rej.

Set this to **FALSE** if operating in North America and **TRUE** if operating in Europe.

Display APPRES

Setting this to **TRUE** causes the system to display apparent resistivity instead of amplitude and write apparent resistivity values into the data file.

Show Amp & Phase

Setting this value causes amplitude and phase to be displayed in the status box during a data run. The default is **TRUE**.

6.3.3 Data Progress Menu

When the system starts collecting data it switches to the progress menu. The menu displays the date and time, the base frequency used, amount of data collected, the transmitter pair, current, contact resistance, the most recent data collected, Main (Rx) and Tx batteries, Tx voltages and the temperatures of the receivers (Main), transmitter primary (Txp) and secondary (Txs) (Figure 6.3.2).

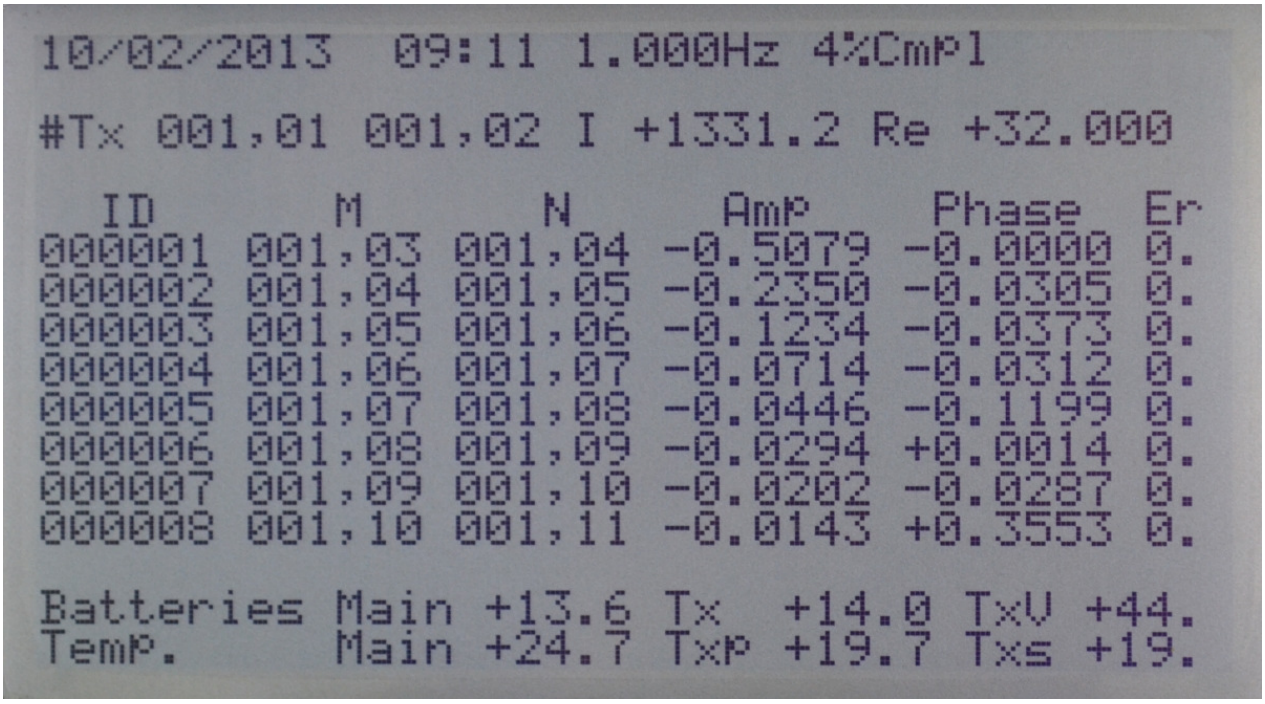
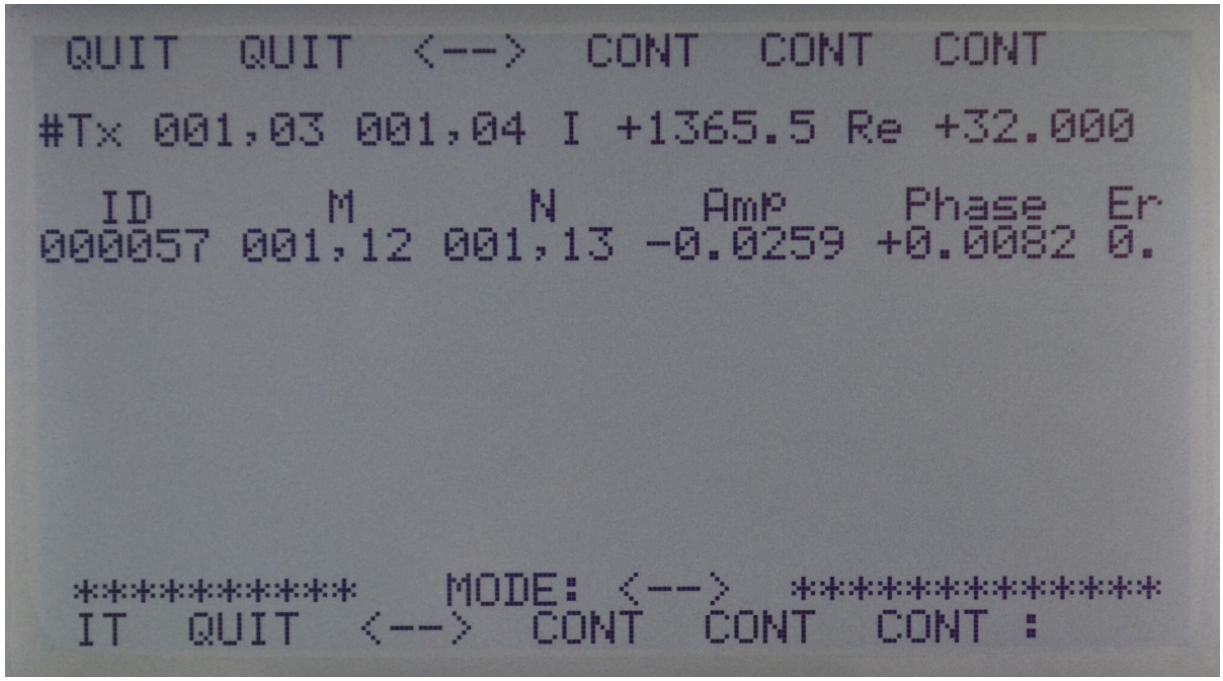


Figure 6.3.2 FDIP Progress Menu

6.3.4 Stopping the Data Collection Progress

In general this will be true for any data run (FDIP, TDIP and DSTRM). To halt a data run, hold down the **STOP** key on the keypad. After a few seconds the system will display an additional line at the bottom of the LCD (Figure 6.3.3A). To halt a data run the user must hit the **LEFT** arrow key then the **ENTER** button (Figure 6.3.3B). To continue the data run hit the **RIGHT** arrow key then the **RETURN** key. Status and data should continue to be displayed.

A



B

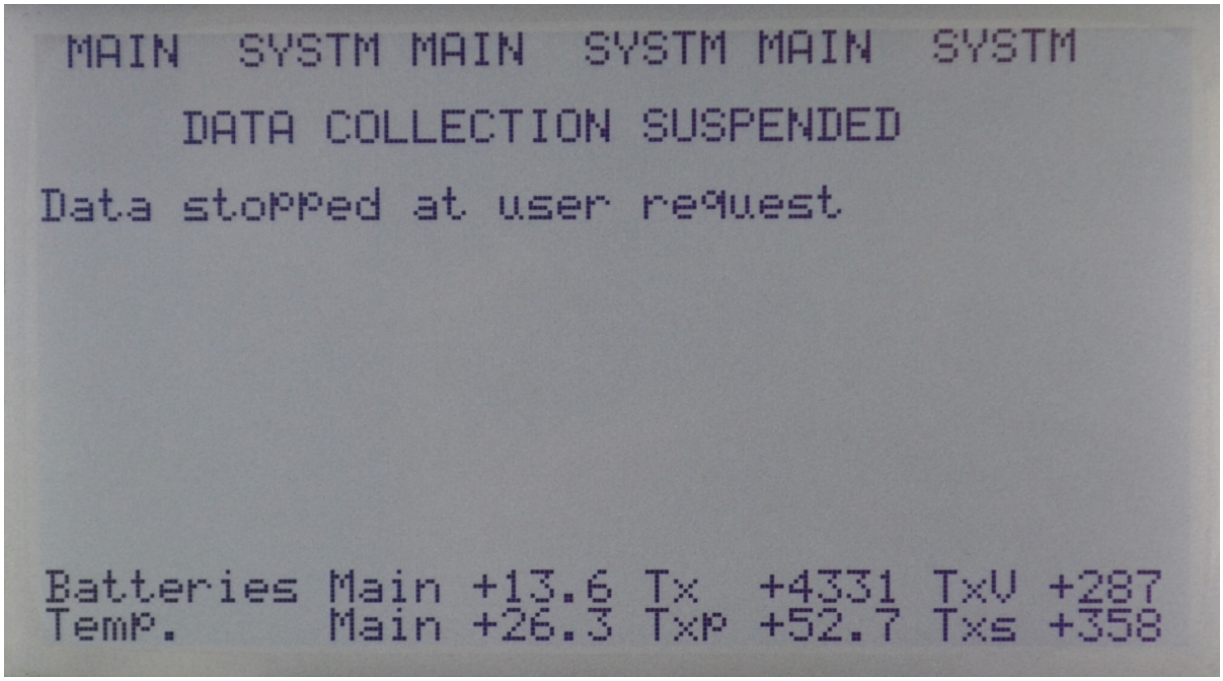


Figure 6.3.3 A) Result of holding the STOP key and B) Message displayed indicating stopped data collection.

6.4 TDIP Menu

6.4.1 Introduction

This menu is used for Time Domain Induced Polarization or resistivity –only data collection modes. In TDIP Data Mode the system uses a standard TDIP current waveform as shown in Figure 6.4.1. To collect IP data, the system begins by transmitting current on for a period of 1/ (4 Base Frequency). The system waits a length of time given by the Resistivity Time Delay (TRDely), then measures the On-Time Voltage averaged over a period given by Resistivity Measurement Time (TlngthR). The current is then turned off for the same length of period, 1/(4 * Base Frequency). During this time the TDIP decay waveform is measured during 1 or more windows. The system then transmits current with opposite polarity and repeats the sequence.

The DAS-1 uses a proprietary algorithm to stack the data over several waveforms. In this system the first stack requires 2 complete waveforms and each subsequent stack 1.5 waveforms. The fastest data acquisition would be for 9 Hz with 2 Stacks and requires roughly 0.5 seconds to collect data on 1 to 8 channels.

In resistivity only mode, the system uses a square wave and has a maximum frequency of 16 Hz for 60 Hz power line noise rejection and 14.6 Hz for 50 Hz power line noise rejection. The system should collect about 3 x [number of channels] data points per second.

Acquisition times increase proportionally to the number of stacks and inversely with the frequency.

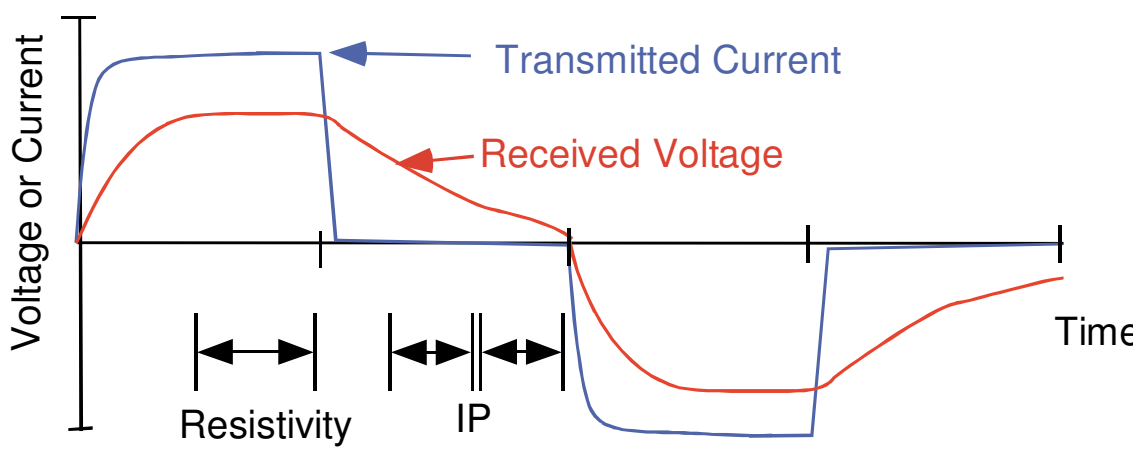


Figure 6.4.1 Typical TDIP waveform

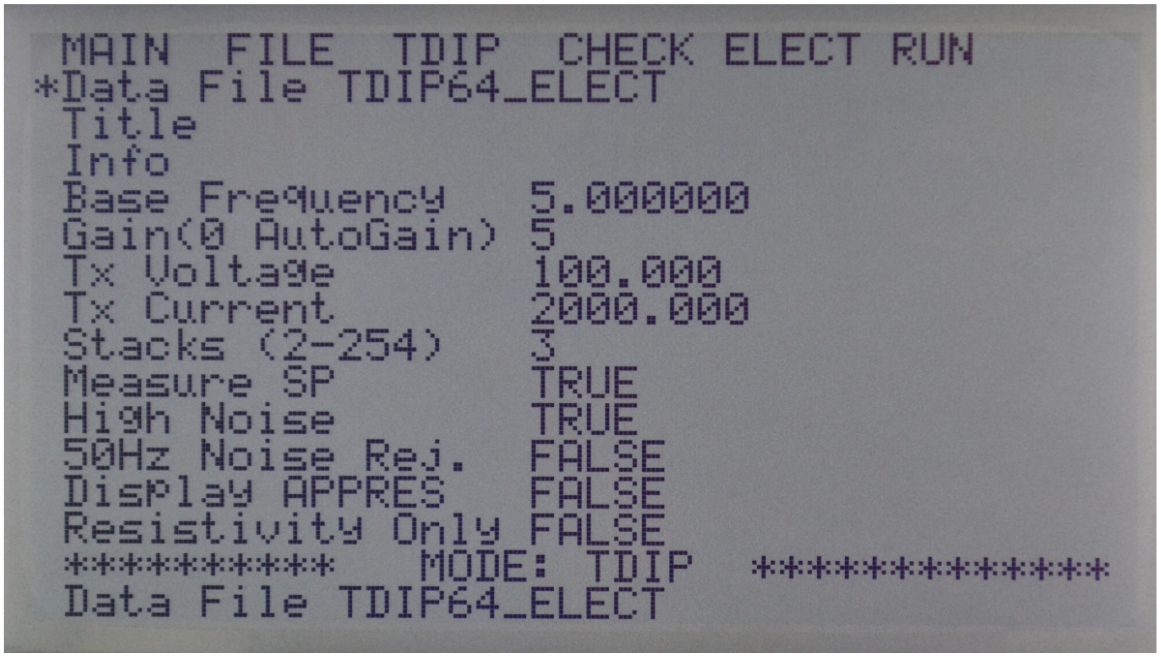


Figure 6.4.2 TDIP System menu

The **TDIP Menu** (Figure 6.4.2) allows the user to modify certain parameters of an already created TDIP Command File. Once the parameters are changed (as discussed above in Section 6.2), test the configuration by pressing the **RIGHT** arrow button on the keypad until **CHECK** is selected (note: this process is similar to using the Update Configuration button in the PC Software). The file can then be run by pressing the right arrow button until **RUN** is selected. The **ELECT** option allows the user to edit the command file on the console, see Section 6.7 below.

6.4.2 TDIP Menu Commands

Data File

Displays the name of the open command file.

Title

The project title is any line of text included for information. It is included in the data file but is not used. For command files to be downloaded to the DAS-1 this should be 35 characters or less.

Info

For files downloaded to the DAS-1 only one line of 35 characters is allowed to include documentation to the data file.

Base Frequency

The maximum frequency is 5 Hz. Acquisition is restricted to fractions of 5 Hz i.e. 5/2 Hz, 5/3 Hz, 5/4 Hz, 1 Hz and so on.

Gain (0 AutoGain)

The default gain is an integer from 0 to 5 giving the index of the gain/range settings. The default is 5 which allows the system to use Auto-Gain settings and should be used except for very unusual circumstances. Using values along with setting the Use Pre-Assigned Gain checkbox will force the system to use that gain/range value for all data. If the data values are too large for the range the system will produce erroneous results or may fail to collect one or more data. Table 6.4.1 gives the gain and range settings.

Table 6.4.1

Gain Index	Gain	Max Voltage
0	Auto Range	10
1	1	10
2	5	2
3	25	0.4
4	125	0.08
5	**Auto Range**	**10**

Tx Voltage

This is the approximate transmitter voltage in volts used for the data series. The actual voltage may vary from this somewhat and is typically smaller than this voltage but depends on load conditions. For typical transmitter contact resistances (a few hundred to a few thousand Ohms) the system will choose a transmitter and will seek to find an optimal voltage which is at or slightly below this value but still has a high efficiency and is unlikely to exceed the transmitter current, power, and voltage limits. For very high contact resistances (tens of thousands of Ohms) the transmitter has a minimum output voltage of about 25 volts. Typical values range from 20 volts to 480 volts. ***Operators should never assume that the voltage is necessarily limited to this voltage and data should never be collected if humans or animals may be in contact with exposed metal on cables, connectors or electrodes***. However, lower voltages are in general safer than higher voltages. Also higher voltages do not necessarily result in better signal to noise values. We recommend running preliminary tests and using the lowest target voltage that provides adequate data values. Ideally this voltage should be under 100 volts.

Tx Current

This is the approximate transmitter current limit in milliamps for a data series. For each set of readings the transmitter will try to limit the current flow to approximately this value. Typically this is set at or near the system limit of 2500 milliamps.

Stacks (2-254)

A Stack is the number of values averaged to create the final data and noise estimates. In the DAS-1 in FDIP Mode, two full waveforms are used for each stack. The minimum number of stacks is 2, maximum is 254.

Measure SP

When this value is set to **TRUE** the DAS-1 measures the self-potential prior to starting the normal data collection. Therefore setting this value does increase run times slightly.

High Noise

Setting the high noise value to **TRUE** changes the auto gain values generally causing the system to choose a gain setting with a higher voltage range.

50Hz Noise Rej.

Set this to **FALSE** if operating in North America and **TRUE** if operating in Europe.

Display APPRES

Setting this to **TRUE** causes the system to display apparent resistivity instead of amplitude and write apparent resistivity values into the data file.

Resistivity only

In **Resistivity Only** mode no IP windows are collected. The off-time period of the waveform is shortened to 2 milliseconds and higher frequencies are available.

6.4.3 TDIP Data Progress Menu

When the system starts collecting data it switches to the progress menu. The menu displays the date and time, the base frequency used, amount of data collected, the transmitter pair, current, contact resistance, the most recent data collected, Main (Rx) and Tx batteries, Tx voltages and the temperatures of the receivers (Main), transmitter primary (Txp) and secondary (Txs) (Figure 6.4.3).

To halt a data run, hold down the **STOP** key on the keypad. After a few seconds the system will display an additional line at the bottom of the LCD (Figure 6.3.3A). To halt a data run the user must hit the **LEFT** arrow key then the **ENTER** button (Figure 6.3.3B). To continue the data run press the **RIGHT** arrow key then the **RETURN** key. Status and data should continue to be displayed.

6.5 DStream Menu

6.5.1 Introduction

The Data Stream data mode allows the user to collect raw current or voltage values in up to 128 windows. These data can then be plotted or processed using user created software. The user then chooses frequency, the number of half-waveforms (see below) and the window length. The DStream Data Mode is set up in terms of Half Waveforms. A half-waveform has a period of 1.0 / (2 * Frequency) and begins when the transmitter current is turned on (see Figure 6.5.1). The system transmits a TDIP style waveform. The first half-waveform and thus the first window begins when the transmitter is turned on. The code chooses the number of windows that will fit within the Half-Waveform. Each half waveform has the same number of windows and there may be gaps after the last window in one Half-Waveform and the first window in the next. Note that some windows can span the time when the transmitter is turned off.

The **DStream Menu** (Figure 6.5.2) allows the user to modify certain parameters of an already created DStream Command File. Once the parameters are changed (as discussed above in section 6.2), test the configuration by pressing the right arrow button on the keypad until **CHECK** is selected (note: this process is similar to using the Update Configuration button in the PC Software). The file can then be run by pressing the **Right** arrow button until **RUN** is selected. The **ELECT** option allows the user to edit the command file on the console, see Section 6.7 below.

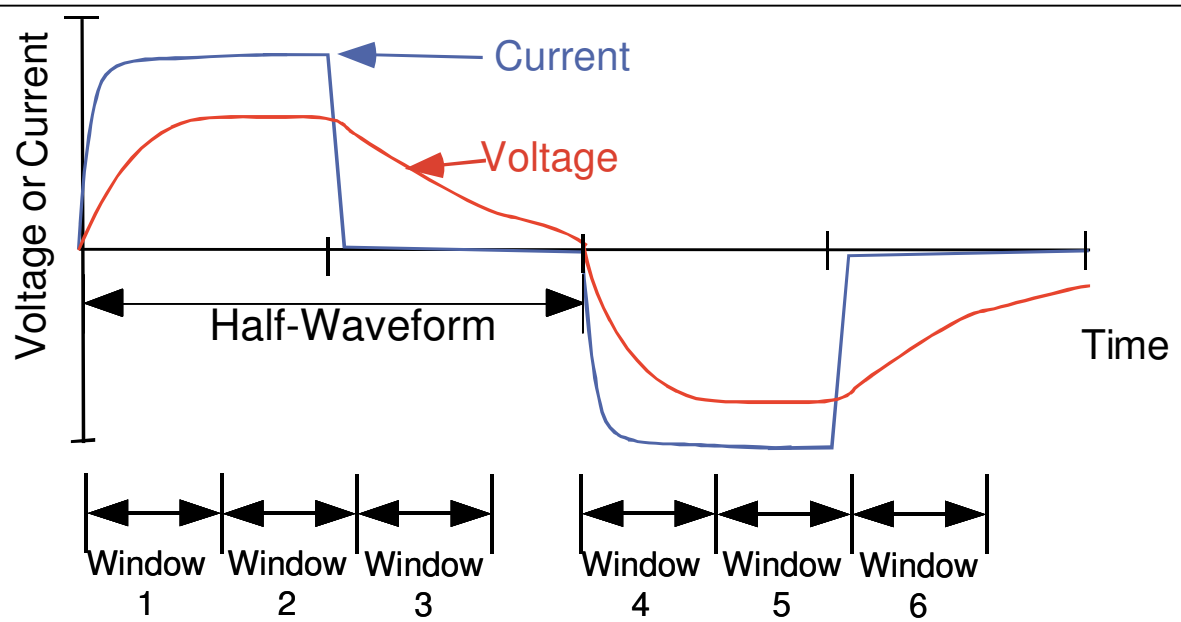


Figure 6.5.1 Typical DStream Waveform showing timing of windows with respect to Half Waveforms.

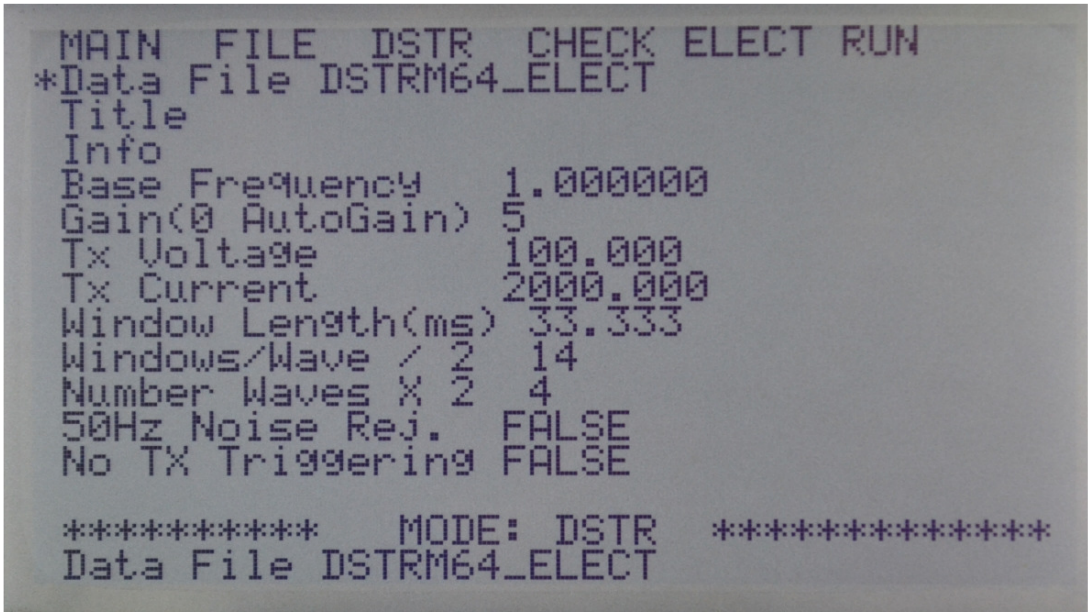


Figure 6.5.2 DStream System menu.

6.5.2 Dstream Menu Commands

Data File

Displays the name of the open command file.

Title

The project title is any line of text included for information. It is included in the data file but is not used. For command files to be downloaded to the DAS-1 this should be 35 characters or less.

Information

For files downloaded to the DAS-1 only one line of 35 characters is allowed to include documentation to the data file.

Base Frequency

The maximum frequency is 5 Hz. Acquisition is restricted to fractions of 5 Hz i.e. 5/2 Hz, 5/3 Hz, 5/4 Hz, 1 Hz and so on.

Gain (0 AutoGain)

The default gain is an integer from 0 to 5 giving the index of the gain/range settings. The default is 5 which allows the system to use Auto-Gain settings and should be used except for

very unusual circumstances. Using values along with setting the Use Pre-Assigned Gain checkbox will force the system to use that gain/range value for all data. If the data values are too large for the range the system will produce erroneous results or may fail to collect one or more data. Table 6.5.1lists the gain and range settings.

Table 6.5.1

Gain Index	Gain	Max Voltage
0	Auto Range	10
1	1	10
2	5	2
3	25	0.4
4	125	0.08
5	**Auto Range**	**10**

TX Voltage

This is the approximate transmitter voltage in volts used for the data series. The actual voltage may vary from this somewhat and is typically smaller than this voltage but depends on load conditions. For typical transmitter contact resistances (a few hundred to a few thousand Ohms) the system will choose a transmitter and will seek to find an optimal voltage which is at or slightly below this value but still has a high efficiency and is unlikely to exceed the transmitter current, power, and voltage limits. For very high contact resistances (tens of thousands of Ohms) the transmitter has a minimum output voltage of about 25 volts. Typical values range from 20 volts to 480 volts. ***Operators should never assume that the voltage is necessarily limited to this voltage and data should never be collected if humans or animals may be in contact with exposed metal on cables, connectors or electrodes***. However, lower voltages are in general safer than higher voltages. Also higher voltages do not necessarily result in better signal to noise values. We recommend running preliminary tests and using the lowest target voltage that provides adequate data values. Ideally this voltage should be under 100 volts.

TX Current

This is the approximate transmitter current limit in milliamps for a data series. For each set of readings the transmitter will try to limit the current flow to approximately this value. Typically this is set at or near the system limit of 2500 milliamps.

Window Length (ms)

Voltages collected in DStream Data Mode are averaged over windows that are integer multiples of 16.67 milliseconds per window for 60 Hz powerline noise rejection and 20 milliseconds for 50 Hz powerline noise rejection. There must be at least one window per data half-waveform.

Windows/Wave / 2

This shows the number of windows per half-wave. The code chooses the number of windows that will fit within the time period of the Half-Waveform.

Number waves X 2

These are the number of Half-Waveforms collected during a data run.

No TX Triggering

This parameter disables the synchronization between the transmitter and DStream windows. If this value is set, the system will collect a continuous series of data windows starting slightly before the transmitter is turned. Often windows will span the turn-on times of the transmitter and the data sequence will likely complete before the transmitter is finished. This mode is primarily for diagnostic purposes.

6.5.3 Data Progress Menu

When the system starts collecting data it switches to the progress menu. The menu displays the date and time, the base frequency used, amount of data collected, the transmitter pair, current, contact resistance, the most recent data collected, Main (Rx) and Tx batteries, Tx voltages and the temperatures of the receivers (Main), transmitter primary (Txp) and secondary (Txs) (Figure 6.5.3).

To halt a data run, hold down the **STOP** key on the keypad. After a few seconds the system will display an additional line at the bottom of the LCD (Figure 6.3.3A). To halt a data run the user must hit the **LEFT** arrow key then the **ENTER** button (Figure 6.3.3B). To continue the data run press the **RIGHT** arrow key then the **RETURN** key. Status and data should continue to be displayed.

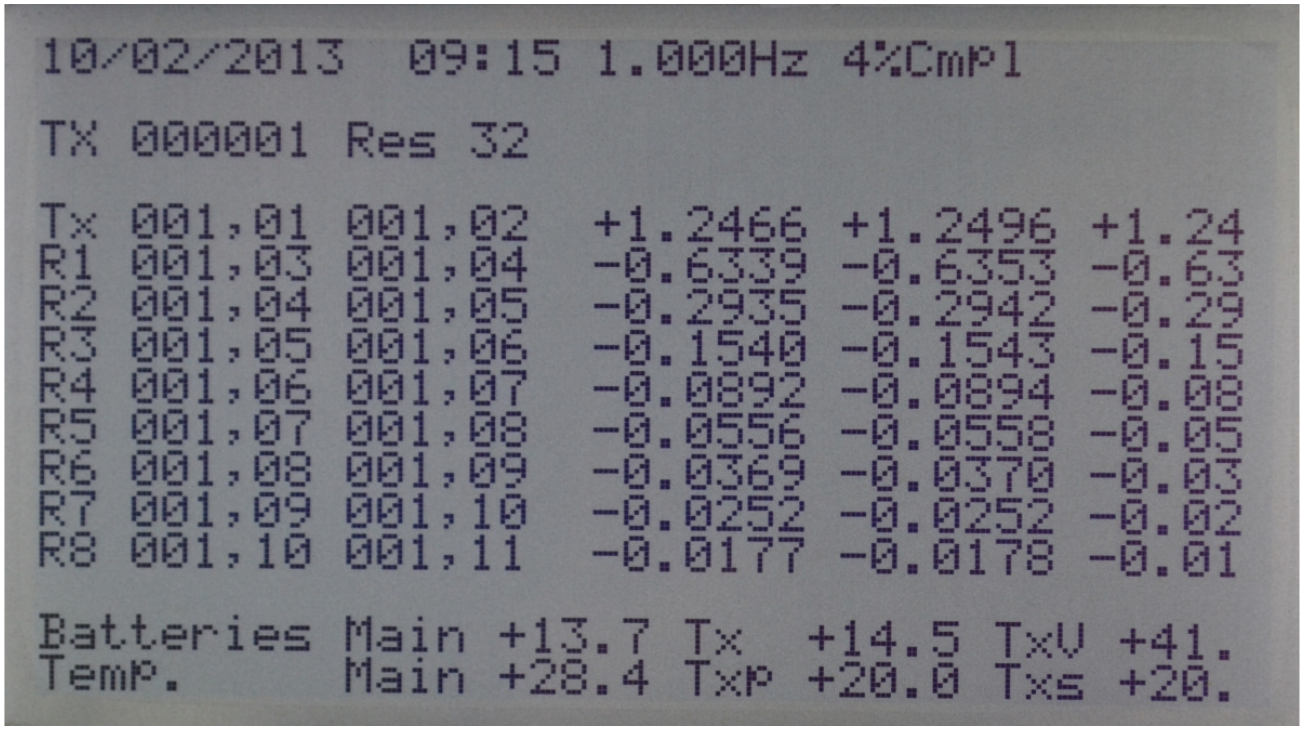


Figure 6.5.3 DStream Progress Menu

6.6 Check Contact Resistance Menu

6.6.1 Introduction

This selection allows the user to perform a quick resistance check on adjacent electrode pairs. We recommend using this function after electrodes are in place and prior to initial data collection. It is not necessary to perform this test before each data run.

This procedure performs an estimate of contact resistance. The highest reading for this method is limited to approximately 300,000 Ohms; thus any reading greater than 200,000 Ohms should be considered an open circuit.

6.6.2 Check Contact Resistance Menu Commands

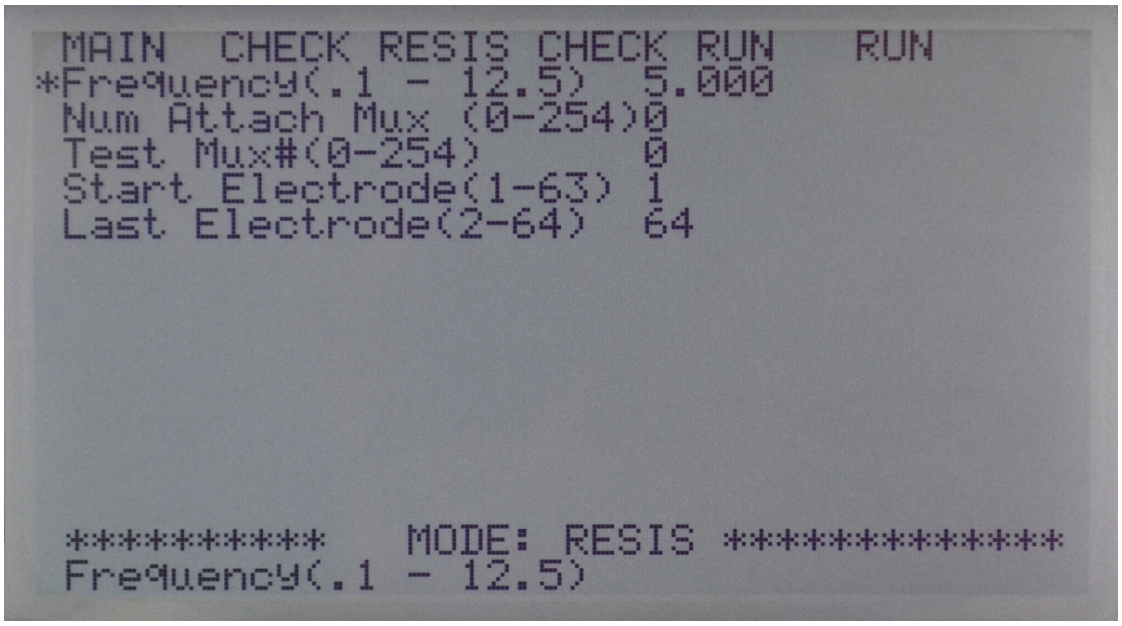


Figure 6.6.1 Check Contact Resistance Menu

Frequency (.1 – 12.5)

Enter the frequency desired (.1 Hz to 12.5 Hz) for testing contact resistance between electrodes. The default is 5.0 Hz.

Number Attach Mux (0-254)

This is the total number of units being tested, the DAS-1 Main unit is considered as 0. For example, to test the DAS-1 Main Unit only, enter 0. For the DAS-1 and one external multiplexer, enter 1, for two external multiplexers enter 2, etc.

Test Mux# (0-254)

Enter the multiplexer you want to test. For testing the DAS-1 Main unit only, use 0 (this is the default). To test the first external multiplexer, enter 1; for the second multiplexer, enter 2, etc.

Start Electrode (1-63)

Enter the range of electrodes you want to test (the default is 1-63).

Last Electrode(2-64)

Enter the range of electrodes you want to test (the default is 2-64). There needs to be at least two electrodes selected to conduct a check electrodes test.

6.7. Edit Command File (ELECT)

6.7.1 Introduction

The Edit Command File (**ELECT**) selection is a valuable tool in editing previously created command files (i.e. *.CMND). This menu will allow the user to do the following: skip pins, limit the number of pins to use, limit the number of data points, scale the spacing between pins, reverse the order of the pins on a cable, and skip or shift lines.

When editing a command file for any of the data acquisition modes such as FDIP, TDIP and DStream the Edit Command File menu in Figure 6.7.1 will be shown.

6.7.2 Edit Command File Menu

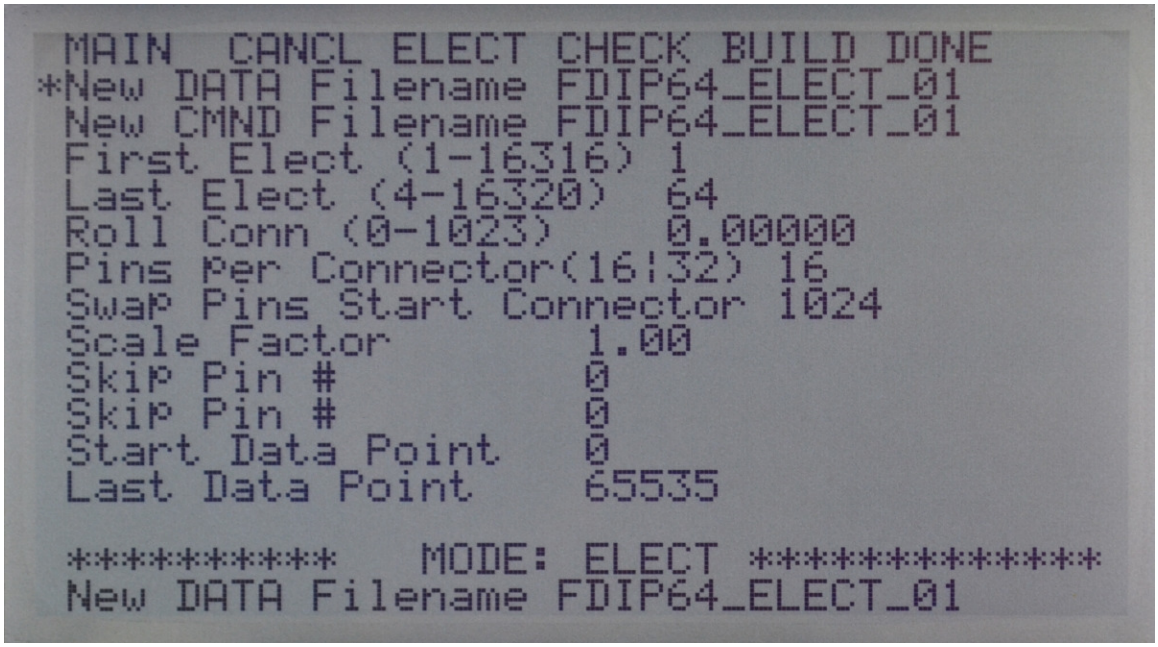


Figure 6.7.1 Edit Commands Menu

New DATA File Name

This is the name of the data file that will be created when running the newly edited command file. The new data file name may be a maximum size of 20 characters long.

New CMND Filename

This shows the name of the new command file that will be created. By default, this new command file name is the same name as the old command file name appended with an underscore and a number (i.e. "old_command_file_name_**1**.CMND").

Change the name of the edited command file on this line. The command file name may be a maximum size of 32 characters long.

First Elect (1-16316)

The first pin default number is one (1) in the command builder. If you wish to edit the number of the first pin, you may enter the number you require. The values must be between 1 and 16316 (this is the maximum number allowed and can accommodate 255 multiplexers with 64 pins each).

Last Elect (4-16320)

The last pin default number is sixty-four (64) in the command builder. If you wish to edit the number of the last pin, you may enter the number you require. Ensure that the last pin is a larger value than the first pin by at least four. The pvalues for the text field must be between 4 and 16320.

Roll Conn (0-1023)

This will shift or "roll" the pins on the line. The values do not have to be whole numbers and decimals may be used if you wish to shift a fraction of a line. For instance, to shift a quarter of a line on a 16 electrode line enter, "0.25" and the command file will shift down four electrodes to line 001, electrode 05. To shift the entire line, enter "1" and the command file will shift past the entire line. The values must be between 0 and 1023.

When editing the Roll Conns with a multiplexer attached to the DAS-1, and you roll the connectors so that only the DAS-1 is used, it is advisable to disconnect the multiplexer before data collection.

Pins per Connector (16|32)

This must match the system connector configuration in use. Enter either the value 16 or 32.

Swap Pins Start Connector

This will place the order of the pins in reverse order. When entering either "0" or "1" all of the lines in use will be set in reverse order. For lines 2 and greater, the line number entered and all lines greater than that value will be reversed. For instance, entering "3" will keep lines 1 and 2 in normal order and reverse lines 3 and greater. The values must be between 0 and 1023.

Scale Factor

This option allows for the distance between electrodes to be scaled. The scale factor must be between 0.001 and 1000.

Skip Pin #

There are two Skip Pin boxes; only one pin number may be entered each box. If two pins need to be skipped, use both Skip Pin text fields. This must be a value between the First and Last pin. The minimum total number of pins is four.

Start Data Point

This will change the initial starting data point on the data collection schedule. Any starting data point may be used.

Last Data Point

This is the last data point that will be collected. The number of allowable data points may vary since each data point is collected in blocks while using the same transmitter. This number must be greater than the Start Data point.

Warning: It is not advisable to edit a previously edited command file. Please edit the original command file only.

Appendix A: Procedure for Testing System Isolation

To test the system isolation as indicated in Section 2.1 of the DAS-1 Manual, use the following procedure (at any time during testing if you detect voltages greater than 0, or resistance values significantly less than specified, stop and contact MPT):

1. Turn the system off and connect the external power supply cable to the Batt1 or Battery connector.

2. With the system turned off, use a volt-ohm meter and leads rated to at least 500V DC to check for stray voltage. Connect the ground lead of the probe to the negative (black) receptacle of the external power supply cable. Use an insulated test probe to check for voltage between the negative (black) external power supply cable and a) the two external battery connections, b) the ground (green) connection, c) each of the two TX Out connections, and d) any of the bolts on the outside of the case (see Figure A.1). Voltages should be less than the open circuit voltages for the volt-ohm meter, generally less than one volt.

3. Set the volt-ohm meter to its highest resistance range (this should be at least 10MOhms) and check the resistance values between negative (black) external power supply cable and a) the two external battery connections, b) the Ground (green) connection, c) each of the two TX Out connections, and d) any of the bolts on the outside of the case (see Figure A.1). Resistance values should be greater than 10MOhms between the external power supply and the various connections with the exception of the ground and the external case. The resistance of the ground should be greater than 500 kOhms, and the value for the bolts on the case should be greater than 200 kOhms.

4. Return the volt-ohm meter to the voltage measuring mode. Connect the ground lead of the probe to the negative (black) external battery connection. Use the probe to check for voltage between the negative (black) external battery connection and a) the ground (green) connection, and b) each of the two TX Out connections (see Figure A.2). Voltages should be less than the open circuit voltages for the volt-ohm meter, generally less than one volt.

5. Set the volt-ohm meter to its highest resistance range and check the resistance values between the negative (black) external battery connection and a) the ground connection, and b) the two TX Out connections. Resistance values should be greater than 10MOhms.

6. Turn the system on and test the voltage between the system case and a) the negative (black) external battery connection, b) the ground (green) connection and c) each of the two TX Out connections (see Figure A.3). Voltages should be less than one volt.

7. Set the volt-ohm meter to its highest resistance range and check the resistance values between the system case and a) the negative (black) external battery connection, b) the ground (green) connection and c) each of the two TX Out connections (see Figure A.3). The resistance of the ground should be greater than 600 kOhms.

If all of the voltage values are less than 0 and resistance values are greater than the values specified, the system is electrically isolated.

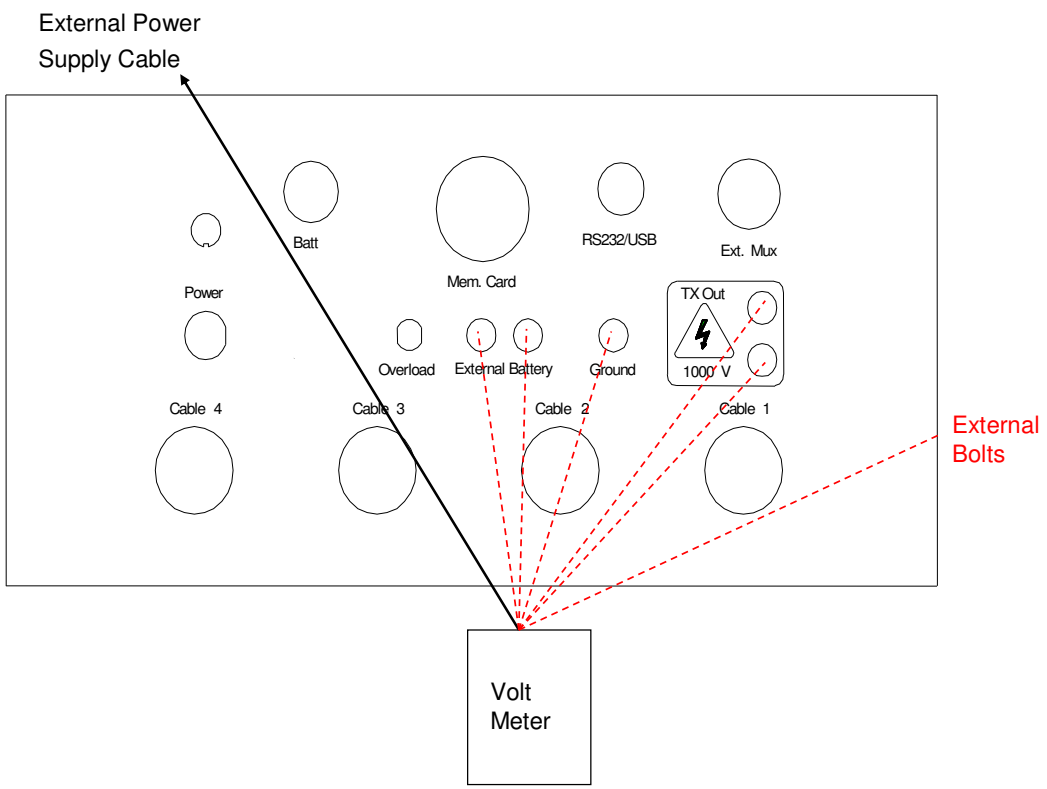


Figure A.1. Isolation test with volt meter between the external power supply cable and a) two external battery connections, b) the Ground (green) connection, c) each of the two Tx Out connections, and d) any external bolt

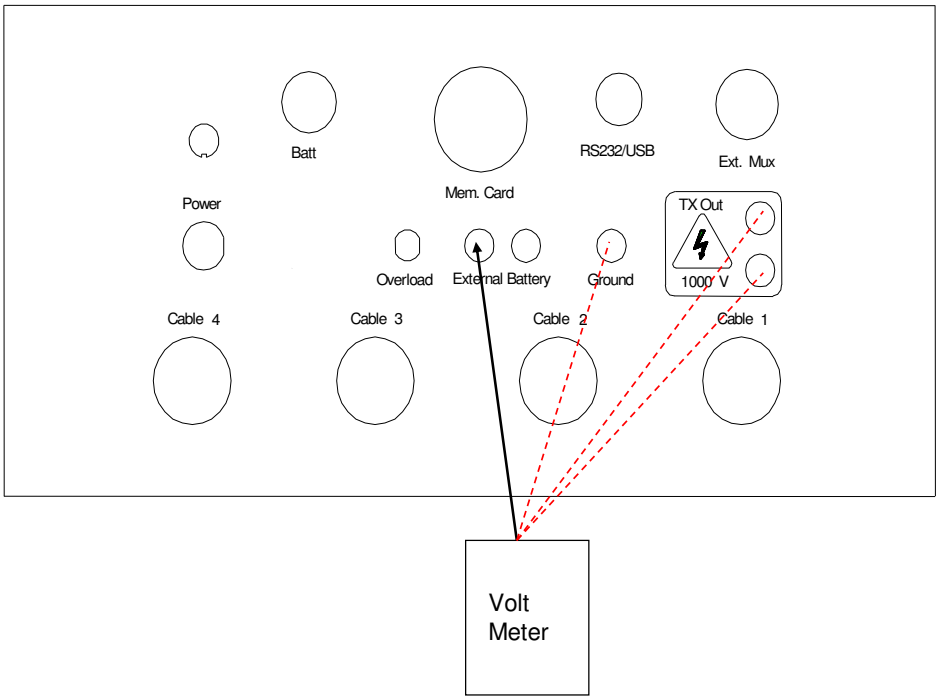


Figure A.2. Isolation test with volt meter between the negative External Battery connection and the a) Ground, and b) Tx Out connections.

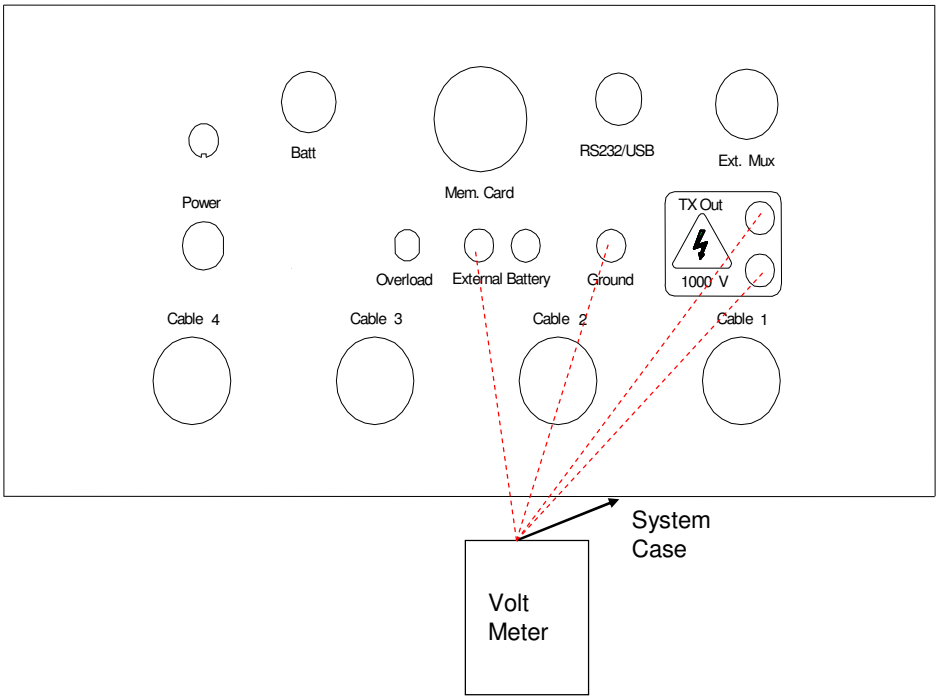


Figure A.3. Isolation test with volt meter between the System Case and the a) negative External Battery connection, b) Ground, and c) Tx Out connections.

Appendix B: Examples of Command and Data Files

B.1 Overview

As noted in Section 4.0, the system can run either under internal control using its micro-secure digital card for command and data storage, or it can run under the control of an external computer, in which case the data are stored on the local computer. In both cases, the system runs off of command files and creates data files. Examples of command and data files are outlined in this section. Further information about command files, data files, and file structure can be found in Section 4.0.

B.2 Example of a Command File

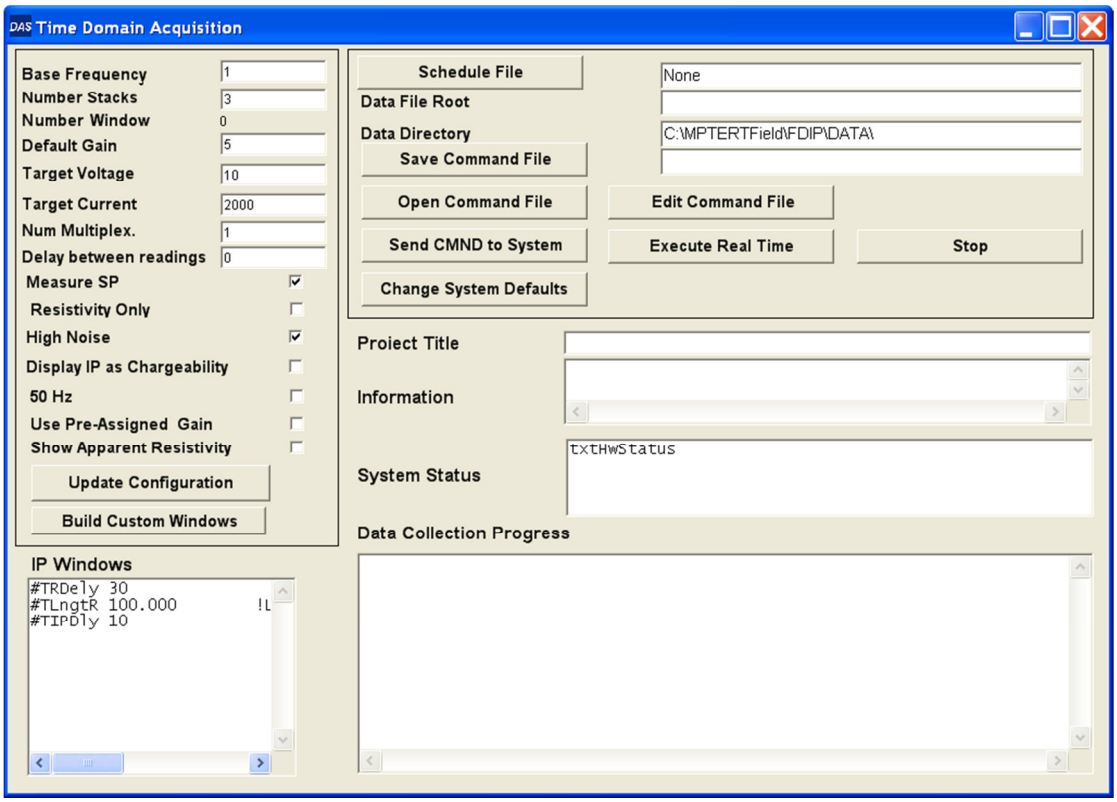


Figure B1. Example image of TDIP command file settings shown to the left of the window.

B.2.1 System Configuration Section

The first section of the command file contains configuration information chosen from settings in the menu shown in figure B1. In order to create a command file, an appropriate schedule file must be loaded and the desired configuration settings to the left of the acquisition window must be selected. These configuration settings are discussed in detail below.

This section includes:

- **#SName**: The name of the command file
- **#SDirc**: The directory into which data files will be saved
- **#SR50 Hz**: If 50 Hz power is being used, and the command file was set with 50 Hz noise rejection selected, this command will be present
- **#SHiNse**: If the high noise setting is selected, this command will be present
- **#SGDflt**: The gain index for fixed gain settings. This value is set in the "Default Gain" field in the configuration section of an acquisition window
- **#SMuxN**: The number of multiplexers being utilized. This value is set in the "Num Multiplex." field in the configuration section of an acquisition window
- **#SCltSP**: Begins the transmitter configuration settings section
- **#XMXVlt**: The maximum transmitter voltage
- **#XCurMx**: The maximum transmitter current
- **#XPowMx**: The maximum transmitter power
- **#XVTrgt**: Target transmitter voltage. This value is set in the "Target Voltage" field in the configuration section of an acquisition window
- **#XITrgt**: Target transmitter current. This value is set in the "Target Current" field in the configuration section of an acquisition window
- **#XBtVmn**: The minimum transmitter battery voltage
- **#XTmpMx**: The maximum transmitter temperature
- **#XLrRes**: The minimum transmitter electrode pair resistance
- **#XUpRes**: The maximum transmitter electrode pair resistance
- **!Time Domain IP Section**: The following section contains configuration settings specific to the data mode being used. In this example, Time Domain settings are shown. For configuration settings for other data modes, see section 5.0.
- **#TFrequ**: Target frequency in Hz is shown here. This value is set in the "Base Frequency" field in the configuration section of an acquisition window.
- **#TStcks**: Target number of stacks is shown here. This value is set in the "Number Stacks" field in the configuration section of an acquisition window
- **#TRDely**: Pre-Resistivity Measurement Delay (ms)
- **#TLngtR**: The length of the resistivity measurement window in ms
- **#TIPDly**: The IP delay before first IP window in ms
- **#TChrg**: If the Display IP Values as Chargeability option was selected, this command will be present here

- **#TW01**: IP Window 1. If more than one IP window is set, they will appear as #TW02 and so on

When opening a command file, the settings are shown in a text format, as shown in figure B2.

```
! Command File written by ERTLab DACQ
#IVersion                    9.010
#IDate       Date: 20100510_1043

! ----------------------------------------------------!
#ST
! ----------------------------------------------------!
#ITitle                      ""
#SName                       "TESTBOX_2"
#SDirc
"C:\MPTERTField\TDIP\DATA\"
#SR50Hz
#SHiNse
#SGDflt                       5
#SMuxN                        1
#SCltSP      !TX Section
#XMXVlt                      480
#XCurMx                      2500
#XPowMx                      250
#XVTrgt                      10
#XITrgt                      2000
#XBtVmn                      11
#XTmpMx                      70
#XLrRes                      1
#XUpRes                      1000000
!Time Domain IP Section
#TFrequ                      01.00000
#TStcks                      3
#TRDely                      100
#TLngtR                      100.000
#TIPDly                      100
#TChrg
#TW01                        100.000
!
```

Figure B2. Example of the system configuration section of the command file

B.2.2 Electrode Configuration Section

The second section of the command file contains information on the electrode configuration. Electrodes are designated by cable ID and electrode ID (i.e. 001, 01) and are given location and elevation values such as X, Y, Z, and Terrain(z) in meters.

Additionally, this section contains translation information that gives ID numbers to cable/electrode orientations (see Figure B3)

```
!Elec Trans Section
#ENum        000064
#ELectrd 001,01 +0.0000 +0.0000 +0.0000 +0.0000 001
#ELectrd 001,02 +0.0000 +1.0000 +0.0000 +0.0000 002
#ELectrd 001,03 +0.0000 +2.0000 +0.0000 +0.0000 003
#ELectrd 001,04 +0.0000 +3.0000 +0.0000 +0.0000 004
#ELectrd 001,05 +0.0000 +4.0000 +0.0000 +0.0000 005
#ELectrd 001,06 +0.0000 +5.0000 +0.0000 +0.0000 006
#ELectrd 001,07 +0.0000 +6.0000 +0.0000 +0.0000 007
#ELectrd 001,08 +0.0000 +7.0000 +0.0000 +0.0000 008
#ELectrd 001,09 +0.0000 +8.0000 +0.0000 +0.0000 009
#ELectrd 001,10 +0.0000 +9.0000 +0.0000 +0.0000 010
#ELectrd 001,11 +0.0000 +10.000 +0.0000 +0.0000 011
#ELectrd 001,12 +0.0000 +11.000 +0.0000 +0.0000 012
#ELectrd 001,13 +0.0000 +12.000 +0.0000 +0.0000 013
#ELectrd 001,14 +0.0000 +13.000 +0.0000 +0.0000 014
#ELectrd 001,15 +0.0000 +14.000 +0.0000 +0.0000 015
#ELectrd 001,16 +0.0000 +15.000 +0.0000 +0.0000 016
#ELectrd 002,01 +1.0000 +16.000 +0.0000 +0.0000 017
#ELectrd 002,02 +2.0000 +16.000 +0.0000 +0.0000 018
#ELectrd 002,03 +3.0000 +16.000 +0.0000 +0.0000 019
#ELectrd 002,04 +4.0000 +16.000 +0.0000 +0.0000 020
#ELectrd 002,05 +5.0000 +16.000 +0.0000 +0.0000 021
#ELectrd 002,06 +6.0000 +16.000 +0.0000 +0.0000 022
#ELectrd 002,07 +7.0000 +16.000 +0.0000 +0.0000 023
#ELectrd 002,08 +8.0000 +16.000 +0.0000 +0.0000 024
#ELectrd 002,09 +9.0000 +16.000 +0.0000 +0.0000 025
#ELectrd 002,10 +10.000 +16.000 +0.0000 +0.0000 026
#ELectrd 002,11 +11.000 +16.000 +0.0000 +0.0000 027
#ELectrd 002,12 +12.000 +16.000 +0.0000 +0.0000 028
#ELectrd 002,13 +13.000 +16.000 +0.0000 +0.0000 029
#ELectrd 002,14 +14.000 +16.000 +0.0000 +0.0000 030
#ELectrd 002,15 +15.000 +16.000 +0.0000 +0.0000 031
#ELectrd 002,16 +16.000 +16.000 +0.0000 +0.0000 032
#ELectrd 003,01 +16.000 +15.000 +0.0000 +0.0000 033
#ELectrd 003,02 +16.000 +14.000 +0.0000 +0.0000 034
#ELectrd 003,03 +16.000 +13.000 +0.0000 +0.0000 035
#ELectrd 003,04 +16.000 +12.000 +0.0000 +0.0000 036
#ELectrd 003,05 +16.000 +11.000 +0.0000 +0.0000 037
#ELectrd 003,06 +16.000 +10.000 +0.0000 +0.0000 038
#ELectrd 003,07 +16.000 +9.0000 +0.0000 +0.0000 039
#ELectrd 003,08 +16.000 +8.0000 +0.0000 +0.0000 040
#ELectrd 003,09 +16.000 +7.0000 +0.0000 +0.0000 041
#ELectrd 003,10 +16.000 +6.0000 +0.0000 +0.0000 042
#ELectrd 003,11 +16.000 +5.0000 +0.0000 +0.0000 043
#ELectrd 003,12 +16.000 +4.0000 +0.0000 +0.0000 044
#ELectrd 003,13 +16.000 +3.0000 +0.0000 +0.0000 045
#ELectrd 003,14 +16.000 +2.0000 +0.0000 +0.0000 046
#ELectrd 003,15 +16.000 +1.0000 +0.0000 +0.0000 047
#ELectrd 003,16 +16.000 +0.0000 +0.0000 +0.0000 048
#ELectrd 004,01 +15.000 +0.0000 +0.0000 +0.0000 049
#ELectrd 004,02 +14.000 +0.0000 +0.0000 +0.0000 050
#ELectrd 004,03 +13.000 +0.0000 +0.0000 +0.0000 051
#ELectrd 004,04 +12.000 +0.0000 +0.0000 +0.0000 052
#ELectrd 004,05 +11.000 +0.0000 +0.0000 +0.0000 053
#ELectrd 004,06 +10.000 +0.0000 +0.0000 +0.0000 054
#ELectrd 004,07 +9.0000 +0.0000 +0.0000 +0.0000 055
#ELectrd 004,08 +8.0000 +0.0000 +0.0000 +0.0000 056
#ELectrd 004,09 +7.0000 +0.0000 +0.0000 +0.0000 057
#ELectrd 004,10 +6.0000 +0.0000 +0.0000 +0.0000 058
#ELectrd 004,11 +5.0000 +0.0000 +0.0000 +0.0000 059
#ELectrd 004,12 +4.0000 +0.0000 +0.0000 +0.0000 060
#ELectrd 004,13 +3.0000 +0.0000 +0.0000 +0.0000 061
#ELectrd 004,14 +2.0000 +0.0000 +0.0000 +0.0000 062
#ELectrd 004,15 +1.0000 +0.0000 +0.0000 +0.0000 063
#ELectrd 004,16 +0.0000 +0.0000 +0.0000 +0.0000 064
!
```

Figure B3. Example of the electrode configuration section of the command file

B.2.3 Multiplexer Configuration Section

The final section of the command file contains information that allows the system to run the schedule. This section is created in the command file through information in a schedule file, and is not generally edited outside of the schedule file (Figure B4).

```
!
!Mux-RxSection
#MA      08          00C0001030507060807090 80A090B0A0C0B0D393B98
#MT      000001 001,01 001,03
#MR1 001,05 001,07  -37.69913
#MR2 001,06 001,08  -82.46685
#MR3 001,07 001,09  -150.7966
#MR4 001,08 001,10  -247.4007
#MR5 001,09 001,11  -376.9912
#MR6 001,10 001,12  -544.2809
#MR7 001,11 001,13  -753.9828
#MR8 004,09 004,11  -713.3441
#MA      02          00C0001033A3C3B3D9F
#MT      000002 001,01 001,03
#MR1 004,10 004,12  -352.1885
#MR2 004,11 004,13  -150.7534
#MA      08          00C00013E0406050706083436353736383739383A73
#MT      000003 001,01 004,14
#MR1 001,04 001,06  +150.7534
#MR2 001,05 001,07  +352.1885
#MR3 001,06 001,08  +713.3441
#MR4 004,04 004,06  +753.9828
#MR5 004,05 004,07  +544.2809
#MR6 004,06 004,08  +376.9912
#MR7 004,07 004,09  +247.4007
#MR8 004,08 004,10  +150.7966
#MA      02          00C00013E393B3A3CA9
#MT      000004 001,01 004,14
#MR1 004,09 004,11  +82.46685
#MR2 004,10 004,12  +37.69913
#MA      08          00C00020406080709080A090B0A0C0B0D0C0E383AB4
#MT      000005 001,02 001,04
#MR1 001,06 001,08  -37.69913
#MR2 001,07 001,09  -82.46685
#MR3 001,08 001,10  -150.7966
#MR4 001,09 001,11  -247.4007
#MR5 001,10 001,12  -376.9912
#MR6 001,11 001,13  -544.2809
#MR7 001,12 001,14  -753.9828
#MR8 004,08 004,10  -753.9046
#MA      03          00C000204393B3A3C3B3D83
#MT      000006 001,02 001,04
#MR1 004,09 004,11  -433.2448
#MR2 004,10 004,12  -230.9331
#MR3 004,11 004,13  -112.3845

#Run_End
```

Figure B4. Example of the multiplexer configuration section of the command file

B.3 Example of a Data File

The DAS-1 creates the data file names by appending the date, time and a four letter extension "DATA" onto a file name root parameter in the command file. A typical file name is SANDTANK_20090313_1334.Data. Note that the year is first followed by the month, day then an underscore followed by the time in hours and minutes.

Data files are written directly in ERTLab format. Descriptions of this format are found in section B.3.3.

B.3.1 System Configuration Section

The first section of a data file contains information on the system configuration written in by the command file. For explanations of the listed commands, electrode configurations, and any other information also found in command files, see Section B.2.1 on command files. Figure B.5 shows an example of the first section, in text format, of a data file.

```
! Data File written by ERTLab DACQ
#IVersion          9.020
#IDate             5/20/2010
! ----------------------------------------------------!
#ST
! ----------------------------------------------------!
#ITitle            ""
#IInfo             ""
#SName             "TESTBOX_2"
#SGDflt            5                    !Gain Index for Fixed Gain Settings
#SHiNse                                 !Use High Noise Settings
#SMuxN              1
#SCltSP                                 !TX Configuration  Section
#XMXVlt            480                  !Maximum Tx Voltage
#XCurMx            2500                 !Maximum Tx Current
#XPowMx            250                  !Maximum Tx Power
#XVTrgt            10                   !Target Tx Voltage
#XITrgt            2000                 !Target Tx Current
#XBtVmn            11                   !Minimum Tx Battery Voltage
#XTmpMx            70                   !Maximum Tx Temperature
#XLrRes            1                    !Minimum Tx Electrode Pair Resistance
#XUpRes            1000000              !Maximum Tx Electrode Pair Resistance
!Time Domain IP Section
#TFrequ            05.000000
#TStcks            3                    !Number of Stacks for TDIP
#TRDely            30                   !Pre-Resistivity Measurement Delay (ms)
#TLngtR            16.667               !Length of Resistivity Measurement Window (ms)
#TIPDly            30                   IP Delay Before First IP Window (ms)
#TChrg                                  !Display IP Values as Chargeability
!List of IP Windows
#TW01              16.667
```

Figure B.5. Example of the system configuration section of the data file

B.3.2 Electrode Configuration Section

The second section of the data file *contains* information on the electrode configuration as set in the command file.

```
#elec_start
!Cbl# El# Elev-X  Elev-Y  Elev-Z  Terrn-Z  Type  El.Num
001,01 +0.0000 +0.0000 +0.0000 +0.0000 001
001,02 +0.0000 +1.0000 +0.0000 +0.0000 002
001,03 +0.0000 +2.0000 +0.0000 +0.0000 003
001,04 +0.0000 +3.0000 +0.0000 +0.0000 004
001,05 +0.0000 +4.0000 +0.0000 +0.0000 005
001,06 +0.0000 +5.0000 +0.0000 +0.0000 006
001,07 +0.0000 +6.0000 +0.0000 +0.0000 007
001,08 +0.0000 +7.0000 +0.0000 +0.0000 008
001,09 +0.0000 +8.0000 +0.0000 +0.0000 009
001,10 +0.0000 +9.0000 +0.0000 +0.0000 010
001,11 +0.0000 +10.000 +0.0000 +0.0000 011
001,12 +0.0000 +11.000 +0.0000 +0.0000 012
001,13 +0.0000 +12.000 +0.0000 +0.0000 013
001,14 +0.0000 +13.000 +0.0000 +0.0000 014
001,15 +0.0000 +14.000 +0.0000 +0.0000 015
001,16 +0.0000 +15.000 +0.0000 +0.0000 016
002,01 +1.0000 +16.000 +0.0000 +0.0000 017
002,02 +2.0000 +16.000 +0.0000 +0.0000 018
002,03 +3.0000 +16.000 +0.0000 +0.0000 019
002,04 +4.0000 +16.000 +0.0000 +0.0000 020
002,05 +5.0000 +16.000 +0.0000 +0.0000 021
002,06 +6.0000 +16.000 +0.0000 +0.0000 022
002,07 +7.0000 +16.000 +0.0000 +0.0000 023
002,08 +8.0000 +16.000 +0.0000 +0.0000 024
002,09 +9.0000 +16.000 +0.0000 +0.0000 025
002,10 +10.000 +16.000 +0.0000 +0.0000 026
002,11 +11.000 +16.000 +0.0000 +0.0000 027
002,12 +12.000 +16.000 +0.0000 +0.0000 028
002,13 +13.000 +16.000 +0.0000 +0.0000 029
002,14 +14.000 +16.000 +0.0000 +0.0000 030
002,15 +15.000 +16.000 +0.0000 +0.0000 031
002,16 +16.000 +16.000 +0.0000 +0.0000 032
003,01 +16.000 +15.000 +0.0000 +0.0000 033
003,02 +16.000 +14.000 +0.0000 +0.0000 034
003,03 +16.000 +13.000 +0.0000 +0.0000 035
003,04 +16.000 +12.000 +0.0000 +0.0000 036
003,05 +16.000 +11.000 +0.0000 +0.0000 037
003,06 +16.000 +10.000 +0.0000 +0.0000 038
003,07 +16.000 +9.0000 +0.0000 +0.0000 039
003,08 +16.000 +8.0000 +0.0000 +0.0000 040
003,09 +16.000 +7.0000 +0.0000 +0.0000 041
003,10 +16.000 +6.0000 +0.0000 +0.0000 042
003,11 +16.000 +5.0000 +0.0000 +0.0000 043
003,12 +16.000 +4.0000 +0.0000 +0.0000 044
003,13 +16.000 +3.0000 +0.0000 +0.0000 045
003,14 +16.000 +2.0000 +0.0000 +0.0000 046
003,15 +16.000 +1.0000 +0.0000 +0.0000 047
003,16 +16.000 +0.0000 +0.0000 +0.0000 048
004,01 +15.000 +0.0000 +0.0000 +0.0000 049
004,02 +14.000 +0.0000 +0.0000 +0.0000 050
004,03 +13.000 +0.0000 +0.0000 +0.0000 051
004,04 +12.000 +0.0000 +0.0000 +0.0000 052
004,05 +11.000 +0.0000 +0.0000 +0.0000 053
004,06 +10.000 +0.0000 +0.0000 +0.0000 054
004,07 +9.0000 +0.0000 +0.0000 +0.0000 055
004,08 +8.0000 +0.0000 +0.0000 +0.0000 056
004,09 +7.0000 +0.0000 +0.0000 +0.0000 057
004,10 +6.0000 +0.0000 +0.0000 +0.0000 058
004,11 +5.0000 +0.0000 +0.0000 +0.0000 059
004,12 +4.0000 +0.0000 +0.0000 +0.0000 060
004,13 +3.0000 +0.0000 +0.0000 +0.0000 061
004,14 +2.0000 +0.0000 +0.0000 +0.0000 062
004,15 +1.0000 +0.0000 +0.0000 +0.0000 063
004,16 +0.0000 +0.0000 +0.0000 +0.0000 064
#elec_end
```

Figure B.6. Example of the electrode configuration section of the data file

B.3.3 ERTLab Header Info Section

The third section of the data file includes configuration information used by ERTLab to process data. For further information, see the Schedule and data file format section of the ERTLab user manual. These settings include:

Electrodes input/output format:

- **#elec_no_cable**: A flag indicating the presence of cable identifiers (1=present; -1=not present
- **#elec_cable_col**: Column identifier for the cable group (cable number)
- **#elec_id_col**: Column identifier for the electrode number
- **#elec_x_col**: Column identifier for the electrode X location
- **#elec_y_col**: Column identifier for the electrode Y location
- **#elec_z_col**: Column identifier for the electrode Z location
- **#elec_elev_col**: Column identifier for the electrode Z terrain elevation
- **#elec_type_col**: Column identifier for the type of electrode

Data input/output format

- **#data_id_col:** Column identifier for the quadrupole number
- **#data_a_cable_col:** Column identifier for the TX+ (A) electrode cable number
- **#data_a_elec_col:** Column identifier for the TX+ (A) electrode id number
- **#data_b_cable_col:** Column identifier for the TX- (B) electrode cable number
- **#data_b_elec_col:** Column identifier for the TX- (B) electrode id number
- **#data_m_cable_col:** Column identifier for the RX+ (M) electrode cable number
- **#data_m_elec_col:** Column identifier for the RX+ (M) electrode id number
- **#data_n_cable_col:** Column identifier for the RX- (N) electrode cable number
- **#data_n_elec_col:** Column identifier for the RX- (N) electrode id number

```
!ERTLab Header Info
Electrodes input/output format
#elec_no_cable= 1
#elec_cable_col= 1
#elec_id_col= 2
#elec_x_col= 3
#elec_y_col= 4
#elec_z_col= 5
#elec_elev_col= -1
#elec_type_col= -1
!Data input/output format
#data_id_col= 1
#data_a_cable_col= 2
#data_a_elec_col= 3
#data_b_cable_col= 4
#data_b_elec_col= 5
#data_m_cable_col= 6
#data_m_elec_col= 7
#data_n_cable_col= 8
#data_n_elec_col= 9
#data_res_col= 010
#data_ip_wind_col= 014
#data_std_res_col= 011
#data_std_ip_col= 015
#data_appres= 1
#data_ip_scale= 1000
#data_i_curr_col= 017
!End ERTLab Header Info

!-------------------------------------------------!
```

Figure B.7. Example of the ERTLab Header Info section of the data file

- **#data_res_col**: Column identifier for field data resistance (V/I)
- **#data_ip_wind_col:** Column identifier for field data IP
- **#data_std_res_col**: Column identifier for field data resistance standard deviation
- **#data_std_ip_col**: Column identifier for field data IP standard deviation
- **#data_calc_res_col:** Column identifier for calculated resistance (V/I)
- **#data_calc_ip_col:** Column identifier for calculated IP
- **#data_calc_std_res_col:** Column identifier for calculated V/I standard **deviation**
- **#data_calc_std_ip_col:** Column identifier for calculated IP standard **deviation**
- **#data_appres:** Flag for data in terms of resistance V/I (1) or apparent resistivity (2)
- **#data_ip_scale:** Scale factor for IP data
- **#data_i_curr_col:**

B.3.4 Data Section

The final section of the data file includes the data and their headings. The headings are:

- **ID**: The individual datum I.D. number
- **A** (CA EL): Transmitting Electrode A
- **B** (CA EL): Transmitting Electrode B
- **M** (CA EL): Receiving Electrode M
- **N** (CA EL): Receiving Electrode N
- **V/I** (Ohms): Resistance given in ohms.
- **Std** (Ohms):
- **Amp** (V): Amplitude given in volts
- **Std** (Volts):
- **IP Window 01** (mV/V):
- **Std** (mV/V):
- **SP** (mV): Self Potential given in millivolts
- **Current** (ma):
- **ContactR** (Ohms): The contact resistance given in ohms
- **Date and Time**: The date and time given by the year, month, date and time (after the underscore) in hours and minutes.
- **Channel**:
- **Gains**:
- **Tx_V:**

```
!Begin Data Section!
#data_start
! ID      A      B      M      N        V/I,      Std.     Amp.,     Std. IP Window 01,   Std.      SP      Current     ContactR  Date_And_Time    Gains     Tx_V
! num   Ca El  Ca El  Ca El  Ca El     (Ohms)    (Ohms)   (Volts)  (Volts)     (mV/V)    (mV/V)    (mV)      (ma)        (Ohms)
000001 001,01 001,03 001,05 001,07 -55.4870800 +0.000000 -0.356704 +0.000000 +0.003139 -0.000002 +1.716010 +6.42860000 +3931.000 20100520_105823 CH 01 GN 2   20
000002 001,01 001,03 001,06 001,08 -31.9164300 -0.000038 -0.205178 -0.000000 -0.023101 -0.000014 +1.767610 +6.42860000 +3931.000 20100520_105823 CH 02 GN 2   20
000003 001,01 001,03 001,07 001,09 -19.8915000 +0.005063 -0.127874 +0.000032 +0.018220 -0.000017 +1.796750 +6.42860000 +3931.000 20100520_105823 CH 03 GN 2   20
000004 001,01 001,03 001,08 001,10 -13.1315800 +0.000000 -0.084417 +0.000000 -0.001776 -0.000004 +1.943670 +6.42860000 +3931.000 20100520_105823 CH 04 GN 3   20
000005 001,01 001,03 001,09 001,11 -9.03267900 +0.000000 -0.058067 +0.000000 -0.002410 -0.000019 +1.883850 +6.42860000 +3931.000 20100520_105823 CH 05 GN 3   20
000006 001,01 001,03 001,10 001,12 -6.38343300 +0.000000 -0.041036 +0.000000 +0.026805 -0.000031 +1.766940 +6.42860000 +3931.000 20100520_105823 CH 06 GN 3   20
000007 001,01 001,03 001,11 001,13 -4.57314500 +0.000000 -0.029398 +0.000000 +0.051022 -0.000068 +1.777880 +6.42860000 +3931.000 20100520_105823 CH 07 GN 3   20
000008 001,01 001,03 004,09 004,11 -16.9703000 -0.000018 -0.109095 -0.000000 +0.038681 -0.000021 +1.803600 +6.42860000 +3931.000 20100520_105824 CH 08 GN 2   20
000009 001,01 001,03 004,10 004,12 -25.8352400 +0.000000 -0.166176 +0.000000 +0.039536 -0.000013 +1.700550 +6.43216000 +3640.000 20100520_105825 CH 01 GN 2   20
000010 001,01 001,03 004,11 004,13 -41.4263300 -0.000077 -0.266460 -0.000000 +0.007993 -0.000006 +1.746030 +6.43216000 +3640.000 20100520_105825 CH 02 GN 2   20

…

#data_end
Run Complete
```

Figure B.8. Example of the data section of the data file

Appendix C: Optional DAS-1 32-pin Mil Spec Connector System

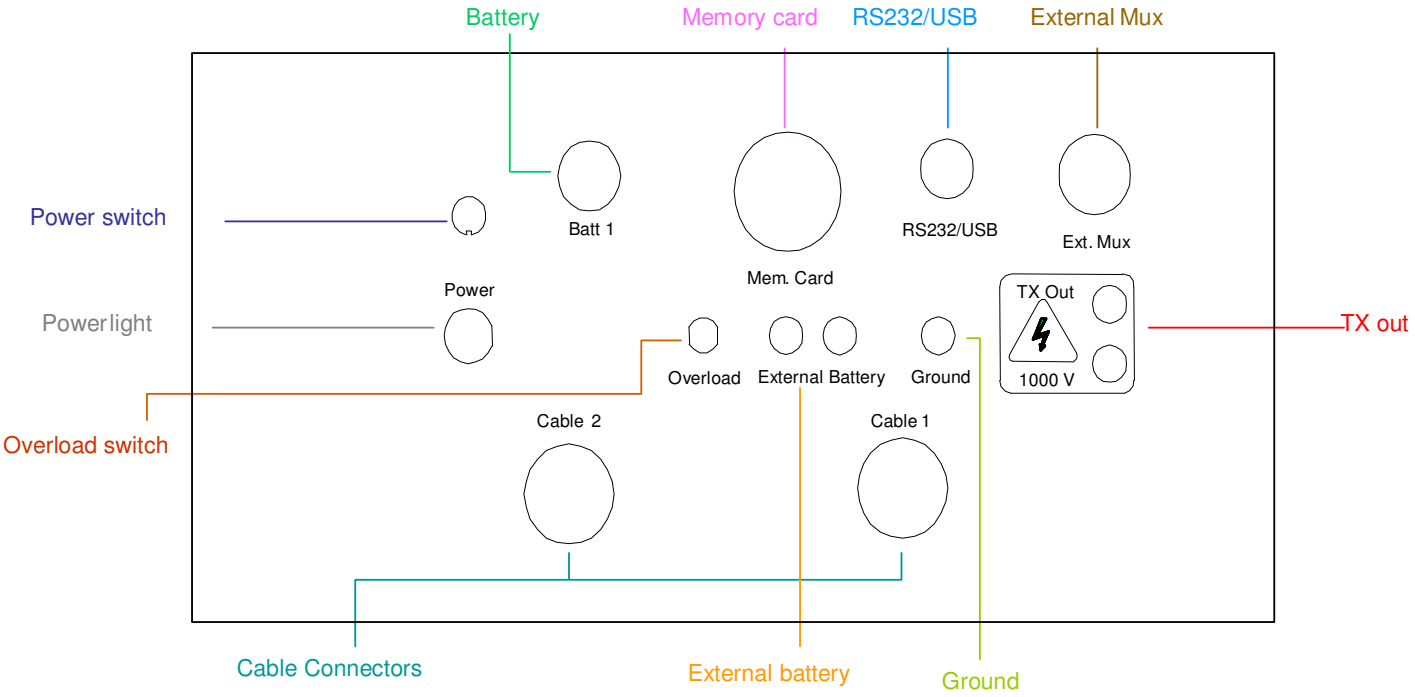
The DAS-1 ERT System can also be configured with two (2) 32-pin Mil Spec connectors. Multiplexers with 32-pin connectors are also available.

Connectors and Associated Cables

The following is a description of the receptacles for each connection on the DAS-1 receiver:

- Batt 1 – 5-pin Mil Spec: system internal power source:
  - Mil Spec connector to banana plugs for external power supply
  - Mil Spec connector to battery charger
- RS232/USB – 6-pin Mil Spec: to PC
  - Mil Spec connector to serial port connector
  - Mil Spec connector to USB connector
- Ground – Green banana plug (no cable included)
- External Battery - Black & red banana plug sockets: External power source for System Transmitter
  - Banana plugs to alligator clips for external 12V battery
  - Banana plugs to banana plugs for external 13.8V power source
- Cable 1 / 2 – 32-pin Mil Spec: to ERT cables or converter box
- Ext Mux - 24-pin Mil Spec: to additional multiplexer
  - Mil Spec to Mil Spec connector
- TX Out – Blue & yellow banana plug sockets: to additional multiplexer
  - Banana plugs to banana plugs

DAS-1 Main unit with optional 32-pin connectors


Battery
Memory card
RS232/USB
External Mux
Power switch
Batt 1
Mem. Card
RS232/USB
Ext. Mux
Power
Powerlight
TX Out
1000 V
TX out
Overload
External Battery
Ground
Overload switch
Cable 2
Cable 1
Cable Connectors
External battery
Ground

Appendix D: Troubleshooting Guide for the DAS-1

I cannot run Tx voltage on the DAS-1 higher than 20 V when my command file should be running at 100 V.

1) The DAS-1 tries to run at an optimum level; the environment in which you are running may cause the voltage to run lower than what you have programmed.
2) Similarly, you may have a bad connection between the electrodes and the DAS-1, check to see if your electrodes are properly connected. If you cannot physically check the electrodes, run a continuity check (**Check electrodes**) on either the DAS-1 console or on the PC connected to the DAS-1.
3) You may have an issue with the DAS-1 itself. As you run your command file, make note of the current, the Tx_V, and the Tx values.
4) If the Tx values are high, there may be a problem with the optical relay. Contact Multi-Phase Technologies and ask for further assistance.

I am unable to run a command file from the DAS-1. It says Tx Battery Low: Data Run Suspended.

1) Ensure that the DAS-1 is running on an external battery and not on the internal battery. On the DAS-1 console, select the **SYSTM** menu and set the **USE Int. Batt.** to FALSE.
2) If you have an optional internal battery, check to make sure that the battery is charged.
3) Check to make sure that the Tx Battery port is connected to an external battery or power supply and that the connections to the battery/power supply are secure.
4) If using an external 12 V battery, ensure that it has a voltage greater than 11 V.
5) There may be an issue with the command file that you created. Check to see what the value is for the line `#XBtVmn`. This value is set at a default of 11.000. You can change this value to as low as 10.000; however, do not set this any lower as this may affect data collection.

I am unable to run a command file from the DAS-1. It says TX Battery Low: Data Run Suspended and I ran the same command file from the PC with no issues.

1) Ensure that the DAS-1 is running on an external battery and not on the internal battery. On the DAS-1 console, select the **SYSTM** menu and set the **USE Int. Batt.** to FALSE.
2) If you have an optional internal battery, check to make sure that the battery is charged.
3) Check to make sure that the Tx Battery port is connected to an external battery or power supply and that the connections to the battery/power supply are secure.
4) If using an external 12 V battery, ensure that it has a voltage greater than 11 V.
5) There may be an issue with the command file that you created. Check to see what the value is for the line `#XBtVmn`. This value is set at a default of 11.000. You can change this value to as low as 10.000; however, do not set this any lower as this may affect data collection.

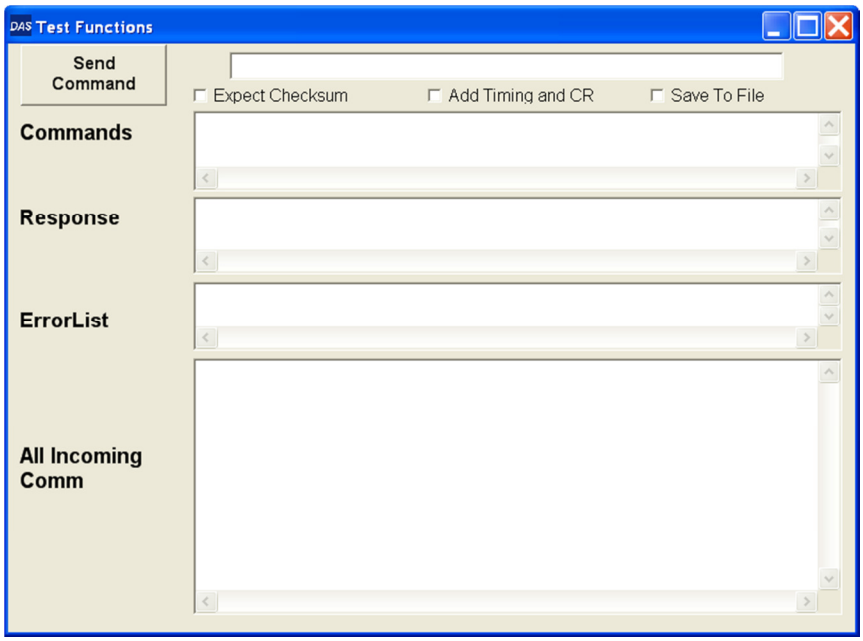
6) There may be an issue with the command file when it was uploaded to the DAS-1. Try uploading again from the PC to the DAS-1 to see if the issue has been resolved.

I cannot see the DAS-1 display clearly in direct sunlight.

1) On the DAS-1 console increase the contrast by pressing **Contrast Up** until the letters on the console are clearly visible.

I still cannot resolve a problem on the DAS-1. What can I do?

1) You can try running test functions from your PC. Commands can be sent using the Test Functions menu of the DAS Acquisition application. The Test Functions menu can be used to send simple commands and monitor the responses. These functions can be used to perform simple diagnosis on the system.
2) To use the **Test Functions** menu, enter the command into the textbox at the top of the form and press the **SEND Command** button. Note that the application will add the ">", checksum, and {cr} to the command (details below). The complete command is shown in the second text box and response on the following text box. If the system fails to respond within the timeout period (the default is 1.5 seconds and is set in the communications menu) then an error message will appear in the third text box. The lowest textbox shows any data sent from the DAS system regardless of whether a command has been sent.



The following are some common interface commands and are discussed in more detail below.

1) AP0 - turns off the power to the transmitter, internal mux and receivers.
    a. Normal response is AaP0
2) AP2 - turn on the power to the transmitter, internal mux and receivers.
    a. Normal response is AaP2
3) R0A - send acknowledgement to current monitor
    a. Normal response is R0aA
4) R1A – R8A send acknowledgement to receiver channel 1 – 8
    a. Normal responses are R1aA – R8aA
5) TA - send acknowledge to the transmitter card
    a. Normal response is TaA
6) M00A send an acknowledge to the internal multiplexer (DAS-1)
    a. M00a
7) M01A send an acknowledge to multiplexer address 1 (MUX)
    a. M01a

Explanation of Test Functions

Command Basics

The DAS-1 communicates with the PC using a simple 8 bit ASCII based command structure. Most commands have the structure of >DAaCYYYYZZ{cr} where

> is the ASCII character **,

D is the device type A-interface board, T-transmitter, M-multiplexer, and R receivers;

A is a 0 (interface and transmitter), 1 (receivers) or 2 (multiplexers) byte length address;

C is a single ASCII letter command;

YYYY are hexadecimal data bytes as needed by the command;

ZZ is an 8 bit (0 to 255) checksum in hexadecimal characters created by adding the bits of all the characters except for the “>”, checksum and carriage return; and

{cr} is the carriage return that terminates the command.

Most commands response as >DAaCYYYYZZ{cr} where

> is the ASCII character 62,

D is the device type A-interface board, T-transmitter, M-multiplexer, and R receivers;

a is the acknowledge character which is **a** for most commands, **d** for data commands, **c** for checksum errors, or **e** for other types of errors;

Users can monitor the communications between the DAS and the PC by leaving this menu open during a data run, however this process can slow down data acquisition.

Important Test Commands

Some important interface commands are:

1) AA send an acknowledgement to interface card. The normal response is Aa
2) AP0 turn the power off to the transmitter, internal mux and receivers

3) AP1 power up the receivers and multiplexer but not the transmitter
4) AP2 turn on the power to the transmitter, internal mux and receivers
5) AP3 use internal transmitter battery
6) AP4 use external transmitter battery
7) AP5 power mux off
8) AP6 power mux on
9) AB reboot the interface
10) AV return the interface card firmware version number
11) AF put the interface into diagnostic mode. Issue the command a second time to exit diagnostic mode.

To communicate with the other devices, turn on the system power using an AP2 command. However, note that leaving the system power will increase the drain on the internal battery!

Some important transmitter commands are:
1) TA send acknowledge to the transmitter card
2) TV return the firmware version number of the transmitter unit,
3) TB reboot the transmitter

Note that there are a total of nine receiving channels in the unit, 0 is the current monitor and units 1 through 8 measure external voltages. Some example commands are:
1) R1A send acknowledge to receiver channel 1
2) R0B reboot the current monitor
3) R7V return the firmware version for receiver channel 7

The internal multiplexer in the DAS main unit is always designated as address 0. To communicate with this multiplexer you must issue either an AP2 or AP5 command to enable the power. However, you can communicate to any external multiplexer without sending a power command. Some example commands are:
1) M00A send an acknowledge to the internal multiplexer
2) M01B reboot multiplexer address 1
3) M02C reset all switches in multiplexer 2 to their default (off) positions
4) M00C000A0B01020304 set the switches in the internal multiplexer for:
   A – Pin 10
   B – Pin 11
   M1– Pin 1 (Receiver Channel 1)
   N1– Pin 2 (Receiver Channel 1)
   M2 – Pin 3 (Receiver Channel 2)
   N2 – Pin 4 (Receiver Channel 2)
5) M03NMUX02 this command resets the address of a multiplexer. In this case the multiplexer with address 03 will be reset to address 02. After resetting the address of the multiplexer, use the M**A command to test that the address is reset. **THIS COMMAND SHOULD BE USED WITH CAUTION**! First, if two multiplexers are connected to the system at the same time and have the same address, communication to these multiplexers will produce erratic results. You must disconnect one of the multiplexers to correct this problem. Second, you must know the existing address of a multiplexer to communicate

with it. If you are unsure of the address of a multiplexer then: you will have to disable the internal multiplexer by cycling the system power or using the AP5 or AP0 command. Then query the multiplexer addresses one at a time. If you must proceed through all 256 addresses, this could take a long time. Third, do not reset the internal (address 0) multiplexer. If you accidently reset this multiplexer: issue the command M**NDAS00 where ** is the current (incorrect) address of the internal multiplexer.

Running the test functions has still not solved the problem, what is the next step?

1) Try running a trace file from the PC. Users can monitor the communications between the DAS and the PC by leaving the Test Function menu open during a data run and the results can be saved in a series of files by selecting the **Save to File** control and choosing an appropriate file name. This trace file must be sent to MPT for further analysis.
2) The steps to running the trace file:
    a. Open the DasAcquisition program.
    b. Click on the button; **Test Functions** (this will open a new window)
    c. At the top, check the box **Save To File** (this will open another window, keep the default name as TestFile.txt). Save the file to the desktop if possible.
    d. Keep the **Test Functions** window and DasAcquisition main menu open; conduct a test run from the DAS-1 console. The test run may be significantly slower than usual, this is normal.
    After the test run, three files will be created; TestFileCMD.Txt, TestFileERR.Txt and TestFileINC.Txt

3) Send these files along with the .Data file that you created to MPT.