

Close Interval Potential Surveys (CIPS or CIS) using
MCM's Integrated Pipeline Survey Test Equipment
and Database Management Package

CIS Training Manual – G1 Version



M. C. Miller Co., Inc.
11640 U.S. Highway 1, Sebastian, FL 32958
Telephone: 772 794 9448; Website: www.mcmiller.com

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SECTION I: INTRODUCTION AND BACKGROUND

I. 1 Introduction

This manual is designed to provide individuals who will be performing “Close Interval Potential Surveys” (CIPS or CIS) with a practical knowledge of how to select appropriate test equipment, how to set up and properly connect the test apparatus, how to actually perform close interval potential surveys, and, ultimately, how to transfer (upload) stored survey data from data-loggers to a database management system, after performing such surveys. The equipment and software described here comprise MCM’s Integrated Pipeline Survey Test Equipment and Database Management Package.

I. 2 Background on the ECDA methodology and the role of CIS

By way of background, the National Association of Corrosion Engineers (NACE), under a directive from the U.S. Government, recently developed a methodology for assessing and reducing the impact of external corrosion on the integrity of onshore buried pipelines (primarily ferrous pipelines). The methodology is termed an External Corrosion Direct Assessment (ECDA). ECDA is a continuous improvement process designed to not only identify areas where external corrosion is underway, but to also predict potential future corrosion areas, which will assist greatly in future corrosion prevention.

The ECDA methodology is a 4 step process and each step must be performed to fully-satisfy the **integrated** requirements of an ECDA evaluation. The 4 major steps in the process are summarized below:

Step 1: Pre-Assessment.

This step requires the integration of historical, construction, operations and maintenance records for each ECDA Region.

Step 2: Indirect Inspection.

The objective of this step is to estimate areas of active corrosion by performing above-the-ground measurements.

The results obtained in Step 2 are compared with the information compiled in Step 1 and areas that need to receive “Direct Examination” are identified.

Step 3: Direct Examination.

The objective of this step is to excavate (dig) at least in those areas identified using the complementary steps above (steps 1 and 2) and, by direct inspection, to measure the extent of corrosion in those areas. Typically, wall thickness is measured and other corrosion-related data are collected in this step.

Step 4: Post-Assessment

The objective of this step is to prioritize the repair schedule and to decide on the mitigation approaches to be used based on the results obtained in Step 3. The period of time before the next integrity evaluation is to be undertaken is also decided in this step for each ECDA Region.

The subject of this Training Manual is a measurement process that is applied in Step 2 of the ECDA evaluation process, ie, in the “Indirect Inspection” Step. The measurement process is known as a **close interval potential survey** (CIPS or CIS), the details of which are discussed below.

I. 3 CIS Overview

With regard to “**Indirect Inspection**” of a buried pipeline, one major technique that is employed is a **close interval potential survey** (CIS), which involves performing above-the-ground measurements of pipe-to-soil potential (voltage) along the entire length of the pipeline. In a CIS, it is critical that measurements be made in a highly consistent fashion (from individual technician to individual technician) and data (pipe-to-soil potentials) be recorded and analyzed in a consistent fashion in order that such data can be considered an integral part of an ECDA evaluation.

Close interval potential surveys are performed in order to obtain a continuous potential profile along the pipeline.

In the Cathodic Protection industry, it is well known that pipe-to-soil potential (voltage) measurements at test stations, which are typically spaced a considerable distance apart, are **insufficient** to judge the overall condition of a pipeline and to judge whether or not there is complete protection. As a result, close interval potential surveys involving the measurement of potentials at short intervals along the entire length of a pipeline have become the industry standard. In fact, with regard to the ECDA protocol, pipe-to-soil potential readings are typically recorded at 2.5 feet intervals between test stations. (Test stations are insulated electrodes that are in permanent electrical contact with the pipeline and that can be contacted above ground.)

I. 4 Key Components of a CIS Measurement System

The diagram below (Figure 1) illustrates the essential components of a close interval potential survey measurement apparatus.

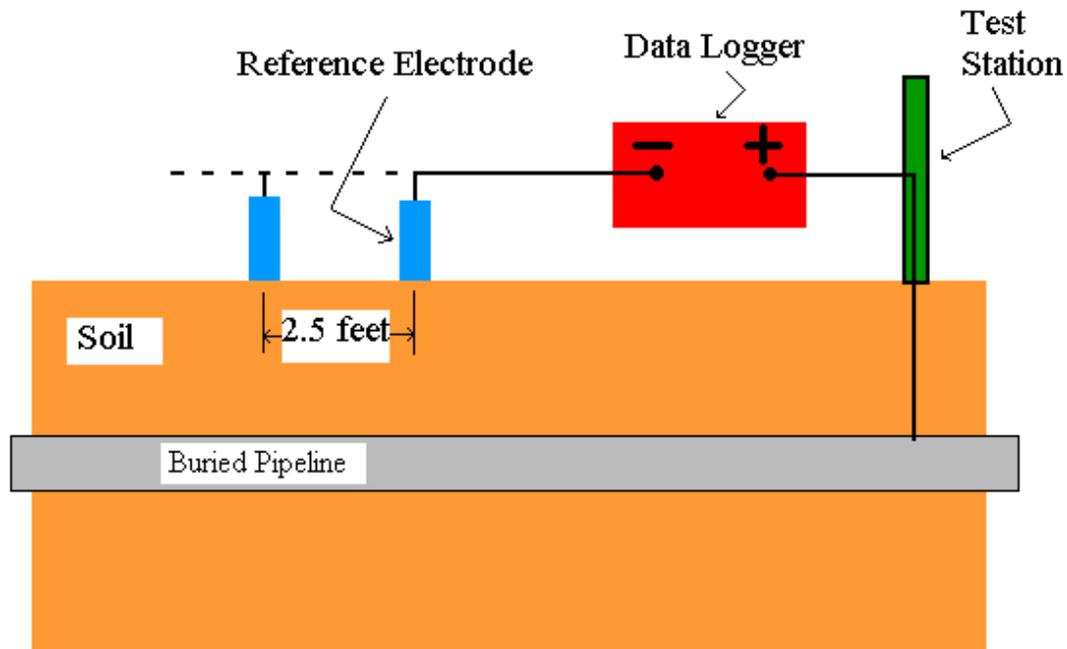


Figure 1: Key Components of a CIS Test Equipment System

The key components of the CIS apparatus are the **reference electrode**, connecting the negative terminal of the data logger to the soil, and the **data logger**, the positive terminal of which is connected to the test station (and therefore to the pipe). The Data Logger is a sophisticated digital voltmeter/data storage unit. Consequently, with this apparatus, the potential difference (voltage difference) between the pipe and the soil (at the reference electrode location) can be measured and this data point (voltage at a specific location along the length of the pipe with respect to the reference electrode) can be stored for processing by means of the digital voltmeter/data storage unit (data logger). Similarly, data (of pipe-to-soil potential with respect to the reference electrode) can be recorded at intervals of, typically, 2.5 to 5.0 feet along the length of the pipeline.

The ultimate goal of a CIS is to identify locations (if any) along the length of a buried pipeline that are not registering a sufficient potential difference between pipe and soil, which would be indicative of locations that might be experiencing external corrosion. As discussed below in Section II, there is an industry standard (0.85 Volts or 850mV) which is applied in the Cathodic Protection industry and which represents the minimum potential difference (voltage) recorded between the pipe and the soil (with respect to a particular reference electrode (see below in Section II)), that signifies sufficient cathodic protection. Since, on a pipeline that is under cathodic protection (CP) (impressed current CP), the pipe is held at **negative** potential due to an electron current flowing to (and in) the pipe, the minimum potential difference between pipe and soil would be -0.85 Volts. Any more-positive (less-negative) voltages, for example, -0.7 Volts, would suggest insufficient cathodic protection and would indicate a location where external corrosion might be taking place. Actually, a potential difference of greater than -0.85 Volts (for example, -0.95 Volts or higher) will be required to be in the “safe” area with regard to a pipeline being fully cathodically protected under **current flow** conditions, particularly if the amount of current flowing in the soil to the pipe is large. This situation would result in a significant, so-called, IR drop (voltage drop) due to the electron current flow which must be **added** to the minimum 0.85 Volt potential difference to ensure sufficient cathodic protection. As is discussed in Section III, it is possible to determine the magnitude of this IR drop voltage during the performance of a CIS by conducting the CIS measurements in the “High-Low”, or current-interrupted, mode, where the pipe-to-soil potential is sampled as the current is switched ON and OFF in a

cyclic fashion (see Section III). The critical pipe-to-soil potential (with regard to ensuring sufficient cathodic protection) would be the potential measured during the current OFF part of the cycle, since in this case the IR drop would be eliminated.

In any case, once a critical pipe-to-soil potential difference has been established for sufficient cathodic protection of a particular pipeline (taking the IR drop into account), a CIS can be performed to monitor the condition of the pipe, by comparing the pipeline potential profile recorded with the ideal case scenario, which would be a **uniform** (constant) potential along the length of the pipe.

The following two sections, Sections II and III, describe the set up procedures and operation of the reference electrodes and data-loggers employed in MCM's Integrated CIS Test Equipment Package.

SECTION II: MCM's REFERENCE ELECTRODE FOR CIS

II. 1 Background

As illustrated in Figure 1 in the above section (Section I), the reference electrode makes physical contact with the ground (soil) and is connected electrically to the negative terminal of the data logger (digital voltmeter/data storage unit). Since the reference electrode is an integral part of the electrical circuit that is allowing the data logger to measure the potential difference between the pipe and the soil, the reference electrode must make good and consistent electrical contact with the soil at each measurement point during a CIS.

The industry standard reference electrode for pipe-to-soil measurements is the copper-copper sulphate half-cell or, as it's more commonly referred to as, the copper sulphate reference electrode. A schematic illustration of an MCM copper sulphate reference electrode is shown in Figure 2. Also shown in the figure is the reference electrode attached to a push-button cane assembly for use in CIS measurements (see Section III. 2, step 6).

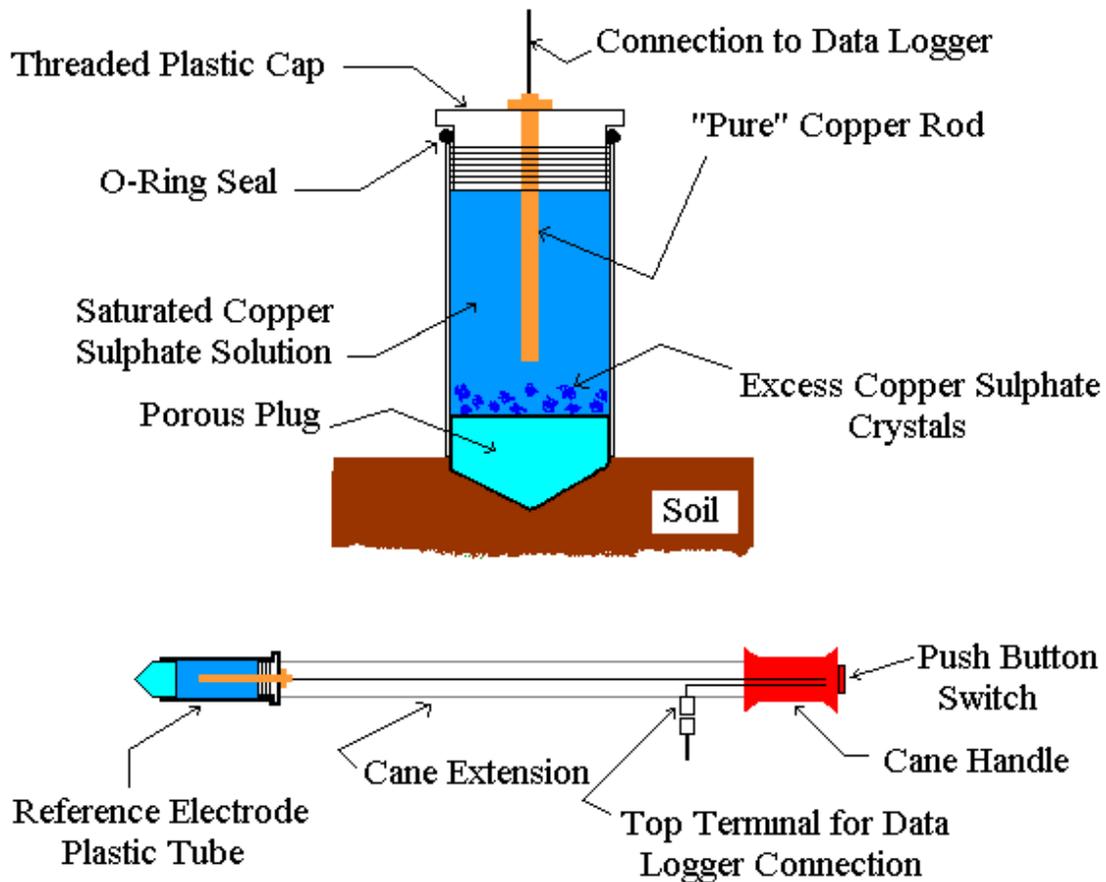


Figure 2: MCM's Reference Electrode for Pipeline Surveys

As can be seen in Figure 2, the reference electrode consists of a pure copper rod that is immersed in a saturated copper sulphate solution within the body of the electrode. The copper rod connects electrically to the negative terminal of the data logger. During operation, the porous plug is saturated with the copper sulphate solution and it is the solution-saturated plug that makes actual electrical contact with the soil (not the copper rod itself).

It should be noted that the copper/saturated copper sulphate solution combination within the body of the electrode, is actually a half-cell with a built-in half-cell potential (voltage).

Consequently, when the data logger is connected between the reference electrode and the pipe, as shown in Figure 1 (Section I), the observed voltage reading is actually a combination of two voltages, the copper-copper sulphate half-cell voltage (a constant voltage) and the pipe-to-soil voltage (variable, depending on corrosion conditions).

Therefore, if it can be assumed that the reference electrode half-cell voltage is fixed (a constant value), any variation in the voltage measurements recorded during a CIS can be assumed to be due to variations in pipe-to-soil potential and, therefore, due to the external corrosive condition of the pipe in the various measurement areas. The industry standard voltage value of -0.85 Volts discussed in Section I. 3, which represents a minimum pipe-to-soil potential difference for adequate protection against corrosion, is actually a combination (sum) of the reference electrode half-cell voltage and the pipe-to-soil voltage.

Consequently, since so much emphasis is placed on this critical voltage value, it is imperative that the reference electrode be set up, operated and maintained appropriately so that its half-cell voltage value will, in fact, be fixed.

II. 2 How to Prepare Reference Electrode for Use

The reference electrode will arrive from M.C. Miller Co., Inc. (MCM) assembled, but without liquid in the plastic tube. There will, however, be a concentration of blue copper sulphate crystals inside of the transparent plastic tube. To prepare the reference electrode for use, the transparent plastic tube should be unscrewed from the threaded cap/copper rod assembly (by turning the plastic tube counter-clockwise with respect to the threaded cap/copper rod assembly) and the tube (with the copper sulphate crystals at the bottom) should be filled up to about ½ inch from the bottom of the threads with distilled water (or MCM's Electrode Anti-Freeze solution). The plastic tube should then be screwed back on to the threaded cap/copper rod assembly and tightened firmly (do not over-torque) to effectively seal the tube via the compressed O-ring. At this point, the electrode assembly should be shaken a few times to make sure that a saturated solution of copper sulphate is formed inside the tube. Remember that the half-cell is

established, as discussed in (Section II. 1), between the copper rod and a saturated copper sulphate solution. Once the tube is shaken, the liquid will be blue in color and there should always be some excess copper sulphate crystals remaining out of solution at the bottom of the tube. Before using the reference electrode for the first time, a period of at least 5 minutes should be allowed, after filling the tube and establishing the saturated solution, in order that the porous plug on the bottom of the electrode tube can become moist. The protective cap supplied with the electrode assembly should be kept on the porous plug end when the electrode is not being used.

For more details on the preparation and maintenance of copper sulphate reference electrodes, including important **safety precautions**, please visit the M. C. Miller Co., Inc. website at www.mcmiller.com. On the home page, click on “manuals, data sheets” and then click on “Electrodes – How to use and maintain copper sulphate electrodes”.

II. 3 How to Use Reference Electrode in CIS Measurements

In order to proceed with CIS measurements, remove the protective cap from the porous end of a properly set-up (prepared) MCM reference electrode [see Section II. 2 for preparation instructions].

Place the reference electrode (porous plug side down) on the ground over the pipe at the first measurement location (typically at a test station electrode). The porous plug of the reference electrode (suitably moist) should be in firm contact with moist soil.

This may require “digging in” where the earth’s surface is dry. If the soil is particularly dry, it may be necessary to moisten the soil around the electrode using fresh water to obtain good electrical contact.

The top terminal of the reference electrode is connected to the negative side of the data logger’s voltmeter and the positive side of the voltmeter is connected to the test station electrode (**Note: The specifics on cable hook-ups are provided in Section IV**).

For CIS work, the reference electrode plastic tube assembly is attached to an extension rod (commonly known as a cane) for upright handheld operation. The cane handle houses a push-button switch (for “triggering” voltage recordings and other “events”) and the terminal on the cane for electrical connection to the data logger is a 5-pin connector. As discussed in Section IV, the receiving terminal for the reference electrode on the data-logger is also a 5-pin connector. All electrical cables are provided for these connections in the MCM Integrated CIS Test Equipment Package. A schematic illustration of a reference electrode cane assembly is shown above in Figure 2.

If a **matched-pair** of reference electrodes (canes) is to be used (see Section II. 4), the top terminals of the two canes are connected to an MCM adapter (dual-probe adapter) and the adapter is connected (effectively) to the negative terminal of the voltmeter (see Section IV for cable hook-ups).

At this point, a voltage reading can be made using the data-logger, establishing the pipe-to-soil potential difference (with respect to the copper sulphate electrode) at the first measurement location. The operating procedures for the data-logger are described in Section III. All subsequent CIS measurements can be made in the same fashion by moving down the length of the pipeline between test stations and placing the reference electrode (or electrodes, if using a matched-pair) in good electrical contact with the soil at intervals of 2.5 feet.

II. 4 How to Use Matched-Pairs of Reference Electrodes (Canes)

In CIS measurements, it is convenient to use a pair of matched reference electrodes, rather than a single reference electrode. A pair of electrodes is referred to as either a set of “poles” or a set of “canes”. As is discussed in Section III, MCM’s data-loggers can be set up to accept readings (voltage readings) during the performance of a CIS from two reference electrodes (canes). In this case, the canes would be connected to the data-logger via the dual-probe adapter mentioned above.

Since each cane in the pair has a push-button switch located on the handle section on top of the cane, the individual performing the CIS can determine

which of the two canes (reference electrodes) is to be involved in a voltage recording at any given time. As discussed in Section III. 2, these push buttons can also be designated to have other functions, such as triggering a survey flag location or triggering a pause in the CIS.

When performing CIS measurements using a pair of canes, one of the canes is held in the operator's right hand (green-colored cane) while the second cane is held in the operator's left hand (red-colored cane). When, for example, the right-hand cane is placed in electrical contact with the soil above the pipe and the push-button switch is activated on the cane, the data-logger (see Section III. 2) will record the pipe-to-soil potential with respect to the right-hand cane (reference electrode). Similarly, when the left-hand cane is placed in electrical contact with the soil above the pipe and the push-button switch is activated on the cane, the data-logger will record the pipe-to-soil potential with respect to the left-hand cane (reference electrode), assuming that both canes have been set up to "read" voltages (see Section III. 2, Step 7).

There are several advantages to using a pair of canes (reference electrodes), rather than a single cane (a single reference electrode) for CIS. For example, both canes can be used to record pipe-to-soil voltages in an alternating fashion (one after the other) as the operator walks down the length of the pipeline. In this fashion, the operator can establish a rhythm, very much like a cross-country skier, contacting the soil above the pipe every 2.5 feet by "triggering" the left-hand cane, then the right-hand cane, then the left-hand cane etc., etc.

Also, one of the canes, for example, the left-hand cane could be used to register the location of survey flags, which are typically located every 100 feet down the length of a pipeline. With this arrangement, the right-hand cane would be used to record pipe-to soil voltages every 2.5 feet while the left-hand cane would register survey flags. This methodology has the advantage of periodic "checks" on the operator's location, with the data-logger's software being able to re-establish starting points every 100 feet (survey flag separation).

A critical requirement with regard to using reference electrode pairs is that the two electrodes (canes) be essentially identical. As discussed in Section II. 1, a copper/copper sulphate reference electrode is a half-cell with a built-in voltage and the half-cell is an integral part of the electrical circuit of Figure 1 (Section I). Consequently, if two reference electrodes (canes) are used to measure pipe-to-soil potential in an alternating fashion, their half-cell voltages need to be essentially identical if any measured pipe-to-soil potential differences are to be attributed to the corrosive condition of the pipe, rather than to any variation in the half-cell voltages of the two reference electrodes.

A pair of canes can be tested for compatibility in the following manner: The two electrodes can be placed end-to-end (with the moist porous plug ends in firm contact) and the voltage difference between them measured using a high-input-impedance voltmeter connected between their top terminals. If a voltage difference (difference in half-cell voltages) of less than 10mV is observed, the two reference electrodes (canes) are matched. The two reference electrodes could also be placed in a plastic container filled with distilled water and the voltage difference measured again between their top terminals. If this voltage is less than 10mV, the two reference electrodes are matched for use as a cane pair in CIS applications.

SECTION III: MCM's G1 DATA-LOGGER

III. 1 Introduction

MCM data-loggers are sophisticated high-input-impedance digital voltmeter/data storage units that are used in conjunction with the reference electrodes described above in Section II to perform CIS measurements. When properly connected with reference electrodes (as described in Section IV), a data-logger reads and records pipe-to-soil voltages (with respect to a reference electrode) at each of the measurement locations along the length of the pipeline (typically every 2.5 feet for CIS work).

The particular data-logger described here is the, so-called, Gatherer One (G1). This data-logger is a combination of a high-input-impedance digital voltmeter and a handheld Personal Computer (PC). The operating system of the PC is “Microsoft Pocket PC” and MCM has designed proprietary application software programs in order that the G1 can be employed to run both “Scripted” Site Surveys and Pipeline Surveys (such as CIS, DCVG and Surface Potential Surveys).

Your G1 data-logger will arrive from MCM with the Windows operating system and our survey application programs installed. The survey application programs will remain installed unless the main battery pack, and its backup, are allowed to fully-discharge, in which case the application programs will have to be re-installed (see your G1 Data-Logger User’s Manual). However, your survey data will always be safe, regardless of battery status, as this data is stored in a non-volatile memory.

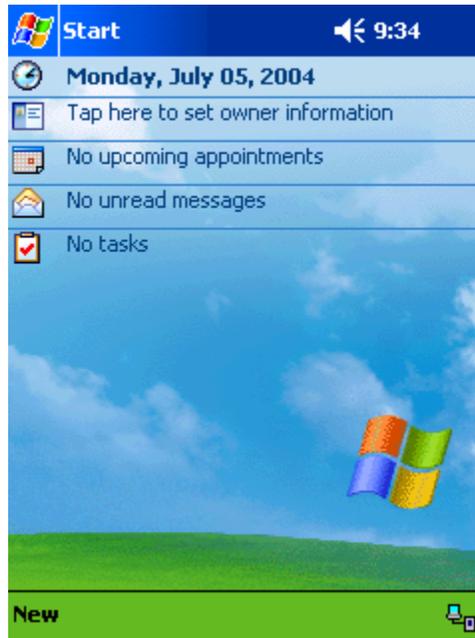
The particular application software program required to run Close Interval Survey (CIS) applications is called the **G1 PLS** (G1 Pipe Line Survey) program and the use of this program is described below in detail in Section III. 2.

III. 2 How to Set-Up the G1 Data-Logger for CIS Applications

The following section outlines the steps required in setting up the G1 data-logger to participate in CIS measurement applications. The set up process establishes the conditions of the particular survey about to be performed and identifies the section of pipeline that is about to be examined by the CIS application. The set up process (and this is very important) also establishes a file in which the voltage recordings (survey data) will be stored. At the completion of the survey, CIS data can then be retrieved by a PC that is in communication with the G1, by accessing the file in which the survey data is stored. The “uploading” process of transferring survey data to a PC following completion of a CIS is discussed in Section VI. The software program required to “upload” or transfer the CIS data to a PC is part of an MCM proprietary software package known as ProActive. As discussed in Section VI, the ProActive software package is a critical component of MCM’s Integrated CIS Test Equipment and Database Management Package.

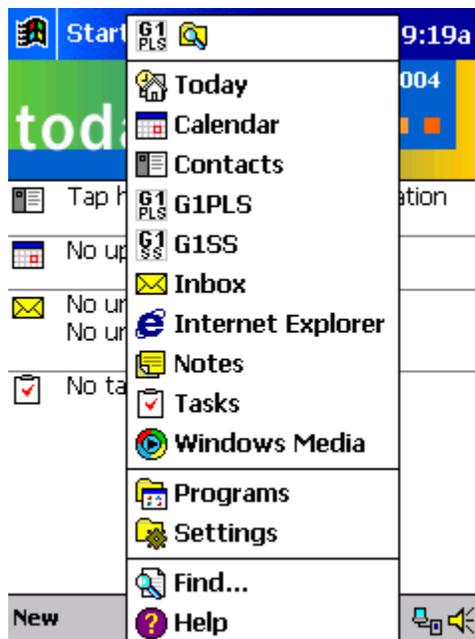
Step 1:

Switch on the G1 by pressing the power button (red key on keyboard). Assuming that the battery pack is charged (see Section II), the screen will light up and will display the “home” screen (“Today” screen).



Step 2:

Tap (using the special pen (stylus) provided with the G1) on the “Start” icon. This will open up the main menu window as shown below.



Step 3:

Tap on the G1 PLS icon in the main menu list which will pull up the “Survey” screen shown below.

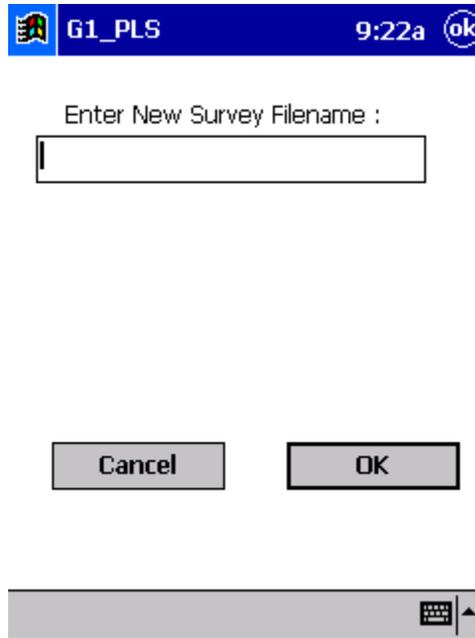
The screenshot shows the 'Survey' screen in the G1_PLS application. The header is blue with 'G1_PLS' on the left and '9:20a' on the right. The main interface consists of several buttons on the left and input fields on the right. The buttons are 'Flag', 'Undo Flag', 'GPS Data', 'Log GPS', 'Geo-Feat.', 'Device', and 'Read'. The input fields are for 'Station', 'Total Dist.', and 'Dist. From Flag'. Below these are fields for 'Geo-Feat.' (value: -0.500), 'Device', and 'Read' (value: 0.000). At the bottom, there is a menu bar with 'Survey Options Help' and several icons.

Step 4:

Tap on “Survey” in the menu bar along the bottom of the above screen. The screen shown below will appear.

The screenshot shows the 'Survey' screen in the G1_PLS application with a context menu open. The menu options are 'New Survey', 'Continue Previous Survey', 'Finish Survey', and 'Exit'. The background shows the same interface as the previous screenshot, but with the menu bar at the bottom showing 'Survey' selected.

Under “Survey” there are several options. If this is a new survey (not a continuation of a previous survey) tap on “New Survey”. The screen shown below will appear.



Step 6:

Enter a “filename” for the Survey.

Note: This is an important step as the filename is used to identify the survey and, also, recorded data (voltages) will be stored in this named file for future retrieval. It is highly recommended that a protocol be established for selecting Survey Filenames. Critical information should be included in the filename, such as pipeline company’s name, city or state in which the pipeline is located, pipeline number and section of pipeline number under survey. The protocol developed should be applied consistently for each survey.

For example, let’s assume that pipeline company XYZ has a pipeline located in Texas and that the pipeline is identified as pipeline 12 and a survey is being performed on section 085 of this pipeline. A good filename for this survey would be:

XYZ TX 12 085 CIS

When this data file is later accessed, with this filename we know the name of the pipeline owner, we know the state in which the pipeline is located, we know the pipeline number, we know the section number of the pipeline that was surveyed and we know that it was a CIS.

Note: You will not be permitted to use invalid characters, such as slashes(/ or \), as part of a filename. You will be alerted if you try to use any invalid characters.

Step 7:

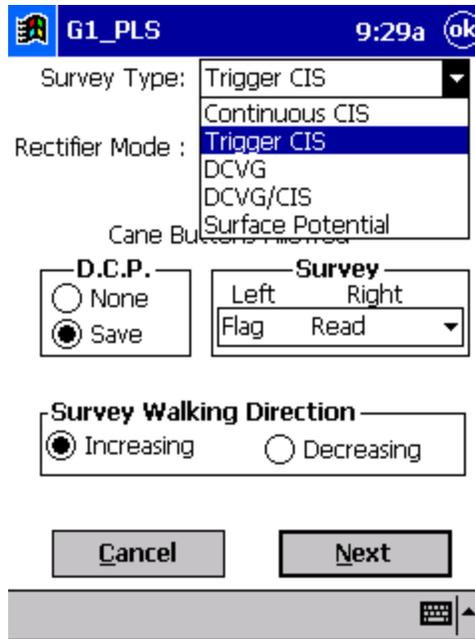
Tap once on the OK button. The screen shown below will appear.

The screenshot shows a mobile application interface with a blue header bar. The header bar contains a small icon on the left, the text "G1_PLS" in the center, and "9:41a" and an "OK" button on the right. Below the header bar, there are two dropdown menus: "Survey Type:" with "Trigger CIS" selected, and "Rectifier Mode:" with "Cycle ON/OFF" selected. Below these are two sections of radio buttons. The first section is titled "Cane Buttons Allowed" and has two sub-sections: "D.C.P." with "None" and "Save" (selected) options, and "Survey" with "Left", "Right", "Flag", and "Read" options. The second section is titled "Survey Walking Direction" and has "Increasing" (selected) and "Decreasing" options. At the bottom, there are two buttons: "Cancel" and "Next". A grey bar at the very bottom contains a small icon and a right-pointing arrow.

Step 8:

Select "Survey Type".

For CIS measurements there are 2 options for "type of survey": Trigger CIS and Continuous CIS. Other survey types are available, as can be seen by tapping on the pull-down list arrow in the "Survey Type" box as shown below.



DCVG and combined DCVG/CIS surveys are available for selection (as well as Surface Potential), however, for **CIS-Only** surveys, either Continuous CIS or Trigger CIS should be selected by tapping once on the selection.

In **Trigger CIS mode**, voltage recordings are “triggered” by the operator pressing on the push-button switch located on top of a reference electrode cane while making electrical contact with the soil above the pipe with the copper/copper sulphate half-cell end of the cane. Consequently, in this survey mode, the **operator is in control of the timing** of when voltage recordings are made as a CIS is conducted.

In contrast, with the **Continuous CIS** mode, the timing of when voltage recordings will be made is preset. For instance, if you select 1 second intervals, voltage recordings will be made every second. Consequently, the operator must synchronize his cane repositioning pace to match the preset voltage recording timing.

Step 9:

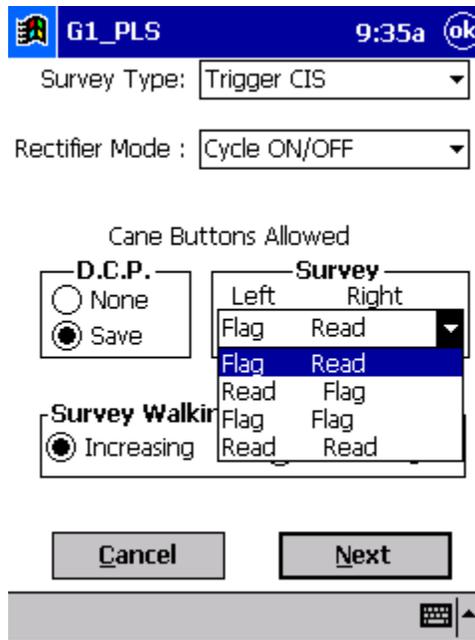
Select the function (operating mode) of the cane buttons associated with the two reference electrodes (canes) to be used in the CIS. Selections are made by tapping choices in the **D.C. P.** and **Survey** boxes shown in the above screen.

The function of the cane buttons during regular survey measurements is determined by the selection made in the “survey” box while the selection made in the “D.C.P.” box determines the function of the cane buttons when measurements are made at specially-identified locations (devices).

Cane Button Functions – During Regular Survey (Between “Devices”)

The functionality available for the cane buttons depends on the survey mode selected in Step 8 [Trigger mode or Continuous (automatic) mode].

If the **Trigger CIS mode** is selected, the screen will appear as shown below.

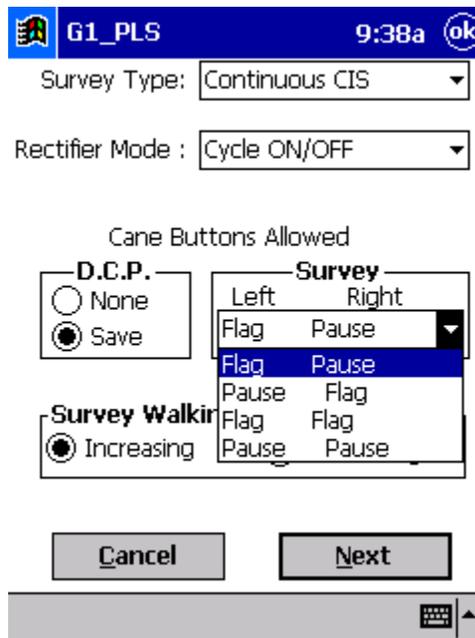


For the above screen, the pull-down-list arrow in the Survey box was tapped to reveal the 4 choices for the push buttons on the pair of canes to be used in the Trigger CIS (the left cane, held in the left hand with the left thumb operating the **left** cane button and the right cane, held in the right hand with the right thumb operating the **right** cane button) .

The left and right cane buttons can both be selected to **read** voltages (**read read**) meaning that as the operator walks down the pipeline alternately contacting the soil with the left and right canes, a voltage recording will be made when either cane is triggered. Alternatively, one of

the canes can be selected to **read** voltages while the other is selected to register the location of a survey **flag** (survey flags are typically located every 100 feet down the length of a pipeline). This would be the (**flag read**) or (**read flag**) choice. In this case, the push button on the cane selected to register flags would only be pressed at each survey flag location. Finally, the (flag flag) choice can be selected and, in this case, both canes would only be used to register survey flags. Pressing the push-button on the “read” designated cane or pressing the cane button on the “flag” designated cane has the same affect as tapping the read button (and saving the reading) or the flag button, respectively.

If **Continuous CIS mode** is selected, the screen will be as shown below.



The 4 choices for the set of two canes in the **Continuous CIS mode** are revealed in the Survey box by tapping on the pull-down-list arrow. The 4 choices are shown in the screen above. In this case, one of the cane buttons can be selected to effect a pause in the continuous (automatic every so many seconds as prescribed) voltage recordings while the other cane button is selected to register survey flag locations [(**flag pause**) or (**pause flag**)]. Alternatively, both cane buttons can be selected to register flags or to affect pauses. The **pause** cane would also act as the **start** or **restart** cane.

Cane Button Functions – At “Device” Locations

“Devices” are defined as specially-identifiable entities that exist along the length of the pipeline. Examples of “Devices” include, rectifiers, test stations, valves, etc.

For both CIS modes (Trigger and Continuous), a cane button function selection (selection will apply to both left and right canes) has to be made with regard to Data Collection Points (**see D.C.P. box in above screen**). A Data Collection Point is a “Device” location point.

In this case there are 2 choices: “**None**” and “**Save**”. Your selection is made by tapping in the circle beside your choice.

If “**None**” is selected: Pressing a cane button will do nothing. In this case, you would have to tap the “save” button on the screen, having previously tapped the “device” button, if you wished to read and record the voltage data at the “Device” location.

If “**Save**” is selected: Pressing a cane button has the same effect as tapping the save button on the “Device Readings” screen.

For the most part, selecting the “**Save**” choice will be preferable, since voltage recordings at special data collection points (such as rectifiers, test stations, valves, etc.) are important and should be saved as part of the overall CIS and a convenient way to do this is to use the push-button on one of the canes, having tapped on the “Device” button on the screen when a “Device” is encountered.

Step 10:

Make “**Survey Walking Direction**” selection

The “Survey Walking Direction” box is shown in the screen above. There are only 2 selection choices: Increasing and Decreasing.

This selection establishes the walking direction during the survey. If the survey is going to entail walking from a low-numbered test station to a higher-numbered test station, for example, select “Increasing” by tapping once on the circle beside “Increasing”. Select “Decreasing” if the opposite is true.

If the following selections have been made so far, the screen will appear as shown below:

Survey Type: Trigger CIS

Cane Buttons

Survey: Flag Read

D.C.P.: Save

Survey Walking Direction: Increasing

G1_PLS 9:41a ok

Survey Type: Trigger CIS

Rectifier Mode : Cycle ON/OFF

Cane Buttons Allowed

D.C.P. Survey

None Save

Left Right

Flag Read

Survey Walking Direction

Increasing Decreasing

Cancel Next

Tap the “Next” button on the above screen.

Step 11:

Make “**Rectifier Mode**” selection.

In the case where a pipeline is cathodically-protected via an impressed current (current flow to the pipe from a sacrificial anode driven by an external DC voltage source), the rectifier (DC voltage source) is typically always ON, so that the line is continuously protected. However, with current flowing in the soil to the pipe, the “pipe-to-soil” voltages being measured during a CIS will **include** any voltage drop (IR drop) occurring in the soil itself.

If a large amount of current is flowing in the soil and/or the soil has a high-resistivity, the magnitude of the voltage drop (IR drop) could be significant. Consequently, it is important to measure the actual pipe-to-soil potential (voltage) with no current flowing to (and along) the pipe, with a view to establishing that the pipe is at a sufficiently negative potential (at least -0.85 Volts with respect to copper sulphate reference electrodes). The problem is that the rectifiers (DC voltage sources) cannot be switched OFF for the duration of CIS measurements, since the pipeline would lose its cathodic protection while the CIS measurements were being performed.

The solution to this problem is to only “interrupt” the current flow for very short periods of time (typically less than a second) and to be able to record the pipe-to-soil voltages (with respect to the reference electrode) during the “current OFF” periods. If pipe-to-soil voltages are also recorded during the “current ON” periods, the magnitude of the IR drop can be determined, which would just be the difference between the “current ON” and current OFF” voltages.

In terms of CIS measurements, a convenient way to “sample” or “capture” “current ON” and “current OFF” pipe-to-soil voltages is to employ a “Current Interrupter” which is a DC current-switching device that is connected to a Rectifier. The Current Interrupter can be programmed to switch the rectifier current ON and OFF in a predetermined cyclic fashion. In this case, when a cane is in contact with the soil and the push button on the cane is pressed, in the process of a CIS, the G1 data-logger will record average High and Low voltages taken over at least one current ON/OFF cycle.

Such a “Current Interrupted” method is known as a **High/Low CIS mode**.

It should be noted that **all** rectifiers that might have an affect on a pipeline under survey (ie, might generate current in the line) need to simultaneously be switched ON and OFF in an identical cyclic fashion and, in addition, all current-interrupter waveforms (ON/OFF) cycles need to be synchronized with each other. In other words, all rectifiers need to be ON at the same time and for the same length of time, and all rectifiers need to OFF at the same time and for the same length of time. One way to accomplish such

synchronization, is to have GPS receivers integrated with current-interrupter switches and to employ a GPS satellite's timing system to control the current switching timing on all participating rectifiers simultaneously.

Such GPS Receiver/Current Interrupter Switches are available through MCM. This type of current-interrupted method is known as a **GPS Satellite-Synchronized High/Low CIS mode**.

Figure 3 shows an illustration of a CIS being performed using GPS satellite-synchronization of rectifier current-interrupter switches. Again, the ON/OFF current switching cycle would be synchronized for all rectifiers having an affect on the pipeline section being surveyed.

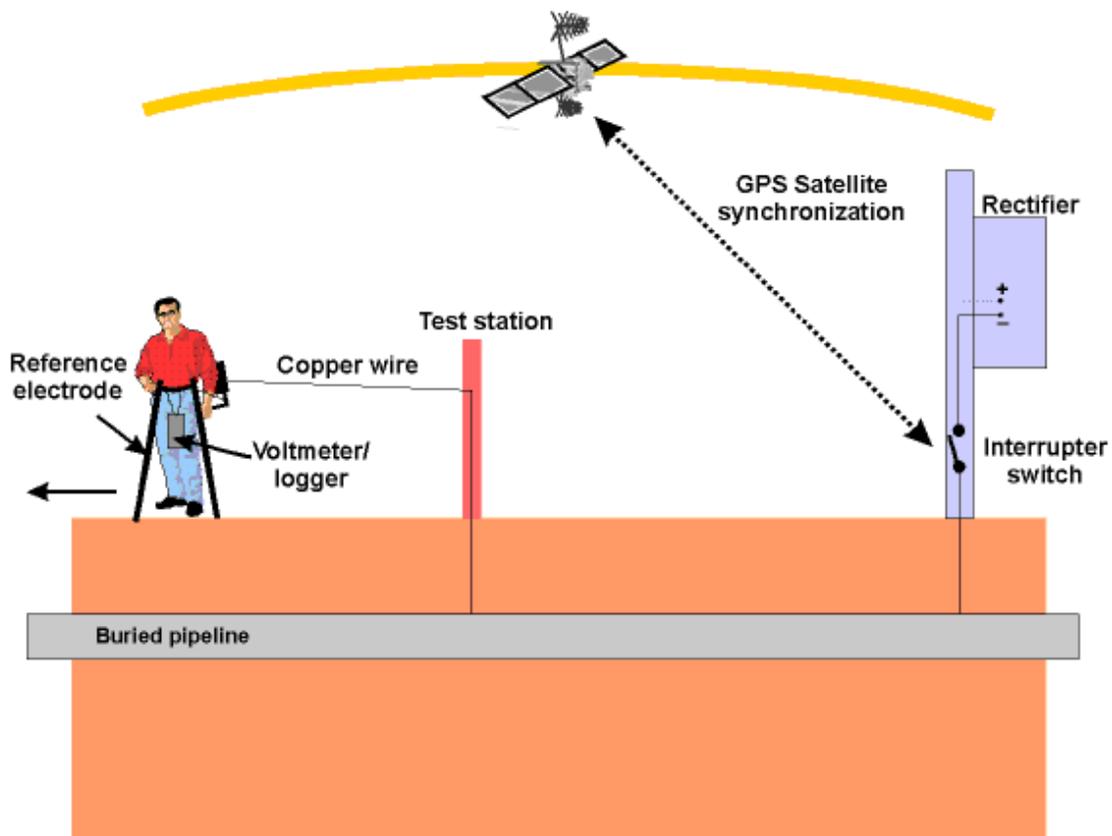


Figure 3: A GPS satellite-synchronized high/low CIS mode illustration

Of course, a CIS can be performed with rectifiers permanently ON (current permanently flowing to and along a pipeline during measurements) and this method is known as a **Non-Interrupted CIS mode**, since, in this case, the rectifier current is non-interrupted.

Finally, a CIS can be performed with rectifiers permanently OFF, which could be the case, for example, if a potential profile is desired of a **depolarized** pipeline, ie, a pipeline whose polarization potential has had a chance to fully dissipate. Under such conditions, however, the pipeline would **not** be cathodically-protected.

“Rectifier Mode” Selection:

By tapping on the pull-down list arrow in the “Rectifier Mode” box on the above screen, the screen shown below will appear.

The screenshot shows a mobile application interface with a blue header bar containing a logo, the text 'G1_PLS', the time '9:42a', and an 'ok' button. Below the header, there are several input fields and controls:

- Survey Type:** A dropdown menu currently showing 'Trigger CIS'.
- Rectifier Mode:** A dropdown menu with a pull-down arrow. The menu is open, showing three options: 'Cycle ON/OFF' (highlighted in blue), 'Always ON', and 'Always OFF'.
- Cane Bu:** A label next to the 'Always ON' and 'Always OFF' options.
- D.C.P.:** A section with two radio buttons: 'None' and 'Save' (which is selected).
- Survey:** A section with two columns: 'Left' and 'Right'. Below these columns is a dropdown menu with 'Flag' and 'Read' options.
- Survey Walking Direction:** A section with two radio buttons: 'Increasing' (selected) and 'Decreasing'.
- Buttons:** 'Cancel' and 'Next' buttons at the bottom.
- Footer:** A grey bar at the very bottom with a keyboard icon and an upward arrow.

As can be seen from the above screen, there are 3 choices for “Rectifier Mode”: **Cycle ON/OFF**, **Always ON** and **Always OFF**.

If **Always ON** is selected, it will be assumed that the rectifiers affecting the line will be permanently ON, which would be the case, for example, for a **non-interrupted CIS**.

If **Always OFF** is selected, it will be assumed that all rectifiers having an affect on the line will be permanently OFF (at least for the duration of the CIS).

If **Cycle ON/OFF** is selected, it will be assumed that all rectifiers having an affect on the line have current-interrupters installed and that their switching waveforms will be synchronized. This would be the case for a **High/Low CIS**.

Step 12:

Tap on the “**Next**” button following your selection of “Rectifier Mode”.

The screen shown below will appear.

The screenshot shows a configuration screen for a device named 'G1_PLS'. The top status bar displays the time as 9:55a and an 'ok' button. The main content area contains several settings:

- Max. Far/Near Diff: 5 %
- AC System: 60 Hz.
- Beep if below: 9999 V (9999 = Never Beep)
- GPS: MCM Interr, Com 4
- Differential GPS Required
- Use GPS for Altitude
- Log GPS at Flags
- Log GPS DCP/Feature

At the bottom of the screen, there are three buttons: 'Previous', 'Next', and 'Cancel'. A navigation bar is visible at the very bottom of the screen.

Step 13:

Make Selection of “Maximum Acceptable % Difference between Far and Near Ground Readings”.

When you are **reconnecting** the trailing wire from one test station to another test station further down the pipeline, the last voltage recorded prior to breaking the connection with the first test station should be recorded as a “Device” voltage. After tapping on the “Device” button on the survey screen and selecting “Reconnect”, follow the predetermined voltage

recording procedures for a “Reconnect”. The specific procedures for a given “Device”, such as a “Reconnect”, will have been set up (scripted) via the software. The voltage recorded prior to disconnecting the trailing wire will be considered the **FAR-Ground** reading, since you will be a considerable distance from the first test station. Once the reconnect has been made at the second test station, you will be prompted to make a new voltage recording. This new voltage recording will be considered the **Near-Ground** reading, since you are standing very NEAR to the second test station.

By tapping inside the box marked “Max. Far/Near Diff:”, the number indicated (in the above case the number shown is 5) can be changed to any % value desired by typing in the number.

If, for example, the number (5) is entered in this box, this means that the maximum allowable difference between FAR and NEAR voltage recordings has been set at 5%, otherwise an error window will be displayed on the screen. If the FAR and NEAR voltage recordings are within 5% (in this case) of each other, there will be no error message. If, on the other hand, the recordings differ by more than 5%, an error window will appear on the screen. The error window will indicate 2 options:

- Option 1: Retake Near Reading
- Option 2: Accept This Error

By selecting Option 1, you have the chance to make another recording at the second test station which would be compared to the stored FAR-Ground recording. If this voltage difference is <5% there will be no error message.

By selecting Option 2, you will be choosing to ignore the difference in the recordings and move on with the survey.

Step 14:

Set AC Frequency for Digital Voltmeter

By tapping on the pull-down-list arrow in the “AC System” box on screen shown above, you will have the choice of 60Hz or 50Hz AC. Select 60Hz for all U.S. applications (by tapping on “60Hz”).

Step 15:

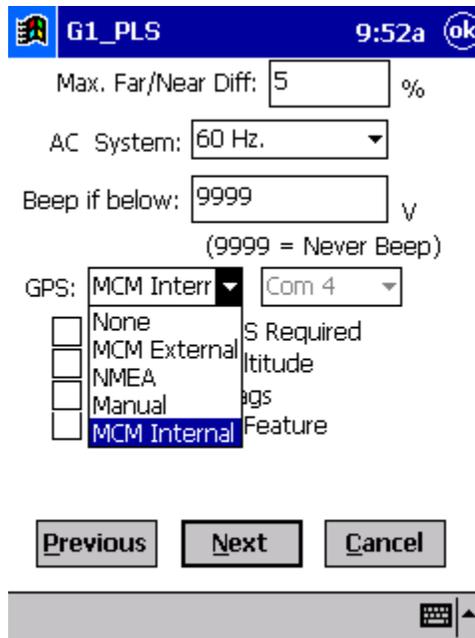
Select “Beeping” (or Alarm) Voltage:

By tapping on the “Beep if below” box on the above screen, a voltage value can be entered, for example -0.850. With this value entered, the G1 Meter will beep to alert you to the fact that a voltage reading lower than -0.850 Volts has been made. This would be a location that you might want to check again and mark if the lower reading persists.

Step 16:

Select the GPS Accessory Being Used (If Any).

By tapping on the pull-down-list arrow in the “GPS ” box on the above screen, the screen shown below will appear.



This selection pertains to the GPS receiver that you will be using in conjunction with your G1 data-logger. The GPS receiver can be called upon to record the precise location of “Flags”, “Devices” and “Geographical Features” that are encountered during a CIS.

As can be seen from the above screen, there are 5 choices for “GPS Type”:

- None: This means that a GPS receiver is not being used
- MCM External: This means that an external MCM GPS Accessory is being used

- NMEA: This means that an external NMEA 0183 compatible GPS receiver is being used
- Manual: This means that location data will be entered manually when the GPS button is tapped on the survey screen during a CIS
- MCM Internal: This means that the G1 Meter's internal GPS unit will be used (a Garmin (Model 15L) WAAS-enabled receiver)

Select the appropriate choice by tapping on your selection.

When using an external GPS unit, you need to select the Com Port that you'll be using on the G1 (see above screen). The connector terminal on the left-hand side of the data-logger (facing the bottom side) is the COM 1 Port and the terminal on the right-hand side is the COM 4 Port. It is recommended that you select the COM 4 Port for your external GPS unit in order to avoid potential conflicts with ActiveSync which uses COM 1.

Step 17:

Select GPS Options.

The screenshot shows the 'G1_PLS' application window with the following settings:

- Max. Far/Near Diff: 5 %
- AC System: 60 Hz.
- Beep if below: 9999 V (9999 = Never Beep)
- GPS: MCM Interr, Com 4
- Differential GPS Required
- Use GPS for Altitude
- Log GPS at Flags
- Log GPS DCP/Feature

Navigation buttons: Previous, Next, Cancel.

After selecting the GPS Receiver Type and the Com Port the receiver will be using, choices need to be made regarding GPS Options (see above screen).

If a GPS accessory has been selected for use with the G1 data-logger for a particular CIS, all, or some of the functions available can be enabled (box ticked). A box can be “ticked” or “unticked” by tapping inside the box.

The options available are as follows:

Differential GPS Required:

This box should be ticked if you only want **differentially-corrected** GPS signals to be logged by the data-logger. In this case, only GPS signals that include a correction message generated by a ground tower station situated at a precisely-known location will be logged. If this box is left unticked, it means that you will allow the G1 Meter to log either **standard** GPS signals or differentially-corrected GPS signals.

Use GPS Altitude:

If this box is ticked, altitude data will be included with the position data whenever GPS data is logged. (Note: Altitude data on some GPS units is not particularly accurate in CIS applications).

Log GPS at Flags:

If this box is ticked, GPS position data will be logged automatically at flags when either the flag button is tapped (directly on the Survey screen) or when the push-button on the designated “flag cane” is pressed.

Log GPS at DCP/Feature:

If this box is ticked, GPS position data will be logged automatically at “Devices” or “Geo-Features” when either the “Device” button is tapped on the Survey screen and a “Device” reading is logged or when the “Geo-Feat.” button is tapped on the Survey screen and a geo-feature is registered.

Step 18:

Tap on the “**Next**” button on the above screen

The specific screen that will appear will depend on if you selected “**Trigger CIS**” mode or “**Continuous CIS**” mode back at Step 8. If **Trigger CIS** mode was selected, for example, the screen shown below will appear.

G1_PLS 10:19a

Name of P/L:

Valve Segment:

Station #:

CIS Flag Read Count %: %

of Feet Per Reading: ft.

of Feet Between Flags: ft.

Number of Data Probes

One Two

Auto Pacing Mode

Previous Next Cancel

Step 19:

Select Voltage Reading Interval (Distance Between Recordings)

By tapping in the box on the above screen labeled, “# of Feet Per Reading” you can type in the voltage reading interval (distance, in feet, expected between recordings) for the CIS. Typically, in CIS work this expected interval distance is 2.5 feet or 5.0 feet.

Step 20:

Select Survey Flag Interval (Distance Between Survey Flags)

By tapping in the box labeled, “# of Feet Between Flags”, you can type in the survey flag interval (distance between survey flags) for the section of pipeline being measured. Typically, survey flags are located at 100 feet intervals.

Step 21:

Select the maximum permissible error between the **actual** number of recordings made between 2 survey flags and the **expected** number of recordings.

By tapping in the box labeled, “CIS Flag Read Count %” you can type in the maximum permissible error. For example, the maximum permissible error is indicated as 20% on the above screen. If the recording interval is expected to be 2.5 feet and the survey flag separation is 100 feet, that means that 40 recordings are **expected**. If, however, only 30 recordings are **actually** made between survey flags, an error window will appear on the screen, since there is a 25% difference between the expected and actual number of recordings made. No error window will appear if the difference is less than 20% for this example, ie, you could have a minimum of 32 recordings and a maximum of 48 recordings between survey flags to stay within the 20% (max.) error allowance.

Step 22:

Select whether or not you would like the recordings to be uniformly spaced between survey flags in cases where less than or greater than 40 recordings are taken.

By tapping in the box labeled, “Auto Pacing Mode”, and inserting a tick in the box, you will enable the data-logger to automatically adjust the actual recordings and space them evenly over a 100 feet span (distance between survey flags), regardless of the actual number of recordings made. This setting is recommended.

Step 23:

Select the number of reference electrodes (canes) that will be used in the CIS.

The number of reference electrodes (also known as data probes) that will be used in the CIS can be selected by tapping in either the “one” or “two” circle in the box labeled, “Number of Data Probes”.

Step 24:

Provide the Name of the Pipeline:

By tapping in the box labeled, “Name of P/L”, you can type in the pipeline name. Note: This is **not** the same as the filename for the CIS that was selected back in Step 4. **This is the actual name of the pipeline.**

Step 25:

Provide the Valve Segment Identification Number

By tapping in the box labeled “Valve Segment”, you can type in the valve segment name or number (if known).

Step 26:

Provide the Starting Station Number

By tapping in the box labeled “Starting Station”, you can type in the number of the starting station (if known). For example, if you are starting the survey at a location 1200 feet from the reference zero location (usually the beginning of the pipeline), you would type in 12+00.0

If you do not know the station number (distance from reference zero) where you’re beginning your survey, type 0+00.0

As an example, if you are working on pipeline ABC within valve segment 45 and you are about to begin a CIS at station number 12+00.0, your screen would be as shown below.

G1_PLS 10:23a ok

Name of P/L: Line ABC

Valve Segment: 45

Station #: 12+00.0

CIS Flag Read Count %: 20 %

of Feet Per Reading: 2.5 ft.

of Feet Between Flags: 100 ft.

Number of Data Probes

One Two

Auto Pacing Mode

Previous Next Cancel

Step 27:

Tap on the “Next” button on the above screen.

The screen shown below will appear.

The screenshot shows a mobile application window with a blue title bar containing a small icon, the text "G1_PLS", and the time "10:25a" next to an "ok" button. Below the title bar are several input fields: "Work Order #:" followed by an empty text box; "Technician Name:" followed by an empty text box; "Comments / Description:" followed by a larger empty text area with a vertical scrollbar on the right; "Survey Name:" followed by a text box containing the path "\Compact Flash\My Doc"; and "Start Date:" followed by a text box containing "6/23/2004 10:25:25". At the bottom of the form are three buttons: "Previous", "Next", and "Cancel". A grey bar at the very bottom of the screen contains a small icon and an upward-pointing arrow.

Step 28:

Provide the Work Order Number for the CIS

By tapping in the box labeled, “Work Order #”, you can type in the work order number for the CIS.

Step 29:

Provide Your Name

By tapping in the box labeled “Technician Name” you can type in your name. Or, you can type in the name of a supervisor and add your name in the “comments” section.

Step 30:

Provide Comments

By tapping in the box labeled, “Comments/Description”, you can enter any comments you might have regarding the survey (perhaps weather conditions, soil conditions etc.).

Also shown on the above screen are the Survey (File) Name (CompactFlash card file identification name) and the Start Date and Start Time of the survey.

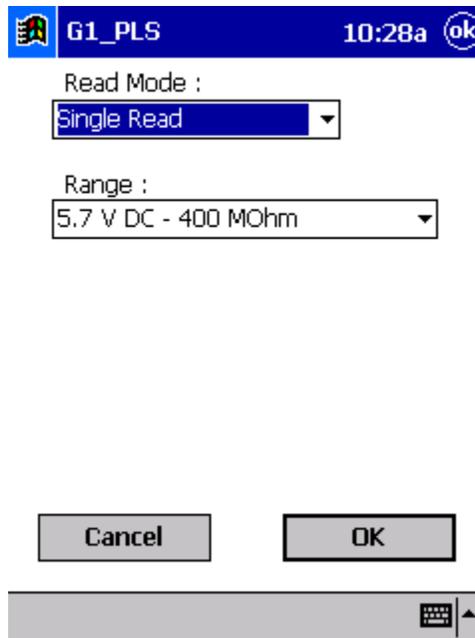
Note: Do not attempt to change the Survey (File) Name indicated here as this identification will be required by the ProActive software to upload your CIS data to your PC.

Step 31:

Make **Voltmeter Mode** Selection

Tap on the “**Next**” button on the above screen.

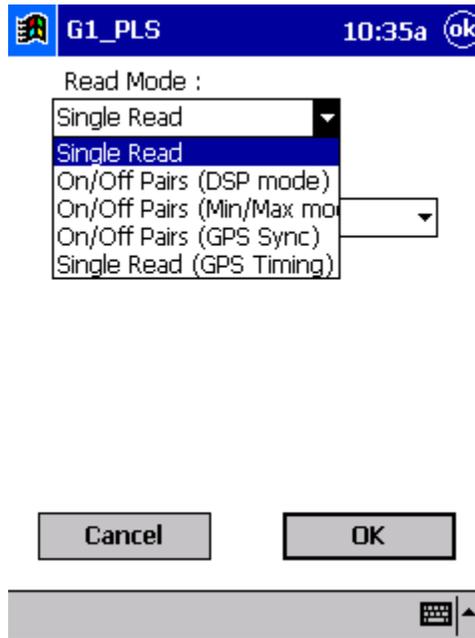
The screen shown below will appear.



The above screen is used to establish the mode in which the digital voltmeter will be operating during the CIS measurements. Remember, the data being logged by the data-logger are actually voltages that are measured by a voltmeter.

Also, the recommended settings for the voltmeter for CIS are 5.7 Volts (full-scale) and an input impedance value of 400MOhm, These settings provide a relatively-fast response time (~80 ms), which is important in rectifier-current-interrupted applications.

The 5 choices available for the voltmeter's reading mode are observed by tapping on the pull-down-list arrow in the "Read Mode" box on the above screen. The new screen will appear as shown below.



The 5 choices for voltmeter mode are as follows:

Note: Selection of voltmeter mode should be made with reference to your selection of "Rectifier Mode" back at Step 11 and GPS Accessory selection back at Step16

Single Read:

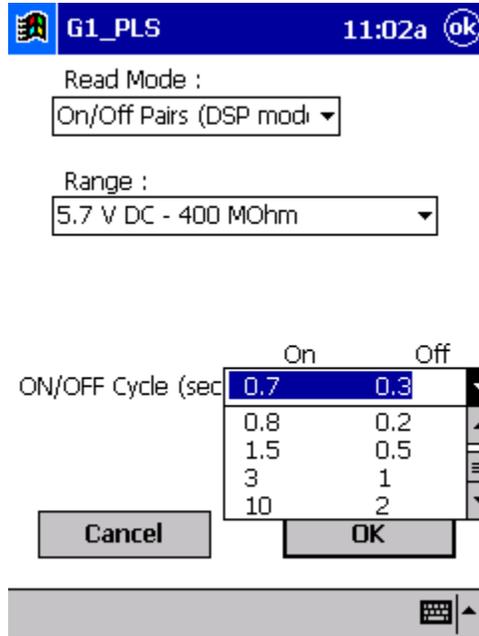
This voltmeter mode would be selected if you were performing a

non-interrupted CIS, with either the rectifiers ON continuously [Always ON] or OFF continuously [depolarized pipeline].

On/Off Pairs (DSP mode):

This voltmeter mode would be selected if you were performing a **High/Low CIS** (current-interrupted CIS). In this mode, the voltmeter uses digital signal processing to determine the voltage during the ON portion of the rectifier-current cycle and the voltage during the OFF portion of the current cycle. For these measurements to be successful, the data probe (reference electrode cane) must remain in good electrical contact with the soil for at least one rectifier-current cycle. A measurable difference between the High and the Low voltage readings is required for this mode, ie, a measurable IR drop is required.

With this voltmeter reading mode selected, after tapping on the “OK” button, the screen shown below will appear.



You are being asked here to select the particular rectifier-current-interrupter cycle that will be employed during your CIS. As can be seen from the above screen, 5 industry-standard cycles are available for selection.

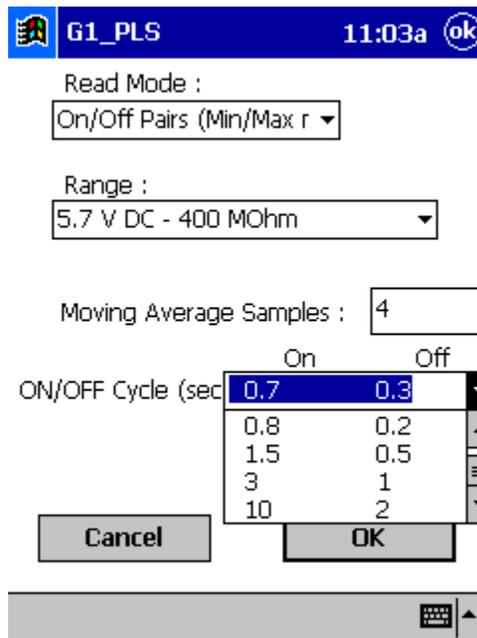
- 0.7 0.3 Means current is ON for 0.7 sec. and OFF for 0.3 sec.
- 0.8 0.2 Means current is ON for 0.8 sec. and OFF for 0.2 sec.
- 1.5 0.5 Means current is ON for 1.5 sec. and OFF for 0.5 sec.
- 3.0 1.0 Means current is ON for 3.0 sec. and OFF for 1.0 sec.
- 10 2.0 Means current is ON for 10 sec. and OFF for 2.0 sec

There are actually 10 choices, since, if the Off>On box is ticked, the above waveforms would be reversed. For example, the 0.7/0.3 waveform would become: Current OFF for 0.7 sec. and ON for 0.3 sec.

On/Off Pairs (Min/Max mode):

This voltmeter mode would be selected if you were performing a High/Low CIS but the data-logger was having trouble distinguishing between the High and the Low voltage readings. This would be the case, for example, if the IR drop was very small (remember that the difference between High and Low voltage readings in a current-interrupted CIS is just the magnitude of the IR drop). In this case, the voltmeter would record the maximum and minimum voltages read during each rectifier-current cycle.

With this voltmeter reading mode selected, after tapping on the “OK” button, the screen shown below will appear.

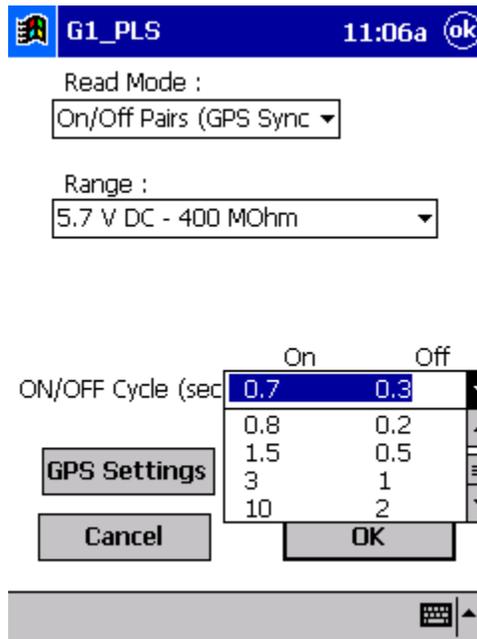


Again, you would make your selection of ON and OFF cycle times. In this case, you would also provide a number for the “Moving Average Samples”. In the above case, since the number 4 has been entered, 4 sample readings would be used to compute an average value for the Minimum (Min) voltage reading during each OFF portion of the cyclic waveform and, also, 4 sample readings would be used to compute an average value for the Maximum (Max) voltage reading during each ON portion of the waveform.

On/Off Pairs (GPS Sync):

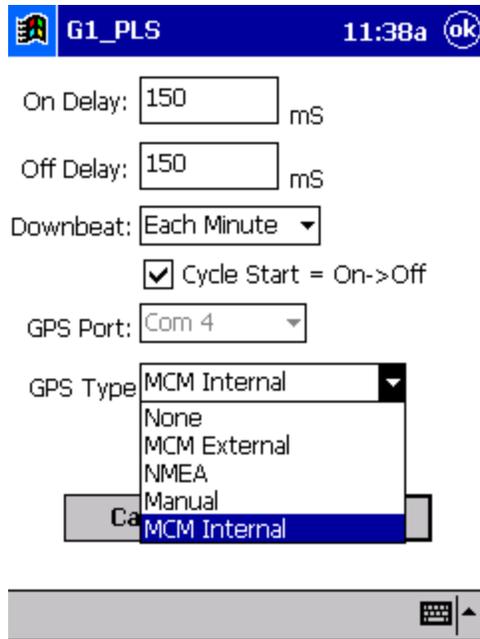
This voltmeter mode can only be selected if you are using either the MCM Internal GPS unit or the MCM External GPS unit on your G1 AND current-interrupter switches equipped with GPS units are being employed on your rectifiers. In these cases, with this setting, voltage readings (High/Low readings) are synchronized with the current-interrupter switching timing.

With this voltmeter reading mode selected, after tapping on the OK button, the screen shown below will appear.



Again, you would make your selection of ON and OFF cycle times.

Also, in this case, you would tap on the “GPS Settings” button, which would bring up the screen shown below.



You are being asked here to make several selections.

First, select the type of GPS unit you will be using (currently, only the MCM External and the MCM Internal GPS units can be used in the “GPS Sync” voltage reading mode).

Next, enter your “On Delay” and your “Off Delay” selections by tapping on the appropriate box and typing in the requested delay time in milliseconds. These delay times are employed so that any spiking in the voltage waveform that might occur as the rectifier-current is switched from ON to OFF and from OFF to ON does not become a factor in the voltmeter’s determination of the “true” ON and OFF voltage values for each CIS measurement. For example, if 150 ms was selected for the “Off Delay”, the data logger would record the voltage value sampled 150 ms after the rectifier-current was switched from the ON to the OFF state. Also, if 150 ms was selected for the “On Delay” the data logger would record the voltage value sampled 150 ms after the rectifier-current was switched from the OFF to the ON state.

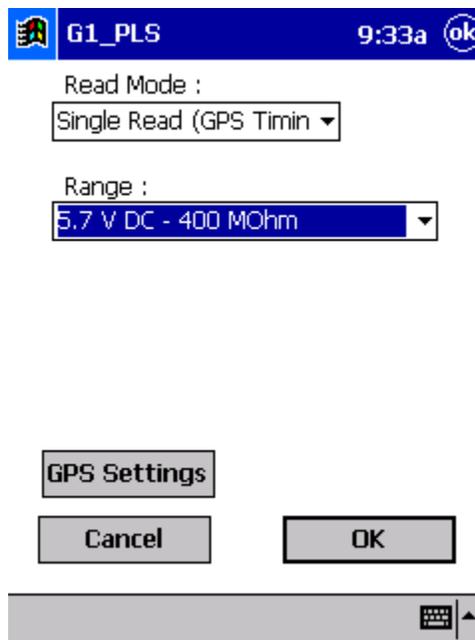
Finally, select your rectifier’s “Downbeat” timing. As indicated by tapping on the pull-down-list arrow in the “Downbeat” box, there are 3 selection choices; Each Minute, Each Hour and Midnight. If “Each Minute” is an option for your rectifier, we suggest making this selection. Also, if your

rectifier cycle starts with the current in the ON state (the first transition is from ON to OFF), place a tick in the “Start Cycle” box (remove the tick if the opposite is true).

Single Read (GPS Timing):

This voltmeter mode is similar to the “Single Read” mode except that in this case the data logger uses the GPS timing signal to associate voltage recordings with the actual time they were made.

With this voltmeter reading mode selected, after tapping on the “OK” button, the screen shown below will appear.



The only addition information that needs to be supplied here is the type of GPS unit you will be using (MCM internal or MCM external units ONLY), which you can select by tapping on the “GPS Settings” button and highlighting the appropriate type of GPS unit.

Step 32:

Pull Up “Active” Survey Screen.

Tap once on the **OK** button on the Voltmeter Read Mode screen (or the GPS Settings” screen, if the GPS timing signal will be involved in the timing of voltage recordings), which will pull up the Survey screen shown below.



As voltages are recorded by the data-logger (by either tapping on the “Read button on the Survey screen or by pressing the appropriate cane push button, the “Total Distance” (total distance from the start of the survey) parameter will increase in increments of 2.5 feet, or whatever the “feet per reading” value was that was entered back at Step 19.

Also, the “Distance From Flag” parameter will increase in the same increments as voltages are recorded. The difference in this case, however, will be that when each survey flag is registered, this distance parameter will begin again at zero. In other words, this will show the distance you are assumed by the data-logger to have traveled from the last flag that you encountered (and registered).

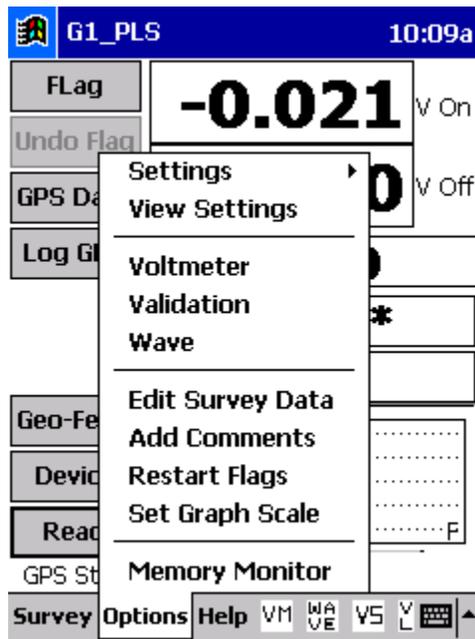
You are now ready to perform a close interval survey using the G1 data-logger.

III. 3 How to Make Changes to Your Set-Up Selections

Once you've set up the G1 data-logger for a particular pipeline survey, as described above in Section III. 2, you can make changes to your set-up selections with the exception of your "Survey Type" selection and the currently indicated "Station Number". If you have selected a Trigger Mode CIS, for example, you cannot change to a Continuous Mode CIS, without setting up a new survey.

You can, however, make other selection changes. For example, if you examine the pipe-to-soil voltage waveform prior to beginning a survey (highly recommended) and discover that the IR drop magnitude is quite small, or there is considerable noise on the waveform, you might decide to switch the voltmeter reading mode from On/Off Pairs (DSP mode) to On/Off Pairs (Min/Max mode) (see Step 31 above.). Or, in another case, you might decide to change the "feet between readings" interval from 2.5 feet to 5.0 feet, for example.

To make survey set up selection changes, tap on "**Options**" at the bottom of the screen. The screen will appear as shown below.



To make any (allowed) changes, tap on “**Settings**” on the above menu, tap on “**Change Global Settings**” and proceed to make any desired changes.

To simply view your set up selections, you can tap on “**View Settings**” on the above menu (after tapping on “Options”).

SECTION IV: TEST EQUIPMENT HOOK-UPS FOR CIS

IV. 1 How to make Cable Hook-Ups for CIS Measurements

The connections for CIS applications employing MCM test equipment are illustrated below in Figure 4.

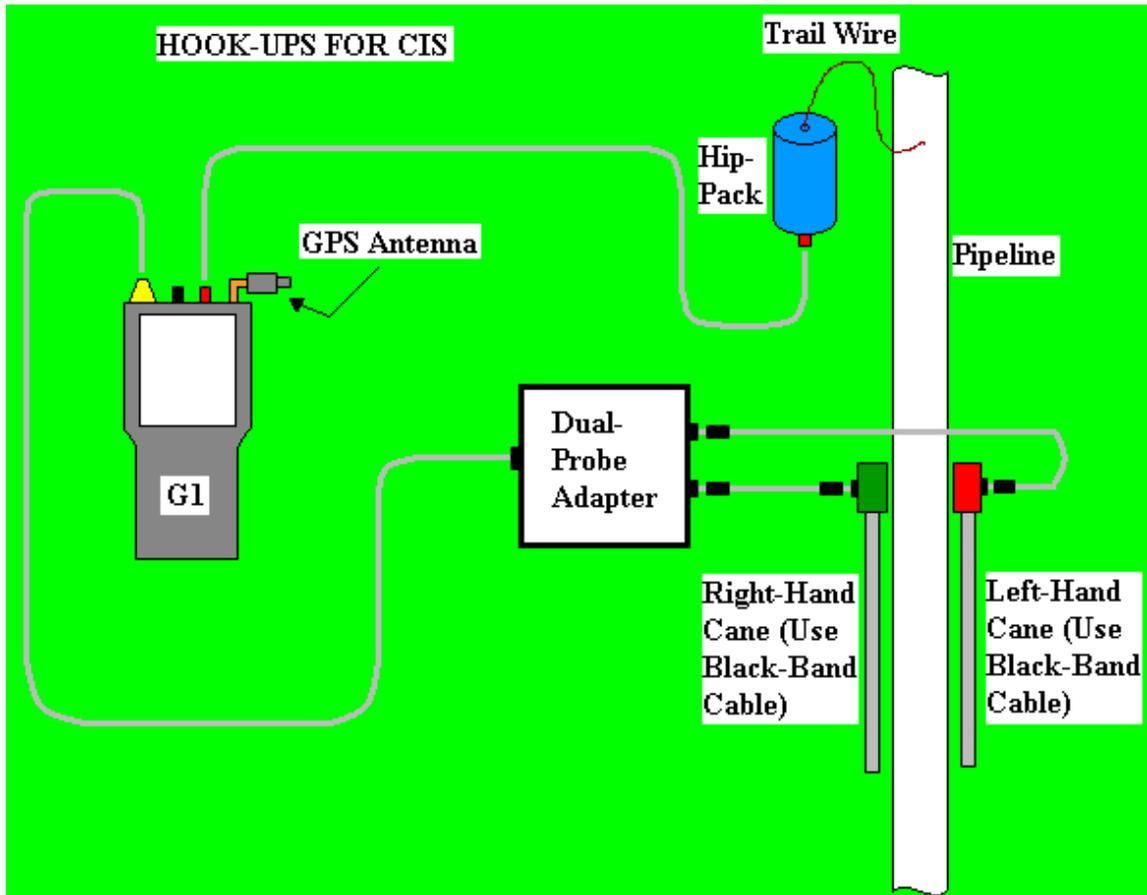


Figure 4: Cable Connections for Hook-Up of MCM's CIS Test Equipment

As can be seen from Figure 4, a pair of canes (reference electrodes – see Section II. 4) is illustrated, the left-hand cane (red cane) and the right-hand cane (green cane). These canes, which will be placed on the soil above the pipeline in an alternating fashion, have push buttons on top of the handles so that the operator can “trigger” voltage recordings on his command at each of the CIS measurement locations as well as at “Devices”. See Section III. 2 for a discussion on cane button functionality (Step 9 of the Set Up Process).

The canes (data probes) are connected as shown to the “input” terminals of the dual-probe adapter and the “output” terminal of the adapter is connected to a 5-pin Data Probe Connector socket on the top side of the G1 data-logger. This effectively connects the canes (reference electrodes) to the **negative side** of the data logger’s voltmeter. For CIS, the cables connecting the data probes to the dual-probe adapter are both “**black band**” cables.

In order that the data-logger will record “pipe-to-soil” voltages when the canes are triggered, the pipe under survey needs to be connected to the **positive side** of the data logger’s voltmeter. This electrical connection is made by hooking a cable from the **red** banana plug terminal on the top side of the G1 to a banana plug terminal on the underside of a Hip Pack containing a spool of trail wire (insulated copper wire). The trail wire coming out of the topside of the Hip Pack is then connected to a Test Station Electrode (which in turn is connected electrically to the pipe).

The GPS Antenna illustrated on the top side of the G1 in Figure 4 represents the antenna employed by the data-logger’s internal GPS receiver. External GPS receiver units, if employed, would be connected to the data-logger via one of the two USB COM terminals located on the bottom side of the G1. The right-hand-side COM Port (COM 4) is recommended. With either the internal unit or an external unit, the location of items such as flags, devices and geo-features can be recorded during the performance of a CIS, either manually by tapping on the “Log GPS” button on the survey screen at each critical location or automatically by pre-programming the data-logger as described above in Section III. 2 (Step 17).

IV. 2 How to Attach Cables and Accessories to the G1 Data-Logger

The terminals on the top side of the G1 data-logger for the various connections described above are illustrated below in Figure 5.

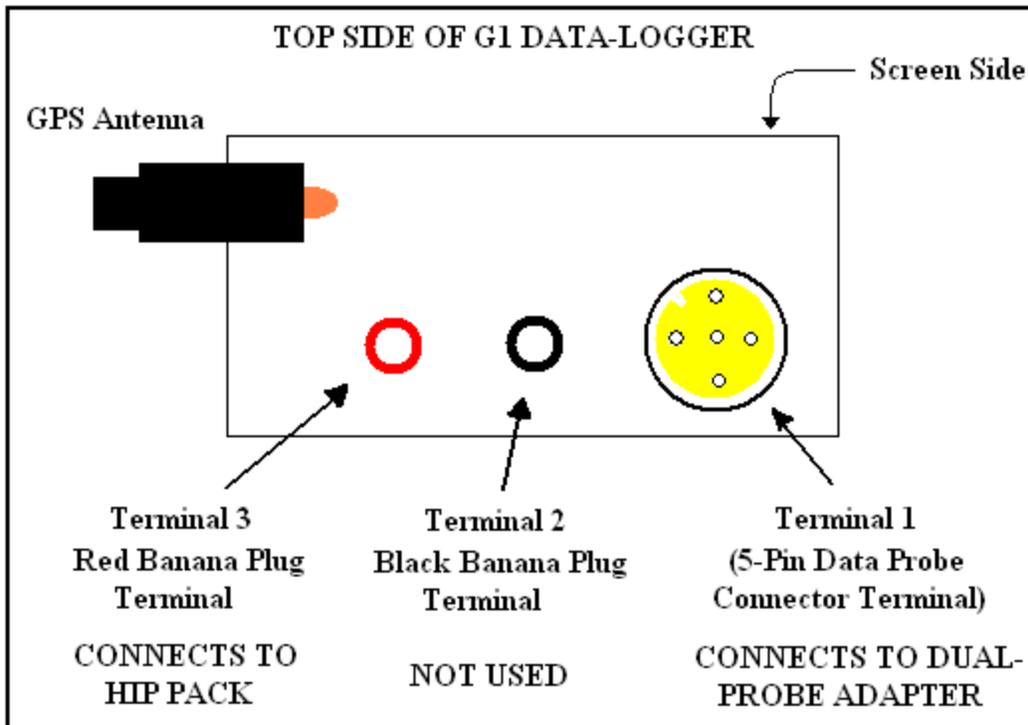


Figure 5: Connection terminals on top side of G1 Data-Logger

The 5-pin Data Probe Connector Terminal is shown above as **Terminal 1**. As discussed above, the reference electrode canes are connected to this terminal via the dual probe adapter. Again, the reference electrodes are effectively connected to the **negative** side of the data logger's voltmeter with this connection.

(Consequently, the black banana plug terminal (Terminal 2) is not used when push button canes are employed)

The red banana plug terminal (for connection to the hip pack) is shown as **Terminal 3**. This will establish connection to the **positive** side of the data logger's voltmeter.

The GPS Antenna shown above is employed by the data-logger's internal GPS unit. External GPS units are connected to either the left-hand-side COM Port (COM 1) or the right-hand-side COM Port (COM 4) located on the bottom side of the data-logger. As mentioned above, in Section III. 2, the COM 4 Port is recommended to avoid conflict with ActiveSync.

SECTION V: HOW TO PERFORM CLOSE INTERVAL SURVEYS

V. 1 How to Carry the Test Equipment During a CIS

With the equipment connected as shown in Figure 4, and the G1 data-logger set up as described in Section III. 2, you are ready to perform a close interval survey.

To make a pipeline survey more manageable, MCM has developed a special harness which allows the G1 and the trail-wire Hip Pack to be carried around the waist area in a “hands-free” fashion, allowing the individual to be able to position the reference electrodes (canes) over the pipeline (every 2.5 feet, or so, in an alternating manner) and to be able to “trigger” the push button canes when appropriate to do so.

With the harness assembly, the G1 sits on a tray at waist level allowing the operator to view the screen at all times and to make any selections required by tapping on the screen. Also, the dual-probe adapter shown in Figure 4, is attached to the underside of the tray, allowing convenient (5 pin cable) connection of the adapter’s “output” to the data-logger. [Again, this will effectively connect both data-probes (reference electrode canes) to the negative side of the data logger’s voltmeter].

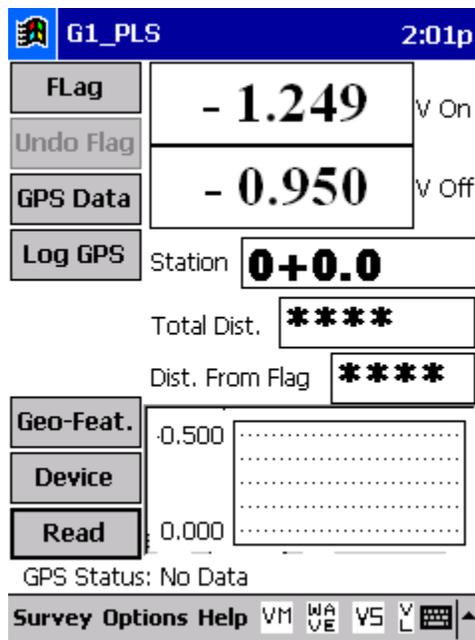
The Hip Pack, which contains a spool of copper wire (trail wire) [typically 1 mile or 3 miles in length], is attached to the waist belt of the harness and, as described in Section IV. 1, a cable connects the banana plug terminal on the underside of the Hip Pack to the red (positive) banana plug terminal on the G1. Typically, the Hip Pack sits on the operator’s left-hand side at waist level.

In addition, an external GPS receiver unit (together with its battery pack and antenna), if the internal GPS unit is not being employed, can also be attached to the waist band of the harness, typically on the operator’s back at waist level, with the antenna rising to above-head height.

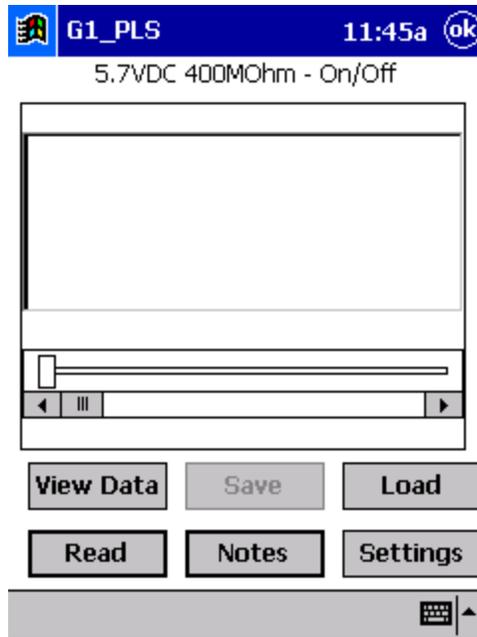
V. 2 How to Examine and Record a High/Low Voltage Waveform

When you are performing a High/Low (current-interrupted) CIS, it is recommended that you examine the pipe-to-soil voltage waveform at your starting location (starting test station) and it is suggested that you make a recording of this voltage waveform using your G1 data-logger. The nature of the voltage waveform that you are examining will reflect the nature of the rectifier-current waveform that is currently in effect on your pipeline.

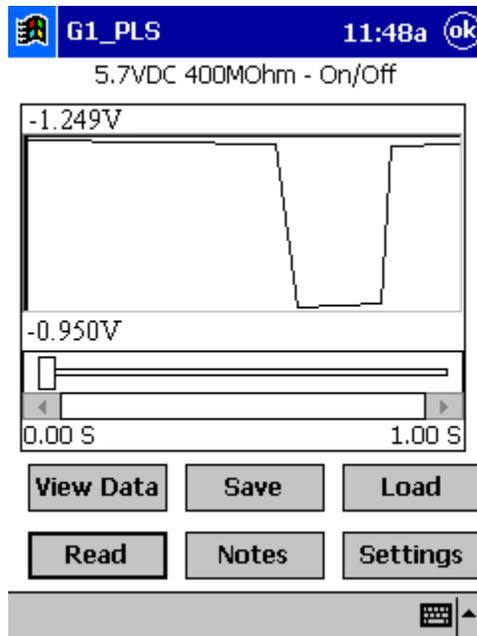
With at least one of the two reference electrodes making good electrical contact with the soil above the pipe at the first test station and a test cable connected from the test station to the red banana plug terminal on the G1 (the cable connection to the Hip Pack will be temporarily disconnected), you will see voltage readings displayed for the “ON” and the “OFF” portions of the current-interrupted waveform cycle – see screen shown below.



To examine the pipe-to-soil voltage waveform, either tap on the WAVE button at the bottom of the screen or tap on “Options” followed by “Wave”. The screen shown below will appear.



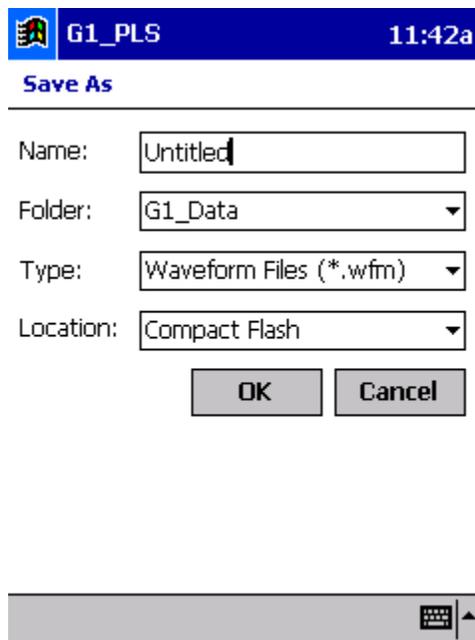
By tapping on the “**Read**” button on the above screen, you can view the actual pipe-to-soil voltage waveform. A typical waveform would be as shown in the screen below.



Since we set up a 700ms ON and a 300ms OFF rectifier cycle, the pipe-to-soil voltage is “High” for 0.7 sec. and “Low” for 0.3 sec., as evidenced by the 1 second “snap shot” of the voltage waveform shown in the above screen. Since the voltmeter in the G1 has a finite response time (~80ms), the transitions from High to Low and Low to High are not perfect (right-angled) steps. Also, since the voltmeter samples the voltage only 50 times per second (every 20 milliseconds), any AC components of the waveform with a frequency higher than 50 Hz will be “filtered out” by the voltmeter.

However, these voltage waveforms are very useful with regard to confirming multiple-rectifier synchronization and to selecting “On Delays” and “Off Delays” to avoid voltage spikes (see Section III. 2, Step 31), for example.

To record a pipe-to-soil voltage waveform, tap on the “**Save**” button on the above screen. The screen shown below will appear.



You are being asked here to establish a file in which the waveform data will be stored (saved). The name of this file will be the name you type into the “Name” box on the above screen. For ease of future retrieval when you uploaded your survey data to the Data Management software package (ProActive) [see Section VI], it is recommended that you use the same name

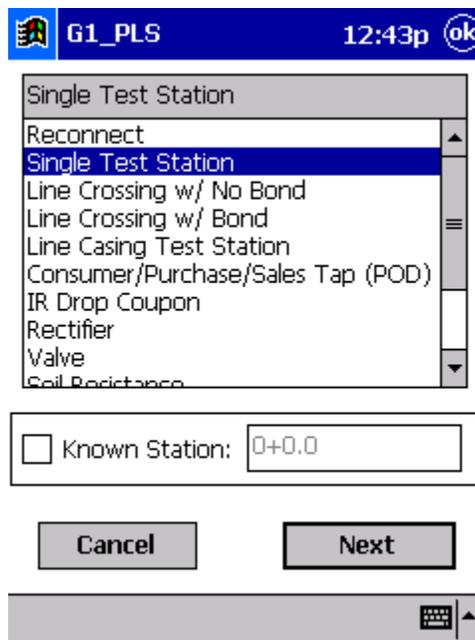
as your survey filename with the addition of something like “Wave TS 1” to the file name. This would represent the waveform data recorded at Test Station 1 at the beginning of your survey.

You should then tap on the OK button. This process will “save” the waveform data in the G1 data-logger’s CompactFlash memory for future retrieval by ProActive’s driver.

V. 3 How to Record the Voltages at a Starting Test Station:

At this point, it is recommended that you record the High/Low voltages at the starting test station. This will represent the first “**Device**” on this survey.

To do so, tap on the “Device” button on the survey screen. The screen shown below will appear.



As can be seen from the above screen, you can choose from a number of “Devices”. In this case, you would tap on “**Single Test Station**” to highlight this selection. You should then tap on the “**Next**” button. The screen shown below will appear.

The screenshot shows a handheld device interface with a blue header bar containing 'G1_PLS' and '12:48p' with an 'ok' button. Below the header, the text 'Single Test Station' and 'Pipe To Soil' is displayed. There are two dropdown menus: 'Reading Mode' set to 'ON/OFF' and 'Reading Range' set to '5.7 V DC - 400 MOhm'. Below these are two data fields: 'ON: -1.2495 v.' and 'OFF: -0.9508 v.'. At the bottom, there are three buttons: 'Notes', 'Previous', and 'Save', followed by a 'Cancel' button. A status bar at the very bottom shows a battery icon and a signal strength indicator.

The High and Low Voltage readings measured (per cycle) at the starting test station will be displayed on this screen (the above voltages represent a snapshot in time). You have the option at this point to tap on the “**Save**” button to record the data at the first test station. As an alternative, you could press the trigger button on either your right-hand or left-hand cane (reference electrode) to record the data, assuming that you selected the ”save” option for the canes at D.C.P.s (see Section III. 2, Step 9).

Saving the first test station voltages will bring you back again to the Survey screen. **You are now ready to proceed with the “walking” portion of the CIS.**

V. 4 How to Perform a CIS

In order to illustrate some of the important processes associated with performing a CIS, we have designed a fictitious section of pipeline and the steps outlined below with regard to conducting a CIS pertain to this fictitious section. Our 350 feet long section of pipeline is shown below in Figure 6.

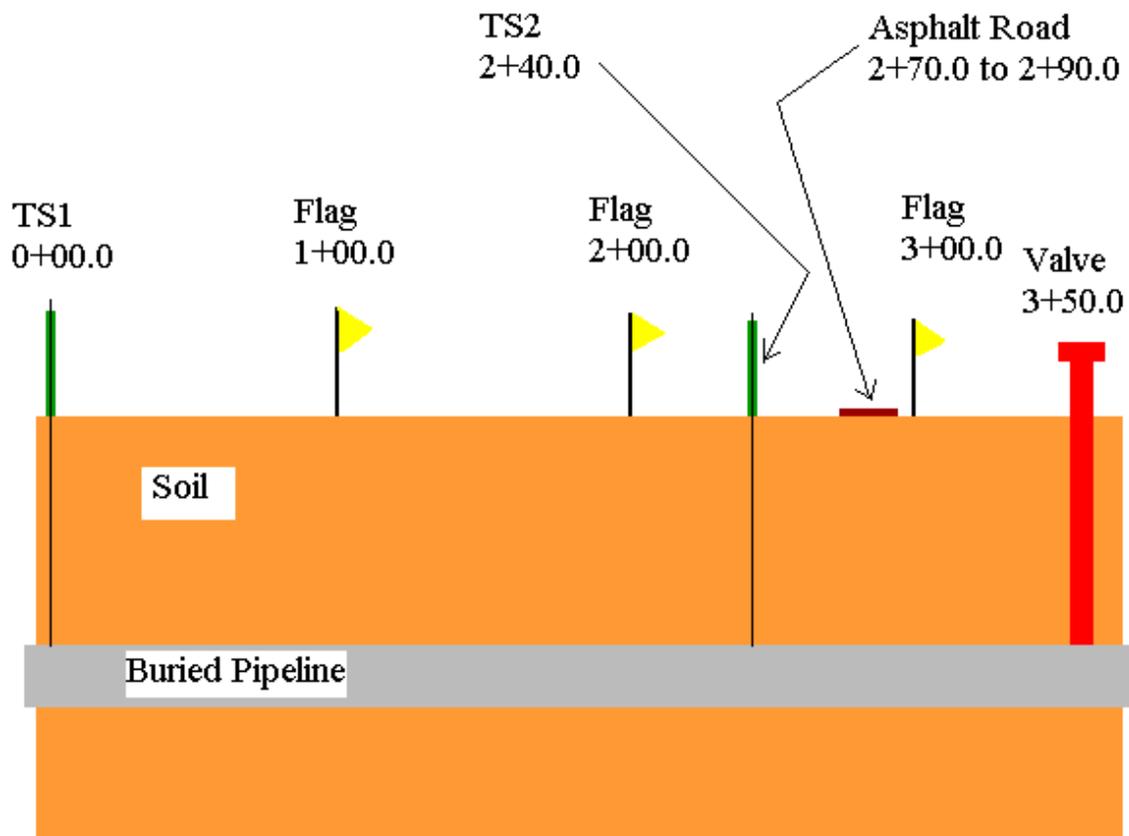


Figure 6: Fictitious Section of Pipeline

The important features on this section of pipe are as follows:

TS1: Test Station 1. Coincides with station 0+00.0 (reference zero station)

Flags: Located at 1+00.0 (100 feet from reference zero station), 2+00.0 (200 feet from reference zero station) and 3+00.0 (300 feet from reference zero station).

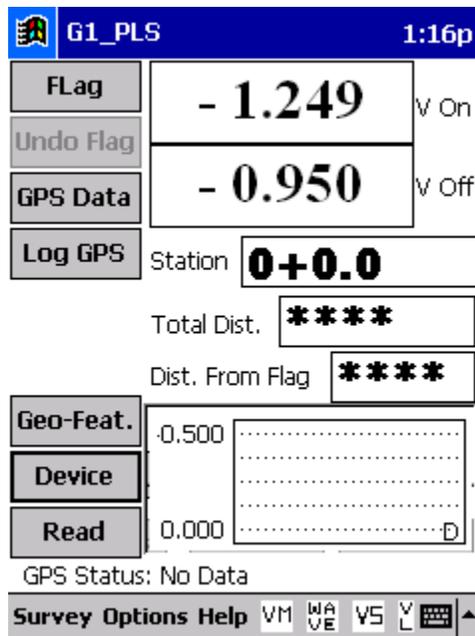
TS2: Test Station 2 located at 2+40.0 (240 feet from reference zero station)

Asphalt Road: A 20 feet wide asphalt road located b/w 2+70.0 and 2+90.0
 (270 feet from reference zero to 290 feet from reference zero)
 Valve: Located at 3+50.0 (350 feet from reference zero station)

Let's consider, as an example, that you are doing a "Trigger-Mode" CIS with the left-hand cane set to "flag" and the right-hand cane set to "read". Also, you are performing the CIS under rectifier-current "ON/OFF" conditions with a 0.7 sec. ON and a 0.3 sec. OFF cycle. Also, let's assume that you are beginning your survey at the beginning of the pipeline, or at reference location zero. This means that you're starting station is zero feet from the "reference zero" location.

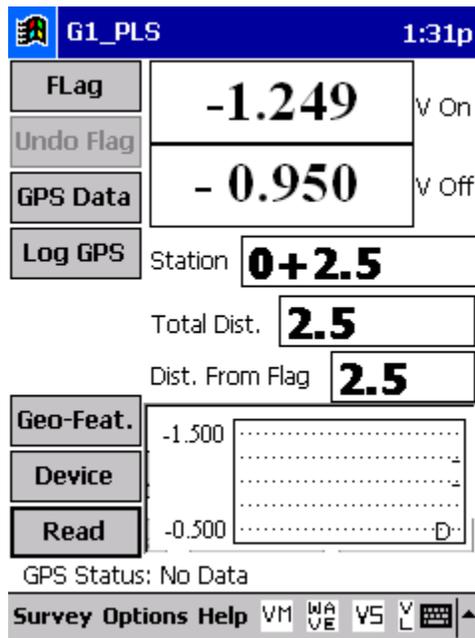
Since, in our example, we have set up the right-hand cane to be the "read" cane, voltages will be recorded each time you "trigger" the right-hand cane's push button (by pressing down on the button) as you walk down the length of the pipeline. Triggering a recording using the right-hand cane button, in this case, would have the same effect as tapping on the "Read" button on the Survey screen.

Since you recorded voltages at the starting test station (TS1 in Figure 6), you have already established a "Device" location and, as shown below, this device is identified in the graph on the Survey screen by the letter "D". In fact, all "Devices" encountered as you go down the length of the survey section will be marked on the graph in this fashion.



Since we indicated during the G1 data-logger's set up process that we expected to record voltages every 2.5 feet, each time you "trigger" readings using the right-hand cane's push button, the data-logger will assume that you have traveled an additional 2.5 feet down the line section. Consequently, you should try to place the electrodes over the pipe at 2.5 foot intervals.

For instance, the screen will appear as shown below after the **first** triggering event (voltages recorded at an assumed distance of 2.5 feet from the first test station).



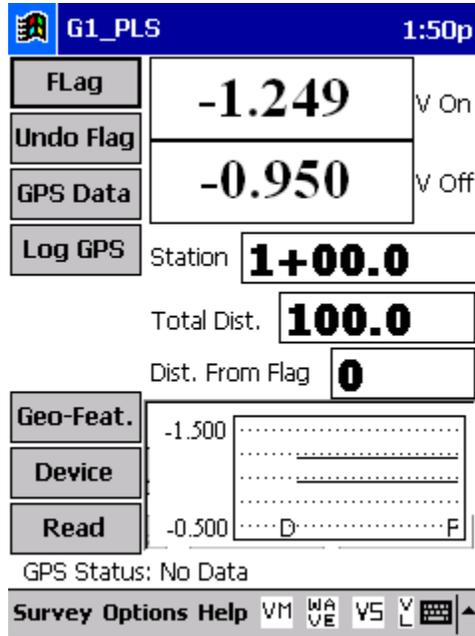
As can be seen from the above screen, the data-logger assumes that you are now at a distance of 2.5 feet from where you started, which was at starting station 0+0.0 (or, 0+00.0).

The G1 data-logger's software program will add 2.5 feet to the assumed distance from the starting station every time the right-hand cane button is triggered.

If you recall, we also set things up so that when the left-hand cane's push button is pressed (triggered), we would register the location of survey flags, which are typically placed at 100 foot intervals down the length of the pipe.

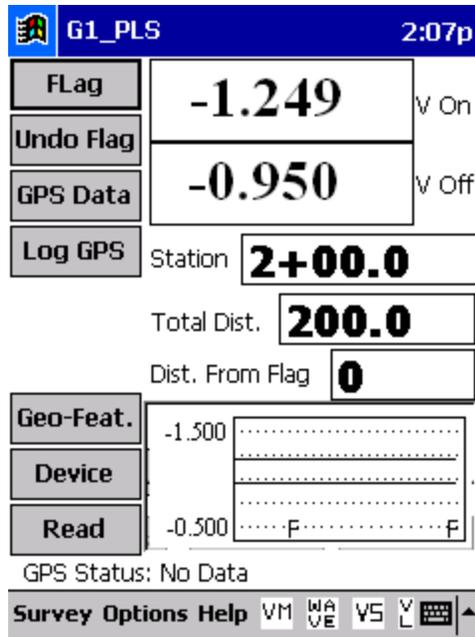
In this case, triggering the left-hand cane would have the same effect as tapping on the “Flag” button on the Survey screen. Consequently, when you encounter your first survey flag and trigger the left-hand cane, the data-logger’s software will assume that you have traveled a distance of 100 feet from the starting test station.

At this point, the screen will appear as shown below.



Notice that the station number is now 1+00.0 The” 1” represents 100 feet, so the G1 assumes that you are now 100 feet from your reference zero location. Notice also the “F” marker on the graph (for Flag).

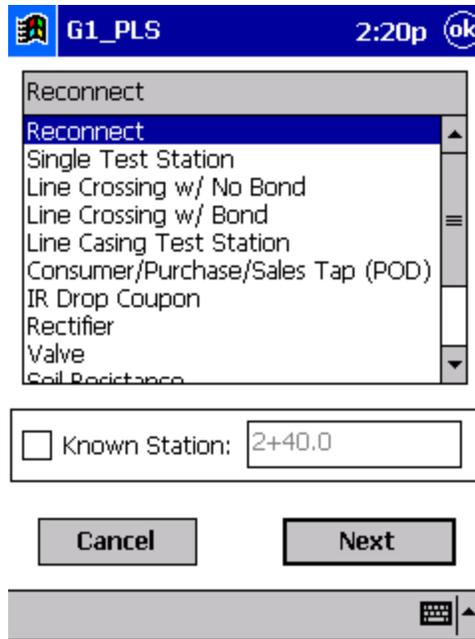
If you continue on down the pipe triggering voltage recordings using the right-hand cane’s push button until you encounter the next survey flag and you then press the left-hand cane’s push button to register this second survey flag, the screen will appear as shown below.



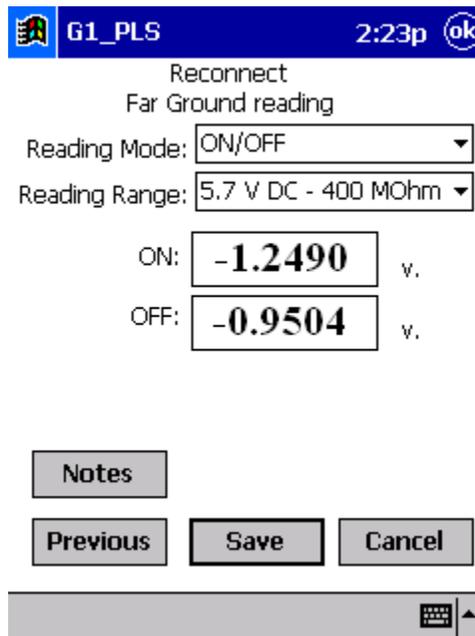
In this case, the station number is now 2+00.0. The “2” represents an assumed 200 feet from the reference zero location. A second Flag marker also appears on the graph.

Let’s now assume that you encounter a second test station (TS2 in Figure 6) at a distance of 40 feet from the second survey flag location and you need to do a “**reconnect**” of the trail wire at this location.

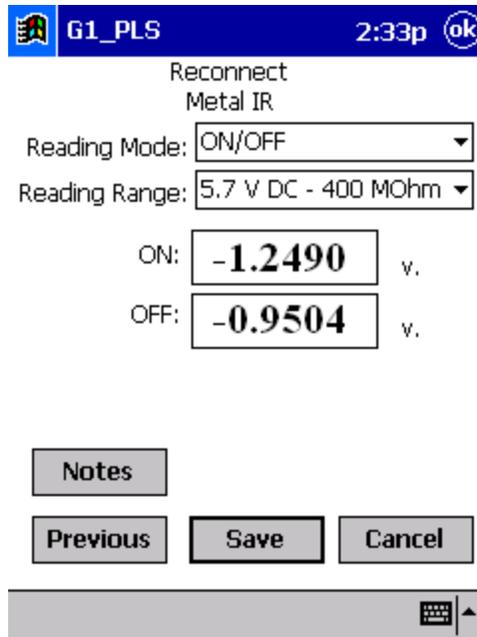
In this case, when you encounter the test station, you would tap on the “Device” button on the screen and tap on “reconnect”. The screen at this point will appear as shown below.



By tapping on the “Next” button, the screen shown below will appear.

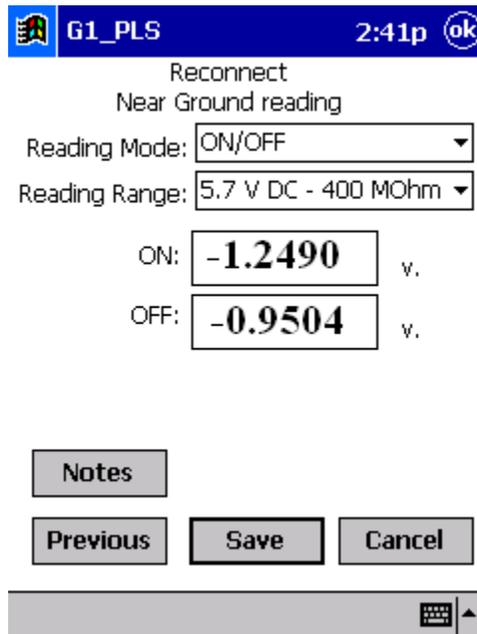


You are being prompted here to “**Save**” the “Far Ground” voltages prior to breaking the trail wire connection (see Section III. 2, Step 13 for an explanation of Far- and Near-Ground readings). By tapping on the “Save” button, the screen shown below will appear.



At this point you are being prompted to take “Metal IR” readings at the test station. If you’d like to do so, you would save the readings by tapping on “save” after setting up to take the readings, or, if you are not interested in taking “Metal IR” readings, you would tap the “OK” button.

The next screen to appear will be as shown below.



In this case, you are being prompted to save the “Near Ground” voltages after connecting the trail wire to the second test station (TS2).

After tapping on “Save”, the screen shown below will appear.

The screenshot shows a surveying application interface with a blue header bar containing a logo, the text "G1_PLS", and the time "2:47p". Below the header are several buttons and data fields:

- FLag** button: displays **-1.249** V On
- Undo Flag** button
- GPS Data** button: displays **-0.950** V Off
- Log GPS** button: displays Station **2+40.0**
- Total Dist. **240.0**
- Dist. From Flag **40.0**
- Geo-Feat.** button: displays -1.500 and a text input field with a dotted line.
- Device** button
- Read** button: displays -0.500 and a text input field with a dotted line.

At the bottom, it shows "GPS Status: No Data" and a navigation bar with "Survey Options Help" and several icons.

Now, let’s assume that at an additional 30 feet down the pipe from the “reconnect” location, you encounter a “Geo-Feature”, ie, a geographical feature of some type. In this case, when you reach this location, you would tap on the “Geo-Feat.” button on the above Survey screen. At this point, the screen would be as shown below.

G1_PLS 3:01p ok

Quick Search :

Feature: 1-Highway ▼

Feature Length:

Skip Distance:

Change Direction

Known Station: 2+40.0

Notes:

Cancel Save

You can select the type of geo-feature that you have encountered by tapping on the pull-down-list arrow in the “Feature” box. Alternatively, you could perform a quick search for the feature by typing in the “Quick Search” box the number associated with the feature or the first few letters of the name of the feature.

If, for example, the geo-feature is an “Asphalt Road”, and the width of the road that you have to cross is 20 feet, you can enter a “Feature Length” of 20 feet (see Figure 6). You could restart voltage recordings immediately on the other side of the road, in which case our “skip distance” would also be 20 feet. However, if there is a survey flag an additional 10 feet beyond the other side of the road, you might want to restart making voltage recordings at the flag location. We would have a “skip distance” of 30 feet in this case. If this were the case, the survey screen would appear as shown below.

G1_PLS 3:11p

Quick Search :

Feature:

Feature Length:

Skip Distance:

Change Direction

Known Station:

Notes:

By tapping on the “Save” button, the Survey screen shown below will appear.

G1_PLS 3:29p

-1.249 On

-0.950 Off

Station **2+97.5**

Total Dist. **297.5**

Dist. From Flag **-2.5**

-1.500

-0.500

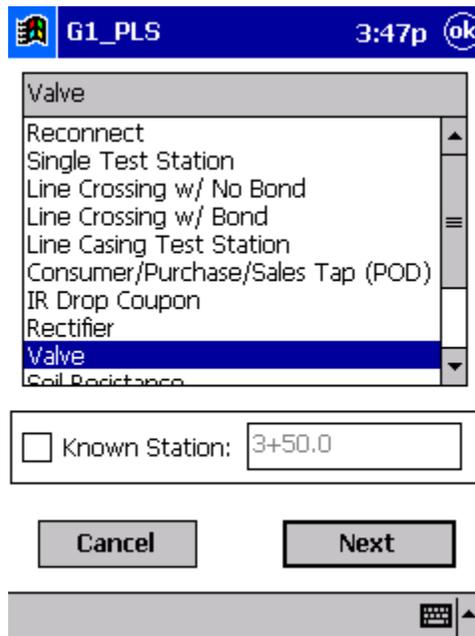
GPS Status: No Data

Survey Options Help

As can be seen from the above screen, the G1 data-logger's software assumes that you are 2.5 feet short of the survey flag on the other side of the asphalt road and that your next voltages will be recorded when you trigger the "read" cane when you are actually **at** the survey flag location. Notice that a "G" marker has been added to the graph (for Geo-Feature).

By triggering the "read" cane (your right-hand reference electrode cane) when you reach the flag beyond the asphalt road, the station number will advance to 3+00.0. You can also trigger the "flag" cane (your left-hand reference electrode cane) at this time, to register the survey flag.

Now, let's assume that you encounter a "Valve" at an additional 50 feet down the pipe from this survey flag (see Figure 6). Since, a valve is considered a "Device", you would stop and tap once on the "Device" button on the Survey screen. By tapping on "Valve" from the Device List, the screen will appear as shown below.



By tapping on the "Next" button, the screen shown below will appear.

G1_PLS 3:52p ok

Valve
Pipe To Soil

Reading Mode: ON/OFF

Reading Range: 5.7 V DC - 400 MOhm

ON: -1.2490 v.

OFF: -0.9504 v.

Notes

Previous Save Cancel

In this case, you would record the pipe-to-soil voltages at the valve location by triggering the right-hand cane (or by tapping on the “Save” button on the above screen).

Having done so, the screen shown below will appear.

G1_PLS 3:58p ok

Valve

Condition: Good

Notes:

Good
Fair
Poor

Previous Save Cancel

This screen allows you to note the condition of the valve and to make any relevant comments about the valve.

After tapping on the “Save” button, you will be returned to the Survey screen.

Since, in our fictitious section of pipe, the valve represents the end of the line segment, you would terminate the survey by tapping on “Survey” at the bottom of the screen and tapping on “Finish Survey”.

At this point you have completed the CIS on this section of the pipeline (line segment) and the survey data has been stored (saved) in the data-logger’s memory in the file that you named at the outset of the CIS.

You are now ready to “upload” the survey data file to MCM’s Database Management System (ProActive) (see Section VI).

SECTION VI: HOW TO UPLOAD SURVEY FILES TO MCM’s DATABASE MANAGEMENT SYSTEM - PROACTIVE

VI.1 Introduction

As surveys are performed, as described in the previous sections, the readings are stored in the data logger’s memory in separate files (one for each survey) under the survey filenames that you assigned to them during the G1 data-logger’s set up process (described in Section III. 2).

The data stored in each of the data logger’s survey files (representing each separate survey) can be uploaded independently to a PC for further analysis and database management. The software required to upload survey data from your G1 to your PC and, to subsequently manage your survey data, is the final component of MCM’s Integrated CIS Test Equipment and Database Management Package. This software package, known as “ProActive”, is an extremely powerful database management system, the full functionality of which is described elsewhere. With ProActive, it is possible to upload

survey data from data loggers to multi-user computer networks and servers, however, the focus here is the uploading of survey data to an individual PC.

VI. 2 Pre-Uploading Procedures

Before survey data can be uploaded to a PC, the following “pre-uploading” procedures need to be performed. These procedures suitably configure your PC and enable two-way communications between your data-logger and your PC.

Pre-step 1:

Install MCM’s ProActive software package and Microsoft’s ActiveSync software program on your PC. The ActiveSync program will enable two-way communication between data-logger and PC.

Pre-step 2:

Create a Folder on your PC’s hard-drive that you’ll use to permanently save survey files uploaded from your data-logger. You might choose to name this Folder something like, “Surveys”. If you are only interested in viewing survey data in the form of excel spreadsheets, you should also create a Folder within the “Surveys” Folder that can be used for this purpose and name this Folder something like “Exported Surveys”. More on this later.

Pre-step 3:

Connect a USB cable between the G1’s communication terminal (COM 1 Port) (left-hand-side COM Port) and a USB Port on your PC and switch on your G1. With Microsoft’s ActiveSync installed, the ActiveSync window will appear on your desktop and the program will confirm that two-way communication has been established.

VI. 3 How to Upload CIS Files to Database Management System.

Performing the following steps will permit the uploading of CIS files saved in the G1’s memory to ProActive, MCM’s Database Management System.

Step 1:

Double-click on the “ProActive” icon on your PC’s desktop screen.

This will open up ProActive's main menu window. A window labeled "Entire Database" will also be seen here. The suggested organization of your "Entire Database" (which will represent a hierarchical structure of all of your survey data within ProActive) is discussed in the ProActive Manual.

Step 2:

Click once on the "Surveys" button on the main menu bar at the top of the screen.

This will open a window labeled "Data Logger: Get Pipeline Survey".

By clicking on the pull-down-list arrow on the "Data Logger" box, you can select the data-logger from which you are uploading survey data. As shown in the pull-down-list, the various data-loggers currently supported are offered as choices.

Step 3:

Select "Gathererone" Option (G1 Option).

Highlight "Gathererone" in the pull-down-list and click on the "Go" button. This will open up a window labeled, "Gatherer One Driver"

Note: The "Gatherer One Driver" window is identical to the "DA Meter Driver" window which is shown in the examples below.

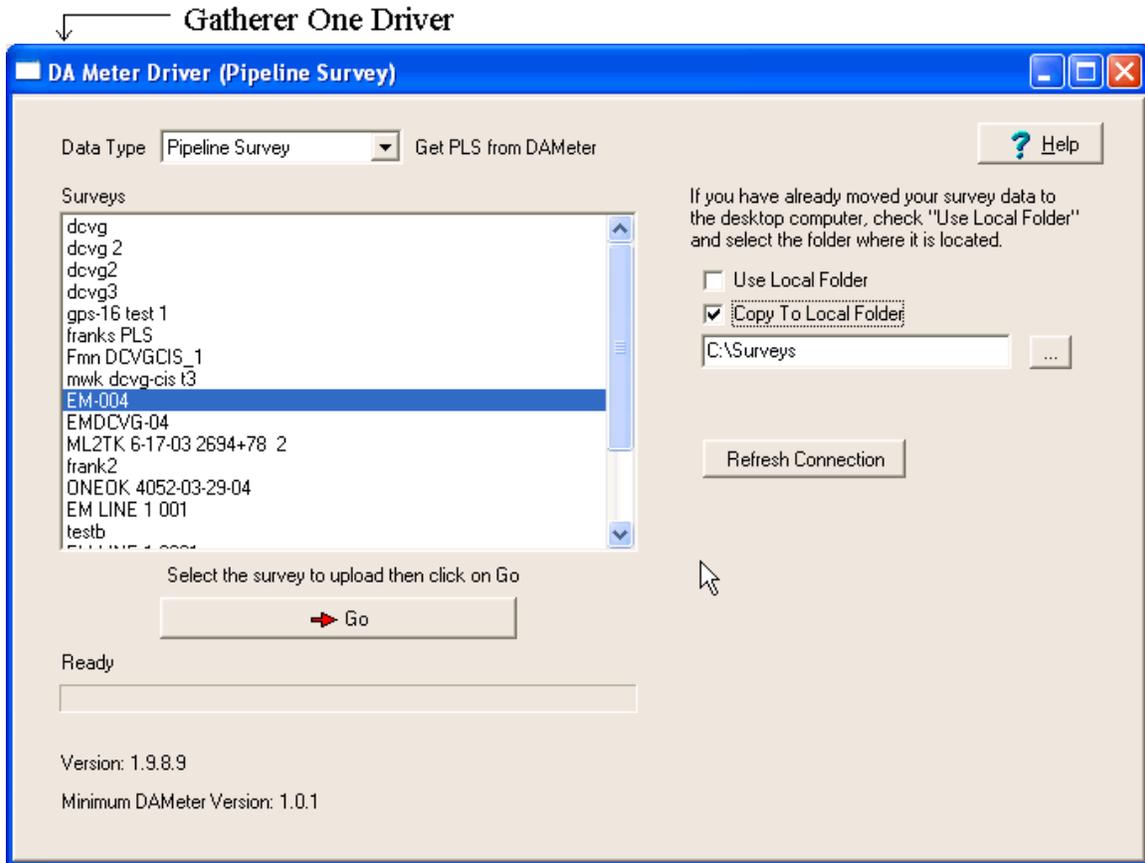
Step 4:

Select the Survey to be Uploaded and Upload Survey.

Select "Pipeline Survey" in the box labeled "Data Type".

The "Survey" box in the "Gathererone" window will list all of the survey files currently stored on your G1's CompactFlash memory card. Click on the file (survey) name that you would like to be uploaded onto your PC. Also, place a tick in the box labeled "Copy to Local Folder" and identify the Folder's location on your hard-drive in the box underneath. This is the Folder that you set up previously to accept all of your survey files from your data-logger (see Section VI. 2, Pre-step 2). If you named the Folder "Surveys", the Folder's location would be:

C:\Surveys



As an example, the “Driver” window would appear as shown above if the survey named “EM-004” was selected for uploading to your PC and if the Folder to which the survey file was to be sent was named, “Surveys” on your hard-drive. Of course, the actual survey names appearing in this box will depend on the filenames of the surveys that have been performed using your own G1 data-logger.

In our example, the “Driver” will have located survey EM-004 in our G1’s memory and when the “Go” button on the Driver Window is clicked, the survey file named EM-004 will be saved on our PC’s hard-drive ready to be brought into the database management section of ProActive.

Click on the “Go” button.

Step 5:

Examine Survey Data Prior to Bringing Survey File into Database Management Section of ProActive.

It is recommended that you examine your survey data prior to bringing the survey file into the Database Management Section of ProActive (currently you are in the Driver Section of ProActive).

To do so, click on the “**cancel**” button on the window that is currently showing (“Data Logger: Get Pipeline Survey Window”). The “Gatherer One Driver” window will be shown but, this time, there will be a selection of tabs on the window, labeled as follows:

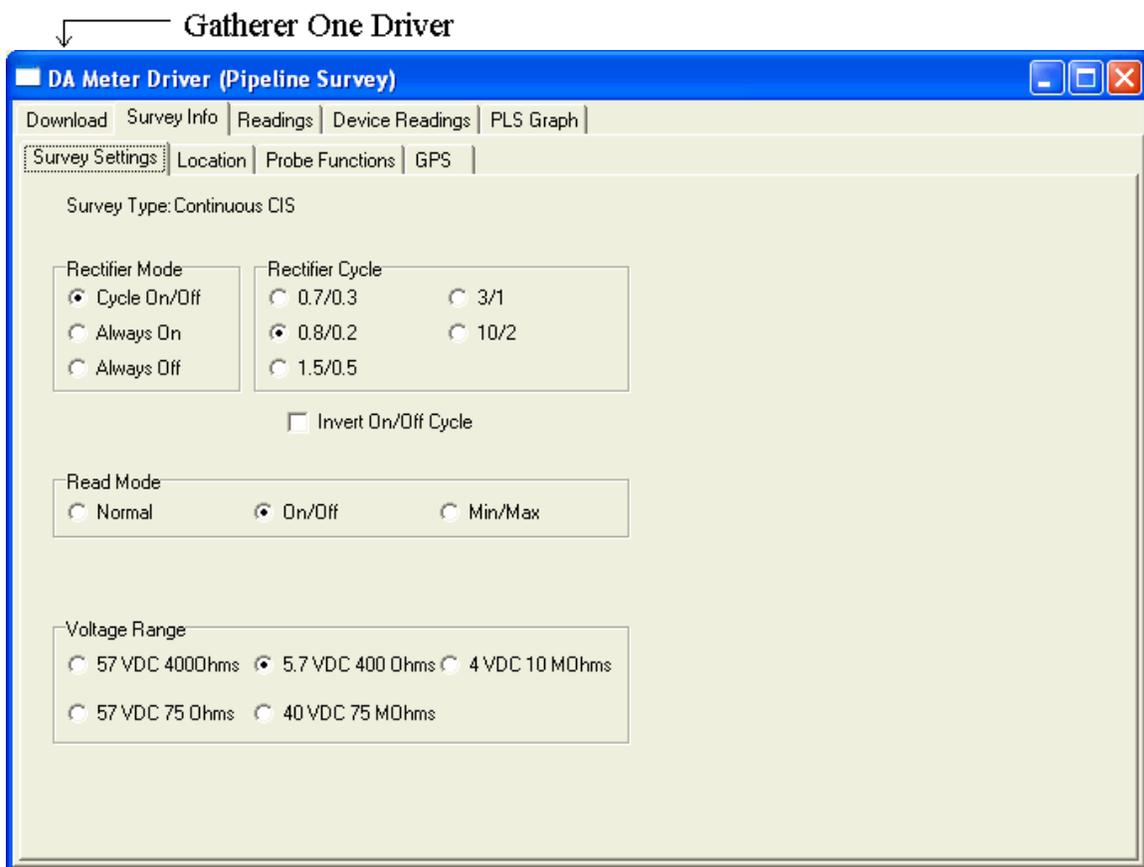
Survey Info’
Readings
Device Readings
PLS Graphs

By clicking on these tabs, you can view information on the Survey conditions or you can view actual survey readings either in spreadsheet form or displayed graphically.

Example:

The EM-004 Survey mentioned above is an actual survey that was performed on a buried pipeline. It was a continuous-mode CIS performed under High/Low rectifier-current interrupted conditions. By clicking on the various tabs on the “Driver” window for this uploaded survey, we can view either the survey conditions that were set up on the G1 for the survey (see Section III. 2), or we can view actual readings and graphical representations of the CIS data for this example.

By clicking on the “**Survey Info**” tab the window shown below is displayed.



As can be seen, the window indicates a Continuous CIS, with rectifier in the current ON/OFF mode and the specific rectifier-current cycle is indicated. The voltmeter setting is also indicated. Again, this survey information was established during the G1’s set up procedures (Section III. 2) and it is summarized on the above window.

By clicking on the “**Readings**” tab, the window shown below is displayed.

↓ Gatherer One Driver

| Data No | Dist From Sta | Station No | On Voltage | Off Voltage | Comments | DCP/Feature | Latitude | Longitude | Altitude |
|---------|---------------|------------|------------|-------------|----------|-------------|----------|-----------|----------|
| 1 | 4.000 | 00017+22 | -1.0501 | -0.8588 | | Line Marker | 26.96132 | -98.06273 | 75.393 |
| 2 | 8.000 | 00017+18 | -1.0482 | -0.8317 | | | | | |
| 3 | 12.000 | 00017+14 | -1.0456 | -0.8577 | | | | | |
| 4 | 16.000 | 00017+10 | -1.0454 | -0.8541 | | | | | |
| 5 | 20.000 | 00017+06 | -0.8492 | -0.8492 | | | | | |
| 6 | 24.000 | 00017+02 | -1.0390 | -0.6666 | | | | | |
| 7 | 28.000 | 00016+98 | -1.0468 | -0.8558 | | | | | |
| 8 | 32.000 | 00016+94 | 0.9571 | -0.1642 | | | | | |
| 9 | 36.000 | 00016+90 | -1.0628 | -0.8729 | | | | | |
| 10 | 40.000 | 00016+86 | -1.0496 | -0.8607 | | | | | |
| 11 | 44.000 | 00016+82 | -1.0477 | -1.0084 | | | | | |
| 12 | 48.000 | 00016+78 | -1.0515 | -0.8616 | | | | | |
| 13 | 52.000 | 00016+74 | -1.0501 | -0.8595 | | | | | |
| 14 | 56.000 | 00016+70 | -1.0207 | -0.6426 | | | | | |
| 15 | 60.000 | 00016+66 | -1.0188 | -0.8285 | | | | | |
| 16 | 64.000 | 00016+62 | -1.0181 | -0.8282 | | | | | |
| 17 | 68.000 | 00016+58 | -1.0009 | -0.8120 | | | | | |
| 18 | 72.000 | 00016+54 | -0.5916 | -0.7701 | | | | | |
| 19 | 76.000 | 00016+50 | -0.9693 | -0.7777 | | | | | |
| 20 | 80.000 | 00016+46 | -0.9715 | -0.7803 | | | | | |
| 21 | 84.000 | 00016+42 | -0.9719 | -0.7817 | | | | | |
| 22 | 88.000 | 00016+38 | -0.9776 | -0.7831 | | | | | |

As can be seen from the above window, the actual readings recorded during the CIS are presented here. It can be seen that readings in this case were taken at 4 feet intervals. And, the High and the Low voltage readings are presented at each of the measurement locations.

It can also be seen from the above window that DCP (Device) and/or Geo-Feature locations are identified (for example, a “line marker” is indicated at the first measurement point).

By clicking on the “**Device Readings**” tab, the window shown below is displayed.

↓ Gatherer One Driver

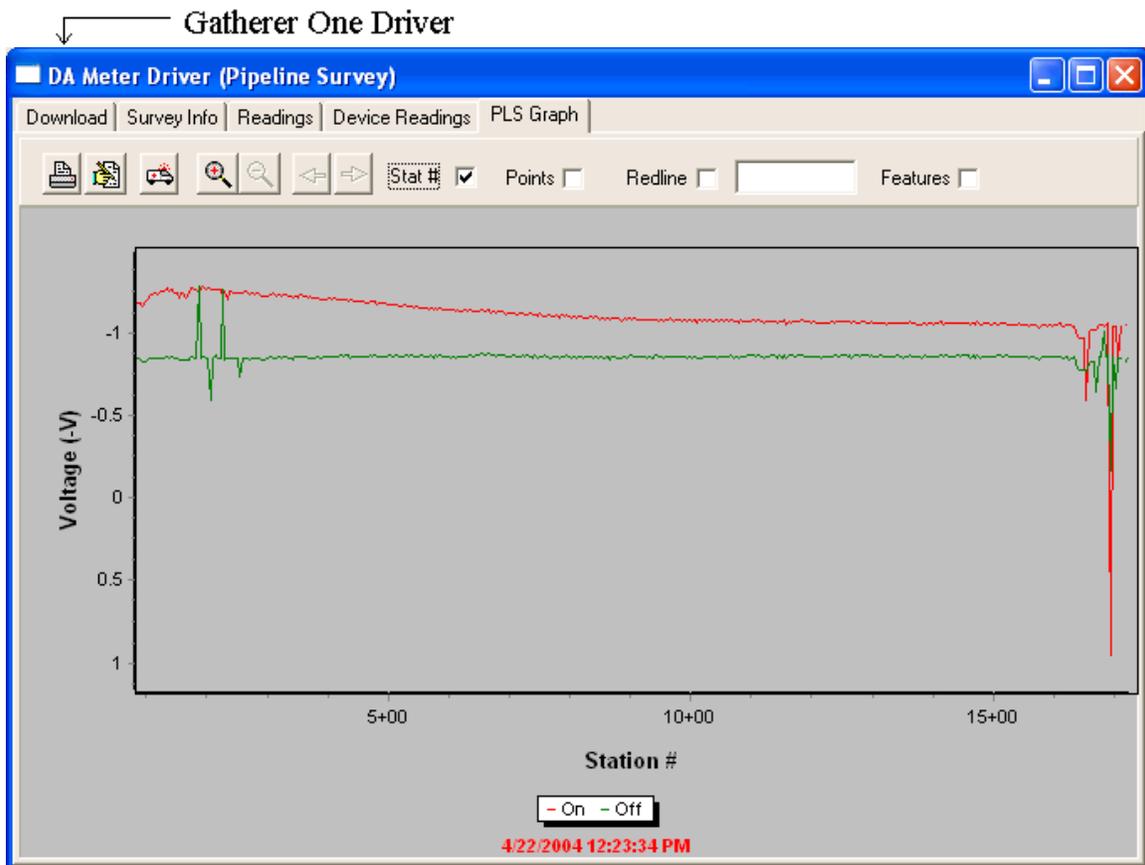
| Station No | DCP/Feature | Value1 | Value2 | Value3 | Reading Text | Comment | Latitude | Longitude | Altitude |
|------------|----------------|---------|---------|--------|--------------|-------------|----------|-----------|----------|
| 00017+22 | Line Marker | 0.0000 | 0.0000 | 0.0000 | | | 26.96132 | -98.06273 | 75.360 |
| 00017+22 | Test Station | 0.0000 | 0.0000 | 0.0000 | | | 26.96132 | -98.06273 | 75.360 |
| 00017+22 | Casing Vent | 0.0000 | 0.0000 | 0.0000 | | | 26.96132 | -98.06273 | 75.360 |
| 00012+22 | Custom 1 | 0.0000 | 0.0000 | 0.0000 | | 4FT 0IN | 26.96247 | -98.06362 | 70.209 |
| 00007+18 | Custom 1 | 0.0000 | 0.0000 | 0.0000 | | 4FT 7IN | 26.96360 | -98.06450 | 69.028 |
| 00003+46 | Power Line Cr | 0.0000 | 0.0000 | 0.0000 | | IRON GIANT | 26.96444 | -98.06516 | 70.144 |
| 00002+98 | Line Marker | 0.0000 | 0.0000 | 0.0000 | | | 26.96457 | -98.06526 | 71.587 |
| 00002+98 | Bend in Pipe | 0.0000 | 0.0000 | 0.0000 | | LEFT | 26.96457 | -98.06526 | 71.587 |
| 00002+82 | Custom 2 | 0.0000 | 0.0000 | 0.0000 | | AGM 12 | 26.96457 | -98.06526 | 71.522 |
| 00002+50 | Line Crossing | 0.0000 | 0.0000 | 0.0000 | | DUKE ENER | 26.96458 | -98.06539 | 72.375 |
| 00002+50 | Line Crossing | -1.2505 | -0.8473 | 0.0000 | | NO TEST ST | 26.96458 | -98.06539 | 72.375 |
| 00002+50 | Line Crossing | -0.0696 | -0.0221 | 0.0000 | | TOP LUG ON | 26.96458 | -98.06539 | 72.375 |
| 00002+50 | Line Crossing | -1.2505 | -0.8470 | 0.0000 | | FAR GROUN | 26.96458 | -98.06539 | 72.375 |
| 00002+50 | Line Crossing | -1.4747 | -1.2450 | 0.0000 | | BOTTOM LU | 26.96458 | -98.06539 | 72.375 |
| 00002+22 | Custom 1 | 0.0000 | 0.0000 | 0.0000 | | 3FT 11IN | 26.96459 | -98.06548 | 71.128 |
| 00001+30 | Fence | 0.0000 | 0.0000 | 0.0000 | | | 26.96460 | -98.06575 | 75.492 |
| 00001+30 | Line Marker | 0.0000 | 0.0000 | 0.0000 | | | 26.96460 | -98.06575 | 75.492 |
| 00001+30 | Custom 3 | 0.0000 | 0.0000 | 0.0000 | | ENTER VAL | 26.96460 | -98.06575 | 75.492 |
| 00001+30 | Rocky | 0.0000 | 0.0000 | 0.0000 | | | 26.96460 | -98.06575 | 75.492 |
| 00000+82 | Pig Trap | 0.0000 | 0.0000 | 0.0000 | | | 26.96461 | -98.06586 | 77.165 |
| 00000+82 | Reconnect: F | -1.1602 | -0.8278 | 0.0000 | | THIS IS WHI | 26.96461 | -98.06586 | 77.165 |
| 00000+82 | Valve: Structu | -1.1345 | -0.7939 | 0.0000 | | | 26.96461 | -98.06586 | 77.165 |

In the case of the above window, High and Low voltage readings recorded at “Devices” only are displayed. The “Device” (and geo-feature) locations along the survey are indicated by their station number and both device and geo-feature locations are indicated by their GPS data (for surveys in which a GPS unit was employed).

A description of each Device or Geo-Feature is provided, as are specific comments in the cases where comments are entered by the operator during the CIS.

Having the ability to isolate “Device Readings” and to examine them separately from the general survey readings is a very useful feature, as you can immediately focus in on potential problem areas and directly relate the observations to identifiable “Devices”.

Finally, by clicking on the “**PLS (pipeline survey) Graph**” tab, the window shown below is displayed.



The above window shows a graphical representation of the survey data in a specific section of the survey. As can be seen, both the high voltage and the low voltage readings are shown together in graphical form (the red line represents the high voltage readings and the green line represents the low voltage readings in the above case).

As can be seen from the above window, a graphical representation of the survey data is extremely useful with regard to immediately identifying potential problem areas.

Excel Spreadsheet Option:

Another option exists at this point, particularly if you **do not** plan to bring the survey file into the Database Management Section of ProActive, and that is to export the survey back out of the Driver in the form of spreadsheets.

This can be done by clicking on the “**Export to Excel**” button on the “Gatherer One Driver” window and selecting the “**Exported Surveys**” Folder in the “Save-As” window.

Remember that you previously set up an “Exported Surveys” Folder on your hard-drive during the “Pre-Uploading Procedures” (Section VI. 2, pre-step 2).

By accessing your “Exported Surveys” Folder you can view the survey information, survey readings and DCP/Feature readings in spreadsheet form.

Step 6:

Make Decision to Bring the Survey File into the Database Management Section of ProActive.

At this point in the uploading process, having examined your survey data, you can decide whether or not to bring the survey file into the Database Management Section of ProActive, where the particular survey that you are uploading can be integrated with any other surveys you might have in your ProActive Database.

After importation, you can manage the data associated with all of your surveys in a whole host of ways inside ProActive. The database management functions available within ProActive are beyond the scope of this particular manual, however, you are referred to the ProActive Training Manual for specific information.