# "GATHERER ONE" DATA-LOGGER

# USER'S MANUAL

## (Software Version 1. 5. 3)



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# SECTION I

# INTRODUCTION

The "Gatherer One (G1)" data-logger, manufactured by MCM, is a combination of a high-input-impedance digital voltmeter and a handheld Personal Computer (PC). The operating system of the PC is either Microsoft "Pocket PC", for the Q100, or CE.NET 4.2, for the Q200, and MCM has designed proprietary application programs in order that the G1 data-logger can be employed to run "Scripted" Site Surveys and also Pipeline Surveys (such as CIS, DCVG and Surface Potential Surveys). In addition, the G1 can collect "time-stamped" data in a Stationary Data-Logger (SDL) mode.

Your G1 data-logger will arrive from MCM with the Microsoft operating system and our application programs pre-installed. The application programs will remain installed (in RAM) unless the main battery pack, and its backup, are allowed to fully-discharge. However, your survey and SDL data will always be safe, regardless of battery status, as these data are stored on a non-volatile CompactFlash card. Also, a copy of the application programs is maintained on the CompactFlash card and these programs are automatically re-installed whenever a "hard reset" is performed (see Section II.3).

The G1 data-logger is designed to work hand-in-hand with ProActive, which is MCM's (Pipeline Integrity) Data Management Software Package.

In the case of Site Surveys, "Scripted" Routes are downloaded onto the G1 data-logger from ProActive, having been created in ProActive, and, in turn, completed site surveys are transferred back into ProActive for proactive management of the collected data. The software application program required to run "Scripted" Site Surveys is termed the G1SS (G1 Site Survey) Program and, in Section IV, we describe in detail how to use this program on the G1 data-logger to perform Scripted Site Surveys.

On the other hand, Pipeline Surveys, such as CIS and DCVG Surveys are set up on the G1 data-logger itself and completed surveys are uploaded from the G1 to ProActive, where the survey data can be managed inside of ProActive itself. The particular application program required to run Pipeline Surveys on the G1 data-logger is called the G1PLS (G1 Pipe Line Survey) Program

and we describe the use of this program in detail in Section III.
Finally, the G1 data-logger can be used to collect time-stamped data in a stationary mode. The application program required to operate the G1 in the stationary mode is called the G1SDL (G1 Stationary Data-Logger) Program and we describe the use of this program in detail in Section V.

One of the attractive features of the G1 data-logger, with regard to performing both Pipeline Surveys and "Scripted" Site Surveys, as well as being operated in the Stationary Data-Logger mode, is the G1's built-in (internal) GPS receiver. Having a GPS receiver built into the unit means that critical location data can be logged during surveys and accurate time-stamping of SDL data can be achieved without the need to carry an external GPS receiver along with its associated power supply and antenna.

The G1 data-logger's internal GPS receiver is a Garmin 15L receiver unit that is WAAS-enabled. A WAAS-enabled receiver can give you position accuracy of around 1 meter (95% of the time) and you do not have to purchase additional receiving equipment or pay service fees to utilize WAAS (Wide Area Augmentation System). WAAS corrects for GPS signal errors caused by ionospheric disturbances, timing, and satellite orbit errors. This system, which was developed by the FAA and the DOT, consists of approximately 25 ground reference stations positioned across the United States (hence the "Wide Area" designation) that monitor GPS satellite data. Two master stations, located on either coast, collect data from the reference stations and create a GPS correction message. This correction accounts for GPS satellite orbit and clock drift as well as signal delays caused by the atmosphere and ionosphere. The correction message is broadcast through one of two geostationary satellites positioned over the equator and is picked up by the WAAS receiver.

Currently, WAAS satellite coverage is only available in North America, although other governments are developing compatible systems around the world. Also, it should be noted that, for some users in the United States, the position of the two broadcast satellites over the equator makes it difficult to receive the correction message signal when trees or mountains obstruct the view of the horizon. In these cases, in the absence of a WAAS correction message, the G1's internal GPS unit will process standard (uncorrected) GPS data, with an associated loss of accuracy. Please see Appendix 1 for information on using non-WAAS external GPS receivers in conjunction with the G1.

# SECTION II

# OPERATIONAL ITEMS

### II. 1 Battery-life and How to Check Battery Status

The G1 data-logger is equipped with a (Lithium Ion) rechargeable main battery pack as well as a backup battery (also rechargeable). Since typical battery life of the main battery pack is around 24 hours with the unit running, it is recommended that the battery be recharged overnight (each night) when the data-logger is being used on a daily basis. You might also wish to carry a second battery pack for switch-out. It is also recommended that the data-logger be put on charger when not in use, so that the unit is always ready to go when needed. When the battery is fully-charged, the charger will automatically stop supplying power to the battery, so it is safe to keep the charger on. It is also recommended that the unit be placed on charger when data are being downloaded to a PC, following the performance of survey measurements. Charging is accomplished using the AC Adapter supplied with the data-logger (a DC vehicle charger unit is also available). The charger unit can be connected to either of the two COM Ports on the bottom side of the data-logger, although the right-hand side port is recommended. When the battery is charging, the green LED on the top-left side of the keypad will blink ON and OFF and when the battery is fully-charged, the LED will remain ON. The main battery pack will fully-discharge (from a fully-charged state) in about a 3 week period, with the unit switched off.

The status of the G1 data-logger's battery power, at any given time, can be checked to make sure that the battery has sufficient charge to conduct a survey or to run an SDL application.
The procedure used to check battery status is provided below.

## How to check the battery status

**Q100 Units:**
> Tap on the "Start" button on the "Home" screen ("Today" screen).
> Tap on "Settings" on the main menu
> Tap on the "System" tab at the bottom of the screen

> Tap on the "Handheld Settings" icon
> View battery status

**Q200 Units:**
> Tap on the "Start" button (bottom left-hand corner of desktop)
> Tap on "Settings" on the main menu
> Tap on "Control Panel"
> Double-tap on the "Power" icon
> View battery status

**Battery Status Indications:**
If the main battery status is shown as High, your battery should not need charging in the next few hours. If the status is shown as Low, you should consider charging the battery within the next few hours or so. However, if the status is shown as Critical, you should switch-out or re-charge the battery immediately.
When you switch-out the main battery pack, you will not lose the Operating System's registry or the application programs (assuming that the back-up battery is charged). In addition, you will not lose your survey or SDL data which are stored on a non-volatile CompactFlash memory card.

## II. 2    How the GPS Receiver Unit is Switched ON and How its Internal Battery Gets Charged

The GPS receiver unit is powered by an internal (re-chargeable) battery and the receiver unit will only generate position data if its internal battery is charged.
The internal battery receives its charging current from the G1's main battery whenever the receiver unit is switched ON.

However, the GPS receiver unit is only switched ON (automatically) when GPS data are required for an application, such as during a pipeline survey or when position data are required at a site during a site survey. The GPS receiver is only switched ON when data are required in order to minimize the power consumption rate of the G1's main battery.

In order to allow charging of the GPS receiver's internal battery outside of a survey application, the receiver unit is switched ON, automatically, whenever the G1 unit is placed on charger (see Section II. 1). Consequently, when the main battery of the G1 unit is being charged, the GPS receiver's internal battery also gets charged.

When the GPS receiver unit is switched ON, either because the G1's main battery is being charged, or in response to a survey application demand, the GPS receiver power ON icon, which is the letter G with a lightning bolt, will appear in the blue band at the top of then screen.

In order to avoid a significant time delay in acquiring GPS data in response to a survey application demand, the receiver's internal battery should be fully-charged prior to embarking on a survey. The best way to accomplish this is to fully-charge the G1's main battery prior to embarking on a survey.

**II. 3 How to Reboot (Reset) the G1**

Should the G1 data-logger lock up (freeze up), or fail to operate, the unit can be rebooted (or reset) in one of two ways:

**Soft RESET**

To perform a Soft RESET, press and hold down (simultaneously) both the Power button (Red key on keyboard) and the Orange button for about 5 seconds. The screen will go blank and your data-logger will perform a soft RESET. When you use Soft RESET, you do not lose the Operating System's registry, the G1's application software programs or your survey (or SDL) data. As mentioned above, your survey or SDL data are actually stored on a non-volatile CompactFlash memory card.

**Hard RESET**
To perform a Hard RESET, press and hold down (simultaneously) the following 3 keys for about 5 seconds:
The Power button (Red key on keyboard), the Orange button and the
**White button.**

**Note: A Hard RESET should be used as an emergency procedure only.**

When you perform a Hard RESET, you will lose the Operating System's registry and the G1's application programs. Your survey (or SDL) data, however, will be safe, as these data are stored on a non-volatile CompactFlash card.

After performing a hard reset, or in the event that all battery power is allowed to fully discharge, the application programs can be automatically re-installed from a copy of the programs saved on the CompactFlash card.

Following on-screen instructions, you will have to recalibrate the touch screen and re-enter your personal settings which will have been lost (with the lost registry). In addition, you will receive a "G1 Install" prompt to "Set the date and time". The program copying process (from CompactFlash card to RAM) will be launched after you have set the time and date on your G1 in response to this prompt. When the copying process is complete, the "MCM GPS Power Control" screen will appear. Simply exit this screen (making sure to leave the selection as "Power on when charging") to return to the G1 desktop. The application programs will have been re-installed automatically.

**II. 4 How to Run the Independent GPS Program**

There is a GPS program on the G1 that can be run independently of the survey application programs. You can use the program to view GPS position data on the G1 screen at a given location, and you can also log (save) the GPS position data. Logged data will be stored in a text file on your G1 and you can copy the file to your PC using ActiveSync.

**Q100 Units:**
To access the GPS program on Q100 units, tap on the "Start" button on the "Home" screen, which will pull up the menu shown below, and then tap on the "G1GPS" button.
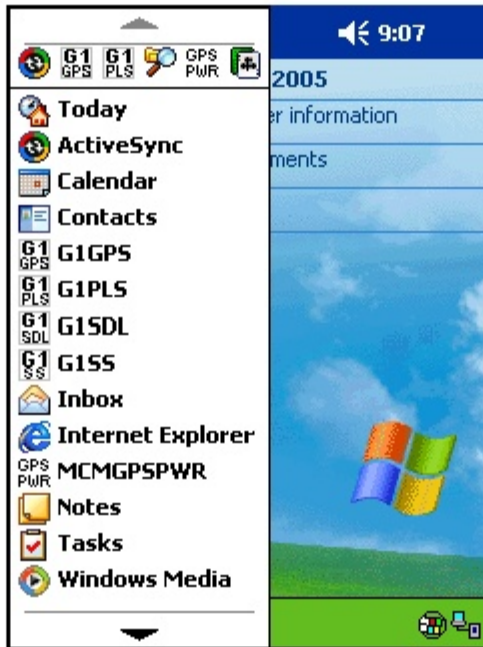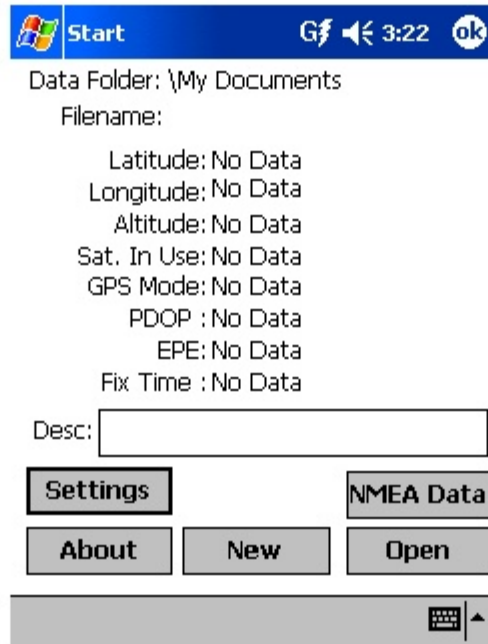
**Q200 Units:**

To access the GPS program on Q200 units, double tap on the "G1GPS" icon on the desktop shown below. Alternatively, you can tap on the "Start" button, tap on "Programs" and then tap on G1GPS.



In either case (Q100 or Q200 units), the screen shown below will appear.

Next, tap on the "Settings" button, which will pull up the screen shown below.
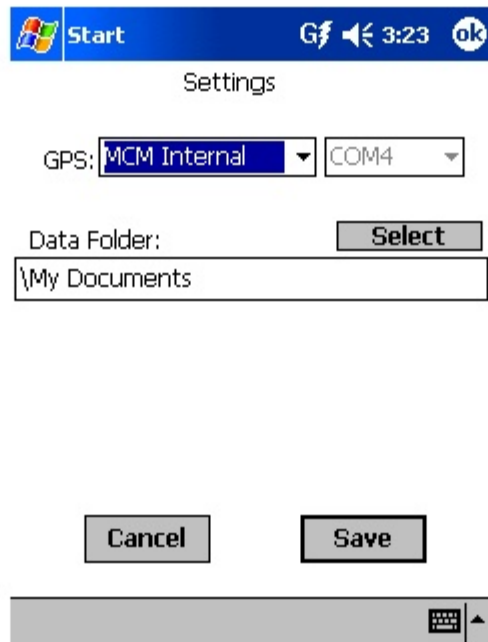


By tapping on the pull-down list arrow button in the GPS field, you can select the type of GPS receiver you are using. You can select either the "MCM Internal" receiver or an external "NMEA" compatible receiver, such

as a Trimble Pathfinder unit or a Garmin unit. If you select to use the MCM Internal receiver, COM 4 will automatically be selected. If you select "NMEA", you can select the COM Port by tapping on the drop-down list arrow button in the COM field. You can select COM 1 or COM 4. COM 1 is the left-hand (26-way) terminal on the data-logger and COM 4 is the right-hand terminal. COM 4 is recommended, which frees up COM 1 for ActiveSync.

<u>"Select" Button:</u>
The storage location (folder) for a GPS data file is the "My Documents" folder which exists on both the CompactFlash memory card and on the main memory. You can add a sub-folder, which you can name, by tapping on the "Select" button and adding a new folder. Your GPS position data file would then be stored in this sub-folder inside of the "My Documents" folder.

By tapping on the "Save" button on the Settings screen, you will be returned to the GPS data screen shown below.
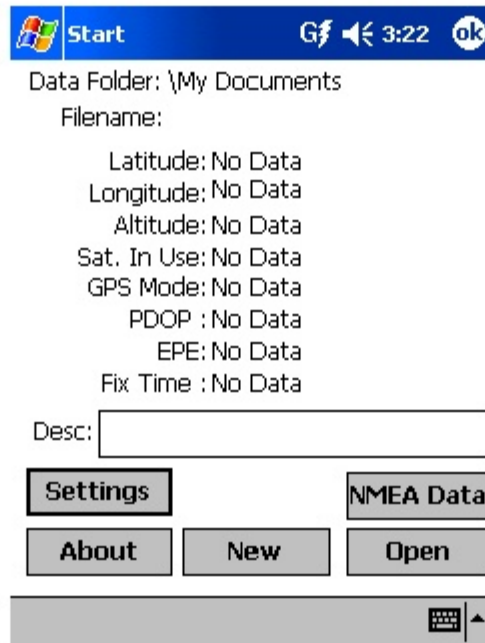


The data parameters are self-explanatory with the exception of the PDOP and EPE parameters. These acronyms stand for, Position Dilution of Precision and Estimated Position Error (available with Garmin receivers only). These data provide position accuracy information.
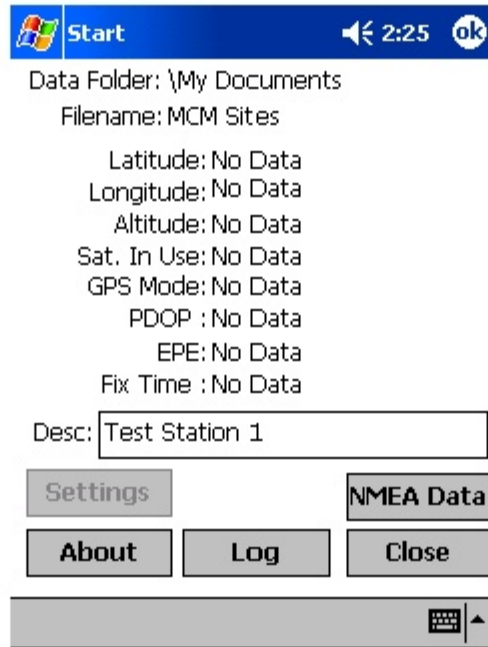
<u>Filename:</u>

You can set up a file to store the logged GPS data by tapping on the "New" survey button on the above screen. This will pull up the screen shown below.
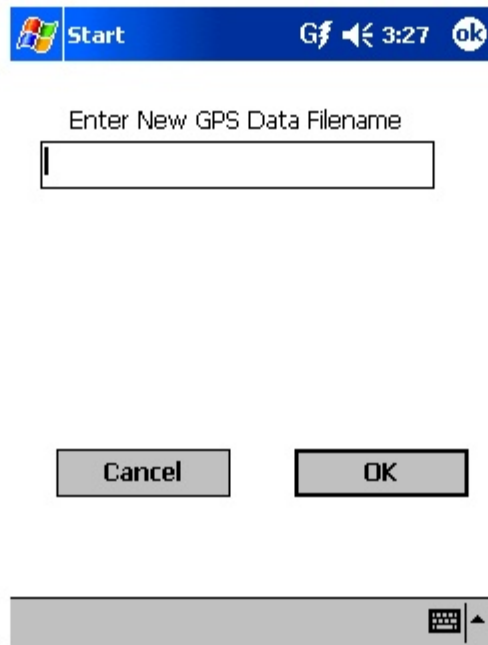


You are being asked here to enter a name for the file in which the GPS data will be stored.

By tapping on the OK button, the screen shown below will appear (for the case of an example file by the name of "MCM Sites".

Description:

You can provide a description of the location for which you are planning to log position data by tapping in the field labeled, "Desc:" and entering a description. The above screen shows "Test Station 1" as an example location description.

You would then be in a position to log GPS position data by tapping on the "Log" button on the above screen.

Alternatively, you could open a previously saved file by tapping on the "Open" survey button, as opposed to tapping on the "New" survey button.

In this case, you could elect to open a file that you had previously saved by selecting a file name from the drop-down list on the screen shown below.

By selecting a previously-saved file, you could, for example, continue to add GPS position data to an existing file that you had set up previously.

How to view saved data:
If you set up a file, as described above, and you logged GPS position data, at one location or multiple locations, you can view the saved data by accessing the file on the G1 using ActiveSync.

To do so, you would connect the G1 to your PC using the COM 1 Port (left-hand terminal), switch on the G1 and make sure that you had an ActiveSync connection. Next, you would double click on the following icons on your PC: My Computer, Mobile Device, My Pocket PC and My Documents.

Next, you would locate the text file (your filename.txt) and copy the text file to a folder on your PC, such as your "My Documents" folder. You can then open the file to display the saved GPS position data.

For instance, the window shown below illustrates an example in which GPS position data were logged at two locations ("Test Station 1" and "Test Station 2") and the data saved in a file named "MCM Sites".

From left to right, the data displayed are: date, time of position fix, latitude, longitude, altitude, GPS status (standard or differentially-corrected), number of satellites in use, the PDOP, the EPE and, finally, the description of the location (provided by you).

# SECTION III

# USING THE G1 DATA-LOGGER TO PERFORM PIPELINE SURVEYS

## III. 1   How to Set Up the G1 for CIS Applications

The following section outlines the steps required to setup the G1 to participate in CIS measurement applications. The setup 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 setup process 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 are stored. The process of transferring CIS data to a PC following completion of a survey is discussed in our CIS Training Manual –G1 Version.

## 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), in the case of the Q100 units, and the desktop screen, in the case of the Q200 units.

The startup screens for the Q100 and the Q200 units are illustrated below:

**Q100 Units:**



**Q200 Units:**

## Step 2:

In the case of the Q100 units, tap on the "Start" button on the "Home" screen. This will pull up the main menu.

## Step 3:

In the case of the Q100 units, tap on the G1 PLS button on the main menu. In the case of the Q200 units, double-tap on the G1PLS icon on the desktop or tap on the start icon (bottom left-hand corner of desktop), tap on the "Programs" button and tap on the G1PLS button.

In either case (Q100 or Q200 units), the survey screen shown below will be displayed.

Note: In the case of the Q200 units, the menu items are arrayed along the top of the screen.

## Step 4:
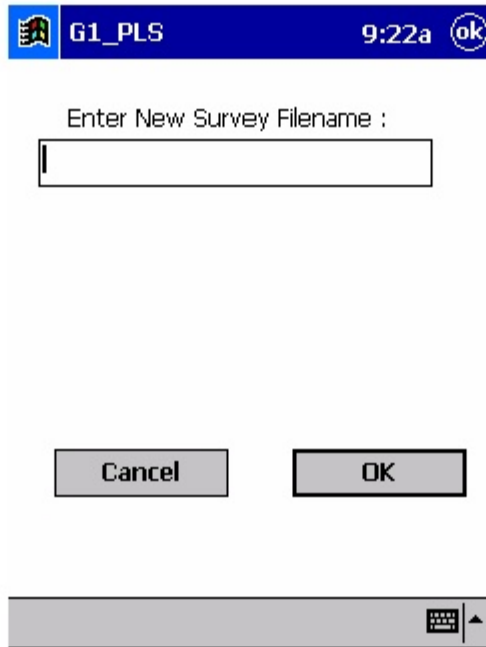
Tap on the "Survey" button located on the menu bar. The screen shown below will appear.



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.

Enter New Survey Filename :

Cancel          OK

## 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.



## 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 button in the "Survey Type" field as shown below.
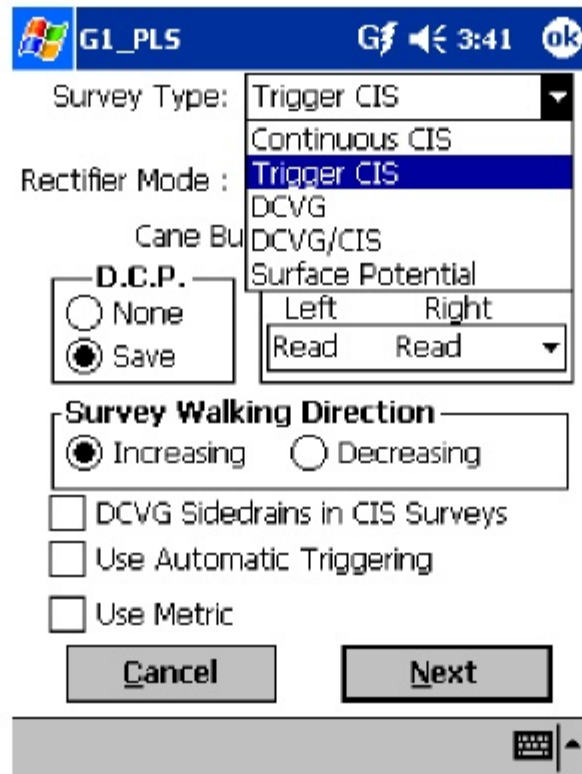
DCVG and combined DCVG/CIS surveys are available for selection (as well as Surface Potential), however, for CIS-Only surveys, either Continuous CIS or Trigger CIS should be selected by tapping once on the selection.

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.

Note: The "Trigger CIS" mode should also be selected when using the trigger cable (part # SIN024) for automatic triggering of readings in conjunction with the wire chainer/counter unit (http://www.mcmiller.com/pdfs/Chainer_Counter_Original.pdf ) or when using the Digital Trigger Cable for automatic triggering of readings (http://www.mcmiller.com/pdfs/Chainer_Counter_New.pdf ).

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 fields shown in the above screen.

The function of the cane buttons during regular survey measurements is determined by the selection made in the "survey" field, 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 (timer) mode].

If the Trigger CIS mode is selected (and the "Use Automatic Triggering" box is not checked), the screen will appear as shown below.
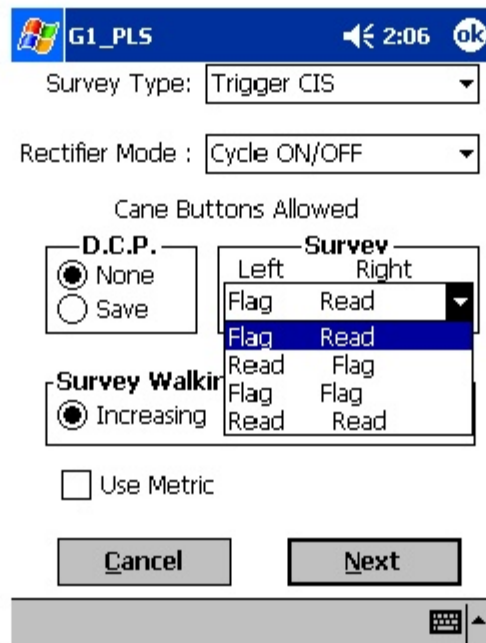
For the above screen, the pull-down-list arrow button in the Survey field was tapped to reveal the 4 choices for the push buttons on the pair of canes to be used in the Trigger CIS (the left cane, held in the left hand with the left thumb operating the left cane button and the right cane, held in the right hand with the right thumb operating the right cane button).

**Manual Triggering of Readings:**
**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.
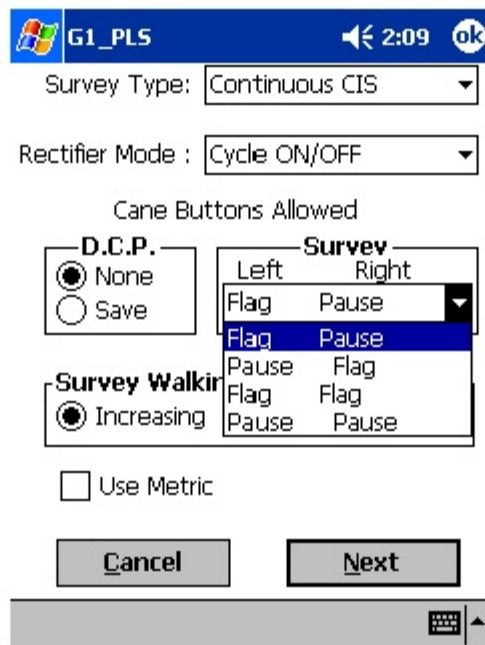
**Automatic Triggering of Readings:**

When the "Use Automatic Triggering" box is checked, the screen will be as shown below:
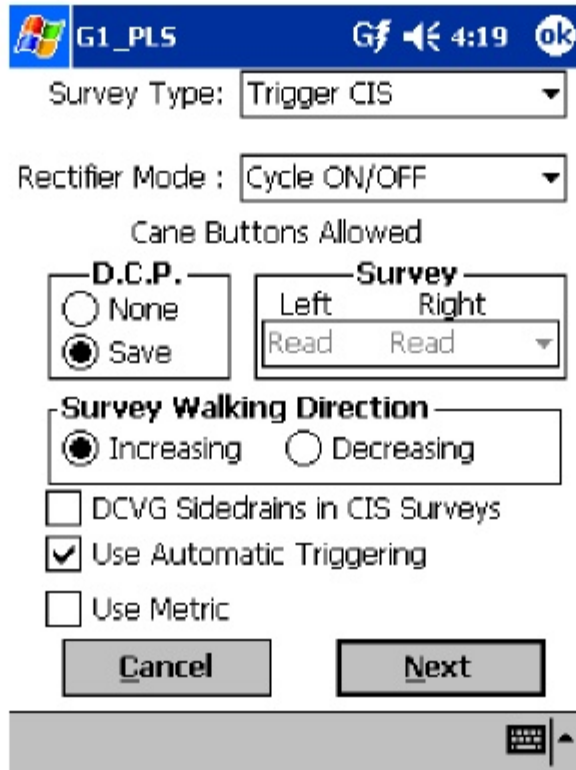
In the above case, the flagging option is disabled and the "Read Read" option is automatically selected.

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 field by tapping on the pull-down-list arrow button. 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. field 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 on the radial button of your choice.

If "None" is selected: Pressing a cane button switch 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 switch 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 switch on one of the canes, having tapped on the "Device" button on the screen when a "Device" is encountered.

# Step 10a:
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.

## Step 10b:
Make selection of "Metric" units if required.

By checking off the box labeled "Metric", the reading interval (distance between voltage recordings) and the flag internal (flag spacing) will be displayed on the Setup 3 of 5 screen in meters, as opposed to feet.

## Step 10c:
Check-off "DCVG Sidedrains in CIS Survey" if you plan to log DCVG sidedrain readings at previously located anomalies during the course of a CIS.

By doing so, a special "Device" selection , named "Mark DCVG" will be made available in the "Device" list, which has a sidedrain prompt associated with it, as indicated in the screens shown below.
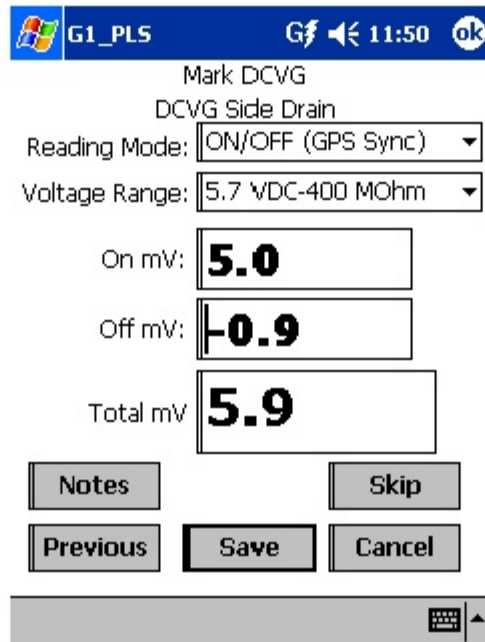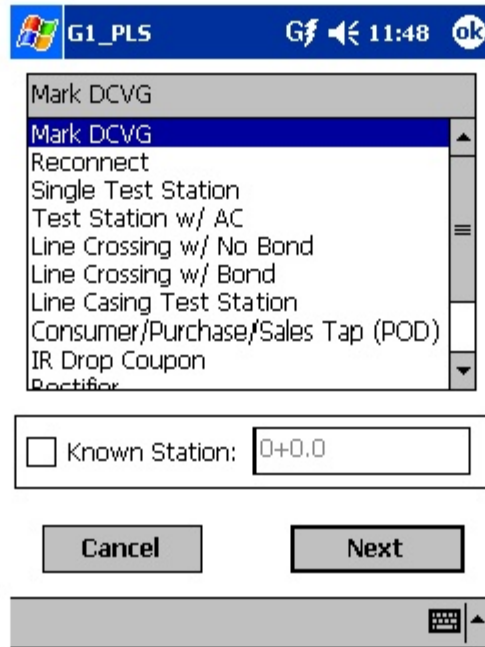
The "Mark DCVG" device will not appear in the Device list if this box is not checked, which would be the case if you were conducting a regular CIS.

## Step 10d:
Check-off "Use Automatic Triggering" if you plan to use the original trigger

cable (SIN024) or the new Digital Trigger Cable for automatic triggering of readings.

## 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 an 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 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 the High and Low voltages for one ON/OFF cycle of the waveform.

**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 (i.e., 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 be 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 1 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.
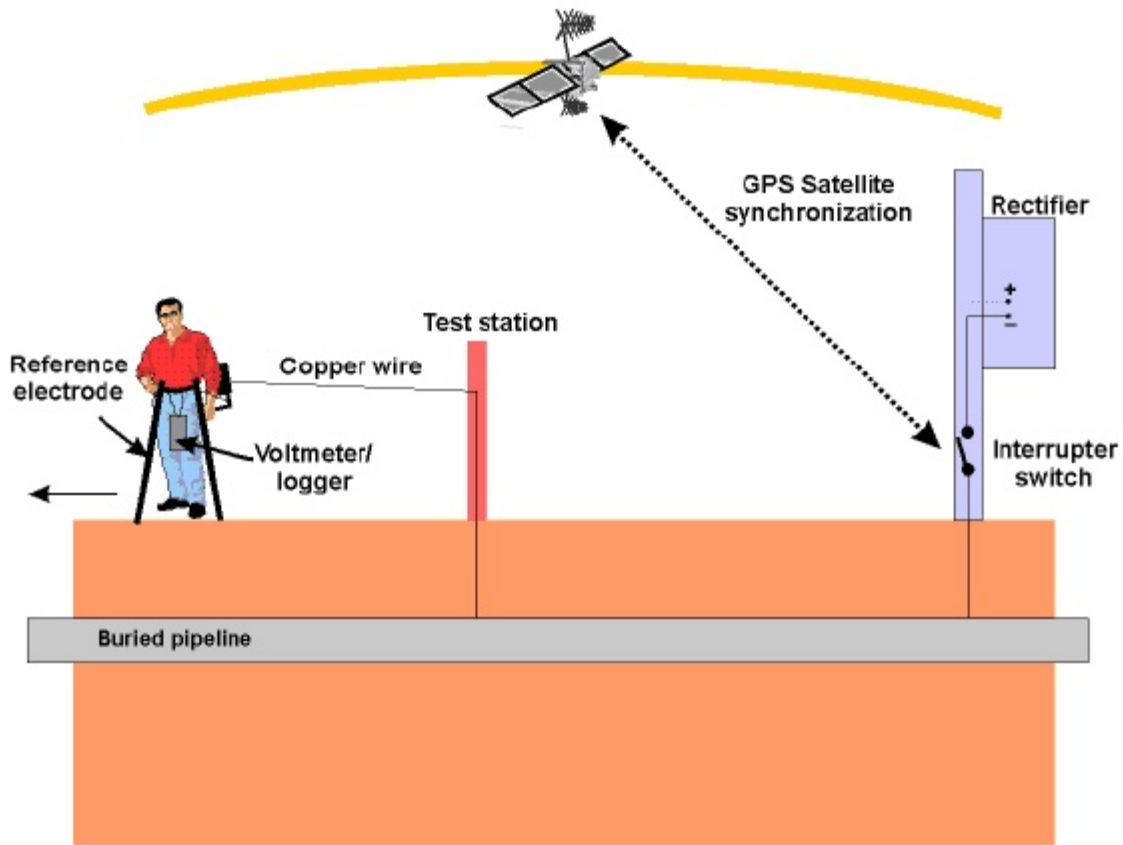
**Figure 1: A GPS satellite-synchronized high/low CIS mode illustration**

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 button in the "Rectifier Mode" field on the above screen, the screen shown below will appear.
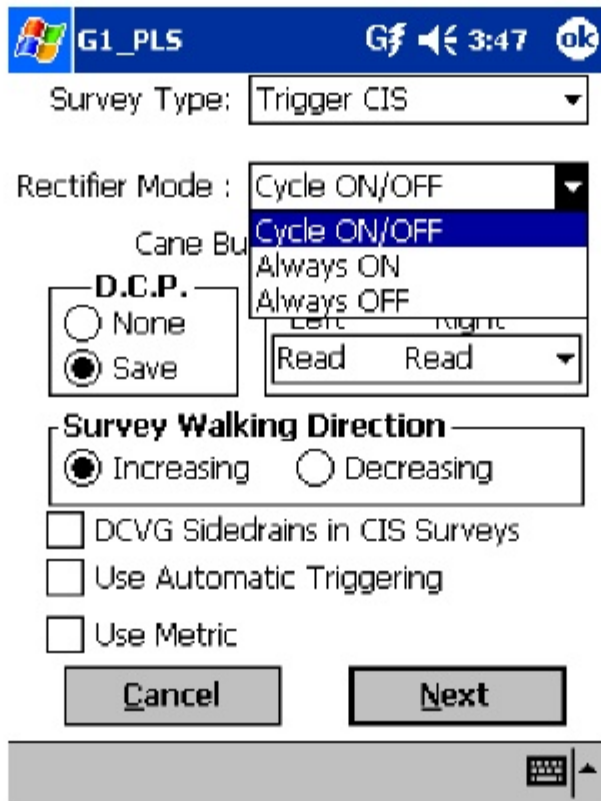
As can be seen from the above screen, there are 3 choices for "Rectifier Mode": **Cycle ON/OFF, Always ON and Always OFF.**

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.



## 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 field labeled, "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 field, 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:
Select Local Electricity AC Frequency
By tapping on the pull-down-list arrow button in the "AC System" field on the 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 in the "Beep if below" field on the above screen, a voltage value can be entered, for example -0.850. With this value entered, the G1 will beep to alert you to the fact that a voltage reading lower (more positive) 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 button in the "GPS" field on the above screen, the screen shown below will appear.
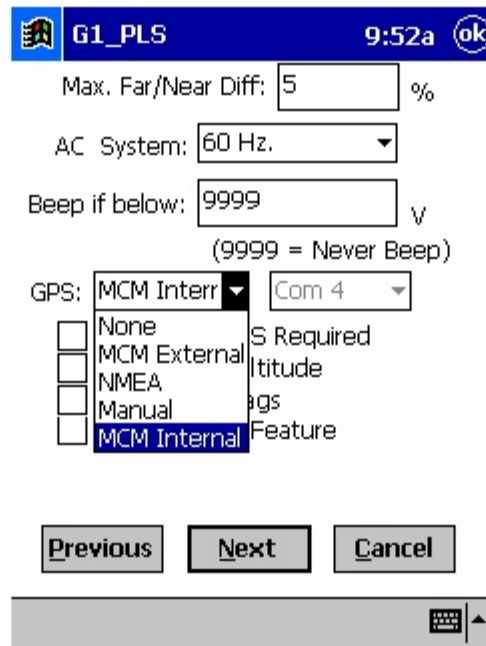


This selection pertains to the GPS receiver that you will be using in conjunction with your G1 data-logger. The GPS receiver can be called upon to record the precise location of "Flags", "Devices" and "Geographical Features" that are encountered during a CIS.

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'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.



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** position data to be logged by the data-logger. If this box is left unticked, it **means that you will allow the G1 data-logger to log either standard GPS** position data or differentially-corrected GPS position data.

Note: Logging "Standard" GPS position data is usually better than having no data logged at all, which would be the case if you checked this box and for some reason your GPS receiver was not outputting differentially-corrected position data. Consequently, it may be preferable to leave this box unchecked, unless it is imperative that you exclusively log differentially-corrected GPS position data.

**Use GPS Altitude:**
If this box is ticked, altitude data will be included with the position data whenever GPS data are logged. (Note: Altitude data on some GPS units are 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 switch 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.

**Auto Log GPS:**
By tapping on the drop down menu button in the "Auto Log GPS" field, the selections available will be displayed as indicated below.
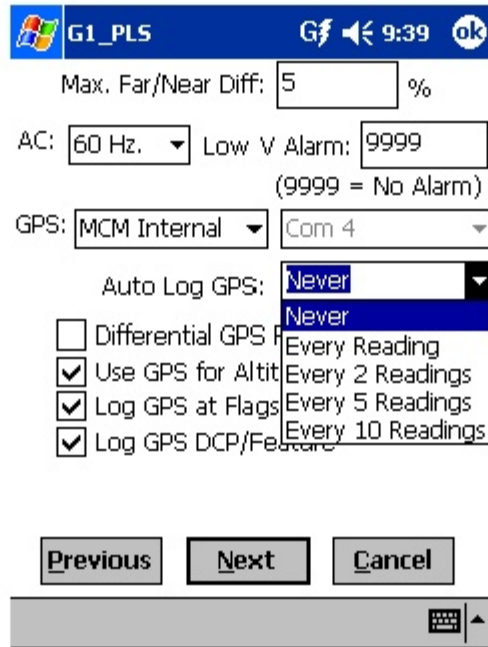
By selecting one of these options, you can elect to have the GPS position data logged automatically at every survey reading, at every second reading, at every fifth reading, at every tenth reading, or not at all (never) at survey readings.

## 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.

## Step 19:
Select Voltage Reading Interval (Distance Per Reading)

By tapping in the field on the above screen labeled, "Distance Per Reading" you can type in the voltage reading interval (distance, in feet (or meters for the metric case), expected between recordings). Typically, in CIS work this expected interval distance is 2.5 feet (or 1 meter in the metric case).

## Step 20:
Select Survey Flag Interval (Distance Between Flags)

By tapping in the field labeled, "Distance 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. Note: This option is disabled in the case of Automatic Triggering. Also, 2.5 feet (or 1 meter) is the automatic selection for "Distance per Reading" in the case of Automatic Triggering.

## 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 field 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 on either the "one" or the "two" radial button in the field labeled, "Number of Data Probes".

## Step 24:
Provide the Name of the Pipeline:

By tapping in the field 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 (if known).

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

## Step 26:

Provide the Starting Location for the Survey

You can select to have location information displayed on the survey screen as station number, feet or milepost (station number, meters or kilometers for the metric case).

Whichever selection you make here will determine how you enter your starting location information.

For example, if your pipeline locations are represented by station numbers, you would select "Station Number" from the drop down list and you would enter a starting location for the survey in the form of a station number. [If you do not know the station number where you're beginning your survey, enter 0+0.0].

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.

## Step 27:

Tap on the "Next" button on the above screen.

The screen shown below will appear.

## Step 28:
Provide the Work Order Number for the CIS

By tapping in the field labeled, "Work Order #", you can type in the work order number for the CIS.

## Step 29:
Provide Your Name

By tapping in the field 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 field 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 Reading Mode and Current Interruption Cycle** Selections

Tap on the "Next" button on the above screen.

The screen shown below will appear.
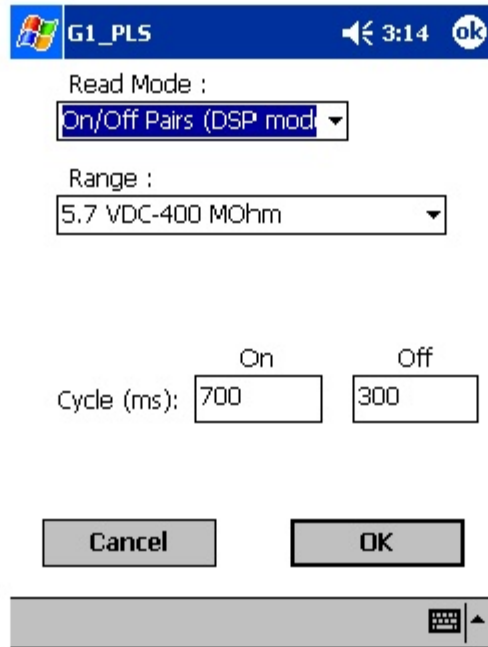
## Voltmeter Reading Mode:

The above screen is used to establish the reading 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.

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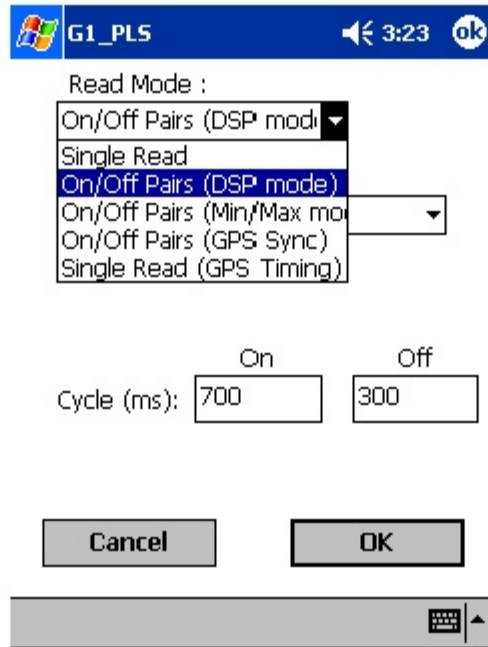
The 5 choices for voltmeter mode are as follows:

**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. 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.

**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 average maximum and minimum voltage readings during each rectifier-current cycle.

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



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.



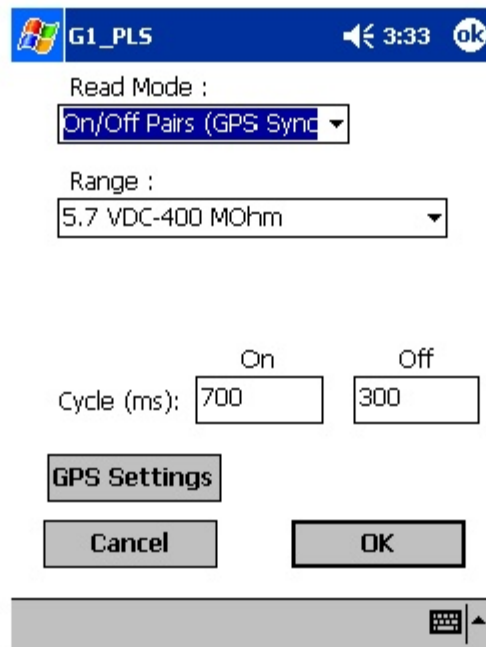Also, in this case, you would tap on the "GPS Settings" button, which would
bring up the screen shown below.
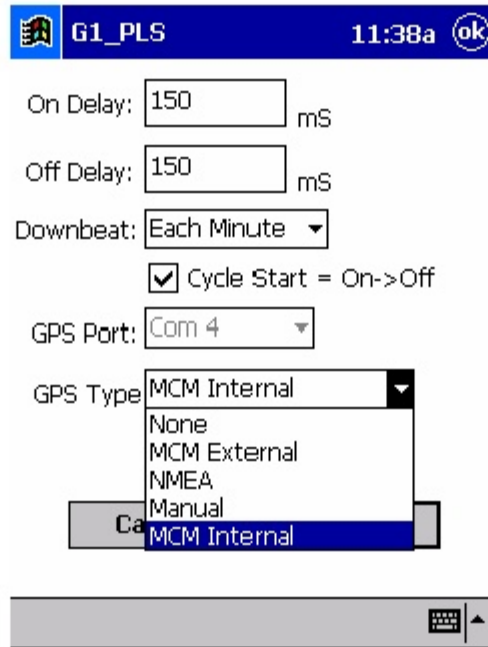
You are being asked here to make several selections.

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 field 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.

Next, select your current-interrupter's "Downbeat" frequency. As indicated by tapping on the pull-down-list arrow button in the "Downbeat" field, there are 3 selection choices; Each Minute, Each Hour and Midnight. If "Each Minute" is an option for your current interrupter, we suggest making this selection.

Finally, if your interruption 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.
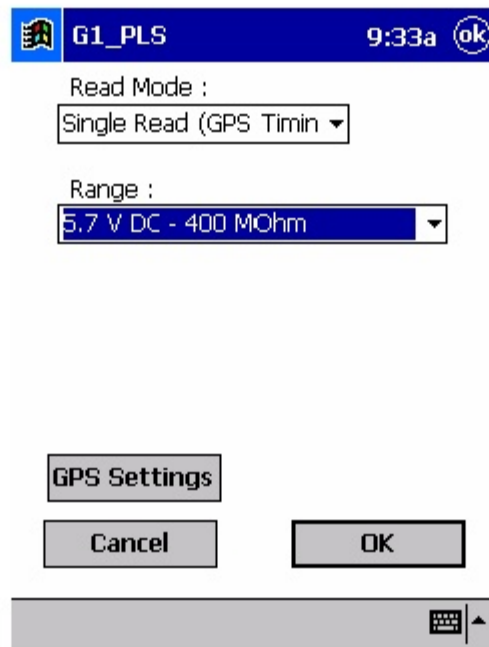


The only addition information that needs to be supplied here is the type of GPS unit you will be using (MCM internal or MCM external units ONLY), which you can select by tapping on the "GPS Settings" button and highlighting the appropriate type of GPS unit.

**Current Interruption Cycle:**
The specific On and Off times for the particular current-interruption waveform cycle that will be employed during your CIS should be entered in the "Cycle (ms)" fields. The On and the Off times should be entered in milli-seconds.

Note: Ideally, the interruption waveform period (which is the On time plus the Off time) should be less than the time between triggered voltage recordings on a CIS. For short waveform periods (< 1 second, for example) this is not a concern, as a typical walking pace would translate to a time between triggered voltage recordings of greater than 1 second.

However, care should be taken if longer waveform periods are in effect (for example, several seconds long waveform periods), in which case a slower than normal walking (and triggering) pace would have to be employed to avoid recording several same value readings until such times as a new waveform cycle has occurred.

## Step 32:
Select Voltmeter Range and Input Impedance

By tapping on the pull-down list arrow button in the "Range" field, you can select the voltmeter range and input impedance settings for your application.

**The recommended settings for the voltmeter for CIS are 5.7 Volts DC (full-scale) and an input impedance value of 400MOhm, These settings provide a relatively-fast response time (~80 ms), which is important in (fast cycle) rectifier-current-interrupted applications. Also, a 400MOhm input impedance setting eliminates reading errors associated with any high source resistance measurements.**

Note: Caution has to be exercised if any of the ranges beginning with the number 4 (for example, 4V, 400mV or 40mV) are selected for CIS applications, since these represent relatively-slow response settings. Such settings provide a higher level of AC filtering, but at the expense of speed of response. Rather than the response time of 80ms for the 5.7V range, these settings have a response time greater than 1 second. Consequently, such settings are not appropriate for fast current-interruption cycles, ie, interruption On and Off times shorter than 1 second, as true On and Off potentials would not be recorded.

## Step 33:
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, assuming that you have not selected the "Use Automatic Triggering" option.
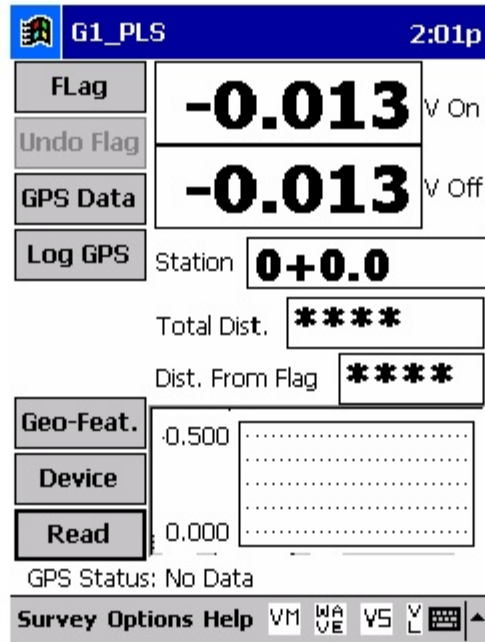


As voltages are recorded by the data-logger (by either tapping on the "Read button on the Survey screen or by pressing the appropriate data-probe push button switch, the "Total Distance" (total distance from the start of the survey) parameter will increase in increments of 2.5 feet (or 1 meter for the metric case), or whatever the "Distance 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).

If you selected the "Use Automatic Triggering" option, the screen will appear as shown below:

In this case, two additional buttons appear on the screen. The "Trg Off" button is used to temporarily interrupt (pause) automatic triggering of readings, which would allow you, for example, to maneuver around an obstacle and then restart automatic triggering (after having entered an appropriate skip distance via the Geo-Feat. Function – please see the CIS Training Manual). The "Trg Skip" button is used to interrupt automatic triggering of readings but the data-logger continues to advance stationing.

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

**You are referred to our CIS Training Manual – G1 Version for** information and recommendations on how to actually perform a CIS using the G1. This Training Manual also provides information on the use of our Reference Electrode Data Probes and gives an overview of the physical principles associated with a CIS.

### III. 2     How to Connect the G1 Data-Logger with the other Test Equipment for CIS Applications

The connections for CIS applications employing MCM test equipment are illustrated below in Figure 2.
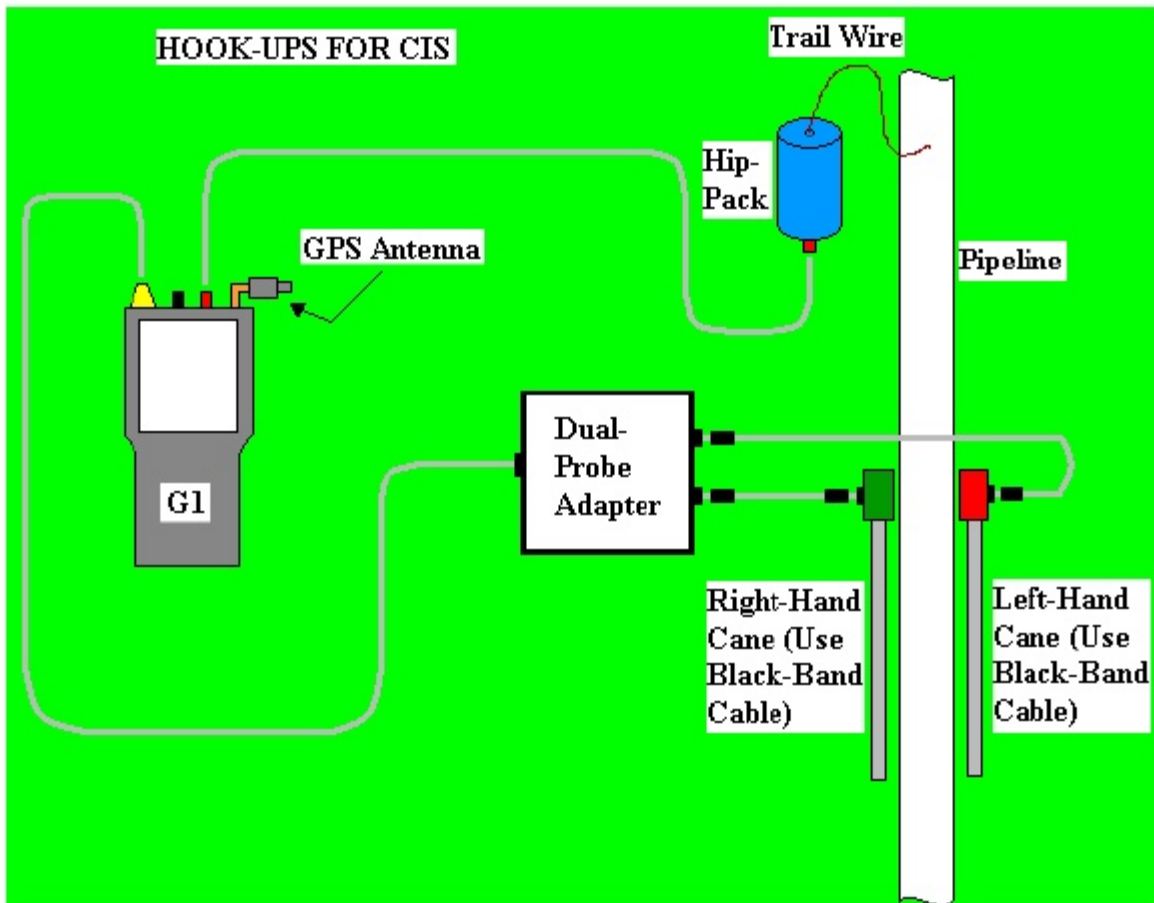


**Figure 2: Cable Connections for Hook-Up of MCM's CIS Test Equipment for Negative Pipe-to-Soil Readings**

As can be seen from Figure 2, a pair of canes 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 button switches 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. 1 for a discussion on cane button functionality (Step 9 of the Set Up Process).
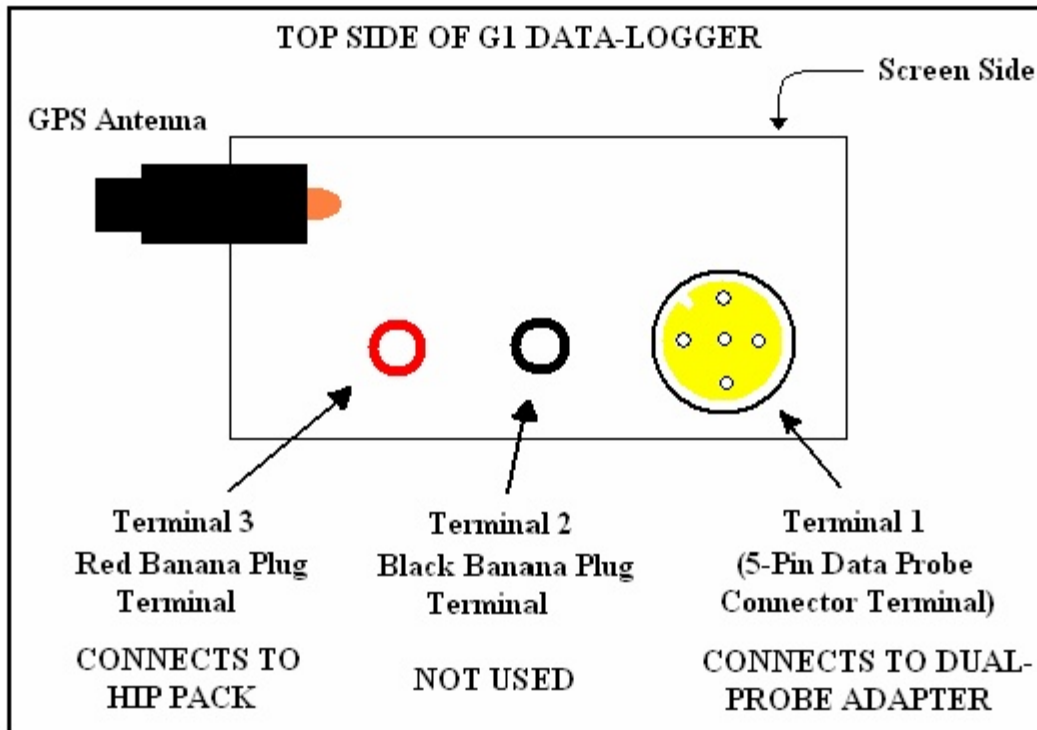
The canes (data probes) are connected as shown to the "input" terminals of the dual-probe adapter and the "output" terminal of the adapter is connected to a 5-pin Data Probe Connector socket on the top side of the data-logger. This effectively connects the canes (reference electrodes) to the negative side of the data-logger's voltmeter, since black-band cables are shown in the Figure. By using black band cables, negative pipe-to-soil readings will be recorded. For positive pipe-to-soil readings, red-band cables should be used.

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, in the case of negative pipe-to-soil readings. [The pipe would be connected to the negative side of the voltmeter in the case of positive pipe-to-soil readings]. The pipe electrical connection is made by hooking a cable from the red banana plug terminal (or the black banana plug terminal) on the top side of the data-logger 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 2 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 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. 1 (Step 17).

**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 in Figure 3.



**Figure 3: Connection terminals on top side of the G1.**

**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 when black band data-probe cables are used.
(Consequently, the black banana plug terminal (Terminal 2) is not used when push button canes are employed together with black band cables).

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. 1, the COM 4 Port is recommended to avoid conflict with ActiveSync.

### III. 3 How to Set Up the G1 for DCVG Survey Applications

The following section outlines the steps required to setup the G1 data-logger to participate in DCVG pipeline survey applications. The setup 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 DCVG application. The setup 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, DCVG survey data can then be retrieved by a PC that is in communication with the data-logger by accessing the file in which the survey data are stored.

## 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), in the case of the Q100 units, and the desktop screen, in the case of the Q200 units.

The startup screens for the Q100 and the Q200 units are illustrated below:

**Q100 Units:**



**Q200 Units:**



## Step 2:

In the case of the Q100 units, tap on the "Start" button on the "Home" screen. This will pull up the main menu.

## Step 3:

In the case of the Q100 units, tap on the G1 PLS button on the main menu. In the case of the Q200 units, double-tap on the G1PLS icon on the desktop or tap on the start icon (bottom left-hand corner of desktop), tap on the "Programs" button and tap on the G1PLS button.

In either case (Q100 or Q200 units), the survey screen shown below will be displayed.

Note: In the case of the Q200 units, the menu items are arrayed along the top of the screen.



## Step 4:

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

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 DCVG

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 DCVG survey.

**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.
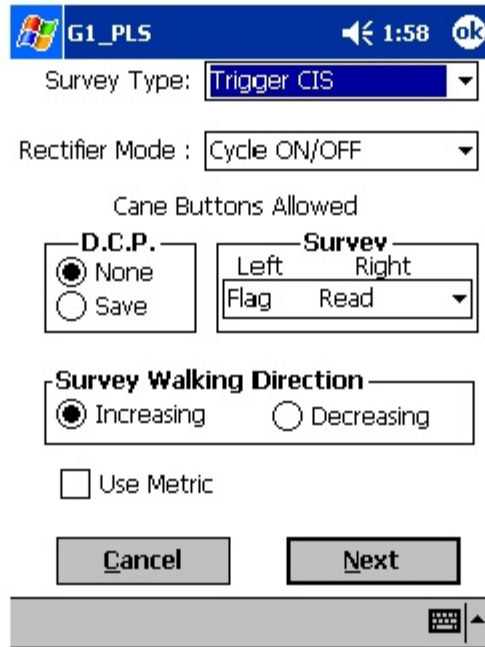
## Step 8:
Select "Survey Type".

The 5 available "survey types" can be seen by tapping on the pull-down list arrow in the "Survey Type" box as shown on the screen below.
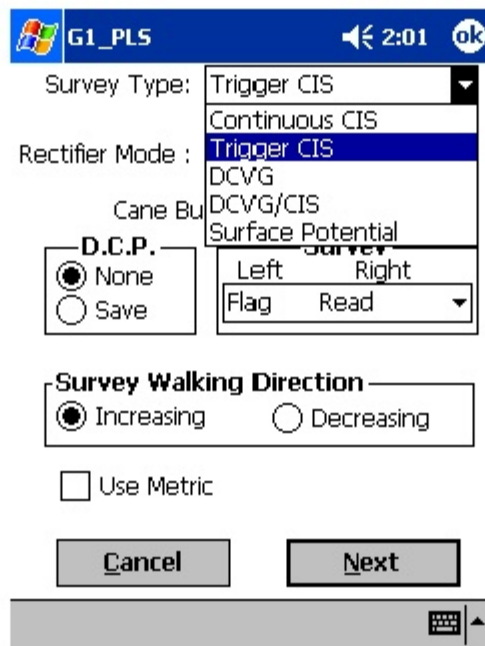
Tap on DCVG to select a DCVG survey type. The screen shown below will appear.



## Step 9:
Select Rectifier Mode.

Select "Cycle ON/OFF" in the "Rectifier Mode" field by tapping on the pull-down list arrow button and highlighting "Cycle ON/OFF". This is the only appropriate rectifier mode for DCVG surveys.

## Step 10:
Make "Cane Button" Functionality Choices

Typically, for DCVG surveys, you would "trigger" DCVG voltage recordings using the right-hand (positive) reference electrode and the left-hand reference electrode's push button switch would be used to designate the location of survey flags. For this case, your "Survey" selection for canes would be "Flag Read" as shown in the above screen. The other options can be viewed by tapping on the pull-down list arrow button in the Survey field.

You can also use either cane button when recording voltages at D.C.P.'s (data collection points (devices)) to "save" a device reading, as opposed to

tapping on the "save" button on the device screen. For example, with the selection as indicated on the above screen, device readings would be recorded automatically by triggering either cane button, which is the "save" option. If you prefer to tap buttons on the screen at Devices, select the "none" option in the D.C.P. box.

Note: When "Marking" DCVG anomalies (see DCVG Training Manual), the cane push-button functionality becomes "accept", regardless of whether "save" or "none" is selected here.

## Step11a:
Select Walking Direction

Finally on the above screen, you should indicate whether station numbers will be increasing or decreasing as you proceed in the survey direction by tapping on either "Increasing" or "Decreasing" in the "Survey Walking Direction" box.

## Step 11b:
Make selection of "Metric" units if required.

By checking off the box labeled "Metric", the reading interval (distance between voltage recordings) and the flag internal (flag spacing) will be displayed in meters, as opposed to feet.

Tap on the "Next" button on the above screen.

## Step 12:
Select GPS Type

By tapping on the pull-down-list arrow button in the "GPS:" field, you can select the type of GPS unit you will be using (if any) from the list shown below.

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 NMEA 0183 compatible GPS receiver is being used |
| Manual: | This means that location data will be entered manually when the GPS button is pressed on the survey screen during a DCVG survey. |
| MCM Internal: | This means that the G1'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 13:
Select GPS Options:

After selecting the GPS Receiver Type and COM Port, choices need to be made regarding GPS Options (see screen below).



If a GPS accessory has been selected for use with the data-logger for a particular DCVG survey, 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 GPS options available are as follows:

**Differential GPS Required:**
**This box should be ticked if you only want differentially-corrected GPS** position data to be logged by the data-logger. If this box is left unticked, it **means that you will allow the G1 data-logger to log either standard GPS** position data or differentially-corrected GPS position data.

Note: Logging "Standard" GPS position data is usually better than having no data logged at all, which would be the case if you checked this box and for some reason your GPS receiver was not outputting differentially-corrected position data. Consequently, it may be preferable to leave this box unchecked, unless it is imperative that you exclusively log differentially-corrected GPS position data.

**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 survey 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.

**Log GPS at Sidedrain/Anomaly:**
If this box is ticked, GPS location data will be logged automatically when DCVG defects (anomalies) are "marked", as described in our DCVG Training Manual – G1 Version.

**Auto Log GPS:**
By tapping on the drop down menu button in the "Auto Log GPS" field, the selections available will be displayed as indicated below.
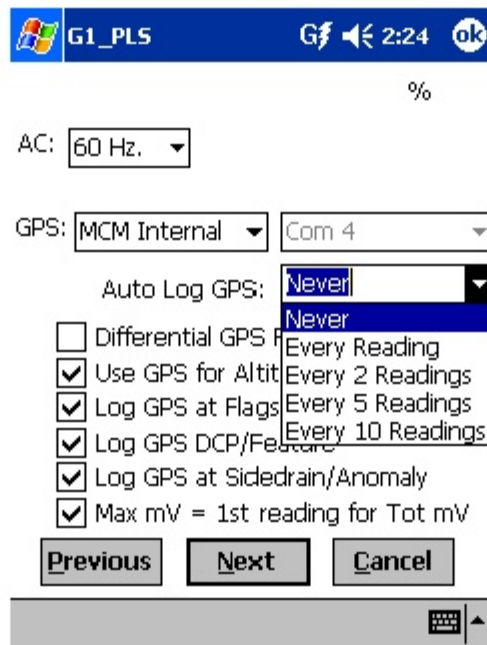
By selecting one of these options, you can elect to have the GPS position data logged automatically at every survey reading, at every second reading, at every fifth reading, at every tenth reading, or not at all (never) at survey readings.

## Step 14:
Select Max mV Reading to be First Reading in Total mV Determination.

The last box in the above screen is actually not related to GPS Options. If this box is ticked, the Max mV voltage value recorded at an anomaly location will automatically become the first voltage value used by the data-logger's software to calculate the Total mV (total voltage gradient). Otherwise, if this box is not ticked, you will have to repeat the Max mV recording a second time as part of the Total mV determination process. (See our DCVG Training Manual – G1 Version).

## Step 15:
Finally on the above screen, select the electricity supply operating frequency of the country in which you are performing the surveys (60Hz or 50Hz). For the U.S., select 60Hz.

Tap on the "Next" button on the above screen. The screen shown below will appear.

## Step 16:

Enter Pipeline Name and Survey Starting Location

**Provide the Name of the Pipeline:**

By tapping in the field labeled "Name of P/L", you can type in the pipeline name. Note: This is not the same as the filename for the DCVG survey that was selected back at Step 6. This is the actual name of the pipeline.

**Provide the Valve Segment Identification Number:**

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

**Provide the Starting Location:**

Provide the Starting Location for the Survey

You can select to have location information displayed on the survey screen as station number, feet or milepost (station number, meters or kilometers for the metric case).

Whichever selection you make here will determine how you enter your starting location information.

For example, if your pipeline locations are represented by station numbers, you would select "Station Number" from the drop down list and you would enter a starting location for the survey in the form of a station number. [If you do not know the station number where you're beginning your survey, enter 0+0.0].

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

## Step 17:
Select Voltage Recording Interval (Distance Between Recordings)

By tapping in the field on the above screen labeled "Distance Per Reading", you can type in the voltage reading interval (distance in feet (or in meters for the metric case) expected between recordings) for the DCVG survey. In DCVG work this expected interval distance is typically 5.0 feet.

## Step 18:
Select Survey Flag Interval (Distance Between Survey Flags)

By tapping in the box on the above screen labeled "Distance Between Flags", you can type in the survey flag interval (distance between survey flags in feet, or in meters for the metric case) for the section of pipeline being measured. Typically, survey flags are located at 100 feet intervals.

## Step 19:
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 field 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 5.0 feet and the survey flag separation is 100 feet, that means that 20 recordings are expected. If, however, only 15 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 16 recordings and a maximum of 24 recordings between survey flags to stay within the 20% (max.) error allowance.

## Step 20:

Select whether or not you would like the recordings to be uniformly spaced between survey flags, in cases where less than or greater than 20 recordings are made.

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 the flag spacing distance, regardless of the actual number of recordings made. Again, enabling this selection is recommended.

Tap on the Next button on the above screen. The screen shown below will appear.

## Step 21:
Provide the Work Order Number for the DCVG survey.

By tapping in the field on the above screen labeled, "Work Order #", you can type in the work order number for the DCVG survey.

## Step 22:
Provide Your Name.

By tapping in the field labeled, "Technician Name", you can type in your name or the name of your supervisor. If you use your supervisor's name here, you might add your own name in the Comments Section.

## Step 23:
Provide Comments.

By tapping in the field 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 and the Survey Start Date and Time.

**Note: Do not attempt to change the File Name indicated here as this identification will be required by the ProActive software to transfer your DCVG survey data to your PC.**

Tap in the Next button on the above screen. The screen shown below will appear.
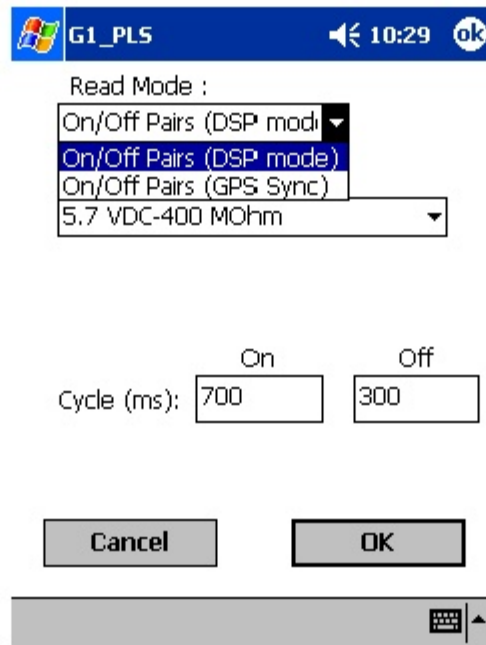


## Step 24:
**Select Voltmeter Settings and Current Interruption Cycle.**

**Voltmeter Reading Mode**
DCVG surveys are performed with the CP system's rectifier-current switched ON and OFF in a cyclic fashion and, as can be seen from the above screen, there are two choices available for the data-logger's voltmeter "Read Mode". The choices are "On/Off Pairs (DSP mode)" and "On/Off Pairs (GPS Sync)".

Note: On/Off Pairs (Min/Max) is not a option here since DCVG surveys require a measurable difference between On and Off voltages, ie, they require a significant IR drop.

**On/Off Pairs (DSP mode):**
In this mode, the voltmeter uses digital signal processing techniques to determine the "flat" portions (for both the On and Off parts of the cycle) of the rectifier-current cycle. ΔV values (see DCVG Training Manual) are then determined for the On and the Off portions of the cycle from which the DCVG voltage is calculated [ΔV(On) minus ΔV(Off)].

For these measurements to be successful, the data probes (reference electrode canes) must remain in good electrical contact with the soil for at least one rectifier-current waveform period following the initial contact of the probes with the soil, for a stable DCVG voltage value to be displayed.

**On/Off Pairs (GPS Sync):**
This voltmeter mode could be selected if you were using an MCM GPS receiver on your G1 data-logger and current-interrupter switches equipped with GPS units were being employed on the rectifiers. In this case, ΔV(On) and ΔV(Off) values are based on potentials measured at pre-determined sampling times on each waveform cycle, which are synchronized with the current-interruption switching timing.

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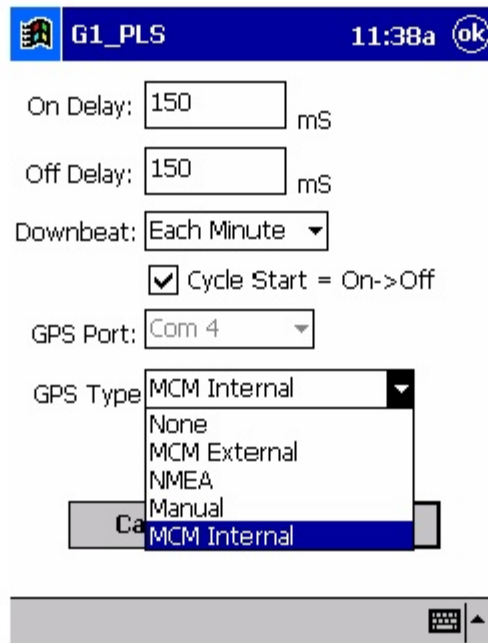


You are being asked here to make several selections.

First, select the type of GPS unit you will be using (the data-logger's Internal unit or the MCM External unit ONLY).

Next, enter your "On Delay" and your "Off Delay" selections by tapping in 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 DCVG 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.

Next, select your current interrupter's "Downbeat" timing. As indicated by tapping on the pull-down-list arrow button in the "Downbeat" box, there are 3 industry-standard selection choices; Each Minute, Each Hour and Midnight. If "Each Minute" is an option for your current interrupter, we suggest making this selection. The "Each Minute" designation indicates to the data-logger that a new interruption cycle will begin at the top of each minute. Consequently, the data-logger can reference its timing to the top of each minute. In this instance, your On plus Off times (your waveform period) should be an even multiple of 60.

Again, for these measurements to be successful, the data probes (reference electrode canes) must remain in good electrical contact with the soil for at least one rectifier-current waveform period following the initial contact of the probes with the soil, for a stable DCVG voltage value to be displayed.

Finally, if your interruption 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).

After making your "GPS Settings" selections, tap on the "OK" button which will return you to the Voltmeter Settings screen.

**Select the Cycle On/Off Times:**
The specific On and Off times for the particular current-interruption waveform cycle that will be employed during your DCVG survey should be entered in the "Cycle (ms)" fields. The On and the Off times should be entered in milli-seconds.

Note: After a time period corresponding to at least one waveform period (On time plus Off time), the DCVG voltage value displayed on the DA Meter survey screen should stabilize (assuming that the data probes are making good electrical contact with the soil) and a DCVG voltage recording can be triggered.

Consequently, the rate at which DCVG voltages can be captured and saved depends critically on the interruption waveform period. This is a particularly important issue in the case of large period waveforms. For example, if a 10 second On and a 2 second Off waveform is employed (12 second waveform period), stabilization times up to 12 seconds could be possible before each DCVG voltage recording can be made. In contrast, the stabilization period would be only on the order of one second for a 700ms On, 300ms Off interruption cycle.

**Select Voltmeter Range and Input Impedance Settings:**
By tapping on the pull-down list arrow button in the "Range" field, you can select the voltmeter range and input impedance settings for your application.

The recommended settings for the voltmeter for DCVG surveys 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 and also a relatively-sensitive scale with regard to the magnitude of the DCVG voltages that you'll be measuring.
Note: Caution has to be exercised if any of the ranges beginning with the number 4 (for example, 4V, 400mV or 40mV) are selected for DCVG applications, since these represent relatively-slow response settings. Such settings provide a higher level of AC filtering, but at the expense of speed of response. Rather than the response time of 80ms for the 5.7V range, these settings have a response time greater than 1 second. Consequently, such settings are not appropriate for fast current-interruption cycles, ie, interruption On and Off times shorter than 1 second, as true On and Off potentials would not be recorded.

## Step 25:
Pull-up "Active" Survey Screen

**By tapping on the "OK" button on the Voltmeter Settings screen, the "active" Survey screen would appear and you would be ready to proceed with your DCVG survey.**

An example starting "active" Survey screen is shown below.
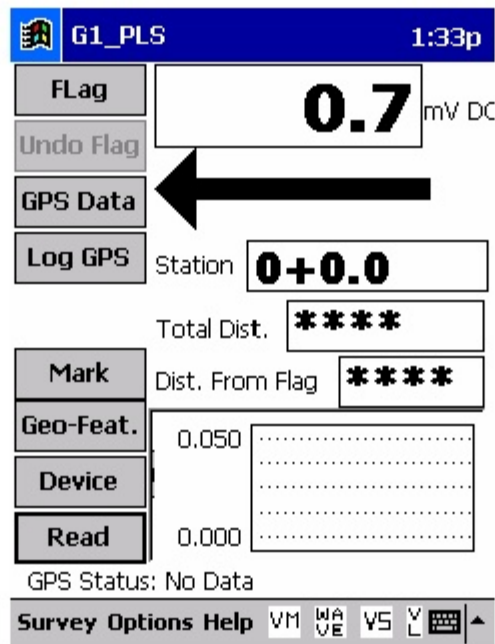


In the above "active" DCVG survey screen, the direction of the arrow (pointing to the left or pointing to the right) depends on the polarity of the DCVG voltage being measured. In the above case, the voltage being measured was positive which produced an arrow pointing to the left.
The opposite would be true if the DCVG voltage reading had been negative (ie, the arrow would point to the right).
With the reference electrodes properly positioned, the polarity of the DCVG voltage will always be positive in the case of perpendicular DCVG surveys (see our DCVG Training Manual – G1 Version). In this case, the arrow on the survey screen will always point back to the pipe.

However, a change in arrow direction will be evident when performing parallel, or in-line, measurements in the vicinity of a DCVG anomaly (coating defect). In this case, the arrow will always point in the direction of the defect location on the pipe with respect to where you are currently standing. As you approach the defect, the arrow will point towards the upcoming defect location and when you are past the defect, the arrow will point back to the defect location. Consequently, performing in-line measurements in the vicinity of a defect can be a good way to pin-point its precise location, by monitoring the arrow's polarity switches. When you are actually straddling a defect location (with the reference electrodes in-line with the pipe), the DCVG voltage will be zero (ie, neither positive nor negative) (see our DCVG Training Manual – G1 Version).

Also, with respect to the above "active" survey screen, as DCVG voltages are recorded by the data-logger, the "Total Distance" (total distance from the start of the survey) parameter will increase in increments of 5.0 feet , or whatever the "Distance Per Reading" value was that was entered back at Step 17. (Distances would be in meters for the metric case).

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 DCVG Survey.**

**You are referred to our DCVG Training Manual – G1 Version for** information and recommendations on how to actually perform DCVG Surveys using the G1 data-logger. This Training Manual also provides an overview of the physical principles associated with DCVG Surveys.

### III. 4    How to Connect the G1 Data-Logger with the other Test Equipment for DCVG Survey Applications

The cable connections for DCVG surveys employing MCM test equipment are illustrated below in Figure 4.
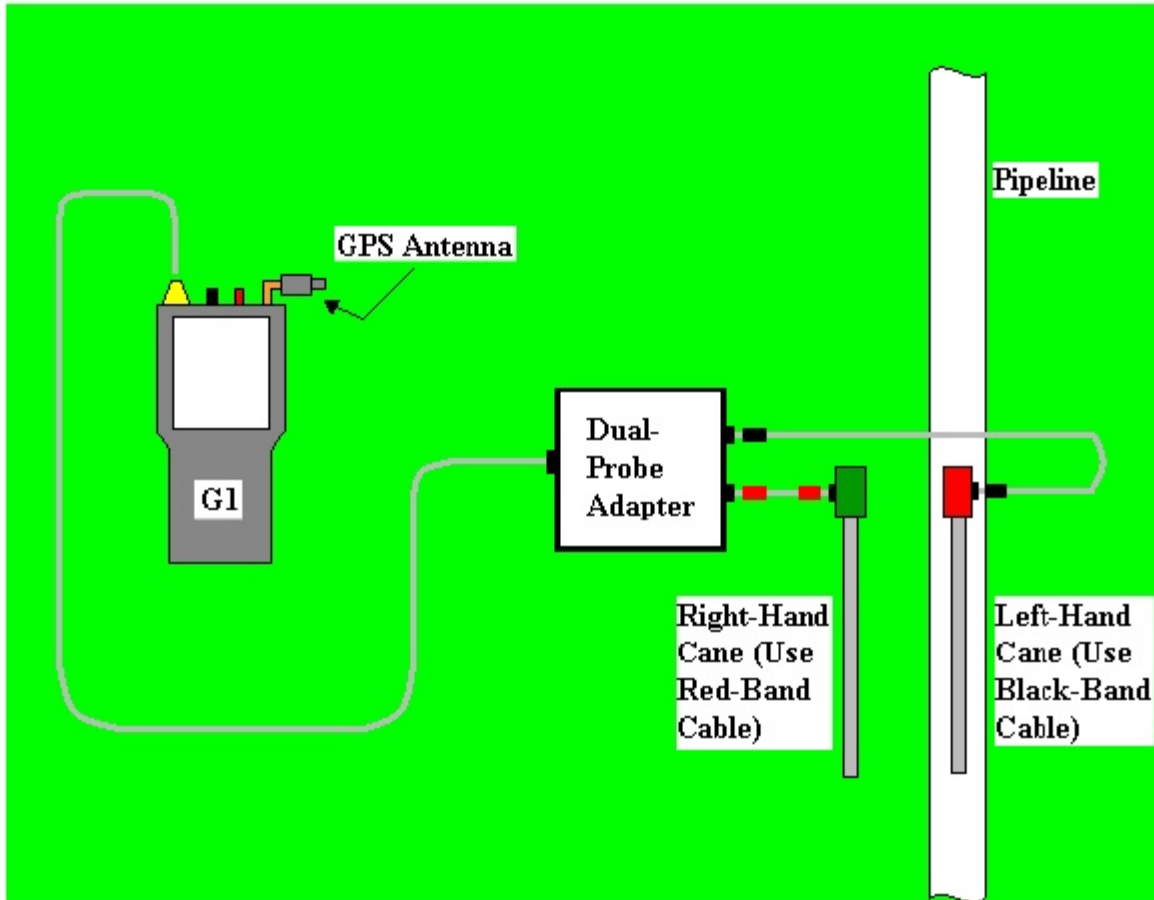


**Figure 4: Cable Connections for Hook-Up of MCM's DCVG Survey Test Equipment**

As can be seen from Figure 4, a pair of canes (reference electrodes) is illustrated, the left-hand cane (RED-handled cane) and the right-hand cane (GREEN-handled cane). These canes, which will be placed on the soil above the pipeline in either the "Perpendicular" or the "In-Line"

configuration (see DCVG Training Manual), have push button switches on top of the handles so that the operator can "trigger" voltage recordings on his command at each of the pipeline survey measurement locations as well as at "Devices" and "Geo-Features". See Section III. 3, Step 10 for a discussion on cane button functionality (Step 10 of the G1's 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.

NOTE: The left-hand reference electrode (red-handled cane) is connected to the dual probe adapter via a "black-band" cable while the right-hand reference electrode (green-handled cane) is connected to the dual-probe adapter via a "red-band" cable. This is important since the right-hand reference electrode connects to the positive side of the data-logger's voltmeter, while the left-hand reference electrode connects to the negative side of the voltmeter. The red-band and the black-band cables can be connected to either one of the dual-probe adapter's "input" terminals.

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 COM Port 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 GPS unit, the location of items such as flags, devices, geo-features and anomalies can be recorded during the performance of a DCVG survey, 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. 3 (Step 13).

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

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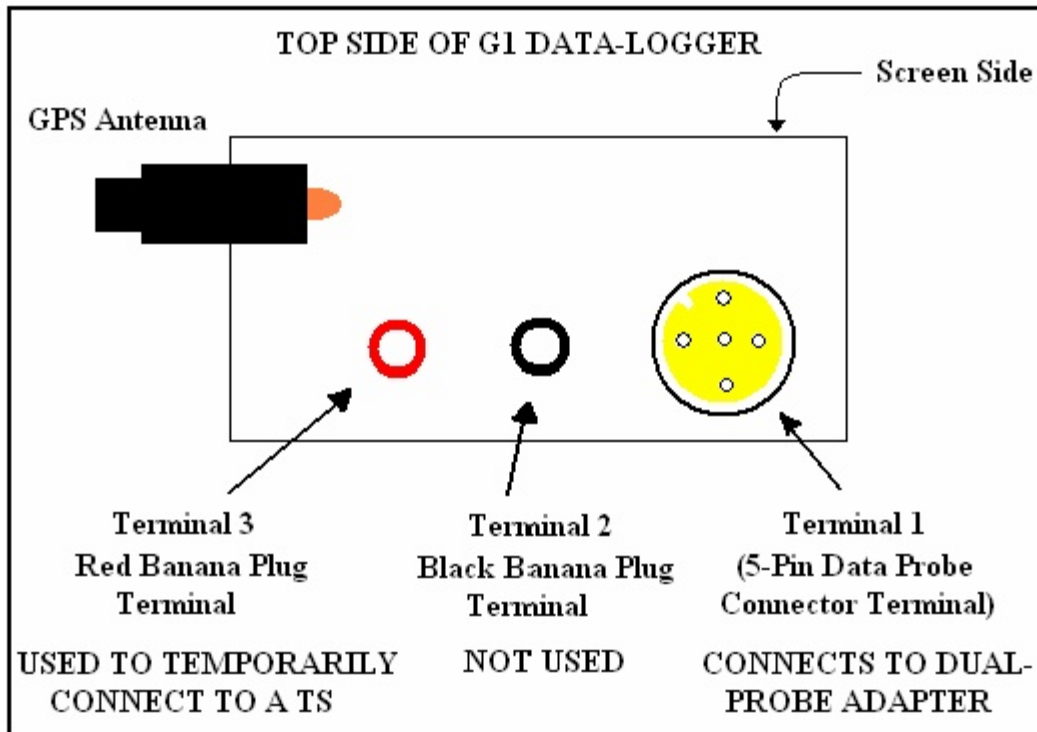
**Figure 5: Connection terminals on top side of the G1.**

The 5-pin Data Probe Connector Socket 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 positive (green-handled cane) or negative (red-handled cane) sides of the voltmeter with this connection.

**Consequently, the red and black banana plug terminals (Terminals 2 and 3)** are not used in this DCVG survey application.

However, the red banana plug terminal (Terminal 3) is used to connect (temporarily) a test cable between the G1and a test station (TS), in order to record pipe-to-soil voltages and voltage waveforms prior to beginning a DCVG survey (see DCVG Training Manual-G1 Version).

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. 3, the COM 4 Port is recommended to avoid conflict with ActiveSync.

### III. 5    How to Set Up the G1 for Combined DCVG/CIS Survey Applications

**Introduction:**

It is possible to collect both DCVG survey data and CIS data from a section of pipeline on a single pass by using the MCM Switch Box in conjunction with the G1 data-logger.

In this combined survey mode, at each measurement location, the DCVG data are first recorded and then the Switch Box performs a switching operation which allows the CIS pipe-to-soil voltages to be recorded. When the CIS data have been recorded, the G1 will "beep", which is the signal that you can move the reference electrodes to the next measurement location. Since, as discussed below, you will be effectively only using one reference electrode (one data probe) to collect the CIS data (the left-hand (red-handled) data-probe that will be positioned over the pipe), the CIS data will be determined from the cycle of the pipe-to-soil waveform that is sampled immediately after the trigger event. This explains why it is imperative that the data-probes remain in contact with the soil for at least one cycle after the trigger. Again, the DA Meter will "beep" to advise you that the CIS data have been recorded and that you can proceed to the next measurement location. In contrast, the DCVG data are determined from the cycle of the waveform occurring just in front of the trigger event. Consequently, it could take up to two waveform periods (two On plus Off times) to record both sets of data, from the time at which the data-probes make good electrical contact with the soil at each measurement location.

Another major difference between Combined DCVG/CIS applications and conventional DCVG and CIS applications is that, in the Combined DCVG/CIS case, only the push-button trigger on the left-hand cane (red-handled cane) is enabled (the push-button on the right-hand cane (green-handled cane) is disabled). This means that the trigger event that will initiate the recording of, first, the DCVG data and, second, the CIS data, will be pressing of the left-hand cane's push-button. This also means that flags will have to be designated by tapping on the "Flag" button on the Survey screen.

Prior to performing Combined DCVG/CIS applications, it is highly recommended that you first use the G1 data-logger to perform individual DCVG and CIS surveys, as described in the preceding sections, in order to become familiar with the test apparatus (including the G1) and the measurement procedures for both survey types. You are also referred to our DCVG and CIS Training Manuals which are companion manuals to the G1 User's Manual for specific instructions on how to perform these survey types.

**Setting Up Combined Surveys:**

The set up procedures for Combined DCVG/CIS applications, as far as the G1 is concerned, are very similar to those detailed above for DCVG surveys. You are referred to Section III. 3 for specific information on screen selections.
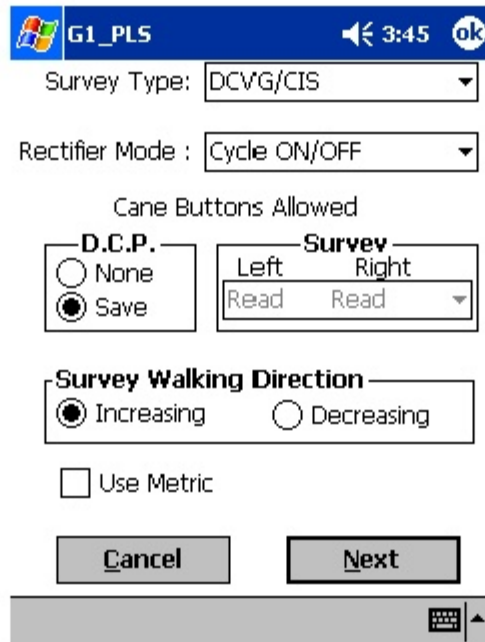


The first step is to select "DCVG/CIS" from the pull-down-list in the "Survey Type" box shown on the above screen.

You will notice that you are not able to select the functionality for the left- and right-hand data-probes in this survey type, since, as discussed above, the push-button on the right-hand cane (green-handled cane) is disabled. You will initiate the recording of, first, the DCVG data and, second, the CIS data, by pressing the left-hand cane's push-button at each measurement location down the length of the pipe.

You can, however, select the functionality you desire for the left-hand cane's push-button during "Device" measurements, ie measurements at data-collection points (D.C.P.'s). As before, you can select "None" which will mean that pressing the push-button at Devices will do nothing, or you can select "Save", which means that the data at D.C.P.'s will be saved when you press the push-button. Alternatively, you can tap on "Device" on the Survey screen and proceed to save data as described in previous sections.

You should then proceed through the various set up screens, making your selections as before. Since this is a Combined DCVG and CIS application, you will only have two choices regarding Voltmeter Read Mode (since the DCVG part requires current-interruption and measurable differences between ON and OFF pipe-to-soil voltages (ie, measurable IR drops, which rules out the Min/Max mode). The two options are On/Off Pairs (DSP mode) and On/Off Pairs (GPS Sync. mode). Again, the GPS Sync. mode can only be selected if you are using either the MCM Internal GPS or the MCM External GPS receiver and you are also using current-interrupters with integrated GPS receivers.

Once you have gone through the setup screens, the Survey screen will appear as shown below.
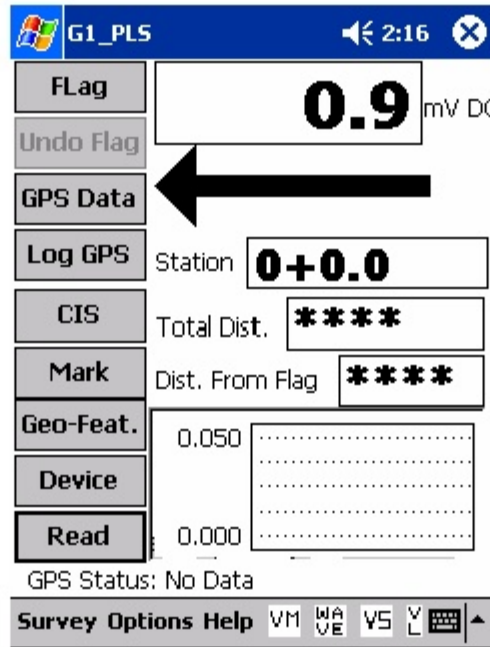
As can be seen from the above screen, the Combined DCVG/CIS Survey screen looks very similar to the DCVG survey screen (see Section III. 3 for a full description of this screen).

The major difference, however, is the presence of the "CIS" button. You can, at anytime during the Combined Survey, tap on the "CIS" button to view the CIS data that has been recorded. The data will be displayed on the graph.

After viewing the CIS graph, you can return to the above screen by tapping on the "DCVG" button which will have replaced the "CIS button".

As mentioned in the Introduction to this section, DCVG and CIS data can be collected at each measurement location by virtue of using an MCM Switch Box. When you select the "DCVG/CIS" Survey Type, the G1 will enable the "DCVG/CIS Switch" option.

You can check to make sure that this Switch option has been enabled by tapping on "Options" and then tapping on "Settings" which will pull up the screen shown below.
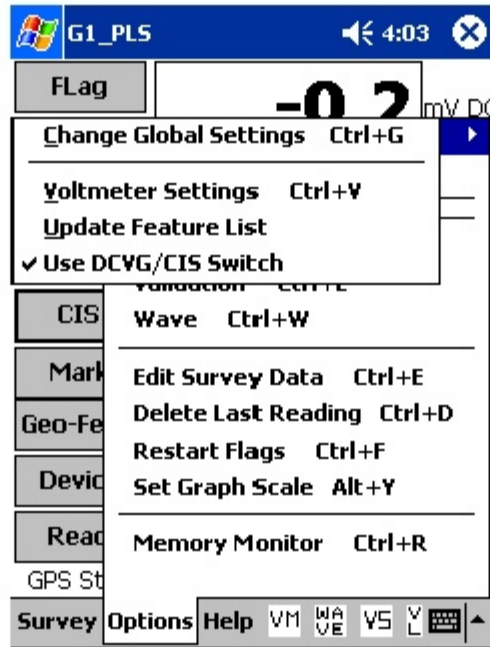
The tick beside the "Use DCVG/CIS Switch" option indicates that this option has been enabled.

### III. 6 How to Connect the G1 with the other Test Equipment for Combined DCVG/CIS Applications

The cable connections for Combined DCVG/CIS applications employing MCM test equipment are illustrated below in Figure 6.
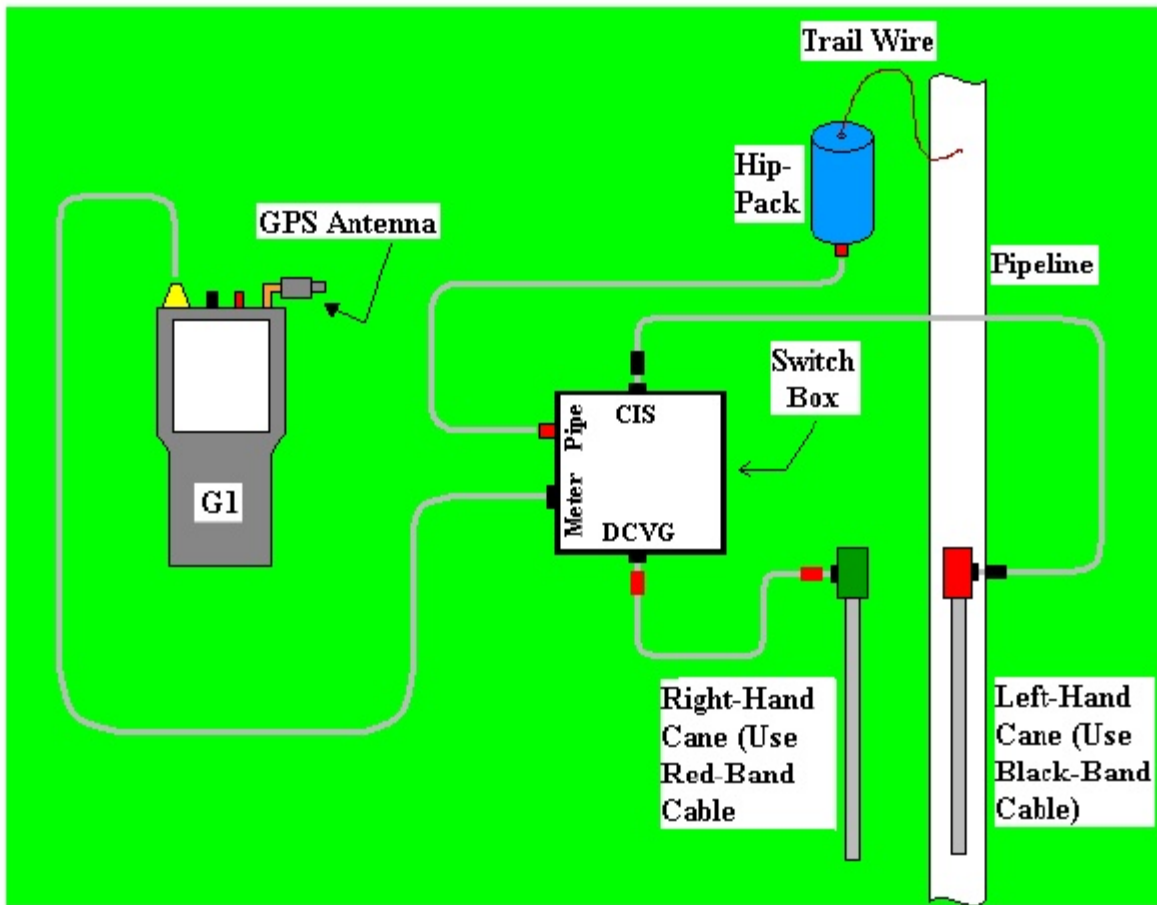
**Figure 6: Cable Connections for Hook-Up of MCM's Combined DCVG/CIS Survey Test Equipment**

As can be seen from Figure 6, a pair of canes (reference electrodes) is illustrated, the left-hand cane (RED-handled cane) and the right-hand cane (GREEN-handled cane). The canes are placed on the soil in the "Perpendicular" configuration (see DCVG Training Manual-G1 Version).

As discussed in the Introduction to this section, only the push-button on the left-hand cane (red-handled cane) is enabled for Combined DCVG/CIS applications. This cane is positioned directly over the pipe and it is connected to the MCM Switch Box via the "black-band" cable. The "black-band" cable is connected to the Switch Box at the 5-pin terminal labeled as "CIS".

The right-hand cane (green-handled cane) is connected to the Switch Box via the "red-band" cable and this cable is connected to the Switch box at the 5-pin terminal labeled as "DCVG".

The cable connecting the G1 data-logger to the Switch Box is connected to the 5-pin terminal labeled, "Meter", on the Switch Box. Finally, the banana plug cable connecting the Hip-Pack (Trail Wire) to the Switch Box is connected to the banana plug terminal labeled, "Structure" on the Switch Box.

The GPS Antenna illustrated on the top side of the G1 in Figure 6 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 GPS unit, the location of items such as flags, devices, geo-features and anomalies can be recorded during the performance of combined surveys, 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 in Section III. 3 (Step 13).

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

The terminals on the top side of the data-logger for the various connections described above are illustrated in Figure 7 below.
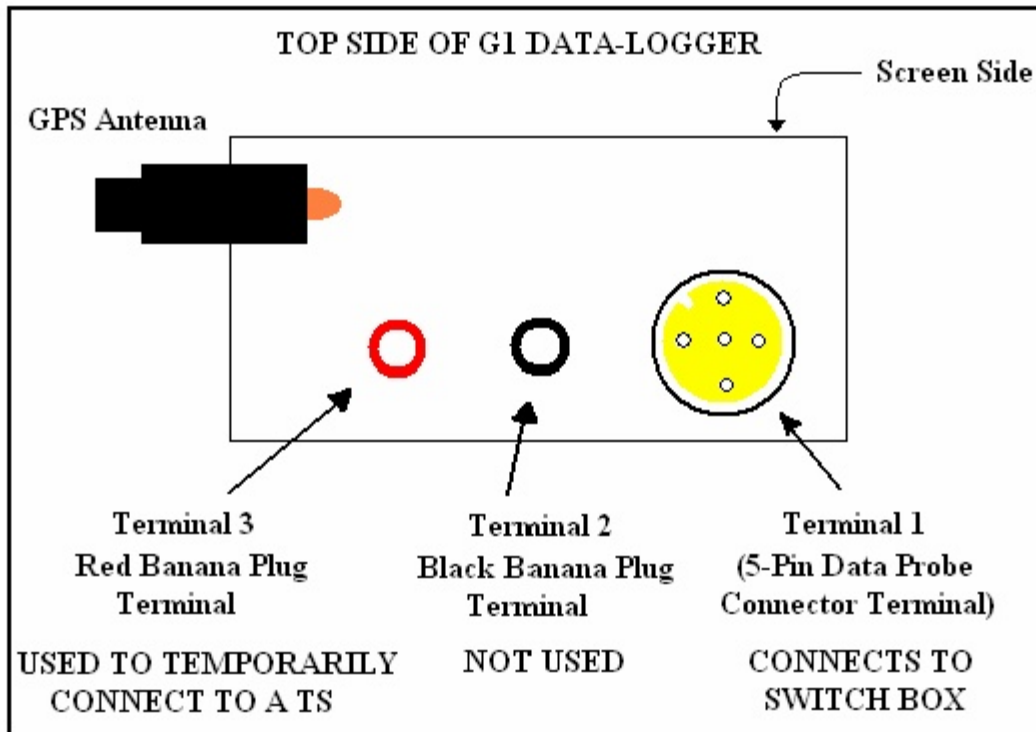
**Figure 7: Connection terminals on top side of the G1.**

The 5-pin Data Probe Connector Socket is shown above as Terminal 1. As discussed above, the reference electrode canes are connected to this terminal via the Switch Box.

The red and black banana plug terminals (Terminals 2 and 3) are not used in this Combined DCVG/CIS application.

However, the red banana plug terminal (Terminal 3) is used to connect (temporarily) a test cable between the G1 and a test station (TS), in order to record pipe-to-soil voltages and voltage waveforms prior to beginning a Combined DCVG/CIS survey (see DCVG Training Manual G1 Version).

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. 3, the COM 4 Port is recommended to avoid conflict with ActiveSync.

### III. 7 How to Set Up the G1 for Surface Potential Survey Applications

The following section outlines the steps required to setup the G1 data-logger to participate in Surface Potential survey applications. The setup 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 Surface Potential application. The setup process also establishes a file in which the voltage recordings (survey data) will be stored. At the completion of the survey, Surface Potential survey data can then be retrieved by a PC that is in communication with the data-logger by accessing the file in which the survey data are stored.

## Step 1:

Switch on the G1 by pressing the power button (red key on keyboard). Assuming that the battery pack is charged, the screen will light up and will display the "home" screen ("Today" screen), in the case of the Q100 units, and the desktop screen, in the case of the Q200 units.

The startup screens for the Q100 and the Q200 units are illustrated below:
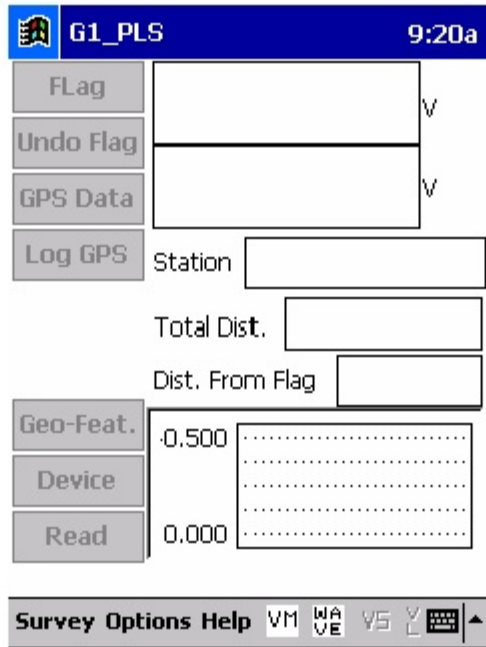
**Q100 Units:**

**Q200 Units:**



## Step 2:
In the case of the Q100 units, tap on the "Start" button on the "Home" screen. This will pull up the main menu.

## Step 3:
In the case of the Q100 units, tap on the G1 PLS button on the main menu. In the case of the Q200 units, double-tap on the G1PLS icon on the desktop or tap on the start icon (bottom left-hand corner of desktop), tap on the "Programs" button and tap on the G1PLS button.

In either case (Q100 or Q200 units), the survey screen shown below will be displayed.

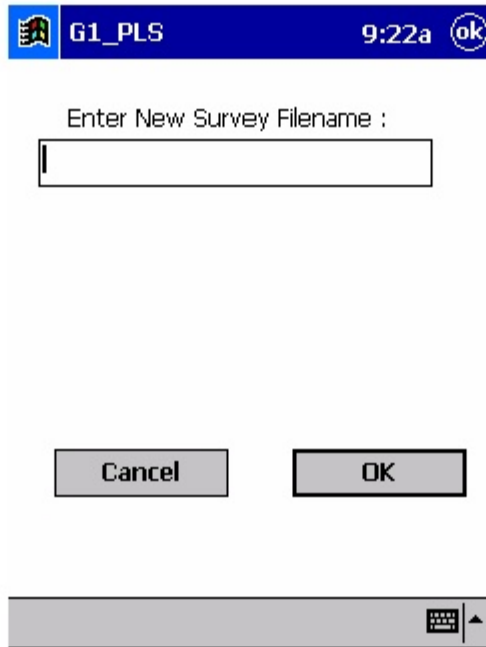Note: In the case of the Q200 units, the menu items are arrayed along the top of the screen.

## Step 4:

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



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 SP

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 SP survey.

**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.**
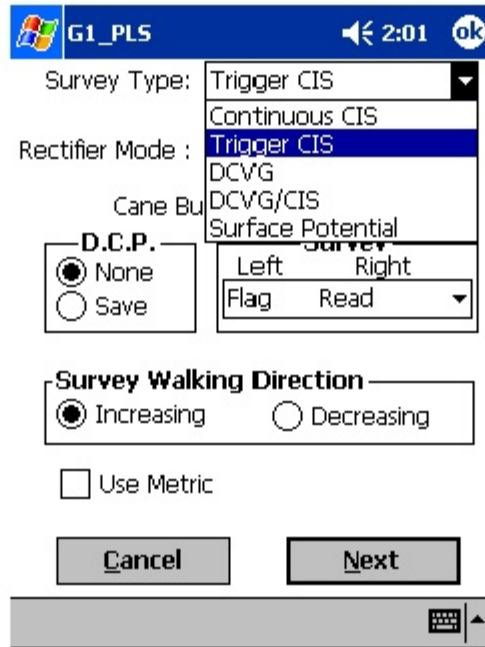
## Step 7:
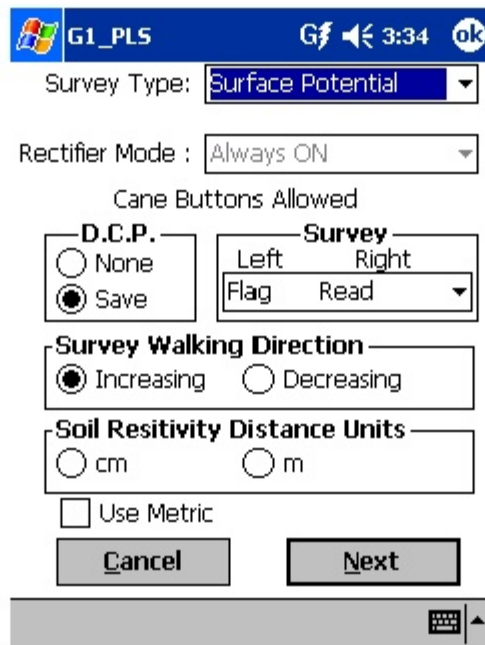Tap once on the OK button. The screen shown below will appear.
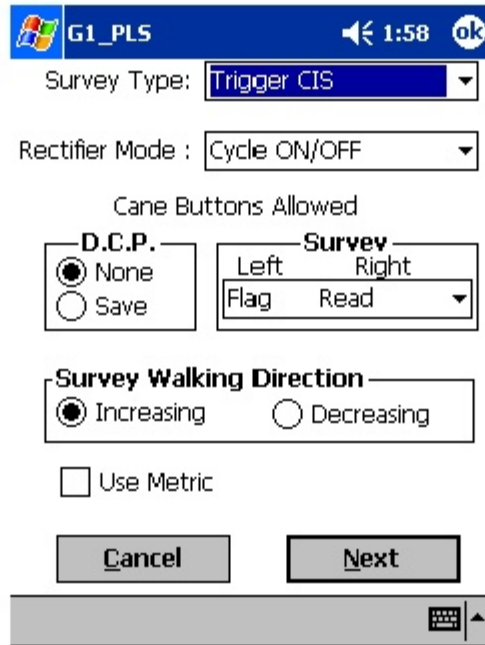


## Step 8:
Select "Survey Type".

The 5 available "survey types" can be seen by tapping on the pull-down list arrow in the "Survey Type" box as shown on the screen below.

Tap on "Surface Potential" to select a Surface Potential survey type. The screen shown below will appear.

## Step 9:
Select Rectifier Mode.

A menu option is not available for "Rectifier Mode", in the case of Surface Potential surveys, as such surveys are conducted on non cathodically-protected pipe.

## Step 10:
Make "Cane Button" Functionality Choices

Typically, for Surface Potential surveys, you would "trigger" voltage recordings using either the positive (green-handled) reference electrode data-probe or the negative (red-handled) reference electrode data-probe. In the case where an "in-line" survey is to be performed by two crew members (one holding the positive electrode (green-handled data-probe), the other holding the negative electrode (red-handled data-probe), the choice of which push-button switch to designate as the "trigger" for readings will depend on which data-probe the crew member operating the G1 is holding. If the G1 operator holds the red-handled (negative) data-probe, the selection should be "read flag" in the "Survey" category and, if the G1 operator is holding the green-handled (positive) data-probe, the selection should be "flag read". In either case, the crew member who is not the G1 operator could use his push-button switch to designate the location of survey flags.

You can also use either cane button when recording voltages at D.C.P.'s (data collection points (devices)) to "save" a device reading, as opposed to tapping on the "save" button on the screen.

Note: When "Marking" SP anomalies (see the Surface Potential Training Manual – G1 Data-logger Version), the cane push-button functionality becomes "accept", regardless of whether "save" or "none" is selected here.

## Step11a:
Select Walking Direction

On the Setup 1 of 5 screen, you should indicate whether station numbers will be increasing or decreasing as you proceed in the survey direction by tapping on either the "Increasing" or "Decreasing" radio button in the "Survey Walking Direction" field.

## Step 11b:

Select the length units for your "Soil Resistivity" measurements.

As indicated in the Surface Potential Survey Training Manual, you have the option to manually enter a value for soil resistivity measured at the location of a "marked" SP anomaly, which will allow the software to calculate a "Corrosion Factor". The units "$\Omega$.cm" or "$\Omega$.m" for soil resistivity that will appear on the SP anomaly "marking" screen, for your manual data entry, will depend on your selection here in the "Soil Resistivity Distance Units" field (cm or m)

## Step 11c:

Make selection of "Metric" units if required.

By checking off the box labeled "Metric", the reading interval (distance between voltage recordings) and the survey flag internal (survey flag spacing) will be displayed in meters, as opposed to feet.

Tap on the "Next" button on the above screen.

## Step 12:

Select GPS Type

By tapping on the pull-down-list arrow button in the "GPS:" field, you can select the type of GPS unit you will be using (if any) from the list shown below.

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 NMEA 0183 compatible GPS receiver is being used |
| Manual: | This means that location data will be entered manually when the GPS button is pressed on the survey screen during a DCVG survey. |
| MCM Internal: | This means that the G1'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 13:
Select GPS Options:

After selecting the GPS Receiver Type and COM Port, choices need to be made regarding GPS Options (see screen below).



If a GPS accessory has been selected for use with the data-logger for a particular Surface Potential survey, 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 GPS options available are as follows:

**Differential GPS Required:**
**This box should be ticked if you only want differentially-corrected GPS** position data to be logged by the data-logger. If this box is left unticked, it **means that you will allow the G1 data-logger to log either standard GPS** position data or differentially-corrected GPS position data.

Note: Logging "Standard" GPS position data is usually better than having no data logged at all, which would be the case if you checked this box and for some reason your GPS receiver was not outputting differentially-corrected position data. Consequently, it may be preferable to leave this box unchecked, unless it is imperative that you exclusively log differentially-corrected GPS position data.

**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 survey 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.

**Log GPS at Sidedrain/Anomaly:**
If this box is ticked, GPS location data will be logged automatically when SP anomalies are "marked", as described in our Surface Potential Surveys Training Manual – G1 Version.

**Auto Log GPS:**
By tapping on the drop down menu button in the "Auto Log GPS" field, the selections available will be displayed as indicated below.
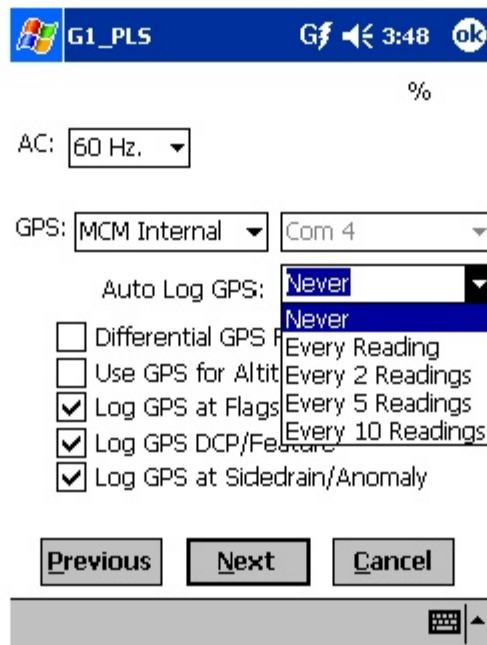
By selecting one of these options, you can elect to have the GPS position data logged automatically at every survey reading, at every second reading, at every fifth reading, at every tenth reading, or not at all (never) at survey readings.

## Step 14:
Finally on the above screen, select the electricity supply operating frequency of the country in which you are performing the surveys (60Hz or 50Hz). For the U.S., select 60Hz.

Tap on the "Next" button on the above screen. The screen shown below will appear.



## Step 15:
Enter Pipeline Name and Survey Starting Location

**Provide the Name of the Pipeline:**
By tapping in the field labeled "Name of P/L", you can type in the pipeline name. Note: This is not the same as the filename for the Surface Potential survey that was selected back at Step 6. This is the actual name of the pipeline.

**Provide the Valve Segment Identification Number:**
By tapping in the field labeled "Valve Segment", you can type in the valve segment name or number (if known).

**Provide the Starting Location:**
Provide the Starting Location for the Survey

You can select to have location information displayed on the survey screen as station number, feet or milepost (station number, meters or kilometers for the metric case).

Whichever selection you make here will determine how you enter your starting location information.

For example, if your pipeline locations are represented by station numbers, you would select "Station Number" from the drop down list and you would enter a starting location for the survey in the form of a station number. [If you do not know the station number where you're beginning your survey, enter 0+0.0].

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

## Step 16:

Select Voltage Recording Interval (Distance Between Recordings)

By tapping in the field on the above screen labeled "Distance Per Reading", you can type in the voltage reading interval (distance in feet (or in meters for the metric case) expected between recordings) for the Surface Potential survey.

## Step 17:

Select Survey Flag Interval (Distance Between Survey Flags)

By tapping in the box on the above screen labeled "Distance Between Flags", you can type in the survey flag interval (distance between survey flags in feet, or in meters for the metric case) for the section of pipeline being measured. Typically, survey flags are located at 100 feet intervals.

## Step 18:

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 field 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 5.0 feet and the survey flag separation is 100 feet, that means that 20 recordings are expected. If, however, only 15 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 16 recordings and a maximum of 24 recordings between survey flags to stay within the 20% (max.) error allowance.

## Step 19:
Select whether or not you would like the recordings to be uniformly spaced between survey flags, in cases where less than or greater than 20 recordings are made.

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 the flag spacing distance, regardless of the actual number of recordings made. Again, enabling this selection is recommended.

Tap on the Next button on the above screen. The screen shown below will appear.

**Step 20:**

Provide the Work Order Number for the Surface Potential survey.

By tapping in the field on the above screen labeled, "Work Order #", you can type in the work order number for the SP survey.

**Step 21:**

Provide Your Name.

By tapping in the field labeled, "Technician Name", you can type in your name or the name of your supervisor. If you use your supervisor's name here, you might add your own name in the Comments Section.

**Step 22:**

Provide Comments.

By tapping in the field 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 and the Survey Start Date and Time.

**Note: Do not attempt to change the File Name indicated here as this identification will be required by the ProActive software to transfer your Surface Potential survey data to your PC.**

Tap in the Next button on the above screen. The screen shown below will appear.
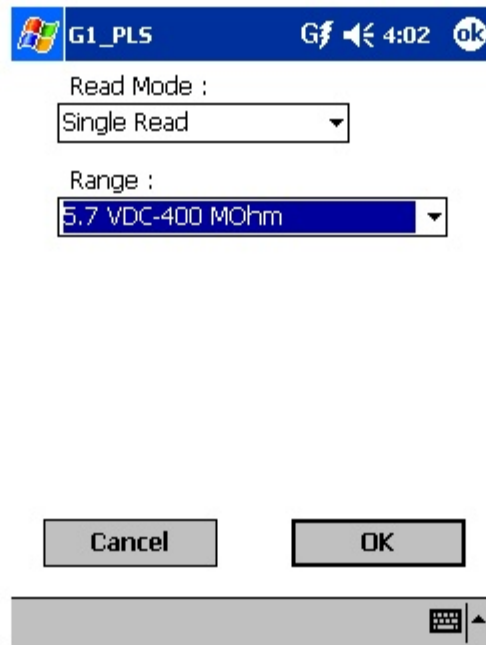
## Step 23:
Select Voltmeter Settings

**Select the "Read Mode":**
SP surveys are typically performed on pipelines that are not cathodically-protected with impressed current from rectifier sources and so the appropriate choice of "Read Mode" would be "Single Read", i.e., "On-Off Pair" read modes are not appropriate, since rectifier current interruption is not a factor.

**Select the "Range":**
As can be seen by viewing the drop down menu in the "Range" field, a number of selections are possible.

The fastest response setting is the 5.7V/400MΩ setting (~80ms response time), however, the noise level on this setting is ±5mV, which could make small anomalies difficult to detect.

Lower noise level settings (±1mV noise level)) can be selected, such as the 40mV or 400mV settings to increase sensitivity, however, please note that the speed of response on these settings is around 1 sec.

## Step 24:
Pull-up "Active" Survey Screen

**By tapping on the "OK" button on the Voltmeter Settings screen, the "active" Survey screen would appear and you would be ready to proceed with your DCVG survey.**

An example starting "active" Survey screen is shown below.
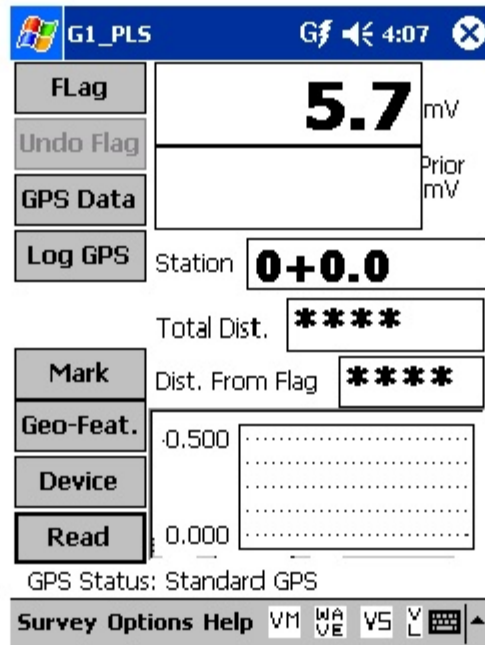
As SP voltages are recorded by the G1 data-logger, the "Distance From Start" (total distance from the start of the survey) parameter will increase in increments of 5.0 feet, or whatever the "Distance Per Reading" value was that was entered back at Step 16. (Distances would be in meters if the metric option had been selected).

Also, the "Distance From Known Station" parameter will increase in the same increments as voltages are recorded. The difference in this case, however, will be that when a known station is registered, this distance parameter will begin again at zero. In other words, this will show the distance you are assumed by the G1 data-logger to have traveled from the last known station that you encountered (and registered).

**You are now ready to perform a Surface Potential survey.**

**You are referred to our Surface Potential Training Manual – G1 Data-**logger Version for information and recommendations on how to actually perform SP Surveys using the G1 data-logger. This Training Manual also provides an overview of the physical principles associated with SP Surveys.

### III. 8    How to Make Changes to Your Pipeline Survey Set Up Selections

Once you've set up the G1 data-logger for a particular pipeline survey, as described above, you can make changes to your setup selections with the exception of your "Survey Type" selection and the currently indicated "Station". 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). Or, in another case, you might decide to change the "Distance Per Readings" interval from 2.5 feet to 5.0 feet, for example.

To make setup selection changes, tap on the "Options" button at the bottom of the screen. The screen will appear as shown below.
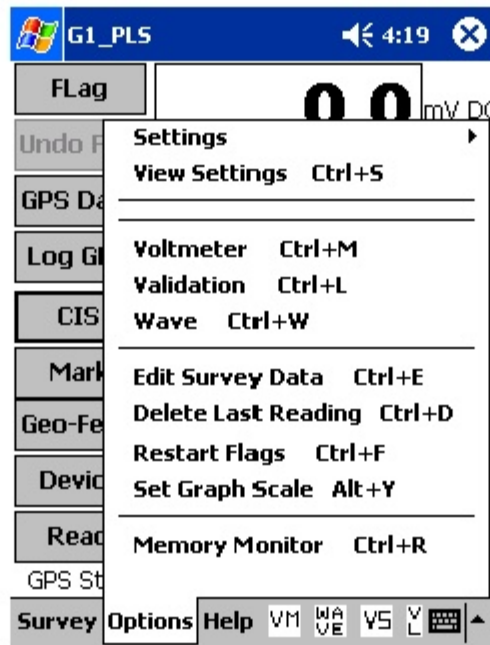
To make any (allowed) changes, tap on "Settings" on the above menu, tap on "Change Global Settings" and proceed to make any desired changes.

To simply view your setup selections, you can tap on "View Settings" on the above menu (after tapping on "Options" menu button).

### III. 9 How to Use the G1 as a "Stand-Alone" Voltmeter/Waveform Analyzer (Pipeline Survey Program).

The G1 data-logger can be used as a "stand-alone" voltmeter/waveform analyzer in situations where such applications maybe warranted in association with the performance of a pipeline survey.

For example, at devices on your pipeline survey where you can make electrical contact with the pipeline, you might wish to confirm that the CP rectifiers are switching On and Off at the prescribed cycle rate and that the IR drop magnitude is sizable enough for the On/Off Pairs (DSP) reading mode to be applicable, for example. Also, you might want to make sure that all of the rectifiers having an affect on the pipeline involved with your survey are being switched On and Off in a synchronized fashion. Or, you

might want to check certain readings that are not an integral part of the survey itself.

You can use the G1 as a "stand-alone" voltmeter by tapping on the "Voltmeter" button ("VM" button) on the bottom of the Survey screen or by tapping on "Options" and then tapping on "Voltmeter".

The "stand-alone" term arises due to the fact that, in this mode, the voltmeter is operating outside of the pipeline survey parameters and is being used in an independent (non-data-logging) capacity.

By tapping on the "Voltmeter" button, the screen shown below will appear (depending on previous settings).



In the above case, the "stand-alone" voltmeter is reading the High and the Low pipe-to-soil voltages at a test station with the "Range" and "Input Impedance" values selected as 5.7V and 400MOhm, respectively.

The Red and the Black banana plug terminals on the top side of the G1 can be used to read voltages or, alternatively, if an MCM data-probe (reference electrode) having a 5-pin connector socket is being used, the data-probe will be connected to the 5-pin socket on the top side of the G1, which will

connect to the negative side of the voltmeter, and the Red banana plug terminal will be used to connect to the positive side of the voltmeter.

To make voltmeter settings changes, click on the "Stop Voltmeter" button, which will activate settings selections.

If other voltmeter settings are required to make a reading, you can tap on the pull-down-list arrow buttons in the 2 fields shown above (Read Mode and Range) and make your selection choices. You can also change the On and the Off times associated with the current-interruption cycle, if necessary.

To have the voltmeter display a reading taken with your new settings selections, click on the "Start Voltmeter" button. When you have completed your "stand-alone" voltmeter measurement, you would click on the "Stop Voltmeter" button and then click on the "Done" button, which will return you to the Survey screen.

By tapping on the pull-down-list arrow button in the "Range" field, you can make your selection of full-scale range (either DC or AC) and also value of Input Impedance required for the voltmeter to make a particular type of reading from the list of options.

By tapping on the pull-down-list arrow button in the "Read Mode" field, you can select from the following voltmeter reading mode choices:

ON – Depolarization: This is a single read mode, where either the rectifier current is permanently ON or the rectifier current is OFF for the duration of the survey.

ON/OFF: In this case, High and Low voltages would be determined by digital signal processing techniques.

ON/OFF Min./Max.: In this case, a number of sampled readings would be averaged to determine both the High and the Low voltages (during each cycle). The specific number of readings used by the voltmeter to come up with these averaged values would be dictated by the number that you enter in the "Moving Ave. Samples" box, which appears when you select this reading mode. The default number is 4.

ON/OFF GPS Sync: This mode can only be selected if you are using either **the Internal GPS unit or the MCM External GPS unit on the G1 AND you** are using rectifier-current-interrupters with integrated GPS units. If this is the case and you select this option, the screen shown below will appear.



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). By tapping on the pull-down-list arrow button in the "GPS Type" field, you can make your selection.

Next, enter your "On Delay" and your "Off Delay" selections by tapping in the appropriate filed 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 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.

Next, select your current-interrupter's "Downbeat" timing. As indicated by tapping on the pull-down-list arrow button in the "Downbeat" field, there are 3 selection choices; Each Minute, Each Hour and Midnight. If "Each Minute" is an option for your current-interrupter, we suggest making this

selection. Also, if your interruption 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). The "Each Minute" designation indicates to the data-logger that a new interruption cycle will begin at the top of each minute. Consequently, the data-logger can reference its timing to the top of each minute. In this instance, your On plus Off times (your waveform period) should be an even multiple of 60.

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.

By tapping on the "OK" button, you will be returned to the voltmeter settings screen.

CURRENT (shunt voltage): This mode would be selected if you were using the G1 to measure current via a shunt. By selecting this mode, the screen shown below will appear.
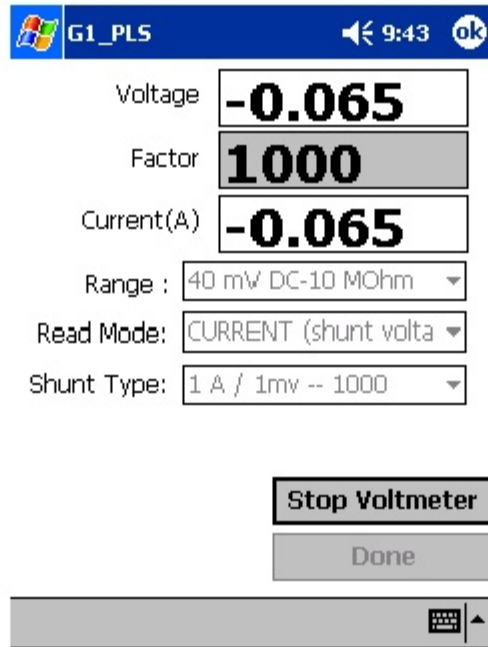
A number of industry standard shunts can be selected by tapping on the pull-down-list arrow button in the "Shunt Type" field, after tapping on the "Stop Voltmeter" button to make any desired settings changes. You can also select "other" and enter your own shunt factor in the "Factor" field.

Note: The units of the displayed "Voltage" (Volts or milli-Volts) will depend on the settings selected in the "Range" field. Current is always displayed in Amps.

DCVG: This voltmeter reading mode would be selected if you were set up to perform a DCVG survey with the reference electrodes connected to the G1 as illustrated in Section III. 4.

By switching to the "stand-alone" voltmeter, you can view the delta V(ON) and delta V(OFF) readings as well as the calculated (by the G1 software) value for the DCVG voltage [delta V(ON) – delta V(OFF)]. (See our DCVG Training Manual – G1 Version).

The screen shown below is an example screen for operation in the DCVG reading mode.
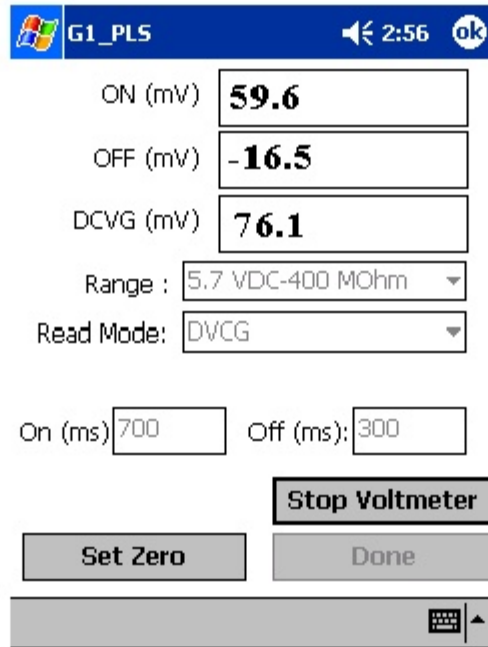
As can be seen from the above screen, the delta V(ON) reading is +59.6mV and the delta V(OFF) reading is -16.5mV. Consequently, the DCVG voltage is 76.1mV.

This is an example of a cathodic/anodic anomaly, in which case current is flowing away from the pipe, at the defect location, into the soil during the OFF part of the current-cycle, but the defect is cathodically-protected when the impressed CP current is ON (current is flowing to the defect location).

This is important information that can be obtained with the G1 in this DCVG voltmeter reading mode without having to go through the process of "marking" a defect, as is the case when you are performing an actual DCVG survey (see our DCVG Training Manual – G1 Version).

The "Set Zero" button on the above screen also represents a useful feature. By placing the reference electrodes on the ground (close together) away from any voltage gradient fields, and tapping on the "Set Zero" button, the voltmeter will eliminate any offset that might exist between the two reference electrodes, which is important when measuring potential differences between two electrodes, as is the case in DCVG surveys.

DCVG GPS Sync.: This voltmeter reading mode is similar to the DCVG reading mode described above except that in this case, the High and the Low

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voltages are sampled each cycle at precise times controlled by GPS receivers.

Again, as was the case with the ON/OFF GPS Sync reading mode, this mode can only be selected if you are using either the Internal GPS unit or the MCM External GPS unit on the G1 AND you are using rectifier-current-interrupters with integrated GPS units.

If this mode is selected, the "GPS Settings" button will again appear, as was discussed for the case of the ON/OFF GPS Sync mode. The GPS Settings selections will have to be made as described above for the ON/OFF GPS Sync mode option.


**Waveform Analyzer**

A second application of the "stand-alone" voltmeter is as a waveform analyzer. To use this function, either tap on the "Waveform" button (WAVE button) at the bottom of the Survey screen or tap on "Options" and then tap on "Wave". The screen shown below will appear (depending on the previous settings).
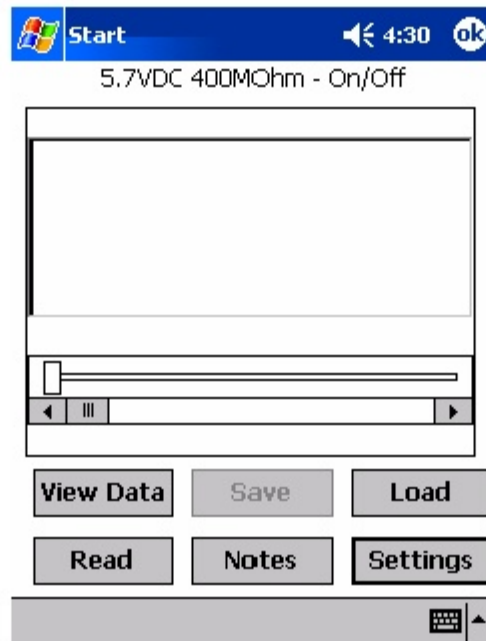
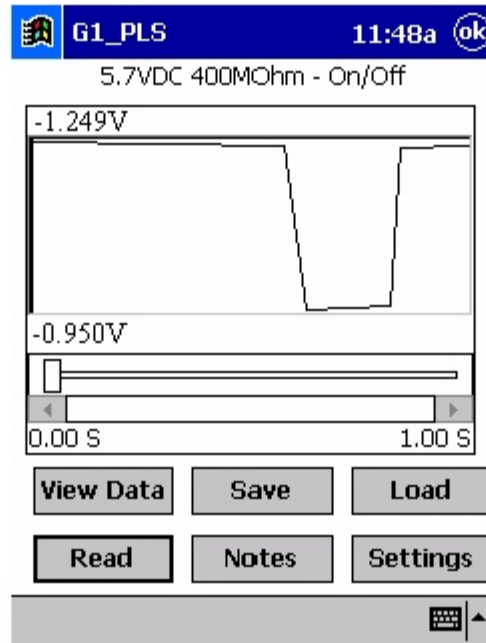By tapping on the "Read" button on the above screen, you can view, for example, the pipe-to-soil voltage waveform at a test site, assuming that you have the appropriate cable connections made to the G1.

A typical waveform would be as shown in the screen below.



Since we set up a 700ms ON and a 300ms OFF rectifier cycle in this example, 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 in the 5.7V, 400MOhm setting), 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, for example, and with regard to checking for On-to-Off and Off-to-On transition spikes.

To record a pipe-to-soil voltage waveform, tap on the "Save" button on the above screen. The screen shown below will appear.
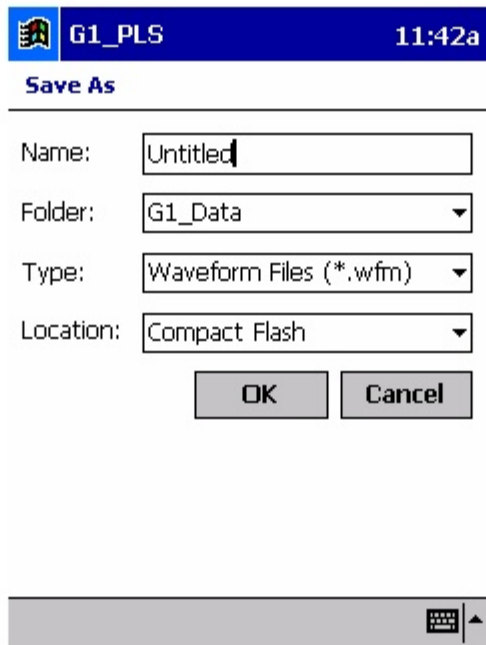
You are being asked here to establish a file in which the waveform data will be stored (saved). The name of this file will be the name you type into the "Name" field on the above screen. For ease of future retrieval when you upload your survey data to ProActive, it is recommended that you use the same 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 Site 1.

You should then tap on the OK button. This process will "save" the waveform data on the G1 data-logger's CompactFlash memory card for future retrieval by ProActive.

Finally, by tapping on the "Load" button on the Waveform screen, a list of previously saved waveform files can be viewed and these files can be opened by tapping on the file name.

# SECTION IV

# USING THE G1 DATA-LOGGER TO PERFORM "SCRIPTED" SITE SURVEYS

## IV. 1   Introduction

In addition to being used for pipeline survey applications, as discussed above in Section III, the G1 data-logger is also designed to be employed in the performance of "Scripted" Site Surveys.

Site Surveys are typically performed either on an annual basis or on a bi-monthly basis and involve collecting data at specific "sites" (or "devices") associated with a pipeline system, such as test stations, rectifiers, valves, etc.

The term "Scripted" is used to describe a site survey involving a route that has been designed (or, scripted) ahead of time. A route is created in MCM's ProActive software program by selecting the specific devices that will comprise the route and setting up the order in which the devices should be tested during the route.

In addition, the data to be gathered at each type of device along the route are "scripted" in the ProActive program. The processes involved with scripting routes, including scripting the actual device readings to be taken at each particular device, are outlined in our ProActive Training Manual.

Once a route has been scripted, the scripted data (route information) can be downloaded from the computer housing the ProActive software program to a data-logger, such as the G1. Once the scripted route data are stored in the data-logger's memory, the operator can follow the "script" of the route on the data-logger to perform the site survey. The operator is directed to each device (site) in turn on the route (in a prescribed order) and he is prompted to collect the appropriate data (either readings or observations) at each device (site) on the scripted route.

**IV. 2 How to "Load" the G1 with a "Scripted" Route from ProActive**

As mentioned above in Section IV. 1, scripted data (route data) are created by means of the ProActive software program. The following process assumes that a route has been created and that your objective is to "load" the route data onto your G1 data-logger with a view to performing a site survey.

**Step 1:**
Establish a connection between your G1 data-logger and your PC.

You must have the Microsoft ActiveSync software program installed on your PC.

Connect a cable between the left-hand-side COM Port (COM 1 Port) located on the bottom side of the G1 and a USB terminal (or a 9-pin serial data terminal) on your PC and switch on your G1 data-logger.

Switch on your G1 by pressing the red button on the keyboard.

The ActiveSync window should appear and indicate that a connection has been established. Select a "Guest Partnership" (file transfer only).

**Step 2:**
Open your ProActive Program and click on the "Load Route" button on the main menu bar.

This will pull up the "Data Logger: Load Route" window as shown below. ProActive's main menu bar (containing the "Load Route" button) is also shown below.
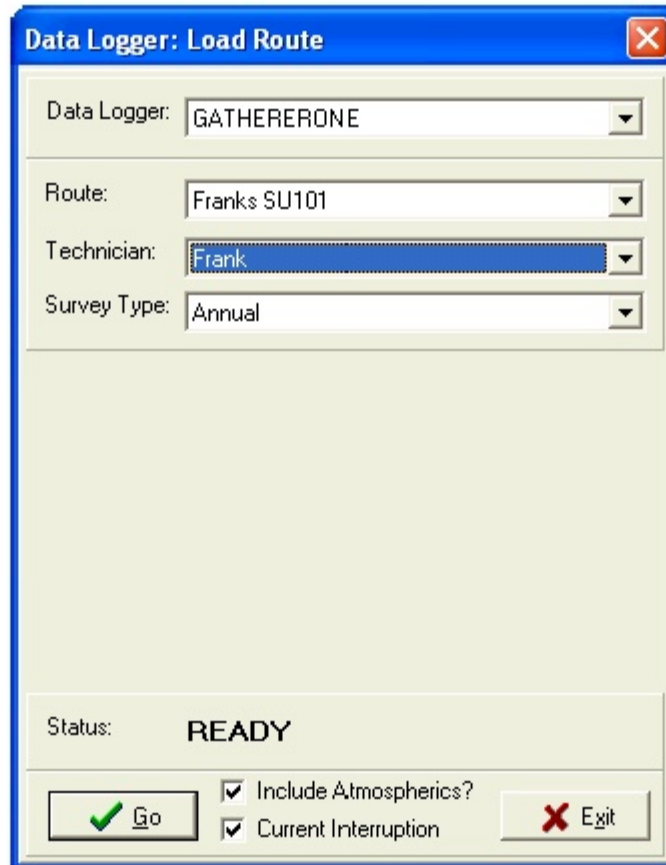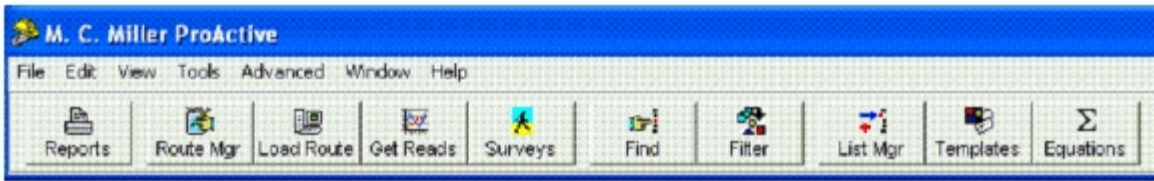
**Step 3:**
Make selections on "Data Logger: Load Route" Window

From the list of Routes available to you, which can be viewed by clicking on the pull-down-list arrow button in the "Routes" field, select the route you will be downloading. In our case, the example route is named "Franks SU101" Also select "GATHERERONE" (for G1 data-logger) after clicking on the pull-down-list arrow button in the "Data Logger" field.

Next, you can select the name of the technician who will be performing the route by clicking on the pull-down-list arrow button in the "Technician" field and selecting an existing name on the list.

Next, select the survey type, by clicking on the pull-down-list arrow button in the Survey Type field and making your choice from the list presented.

Note: This is an important selection, since your choice in this category will determine which reading types will appear as prompts for particular devices, based on the selections that were made on the ProActive side.

For instance, since we have selected "Annual" for the Survey Type in our example above, this would mean, for this example route, that prompts would be downloaded for all reading types for which an annual survey type was selected. Prompts would not be downloaded for any reading type for which "annual" was not a "survey types" selection during the reading template set up process (see the ProActive Training Manual).

Next, check off the "Include Atmospherics" box if you plan to record visual observations data on your route. If atmospheric types have been selected for a particular device on your route but you choose not to include atmospherics, the Atmospherics page for that device will not be downloaded with the route, ie, you will not see prompts for the atmospherics on your data-logger screen.

Finally, check off the "Current Interruption" box if the rectifier current on your route will be switched On and Off during your survey, otherwise, leave this box unchecked.

After making your selections, click on the "Go" button on the above window which will pull up the Data-Logger "Driver" window.

Click on the "Go" button on the above window. The "Driver" window shown below will appear.
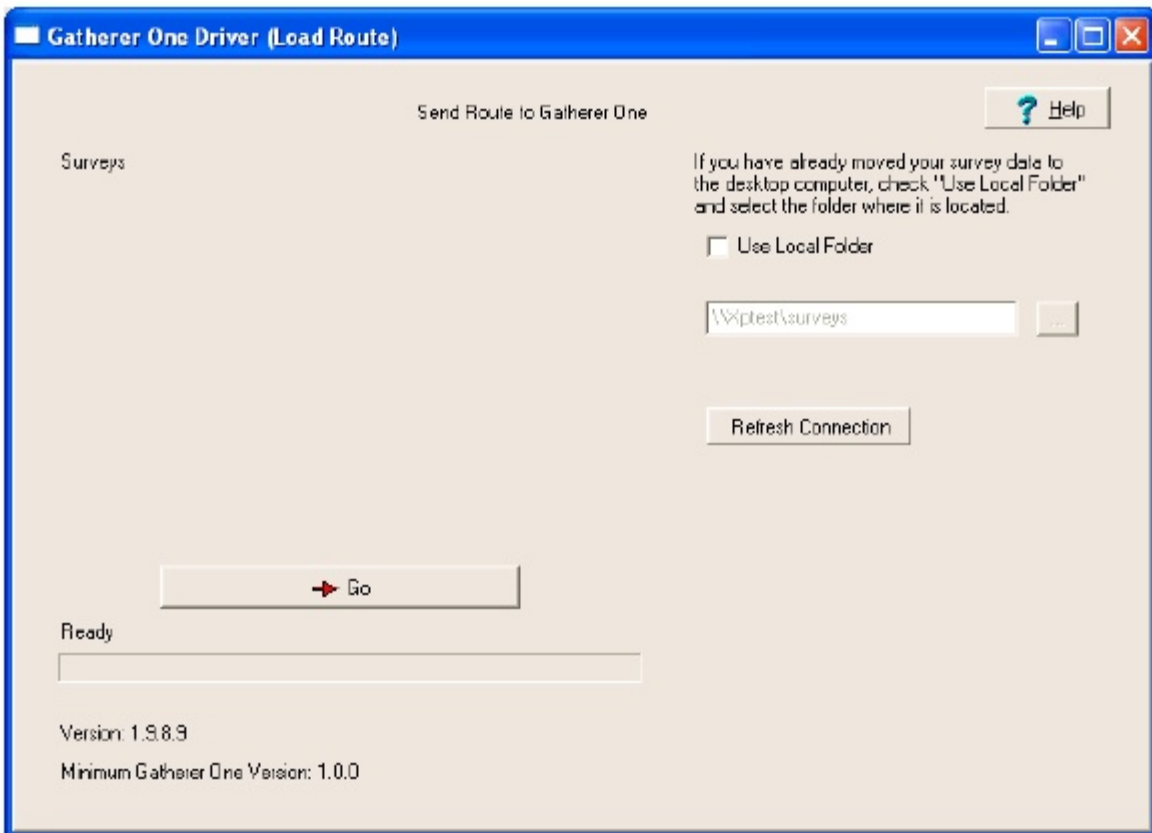
At this point, the route information you selected will have been transferred to the "Driver" within ProActive and by clicking on the "Go" button on the "Driver" window above, the route data will be sent to your G1 data-logger.

## IV. 3   How to Use the G1 to Collect Data on a "Scripted" Route

At this point, the route data that you selected are now stored on your G1 data-logger's memory and the following steps should be followed in order to, first of all, access the file (containing the route data) on your data-logger and, secondly, to perform your site survey by collecting the data dictated by your scripted route.

**Step 1:**
Open the Site Survey Program on your G1 data-logger.

In the case of the Q100 units, tap on the "Start" button on the "Home" screen ("Today" screen) and then on the main menu, tap on G1SS. In the case of the Q200 units, double-tap on the G1SS icon on the desktop or tap

on the start icon (bottom left-hand corner of the desktop), tap on the "Programs" icon and tap on the "G1SS" icon. In both cases, (Q100 and Q200 units), the site survey screen shown below will be displayed.



As can be seen, there are several buttons on this "Site Survey" screen.

The "Open Survey" button will open up the highlighted route as discussed below in Step 3. The above screen will list all of the scripted routes that are currently stored on your G1 data-logger's memory. As can be seen from the above screen, we currently only have the "Franks SU101" route "loaded" onto our data-logger.

The "Delete Svy" button will delete the highlighted route. You can delete a route file once survey data have been uploaded to ProActive. However, route files can be stored on the G1's CompactFlash memory card indefinitely. Repeating the route download process to the G1 prior to performing a new site survey (perhaps the next bi-monthly survey), will result in a refreshing of the route data in the route file, including the addition of the latest readings from ProActive which will be presented on the G1 reading prompt screens as the "prior readings" for comparison purposes to your current readings.

The "Voltmeter" button can be used to select the settings of the G1 data-logger's "stand-alone" voltmeter. (See Section IV. 5 below for information on how to use the G1 as a "stand-alone" voltmeter, in which case you can use the G1 to measure voltages that will, typically, not be logged with the site survey data (unless they are entered manually).

*The settings for the voltmeter will have been scripted (on the ProActive side) for each "prompt" on the route and during a site survey, voltages measured by the voltmeter will be logged by the G1 data-logger.*

Pipe-to-soil voltage waveforms at a site (in cases where rectifier-current interruption is used) can be viewed (and saved) by the G1 data-logger by **tapping on the "Voltmeter" button and then tapping on the "Waveform"** button. Waveforms can be viewed by tapping on the "Read" button and they can be saved by tapping on the "Save" button and selecting a file name for the waveform data. (See Section IV. 5 for more details).

The "About" button will reveal important information about your G1, including the version number of the application program you are currently running (you will receive updates of this software from time to time as new features are implemented) and the serial number of the voltmeter inside of your G1 data-logger, which is licensed to you by MCM. The screen that appears when you tap on the "About" button is as shown below.
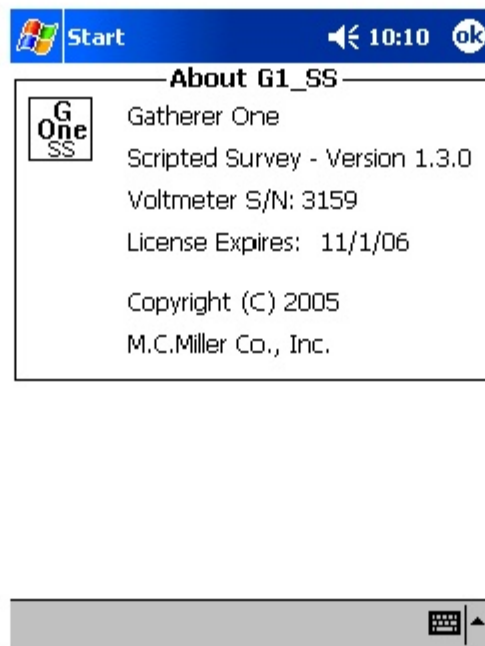
**Step 2:**
Establish Site Survey (Global) Settings

The "Settings" button will pull up the screen shown below.
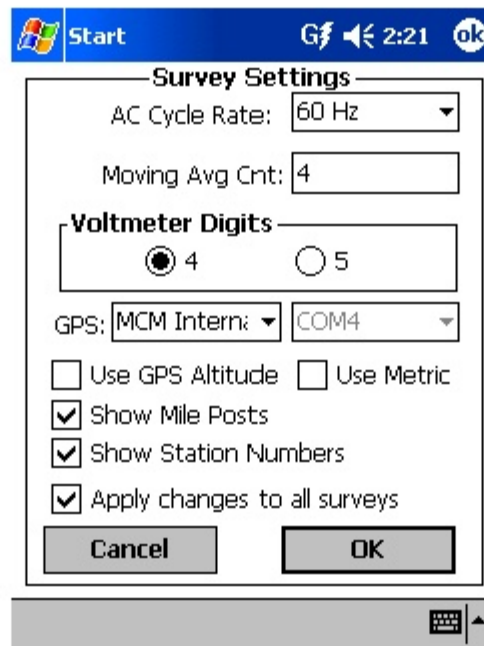


You have the opportunity here to make settings changes for the current survey that you'll be working on, or you can apply the changes you make to all subsequent surveys that you'll be performing (by checking the box labeled "Apply changes to all surveys", if it's appropriate to do so.

The AC Cycle Rate can be set at 60Hz or at 50Hz depending on the electricity supply frequency in your country of operation. For operation in the U.S., this setting should be 60Hz.

**You can change, if desired, the selection of "Moving Average Count"** which is the number of sampled voltage readings (sampled during both the On and the Off portions of the pipe-to-soil voltage waveform cycle) that will be used by the data-logger to determine "average" On and Off pipe-to soil voltage values, in the case where the voltmeter is scripted to read in the Min/Max mode (as opposed to the On/Off DSP mode). By default, 4 sampled readings are used.

You can elect to have 4 or 5 digits displayed for the voltmeter readings on the prompt screens by checking the "4" or the "5" radio button in the "Voltmeter Digits" field.

You can indicate the type (if any) of GPS Unit that you will be using on the survey. By tapping on the pull-down-list arrow button in the "GPS" field, the "Survey Settings" screen will appear as shown below.
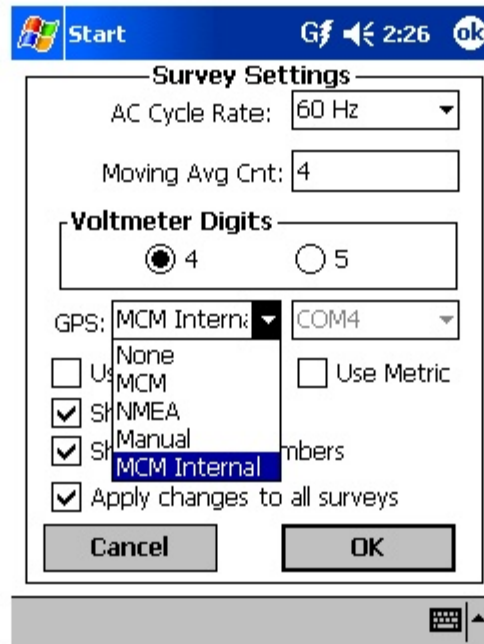


As can be seen from the above screen, there are 5 choices for "GPS Type":

| | |
|---|---|
| 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 NMEA 0183 compatible GPS receiver is being used |
| Manual: | This means that location data will be entered manually when the GPS button is pressed on the "prompt" screens during a survey |
| MCM Internal: | This means that the G1 data-logger's internal GPS unit will be used (a Garmin (Model 15L) WAAS-enabled receiver) |

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.

If you would like to have GPS Altitude Data collected in addition to GPS Position Data, the box labeled "Use GPS Altitude" should be checked.

If you are working in a country where the Metric System is used, you can check the "Use Metric" box. In this case, mileposts and station numbers will be in kilometers and meters, respectively.

**Finally, you can select to show either mileposts or station numbers (or** both) at your data collection points, by checking the appropriate boxes on the Survey Settings screen.

By tapping on the "OK" button on the above screen, you will be returned to the "Route Selection" screen.

**Step 3:**
Select the Scripted Route on which you are about to embark.

By tapping on (highlighting) a scripted route on the "route selection" screen, and tapping on "Open Survey", the "Survey (or Route) Info" screen for that particular survey (route) will appear. For our example route entitled, "Franks SU101", this screen is as shown below.
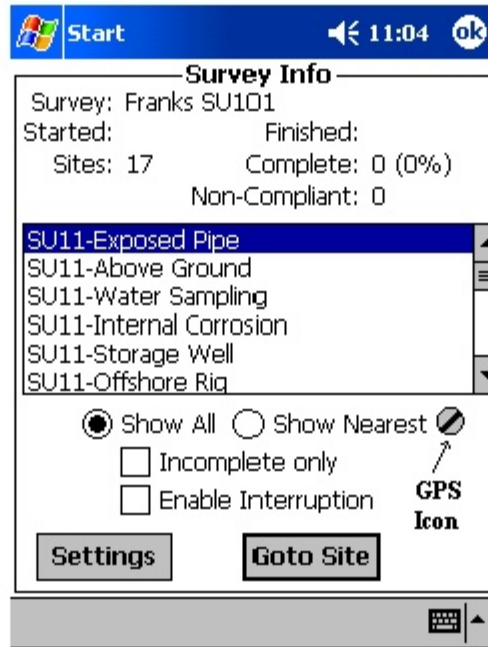
As can be seen from the above "Survey Info" screen, our example route contains 17 sites (or 17 "devices") and the types of devices are listed on the window. All 17 sites can be viewed by scrolling-down the bar on the right-hand-side of the window.

**This screen will indicate the date the site survey was started (the "Started:"** field") and will also show the date the survey was completed (the "Finished:" field)

As can be seen from the above screen, none of the sites on this route have been examined as yet (0% of the total sites have been examined so far). If some of the sites had been examined already, there would be a number indicated in the "% Complete" field. If this were the case, you might want to place a tick in the box labeled, "Incomplete only", in which case only the sites that remain to be examined on the route would be listed on the above screen.

The number in the "Non-Compliant" field (which is presently zero) will indicate the number of sites that are non-compliant based on the readings that are logged on the survey relative to the "allowed" variances established during the scripting process on the ProActive side. So, for example, if the allowed variance for a particular voltage is plus or minus 10%, and your present reading is 15% larger or smaller than the previous reading, the site

will be marked as non-compliant and this will raise a red flag when the survey data are posted to ProActive.

If GPS data were logged previously for each site on the route and you have an active GPS receiver associated with your G1 data-logger (see Step 2 **above), you can elect to "Show All" or "Show Nearest".**

If you select "Show All", the sites will be listed, from top to bottom, in the order that was established on the ProActive side for the route.

If you select "Show Nearest", the data-logger software will re-order the site list and the list will be ordered, from top to bottom, based on the distance of each site from your present location, the closest site being at the top of the list. This site list is updated every 5 seconds.

The GPS status indicator (a flashing on and off icon) provides the following status indications:
Flashing "S" icon: Means that the G1 is receiving standard
         (uncorrected) GPS position data from the GPS receiver.
Flashing "D" icon: Means that the G1 is receiving differentially-
          corrected GPS position data from the GPS receiver.
Flashing "Ǿ" icon: Means that the G1 is not receiving GPS position
          data.

**Finally, you would place a tick in the box labeled, "Enable Interruption",** if your rectifier-current was being interrupted (switched On and Off in a cyclic fashion) during your site survey.

**Step 4:**
Collect Data for each Site

By tapping on the "Goto Site" button on the "Survey Info" screen, the "Site Info" screen will come up for the selected (highlighted) site.

The order that the sites should be examined on the route has been established in ProActive and corresponds to the list shown above, ie, the first site to be examined in our example route is the "SU11–Exposed Pipe" site. The second site to be examined is the "SU11-Above Ground" site, and so on.

When all of the prompts (see below) have been completed for a particular site, the "Prompt List" for the next site in the "batting" order will come up and this process is continued until all sites on the route have been examined.

Valve Example: The "Site Info" screen for the "SU11-Valve" in our example route is as shown below.
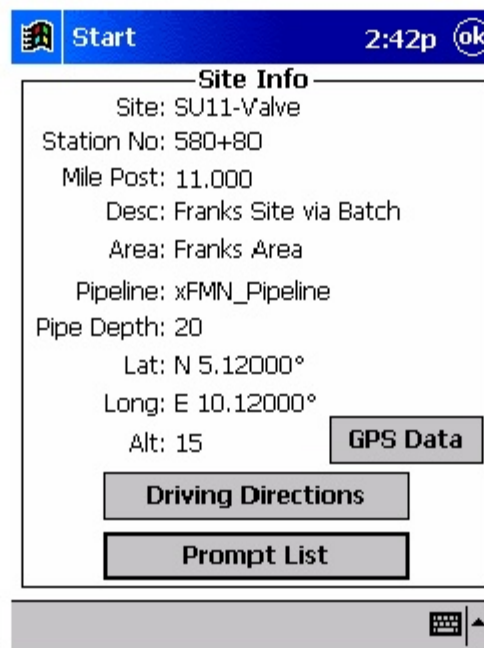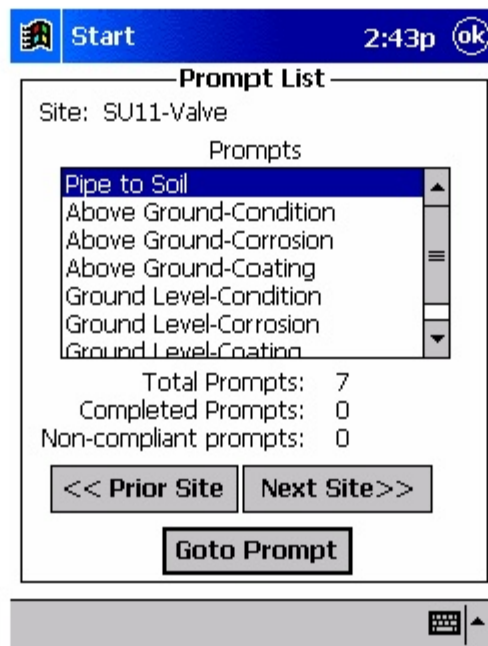


As can be seen from the above screen, important information about the "Valve" site is presented here. This type of information about a particular site is established on the ProActive side and it is downloaded to your G1 data-logger in association with the scripted route.

If not previously established, you can "set" the site location by logging GPS data at the site, by tapping on the "GPS Data" button and then tapping on the "Set Site Location" button.

If a set of driving directions was entered on the ProActive side for this site, the "Driving Directions" button would be active and, by tapping on this button, you could view information on how to locate this site. By tapping on the "OK" button located in the top-right-hand corner of the screen, you would be returned to the Site Info' screen.

By tapping on the "Prompt List" button on the "Site Info" screen, you can view the Prompt List for this "Valve" site.

For our example "SU11-Valve" site, the screen is as shown below.



As can be seen from the above screen, our scripted 'Valve" has a total of 7 prompts.

Each prompt will come up in turn (starting at the top of the list) until all prompts for this site have had a response, ie, data have been entered.

The "Goto Prompt" button is used to initiate the "batting order" sequence. Also, when the "Read" button is tapped on each prompt screen (to log data), the next prompt screen in the sequence will come up.

Note: You can navigate to previous or next sites or to previous or next prompts from a prompt screen by tapping on the relevant buttons on the screen (see above screen) or you can use the keyboard to perform the same functions as follows:

Home key: moves to prior site
End key: moves to next site
PgUp key: moves to prior prompt
PgDn key: moves to next prompt

The specific data to be collected at each site on a route is dictated by the scripts that are generated in ProActive for each site type and, consequently, different sites will have different sets of prompt screens.

Either specific types of voltages (such as pipe-to-soil) are read and recorded by the G1 data-logger when the operator is prompted to set up such measurements, or, the operator is prompted to enter his observations regarding the condition, or status, of a site, or, the operator is prompted to enter data obtained at the site using another instrument, for example soil pH data.

Since we have a total of 7 prompts for this example site, there will be a total of 7 screens that require data, starting with the "Pipe-to-Soil" screen shown below.



The voltmeter's "Range" and "Input Impedance" settings that were scripted on the ProActive side for this prompt are indicated below the site name, as is the reference electrode type to be used.

As can be seen from the above screen, the data-logger is reading the ON and OFF pipe-to-soil voltages at the Valve Site with respect to a copper/copper sulphate reference electrode. These voltages can be compared to the readings **that were logged previously (on 7/1/04) at this site (see "Prior Reading"**

field). When the current readings are logged by tapping on the "Read" button, these readings will be displayed in the "Current Reading" field.

**As Found/As Left Readings:**
If you return to the same prompt and tap the Read button again, the "Current Reading" will be renamed the "As Found" reading and the latest reading will be displayed as the "As Left" reading. You can display the "As Found" reading using the F10 key on the G1's keypad. The "As Found" reading will be included in the "Remarks" field for this reading type in ProActive.

Data can also be entered manually by tapping on the "Manual" button and entering voltage values manually (using the keyboard). For instance, you might measure these voltages, for some reason, using an independent voltmeter and this would be how you'd enter such data. Or, you might wish to manually enter current and voltage data straight off of meters at rectifier sites, rather than using the data-logger to record the current and voltage values.

If, on the ProActive side, instructions had been entered for this prompt regarding how to make cable connections (hook-ups) to perform the scripted measurements, the Help button would have been "active" and tapping on the Help button would have revealed those instructions.
By tapping on the "Skip" button, you can skip to the next prompt without logging data, if, for some reason, you are not able to respond to the prompt.

You also have the opportunity to change the voltmeter settings from those established on the ProActive side (scripted in ProActive) for this particular prompt, or, for all prompts of this type on this route.

To do so, tap on "Settings" which will pull up the screen shown below.
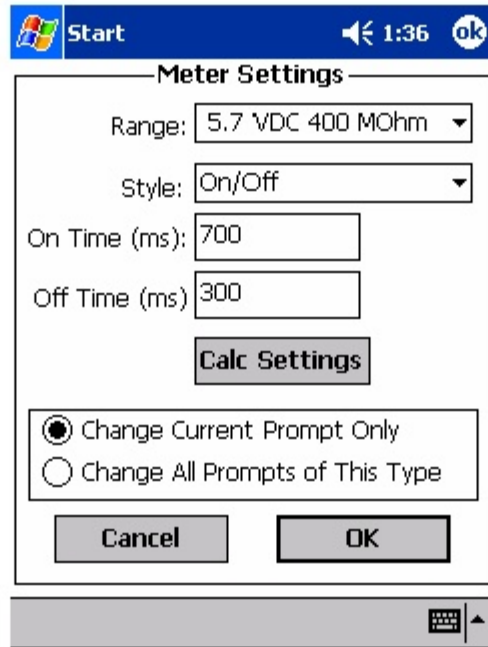
The scripted settings for the voltmeter for this type of prompt (pipe-to-soil) on this route will be displayed on the above screen. By tapping on the pull-down-list arrow buttons, you can select new settings. You can also indicate whether or not your changes pertain to just this prompt or to all prompts of this type, by tapping in the appropriate radial button.

You can also enter the On and Off times (in milli-seconds) associated with the current interruption cycle, if interruption is in effect. These will be "global" settings for the survey.

By tapping on the "Calc Settings" button, you can make changes, if desired, to a calculation associated with the prompt or you can elect to have the "predominant voltage" recorded. The screen shown below will appear in response to tapping on the "Calc Settings" button.
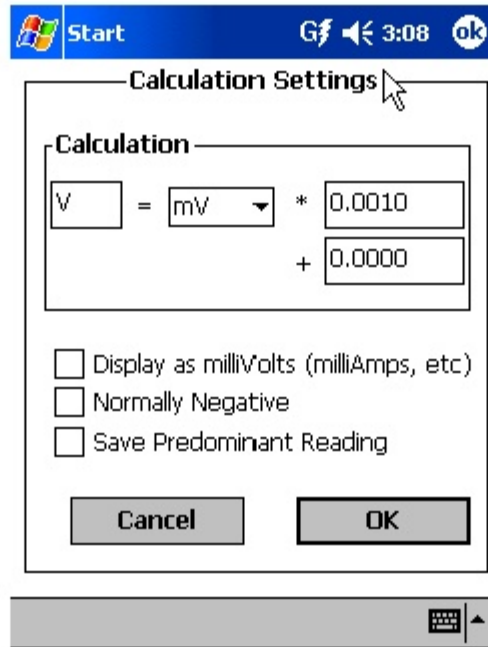
You could, for example, change the type of reference electrode you were using, in which case you would enter an appropriate value for the "addend". Or, if you were logging rectifier-current values at a rectifier site using a shunt, you might want to change the shunt type and/or the calculation from those scripted in ProActive.

**Predominant Voltage:**
If you are concerned about variable interference-type effects occurring during a voltage reading, you can elect to record a "predominant voltage", the value of which is determined over a period of time (perhaps several minutes) as opposed to recording a "snap-shot" reading. If so, check off the box labeled "Save Predominant Reading". In this reading mode, the data-logger will sample the voltage on a time interval basis and save the voltage reading that occurred the most frequently over the sampling period. This is the "predominant voltage". When the "Read" button is tapped, the clock starts ticking on the sampling of the voltages and the voltages will continue to be sampled until the "Reading" button is tapped. At that point the predominant reading will be logged.

If "Predominant Reading" is not selected, regular readings are logged by tapping on the "Read" button on the prompt screen and the next prompt screen in the scripted sequence will appear. For our Valve Site example, the next 6 prompt screens require observation data to be entered (selected).

Such selections are made by tapping on the pull-down-list arrow button in the description field and tapping on the "Read" button in each case until all prompts for this site have received a response.

The remaining 6 prompt screens for our Valve Site example are shown below.
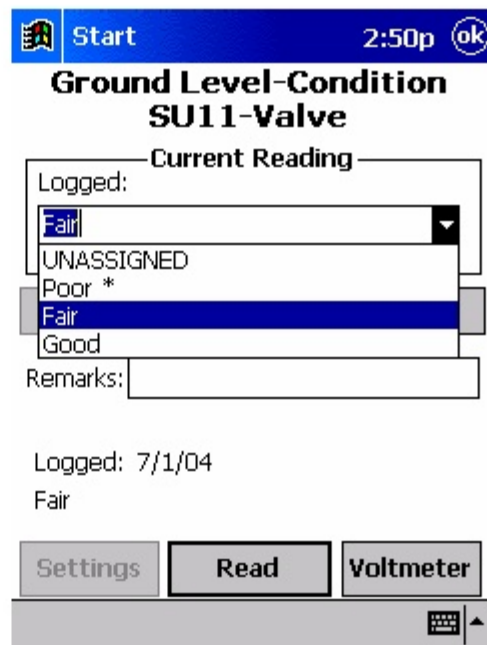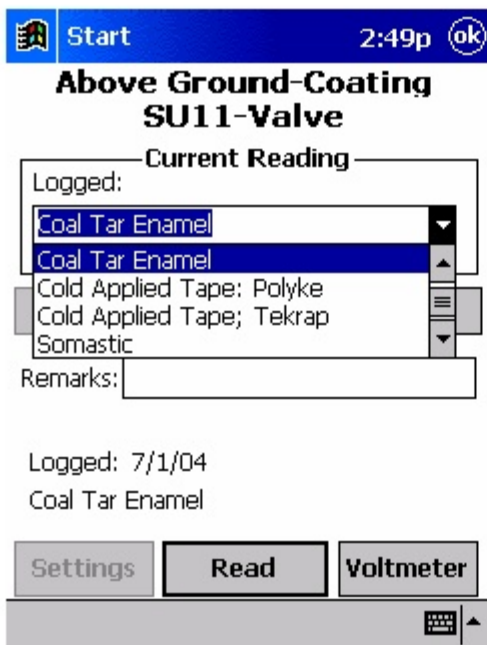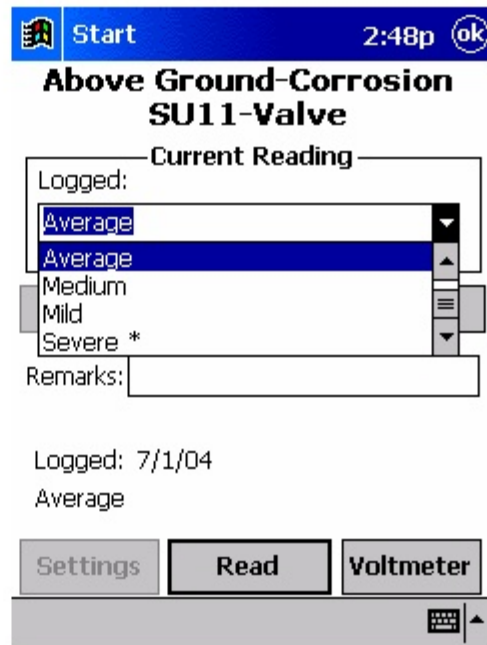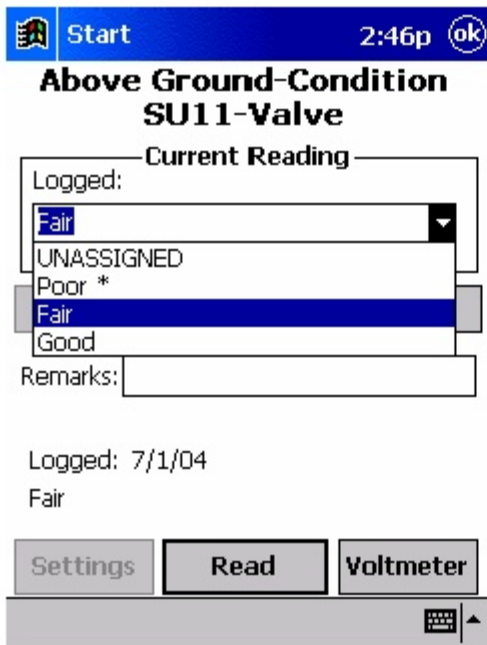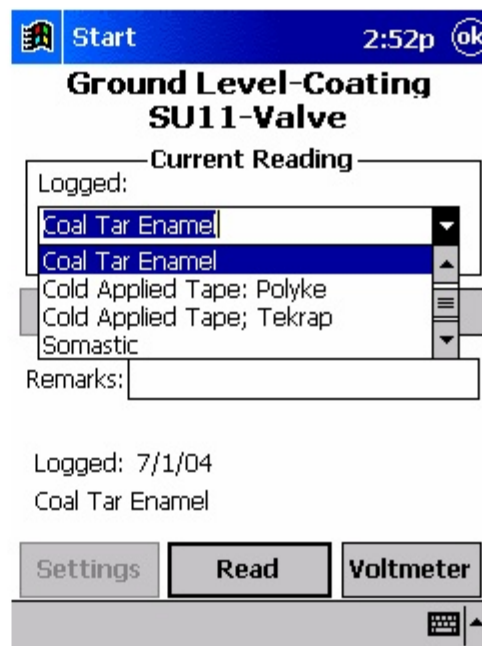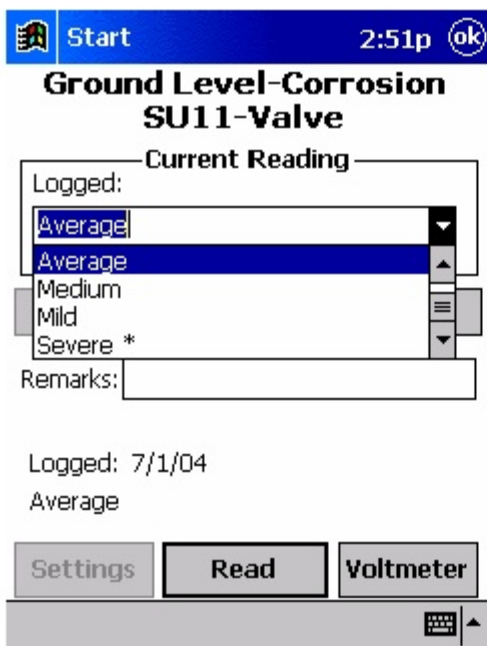
The specific prompt screens associated with the various site types (valves, rectifiers, bonds, towers, test points etc.) will result from the various scripts established on the ProActive side, however, the procedures outlined above for our Valve Site example would pertain to all site types.

### IV. 4    How to Download Data from a Completed Route from the G1 Data-Logger to ProActive

After completing a survey, you can post the site survey data to ProActive where the new data will be stored and integrated with historical data.

To download your data, you would re-establish a communication connection between the G1 and your PC (see Section IV. 2, Step 1) and then open up ProActive on your PC. By clicking on the "Get Reads" button on ProActive's main menu bar, the window shown below will appear.

You would then select the data-logger type from which you will be downloading data, in your case, GATHERERONE (for G1 Data-Logger). You would also select the "Route", by tapping on the pull-down list arrow button in the "Route" field.

Next, you would enter the type of weather condition you encountered during your route by clicking on the pull-down-list arrow button in the "Weather" field and making your selection from the list provided.

Next, you would make an entry in the "Description" field. Note: This is an important entry as you will be effectively naming your site survey here. Since you will build up a history of surveys done on a particular route over time, you might want to develop a naming system for surveys associated with a particular route.

Finally, the "start date" (the date that data were recorded at the first site on the route) and the "last date" (the date that data were recorded at the last site on the route), will be entered automatically, based on the data.

When all of the above entries have been made, you would click on the "Go" button which would initiate the survey data copying process to ProActive.
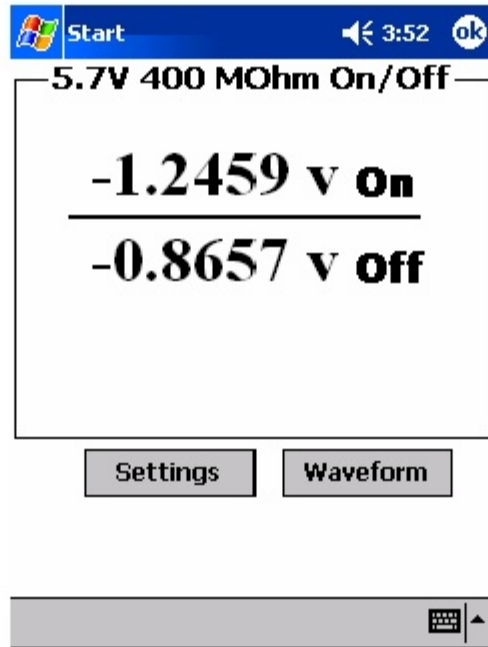

**IV. 5 How to Use the G1 as a "Stand-Alone" Voltmeter/Waveform Analyzer (Site Survey Program).**

The G1 data-logger can be used as a "stand-alone" voltmeter/waveform analyzer in situations where such applications maybe warranted.

For example, at sites on your scripted survey where you can make electrical contact with the pipeline, you might wish to confirm that the CP rectifiers are switching On and Off at the prescribed cycle rate and that the IR drop magnitude is sizable enough for the On/Off reading mode to be applicable, for example. Also, you might want to make sure that all of the rectifiers having an affect on the pipelines involved with your site survey are being switched On and Off in a synchronized fashion.

You can use the G1 as a "stand-alone" voltmeter/waveform analyzer by tapping on the "Voltmeter" button on the Survey screen (Route Selection screen) or on a Prompt screen. The "stand-alone" term arises due to the fact that, in this mode, the voltmeter is operating outside of the site survey parameters and is being used in an independent (non-data-logging) capacity.

By tapping on the "Voltmeter" button, the screen shown below will appear (depending on previous settings).

In the above case, the "stand-alone" voltmeter is reading the High and the Low pipe-to-soil voltages at a test station with the "Range" and "Input Impedance" values selected as 5.7V and 400MOhm, respectively.

The Red and the Black banana plug terminals on the top side of the G1 can be used to read voltages or, alternatively, if an MCM data-probe (reference electrode) having a 5-pin connector socket is being used, the data-probe will be connected to the 5-pin socket on the top side of the G1, which will connect to the negative side of the voltmeter (assuming that a black-band data-probe cable is being used), and the Red banana plug terminal will be used to connect to the positive side of the voltmeter.

If other voltmeter settings are required to make a reading, you can tap on the "Settings" button and make your selection changes before taking the readings. The screen will be as shown below.
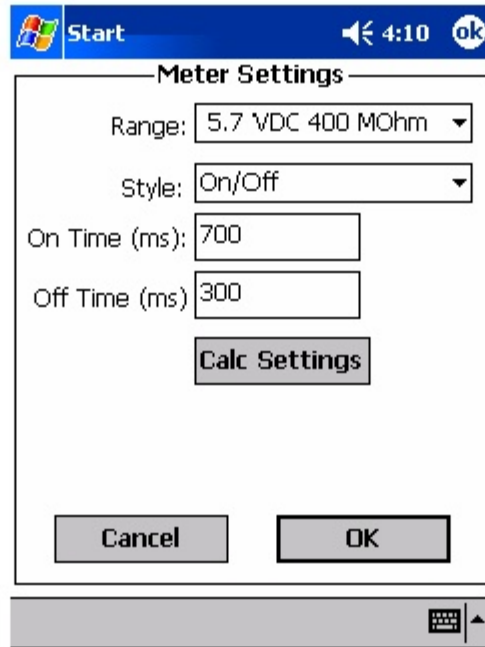
Tapping on the pull-down-list arrow button in the "Style" field and selecting "On/Off" and then tapping on the pull-down list arrow button in the "Range" field, will pull up the screen shown below.
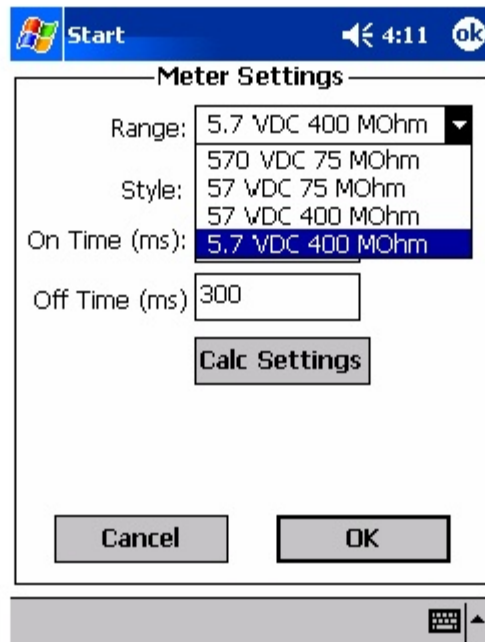


As can be seen, there are 4 selections that can be made in the case of "Range" (depending on the magnitude of the voltage you'll be measuring),
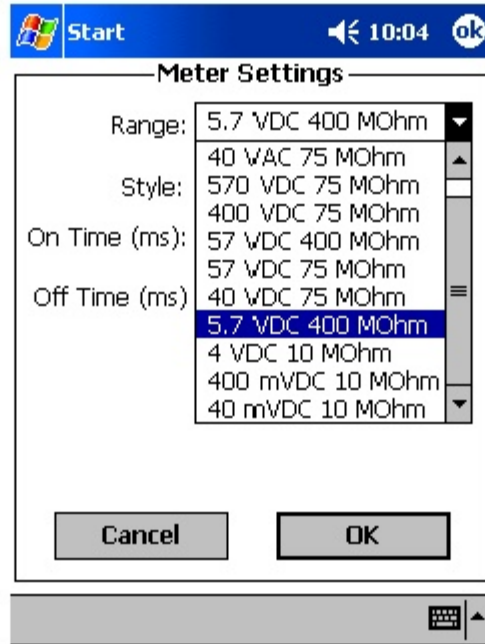
when the "On/Off" style is selected. Each of these 4 settings represents a fast response setting, which is appropriate for fast current interruption cycles.

If you select "Single" for the read mode "Style", all voltmeter full scale ranges (DC and AC) and input impedances are available for selection as indicated on the screen below.



Finally, if your desired data involves a calculation, such as, for example, a voltage-to-current calculation (involving a shunt) or the use of an addend to compensate for using of a reference electrode other then the standard copper sulphate electrode, you would click on the "Calc Settings" button and enter the appropriate information for your measurement on the "Calculation Settings" screen.

Tapping on the "OK" button will return you to the voltmeter screen.

**Waveform Analyzer:**
A second application of the "stand-alone" voltmeter is as a waveform analyzer. To use this function, tap on the "Waveform" button on the Voltmeter screen. The screen shown below will appear (depending on the previous settings).

By tapping on the "Read" button on the above screen, you can view, for example, the pipe-to-soil voltage waveform at a test site, assuming that you have the appropriate cable connections made to the G1.

A typical waveform would be as shown in the screen below.

Since we set up a 700ms ON and a 300ms OFF rectifier cycle in this example, 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 on the 5.7V, 400MΩ setting), the transitions from High to Low and Low to High are not perfect (right-angled) steps.

These voltage waveforms are very useful with regard to confirming multiple-rectifier synchronization, for example, and with regard to checking for On-to-Off and Off-to-On transition spikes.

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" field on the above screen. For ease of future retrieval when you uploaded your survey data to ProActive, 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 Site 1.

You should then tap on the OK button. This process will "save" the waveform data on the G1 data-logger's CompactFlash memory card for future retrieval by ProActive.

Finally, by tapping on the "Load" button on the Waveform screen, a list of previously saved waveform files can be viewed and these files can be opened by tapping on the file name.

# SECTION V

# USING THE G1 DATA-LOGGER IN STATIONARY APPLICATIONS

## V. 1 Introduction

In addition to being used to perform surveys (both pipeline and site surveys), the G1 is also designed to be employed in stationary data-logger (SDL) applications. In such applications, the G1 records and time-stamps data at a fixed location. The time-stamping of data can either be accomplished using the G1's internal clock or the GPS time signal. When a GPS receiver is active on the G1 during an SDL application, the GPS time signal will be used to time-stamp the data, and, in the absence of an active GPS receiver, the data will be time-stamped by the G1's internal clock.

Typically, time-stamped data collected over a period of time are used to examine the impact of transient (non-steady-state) stray current on a cathodically-protected pipeline. The term, transient, is used to describe stray current that is not constant over time. This would represent a situation where the magnitude of the stray current impacting a pipeline at some location would vary as a function of time.

The measurement of pipe-to-soil potential is often used as an indirect method of monitoring the variation in magnitude (over time) of stray current flowing to or flowing away (discharging) from the pipe at some particular location along the pipeline.

For instance, by monitoring the pipe-to-soil potential at a fixed location over a period of time, a chart of pipe-to-soil potential versus time can be generated for the location. If there is no significant transient stray current flowing to or away from the pipe at the measurement location, the potential should remain at the steady-state value (for example, -0.950V, with respect to a copper/copper sulphate reference electrode) for a cathodically-protected pipeline. However, if the pipe-to-soil potential is transient in nature (ie, changes as a function of time from the steady-state value in some fashion), it can be concluded (based on whether the potential increases or decreases) that stray current is either flowing to the pipe at the measurement location or is flowing away from the pipe at the measurement location at the times **when the pipe-to-soil potential is transient. If stray current flows away from** the pipe at a particular location for a significant period of time, it is possible that corrosion will be occurring at that location during that period of time, despite the fact that the pipeline is otherwise cathodically-protected.

There are a number of sources of stray current for buried pipelines including dc rail transit systems and dc welding equipment. In addition, telluric effects can generate stray current.

Telluric effects represent a natural (as opposed to a man-made) source of transient stray current (telluric current) that is induced by transient geo-magnetic activity (transient disturbances in the earth's magnetic field). Telluric effects are more pronounced at higher-latitudes, in higher-resistivity soils and when higher-quality coatings are used.

In addition to being a potential source of corrosion (in locations where stray current leaves the pipeline), transient stray current can also have a significant impact on pipe-to-soil potential values recorded during the course of a close interval potential survey (CIPS or CIS) which can lead to misleading survey data.

Steps can be taken, however, to correct for such effects by using multiple data-loggers operating in the stationary mode coupled with stationary reference electrodes positioned (at test points) strategically along the section of pipeline that is being surveyed. By doing so, "time-stamped" pipe-to-soil potential data recorded by the stationary data-loggers can be compared to similarly "time-stamped" pipe-to-soil potential data collected during a CIS using moving reference electrodes. By applying appropriate correction factors, any spurious CIS data associated with transient stray currents can be "filtered out" of the survey data in ProActive. It should be noted, however, that for correction factors to be determined, the stationary data-logger data and the CIS data must both be GPS time-stamped.

Again, the G1 is ideally-suited to function as a stationary data-logger and the procedures involved with setting up the G1 to collect "time-stamped" potential data are detailed below.


## V. 2 How to Set Up the G1 for Stationary Data-Logger Applications

The following section outlines the process required to set up the G1 to record potential data at a fixed location over a prescribed period of time (using a prescribed time interval), with recorded data being "time-stamped", ie, the actual time the data were recorded being associated with the value of the data. Time-stamping is accomplished using the G1's internal clock when a GPS receiver is not used, and, when a GPS receiver is employed, the potential data are "stamped" with the time signal received from the satellite system.

Once the "time-stamped" data have been collected and saved in a file on the G1 data-logger, the data can be uploaded to ProActive in which time charts can be generated and in which correction factors can be determined in cases where CIS data are to be corrected for spurious stray current effects, for example. Again, however, for correction factors to be determined, the SDL data and the CIS data must both be GPS time-stamped.

The process of uploading time-stamped data from the G1 to ProActive is described in Section V. 4.

## 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), in the case of
the Q100 units, and the desktop screen, in the case of the Q200 units.
The startup screens for the Q100 and the Q200 units are illustrated below:
**Q100 Units:**



**Q200 Units:**

## Step 2:
In the case of the Q100 units, tap on the "Start" button on the "Home" screen. This will pull up the main menu.
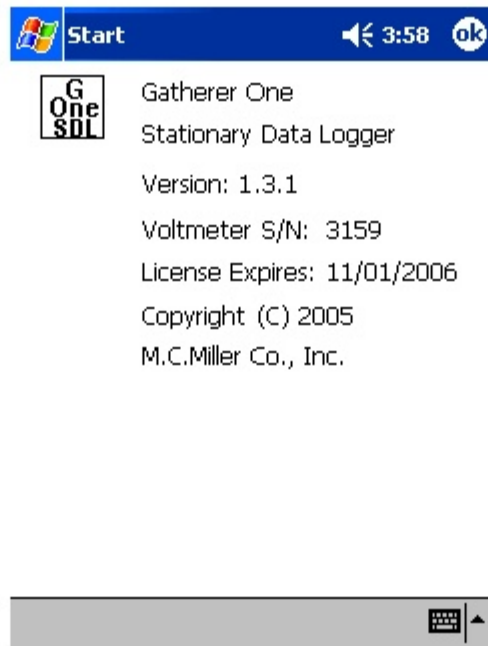
## Step 3:
In the case of the Q100 units, tap on the G1SDL button on the main menu. In the case of the Q200 units, double-tap on the G1SDL icon on the desktop or tap on the start icon (bottom left-hand corner of desktop), tap on the "Programs" button and tap on the G1SDL button.

In either case, (Q100 or Q200 units), the survey screen shown below will be displayed.



At this stage, only certain buttons are "active" since we haven't, as yet, set up an application.

The "About" button will reveal important information about your G1, including the version number of the application program you are currently running (you will receive updates of this software from time to time as new features are implemented) and the serial number of the voltmeter inside of your G1 data-logger, which is licensed to you by MCM. The screen that appears when you tap on the "About" button is as shown below.

The "Voltmeter" button can be used to select the settings of the G1 data-logger's "stand-alone" voltmeter. (See Section V. 3 below for information on how to use the G1 as a "stand-alone" voltmeter).

Furthermore, pipe-to-soil voltage waveforms (in cases where rectifier-current interruption is used) can be viewed (and saved) by the G1 data-logger by tapping on the "Voltmeter" button and then tapping on the "Waveform" button. Waveforms can then be view by tapping on the "Read" button and they can be saved by tapping on the "Save" button and selecting a file name for the waveform data. (See Section V. 3 for more details).

The "Open" button will allow you to select a previously run application.
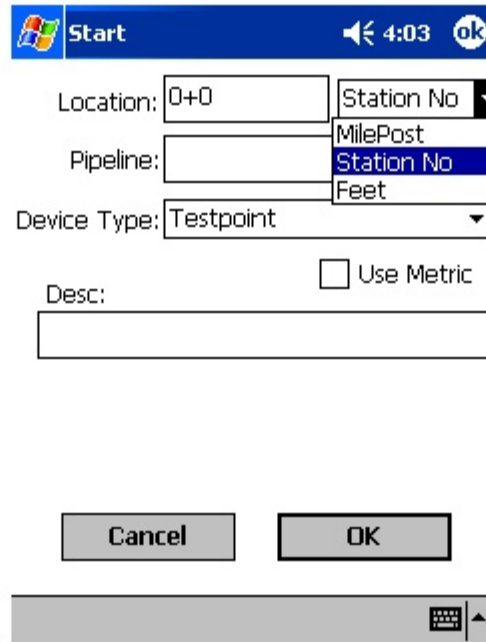
The "New" button allows you to identify a file name for the data that will be recorded in the SDL application. It is important to select a meaningful file name here as this file will be accessed by ProActive to upload the saved data.

The "Quit" button exits you from the SDL program and returns you to the "home" screen (Q100 units) or the desktop (Q200 units).

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## Step 4:

Tap on the "New" button, enter a filename and tap on the OK button.

The screen shown below will appear.



You are being asked here to enter information regarding the type of device from which you will be collecting SDL data and the location of the device. Also, you are being asked to identify the pipeline (by its name) with which the device is associated. You can also enter a description of the location.

By tapping on the pull-down-list arrow button on the above screen, you can select your choices of the "Device Type" and its "Location" by milepost, station number or feet, or you can check off the "Use Metric" box and enter location data by kilometer, station number or meters.

After you make your selections, tap on the "OK" button which will pull up the screen shown below.
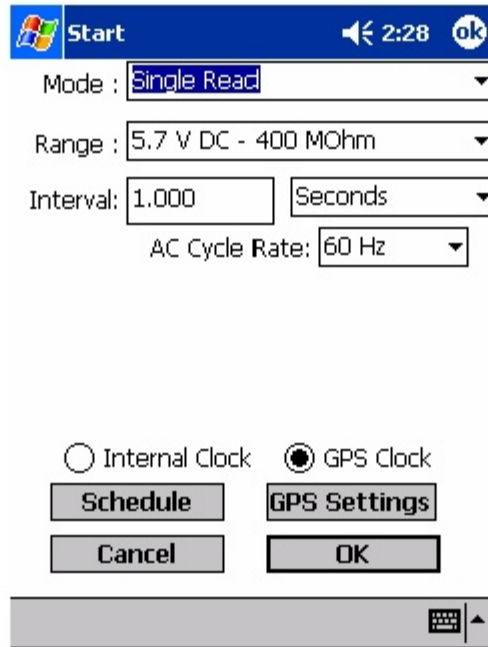
## Step 5:
Select Voltmeter Range, Reading Mode and Recording Interval

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

**AC Cycle Rate:**
As can be seen by tapping on the pull-down-list arrow in the AC Cycle Rate box, you have two choices, 60Hz and 50Hz. Select the electricity supply frequency for the country in which you are operating the G1 data-logger (60Hz for the U.S.).

**Range:**
A variety of voltmeter ranges (full-scale values) (for both AC and DC for "Single Read" cases and DC only for "On/Off Pairs" cases) and input-impedance values are available and can be selected by tapping on the pull-down-list arrow in the field labeled, "Range". Your selection here should be made following your selection of Reading Mode (see below).
The recommended settings for the voltmeter for rectifier-current-interrupted applications, where pipe-to-soil potentials are being recorded, 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 fast cycle current-interrupted applications.

**Voltmeter Reading Mode:**
The 5 choices available to you regarding voltmeter read mode can be viewed by tapping on the pull-down-list arrow in the "Mode" box. The screen will be as shown below.
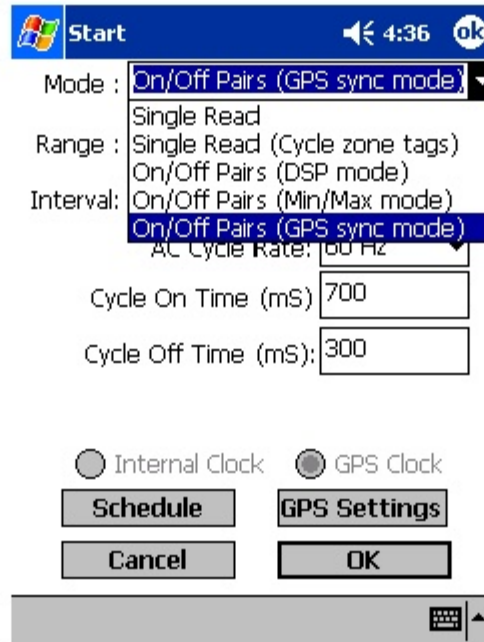


The various reading modes are as follows:

**Single Read:**
With this voltmeter reading mode selected, the screen shown below will appear.

This voltmeter mode would be selected if rectifier-current-interruption was not to be in-effect during the SDL data collection period.
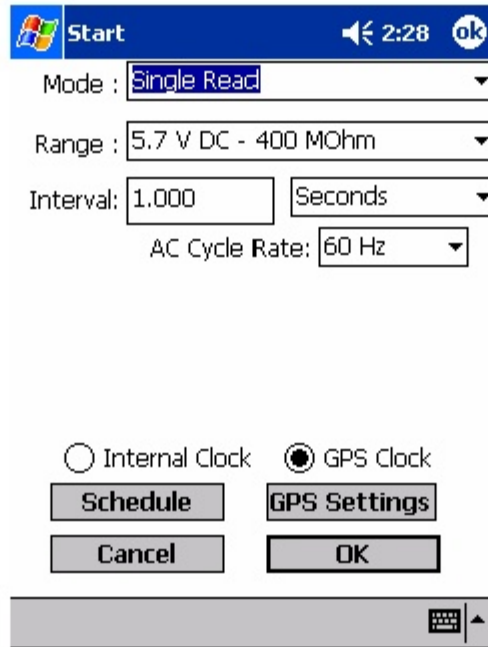
After selecting the "Single Read" mode, you would enter the recording interval by tapping in the box labeled, "Interval" and typing in your desired recording interval. By tapping on the pull-down-list arrow in the box, you can select the units for the recording interval from a choice of milliseconds, seconds, minutes, hours and days. Note: The shortest recording interval for the Single Read mode is 100msec.

For example, if you wanted potential data to be recorded every second, you would select "seconds" and enter "1.0".

In the Single Read mode, you can choose to have the recorded data "time-stamped" via the G1's internal clock, by tapping on the radial button labeled "Internal Clock", or you can choose to have the recorded data "time-stamped" using the time signal from the GPS satellite system, by tapping on the radial button labeled "GPS Clock".

If you choose the latter option, you would tap on the "GPS Settings" button. By tapping on the "GPS Settings" button, you can provide the required information regarding your GPS receiver. The information that needs to be supplied here is the type of GPS unit you will be using (MCM internal or MCM external units ONLY), and the COM Port that you will be using for your GPS receiver. The COM 4 Port will be selected automatically if you

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select the MCM Internal GPS unit. For the case of the MCM External unit, you have a choice between the COM 4 Port and the COM 1 Port. It is recommended that you select the COM 4 Port to avoid potential conflict with ActiveSync which uses the COM 1 Port.

The COM 1 and COM 4 Ports are on the bottom side of the G1, the COM 1 Port is on the left-hand-side and the COM 4 Port is on the right-hand-side looking screen-side up.

**Single Read (Cycle zone tags):**
With this voltmeter reading mode selected, the screen shown below will appear.
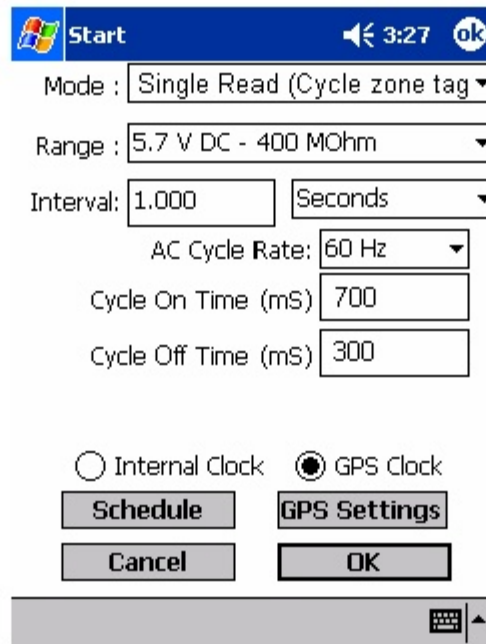


In this case, the rectifier-current is interrupted in a cyclic fashion, however, the voltmeter will only record a single reading at each recording time (as opposed to two readings per cycle in the case of the "On/Off Pairs" reading modes discussed below, where one reading in the pair represents the High (On) voltage and the other reading represents the Low (Off) voltage).

Each single reading in this mode will be stamped with an identifying "zone" tag, as described below. A zone tag could correspond to one of the High (On) zones or it could correspond to one of the Low (Off) zones, depending

on when each single reading is recorded relative to the pipe-to-soil waveform cycle.

In the "Cycle zone tags" reading mode, the pipe-to-soil waveform cycle is divided into 8 zones and readings get tagged (associated) with the particular zone of the waveform cycle in which they were recorded. This reading mode requires a GPS receiver to be used and the GPS settings can be selected by tapping on the radial button labeled "GPS Clock" and then tapping on the "GPS Settings" button.

First, though, you should enter the On and the Off times associated with your rectifier-current-interruption system. Our example above indicates 700ms On and 300ms Off for the current interruption cycle. Next, you should enter your selection of Recording Interval. Again, in the single read mode, the shortest recording interval is 100ms.

To make your GPS settings selections, tap on the "GPS Settings" button. The screen shown below will appear.
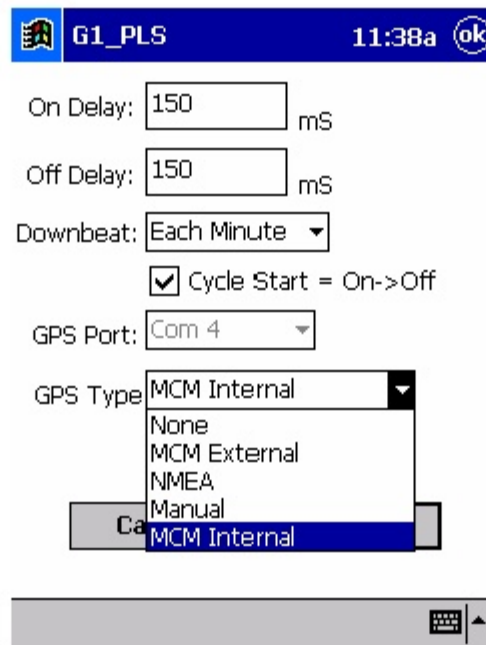


You are being asked here to make several selections.

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 this reading mode).

Next, select the COM Port for your GPS receiver. The COM 4 Port will be selected automatically if you select the MCM Internal GPS unit. For the case of the MCM External unit, you have a choice between the COM 4 Port and the COM 1 Port. It is recommended that you select the COM 4 Port to avoid potential conflict with ActiveSync which uses the COM 1 Port. The COM 1 and COM 4 Ports are on the bottom side of the G1, the COM 1 Port is on the left-hand-side and the COM 4 Port is on the right-hand-side looking screen-side up.

Next, enter your "On Delay" and your "Off Delay" selections by tapping on the appropriate box and typing in the selected delay time in milliseconds. These delay time values are used to establish the "zones" of the cyclic pipe-to-soil waveform.

For instance, you might determine prior to beginning the SDL application that there is significant spiking in the pipe-to-soil waveform following On-to-Off and Off-to-On transitions (see Section V. 3). In this case, you could select "Off Delay" and "On Delay" times to correspond to the times required for steady state (Low and High) voltages to be attained. By doing so, you would be identifying the "zones" on the cyclic waveform that contain the spiking. Consequently, since in the "Cycle zone tag" reading mode, voltage data are tagged with the zone of the cycle in which the data was recorded, you would be in a position, for example, to reject data that is recorded in the zones where you know that spiking is occurring.

Finally, select your current interrupter's "Downbeat" timing. As indicated by tapping on the pull-down-list arrow button in the "Downbeat" field, there are 3 selection choices; Each Minute, Each Hour and Midnight. If "Each Minute" is an option for your current interrupter, we suggest making this selection. Also, if your interruption 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).

**On/Off Pairs (DSP mode):**
With this voltmeter reading mode selected, the screen shown below will appear.

This voltmeter mode is an option if rectifier-current interruption is to be in-effect during the SDL data collection period.

Again, you should enter the On and the Off times associated with your rectifier-current-interruption system. Our example below indicates 700ms On and 300ms Off for the current interruption cycle. Next, you should enter your selection of Recording Interval. For this mode, the shortest recording interval is the period of the waveform cycle, which, in our case, is 1 second.
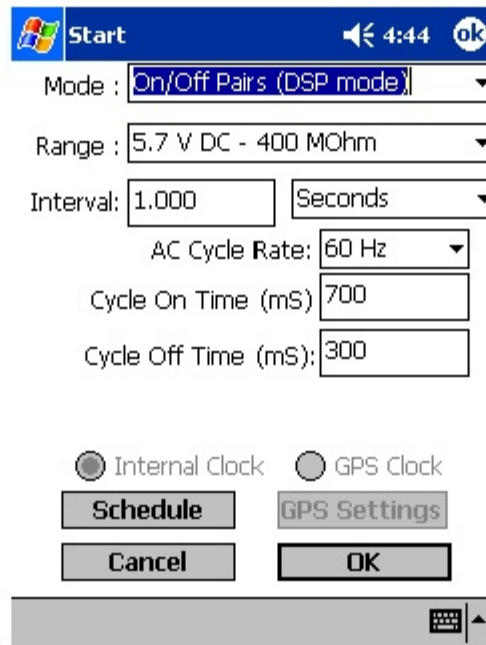


In the On/Off DSP mode, the voltmeter uses digital signal processing to determine the voltage during the ON portion of the rectifier-current cycle and the voltage during the OFF portion of the current cycle. When each reading time occurs (which represents the signal to record voltages), the voltmeter uses the sampled readings from the waveform cycle that immediately preceded the reading time in order to determine the High and the Low voltages for that reading time.

This voltmeter reading mode requires a measurable difference between the High and the Low voltage readings, ie, a measurable IR drop is required. This is because the voltmeter needs to be able to identify High-to-Low and Low-to-High voltage transitions in this mode.

Currently, SDL data can only be time-stamped using the internal clock with the voltmeter reading in the "On/Off Pairs (DSP)" mode.

**On/Off Pairs (Min/Max mode):**

With this voltmeter reading mode selected, the screen shown below will appear.



This voltmeter mode would be selected if rectifier-current-interruption was to be used during the collection of your SDL data 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 is just the magnitude of the IR drop). In this case, the voltmeter would record the average maximum and minimum voltages read during each rectifier-current cycle.

Again, you should enter the On and the Off times associated with your rectifier-current-interruption system. Our example above indicates 700ms On and 300ms Off for the current interruption cycle. Next, you should enter your selection of Recording Interval. For this reading mode, the shortest recording interval is the period of the waveform cycle, which, in our case, is 1 second.

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.

Currently, SDL data can only be time-stamped using the internal clock with the voltmeter reading in the "On/Off Pairs (Min/Max)" mode.

**On/Off Pairs (GPS Sync):**
With this voltmeter reading mode selected, the screen shown below will appear.
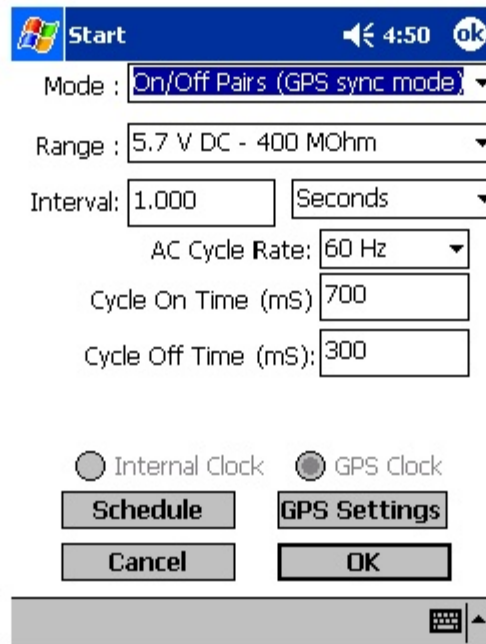


This voltmeter reading mode can only be selected if you are using either the MCM Internal GPS unit or the MCM External GPS unit on your G1 AND current-interrupter switches equipped with GPS units are being employed on your rectifiers. In these cases, with this reading mode, voltage readings (High/Low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

Again, you should enter the On and the Off times associated with your rectifier-current-interruption system. Our example above indicates 700ms On and 300ms Off for the current interruption cycle. Next, you should enter your selection of Recording Interval. For this reading mode, the shortest recording interval is the period of the waveform cycle, which, in our case, is 1 second.

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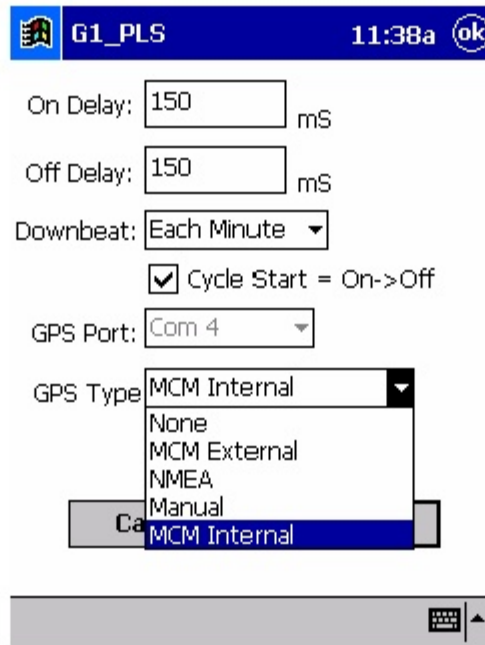


You are being asked here to make several selections.

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) and the COM Port you will be using for your GPS receiver (COM 1 or COM 4). Again, the COM 4 Port is recommended to avoid potential conflict with ActiveSync.

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 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 current interrupter's "Downbeat" timing. As indicated by tapping on the pull-down-list arrow button in the "Downbeat" field, there are 3 selection choices; Each Minute, Each Hour and Midnight. If "Each Minute" is an option for your current interrupter, we suggest making this selection. Also, if your interruption 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).

## Step 6:
Select Recording Schedule

Once you have selected the reading mode and the recording conditions for the voltmeter, as discuss above in Step 5, you can set up the G1 to record data on a programmed recording schedule.

You can also record data manually by tapping on the "Start" button on the main application screen (which will start the G1 recording data using your prescribed recording interval) and, by tapping on the "Stop' button, you would end the recording session. To record manually, tap on the "OK" button on your reading mode selection screen (once you've made your selections) which will return you to the main application screen. You can then tap on the "Start" button.

To set up a programmed recording schedule, tap on the "Schedule" button on your settings selection screen. The screen shown below will appear.
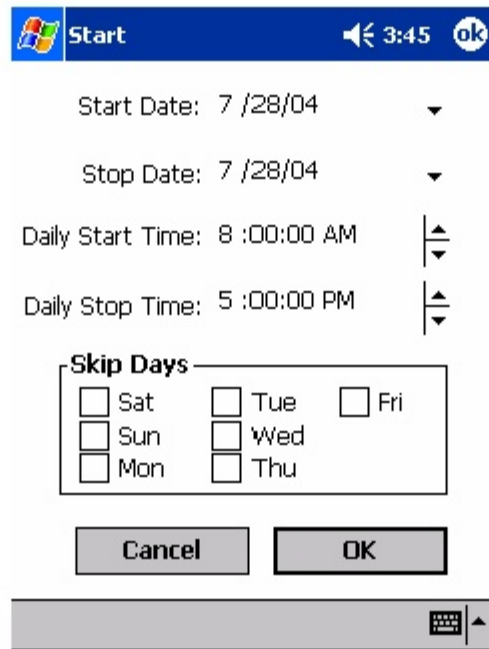
As can be seen from the above screen, you can program the "start date" (the day the recordings will begin) and the "stop date" (the day the recordings will end). You can either tap on the arrows and select a date from the calendar or you can highlight (tap on the numbers) and use the keyboard to change these dates.

You can also select the "daily start time" and the "daily stop time" for the recordings. For example, the above screen indicates that we have programmed the G1 to record data on the 28th of July, 2004 between the hours of 8am and 5pm.

You can also select to skip recording data on certain days of the week, by placing a tick inside the appropriate check box associated with the day, or days, that you'd like to skip in the "Skip Days" field. For example, if you are recording data over the course of several weeks but you are not interested in weekend days, you could select to skip recording on Saturdays and Sundays.

To enter your programmed recording schedule, tap on the "OK" button on the above screen.

Note: If your start time is more than 10 minutes away from the time you enter your programmed recording schedule, the G1 will switch itself off (to conserve battery power) when you tap on the "OK" button, and it will switch itself back on again 10 minutes prior to your programmed start time. Also, the G1 will switch itself off 10 minutes after your programmed stop time (again, to conserve battery power).

## V. 3 How to Use the G1 as a "Stand-Alone" Voltmeter/Waveform Analyzer (Stationary Data-Logger Program)

The G1 data-logger can be used as a "stand-alone" voltmeter/waveform analyzer in situations where such applications maybe warranted in association with SDL applications.

For example, at test points on your pipeline where you can make electrical contact with the pipeline (and where you might set up the G1 in the SDL mode), you might wish to confirm that the CP rectifiers are switching On and Off at the prescribed cycle rate and that the IR drop magnitude is sizable enough for the On/Off reading mode to be applicable, for example. Also, you might want to make sure that all of the rectifiers having an affect on the pipeline under examination are being switched On and Off in a synchronized fashion.

You can use the G1 as a "stand-alone" voltmeter by tapping on the "Voltmeter" button on the main application screen.

The "stand-alone" term arises due to the fact that, in this mode, the voltmeter is operating outside of the SDL parameters and is being used in an independent (non-data-logging) capacity.

By tapping on the "Voltmeter" button, the screen shown below will appear (depending on previous settings).

The Red and the Black banana plug terminals on the top side of the G1 can be used to read voltages or, alternatively, if an MCM data-probe (reference electrode) having a 5-pin connector socket is being used, the data-probe will be connected to the 5-pin socket on the top side of the G1, which will connect to the negative side of the voltmeter (assuming that a black-band data-probe cable is being used), and the Red banana plug terminal will be used to connect to the positive side of the voltmeter.

If other voltmeter settings are required to make a reading, you can tap on the pull-down-list arrows in the 2 fields shown above and make your selection choices. Note: To make settings changes, you first have to tap on the "Stop Voltmeter" button.

By tapping on the pull-down-list arrow button in the "Range" field, you can make your selection of full-scale range (either DC or AC) and also value of Input Impedance required for the voltmeter to make a particular type of reading.

By tapping on the pull-down-list arrow button in the "Read Mode" field, you can select from the following voltmeter read mode choices:

Single Read: This is a single read mode, where either the rectifier current is permanently ON or the rectifier current is OFF for the duration of the measurements.

ON/OFF Pairs (DSP Mode): In this case, two readings would be shown on the screen per rectifier-current cycle. The High and Low voltages (or the ON and the OFF voltages) would be determined by digital signal processing techniques.

ON/OFF Min/Max Mode: In this case, a number of sampled readings would be averaged to determine both the High and the Low voltages (during each cycle). The specific number of readings used by the voltmeter to come up with these averaged values would be dictated by the number that you enter in the "Moving Ave. Samples" box, which appears when you select this reading mode. The default number is 4.

ON/OFF GPS Sync Mode: This mode can only be selected if you are using either the Internal GPS unit or the MCM External GPS unit on the G1 AND you are using rectifier-current-interrupters with integrated GPS units. If this is the case and you select this option, a "GPS Settings" button will appear on the Settings screen and the screen shown below will appear when you tap on the "GPS Settings" button.

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). By tapping on the pull-down-list arrow in the "GPS Type" box, you can make your selection. Also, select the COM Port you will be using for your GPS receiver (COM 1 or COM 4). Again, the COM 4 Port is recommended to avoid potential conflict with ActiveSync.
Note: The COM 4 Port will be selected automatically when you select the MCM Internal GPS receiver.

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 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.

Next, select your current interrupter's "Downbeat" timing. As indicated by tapping on the pull-down-list arrow button in the "Downbeat" field, there are 3 selection choices; Each Minute, Each Hour and Midnight. If "Each Minute" is an option for your current interrupter, we suggest making this selection. Also, if your interruption 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).

By tapping on the "OK" button, you will be returned to the Settings screen.

**Waveform Analyzer**

A second application of the "stand-alone" voltmeter is as a waveform analyzer. To use this function, tap on the "Waveform" button on the Setting screen. The screen shown below will appear (depending on the previous settings).
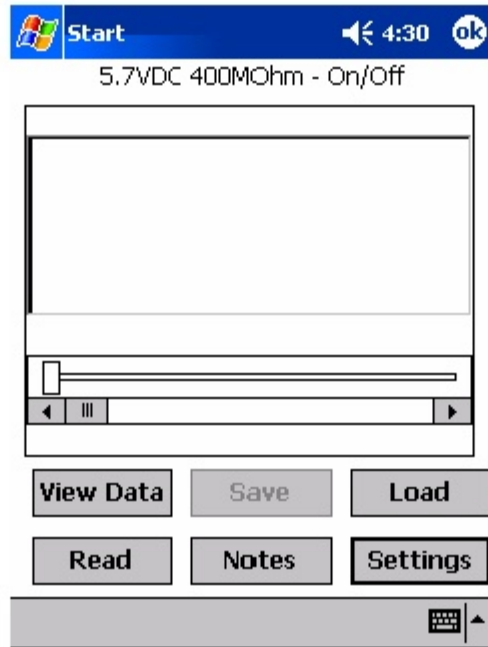
By tapping on the "Read" button on the above screen, you can view, for example, the pipe-to-soil voltage waveform at a test point, assuming that you have the appropriate cable connections made to the G1.

A typical waveform would be as shown in the screen below.

Since we set up a 700ms ON and a 300ms OFF rectifier cycle in this example, 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 on the 5.7V, 400MΩ setting), the transitions from High to Low and Low to High are not perfect (right-angled) steps.

These voltage waveforms are very useful with regard to confirming multiple-rectifier synchronization, for example, and with regard to checking for On-to-Off and Off-to-On transition spikes.

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" field on the above screen. For ease of future retrieval when you uploaded your survey data to ProActive, it is recommended that you use the same name as your SDL filename with the addition of something like "Wave TP 1" to the file name. This would represent the waveform data recorded at Test Point 1. Also, make sure that the target folder for the file is "G1_Data" as indicated above.

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.

Finally, by tapping on the "Load" button on the Waveform screen, a list of previously saved waveform files can be viewed and these files can be opened by tapping on the file name.


**V. 4 How to Download Stationary Data-Logger Data from the G1
          to ProActive**

As SDL applications are run, the recorded data are saved in the data logger's memory (CompactFlash Card) in separate files (one set of files for each application) under the filenames that you assigned to them during the G1 data-logger's setup process (described above in Section V. 2).

The SDL data stored in each file can be downloaded independently to a PC for storage and data management. The software required to download SDL data from the G1 to your PC and, to subsequently manage your SDL data, is the ProActive program.

**Step 1:**
Connect a communication cable between the G1's COM 1 Port (left-hand-side 26-way terminal) and 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.

**Step 2:**
Open the ProActive program on your PC and click on the "Tools" button on the main menu bar. Then, click on "Data-Logger" and click on "Time **Charts".**

The window shown below labeled, "Data Logger: Get Time Chart Data" will appear.
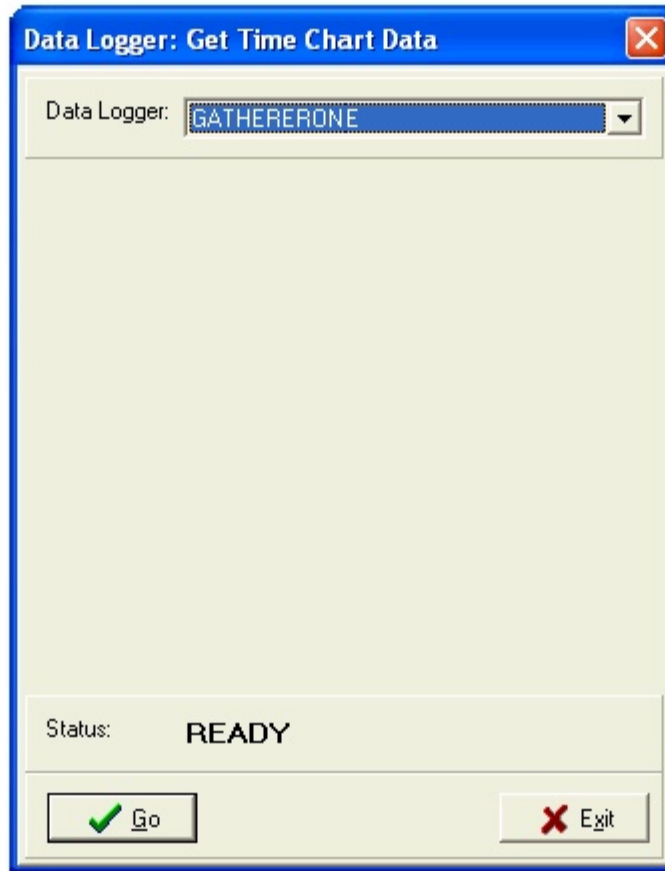
**Step 3:**

Select "GATHERERONE" (for G1) by tapping on the pull-down-list arrow button in the "Data Logger" field and clicking on GATHERERONE.

Click on the "Go" button on the above window, which will pull up the Driver window as shown below.

Next, select the "Logger Data" option in the "Data Type" field.

In order to permanently-save the uploaded SDL file on your PC, it is recommended that you place a tick in the box labeled, "copy to local folder", and identify the location on your hard-drive where you'd like the file to reside.
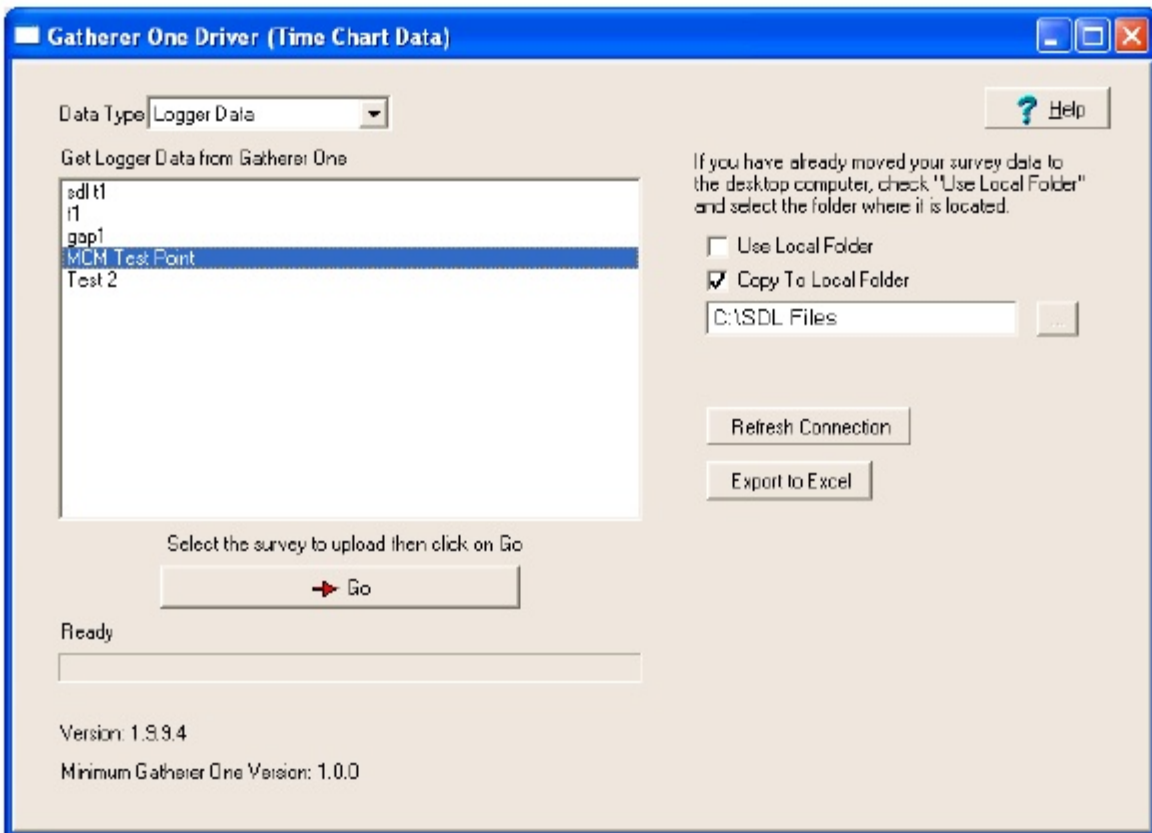
The Driver screen will list all of the SDL files currently stored on your G1.

You would highlight the SDL file that you would like to copy to your PC.

Note: Each time you stop an application and re-start the same application (either manually or via the scheduling function), a new file will be generated to separately-store each segment of time-stamped data (within the same application).

**Step 4:**
Examine Your SDL Data Prior to Posting the Data to ProActive.

It is suggested that you examine your SDL data prior to bringing the data into the Management Suite 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. The "Driver" window will again be shown but, this time, there will be a selection of tabs on the window, labeled as follows:

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Logger Info, Readings and Graph. By clicking on these tabs, you can view information on the SDL conditions (settings) or you can view actual readings either in spreadsheet form or displayed graphically.

By clicking on the "Logger Info" page tab on the "Driver" window, you can view a listing of the selections you made for your SDL application during the data-logger's setup process.

By clicking on the "Readings" tab, a window showing the recorded SDL data will be displayed.

For instance, the window below shows time-stamped "pipe-to-soil" data recorded at a test point by a G1 operating in the stationary data-logger mode, with the voltmeter reading mode being "On/Off Pairs (DSP Mode)". In addition, the "Internal Clock" time-stamping mode was selected. The data was collected for a period of approximately two minutes, with the recording time interval being 1 second.



**Gatherer One Driver (Time Chart Data)**

Download | Logger Info | Readings | Graph

| Data ID | On Time | On Voltage | Off Time | Off Voltage | Comments |
|---|---|---|---|---|---|
| 0 | 07/30/2004 14:16:41.713 | -1.2086 | 07/30/2004 14:16:41.713 | -0.7836 | |
| 1 | 07/30/2004 14:16:43.711 | -1.2065 | 07/30/2004 14:16:43.711 | -0.7850 | |
| 2 | 07/30/2004 14:16:44.710 | -1.2070 | 07/30/2004 14:16:44.710 | -0.7864 | |
| 3 | 07/30/2004 14:16:45.708 | -1.2086 | 07/30/2004 14:16:45.708 | -0.7861 | |
| 4 | 07/30/2004 14:16:46.707 | -1.2076 | 07/30/2004 14:16:46.707 | -0.7870 | |
| 5 | 07/30/2004 14:16:47.706 | -1.2083 | 07/30/2004 14:16:47.706 | -0.7852 | |
| 6 | 07/30/2004 14:16:48.705 | -1.2083 | 07/30/2004 14:16:48.705 | -0.7852 | |
| 7 | 07/30/2004 14:16:49.703 | -1.2084 | 07/30/2004 14:16:49.703 | -0.7861 | |
| 8 | 07/30/2004 14:16:50.703 | -1.2065 | 07/30/2004 14:16:50.703 | -0.7852 | |
| 9 | 07/30/2004 14:16:51.701 | -1.2079 | 07/30/2004 14:16:51.701 | -0.7838 | |
| 10 | 07/30/2004 14:16:52.700 | -1.2083 | 07/30/2004 14:16:52.700 | -0.7857 | |
| 11 | 07/30/2004 14:16:53.699 | -1.2091 | 07/30/2004 14:16:53.699 | -0.7847 | |
| 12 | 07/30/2004 14:16:54.698 | -1.2086 | 07/30/2004 14:16:54.698 | -0.7847 | |
| 13 | 07/30/2004 14:16:55.697 | -1.2091 | 07/30/2004 14:16:55.697 | -0.7850 | |
| 14 | 07/30/2004 14:16:56.696 | -1.2074 | 07/30/2004 14:16:56.696 | -0.7836 | |
| 15 | 07/30/2004 14:16:57.695 | -1.2091 | 07/30/2004 14:16:57.695 | -0.7850 | |
| 16 | 07/30/2004 14:16:58.713 | -1.2076 | 07/30/2004 14:16:58.713 | -0.7850 | |
| 17 | 07/30/2004 14:16:59.712 | -1.2083 | 07/30/2004 14:16:59.712 | -0.7847 | |
| 18 | 07/30/2004 14:17:00.711 | -1.2062 | 07/30/2004 14:17:00.711 | -0.7868 | |
| 19 | 07/30/2004 14:17:01.710 | -1.2086 | 07/30/2004 14:17:01.710 | -0.7847 | |
| 20 | 07/30/2004 14:17:02.709 | -1.2091 | 07/30/2004 14:17:02.709 | -0.7880 | |
| 21 | 07/30/2004 14:17:03.708 | -1.2070 | 07/30/2004 14:17:03.708 | -0.7849 | |
| 22 | 07/30/2004 14:17:04.707 | -1.2091 | 07/30/2004 14:17:04.707 | -0.7839 | |

The above screen displays the first 23 rows of data for the example application. As can be seen from the above screen, the "On" and the "Off" pipe-to-soil voltage recordings are date and time (GMT)-stamped.

The window shown below, which was pulled up by tapping on the "Graph" page tab on the Driver window, displays a graphical presentation of the SDL data (a time-chart).
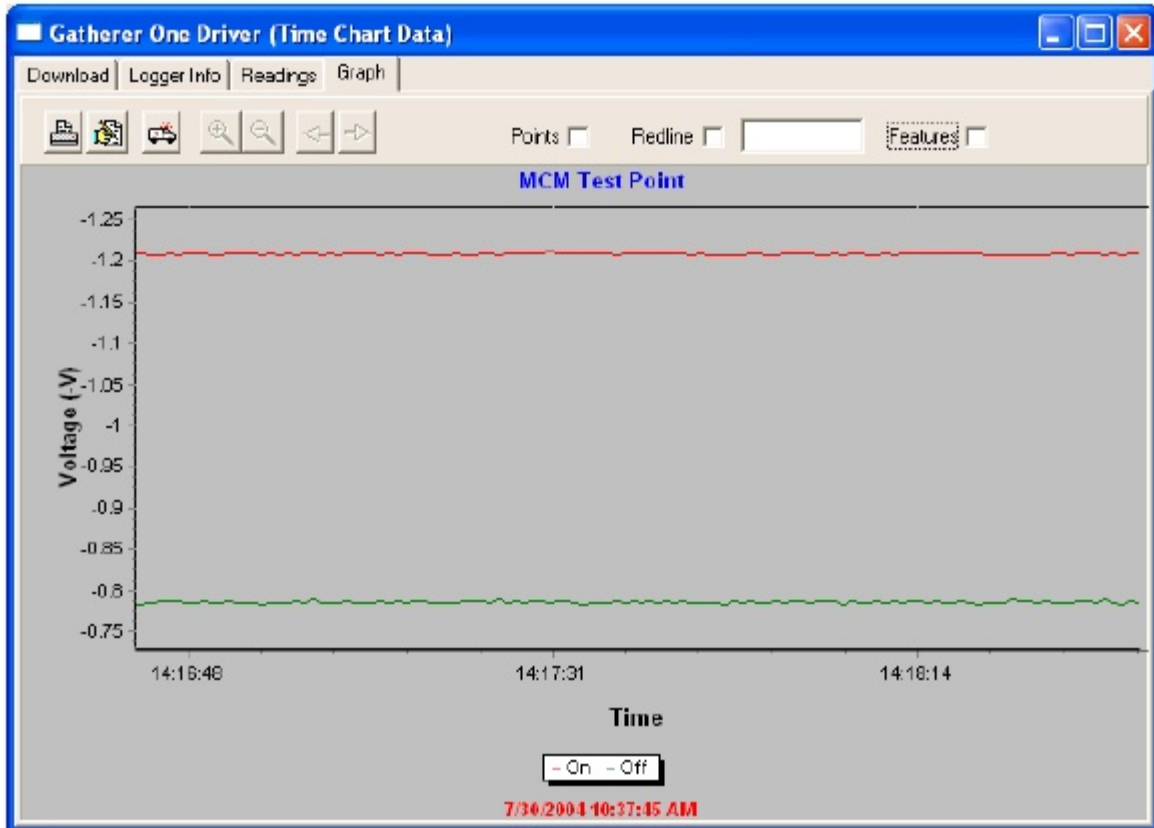


A graphical representation of SDL data is extremely useful with regard to immediately identifying times during the recording process when readings may have deviated significantly from their "steady-state" values. Please note that the time scale on the graph is GMT (Greenwich Mean Time).

**Excel Spreadsheet Option:**
An option exists at this point, particularly if you do not plan to bring the SDL data into the Management Suite of ProActive, and that is to export the data back out of the Driver in the form of spreadsheets. This can be done by

clicking on the "Export to Excel" button on the "Driver" window and selecting a folder on your hard-drive in which to save the exported data. The name of this file is what you would enter in the "Save-As" window, for example, "Exported SDL Files".

By accessing your "Exported SDL Files" folder on your PC (outside of ProActive) you can view the SDL settings for your application and the data itself, in spreadsheet form.

**Step 5:**
Post the SDL Data to ProActive.

At this point in the uploading process, having examined your SDL data in the Driver Section of ProActive, you can decide whether or not to bring the SDL data into the Management Section of ProActive, where the particular data that you are uploading can be integrated with other data in your database. For instance, you might want ProActive to use the SDL data in its determination of telluric compensation in association with time-stamped CIS data, for example.

When you highlight an SDL file and you click on the Go button in the Driver, the window shown below appears.
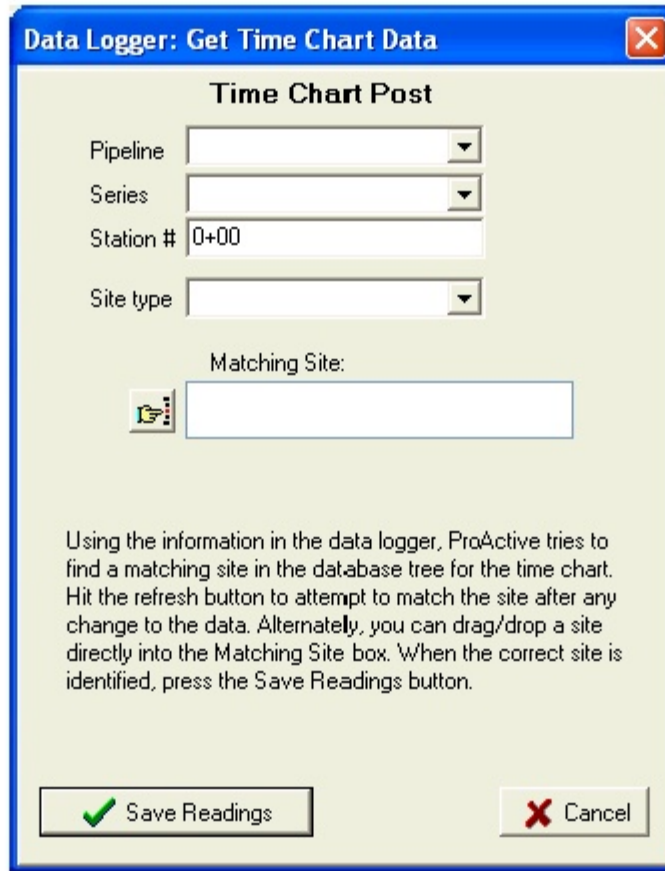
The above window allows you to post the SDL time chart data to a particular site (device) in your ProActive database tree. Remember, you will have collected the SDL data at a particular site, such as a test point, and your goal will be to post the data to the folder in your database that represents that site (device).

As indicated in the above window, you can either select the pipeline, station number and site type for the posting or you can drag and drop the site (device) from your database tree into the "Matching Site" field. ProActive will actually attempt to locate the site in the database tree, based on the information provided in the SDL file, assuming that the pipeline, station number, and site type were correctly entered when setting up the data-logger for the SDL application.

When the site has been correctly identified, you would click on the "Save Readings" button on the above window, which will post the time chart data to the folder (Details Form) representing that particular site. You can then view the time chart data in ProActive by opening the "Details Form" and clicking on the "Time Chart" page tab.

# APPENDIX 1

# HOW TO CONFIGURE TRIMBLE GPS PATHFINDER [XR, XRS, Power and Pocket] RECEIVERS FOR USE WITH THE G1 DATA-LOGGER

## a) Introduction

Although standard (uncorrected) GPS data only provides a position accuracy of around 15 meters, real-time corrected GPS data can result in a position accuracy of better than 1 meter, making real-time corrected GPS data more suitable for pipeline survey applications.

In order to output real-time corrected GPS position data, a GPS receiver has to be coupled with a "correction message" receiver which receives a correction message transmitted by one of three major systems, namely, the WAAS, Satellite and Beacon correction message generating systems. (In most cases, the correction message receiver is integrated with the GPS receiver in one unit, although external correction message receivers are also used).

For example, our MCM GPS receivers (which have integrated correction message receivers) make use of correction messages transmitted by the WAAS system. The WAAS system works well in open areas (throughout North America), however, in some locations, such as heavily-wooded or mountainous areas, it is difficult to receive a correction message from the WAAS system, due to the present positioning, directly over the equator, of the only two (geo-synchronous) re-broadcast satellites currently in the WAAS system.

Consequently, until additional re-broadcast satellites are added to the WAAS system, making it equally effective in all regions of North America, it may be necessary for you to use another type of GPS receiver (other than the MCM GPS receiver) in order to access the correction message transmitted from either the Satellite system or the Beacon system, depending on your particular location.

For instance, Trimble GPS Pathfinder receivers are commonly used to access correction messages available via commercial (subscriber) satellite systems such as OmniSTAR and LandStar or via a system of ground-based beacons (Coast Guard system).

If you plan to use a Trimble "GPS Pathfinder" receiver unit in conjunction with your G1 data-logger, there is a configuration process that you need to perform, in order to set up the GPS unit so that appropriate data will be delivered to the G1 from the receiver. (MCM GPS receivers are automatically-configured for use with the G1 data-logger).

A "GPS Pathfinder" receiver is capable of outputting NMEA data, when appropriately configured, which is the required output data type for a GPS receiver to work in conjunction with the G1.

There are four types of Trimble "GPS Pathfinder" receiver units that can be configured to be compatible with the G1 using a software program called the "GPS Pathfinder Controller". The 4 receiver models are:

GPS Pathfinder Pro XR
GPS Pathfinder Pro XRS
GPS Pathfinder Power
GPS Pathfinder Pocket

MCM supplies a copy of the "GPS Pathfinder Controller" software program which you can use to configure your particular GPS Pathfinder receiver and this program is available on your G1 Installer CD.

The "GPS Pathfinder Controller" program is contained in the folder labeled, "Trimble GPS" on the CD that came with your G1.

By double-clicking on the "Trimble GPS" folder, a number of files will be available to you as shown in the window below.

As can be seen from the above window, two PDF files are part of this package. These PDF files are Trimble manuals that describe in detail the "GPS Pathfinder Controller" software program. You can double-click on these icons to view these documents.

In addition, you will see 2 yellow folders which are labeled, "PC Installer For Pathfinder Controller" and "G1 Installer".

You have the option of installing the "GPS Pathfinder Controller" program on either your PC (or laptop) or on your G1 itself. Actually, you can install the program on both your PC and your G1, if you wish.

Your Trimble receiver unit will have to be connected to which ever computer (your PC or your G1 (a handheld PC)) onto which you have installed the Controller program in order that the GPS receiver can be configured with your settings.

In this regard, it would be advantageous to have the Controller program installed on your G1 data-logger since, in this case, you could make any adjustments in the field to the GPS receiver settings, if required, directly on the G1 itself. In addition, you could check on GPS position and receiver status right on the G1 at anytime.

The Installation Programs available on your CD allow you to install the Controller software on your PC (or laptop) and/or on your G1.

**b) How to Install the "GPS Pathfinder Controller" Software Program onto your PC**

The first step is to double-click on the icon labeled, "PC Installer for Pathfinder Controller". The next step is to follow the instructions associated with the Installation Wizard that will guide you through the simple installation procedure.

At the conclusion of the process, the "GPS Pathfinder Controller" software program will be installed on your PC's hard-drive (or another location of your choosing) and a short-cut icon will appear on your desktop screen.

You can now, at anytime, connect your GPS Pathfinder receiver unit to your PC (or laptop) via the COM 1 Port on the G1, which is the 26-Way Mini-D terminal on the bottom left-hand side of the G1 as you face the screen, and configure your GPS receiver unit to be compatible with your G1 as described below in Section d.

**c) How to Install the "GPS Pathfinder Controller" Software Program onto your G1 Data-Logger**

The first step is to connect the G1 to your PC and to switch on the G1. To make the connection, use the cable with a USB connector on one end and a 26-Way Mini-D connector on the other end and connect to the COM 1 Port on the G1 (bottom left-hand terminal looking screen side up).

Next, double-click on the icon labeled, "G1 Installer".

The next step is to follow the instructions associated with the Installation Wizard that will guide you through the simple installation procedure.

At the conclusion of the process, the "GPS Pathfinder Controller" software program will be installed on your G1. You can verify that this is the case by the following means, depending on whether you have a Q100 unit or a Q200 unit.

**Q100 Units:**
Tap on the "Start" button on the "Home" screen and tap on "Programs". The screen shown below will appear showing the presence of the "GPS Pathfinder Controller" icon.

**Q200 Units:**

Tap on the Start icon on the desktop (bottom left-hand corner of desktop), tap on the "Programs" icon, which will pull up the screen shown below. To open the Controller software program, tap on the "GPS Pathfinder Controller" icon.

You can now, at anytime, connect your GPS Pathfinder receiver unit to your G1 data-logger via the COM 1 Port on the G1, which is the 26-Way Mini-D terminal on the bottom left-hand side of the G1 as you face the screen. You will require a special cable to make this connection, which is MCM part number 126730 (G1 Serial Cable), in conjunction with your Trimble cable.

With the units connected, you can configure your GPS Pathfinder receiver unit to be compatible with your G1 as described below in Section d.

### d) How to Configure "GPS Pathfinder" Receivers to Output NMEA Data Suitable for Use by the G1 Data-Logger:

**Step 1:**
The first step in the configuration process is to connect the GPS receiver to your PC, if you have installed the Controller software program on your PC, or to your G1, if you have installed the Controller program onto your G1. In either case, use the COM 1 Port on the G1.

Make sure that the battery pack is connected and that battery power is being applied to your receiver unit.

**Step 2:**
Next, double-click on the "GPS Pathfinder Controller" icon located on either your PC's desktop screen or on the "Programs" screen of your G1. In either case, the window shown below will appear.

Note: On the G1, the menu bar on the Pathfinder Controller window is located at the bottom of the screen.
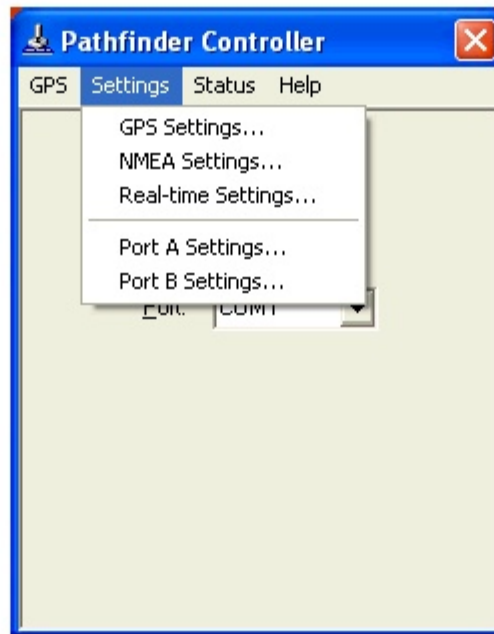
You should then select the appropriate COM port, which is, typically, COM 1, in the case when you are downloading settings from your PC (or laptop), and we recommend using the COM 1 Port on the G1 when downloading configuration settings from the G1 to your receiver.

Step 3:
Click (or tap) on "Settings" on the above window. This will pull up the window shown below.

Step 4:
Click (or tap) on "Port A Settings" or "Port B Settings". This will allow you to configure either Port A or Port B for NMEA data output.

The specific port that you'll configure to output NMEA data (Port A or Port B) will depend on which of the Pathfinder receiver units you are configuring for application with the G1 and whether or not you would like to have the G1 unit signal the receiver to perform GPS tracking only when a survey application requires GPS data, as opposed to the receiver continuously-tracking the GPS signals even when not required to do so by the G1.

For both the XR and XRS receivers, you can select to configure either Port A or Port B for NMEA data output.

**The important issue with regard to the XR and XRS receivers is the connection cable itself.**

If you would like the G1 unit to signal the GPS receiver when GPS tracking is required by the G1, during particular survey applications, you would select cable number 30231-00 to connect the receiver to the G1.

This is a power-saving mode of operation for the GPS receiver, since, when GPS tracking is not required by the G1, the GPS receiver will be in "sleep" mode, which is a low-battery-power consumption mode. Conversely, if you'd like the GPS receiver to be continuously tracking the GPS signals at all times, you would select cable number 30945. With this cable, the G1 does not control when the receiver is in GPS tracking mode, but rather, the receiver will begin tracking as soon as battery power is applied and will continue to track until the battery power is switched off. This would represent the maximum battery power consumption mode for the receiver.

With regard to the Power receiver (which only has one physical terminal but you can connect to either Port A or Port B internally, depending on which cable you select), you would configure Port B for NMEA data output by selecting cable number 40492, assuming that you wanted to have the G1 signal the receiver to perform GPS tracking only when GPS data is required by a survey application. Alternatively, you would configure Port A, using cable number 30945, if you wanted to have the receiver to always be tracking the GPS signals when battery power is applied, even when GPS data is not required by the G1.

Finally, for the Pocket receiver you must configure Port B for NMEA data output and you must connect to the G1 using the standard Pocket receiver cable supplied by Trimble. The Pocket receiver can only track the GPS signals when prompted to do so by the G1 unit. In other words, the Pocket receiver needs a control signal from an external unit (in our case the G1) to be turned on.

**Example:**
The following is an example of how you would configure Port A on the receiver unit for NMEA output.

If you select to configure Port A, by clicking or tapping on "Port A Settings", the window shown below will appear.
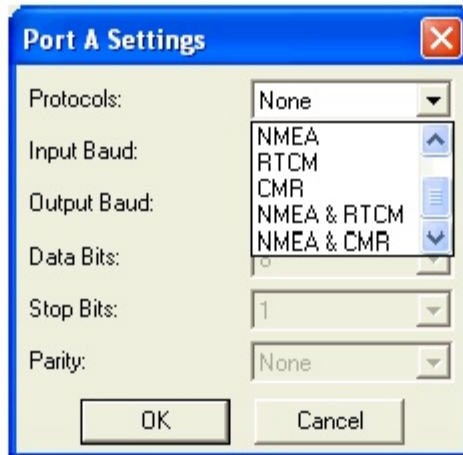
Step 5:

Click (or tap) on the pull-down-list arrow button in the field labeled, "Protocols" on the above window and select "NMEA". The window shown below will appear.
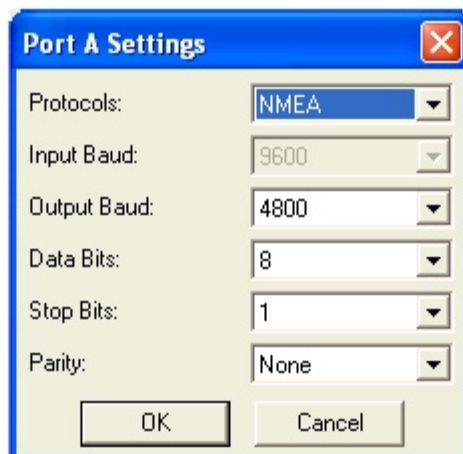


Select the output baud rate for the receiver and the other communications settings required to match the G1's requirements.

The settings on the "Port A Settings" window shown above should be as follows:

Output Baud Rate: 4800
Data Bits:             8
Stop Bits:             1
Parity:                None

Step 6:
Click (or tap) on the "OK" button on the above "Port A Settings" window which will save these communications settings.

Step 7:
Click (or tap) on "Settings", again, and then click (or tap) on "NMEA Settings" this time. By doing so, the window shown below will appear.
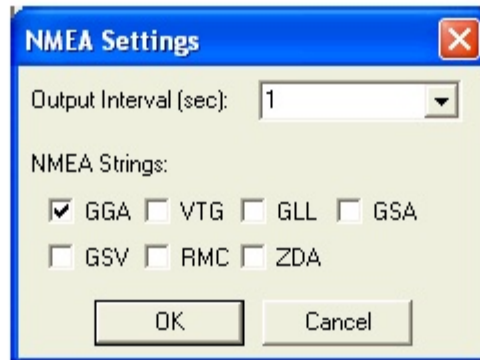


The NMEA data string format labeled as, "GGA" should be selected (box checked). All other boxes should be left unchecked.

The "GGA" data string contains position data (latitude, longitude and altitude) as well as the time (UTC) that each position was fixed. In addition, the "GGA" string contains data that indicate whether or not real-time correction was applied and how many satellites were involved for each position fix.

The "Output Interval" refers to the interval of time between the output of one string of NMEA data and the output of the next string of NMEA data, by the receiver.

For application with the G1, an "Output Interval" of 1 second should be selected by clicking (or tapping) on the pull-down list arrow in the box labeled, "Output Interval" and selecting "1".

Since our data strings contain position data (GGA format) and since we are requesting a new data string to be output by the receiver each second, this means that the receiver has to be generating position data at least every second. This issue brings us to the "GPS Settings" selection step (step 8).

Step 8:
After clicking (or tapping) on the "OK" button on the "NMEA Settings" window, click (or tap) on "Settings" again, and this time click (or tap) on "GPS Settings".

This will pull up the window shown below.
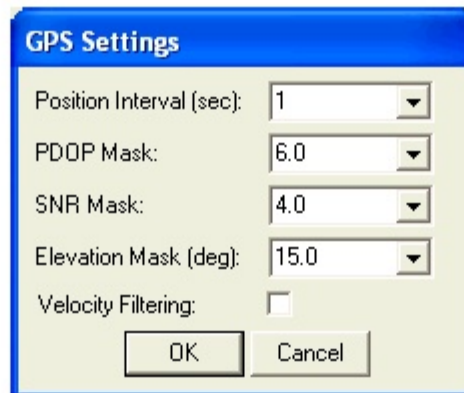


Based on the discussion in Step 7, we require position data to be output every second and so, your selection of "Position Interval" on the above window should be 1 second.

We recommend that the other settings on this window be left at their default values, which are the values shown in the above window. These additional settings pertain to maintaining a minimum "quality" of GPS data, based on the receiver only processing data from satellites that are well positioned (relative to one another) and that are producing good signal strength. Please refer to the Trimble Pathfinder manual for more details on these parameters.

Step 9:
If you require real-time corrected GPS data and you plan to employ a particular system, Satellite (subscriber service), Beacon or WAAS, you would make any necessary selections in this regard by clicking (or tapping) on "Settings" and this time clicking (or tapping) on "Real-time Settings". In the case of both the Satellite and Beacon systems, you would be required to make additional selections to suit your needs. Please refer to the Trimble Pathfinder manual for additional details.

Step 10:
Connect the "GPS Pathfinder Controller" software to the receiver unit by

**clicking (or tapping) on "GPS" and selecting "Connect". By doing so, your settings will be sent to your GPS receiver unit to configure its operation.**

Step 11:
Disconnect the "GPS Pathfinder Controller" software from the receiver unit by clicking (or tapping) on "GPS" and selecting "Disconnect".

Your "GPS Pathfinder" receiver will save your settings in its memory until you decide to re-configure the unit. You are now in a position to connect a suitably-configured receiver to the G1 unit and to perform surveys involving the tagging of readings with GPS position data.

**e) How to Connect a Configured GPS Pathfinder Receiver to the G1**

When you've configured your GPS receiver (either via your PC or via your G1) and are ready to conduct a survey, you would connect your receiver to the G1 via the COM 4 Port on the G1, which is the 26-Way Mini-D terminal on the bottom right-hand side of the G1 as you face the screen.

This would be the case if you selected the COM 4 Port during the survey set up procedure (as recommended) at which time you would also have selected "NMEA" for the "GPS Type".

You will require a special cable (G1 Serial Cable), which is MCM part number 126730, to connect the receiver to the G1. This special cable is used in conjunction with your selection of Trimble cable (see section d (step 4) above).

# APPENDIX 2

# HOW TO CONFIGURE TRIMBLE GPS PATHFINDER [ProXT and ProXH] RECEIVERS FOR USE WITH THE G1 DATA-LOGGER

## SECTION 1

## How to Configure the GPS Receiver for Use with the G1

Step 1: Insert the Trimble "GPS Pathfinder Pro Series" CD into the CD Drive of your laptop or PC and click on the "GPS Controller Software" option on the main menu.

Step 2: Click on the "Install on this PC" option and run through the Installation Wizard for the GPS Controller 2.00 software for the desktop.

Step 3: Exit the CD image

*Step 4:* Press and release the power button on the GPS receiver unit. The battery indicator on the GPS receiver should glow green (permanently ON) and the satellite indicator should flash (green) ON and OFF. The Bluetooth indicator should be OFF. If the Bluetooth indicator flashes (blue), press and hold the power button until the flashing stops permanently and then release the hold.

*Step 5:* Connect the serial cable that came with the Trimble unit (black cable with 9-pin female terminals at both ends) between the GPS receiver and your laptop or PC.

Note: If you use an ActiveSync connection on the laptop or PC, for example, for downloading G1 survey data, ActiveSync has to be temporarily disconnected to allow the GPS receiver to connect to the laptop or PC, since ActiveSync ties up the COM port. Disallow ActiveSync connection via the serial port while configuring the settings on the GPS receiver.

***Step 6:*** Double click on the icon labeled "GPS Controller" that will have been automatically-created on your desktop during the software installation.

Next, click on the drop-down list button at the top of the screen and select the "Setup" option, which will pull up the screen shown below.
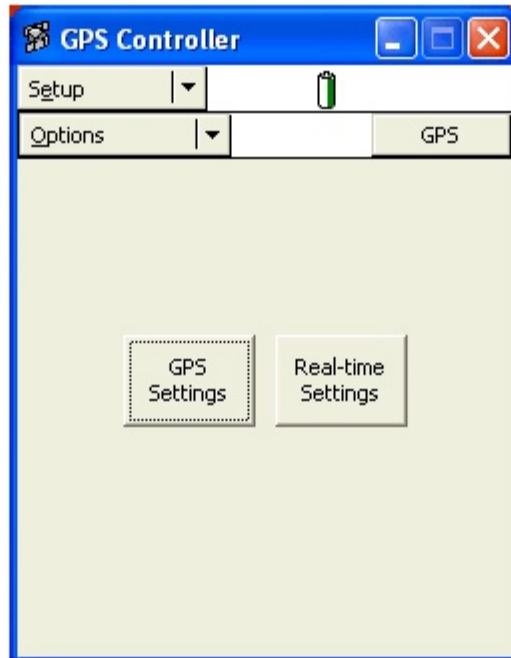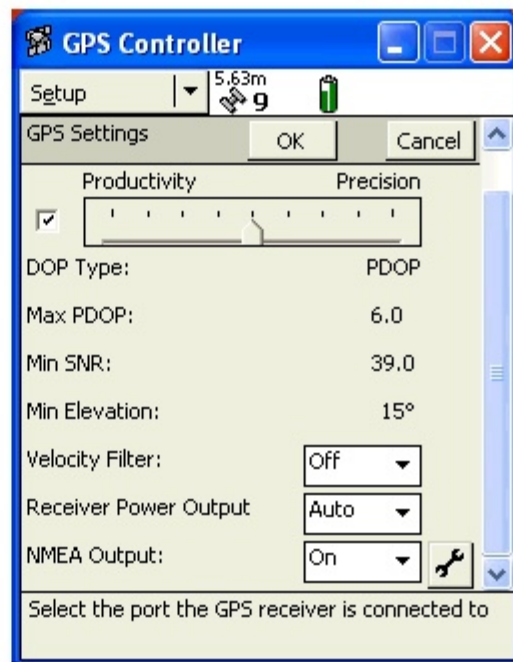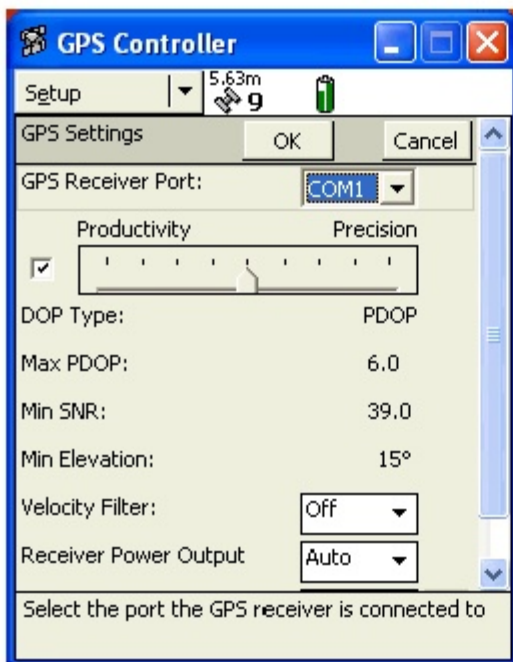


***Step 7:*** Click on the "Options" drop-down and select "Connect to GPS". This will pull up the window shown below.

Note: Typically several seconds (10 to 20 seconds) are required for the connection to be made
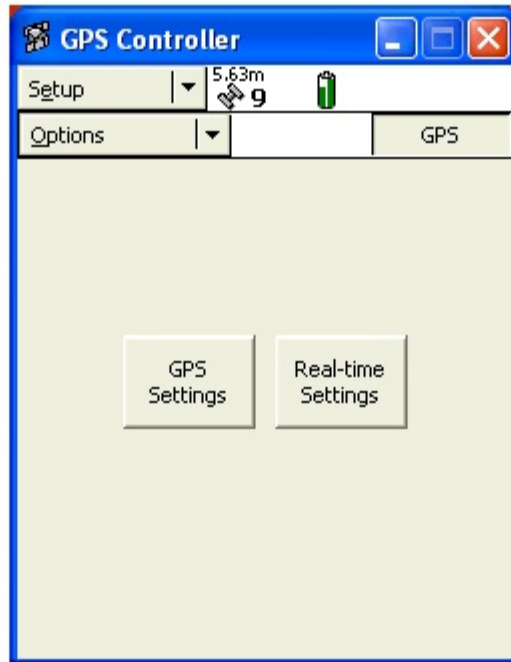
***Step 8:*** Click on the "GPS Settings" button on the above screen, which will pull up the screen shown below (left-hand side screen).



Select the COM1 port for the "GPS Receiver Port" and leave the Productivity check box checked.

Next, use the scroll bar to reveal the "NMEA Output" field and select "On" for this option.
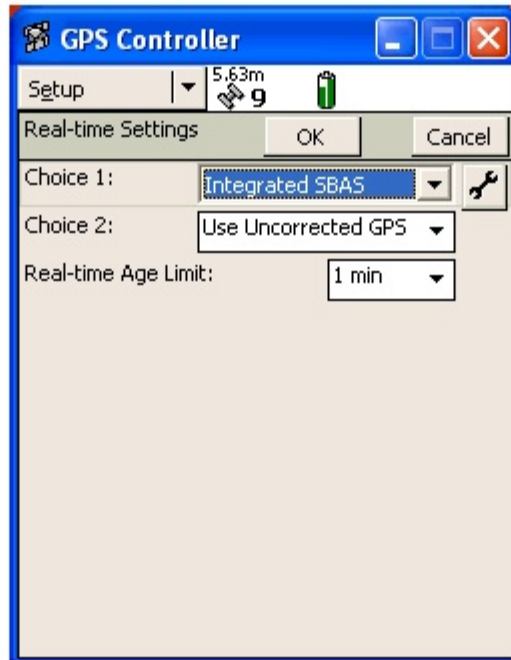
***Step 9:*** Click on the "wrench" button on the above screen (right-hand side screen, bottom right) which will pull up the screen shown below (left-hand side screen).
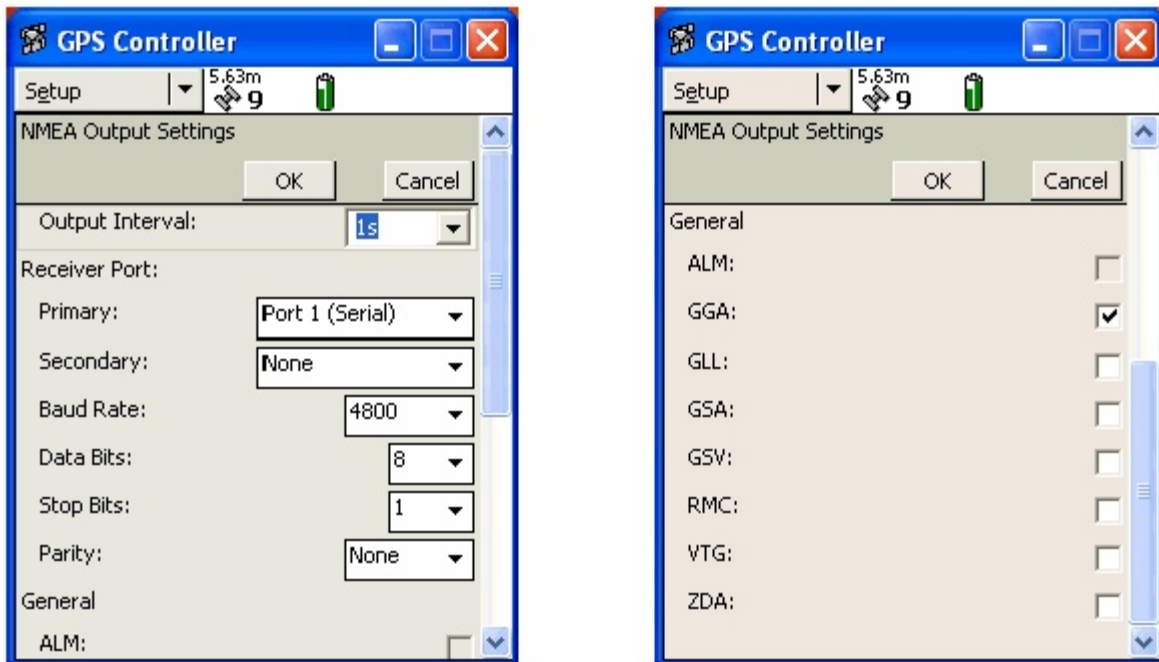


Next, make the selections indicated on the screen above (left-hand side screen). Next, use the scroll bar to scroll down to reveal the screen shown above (right-hand side screen) and select GGA only as the NMEA string type.

Next, click on the OK button on the "NMEA Output Settings" screen and then click on the OK button on the "GPS Settings" screen, which will return you to the Setup screen.

Step 10: Click on the "Real-time Settings" button on the Setup screen, which will pull up the screen shown below.

Next, under "Choice 1", select "Integrated SBAS" (which is WAAS differential correction) and click on the "wrench" button, which will pull up the screen shown below.
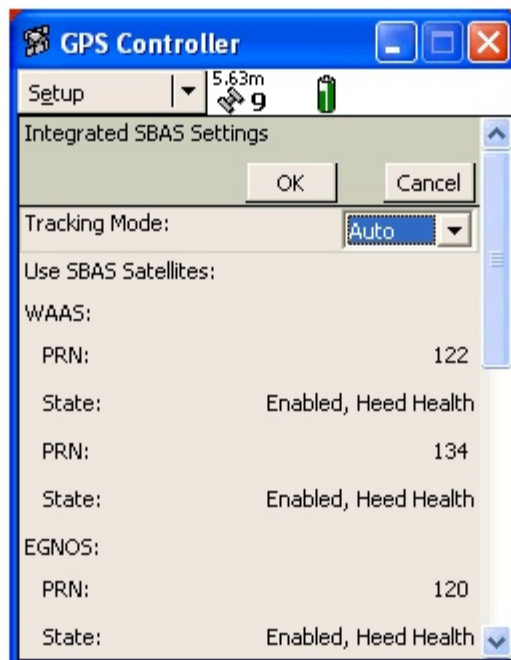


Next, on the above screen, select "Auto" for the Tracking Mode.

Next, click on the OK button on the "Integrated SBAS Settings" screen and then click on the OK button on the "Real-time Settings" screen, which will bring you back to the Setup screen as shown below.
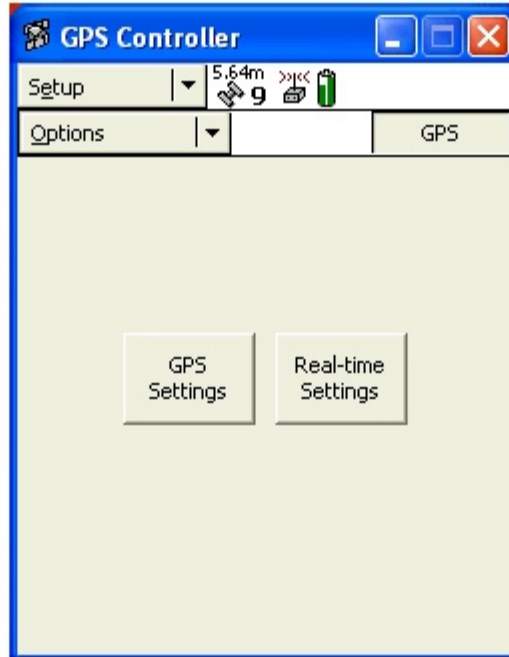


**Step 11:**    Click on the "Options" drop-down on the above screen and select "Disconnect from GPS". Your NMEA settings will be transmitted to the GPS receiver upon disconnecting. The GPS receiver is now configured for use with the G1 data-logger

## SECTION 2

## How to Test the GPS Receiver/G1 Connection

Note: To test the connection, the GPS receiver will require an unobstructed view of the satellites in an outside location.

To test that the G1 is receiving the NMEA output of the GPS receiver, perform the following steps:

Step 1: Switch on the GPS receiver. The battery indicator on the GPS receiver should glow green (permanently ON) and the satellite indicator

should flash ON (green) once per second when a stable NMEA output has been established. The Bluetooth indicator should be OFF.

Step 2: Switch on the G1 and open the G1GPS program to run the G1's GPS utility program. Tap on the "Settings" button and select "NMEA" via the drop-down list in the "GPS" field. Also, select "COM4" from the adjacent drop-down list. Next, tap on the "Save" button.

Step 3: Connect the GPS receiver to the G1 via the serial cable that came with the G1 (black cable with a 26-way terminal on one end and a 9-pin female terminal on the other end). Connect the serial cable to the COM4 port on the G1, which is the right-hand port as you face the screen.

Step 4: View the GPS data on the G1 screen. The screen will appear as indicated in the example below.
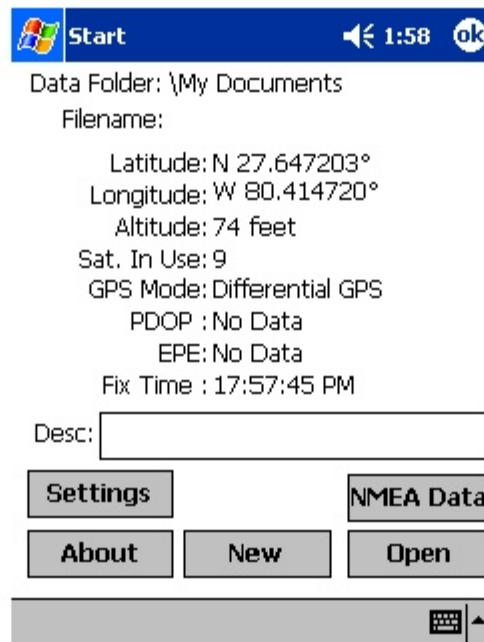


Step 5: Exit the G1GPS program when GPS data have been displayed as indicated above.

# SECTION 3

## How to Setup the G1 for a Pipeline Survey Application with an Integrated Pro Series Receiver

Step 1: Switch on the G1, open the G1PLS program and run through the normal procedures for setting up a survey file.

Step 2: Make the following selections on the second survey setup screen: Select "NMEA" via the drop-down list in the "GPS" field. Also, select "COM4" from the adjacent drop-down list. After making your other selections on this screen, tap on the "Next" button and proceed through the other setup screens. An example setup screen is shown below:



**Step 3:** Switch on the GPS receiver. The battery indicator on the GPS receiver should glow green (permanently ON) and the satellite indicator should flash ON (green) once per second when a stable NMEA output has been established. The Bluetooth indicator should be OFF.

**Step 4:** Connect the GPS receiver to the G1 via the serial cable that came originally with the G1 (black cable with a 26-way terminal on one end and a

9-pin female terminal on the other end). Connect the serial cable to the COM4 port on the G1, which is the right-hand port as you face the screen.

***Step 5:*** View the GPS data on the G1 by tapping on the "GPS Data" button on the survey screen. An example screen is shown below:
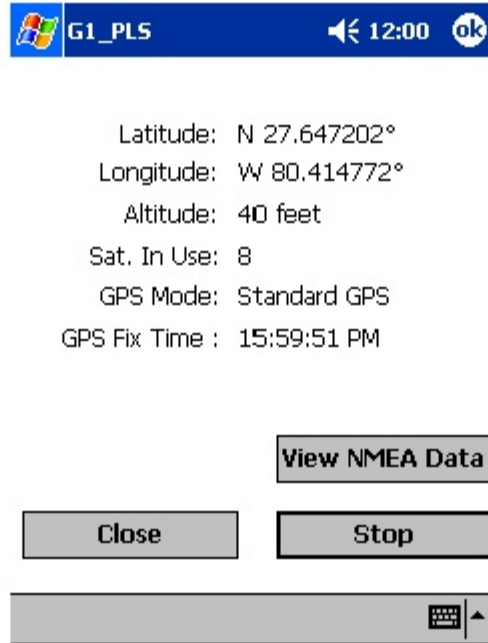


***Step 6:*** Exit the "GPS Data" screen, which will return you to the survey screen. You can now proceed to perform the pipeline survey.