CIS Training Manual – Gx Version

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SECTION I: INTRODUCTION AND BACKGROUND

I. 1 Introduction

This manual is designed to provide individuals who will be performing "Close Interval Potential Surveys" (CIPS or CIS) with a practical knowledge of how to select appropriate test equipment, how to setup and properly connect the test apparatus, how to actually perform close interval potential surveys, and, ultimately, how to download pipeline survey data from the data-logger to a PC using either the ProActive or Gx-ESD software applications.

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

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

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

Step 1: Pre-Assessment.
This step requires the integration of historical, construction, operations and maintenance records for each ECDA Region.

Step 2: Indirect Inspection.
The objective of this step is to estimate areas of active corrosion by performing above-the-ground measurements.

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

Step 3: Direct Examination.
The objective of this step is to excavate (dig) at least in those areas identified using the complementary steps above (steps 1 and 2) and, by direct inspection, to measure the extent of corrosion in those areas. Typically, wall thickness is measured and other corrosion-related data are collected in this step.

Step 4: Post-Assessment
The objective of this step is to prioritize the repair schedule and to decide on the mitigation approaches to be used based on the results obtained in Step 3. The period of time before the next integrity evaluation is to be undertaken is also decided in this step for each ECDA Region.

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

I. 3 CIS Overview

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

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

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

I. 4 Key Components of a CIS Measurement System

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

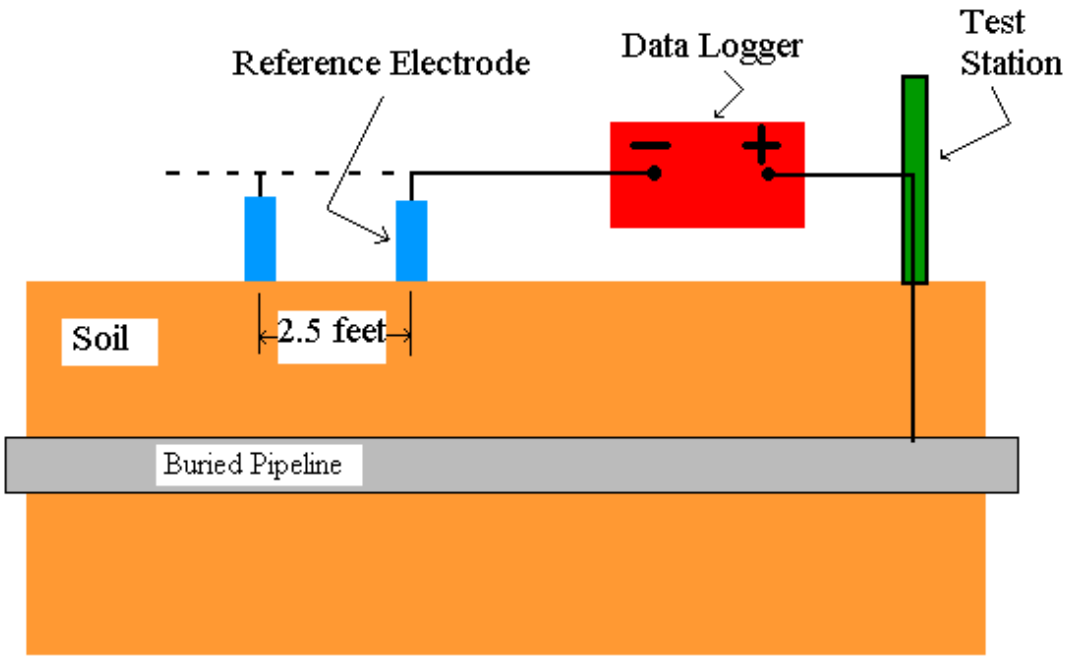


Figure 1: Key Components of a CIS Test Equipment System

Pipe potentials, versus the copper/copper sulfate electrode potential, are recorded at close intervals (for example, every 2.5 feet) using a data-logger. The data-logger's internal voltmeter is connected between the pipe and, typically. two copper/copper sulfate reference electrodes.

For negative pipe-to-soil readings, the pipe is connected to the positive side of the voltmeter, while the reference electrodes (one of which should be in contact with the soil at all times) are connected to the negative side of the voltmeter.

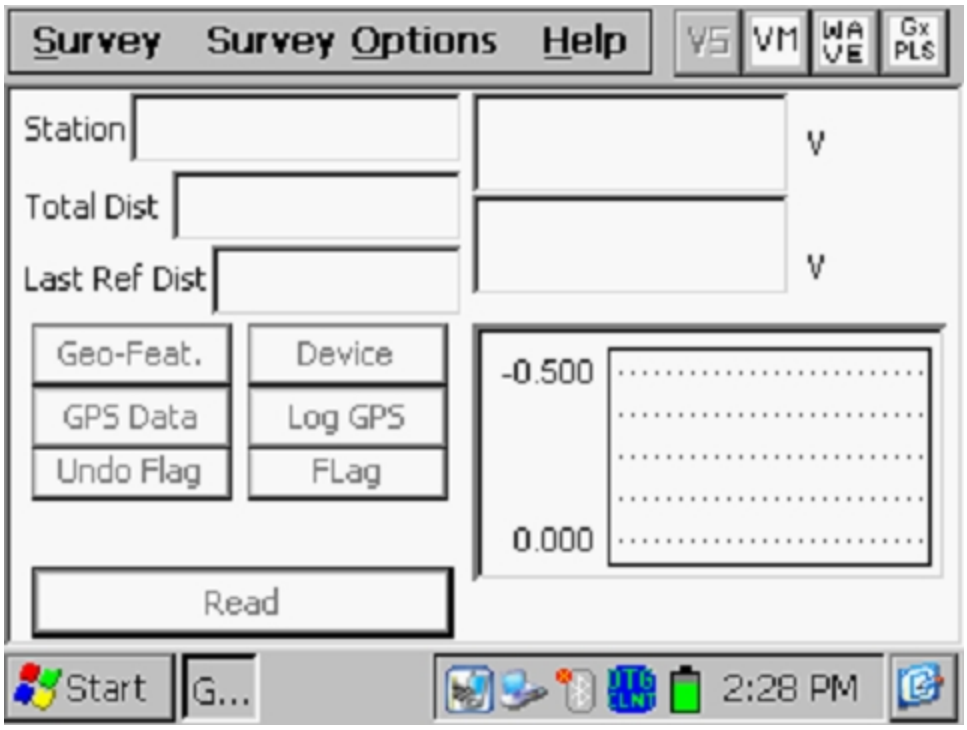
For the case of pipelines that are cathodically-protected via impressed current (rectifier/anode) systems, CIS surveys are performed as the rectifier current is interrupted (switched On and Off in a cyclic fashion). In such cases, both On and Off pipe-to-soil potential values can be determined and saved by the data-logger for each interruption period. The advantage of being able to interrupt the CP current is that the polarized pipe potential (the On potential value minus the IR drop in the soil) can be determined which is typically known as the "instant-off" potential.

SECTION II: HOW TO SETUP THE DATA-LOGGER FOR CIS APPLICATIONS

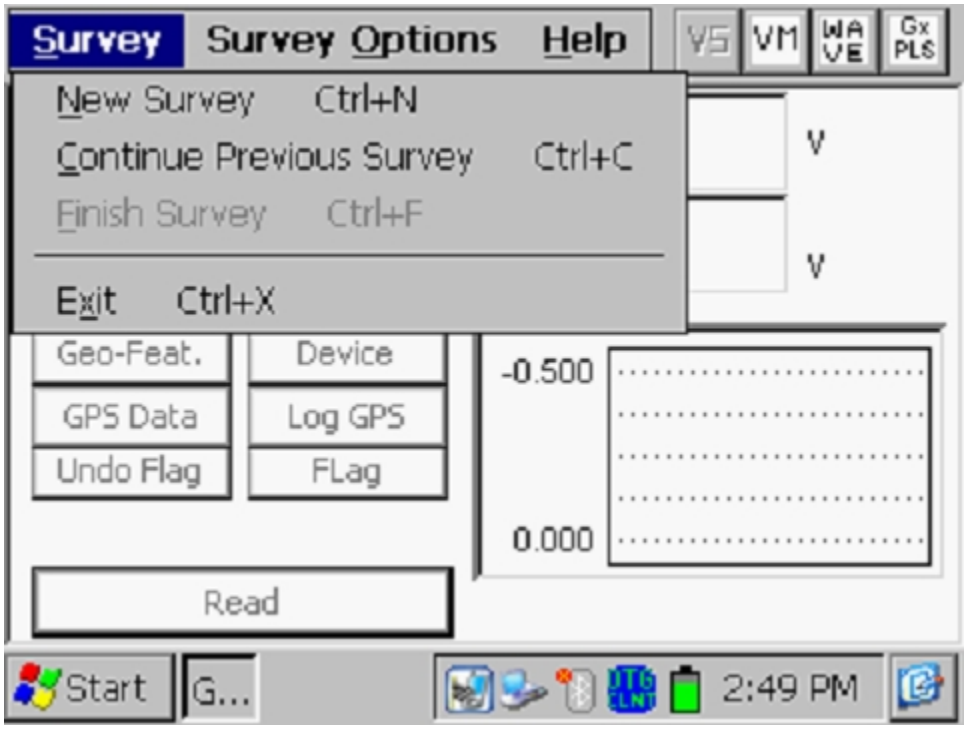
Your Gx data-logger will arrive from MCM with the Windows operating system and our pipeline survey application program (Gx_PLS) pre-installed. The survey application will remain installed unless the batteries are allowed to fully-discharge. Application re-installation is an automatic process, however, during a Cold Boot process (please see the Gx Pipeline Survey Data-Logger User's Manual for details). However, your pipeline survey data will always be safe, regardless of battery status, as these data are stored in a non-volatile Flash memory on the Gx.

II. 1 Gx Data-logger Setup for CIS

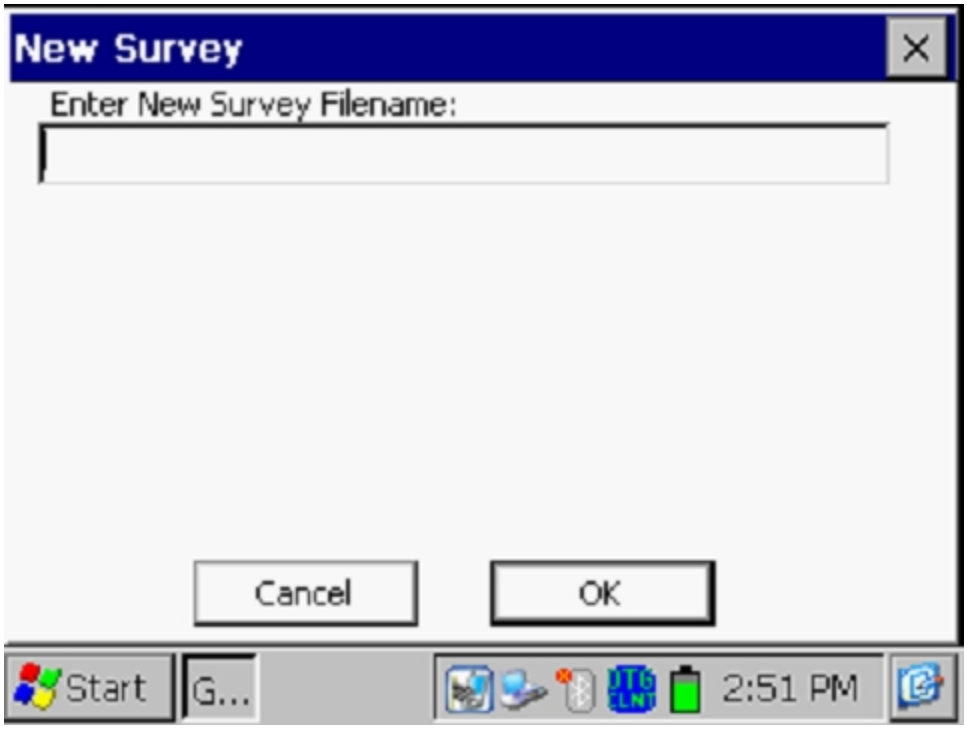
Step 1: Double-tap on the Gx_PLS icon on the Gx desktop. The screen shown below will be displayed.



Step 2: Tap on the "Survey" button located on the menu bar. The screen shown below will be displayed.



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 be displayed.

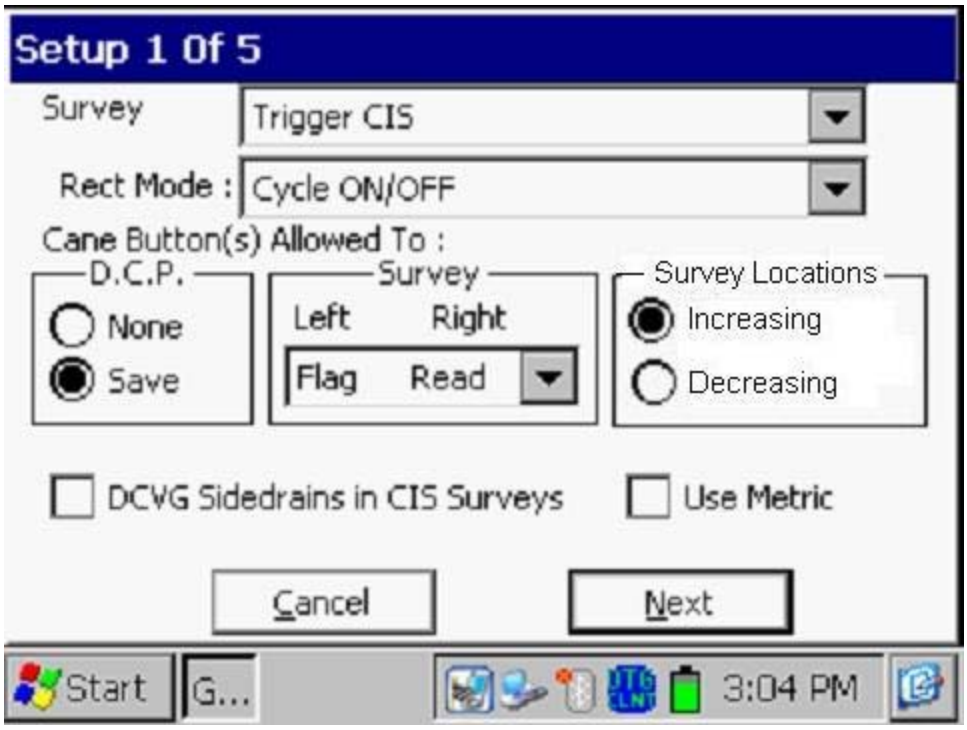


Step 3: Enter a “filename” for the Survey.

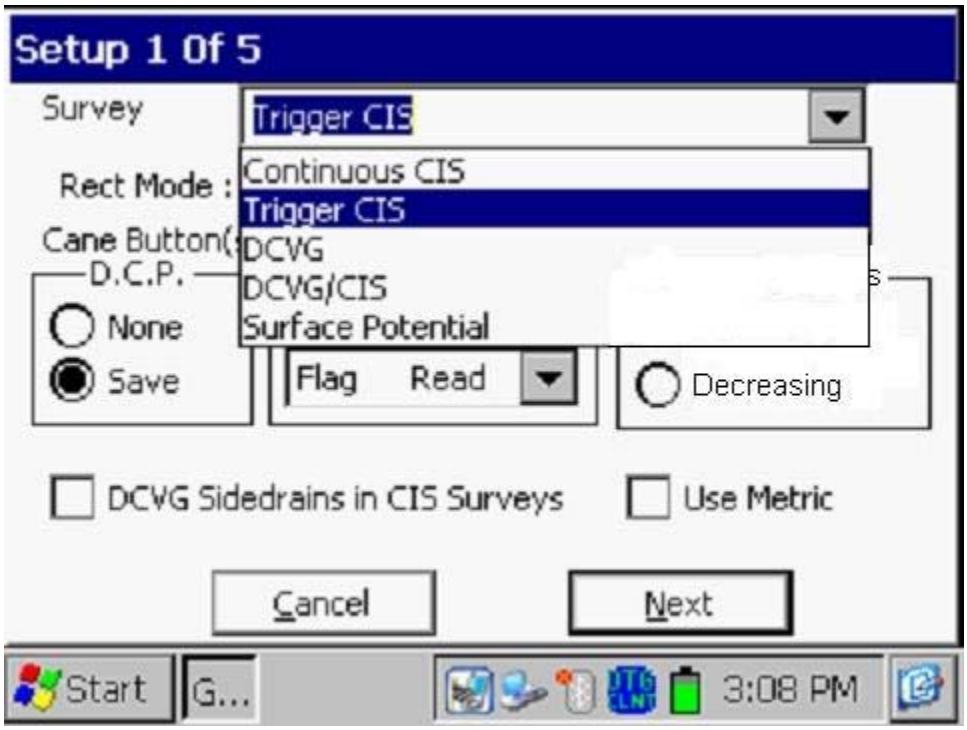
This should be a descriptive name that will help you identify the survey at a later stage. Perhaps the name of the section of pipe you are surveying could be part of the filename. “CIS” and the survey date do not have to be part of the filename as these tags are incorporated with the survey on the ProActive side (assuming that you will be downloading the survey data to the ProActive application).

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 4: Once you have entered a filename, tap the OK button on the above screen. The screen shown below will be displayed. The specific selections indicated on the screen will reflect the selections made for the previous survey.



Step 5: Select the survey type by tapping on the menu button in the "**Survey Type**" field and highlighting the survey type of your choice.



For Close Interval (Potential) Surveys there are 2 options for “type of survey”: Trigger CIS and Continuous CIS.

“**Trigger CIS**” should be selected if you plan to either manually trigger readings (using the push-button data-probes), or, you plan to use an automatic triggering cable in conjunction with a trail wire measure/counter system.

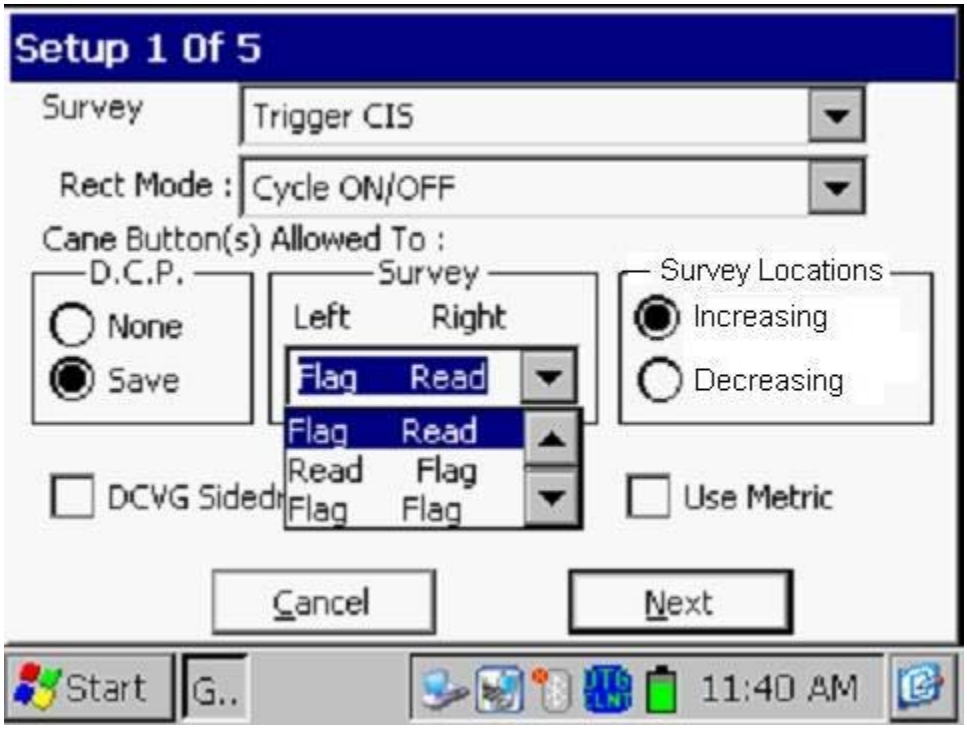
“**Continuous CIS**” should be selected if you do not plan on either manually-triggering readings or having the readings triggered automatically using a triggering cable.

In the Continuous CIS mode, readings are logged based on timing. For example, if you indicate that you require 40 readings to be logged between 100 foot survey flags and that it will take you 60 seconds to walk 100 feet, the data-logger will log readings every 1.5 seconds. You can have the data-logger “learn” your walking pace, which might turn out to be different from “60 seconds for 100 feet”, in which case, the software will adjust the timing between logged readings accordingly in order to target 40 logged readings between 100 foot survey flags (see Setup screen 3 of 5 for the options available if the “Continuous CIS” mode is selected).
An advantage of Continuous CIS over Trigger CIS is that manual triggering of readings (using push buttons) is not required nor is an automatic triggering cable with associated trail wire measure/counter system. However, pre-measured (equally-spaced) survey flags are required for Continuous CIS and, if the pipeline does not run through an open area, extensive pausing may be required.

Step 6: Select the function (operating mode) of the push button switches associated with the data probes, during the survey itself and at test stations (data collection points (D.C.P.s))

<u>Survey</u>
The functionality available for the data probe switches depends on the survey mode selected in Step 5 [Trigger CIS or Continuous CIS].

For the Trigger CIS selection, the options will be as displayed on the screen shown below for the left-hand data probe (red-handled data probe) and the right-hand data-probe (green-handled data-probe).



Manual Triggering of Readings:
When the data probe switches are used to trigger readings, as opposed to an automatic triggering cable, there are 4 combinations possible for selection for the left and right switches, as indicated by tapping on the menu button in the "Survey" field on the above screen.

"R**ead Read"** means that both switches can be used to trigger readings

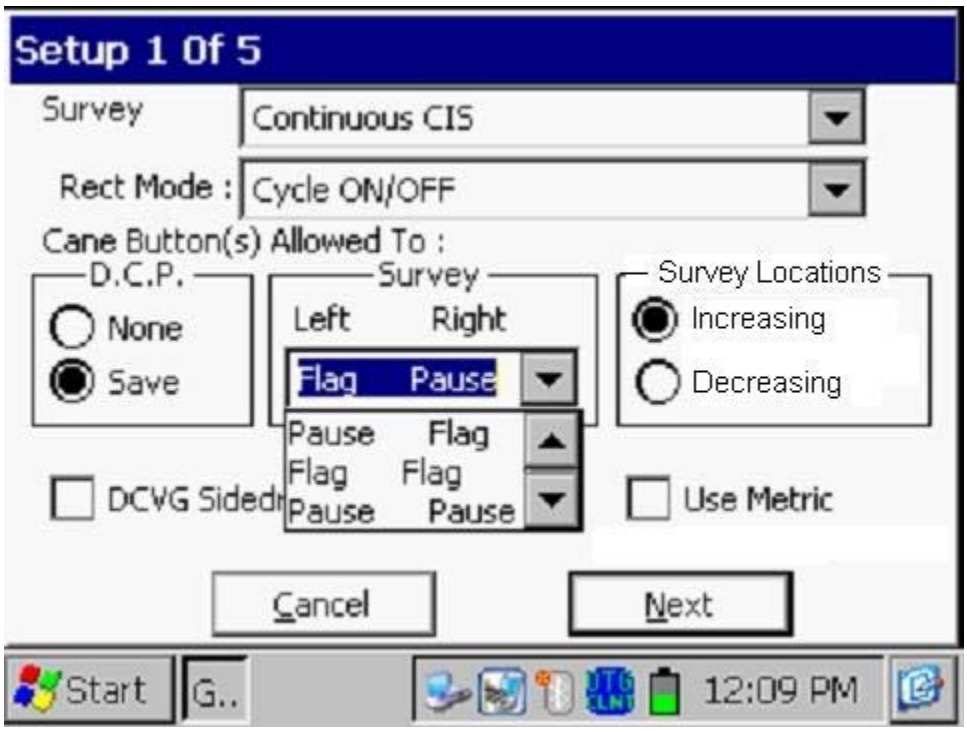
"Flag Read" means that the left hand switch will designate the location of a survey flag and the right hand switch will be used to trigger readings

"Read Flag" means that the left hand switch will be used to trigger readings and the right hand switch will designate the location of a survey flag

"Flag Flag" means that both switches can be used to designate survey flags (and neither switch can be used to trigger readings).

Automatic Triggering of Readings:
The selection in this case should be “Read Read” only, since the readings are triggered by an automatic triggering cable. In this case, the data probe switches have no function, since the data probes are connected to the Gx Data-logger via the banana plugs, rather than via the 5-pin terminal.

For the Continuous CIS selection, the options will be as displayed on the screen shown below for the left-hand data probe (red-handled data probe) and the right-hand data-probe (green-handled data-probe).



In this case, the 4 combinations possible for selection for the left-hand and right-hand switches are as follows:

“**Flag Pause**” means that the left-hand switch will designate a survey flag and the right-hand switch will be used to interrupt (pause) readings and to re-start readings

“**Pause Flag**” means that the left-hand switch will be used to interrupt (pause) readings and to re-start readings and the right-hand switch will designate a survey flag

"**Flag Flag**" means that both switches can be used to designate survey flags (and neither switch can be used to interrupt (pause) readings).

"**Pause Pause**" means that both switches can be used to interrupt (pause) readings and to re-start readings.

D.C.P.
D.C.P. stands for Data Collection Point and on a CIS usually would represent a test station (either the initial hook up station or a reconnect test station where the trail wire is broken and reconnected to the pipe).
The data probe switches can have no functionality at these "devices" (the "**none**" selection) or they can be used to save the D.C.P. readings, such as Near-Ground P/S or Far-Ground P/S readings at a reconnect test station (the "**Save**" selection).

Step 7: Make "**Survey Locations**" selection

Once a value has been entered for the "Distance between Readings" (see the Setup 3 of 5 screen), that distance, for example 2.5 feet, can be added to each successive station number each time a reading is triggered, or, it can be subtracted from each successive station number each time a reading is triggered.

Your selection of "Increasing" or "Decreasing" will depend on your walking direction over the pipe with respect to the pipe's stationing.

You would select "**Increasing**" if the station number will be increasing as you perform the survey and you would select "**Decreasing**" if the station number will be decreasing as you perform the survey.

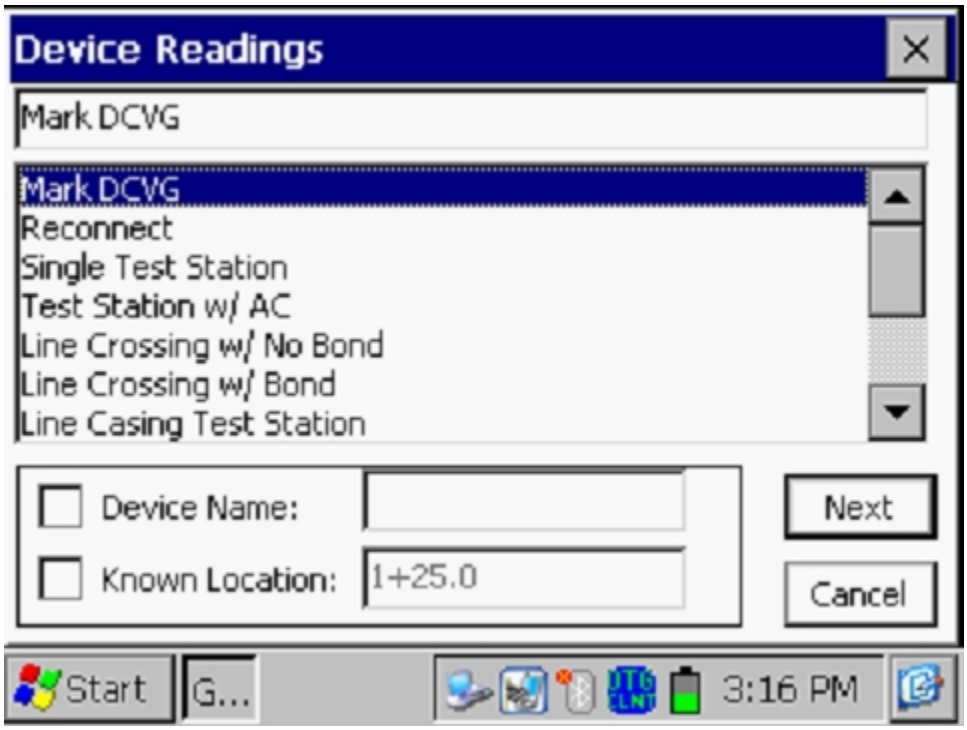
Step 8: Make selection of "Metric" units, if required.

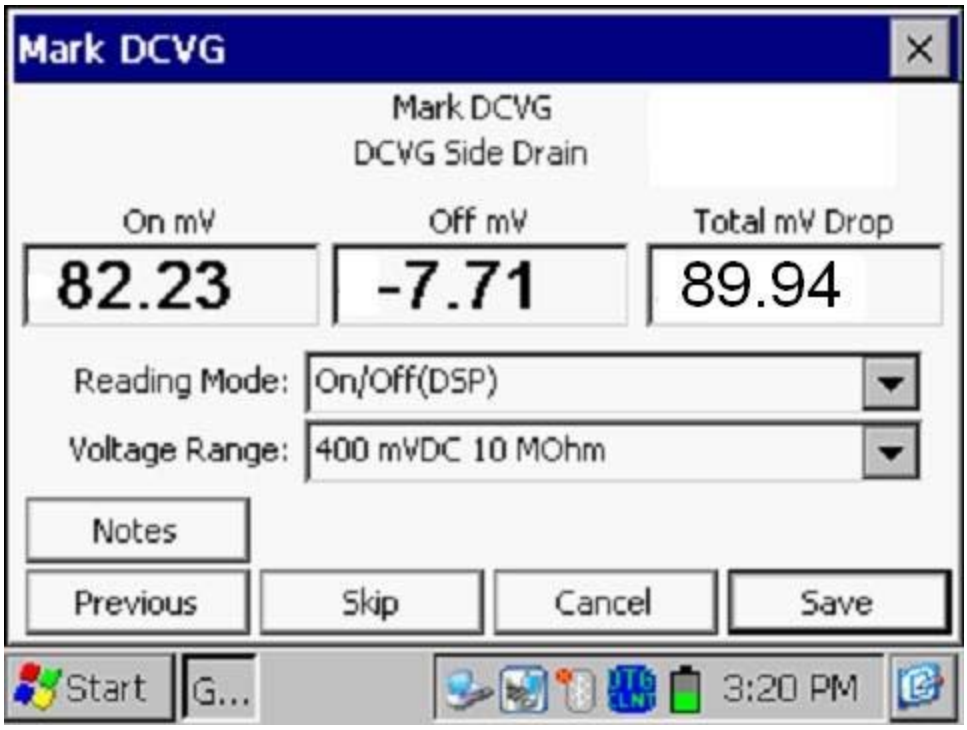
By checking off the box labeled "**Metric**", the reading interval (distance between triggered readings) and the flag internal (survey flag spacing) will be displayed on the Setup 3 of 5 screen in meters, as opposed to feet.

Step 9: Check-off the box labeled, "DCVG Sidedrains in CIS Survey" if you plan to log DCVG sidedrain readings at previously located anomalies, during the course of your CIS.

Note: This is a special case that would only apply if a DCVG survey had been perform in advance of your CIS and it was specified that you should have the anomaly locations determined by the DCVG survey integrated with your CIS file.

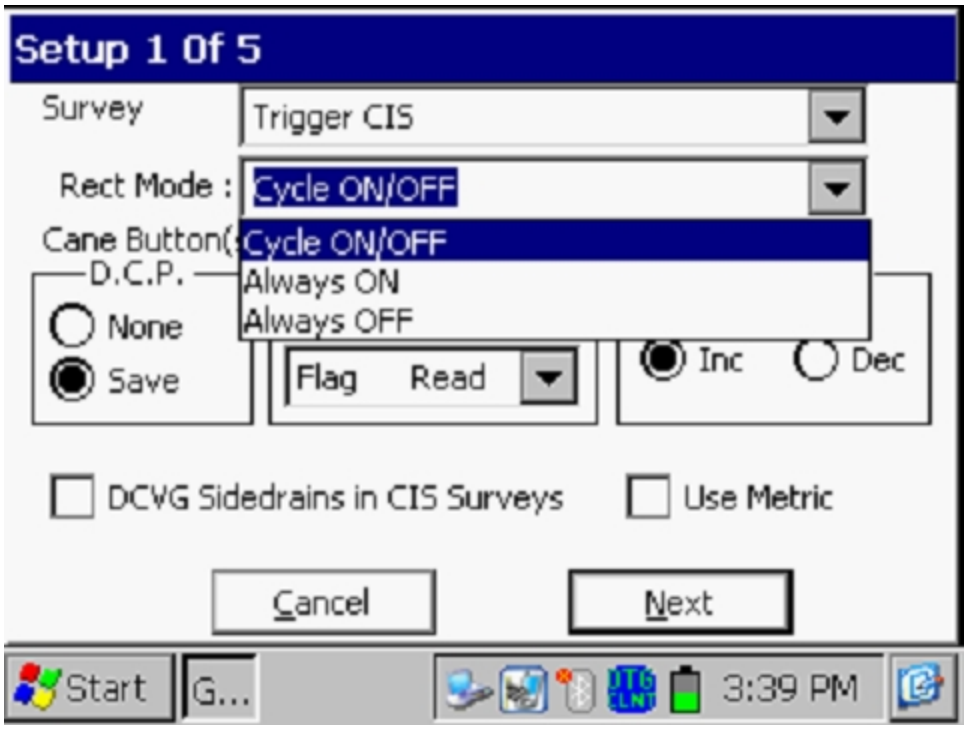
By checking this box, an additional “Device”, named “Mark DCVG” will be made available in the “Device” list, which has a sidedrain prompt associated with it, as indicated in the screens shown below.





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 10: Make “**Rectifier Mode**” selection.

By tapping on the menu button in the “Rectifier Mode” field on the above screen, the screen shown below will be displayed.



As can be seen from the above screen, there are 3 choices for "Rectifier Mode" as follows:

Cycle ON/OFF: Select this option if the DC current flowing (in the soil) to the pipe will be interrupted (switched ON and OFF) in a cyclic fashion during the CIS

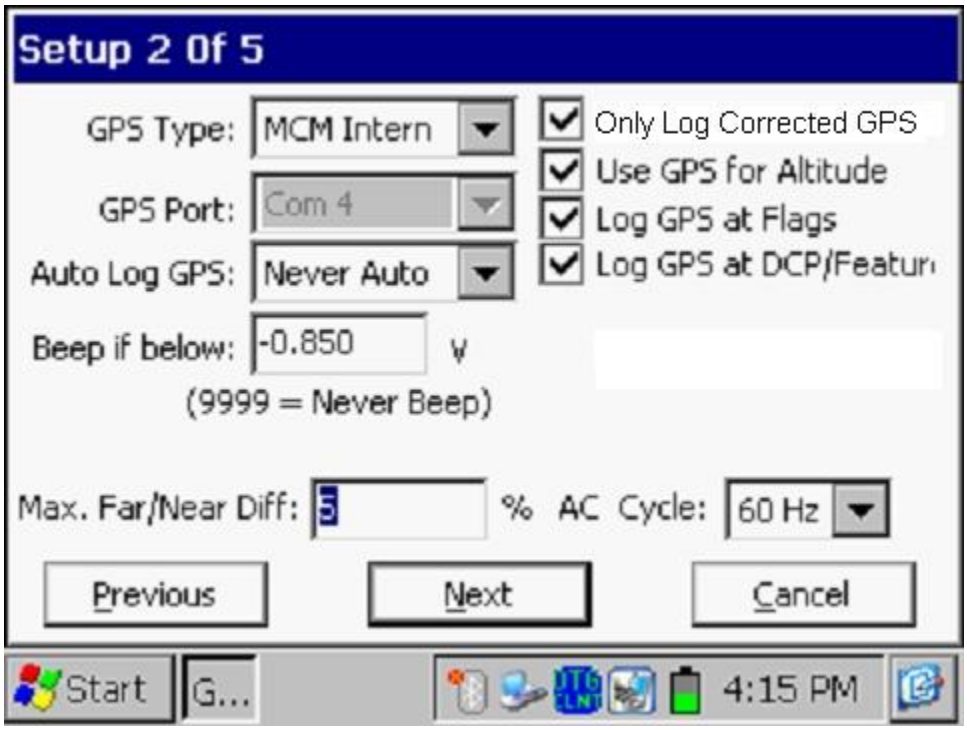
Always ON: Select this option if all rectifiers (or other DC voltage sources) having an affect on the line will be permanently ON (at least for the duration of the CIS).

Always OFF. Select this option if all rectifiers (or other DC voltage sources) having an affect on the line will be permanently OFF (at least for the duration of the CIS).

Note: The selection you make for the Rectifier Mode should relate to the Reading Mode selection you make on Setup screen 5 of 5.

Step 11: Tap on the "**Next"** button following your selection of "Rectifier Mode".

The screen shown below will be displayed. Note: The specific selections shown on the screen will depend on the selections made for the previous survey.



Step 12: Make Selection of "**Max Far/Near Diff**" value.

The value entered in this field will represent a threshold level with respect to the difference between a Far-Ground P/S reading and a Near Ground P/S reading (expressed as a percentage) recorded at a trail wire reconnect test station. For differences above the entered threshold value, an alarm message will be displayed on the Gx survey screen.

For example, if the number (5) is entered in this field, the maximum allowable difference between FAR- and NEAR-GROUND P/S readings will be 5%, otherwise an error window will be displayed on the screen.
The error window will present 2 options:

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

By selecting Option 1, you are given the opportunity to retake the Near-Ground P/S reading (perhaps you need to re-do the connection). If the percentage difference is then below your threshold level, there will be no error message.

By selecting Option 2, you will be choosing to ignore the difference in the readings and move on with the survey (perhaps there is a significant current flowing in the pipe between the 2 test stations).

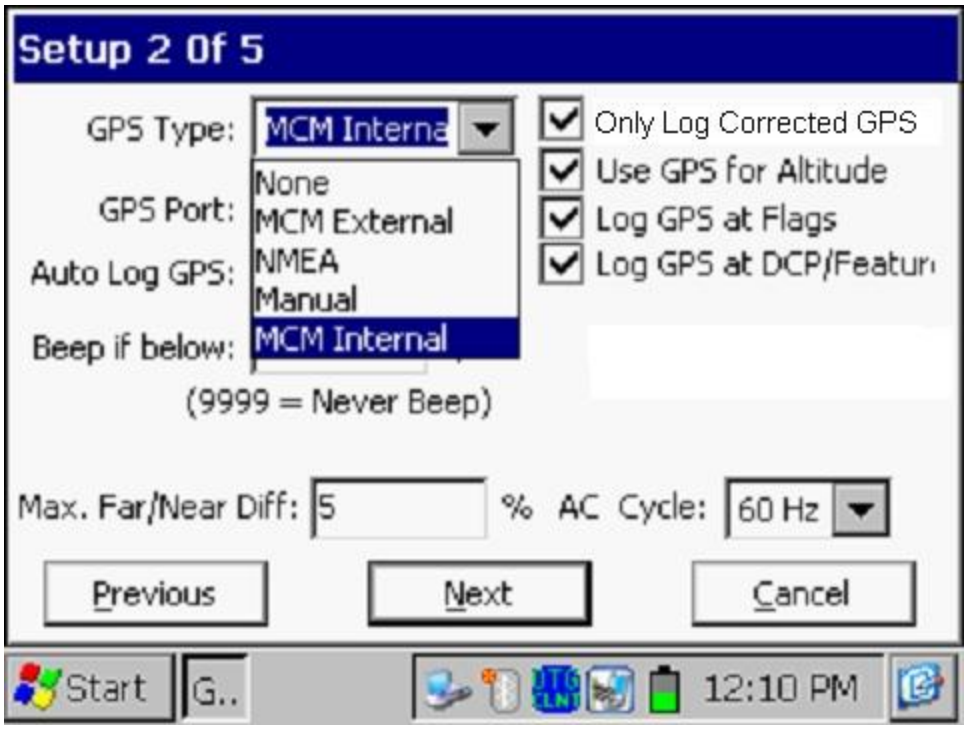
Step 13: Select Local Electricity AC Frequency
By tapping on the menu button in the "**AC Cycle**" field on the screen shown above, you will have the choice of 60Hz or 50Hz AC. Select 60Hz for all U.S. applications. This is an important select with regard to the AC filtering system that's applied to all of the DC voltage channels.

Step 14: Select the "**Beep if below**" value
This gives you the opportunity to receive an alarm (a beep sound) if the reading is below an entered threshold level. The entered value should be in volts and should be a negative value if you are measuring negative pipe-to-soil readings. One option is to set a low threshold value, for example, -0.2 (for -0.2 volts) since any readings below this value (say, zero volts) would be indicative of a trail wire break, for example, which is useful information.

If you not wish to hear any alarm sounds, enter 9999.

Step 15: Select the Type of GPS Receiver Being Used (If Any).

By tapping on the menu button in the "**GPS Type**" field on the above screen, the screen shown below will be displayed.



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 (currently not available)
NMEA:	This means that an external NMEA-compatible GPS receiver is being used (such as a Trimble unit)
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 Gx's internal GPS unit will be used (a u-blox NEO, WAAS-enabled, receiver)

Select the appropriate choice by tapping on your selection.

Com Ports

When using an external GPS unit (NMEA option) connected via a serial cable, select the COM 1 option, which represents the built-in serial port located under the flap on the bottom left-hand side of the Gx data-logger. The COM 4 option will be automatically selected when the MCM Internal GPS receiver option is selected.

Step 16: Select GPS Data Logging Options.

Only Log Corrected GPS:
This box should be checked if you only want differentially-corrected GPS data to be logged by the Gx data-logger on the survey. Leaving this box un-checked will result in standard GPS data being logged in cases where differentially-corrected data are not available.
Note: If this boxed is checked and the unit is not receiving a differential correction message, no GPS data will be logged.

Use GPS Altitude:
If this box is checked, altitude data will be logged, in addition to the Lat/Long data whenever GPS data are logged. (Note: Altitude data on some GPS units are not particularly accurate).

Log GPS at Flags:
If this box is checked, GPS data will be logged automatically at survey 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 checked, GPS 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.

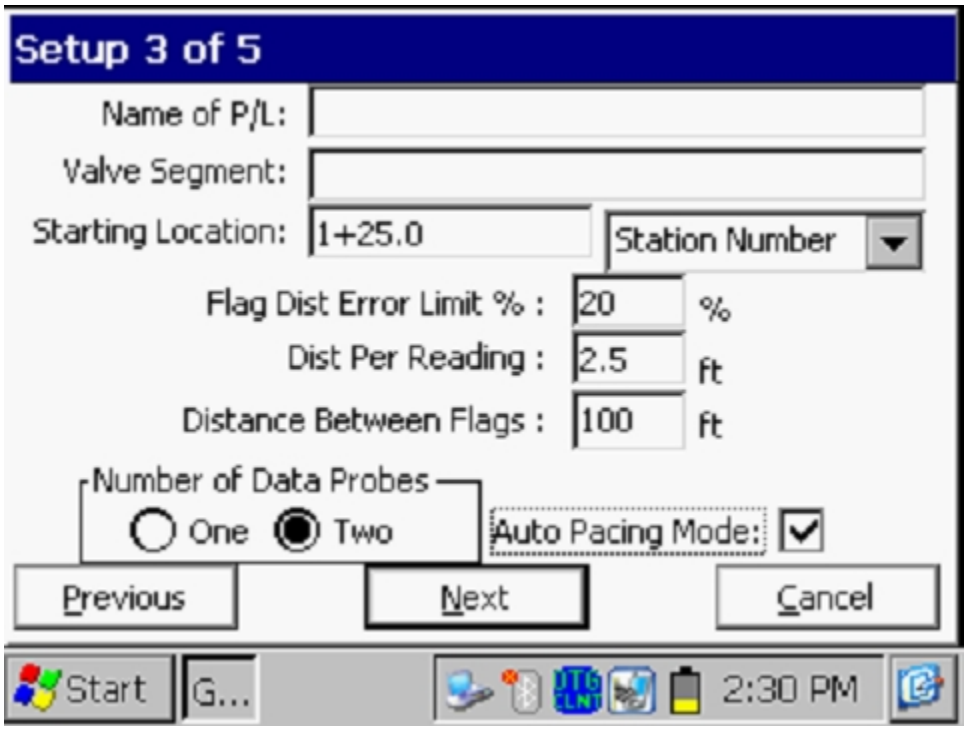
Auto Log GPS:
By tapping on the menu button in the "Auto Log GPS" field, the selections available will be displayed.

By selecting one of these options, you can elect to have GPS data logged automatically at every CIS reading, at every second CIS reading, at every fifth CIS reading, at every tenth CIS reading, or not at all (never) at CIS readings.

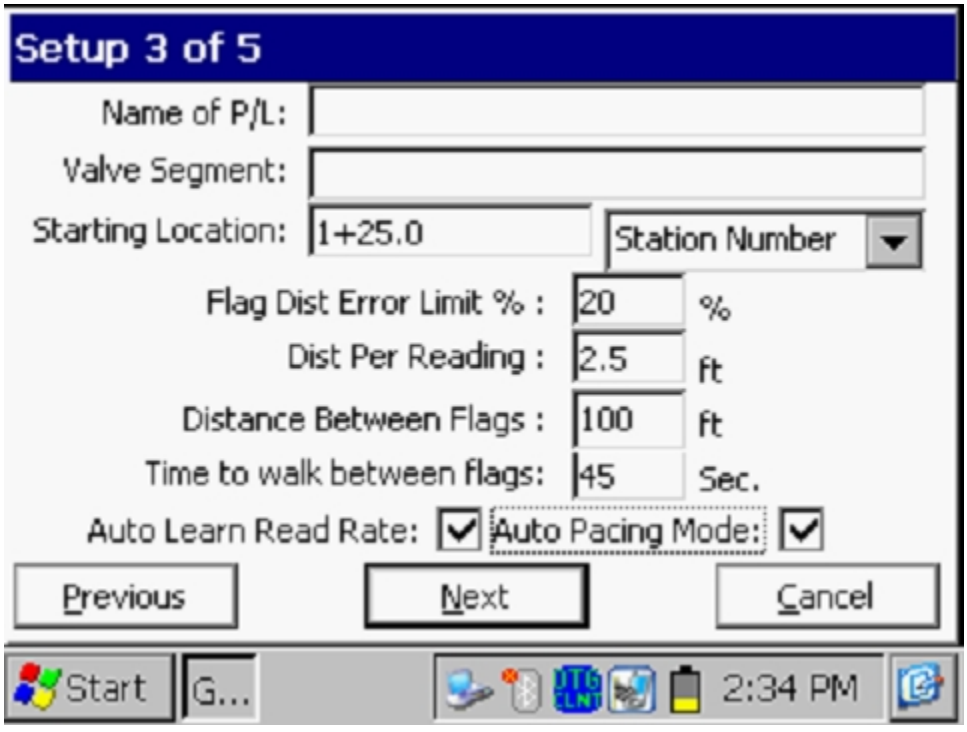
Step 17: Tap on the "**Next"** button on the above screen

The specific screen that will be displayed will depend on if you selected "**Trigger CIS**" or "**Continuous CIS**" on the first screen.

Screen for “Trigger CIS” Case



Screen for “Continuous CIS” Case



Dist Per Reading

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

Note: 2.5 feet (or 1 meter) should be selected for the “Dist Per Reading” when readings are to be triggered using an automatic triggering cable, since the counter is calibrated for this distance.

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, assuming that survey flags have been laid out. Typically, survey flags are located at 100 feet intervals. In such a case, you would have a new reference (a stationing correction) every 100 feet.

Note: If survey flags are not in use, enter zero in this field. In this case, tapping accidentally on the Flag button will not adversely impact your stationing.

Flag Dist Error Limit %

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

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

Auto Pacing Mode (optional):
Select whether or not you would like the readings to be uniformly spaced between any two survey flags, regardless of the actual locations of the readings between the two flags.

By checking the box labeled, “Auto Pacing Mode”, you will enable the data-logger to automatically adjust the reading locations in order to evenly-space the readings between two survey flags.

Auto Learn Read Rate (optional)
Finally, in the case of the “Continuous CIS” mode, readings are logged based on timing. For example, if you indicate that you require 40 readings to be logged between 100 foot survey flags and that it will take you 60 seconds to walk 100 feet, the data-logger will log readings every 1.5 seconds. You can have the data-logger “learn” your walking pace, which might turn out to be different from “60 seconds for 100 feet”, by checking the box labeled “Auto Learn Read Rate”. In which case, the software will adjust the timing between logged readings accordingly in order to target 40 logged readings between 100 foot survey flags, in this example.

Number of Data-Probes
In the case of the Trigger CIS mode, you can use one data-probe or two data-probes for the CIS. Highlight the appropriate radio button, based on your situation.
Note: Two data-probes are required for a Continuous CIS

Name of P/L (optional)
By tapping in the field labeled, “Name of P/L”, you can enter the pipeline name. Note: This is **not** necessarily the same name as the filename for the CIS that you used to setup the survey file.

Valve Segment (optional)
By tapping in the field labeled, “Valve Segment”, you can enter the name or number of the valve segment to be surveyed, if known.

Starting Location (very important)
Provide the Starting Location for the survey by tapping in the field labeled, “Starting Location” and entering the location.

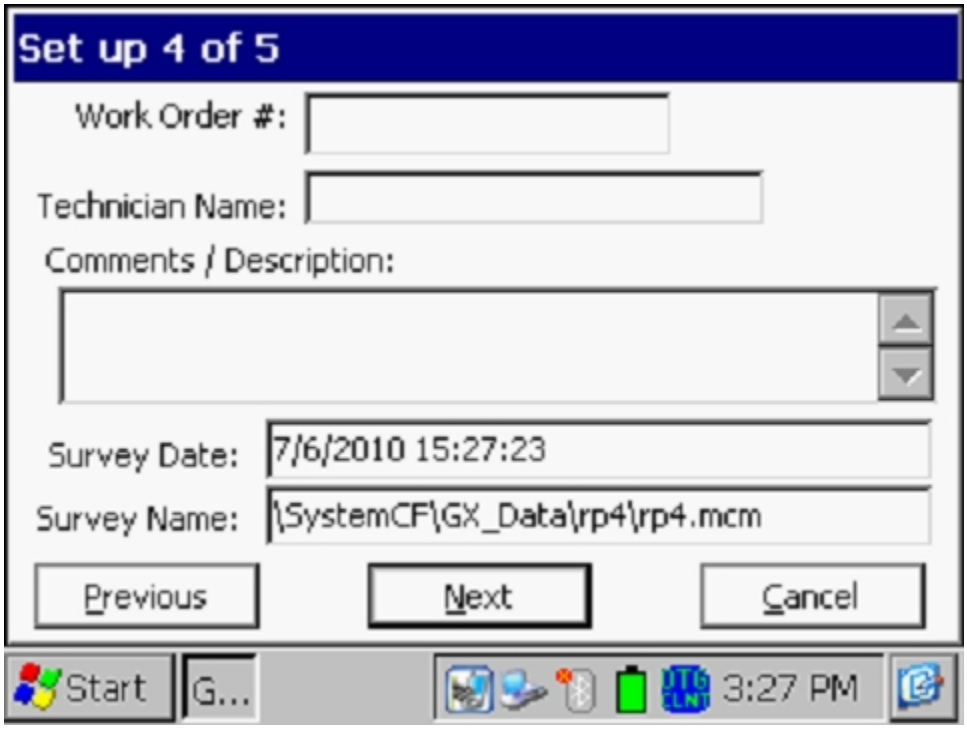
You can select to have location information displayed on the survey screen as station number, feet or milepost (station number, meters or kilometer post for the metric case).

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 menu 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 associated with the beginning your survey, enter 0+0.0].

Step 18: Tap on the “**Next”** button on the above screen.

A version of the screen shown below will be displayed, depending on the current Date & Time and also the filename entered for your survey.



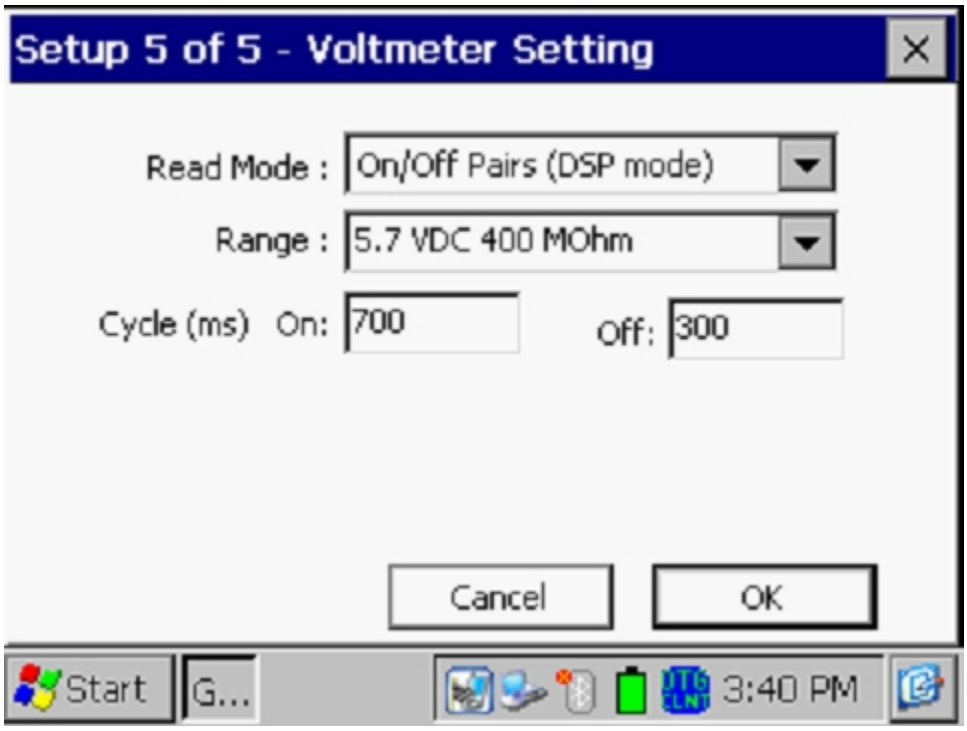
Work Order # (optional)
By tapping in the field labeled, “Work Order #”, you can enter the work order number associated with the survey, if known.

Technician Name (optional)
By tapping in the field labeled, “Technician Name”, you can enter the name of the surveyor.

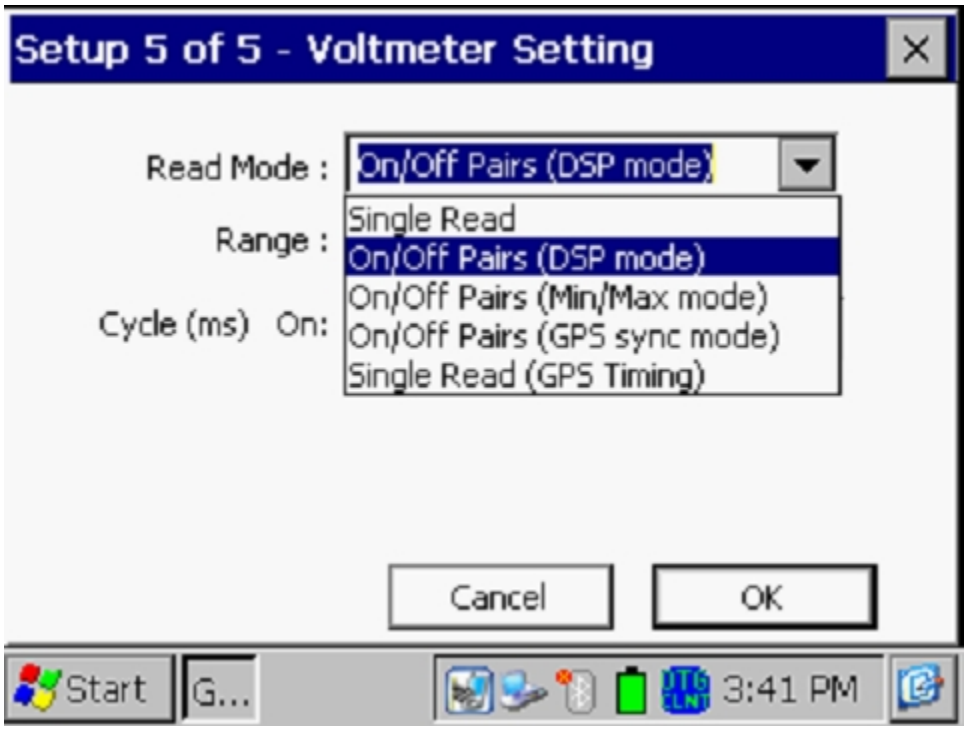
Comments/Descriptions
By tapping in the field labeled, “Comments/Descriptions”, you can enter any general comments you might have regarding the survey (perhaps weather conditions, soil conditions etc.).

Also shown on the above screen are the survey filename (“Survey Name” field) and the Start Date and Start Time for the survey (“Survey Date” field).
Note: The survey files are stored in the Gx_Data folder on the Gx data-logger’s CompactFlash memory (SystemCF) – a non-volatile memory.
Note: These data cannot be changed manually.

Step 19: Tap on the “Next” button on the above screen. A version of the screen shown below will be displayed, depending on the settings selected for the previous survey.



Read Mode:
The 5 choices available for the voltmeter's reading mode are displayed by tapping on the menu button in the "Read Mode" field on the above screen. The new screen will be displayed as shown below.



Note: Your selection of voltmeter reading mode should be made with reference to your previous selections of "Rectifier Mode" and GPS Receiver Type.

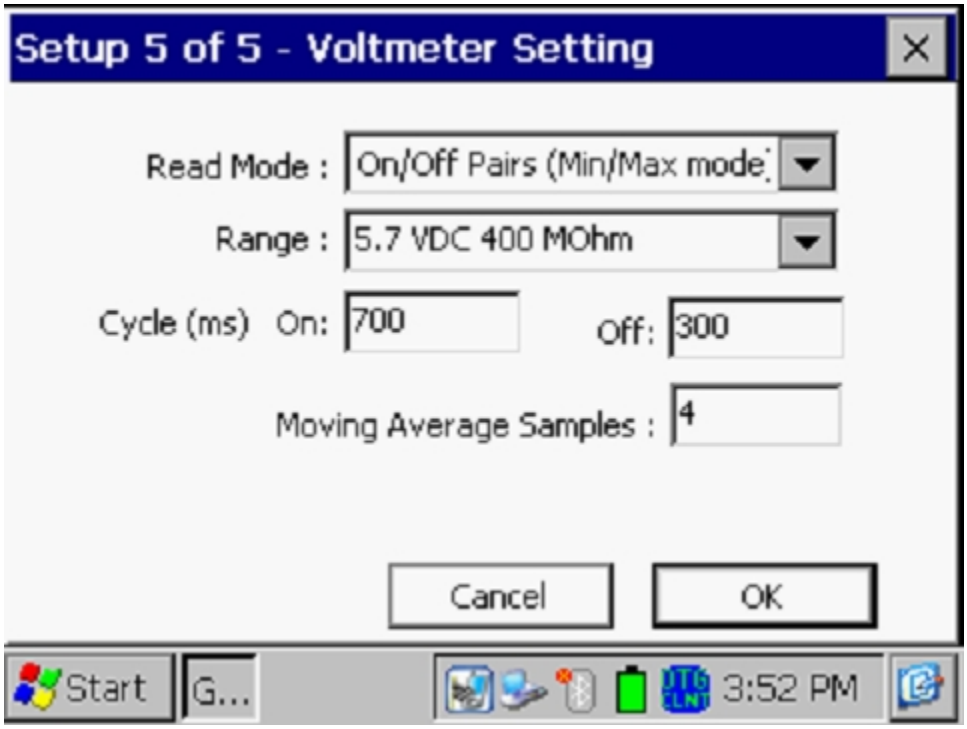
Single Read:
This voltmeter mode would be selected if you were performing a **non-interrupted CIS**, with either the rectifiers ON continuously [Always ON] or OFF continuously [depolarized pipeline].

On/Off Pairs (DSP mode):
This voltmeter mode would be selected if you were performing a rectifier current-interrupted CIS. In this mode, the software uses digital signal processing (D.S.P.) to determine the voltage during the ON portion of the interruption cycle and the voltage during the OFF portion of the cycle, for each successive cycle.

Note: A measurable difference between the ON and the OFF voltage readings is required for this reading mode, ie, a measurable IR drop is required.
Note: In this reading mode, you do not have to concern yourself with selecting recording times for the On and Off readings, for each cycle, with respect to the On-to-Off transitions and the Off-to-On transitions of the waveform, as the software determines appropriate locations on the waveform for you. This is in contrast to the GPS Sync reading mode (see below).

On/Off Pairs (Min/Max mode)
This voltmeter reading mode should be selected if you were performing a rectifier current-interrupted CIS and there was considerable interference indicated on the waveform. In such a case, in the absence of well-defined steps (IR drops), the software determines a average value for the maxima and an average value for the minima occurring in the waveform as being representative of the On and the Off value per cycle.

With this voltmeter reading mode selected, an addition field ("Moving Average Samples") will be displayed, as indicated on the screen shown below.



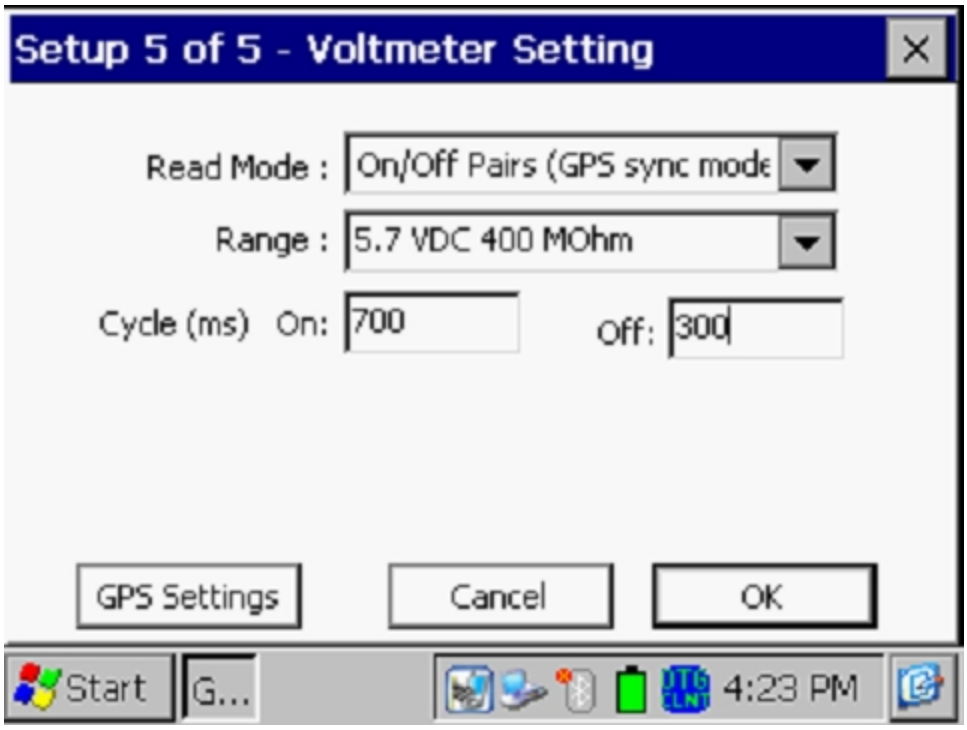
Moving Average Samples
The default value for "Moving Average Samples" is 4. In this case, 4 sample readings would be used to compute an average value for the Minimum (Min) voltage reading during each OFF portion of the cyclic waveform and, also, 4 readings would be used to compute an average value for the Maximum (Max) voltage reading during each ON portion of the waveform. Different values can be entered for this parameter in order to try to "optimize" the On/Off readings, depending on the nature of the interference occurring.

On/Off Pairs (GPS Sync):
This voltmeter reading mode can only be selected if you are using the built-in "MCM Internal" GPS receiver **AND** GPS current-interrupters.

Note: A primary feature of this reading mode is that the readings data are GPS time-stamped. Consequently, applications such as telluric current compensation tools can be applied to such data.

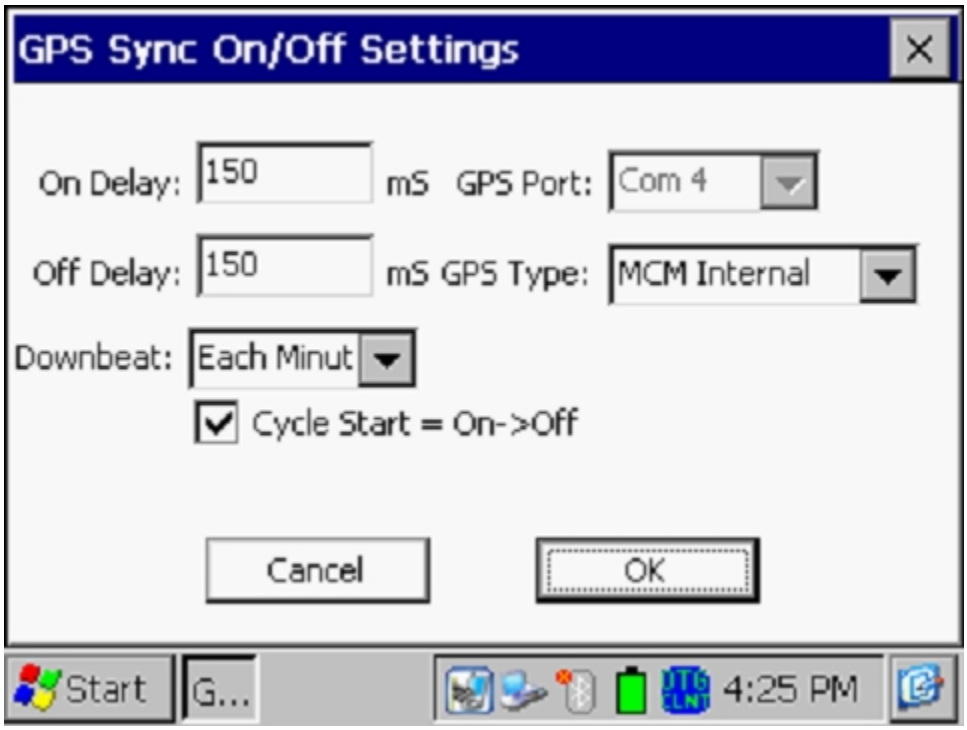
With this reading mode elected, you can select the recording times on the waveform for both the On and Off readings, with respect to the On-to-Off transitions and the Off-to-On transitions of the waveform, as opposed to the software determining appropriate locations on the waveform for you (as in the case of the On/Off Pairs D.S.P. reading mode – see above).

With this voltmeter reading mode selected, the screen shown below will be displayed revealing an additional button ("GPS Settings")



GPS Settings

By tapping on the "GPS Settings" button, the screen shown below will be displayed, depending on the previous settings.



GPS Type
Select the type of GPS receiver being used. Currently, only the MCM Internal GPS Receiver can be used with the GPS Sync reading mode.

On Delay & Off Delay
By tapping in the fields labeled, "On Delay" and "Off Delay", you can enter specific times (in milli-seconds) for these parameters.

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.

The delay times selected should be based on knowledge of the waveform, particularly in terms of any transition spiking. The idea is to select sampling times that will avoid any spiking.

Downbeat
By tapping on the menu button in the "Downbeat" field, you can select the downbeat schedule associated with the particular current interrupters you are using for the survey. The three options are: Each Minute, Each Hour and Midnight.

For example, if "Each Minute" is applicable to your interrupters, and you select this option for the Downbeat schedule, you are indicating to the data-logger software that at the top of each minute, there will be an On to Off transition (the rectifier current will switch from On to Off at the top of each minute). This would mean, in this example, that the software would only have to count back to the top of the last (previous) minute to have a timing reference.

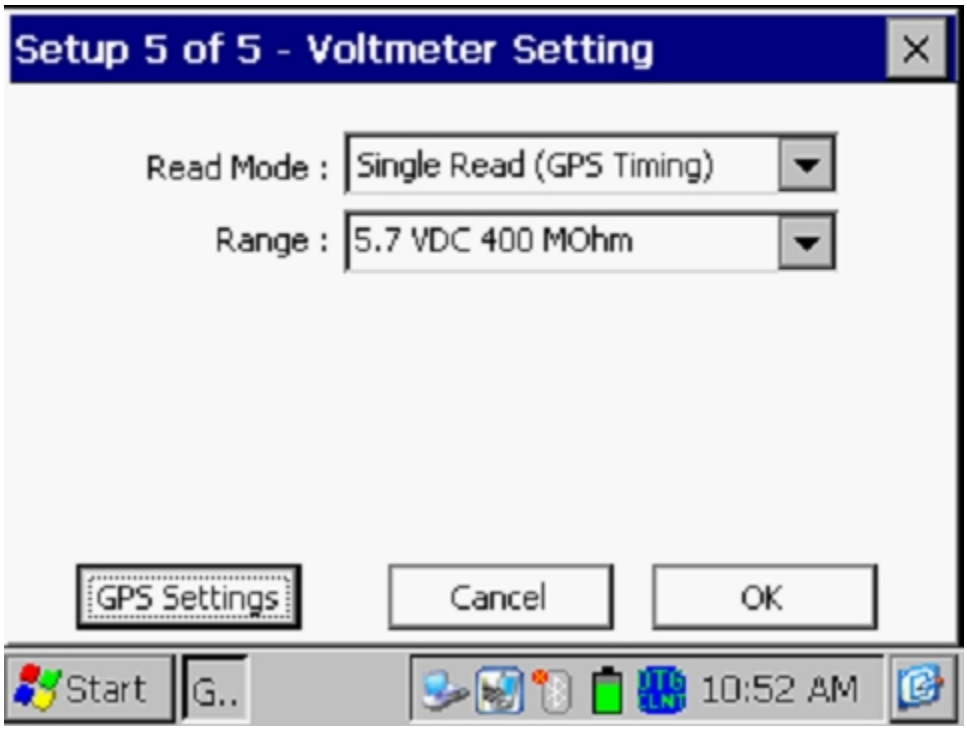
Cycle Start
Finally, if your interruption cycle starts with the current in the ON state (the first transition is from ON to OFF), check off the box labeled, "Start Cycle" (un-check this box if the opposite is true).

Click on the "OK" button on the "GPS Settings" screen in order to return to the Voltmeter Settings screen (Screen 5 of 5).

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 clock signal to associate readings with the actual time they were made.

When the “Single Read (GPS Timing)” mode is selected, the screen shown below will be displayed.



The only addition information that needs to be supplied here is the type of GPS receiver you will be using, via the “GPS Settings” button.
Note: Currently, only the MCM Internal GPS Receiver can be selected for this voltmeter reading mode.

Note: A primary feature of this reading mode is that the readings data are GPS time-stamped. Consequently, applications such as telluric current compensation tools can be applied to such data.

Click on the “OK” button on the “GPS Settings” screen in order to return to the Voltmeter Settings screen (Screen 5 of 5).

Cycle On & Off (Times)
The specific On and Off times setup on the current interrupters should be entered in the "On" and "Off" fields, respectively, on the Setup 5 of 5 Screen.
Note: The On and the Off times should be entered in milli-seconds.

Note: Ideally, the interruption period (On time plus Off time) should be less than the time between triggered readings 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 readings of greater than 1 second.

However, care should be taken if longer waveform periods are in effect (for example, several seconds), in which case a slower than normal walking (and triggering) pace would have to be employed in order to avoid recording several same value readings until the waveform data are refreshed (i.e., until a new cycle of data is used).

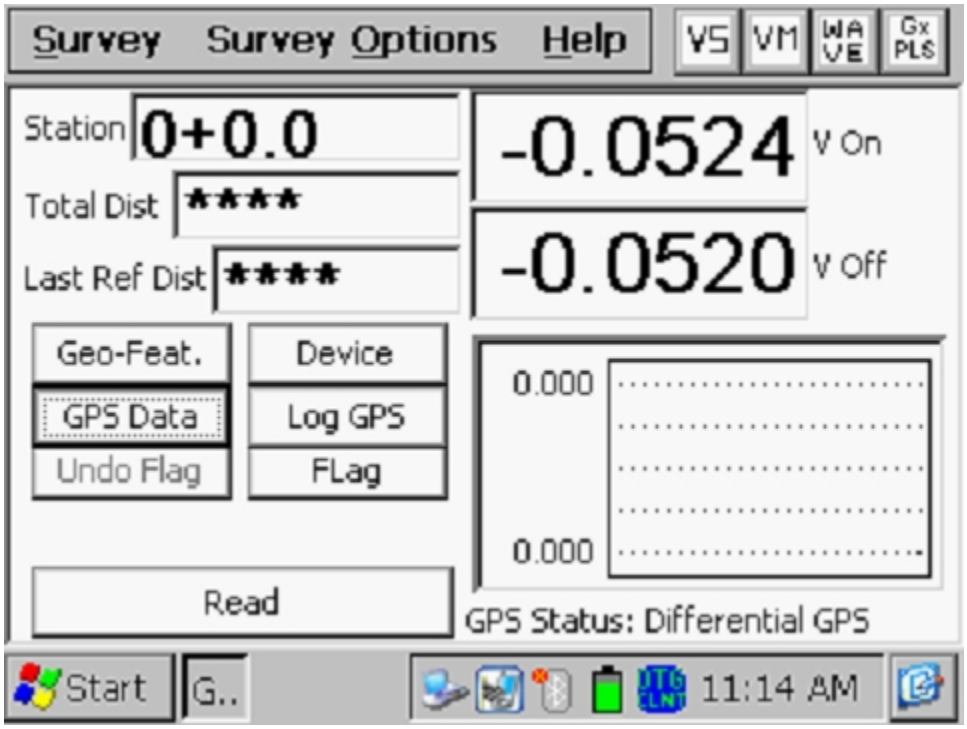
Range:
By tapping on the menu button in the "Range" field, you can select the voltmeter range and associated input impedance setting for your application from the full list of available options.
Note: Use the scroll bar to view all options.

The recommended setting for the "Range" for CIS is ±5.7 Volts DC, which provides an associated input impedance value of 400MOhm. This setting provides a relatively-fast response time (~80 ms), which is important in fast cycle interruption applications. Also, the 400MOhm input impedance minimizes reading errors associated with any high source resistance measurements, and, the ±5.7 V DC Range should be suitable for most On and Off CIS reading values.

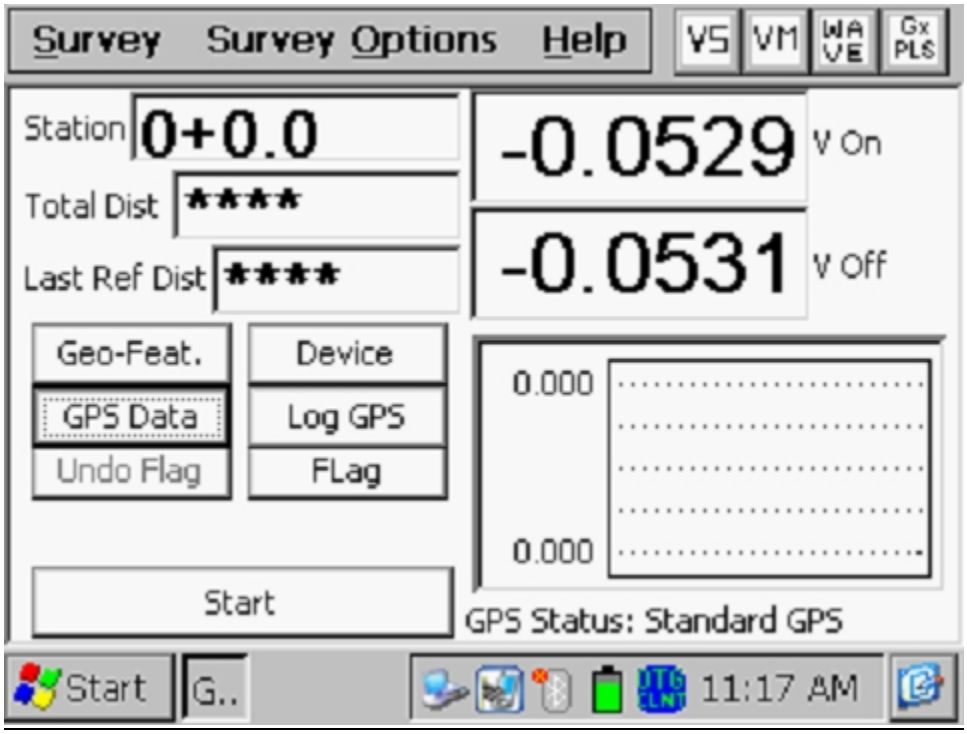
Step 20: Tap on the "OK" button on the "Setup 5 of 5" screen.

Versions of the screens shown below will be displayed, for the "Trigger CIS" and the "Continuous CIS" modes, depending on the start location entered previously and the location type entered previously (station number, feet or milepost (or station number, meters or kilometer post, for the metric option)).

Survey Screen for the “Trigger CIS” Mode



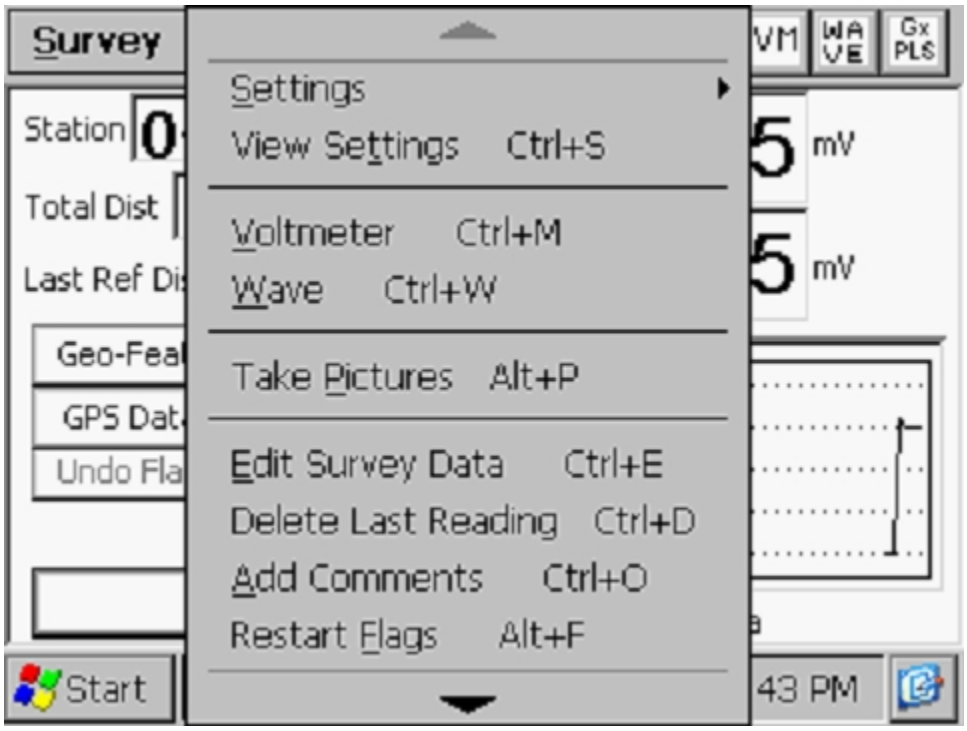
Survey Screen for the “Continuous CIS” Mode



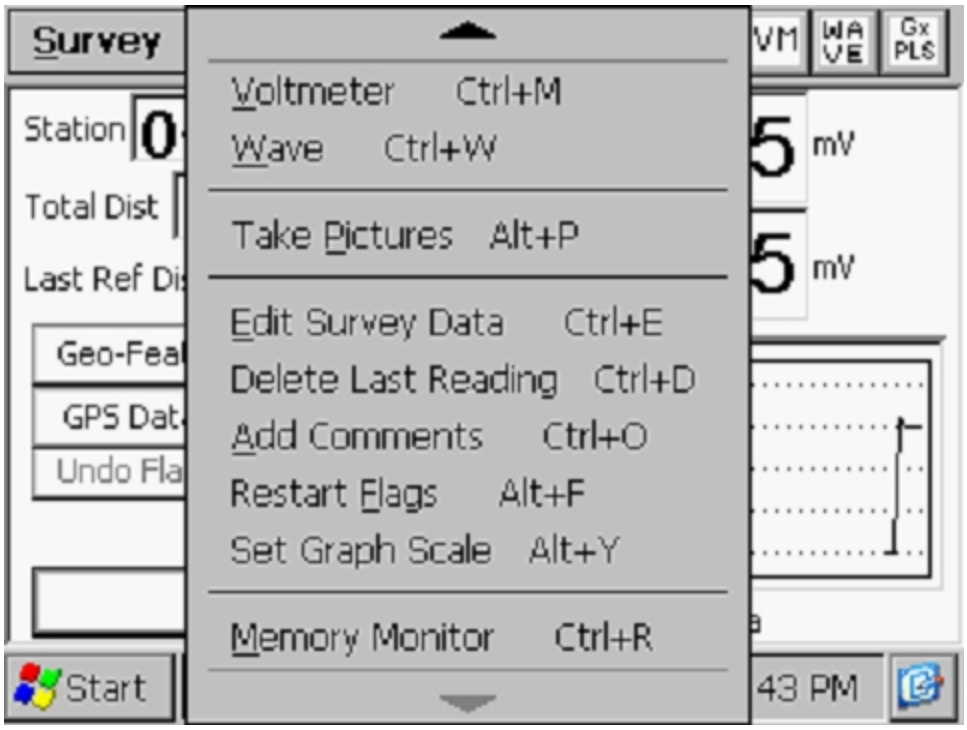
You are now ready to perform a close interval survey using the Gx data-logger and associated pipeline survey equipment.

II. 2 "Survey Options" Menu including Picture Taking Option and Editing Option

By tapping on the "Survey Options" button on the Survey screen, the Survey Options menu will be displayed as indicated below.



Tapping on the down arrow on the above menu will reveal additional options, as illustrated in the screen shown below.



Settings

Once you've setup the Gx data-logger for a particular pipeline survey, 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 CIS survey (highly recommended) and discover that there is considerable noise on the waveform, you might decide to switch the voltmeter reading mode from On/Off Pairs (DSP) to On/Off Pairs (Min/Max). 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 change survey settings, tap on "Settings" and tap on "Change Global Settings".

View Settings

To simply view your setup selections, you can tap on "View Settings" on the above menu. Alternatively, you can use the Ctrl and S keys.

Voltmeter

To run the stand-alone voltmeter, either tap on the “Voltmeter” option on the menu or use the Ctrl and M keys.

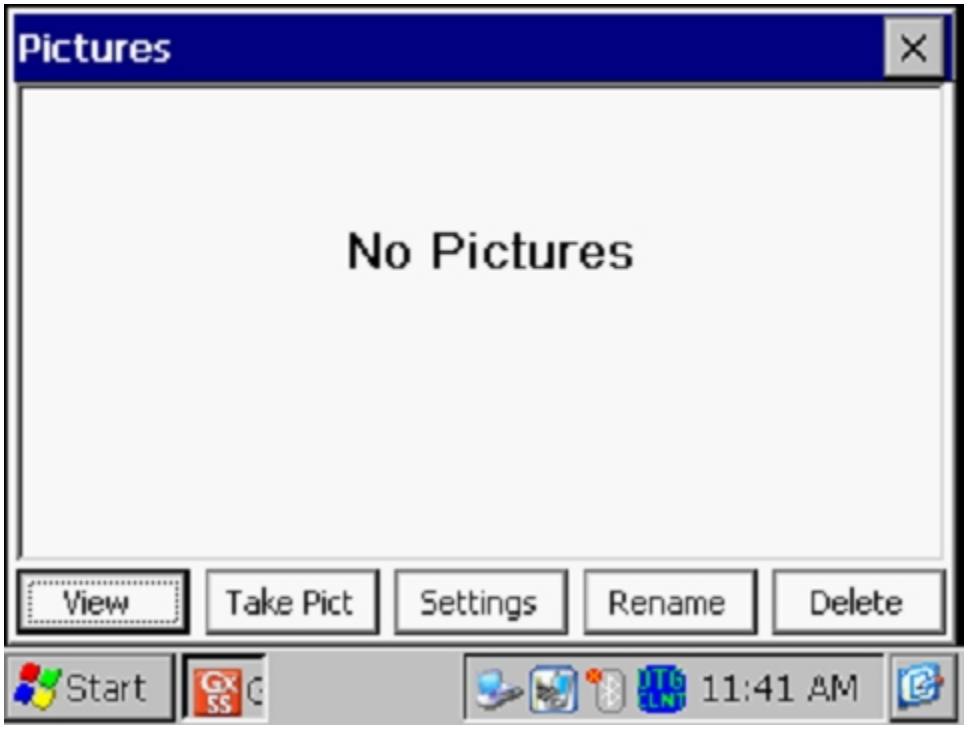
Wave

To run the stand-alone waveprint generator, either tap on the “Wave” option on the menu or use the Ctrl and W keys. Please see section IV.6 below for more information on running the stand-alone voltmeter.

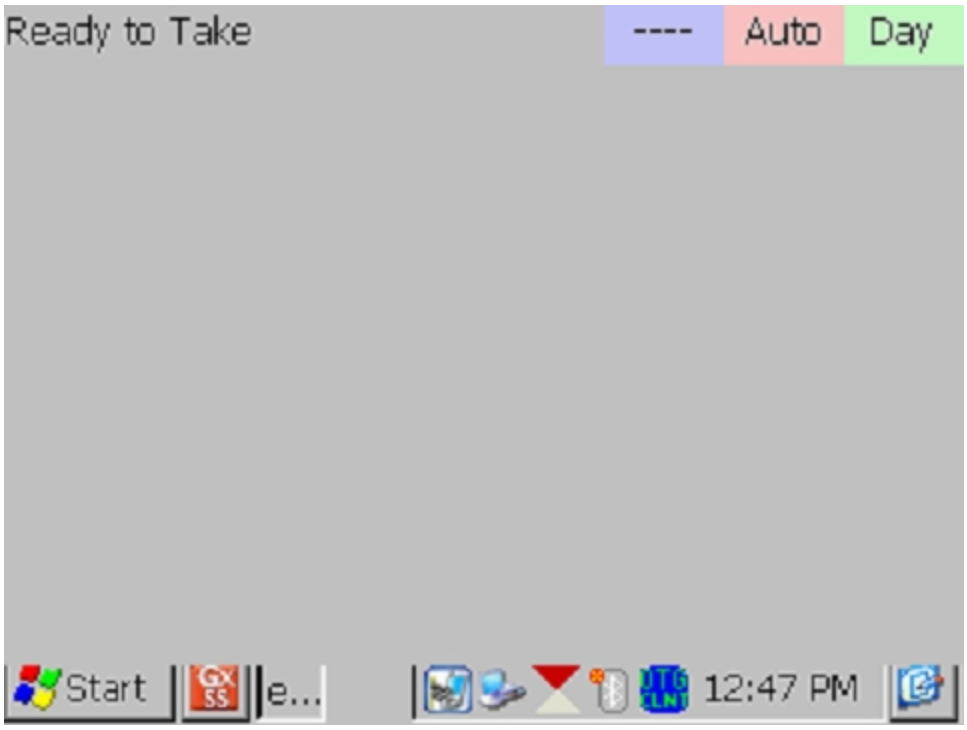
Take Pictures

You can run the integrated camera program by either tapping on the “Take Pictures” option on the menu or by using the Ctrl and A keys.
Note: Several seconds are required to open and close the camera program.

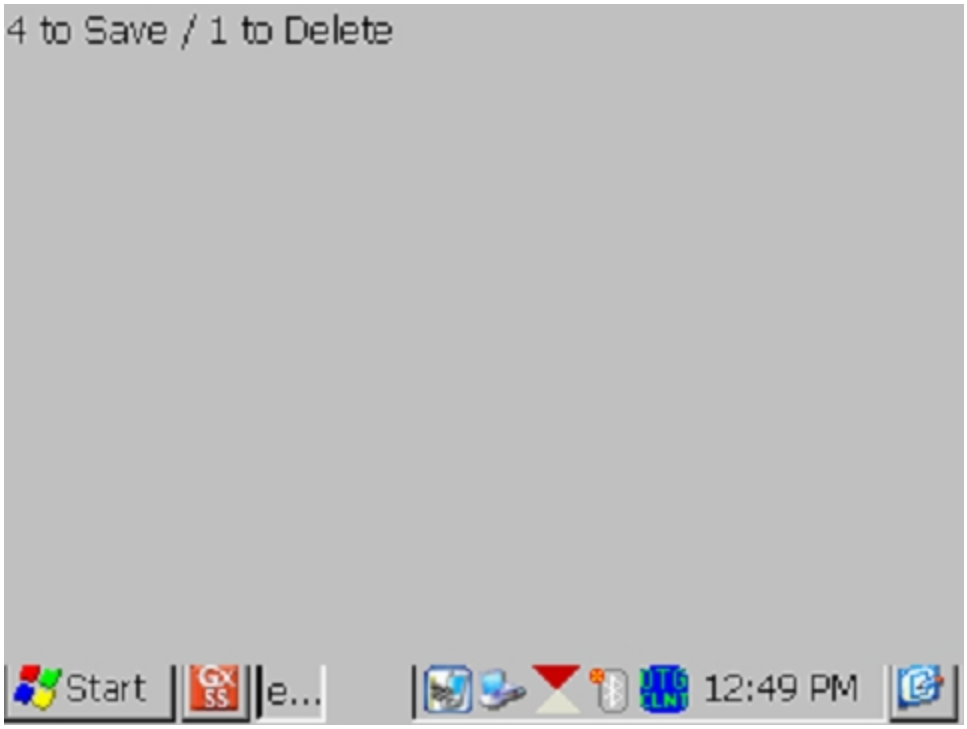
The “Pictures” screen shown below will be displayed.



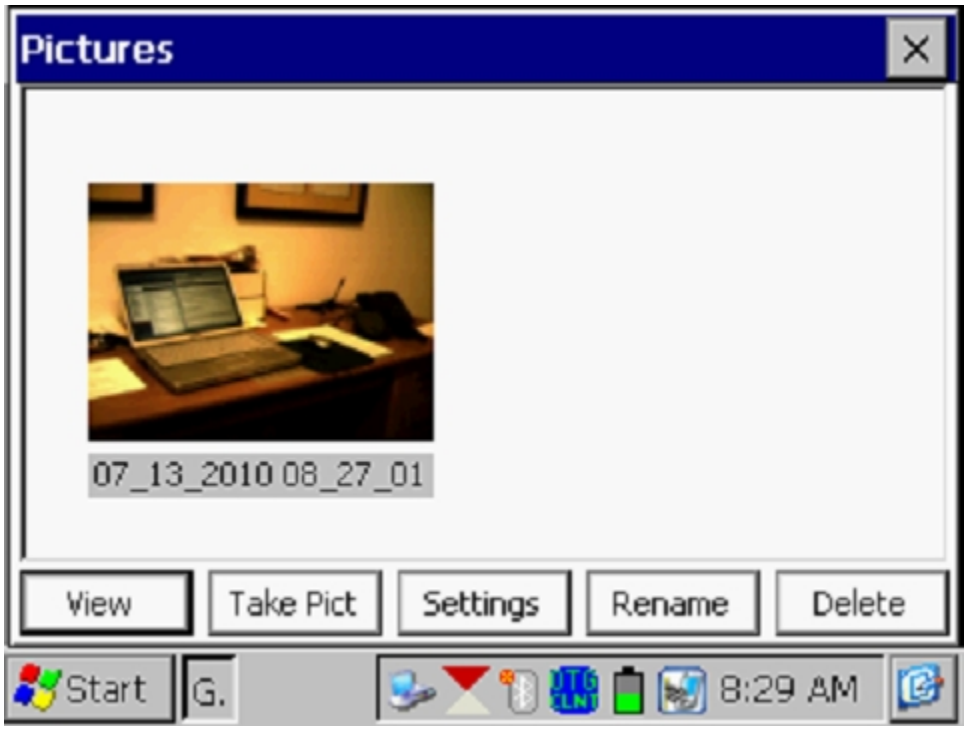
To take a photograph, tap on the “Take Pict” button. The camera will go through a focusing process and you will see a “Ready to Take” indication at the top of the screen when you can take a picture, as indicated below.



At this point, press (and release) the camera button located at the top right hand corner of the keypad. You will have the choice of saving the picture or deleting it, as indicated by the "4 to Save/1 to Delete" indication on the screen below. To save the picture, press (and release) the #4 key.



An example of a saved image is shown below on the Picture screen.



As indicated in the above screen, the image is given a filename, by default, which represents the date/time stamp for the image. The above image, for example, was recorded on July 13, 2010 at 8:27am.

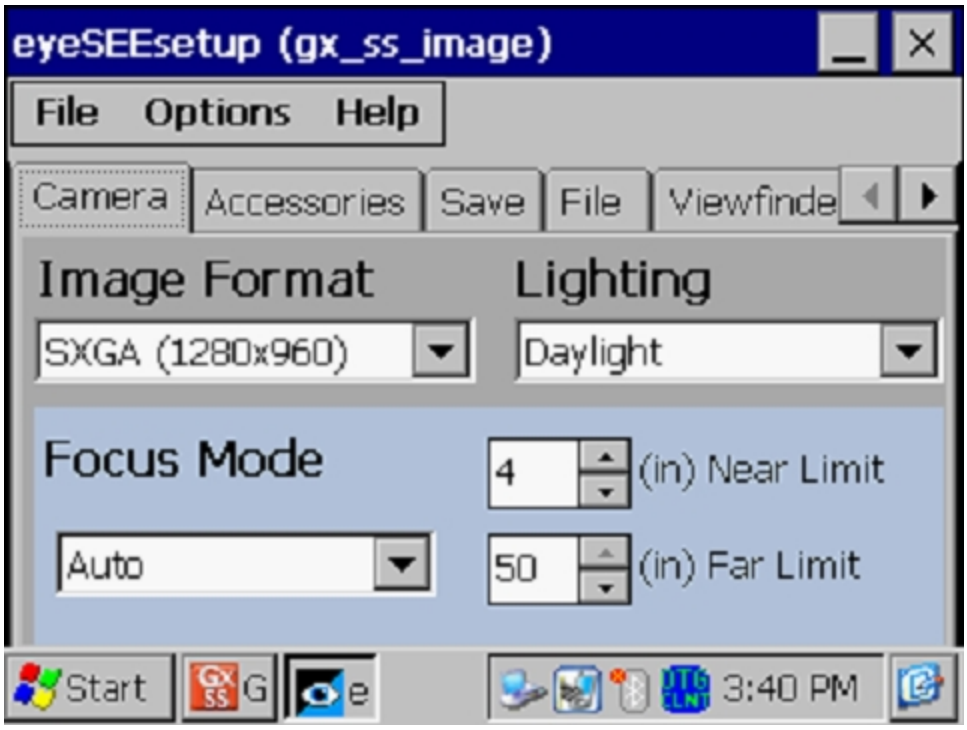
You can rename the image, if you prefer, by highlighting the image (tapping on the image) and tapping on the "**Rename**" button. You can then enter a new name for the image. For example, the image above has been renamed, "Office Desk" on the screen shown below.

You can view a larger version of the image by highlighting the image (tapping on the image) and tapping on the "**View**" button.

You can take multiple photographs at a test site by repeating the process outlined above. For example, the Picture screen shown below shows two (renamed) images.

If you would like to adjust the camera settings from their default settings you can do so via the "**Settings**" button on the Pictures screen. For example, you can change the size and resolution of the image to be captured, the lighting conditions under which the image will be captured and the focusing method to be used, for example.

By tapping on the settings button, the screen shown below will be displayed.



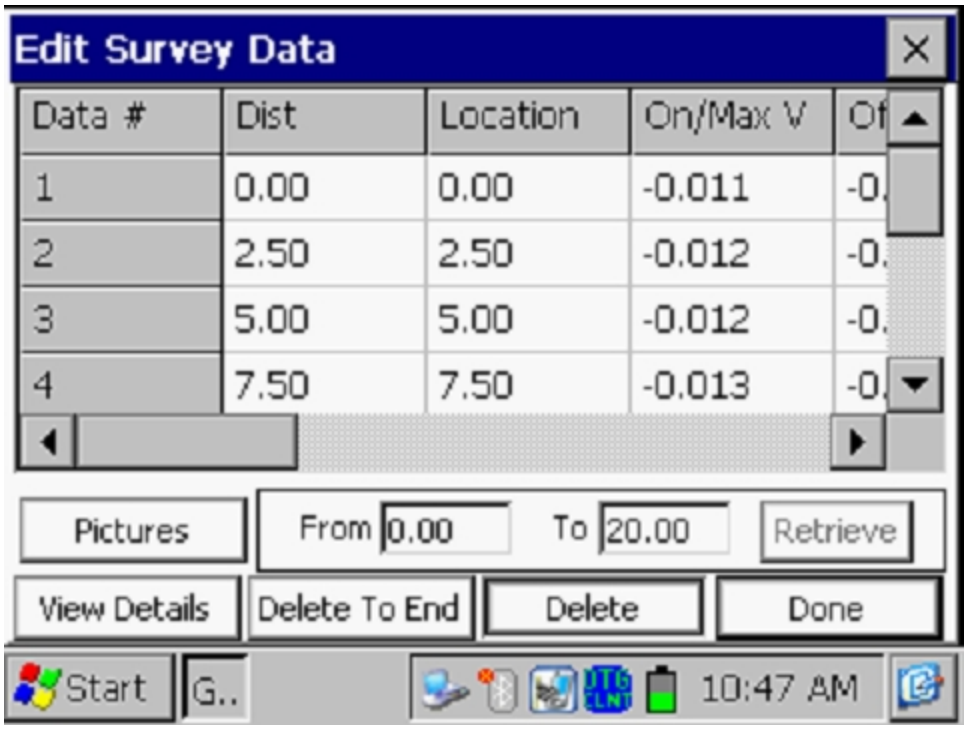
As indicated on the above screen, there are a number of page tabs labeled, "Camera", "Accessories", "Save" etc. For information on the selections available via the various tabs, please see Appendix 3 (Camera Settings) of the Gx Pipeline Survey Data-logger User's Manual.

Note: For the default picture size (SXGA (1280x960)), the Flash light is <u>not</u> available. However, you can turn on the LED Lamp (which is turned OFF by default), if direct light is required. You can do so via the "Accessories" tab on the above screen. Also, please note that the Flash light is available for the largest picture size (highest resolution) setting (QSXGA 2048x1944).

You can return to the "Survey" screen (after the picture taking process) by tapping on the "X" button on the Picture screen.

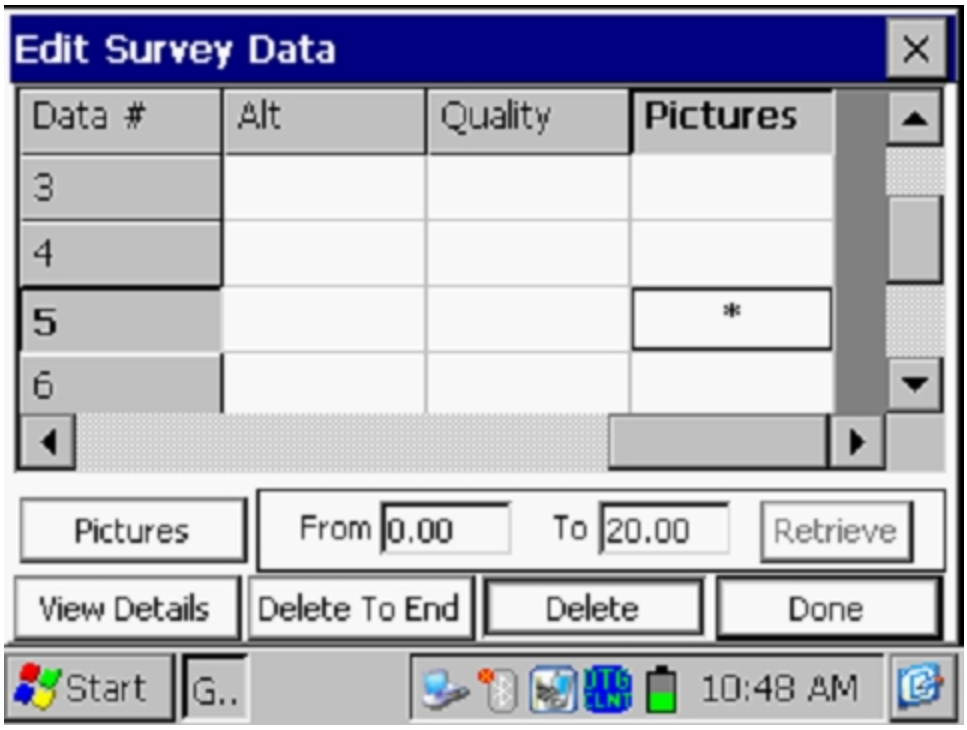
<u>Edit Survey Data</u>
Collected survey data can be edited by tapping on the "Edit Survey Data" button or by using the Ctrl and E keys.

The screen shown below will be displayed, depending on the readings values and reading interval etc.



The data to be viewed can be selected by entering values in the “From” and “To” fields and tapping on the “**Retrieve**” button. Using the horizontal and vertical scroll bars, you can scroll through the collected data. A row of data can be deleted by highlighting the row and tapping on the “**Delete**” button. Multiple rows can also be deleted at the same time.

Pictures can be viewed and/or deleted by first highlighting the location (see screen below) and tapping on the “Pictures” button.



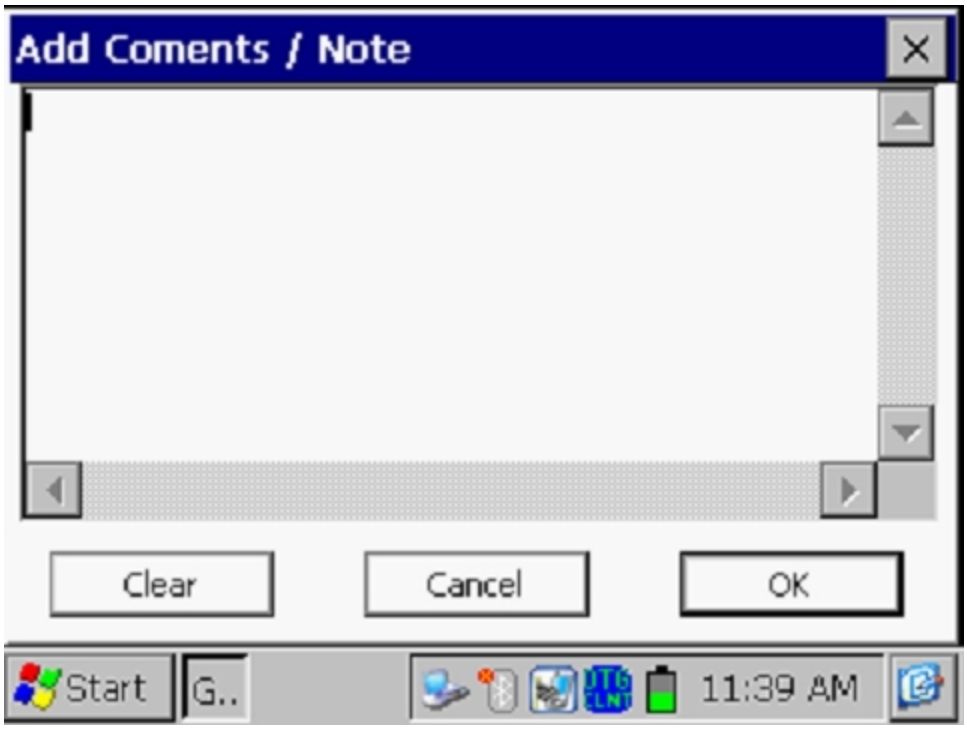
Once highlighted, the picture can be deleted by tapping on the “Delete” button, or viewed by tapping on the “Pictures” button.

Delete Last Reading

By selecting the “**Delete Last Reading**” option from the menu, you can have your last reading deleted, without having to go through the “Edit Survey Data” option. Alternatively, you can use the Ctrl and D keys to access the function.

Add Comments

You can add remarks (comments) at anytime on your survey by selecting the “Add Comments” option and manually entering data on the screen shown below.



Alternatively, you can use the Ctrl and O keys to access the function.

Tap on the “OK button on the above screen to return to the Survey screen after entering your comments.

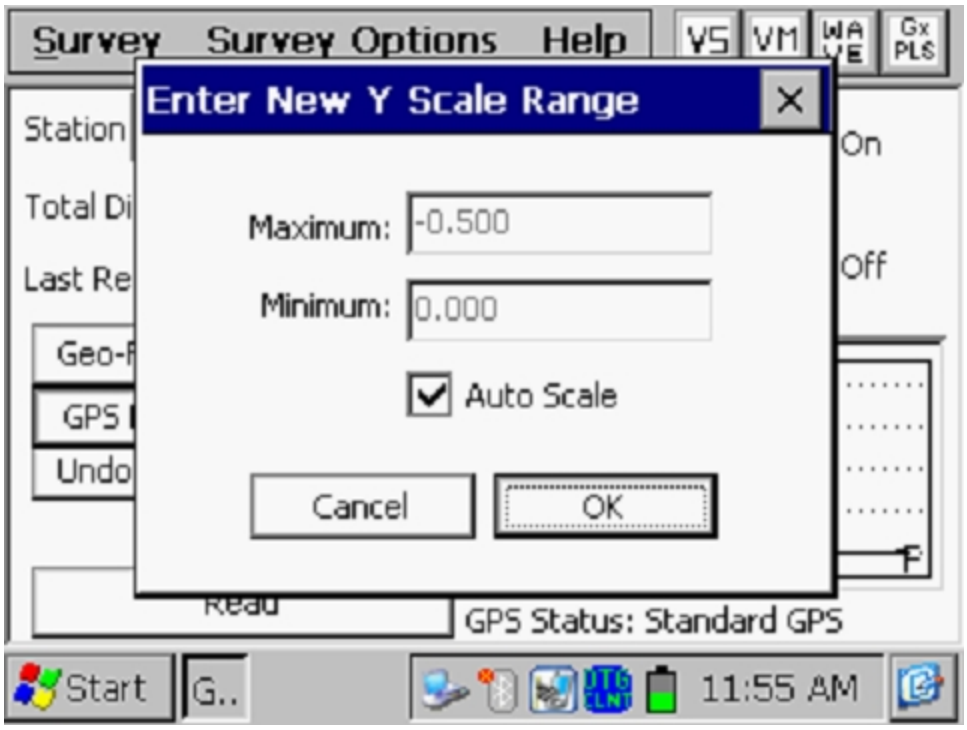
Restart Flags

You can reset survey flags by selecting the “Restart Flags” option from the menu. This action will establish your current location as the new zero reference, as far as flagging is concerned, and “zero” should be entered automatically in the “Last Reference Distance” field on the Survey screen.

Set Graph Scale

Rather than having the software auto scale the graph on the Survey screen to accommodate the actual data values logged, you can establish the maximum and minimum values for the graph scale in order to restrict the data values to be displayed on the graph.

To do so, you would un-check the box labeled, “Auto Scale” on the window shown below and enter specific values for “maximum” and “minimum”.



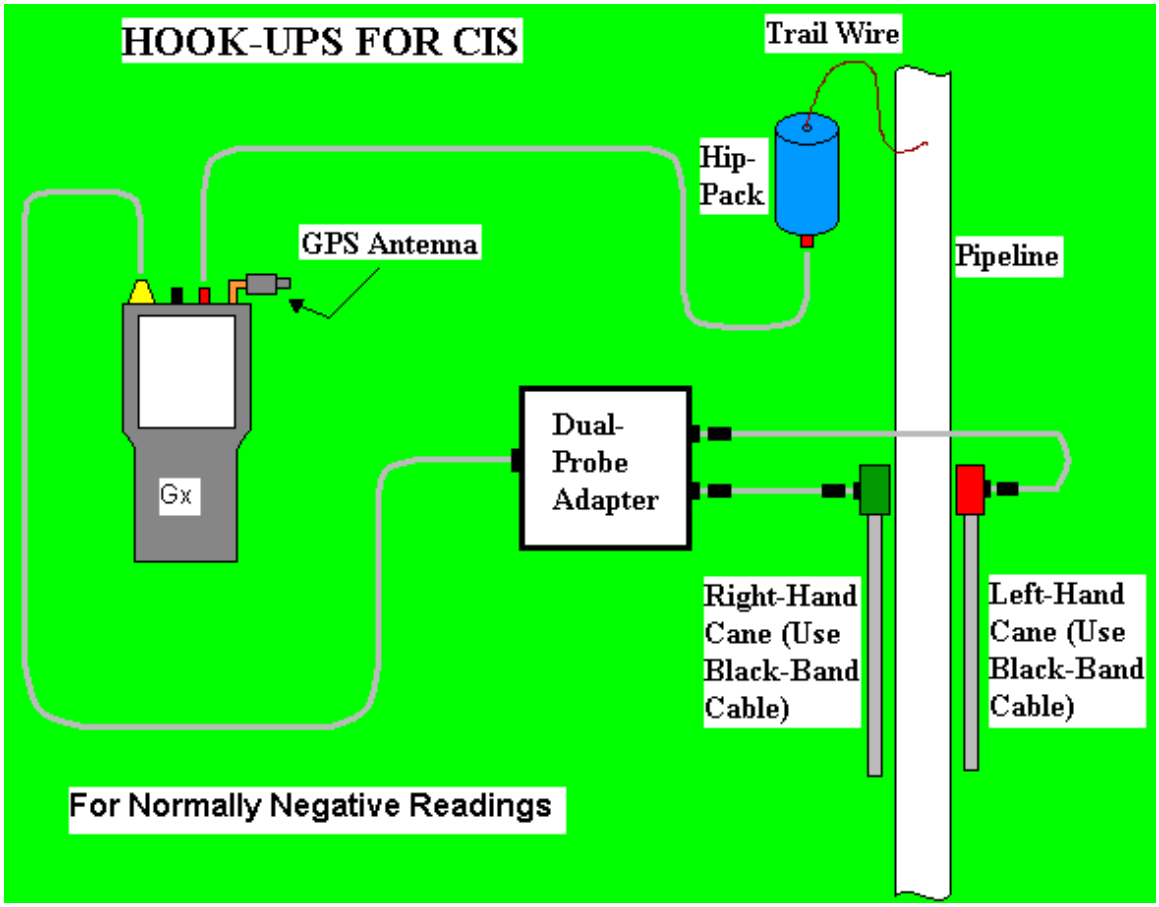
Tapping on the “OK” button will return you to the Survey screen.

SECTION III: TEST EQUIPMENT HOOK-UPS FOR CIS

III. 1 How to make Cable Hook-Ups for CIS Applications

The hook-up connections for CIS applications employing MCM test equipment are illustrated in the figure below.

Note: The connections shown below are for normally negative readings.

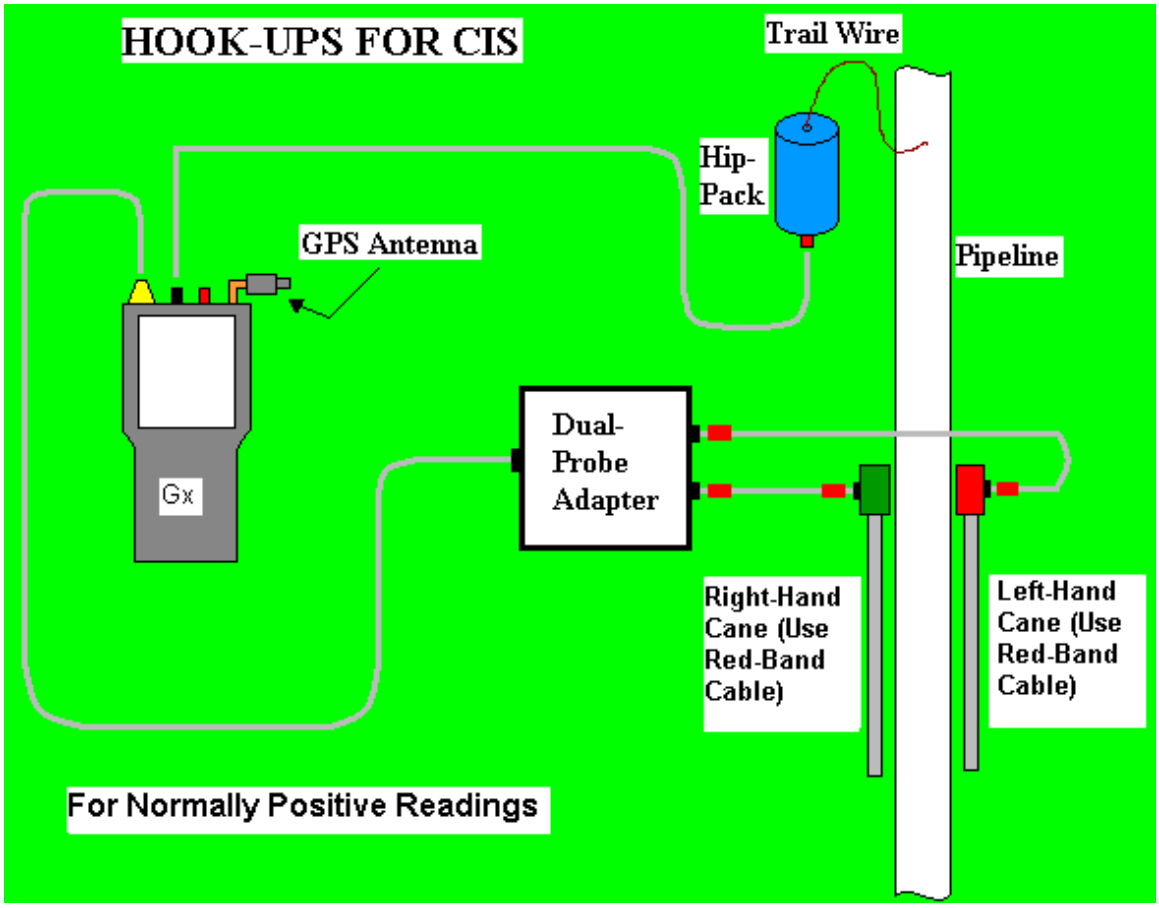


Cable Connections for Hook-Up of MCM's CIS
Test Equipment for **Negative** Pipe-to-Soil Readings

As can be seen from the above figure, a pair of canes (reference electrode data-probes) 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 an alternating fashion, have push buttons on top of the handles so that the operator can "trigger" readings on his command at each of the CIS measurement locations as well as at "Devices".

The canes (data probes) are connected as shown to the "input" terminals of the dual-probe adapter and the "output" of the adapter is connected to the 5-pin connector on the top side of the data-logger. This effectively connects the reference electrodes to the **negative side** of the data-logger's voltmeter, since black-band cables are shown in the above Figure. By using black band cables, negative pipe-to-soil readings will be recorded.

For normally positive pipe-to-soil readings, red-band cables should be used to connect the data-probes to the dual-probe adapter as illustrated in the figure below.

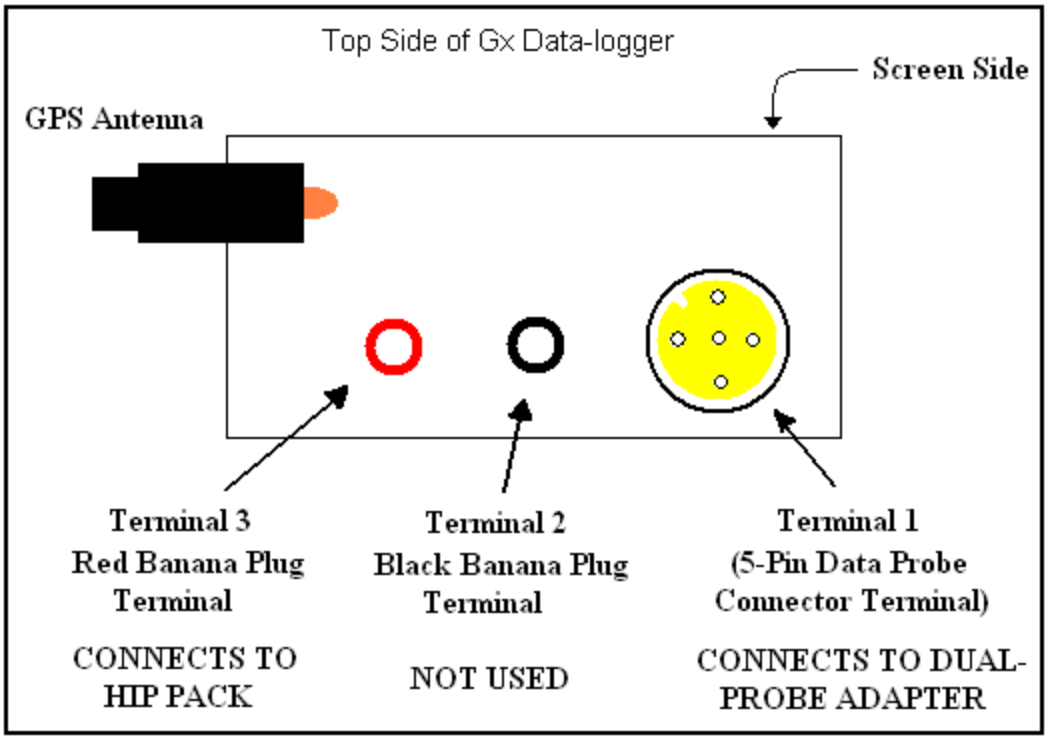


Cable Connections for Hook-Up of MCM's CIS
Test Equipment for **Positive** Pipe-to-Soil Readings

The red band cables indicated in the above figure will connect the data-probes to the positive side of the voltmeter.

The pipe under survey should be connected, via the trail wire, to the **positive side** of the data-logger's voltmeter (red banana plug jack), in the case of normally negative pipe-to-soil readings, and, to the **negative side** of the voltmeter (black banana plug jack), in the case of normally positive pipe-to-soil readings. Please see the figure below for the layout of the terminals on the Gx.

For the case of normally positive readings, the black banana plug jack would be used for the trail wire connection and the red jack would not be used.



The GPS Antenna illustrated on the top side of the Gx represents the antenna employed by the data-logger's internal GPS receiver. An extension antenna is recommended for pipeline survey work.

External GPS receiver units, if employed, would be connected to the data-logger via its built-in serial port (Com 1 Port), assuming that connection is made via a serial cable to the Gx.

With either the internal GPS receiver or an external GPS receiver being used, 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 II.1

SECTION IV: HOW TO PERFORM CLOSE INTERVAL POTENTIAL SURVEYS

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

With the equipment connected as shown in Section III above, and the Gx data-logger setup as described in Section II, you are ready to perform a close interval survey.

Gx Belt Pack Option:
MCM offers a special harness (the Gx Belt Pack) that allows the Gx and a trail-wire Hip Pack to be carried around the waist area in a "hands-free" fashion, allowing the individual to be able to position the reference electrode data-probes over the pipeline (every 2.5 feet, or so, in an alternating manner) and to be able to "trigger" readings manually using the push button switches on the data-probes when appropriate to do so.

With the Belt Pack option, the Gx data-logger mounts onto a platform at waist level allowing the operator to view the screen at all times and to make any selections required by tapping on the screen. Also, the dual-probe adapter shown in Section III, is mounted on the underside of the platform, allowing convenient (5 pin cable) connection of the adapter's "output" to the data-logger.

The Hip Pack, containing a spool of insulated copper wire (trail wire) [typically 1 mile or 3 miles in length], is attached to the waist band of the Belt Pack and a banana plug cable, in the case of the Hip Pack **without** chainer, connects the banana plug terminal located on the underside of the Hip Pack to the Gx data-logger. In the case of a Hip Pack **with** chainer, the trail wire connection to the Gx data-logger is made by connecting a banana plug cable from the counter/display unit to the Gx (please see Appendix 1).

Gx Backpack Option:
The MCM Backpack allows a 5-mile spool of trail wire to be used, with the trail wire spool mounting directly onto the backpack assembly.

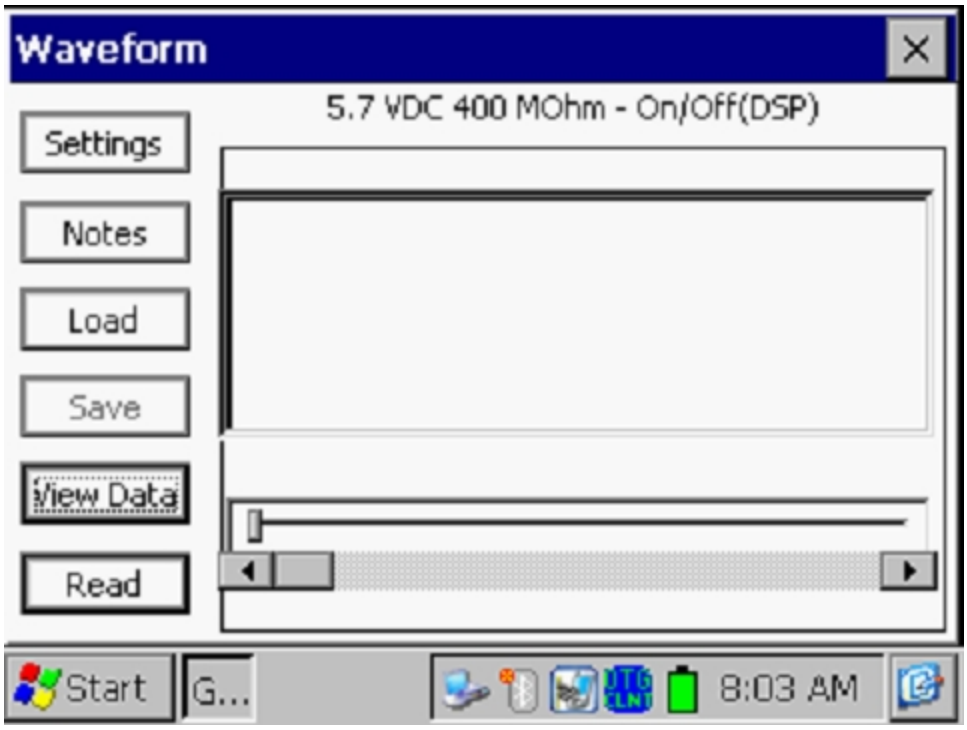
As with the Gx Belt Pack, the data-logger mounts onto on a platform that attaches to the Backpack, allowing the operator to view the screen at all times and to make any selections required by tapping on the screen. Also, the dual-probe adapter shown in Section III, is mounted on the underside of the platform, allowing convenient (5 pin cable) connection of the adapter's "output" to the data-logger.

Since the Backpack has an integrated chainer unit, the trail wire connection to the Gx data-logger is made by connecting a banana plug cable from the counter/display unit to the Gx (please see Appendix 1).

IV. 2 How to View and Save a Pipe-to-Soil On/Off Waveform

When you are performing a current-interrupted CIS, it is recommended that you examine the pipe-to-soil voltage waveform at your starting location (starting test station) and it is suggested that you make a recording of the waveform using your Gx data-logger.

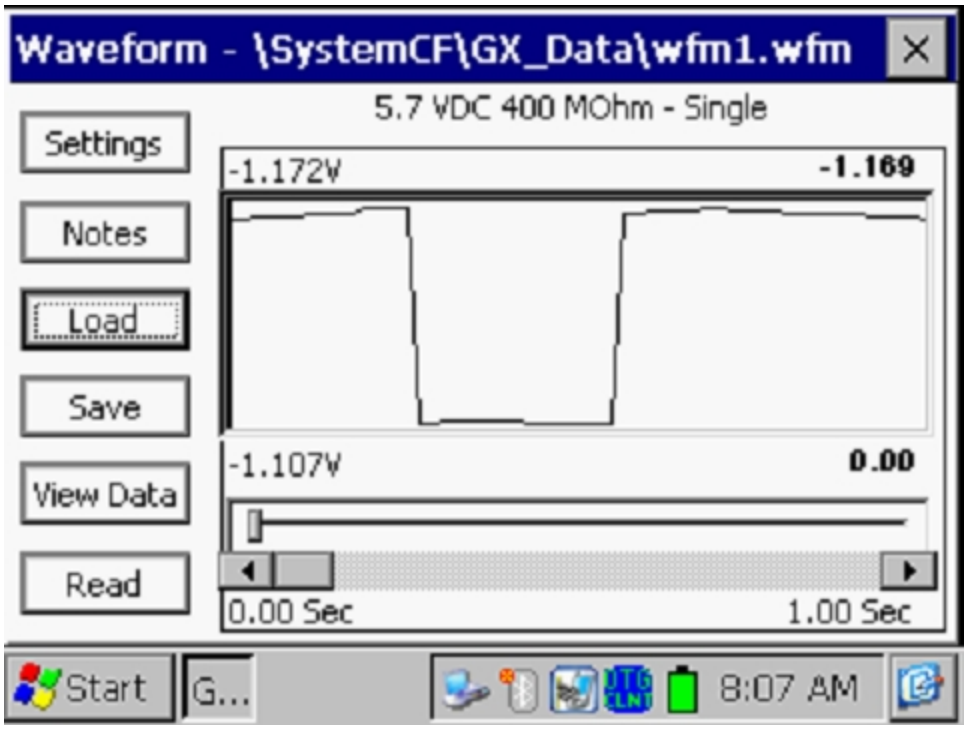
With at least one of the two reference electrode data-probes making good electrical contact with the soil above the pipe at the starting test station and a test cable connected from the pipe connection to the red banana plug terminal on the Gx (assuming you are using black band cables with the data-probes), either tap on the "WAVE" button located at the top of the Survey screen or, tap on "Survey Options" and then tap on "Wave". The screen shown below will be displayed, depending on the previous settings.



Read:
By tapping on the "**Read**" button on the above Waveform screen, you can view the pipe-to-soil voltage waveform at the test site.

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

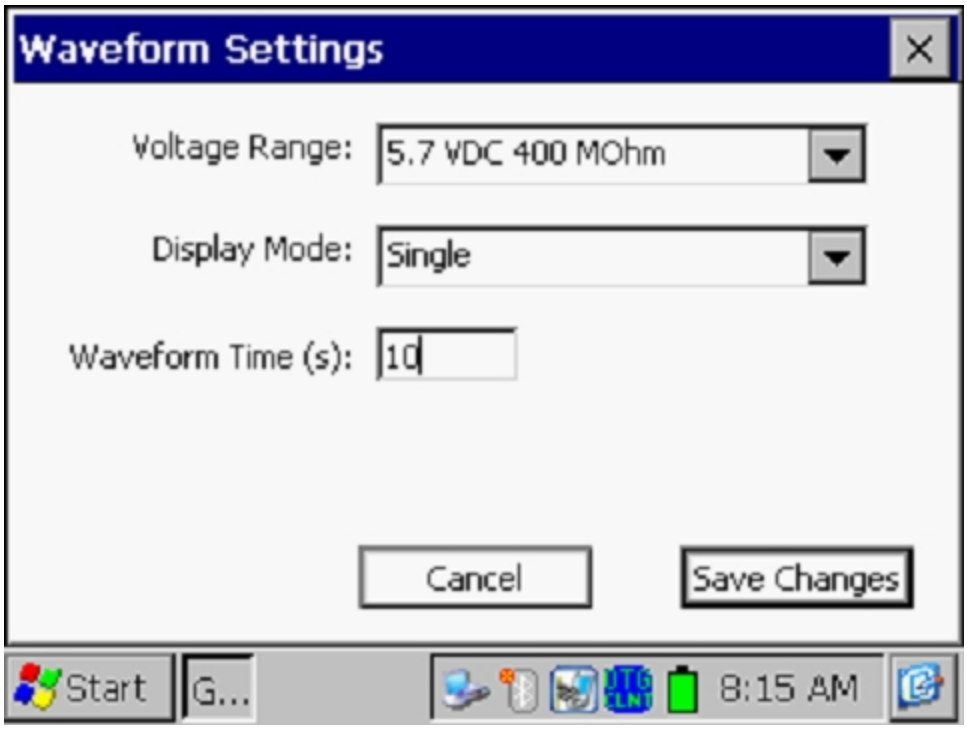
Note: The example waveprint shown is not a "real" waveprint .. it is only presented for illustrative puposes.



Waveprints are very useful with regard to confirming switching synchronization of current interrupters, for example, and with regard to checking for On-to-Off and Off-to-On transition spikes.

Settings

By tapping on the "Settings" button on the Waveform screen, the screen shown below will be displayed, depending on the previous settings.

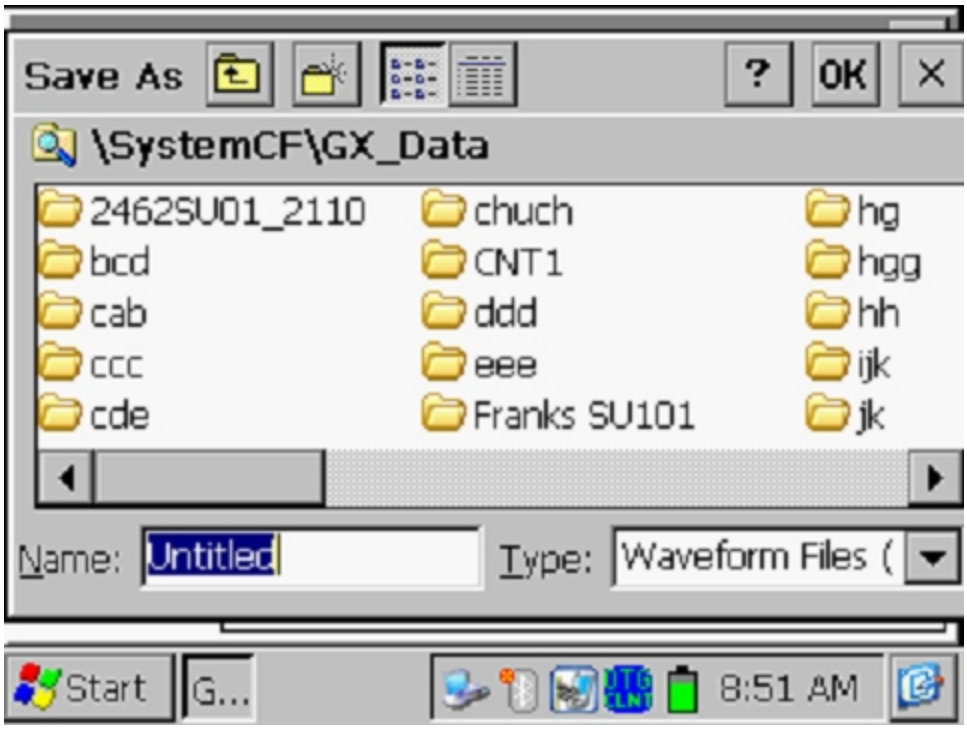


Since all of the DC channels on the Gx data-logger are fast response channels, you can select any "Voltage Range" setting amongst the DC options, regardless of the interruption cycle rate. The main issue with regard to optimum Range selection is sensitivity, in terms of the magnitude of the voltages being measured.

You can also change the "Display Mode" selection, by tapping on the menu button in the "Display Mode" field. In the case of the "Single" reading mode option, you can select the number of waveform periods to be displayed (viewable via the horizontal scroll bar), by tapping inside the "Waveform Time" box and entering a value manually for number of seconds. For example, if the interruption cycle period is 5 seconds (4 seconds On/1 second Off) and you entered 10 (seconds), you would have 2 waveform cycles displayed.

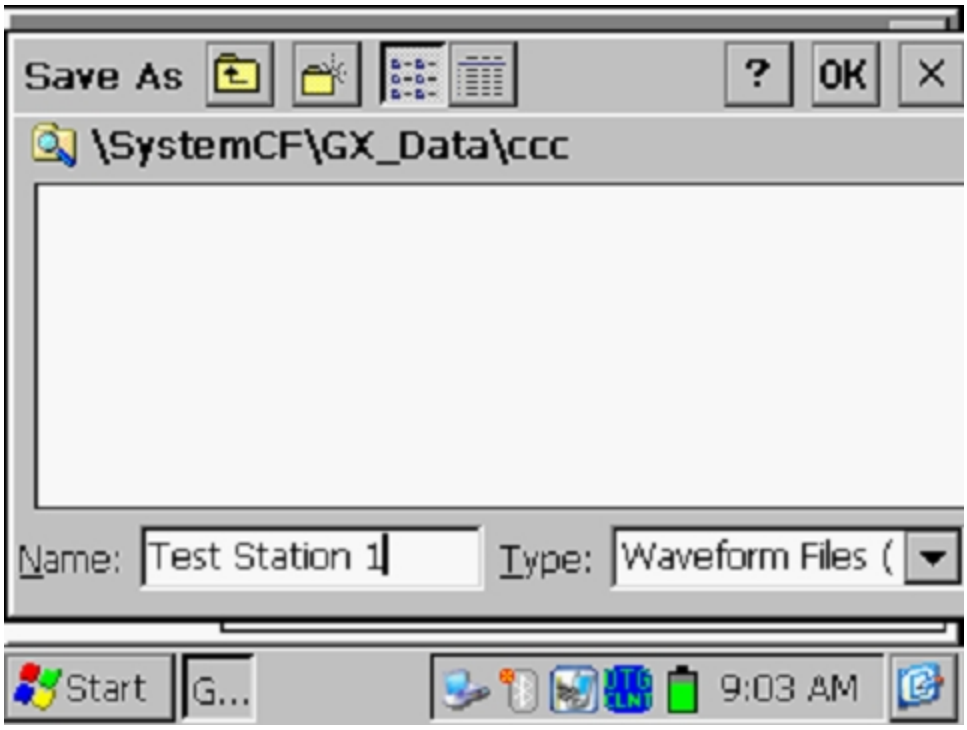
Save

To record a waveprint, tap on the "**Save**" button on the Waveform screen. The screen shown below will be displayed. *Note:* The specific folders presented on the screen will reflect the contents of the Gx_Data folder on your Flash memory card (SystemCF). The Gx_Data folder is used to store all of your survey files.



You have a number of options regarding saving the waveform data.

The recommended option, if you are recording waveform data in the context of a pipeline survey, is to save the waveform data file inside the actual pipeline survey file. To do so, you would double-tap on the survey file (folder) and enter a descriptive name for the waveform data file in the "Name" field. For example, the screen shown below would be displayed for the case of selecting the "ccc" survey file for storage of the waveform data file named, "Test Station 1".



Alternatively, you could just enter a name of the waveform data file in the "Name" field and tap on the "OK" button. In this case, the waveform data file will be saved directly to the Gx_Data folder.

Regardless of your target folder, you should tap on the "OK" button to save the waveform data file.

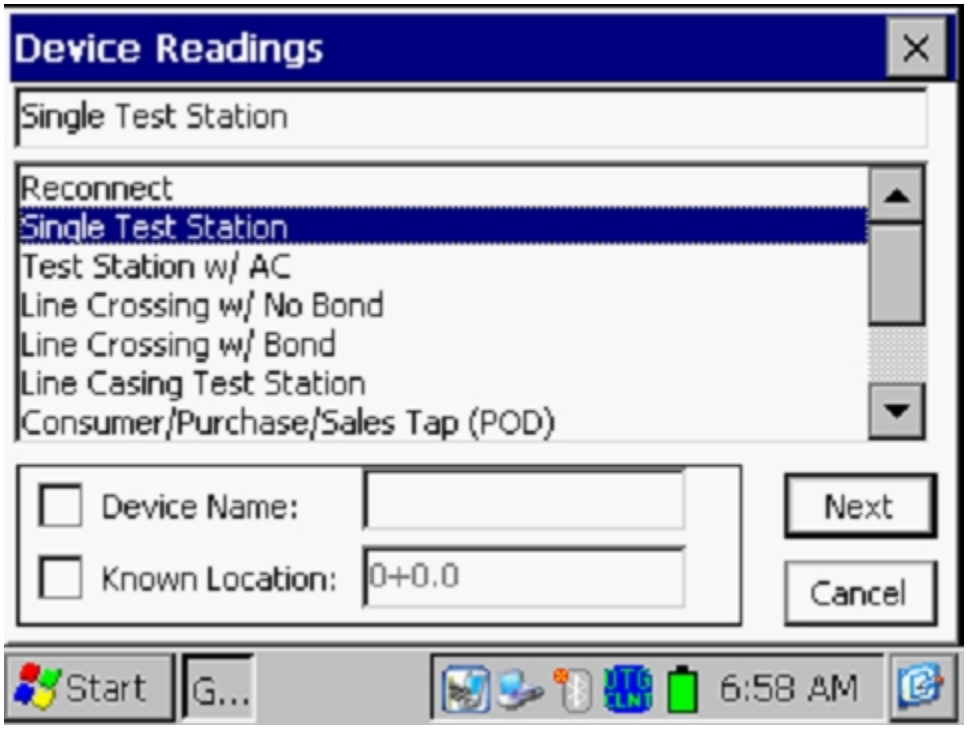
Load:
By tapping on the "**Load**" button on the Waveform screen, and highlighting a particular waveform data file displayed, you can have the previously-saved waveprint displayed by tapping on the "OK" button on the screen

IV. 3 How to Record the Pipe-to-Soil Potential(s) at a Starting Test Station

It is also recommended that you record the pipe-to-soil potential(s) at the starting test station. This will represent the first "**Device**" (Data-Collection Point) associated with the survey.

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

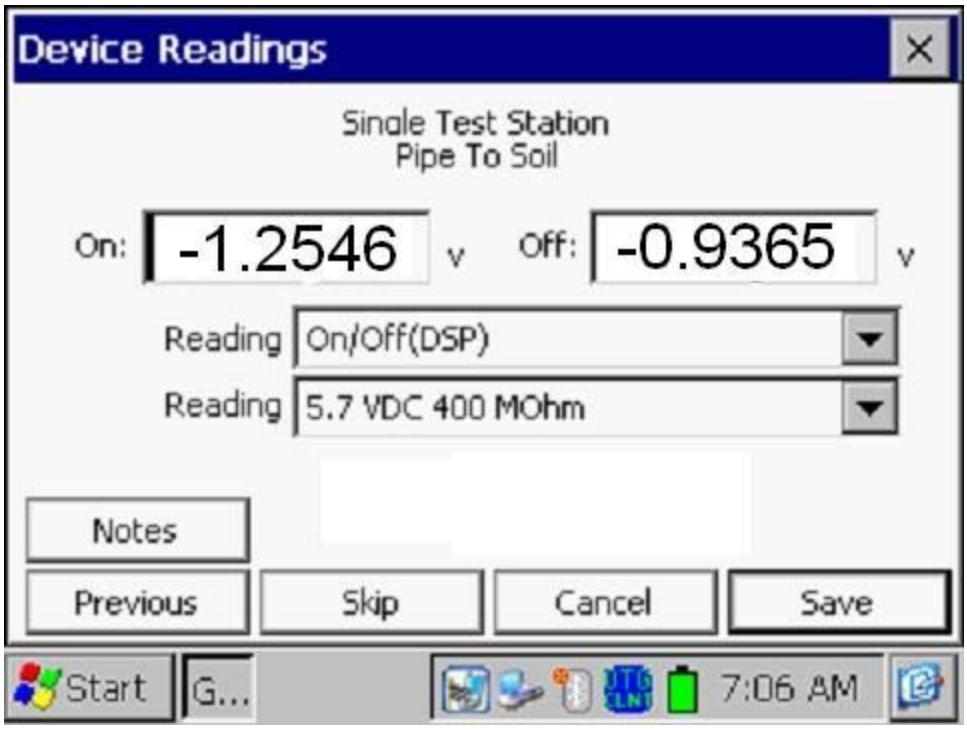
Note: An additional device, named “Mark DCVG” will be available for selection if the box labeled, “DCVG Sidedrains in CIS Survey” was checked-off during initial survey setup.



As can be seen from the above screen, you can choose from a number of “Devices”. In this case, you would tap on “**Single Test Station**” to highlight this selection.

Optional:
By checking off the box labeled, “Device Name”, you can manually enter a descriptive name for the test station. The name you enter here will be associated with this device, as opposed to a default name. Also, by checking off the box labeled, “Known Location”, you have the opportunity to manually enter the actual stationing for the test station, if known (if it is different from the location entered during survey setup for the Start Location).

You should then tap on the “**Next**” button. The screen shown below will be displayed, depending on the previous settings.



The On and Off pipe-to-soil potentials measured (per cycle) at the starting test station will be displayed on the above screen, assuming that one of the On/Off pairs voltmeter reading modes has been selected (see the “Reading” field on the screen). Should you be performing an uninterrupted CIS, you should select one of the Single Read options, in which case, only a single field will be presented for the voltage reading.

You would then tap on the “**Save**” button to record the data at the first test station. As an alternative, you could press the push button switch on either one of your data-probes (canes) to record the data, assuming that you selected the ”save” option for the canes at D.C.P.s during the survey setup process.

When the data are saved, you will be given the opportunity to take a photograph at the “Device” location, as indicated by the question displayed on the screen shown below.

Answering "Yes" on the above screen will take you to the "Pictures" screen, as described in Appendix 3 of the Gx Data-logger Pipeline Survey User's Manual.
Note: Several seconds are required to open the picture program.

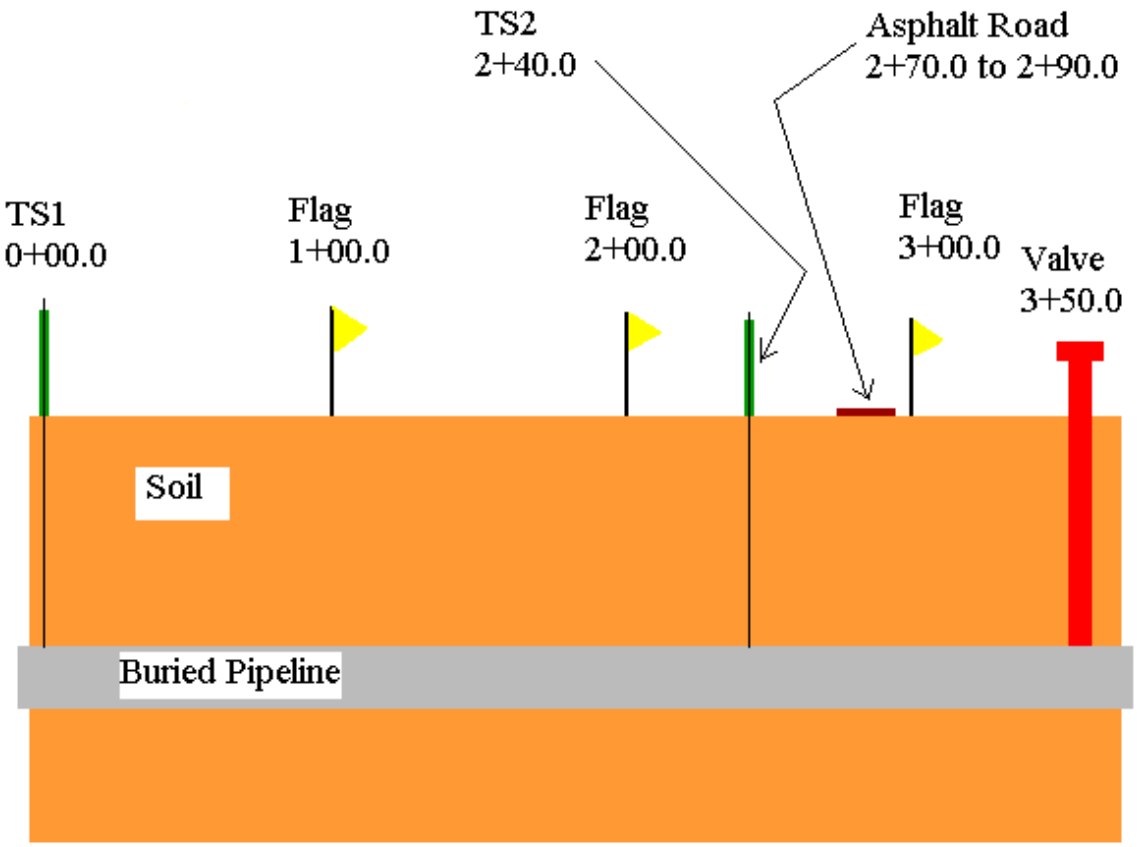
How to Position the Camera for a Picture:
Since the camera on the Gx is located on the underside of the handheld unit, it is necessary to remove the unit from its mounting platform by grasping the unit around its mid section and pulling in an upward motion. The unit should snap out of its retaining brackets. You can now position the camera to take your photograph, since the coiled cable connecting the Gx to the dual-probe adapter provides a considerable degree of flexibility. The unit can then be snapped back into position on the platform, after picture taking, by lining up the groove on the bottom orange bumper with the registration post on the platform and pressing in a downward motion.

Note: By tapping on the "X" button on the "Pictures" screen (top right hand corner), after taking a photograph, you will be returned to the Survey screen.

Answering "No" on the above screen will return you directly to the Survey screen.
You are now ready to proceed with the "walking" portion of the CIS.

IV. 4 How to Perform a CIS

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



Example Section of Pipeline

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

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

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

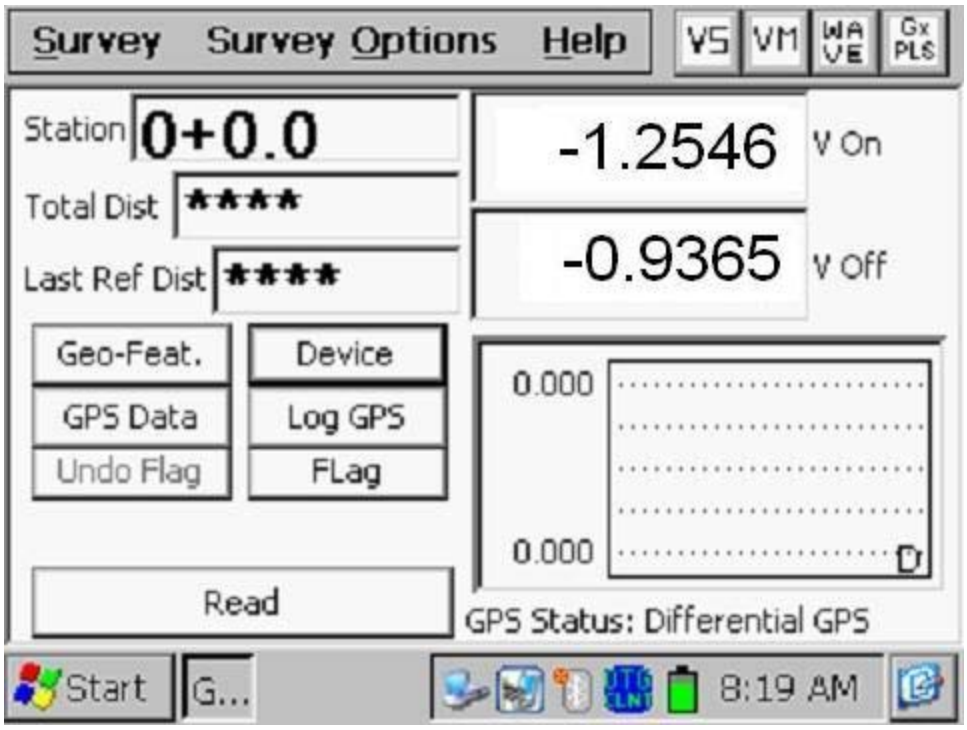
TS2: Test Station 2 located at 2+40.0 (240 feet from reference zero station)

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

Let's consider, as an example, that you are doing a "Trigger-Mode" CIS with the left-hand cane set to "flag" and the right-hand cane set to "read". Also, you are performing a current interrupted CIS with a 0.7 sec. ON and a 0.3 sec. OFF interruption cycle. Also, let's assume that you are beginning your survey at the beginning of the pipeline, or at reference location zero.

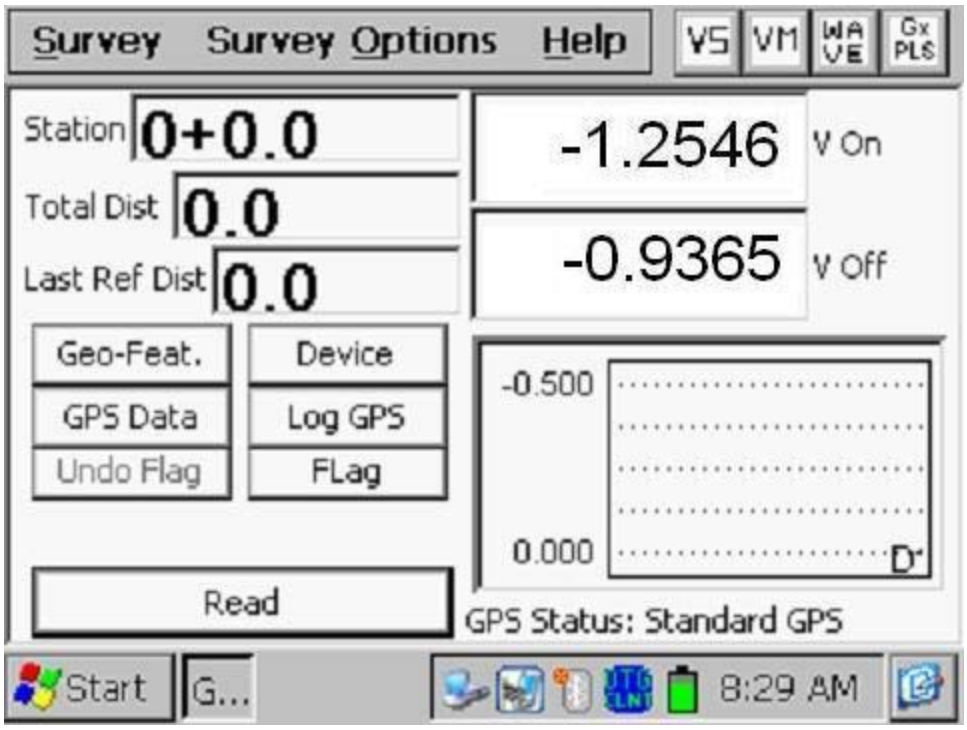
Since, in our example, we have set up the right-hand cane to be the "read" cane, voltages will be recorded each time you "trigger" the right-hand cane's push button (by pressing down on the button) as you walk down the length of the pipeline. Triggering a reading using the right-hand cane button, in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

Since you would have recorded pipe-to-soil voltages at the starting test station (see Section IV.3 above), you would have already established a "Device" location and, as shown below, the device is identified in the graph on the Survey screen by the letter "D". In fact, all "Devices" registered as you go down the line segment will be designated on the graph in this fashion.



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

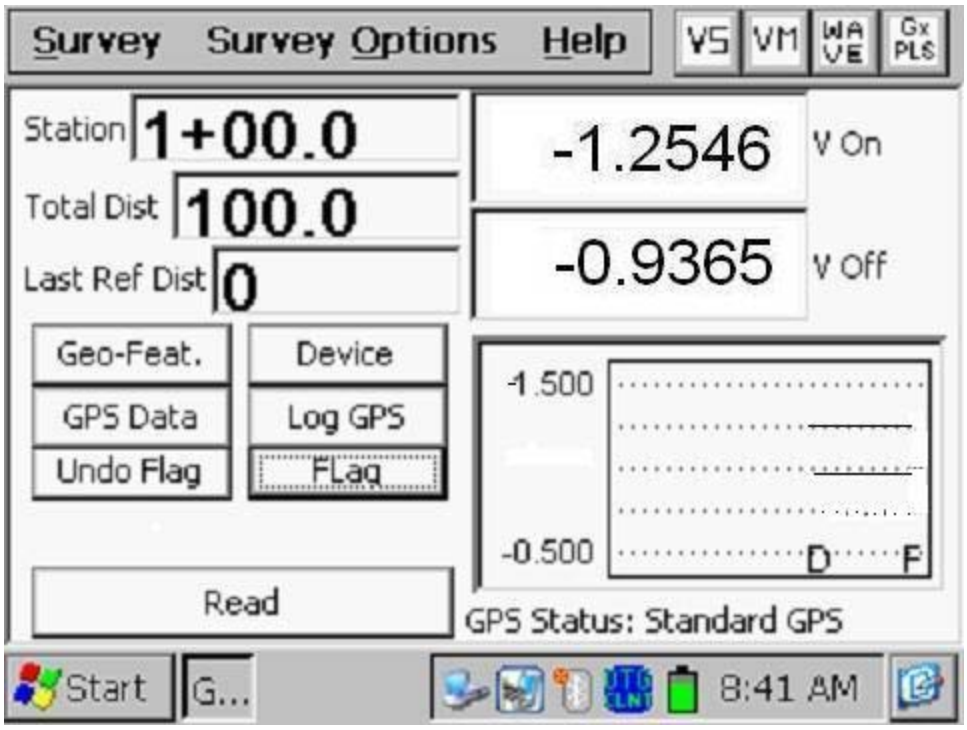
The first triggered reading should be taking when you are physically standing at the starting test station location. When this first reading is triggered, the screen will indicated a total distance from start of zero as indicated on the screen shown below.



The Gx data-logger's software program will add 2.5 feet, in this example survey, to the total distance from the starting station every time the right-hand cane push button is pressed.

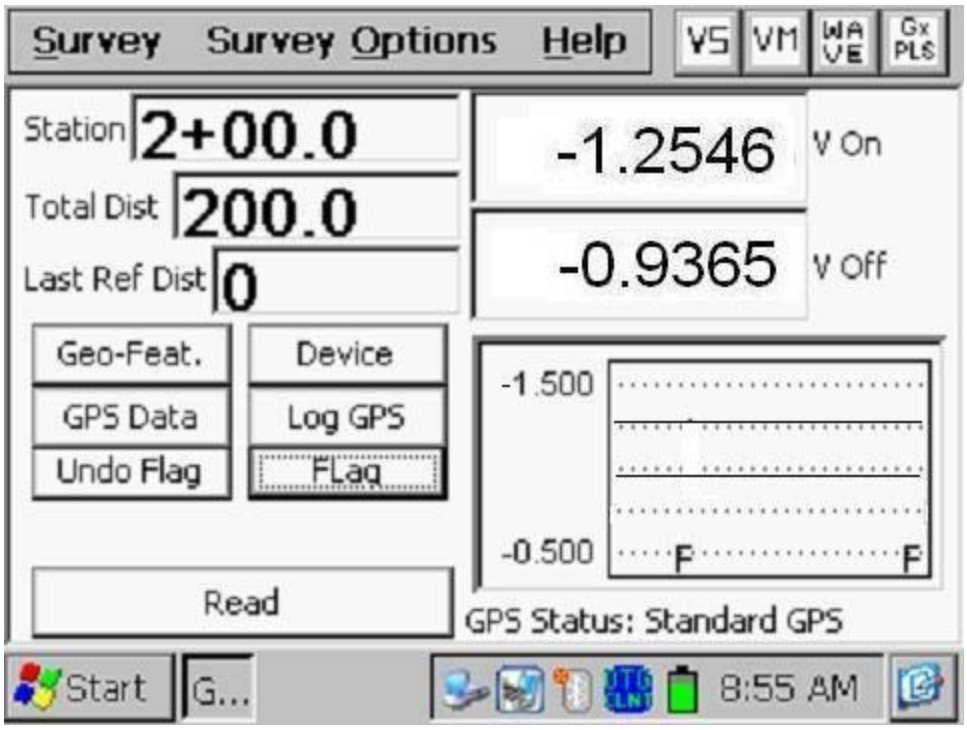
If you recall, we also set things up so that when the left-hand cane's push button is pressed (triggered), we would register the location of survey flags, which are typically placed at 100 feet intervals down the length of the pipe. In this case, triggering the left-hand cane would have the same effect as tapping on the "Flag" button on the Survey screen. Consequently, when you encounter your first survey flag and trigger the left-hand cane, the data-logger's software will assume that you have traveled a distance of 100 feet from the starting test station.

At this point, the screen will be displayed as shown below.



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

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

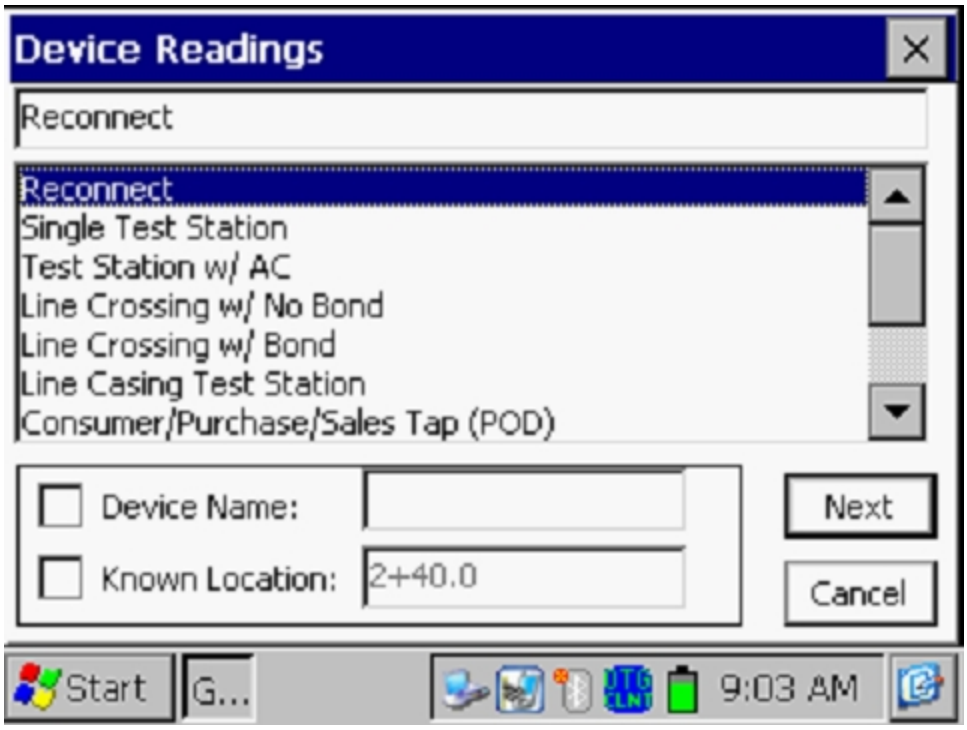


In this case, the station number is now 2+00.0. The "2" represents an assumed 200 feet from the reference zero location. A second Flag marker also appears on the graph.

Reconnect Device

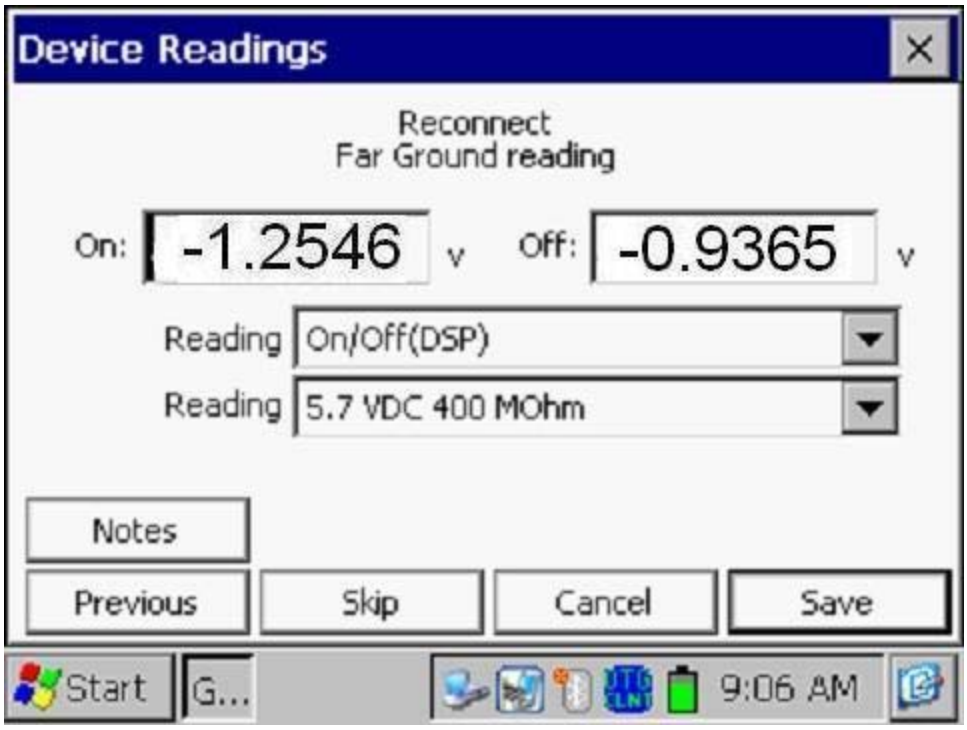
Let's now assume that you encounter a second test station (TS2 in the above figure) at a distance of 40 feet from the second survey flag location and you need to do a "**reconnect**" of the trail wire at this location.

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

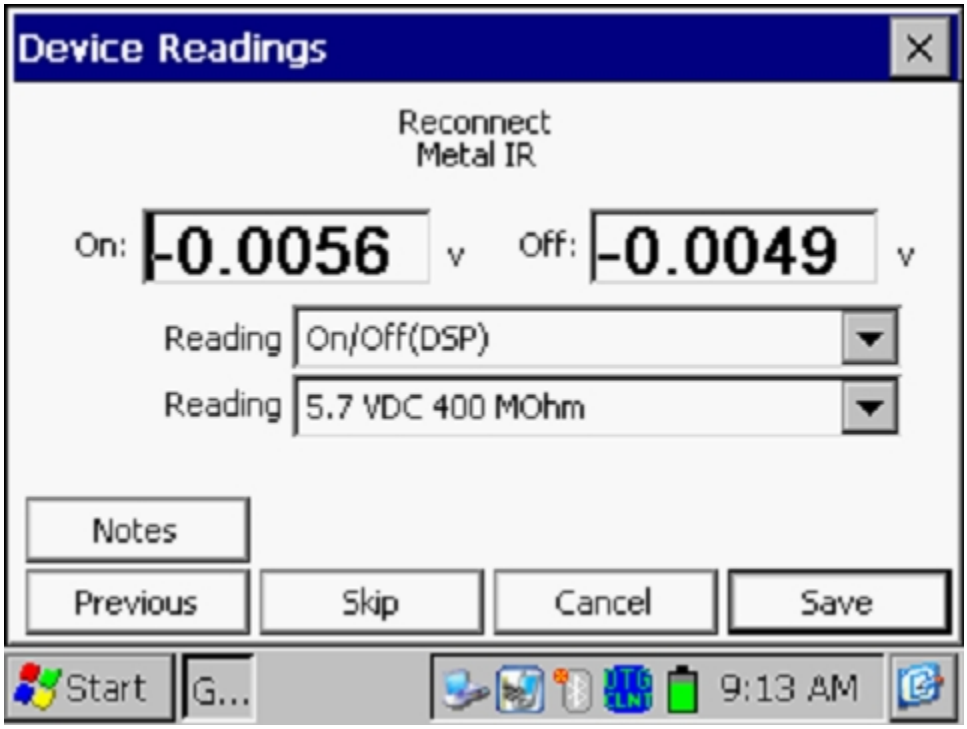


Optional:
By checking off the box labeled, “Device Name”, you can manually enter a descriptive name for the test station. The name you enter here will be associated with this device, as opposed to a default name. Also, by checking off the box labeled, “Known Location”, you have the opportunity to manually enter the actual stationing for the test station, if known (if it is different from the currently displayed station).

You should then tap on the “**Next**” button. The screen shown below will be displayed, depending on the previous settings.



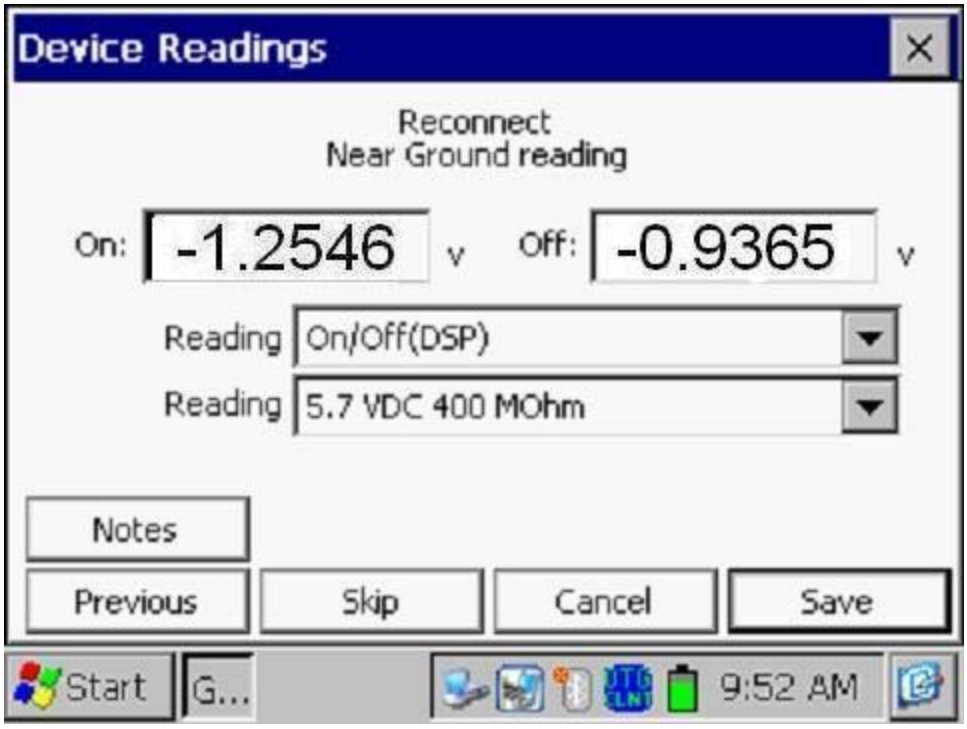
You are being prompted here to record the "**Far Ground**" reading prior to breaking the trail wire connection to the starting test station. By tapping on the "Save" button, the screen shown below will be displayed, depending on previous settings.



At this point you are being prompted to take “Metal IR” readings between your current test station (TS2) and the previous test station (TS1).

To do so, you would connect a test lead from the black banana plug terminal on the Gx to the test station (TS2) and remove the reference electrode data-probes from the measurement circuit (you could place the reference electrodes on top of your shoes, for example). At this point, the Gx will be reading the potential difference between the two test stations (the far-ground station and the near-ground station). If you’d like to record the Metal IR data, you would save the readings by tapping on “save” after setting up to take the readings.

The third prompt screen associated with a Reconnect “Device” will be displayed as shown below, depending on previous settings.



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

After tapping on the “Save” button on the above screen, you will be returned to the Survey screen, assuming that the difference between the Far-Ground and the Near-Ground pipe-to-soil readings (expressed as a percentage) is smaller than the threshold percentage value that you entered for this parameter during the survey setup process. If not, you will be presented with an error screen that will indicate the actual percentage difference values and will give you the option to retake the Near-Ground readings.

When the Reconnect device data are saved, you will be given the opportunity to take a photograph at the “Device” location, as indicated by the question displayed on the screen shown below.

Answering “Yes” on the above screen will take you to the “Pictures” screen, as described in Appendix 3 of the Gx Data-logger Pipeline Survey User’s Manual.
Note: Several seconds are required to open the picture program.

How to Position the Camera for a Picture:
Since the camera on the Gx is located on the underside of the handheld unit,

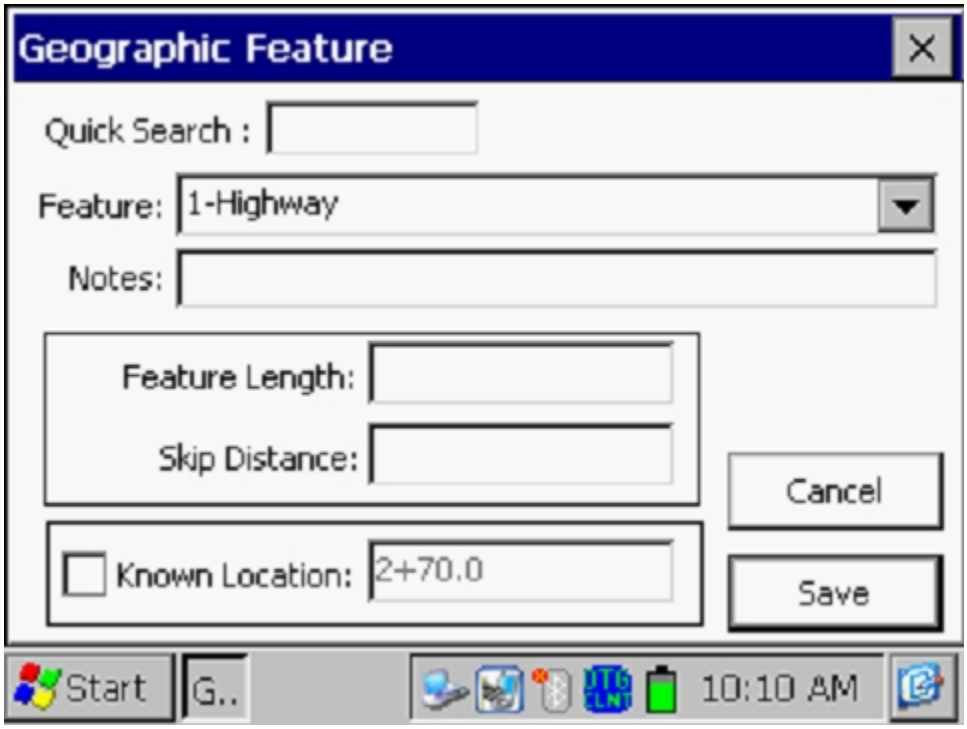
it is necessary to remove the unit from its mounting platform by grasping the unit around its mid section and pulling in an upward motion. The unit should snap out of its retaining brackets. You can now position the camera to take your photograph, since the coiled cable connecting the Gx to the dual-probe adapter provides a considerable degree of flexibility. The unit can then be snapped back into position on the platform, after picture taking, by lining up the groove on the bottom orange bumper with the registration post on the platform and pressing in a downward motion.

Note: By tapping on the "X" button on the "Pictures" screen (top right hand corner), after taking a photograph, you will be returned to the Survey screen.

Answering "No" on the above screen will return you directly to the Survey screen.

Geo-Feature:

Now, let's assume that at an additional 30 feet down the pipeline from the "Reconnect" location, you encounter an asphalt road which is an example of a "Geo-Feature", ie, a geographical feature. When you reach such a location, you would tap on the "Geo-Feat." button on the Survey screen and the screen shown below will be displayed.



You can select the type of geo-feature that you have encountered by tapping on the menu button in the “Feature” field and highlighting your selection. Alternatively, you could perform a quick search for the feature by entering in the “Quick Search” field the number associated with the feature or the first few letters of the name of the feature.

Skip Distance Example:
If, for example, the geo-feature is an “Asphalt Road”, and the width of the road that you have to cross, without taking readings, is 30 feet, you would enter a “Skip Distance” of 30 feet. In this example, you are telling the data-logger to assume that when you trigger the next reading you will be 30 feet beyond where you triggered your last reading.

Optional:
You can enter a “Feature Length” value if you wish, although this entry does not have any impact on the stationing. In addition, you can check off the box labeled, “Known Station” and enter a station value if you know that the current stationing is incorrect. This will give the software a new location reference going forward.

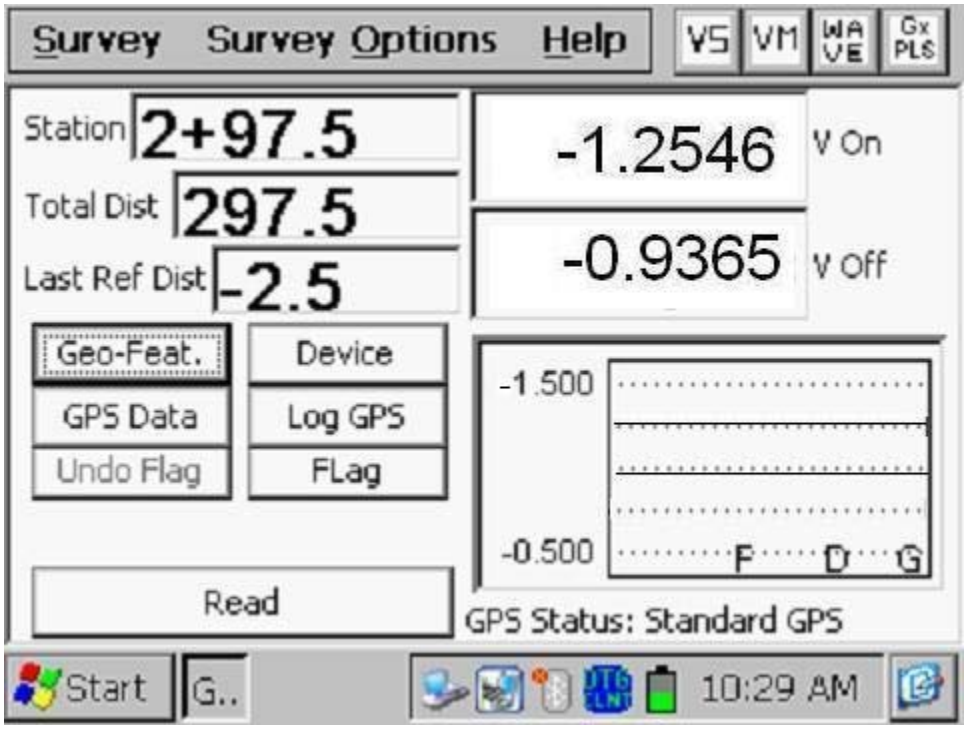
When the Geo-Feature data are saved (by tapping on the “Save” button), you will be given the opportunity to take a photograph at the “Geo-Feature” location, as indicated by the question displayed on the screen shown below.

Answering "Yes" on the above screen will take you to the "Pictures" screen, as described in Appendix 3 of the Gx Data-logger Pipeline Survey User's Manual.
Note: Several seconds are required to open the picture program.

How to Position the Camera for a Picture:
Since the camera on the Gx is located on the underside of the handheld unit, it is necessary to remove the unit from its mounting platform by grasping the unit around its mid section and pulling in an upward motion. The unit should snap out of its retaining brackets. You can now position the camera to take your photograph, since the coiled cable connecting the Gx to the dual-probe adapter provides a considerable degree of flexibility. The unit can then be snapped back into position on the platform, after picture taking, by lining up the groove on the bottom orange bumper with the registration post on the platform and pressing in a downward motion.

Note: By tapping on the "X" button on the "Pictures" screen (top right hand corner), after taking a photograph, you will be returned to the Survey screen.

Answering "No" on the above screen will return you directly to the Survey screen (see below).

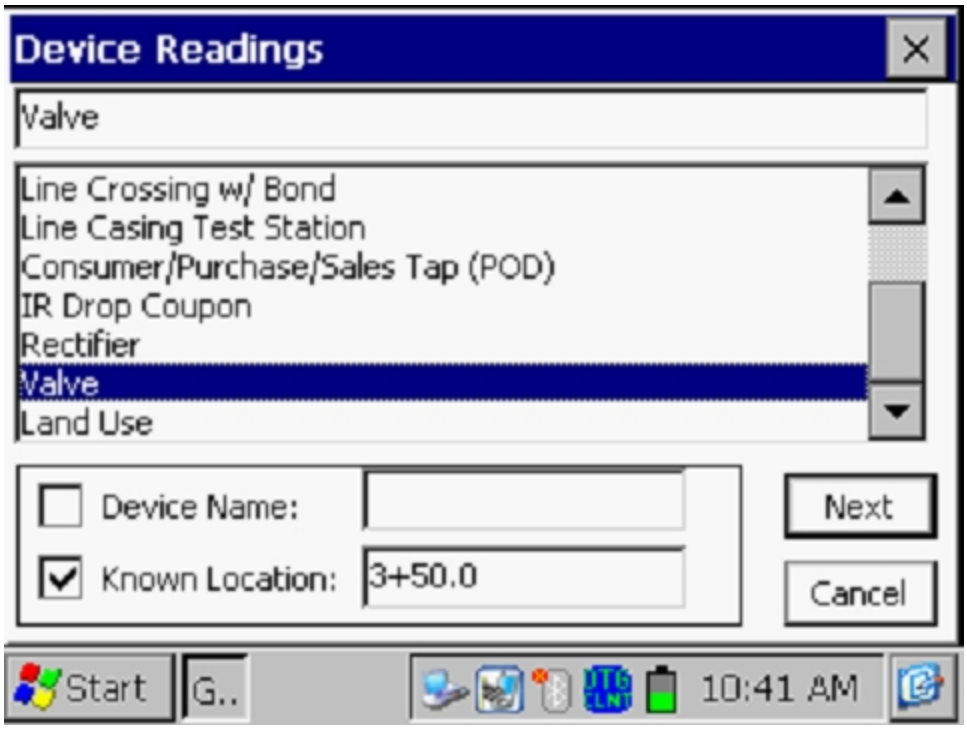


As can be seen from the above screen, the Gx data-logger's software assumes that you are 2.5 feet short of the other side of the asphalt road. The reason for this is that when you trigger your next reading you will be standing at the other side of the skip and at that point, the stationing will be correct (3+00 in this example). Notice that a "G" designation has been added to the graph (for Geo-Feature).

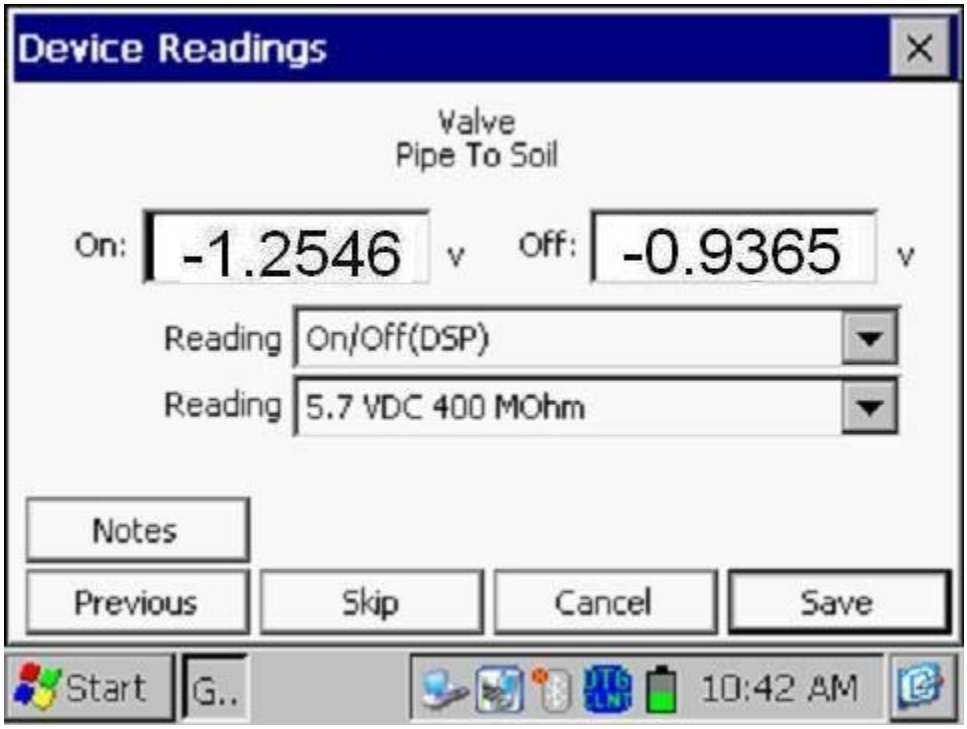
You would also trigger the "flag" cane (your left-hand reference electrode cane) at this point, to register the survey flag.

Now, let's assume that you encounter a "Valve" at an additional 50 feet down the pipe from this latest survey flag. Since, a valve is considered a "Device", you would stop and tap once on the "Device" button on the Survey screen.

By tapping on "Valve" from the Device List, the screen will be displayed as shown below.



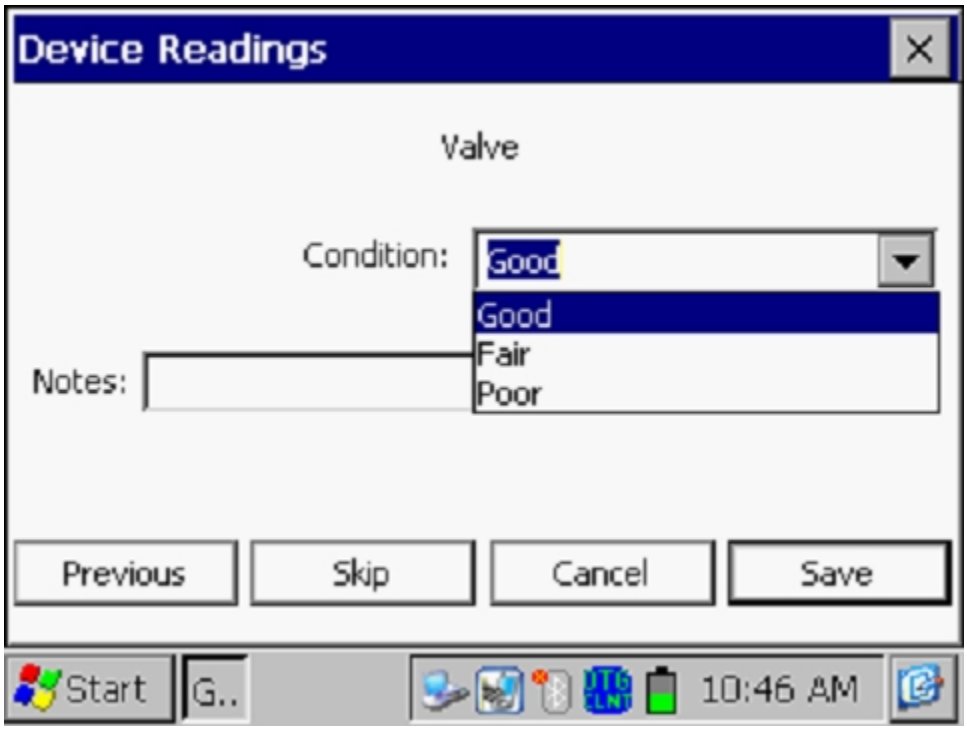
By tapping on the “Next” button, the screen shown below will appear.



In order to view the pipe-to-soil voltages at the valve, you would connect a banana plug test lead from the red banana plug terminal on the Gx to the valve, temporarily disconnecting the trail wire lead from the Gx.

You would save the displayed pipe-to-soil readings at the valve location by triggering the right-hand cane button (or by tapping on the “Save” button on the above screen).

Having done so, the screen shown below will appear.



This screen allows you to note the condition of the valve, by tapping on the menu button in the “Condition” field and making an appropriate selection.

When the Valve “Device” data are saved (by tapping on the “Save” button), you will be given the opportunity to take a photograph at the “Device” location, as indicated by the question displayed on the screen shown below.

Answering "Yes" on the above screen will take you to the "Pictures" screen, as described in Appendix 3 of the Gx Data-logger Pipeline Survey User's Manual
Note: Several seconds are required to open the picture program.

How to Position the Camera for a Picture:
Since the camera on the Gx is located on the underside of the handheld unit, it is necessary to remove the unit from its mounting platform by grasping the unit around its mid section and pulling in an upward motion. The unit should snap out of its retaining brackets. You can now position the camera to take your photograph, since the coiled cable connecting the Gx to the dual-probe adapter provides a considerable degree of flexibility. The unit can then be snapped back into position on the platform, after picture taking, by lining up the groove on the bottom orange bumper with the registration post on the platform and pressing in a downward motion.

Note: By tapping on the "X" button on the "Pictures" screen (top right hand corner), after taking a photograph, you will be returned to the Survey screen.

Answering "No" on the above screen will return you directly to the Survey screen.

Since, in our example section of pipe, the valve represents the end of the line segment, you would terminate the survey by tapping on “Survey” at the top of the screen and tapping on “Finish Survey”. Tap again on “Survey” and this time select “Exit” to close the pipeline survey program.

At this point you have completed the CIS on this section of the pipeline and the survey data have been stored (saved) on the data-logger’s Flash memory card in the file that you named when you setup the survey.

SECTION V: HOW TO COPY SURVEY FILES FROM THE DATA-LOGGER TO YOUR PC

V. 1 Introduction

Survey data are stored in independent files (one file for each survey) on the Flash memory card on the Gx data-logger and you can copy survey files to your PC using one of two approaches; manually or via the driver in the ProActive software program.

The ProActive software program represents MCM’s CP data management system and this program allows integration of pipeline survey data in a database system and offers extensive reporting (both textual and graphical) capabilities on the survey data.

If you have the ProActive software program installed on your PC, or you can bring your Gx to a PC that has ProActive installed on it, you can use the ProActive program to automatically access survey files on the Gx. If either of these situations applies, you would proceed to Section V. 3.

Note: The ProActive program is required to actually view the survey data.

If you do not have ProActive installed on your PC and you cannot bring your Gx to a PC that has ProActive installed on it, you can copy survey files manually from your Gx to your PC and you can subsequently send the copied files to a recipient who is a ProActive user. If this situation applies, you would proceed to Section V. 2.

V. 2 The Manual Approach

Step 1: Establish a connection between the Gx and your PC.

Gx Data-loggers can be connected to a PC using the USB cable supplied with the unit.

Connection via the USB Cable:
The requirements and procedures with regard to Gx Data-logger/PC connectivity depend on the operating system of the PC.

Case 1: Windows XP (or earlier) PC Operating System
The Microsoft "ActiveSync" communication program is required on the PC. If not currently installed, the application can be installed from the CD provided with the Gx Data-logger. Once installed, make sure that the "Allow USB Connections" option is selected in the "Connection Settings" window of the ActiveSync application.

Next, connect the USB cable from the Gx Data-logger to the PC and switch ON the Gx (via the RED power button). The connection should be automatic and you will be asked if you'd like to set up a partnership or not between the Gx and the PC. Answer NO to this question, as the ability to transfer file data is all that is required, as opposed to a synchronized partnership. You can then exit the Activesync application.

If the connection is not established automatically, make sure that the connection option on the Gx is "USB_Serial", which it should be by default. To do so, tap on the "Start" button on the Gx screen, tap, on "Settings", tap on "Control Panel" and double-tap on "PC Connection". If "USB_Serial" is not indicated, tap on the "Change Connection" button and select "USB_Serial" from the drop down menu. Repeat the connection process.

Case 2: Windows Vista or Newer (such as Windows 7) PC Operating System
The Gx Data-logger connects to these systems via the "Mobile Device Center" which replaces the Activesync program on the PC side.

Make sure that the USB connection option is set up via the Mobile Device Center. Connect the USB cable between the Gx Data-logger and the PC and switch ON the Gx. The connection should be established automatically.

If the connection is not established automatically, make sure that the connection option on the Gx is "USB_Serial", which it should be by default. To do so, tap on the "Start" button on the Gx screen, tap, on "Settings", tap on "Control Panel" and double-tap on "PC Connection". If "USB_Serial" is not indicated, tap on the "Change Connection" button and select "USB_Serial" from the drop down menu. Repeat the connection process.

Step 2:
Follow the procedures detailed below:

* Double-click on "My Computer" on your PC
- Double-click on "Mobile Device"
- Double-click on "SystemCF"
- Double-click on "Gx_Data"
- Right-click on the survey file you wish to copy & select "Copy"
- "Paste" the file into a local folder on your hard-drive
- Create a compressed (zipped) version of the file

You would now be in a position to send the compressed file via email, for example, to a recipient who has access to the ProActive software program.

Note: Do not rename the survey file prior to sending the file to the recipient, as the survey file must have the same name as the survey itself.

V. 3 Using the Driver in the ProActive Software Program

Step 1:
Create a folder on your PC's hard-drive (perhaps in your "My Documents" folder) that will be used to "permanently" save files copied from your data-logger. You might choose to name this folder something like, "Surveys".

Step 2: Establish a connection between the Gx and your PC.

Gx Data-loggers can be connected to a PC using the USB cable supplied with the unit.

Connection via the USB Cable:
The requirements and procedures with regard to Gx Data-logger/PC connectivity depend on the operating system of the PC.

Case 1: Windows XP (or earlier) PC Operating System

The Microsoft "ActiveSync" communication program is required on the PC. If not currently installed, the application can be installed from the CD provided with the Gx Data-logger. Once installed, make sure that the "Allow USB Connections" option is selected in the "Connection Settings" window of the ActiveSync application.

Next, connect the USB cable from the Gx Data-logger to the PC and switch ON the Gx (via the RED power button). The connection should be automatic and you will be asked if you'd like to set up a partnership or not between the Gx and the PC. Answer NO to this question, as the ability to transfer file data is all that is required, as opposed to a synchronized partnership. You can then exit the Activesync application.

If the connection is not established automatically, make sure that the connection option on the Gx is "USB_Serial", which it should be by default. To do so, tap on the "Start" button on the Gx screen, tap, on "Settings", tap on "Control Panel" and double-tap on "PC Connection". If "USB_Serial" is not indicated, tap on the "Change Connection" button and select "USB_Serial" from the drop down menu. Repeat the connection process.

Case 2: Windows Vista or Newer (such as Windows 7) PC Operating System

The Gx Data-logger connects to these systems via the "Mobile Device Center" which replaces the Activesync program on the PC side.

Make sure that the USB connection option is set up via the Mobile Device Center. Connect the USB cable between the Gx Data-logger and the PC and switch ON the Gx. The connection should be established automatically.
If the connection is not established automatically, make sure that the connection option on the Gx is "USB_Serial", which it should be by default. To do so, tap on the "Start" button on the Gx screen, tap, on "Settings", tap on "Control Panel" and double-tap on "PC Connection". If "USB_Serial" is not indicated, tap on the "Change Connection" button and select "USB_Serial" from the drop down menu. Repeat the connection process.

Step 3:

Double-click on the "ProActive" icon on your PC's desktop screen.

This will open up ProActive's main menu window. A window labeled "Entire Database" will also be seen here. The suggested organization of your database is discussed in the **ProActive Training Manual**.

Step 4:
Click on the "Surveys" button on the speed button bar.

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

By clicking on the menu button in the "Data Logger" field, you can select the data-logger from which you are copying the survey file. The various data-loggers currently supported by ProActive are offered as choices in the menu list.

Step 5:
Select the Gx Data-logger Option.

Highlight "GX" in the menu list and make the appropriate "Survey Type" selection (CIS in this case). Next, click on the "Go" button. This will open up a window labeled, "Gx Driver (Pipeline Survey)".

Note: It may take a few seconds for the "Driver" Window to appear.

Step 6:
Identify the Survey File to be Copied.

The "Get Pipeline Survey from Gx" field on the "Gx Driver" window will list all of the survey files currently stored on your Gx's Flash memory card.

Highlight the survey file that you would like to be copied to your PC. Also, check-off the box labeled "Copy to Local Folder" and identify the target folder's location on your hard-drive in the field underneath using the "browse" button.

This is the folder that you set up previously (Step 1 above) in which to save all of your survey files copied from your Gx.

Also, if you used the metric system on the data-logger, check off the box labeled, “Use Metric”.

Finally, click on the “Go” button on the Gx Driver window.

Step 7:
Examine the Survey Data Prior to Posting the Data to the ProActive Database.

You will have actually completed the process of copying a survey file to a local folder on your PC by this point, using the Driver in ProActive.

However, before exiting the Driver, it is recommended that you examine your survey data prior to posting the data to the ProActive database. The process of posting the pipeline survey data to the ProActive database is detailed in the **ProActive Training Manual** and is beyond the scope of this manual.

To examine the survey data in the Gx Driver, you can click on the various page tabs now appearing on the Gx Driver (Pipeline Survey) window:

Survey Settings
Readings
Device Readings
Graph

By clicking on these page tabs, you can view information on the Survey settings or you can view the actual survey (and “device”) data - please see the ProActive Training Manual for details.

Appendix 1

How to Connect the Chainer and Counter Unit for Close Interval Survey Applications

The following section describes how you would make appropriate connections in order to incorporate the MCM chainer (wire measure) and counter unit for CIS applications.

When properly configured, the counter emits a short audible signal (beep) each time 2.5 feet (or 1 meter for the metric version) of trail wire is fed through the chainer. A longer beep is emitted each time 100 feet (or 100 meters for the metric version) of trail wire is fed through the chainer. An operator can then trigger readings (or designate survey flag locations) in response to the audible signals using the push-button switches on the MCM data-probes. This represents the "manual triggering" option.

An alternative approach is possible, which is known as the "automatic triggering" option. In this case, readings are triggered automatically each time 2.5 feet (or 1 meter for the metric version) of trail wire is fed through the chainer. In this case, the gray colored trigger cable (Part # SIN024) is required.

Option 1: Manual Triggering

Figure 1 illustrates the cabling configuration for this option. As can be seen from the figure, a 3-wire cable (coiled black cable) connects the hip pack (or the back pack) to the counter/display unit. Two of the wires carry the wire measure signal and the third wire connects to the structure (pipe) via the trail wire.

The structure can be connected to either the positive or the negative side of the data-logger's voltmeter by connecting a banana plug cable from the counter unit to either the red or the black banana plug terminal on the data-logger. By connecting this cable to the red banana plug terminal (positive side of the voltmeter) and using two black-band cables to connect the data-probes to the data-logger via the dual-probe adapter (effectively connecting the data-probes to the negative side of the voltmeter), you would read normally **negative** pipe-to-soil voltages. This situation is illustrated in Figure 1. If you wanted to read normally **positive** pipe-to-soil voltages, you

would connect the banana plug cable from the counter unit to the black banana plug terminal on the data-logger and you would use two red-band data-probe cables.

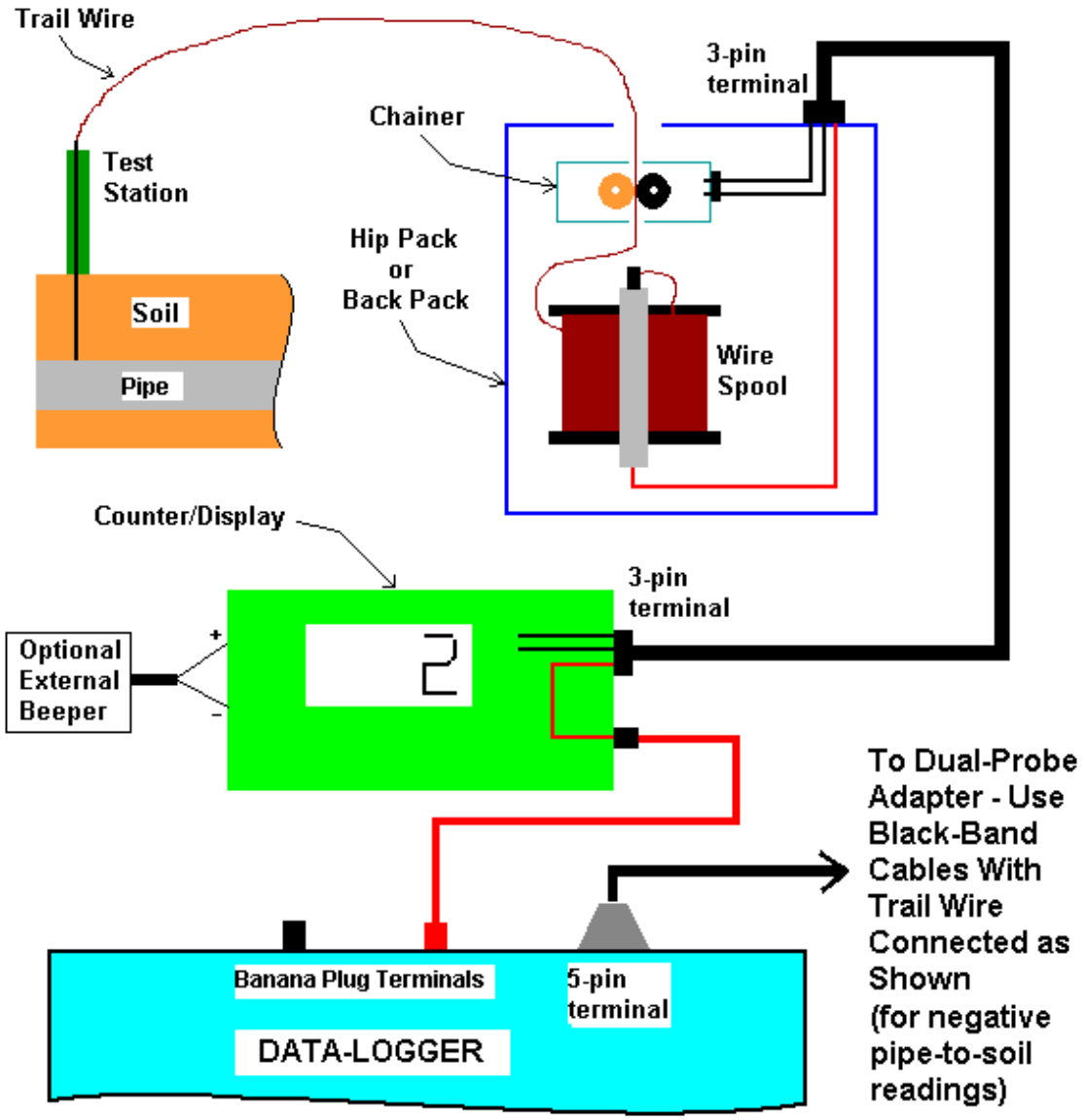


Figure 1: Set up for manual triggering of readings in response to the "beep" emitted by the counter unit every 2.5 feet (or, every meter for the metric case).

Option 2: Automatic Triggering

Figure 2 illustrates the cabling configuration for this option. A "trigger cable" is connected from the counter unit to the 5-pin terminal on the data-logger as shown in the figure. The red and the black wires of the trigger cable are connected to the "External Beeper" connection terminals on the underside of the counter unit. The red and the black wires connect to the terminals labeled, positive and negative, respectively.

Again, as in Option 1, the structure (pipe) can be connected to either the positive or the negative side of the voltmeter by connecting a banana plug cable from the counter/display unit to either the red or the black banana plug terminal on the data-logger. By connecting this cable to the red banana plug terminal of the data-logger (positive side of the voltmeter), as shown in the figure, the data-probes would be connected to the negative side of the voltmeter, via the black banana plug terminal on the data-logger. In this case, you would read normally **negative** pipe-to-soil voltages. If you wanted to read normally **positive** pipe-to-soil voltages, you would connect the banana plug cable from the counter/display unit to the black banana plug terminal on the data-logger and you would connect the data-probes to the red banana plug terminal on the data-logger.

Note: With this option (Option 2), you do not use the MCM data-probe cables. Instead, you would connect banana plug cables (not supplied with the package) to the banana plug terminals on the data-probes and, via a common connection, you would connect both banana plug cables to either the black or the red banana plug terminal on the data-logger, depending on whether you wanted to read negative or positive pipe-to-soil voltages (see above).

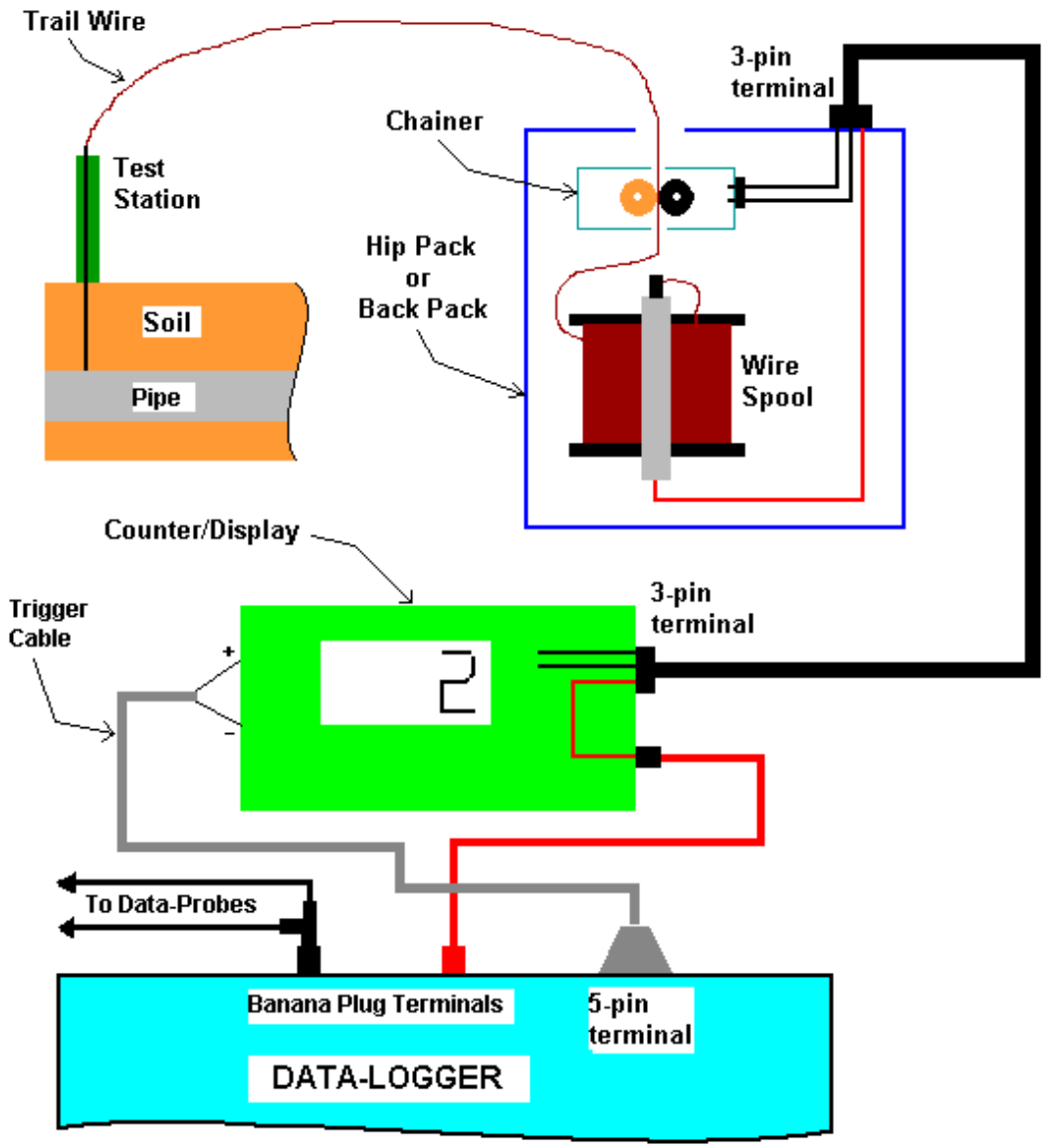


Figure 2: Set up for automatic triggering of readings every 2.5 feet (or every meter in the metric case).

APPENDIX 2: How to Delete Survey Files from the Gx

Once you have copied your survey files to your PC (see Section V), you can (if you wish) delete the files from your Gx's Flash memory card.

Since your survey files are stored on the Flash card, you will have to access this memory (SystemCF) in order to delete selected survey files. The procedure would be as follows:

- Tap on the "Start" button on the Gx
- Tap on "Programs"
- Tap on "Windows Explorer"
- Double-tap on "SystemCF"
- Double-tap on "Gx_Data"
- Tap and hold on the Survey File you wish to delete until a menu pops up
- Tap on the "Delete" option. This will delete the highlighted survey file