

Using the TDR100/SDMX50 with the CR800/1000  
 MultiLogger Application Note #22

**Overview**

The Campbell TDR100 is a Time Domain Reflectometry (TDR) device used to measure soil water content, bulk electrical conductivity and deformation. TDR measurements using the TDR100 use inexpensive readily available coaxial cable, such as RG-58 type, with excellent accuracy and precision. The TDR100 includes a single coaxial cable connection, expansion is accomplished using the Campbell SDMX50 coaxial multiplexer. Up to 512 probes may be multiplexed and controlled by a single TDR100.

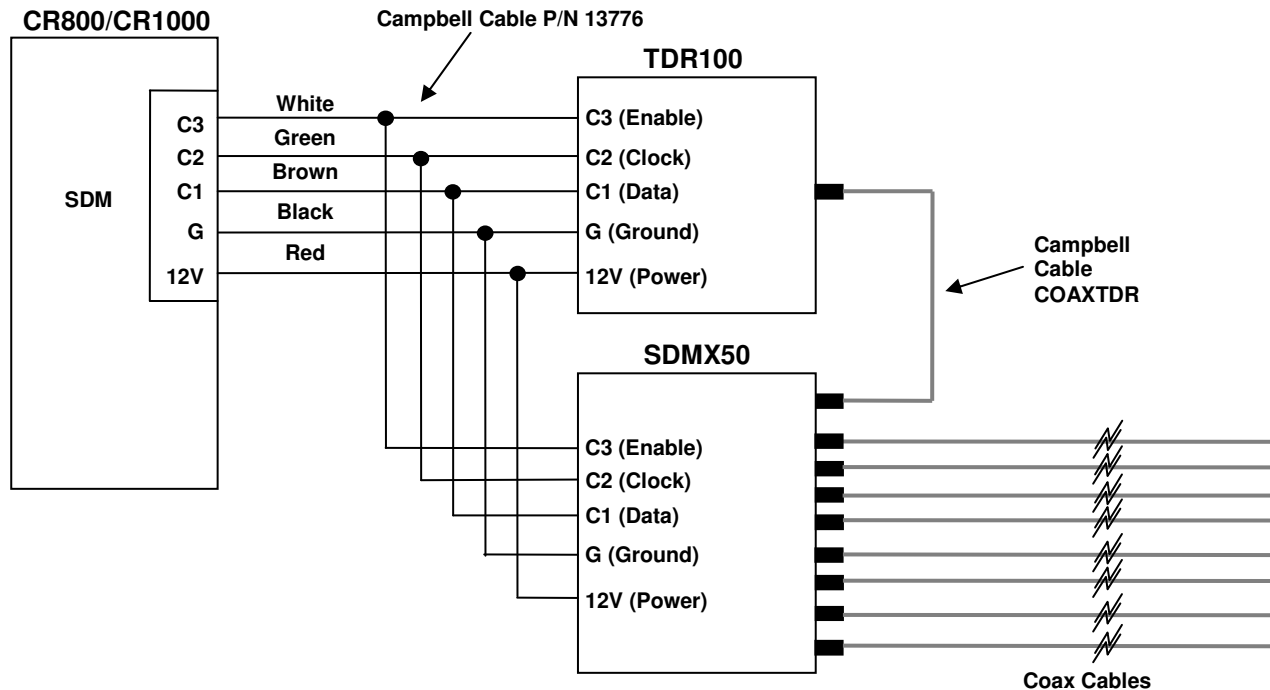


This MultiLogger Application Note will outline using a TDR100 connected to a single SDMX50 to read up to the 8 cables. Contact Canary Systems if your application requires more than 8 cables.

Information regarding data reduction and interpretation is not presented in this application note, contact Canary Systems for a list of resources for soil moisture and deformation monitoring.

**Connections**

Use the supplied Campbell cables for making the TDR100 and SDMX50 connections.



## MultiLogger Configuration

There are essentially 3 configuration steps for using the TDR100/SDMX50 with MultiLogger.

1. Define the locations used to store the TDR channel number, status locations and waveforms.
2. Select the Output Data option to use the TDR100/SDMX50.
3. Customize the TDR100/SDMX50 programming to match the cables/configuration used.

### Define Locations

Use the Input Locations form to define the locations required by the TDR100 programming, this form is accessible from the Program tab in Logger.

Scroll to the bottom of the Location list (should be location 47), locate the cursor in the **Label** edit and enter the Label shown at right, make sure to also check **Store Location**.

The location should be inserted the Location list will increment by 1.

The screenshot shows the 'Configure Input Locations' dialog box. On the left, a list of locations from 45 to 57 is shown, with location 47 selected. The main area shows configuration for location 47. The 'Store Location' checkbox is checked. The 'Label' field is highlighted with a red box and contains the text 'TDR\_Channel'. Below this, there are fields for 'Alias', 'Description', 'Units' (set to 'None'), and 'Reserved'. At the bottom, there is a 'Check Alarms' section with a gear icon, a lightbulb icon, and a 'Type' dropdown set to 'None', along with 'Alarm Low' and 'Alarm High' fields both set to 0. Buttons for 'Help', 'Accept', and 'Cancel' are at the bottom.

Advance to the next Location (should be location 48), locate the cursor in the **Label** edit and enter the Label shown at right.

Move the cursor to another edit on the form, an array of 512 locations will be inserted. The Location list on the left will expand accordingly.

Make to now scroll through all the locations and check **Store Location**.

Due to the large number of locations to check Store Location you may also contact Canary Systems to obtain a pre-configured configuration file.

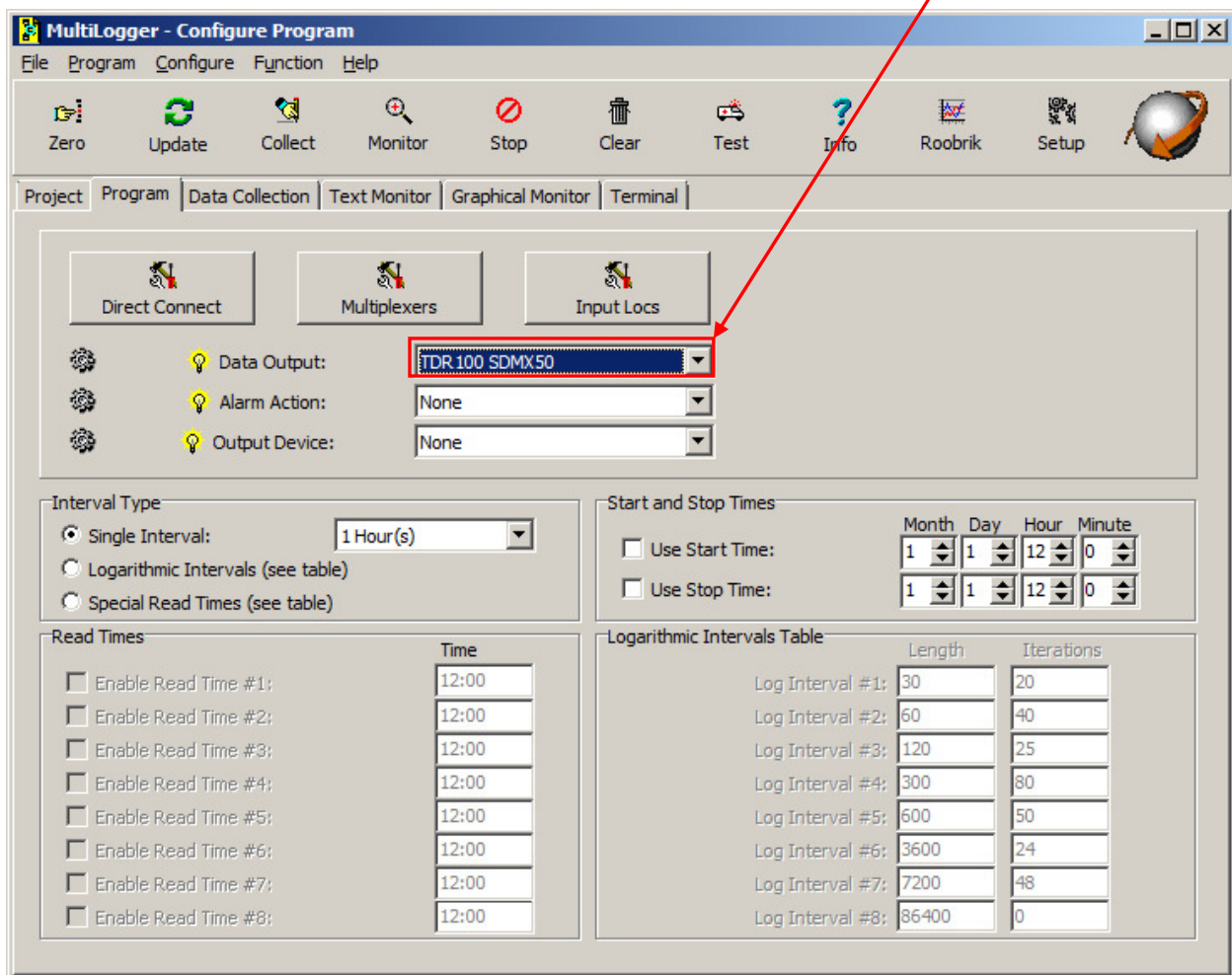
The screenshot shows the 'Configure Input Locations' dialog box for location 48. The 'Store Location' checkbox is checked. The 'Label' field is highlighted with a red box and contains the text 'TDR\_Waveform(512)'. The rest of the dialog box, including the 'Check Alarms' section and buttons, is identical to the previous screenshot.

Once all locations have been configured for storage, press **Accept** to return to the Logger form.

## Output Data Selection

The next step is to select the programming to read the data from TDR100.

This is done using the **Data Output** option on the Program tab. Select **TDR100 SDM50**.



*Hint: If the **TDR100 SDM50** option does not display in the list then MultiLogger must be upgraded. The current version of MultiLogger which will include the TDR100 SDM50 Data Output type is available from the support area at [www.canarysystems.com](http://www.canarysystems.com)*

Configure other options as appropriate, such as the **Interval Type**.

## Customize TDR100/SDMX50 Programming

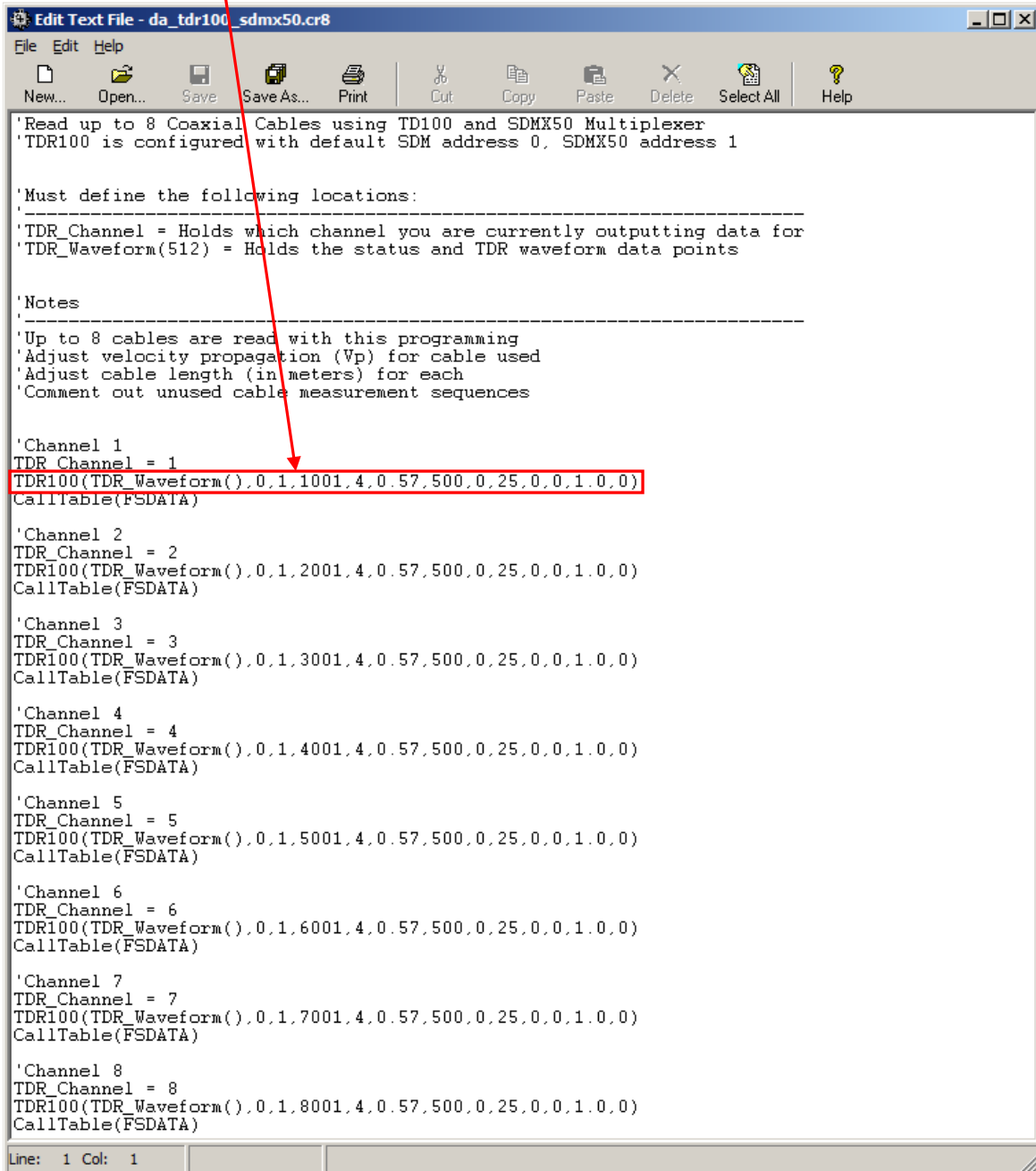
The last step is to customize the programming being used for the TDR100/SDMX50.

There are several parameters that must be configured for each cable, dependent on the application.

Consult the TDR100 Operators Manual for complete information on the TDR100 instruction and other application information.

Press the gear button to the left of the Data Output option to edit the programming, it will be loaded into MLEditor for modification.

Note the TDR100 instructions for each coaxial cable, 8 in total.



```
Edit Text File - da_tdr100_sdmx50.cr8
File Edit Help
New... Open... Save Save As... Print Cut Copy Paste Delete Select All Help

'Read up to 8 Coaxial Cables using TD100 and SDMX50 Multiplexer
'TDR100 is configured with default SDM address 0, SDMX50 address 1

'Must define the following locations:
-----
'TDR_Channel = Holds which channel you are currently outputting data for
'TDR_Waveform(512) = Holds the status and TDR waveform data points

'Notes
-----
'Up to 8 cables are read with this programming
'Adjust velocity propagation (Vp) for cable used
'Adjust cable length (in meters) for each
'Comment out unused cable measurement sequences

'Channel 1
TDR_Channel = 1
TDR100(TDR_Waveform(),0,1,1001,4,0.57,500,0,25,0,0,1,0,0)
CallTable(FSDATA)

'Channel 2
TDR_Channel = 2
TDR100(TDR_Waveform(),0,1,2001,4,0.57,500,0,25,0,0,1,0,0)
CallTable(FSDATA)

'Channel 3
TDR_Channel = 3
TDR100(TDR_Waveform(),0,1,3001,4,0.57,500,0,25,0,0,1,0,0)
CallTable(FSDATA)

'Channel 4
TDR_Channel = 4
TDR100(TDR_Waveform(),0,1,4001,4,0.57,500,0,25,0,0,1,0,0)
CallTable(FSDATA)

'Channel 5
TDR_Channel = 5
TDR100(TDR_Waveform(),0,1,5001,4,0.57,500,0,25,0,0,1,0,0)
CallTable(FSDATA)

'Channel 6
TDR_Channel = 6
TDR100(TDR_Waveform(),0,1,6001,4,0.57,500,0,25,0,0,1,0,0)
CallTable(FSDATA)

'Channel 7
TDR_Channel = 7
TDR100(TDR_Waveform(),0,1,7001,4,0.57,500,0,25,0,0,1,0,0)
CallTable(FSDATA)

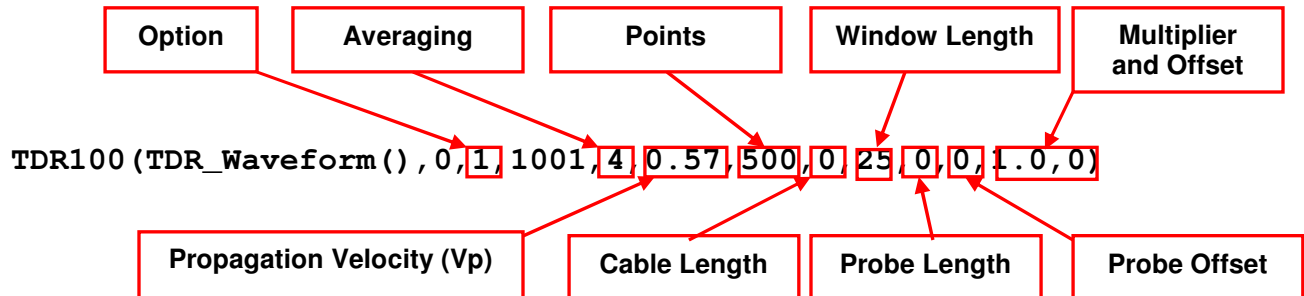
'Channel 8
TDR_Channel = 8
TDR100(TDR_Waveform(),0,1,8001,4,0.57,500,0,25,0,0,1,0,0)
CallTable(FSDATA)

Line: 1 Col: 1
```

The following parameters may need to be modified:

**Number of actual coaxial cables.** This setting is adjust by commenting out the specific TDR100 sections in the programming. Use the apostrophe character to precede the channels to be commented out. See the example following for the format.

**TDR100 Instruction parameters.** These include Propagation Velocity, number of Points, Cable Length, Window Length, Probe Length, Probe Offset, Multiplier and Offset. The instruction syntax is as follows:



Parameter Details:

**Option** - Determines the output of the instruction.

Code	Description
0	Measure La/L (ratio of apparent to physical probe rod length)
1	Collect Waveform values - Outputs reflection waveform values as an array of floating point numbers with a range of -1 to 1. The waveform values are prefaced by a header containing values of key parameters for this instruction (averaging, propagation velocity, points, cable length, window length, probe length, probe offset, multiplier, offset)
2	Collect Waveform plus First Derivative - Returns $(2*n-5)+9$ values where n is the number of waveform reflection values specified by the Points parameter.
3	Measure Electrical Conductivity - Outputs a value that when multiplied by the Multiplier parameter determines soil bulk electrical conductivity in S/m.

**Averaging** – Define the number of waveform reflections averaged by the TDR100 to give a single result. A waveform averaging value of 4 provides good signal-to-noise ratio under typical applications. Under high noise conditions averaging can be increased. The maximum averaging possible is 128.

**Propagation Velocity** – The Vp parameter allows you to enter the propagation velocity of a cable when using the instruction to test for cable lengths or faults. Vp adjustment is not necessary for soil water content or electrical conductivity measurement and should be set to 1.0 for output Option 1, 2, or 3.

**Points** – The Points parameter is used to define the number of values in the displayed or collected waveform (20 to 500). A entry of 251 is recommended for soil water measurements. The waveform consists of the number of Points equally spaced over the Window Length. Contact Canary Systems if more than 500 points are required (up to 2048 may be specified).

**Cable Length** – The Cable Length parameter is used to specify the cable length, in meters, of the TDR probes. If a 0 is entered for the Option parameter, cable length is used by the analysis algorithm to begin searching for the TDR probe. If a 1 or 2 is entered for the Option parameter, cable length is the distance to the start of the collected waveform. The value used for Cable Length is best determined using PCTDR with the Vp = 1.0. Adjust the Cable Length and Window Length values in PCTDR until the probe reflection can be viewed. Subtract about 0.5 meters from the distance associated with the beginning of the probe reflection.

**Window Length** – The Window Length parameter specifies the length, in meters, of the waveform to collect or analyze. The waveform begins at the Cable Length and ends at the Cable Length + Window Length. This is an apparent length because the value set for Vp may not be the actual propagation velocity. For water content measurements, the Window Length must be large enough to contain the entire probe reflection for probes with 20 to 30 cm rods. A Vp = 1 and Window length = 5 is recommended.

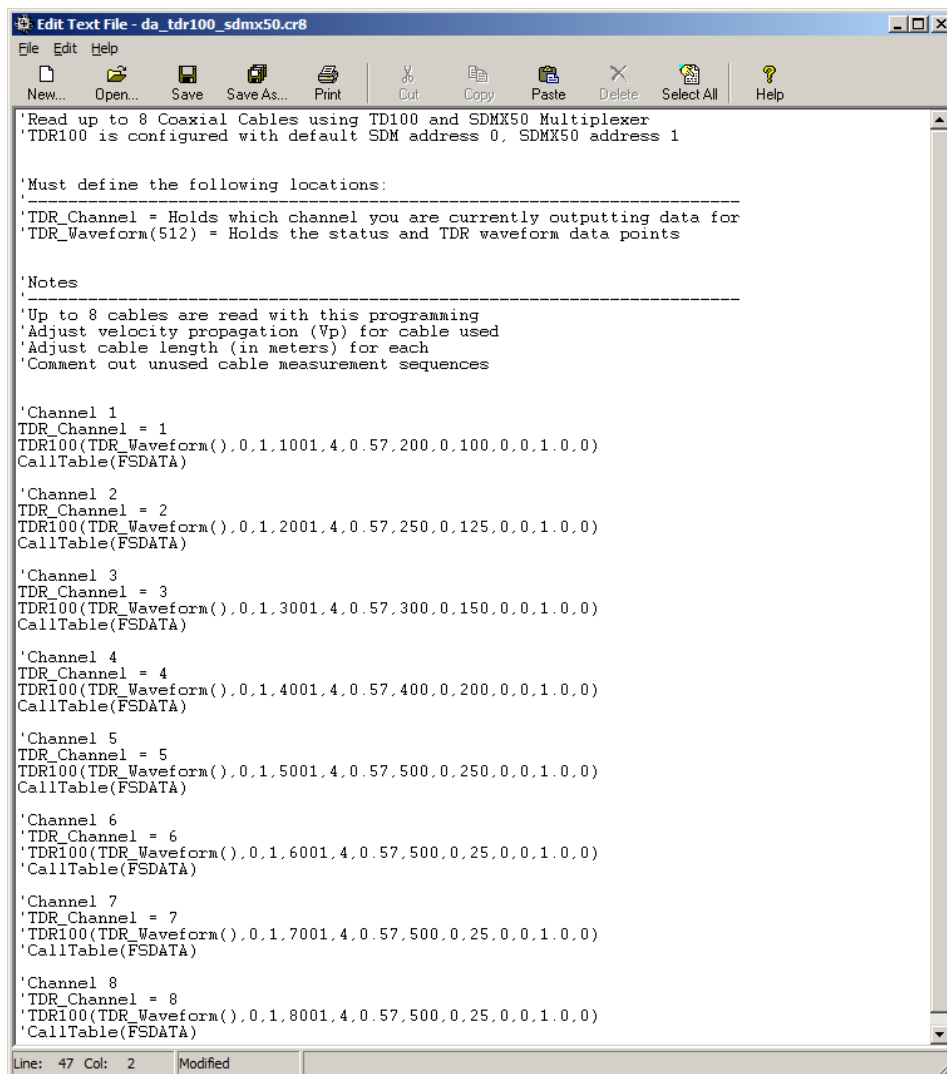
**Probe Length** – The Probe Length parameter specifies the length, in meters, of the probe rods that are exposed to the medium being measured. The value of this parameter only has an affect when Option 0, La/L, is used for the measurement.

**Probe Offset** – The Probe Offset is an apparent length value used to correct for the portion of the probe rods that may be encapsulated in epoxy and not surrounded by soil or other medium being measured. The value of this parameter only has an affect when Option 0, La/L, is used for the measurement.

**Multiplier, Offset** – The Multiplier and Offset parameters are each a constant, variable, array, or expression by which to scale the results of the measurement.

Once all parameters are configured in the MLEditor window press **Save** to update the programming.

For example, the following programming provides for reading 6 probes for deformation measurements with varying points and lengths to provide 0.5m resolution:



```
da_tdr100_sdmx50.cr8
File Edit Help
New... Open... Save Save As... Print Cut Copy Paste Delete Select All Help

'Read up to 8 Coaxial Cables using TDR100 and SDMX50 Multiplexer
'TDR100 is configured with default SDM address 0, SDMX50 address 1

'Must define the following locations:
-----
'TDR_Channel = Holds which channel you are currently outputting data for
'TDR_Waveform(512) = Holds the status and TDR waveform data points

'Notes
-----
'Up to 8 cables are read with this programming
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'Adjust cable length (in meters) for each
'Comment out unused cable measurement sequences

'Channel 1
TDR_Channel = 1
TDR100(TDR_Waveform(),0,1,1001,4,0,57,200,0,100,0,0,1,0,0)
CallTable(FSDATA)

'Channel 2
TDR_Channel = 2
TDR100(TDR_Waveform(),0,1,2001,4,0,57,250,0,125,0,0,1,0,0)
CallTable(FSDATA)

'Channel 3
TDR_Channel = 3
TDR100(TDR_Waveform(),0,1,3001,4,0,57,300,0,150,0,0,1,0,0)
CallTable(FSDATA)

'Channel 4
TDR_Channel = 4
TDR100(TDR_Waveform(),0,1,4001,4,0,57,400,0,200,0,0,1,0,0)
CallTable(FSDATA)

'Channel 5
TDR_Channel = 5
TDR100(TDR_Waveform(),0,1,5001,4,0,57,500,0,250,0,0,1,0,0)
CallTable(FSDATA)

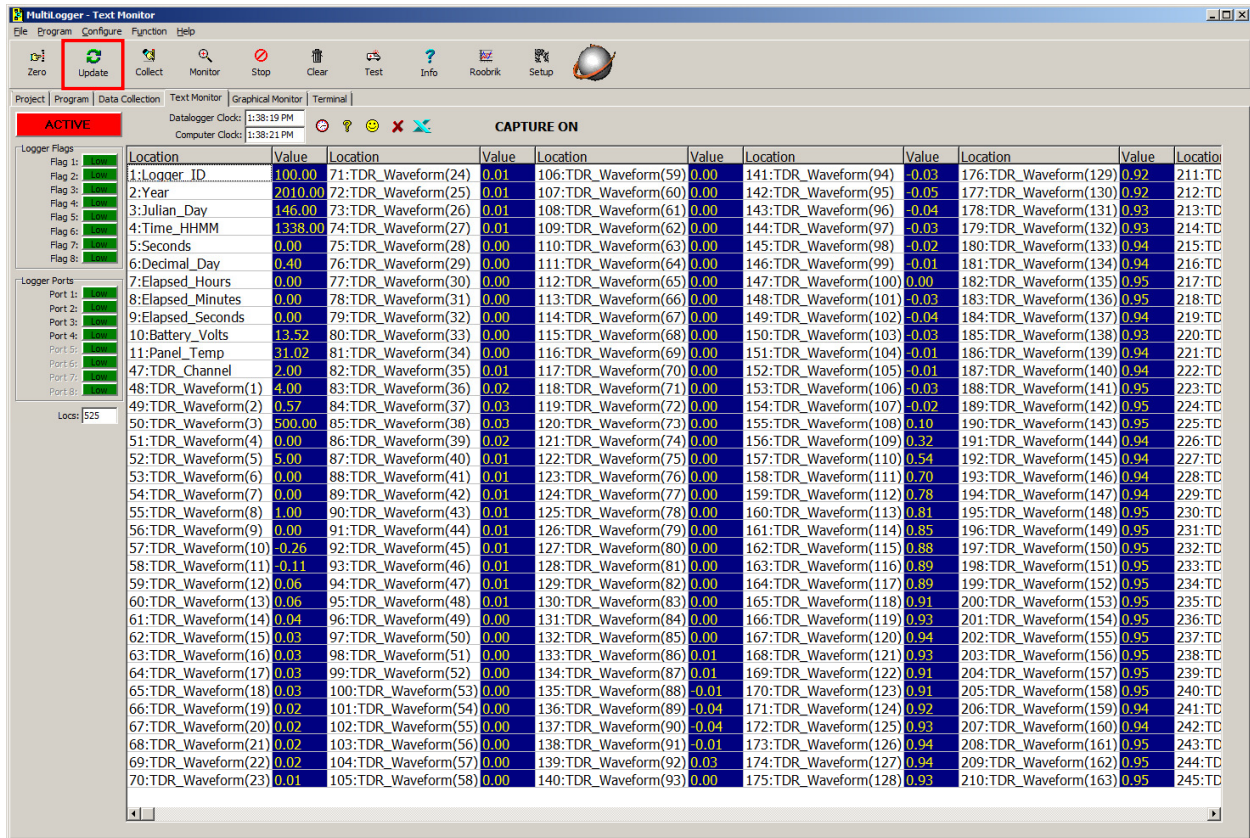
'Channel 6
'TDR_Channel = 6
'TDR100(TDR_Waveform(),0,1,6001,4,0,57,500,0,25,0,0,1,0,0)
'CallTable(FSDATA)

'Channel 7
'TDR_Channel = 7
'TDR100(TDR_Waveform(),0,1,7001,4,0,57,500,0,25,0,0,1,0,0)
'CallTable(FSDATA)

'Channel 8
'TDR_Channel = 8
'TDR100(TDR_Waveform(),0,1,8001,4,0,57,500,0,25,0,0,1,0,0)
'CallTable(FSDATA)

Line: 47 Col: 2 Modified
```

Press **Update** on the Logger form to create the update program, download it to the logger and start the Monitor. A sample view of an activate Monitor session is shown.



Note: When using Option 1 to output raw data, typical when using the TDR100 for deformation monitoring, the waveform data in the TDR\_Waveform array is preceded by several instruction parameters, as follows:

- TDR\_Waveform(1) – Averaging configuration.
- TDR\_Waveform(2) – Propagation Velocity (Vp).
- TDR\_Waveform(3) – Number of Points.
- TDR\_Waveform(4) – Cable Length.
- TDR\_Waveform(5) – Window Length.
- TDR\_Waveform(6) – Probe Length.
- TDR\_Waveform(7) – Probe Offset.
- TDR\_Waveform(8) – Multiplier.
- TDR\_Waveform(9) – Offset.

The waveform data follows beginning with array position (10).