

MLT-1000 Multiple Loop Tester

MLT-1000 User Manual

DRAFT

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1 Overview

The Excel Technology Co MLT-1000 is a portable field service device for in-pavement loop analysis. It is capable of measuring loop inductance, DC series resistance, Q performance factor and loop resonant frequency for a group of up to eight in-pavement loops. It can also detect open and short circuit conditions. The MLT-1000 is based on Excel Technology Co's LTM-100 basic loop tester. The MLT-1000 includes additional switching circuitry that allows up to eight in pavement loops to be measured simultaneously. The device is also capable of measuring loops while traffic is flowing by filtering out vehicles from the measurements. The device is powered and controlled by accompanying PC software via a USB connection. The software allows the user to easily log and save loop data and store it along with relevant site information.

1.1 Terminology

In-pavement induction loops can be characterised by their inductance and DC resistance. The overall sensitivity of the loop is measured by a performance factor Q.

Inductance is a property of a conductor that opposes a change in current. Inductance is measured in Henries (H), but is commonly displayed in Microhenries (μH). Inductance depends on the size, number of turns, configuration of the loop, length of the feeder cable and environmental factors (e.g. steel reinforcement in road, temperature).

DC series resistance is a property of a conductor that opposes current flow. The resistance of a wire depends on its material, cross-sectional area and length. Therefore, an inductive loop using thin cable with a large number of turns and a long feeder cable is likely to have a high DC series resistance.

The Q performance factor of a loop is effectively a relationship between the inductance of a loop and the resistance/impedance of the feeder cable. The Q-factor is calculated as:

$$Q = \frac{2 \times \pi \times \text{frequency} \times \text{Inductance}}{\text{resistance}}$$

The higher the Q-factor, the more sensitive the loop is. Therefore, if the resistance of the loop and feeder cable is large, then the inductance must be large to maintain high sensitivity. For vehicle detection, the Q-factor of a loop should be in the range below for the corresponding frequency ranges:

Q-factor = 5 to 50 for Frequency < 60 kHz

Q-factor = 3 to 50 for Frequency \geq 60 kHz

For reliable vehicle classification or identification, the Q-factor should be in the range 15 to 50.

1.2 Physical Layout

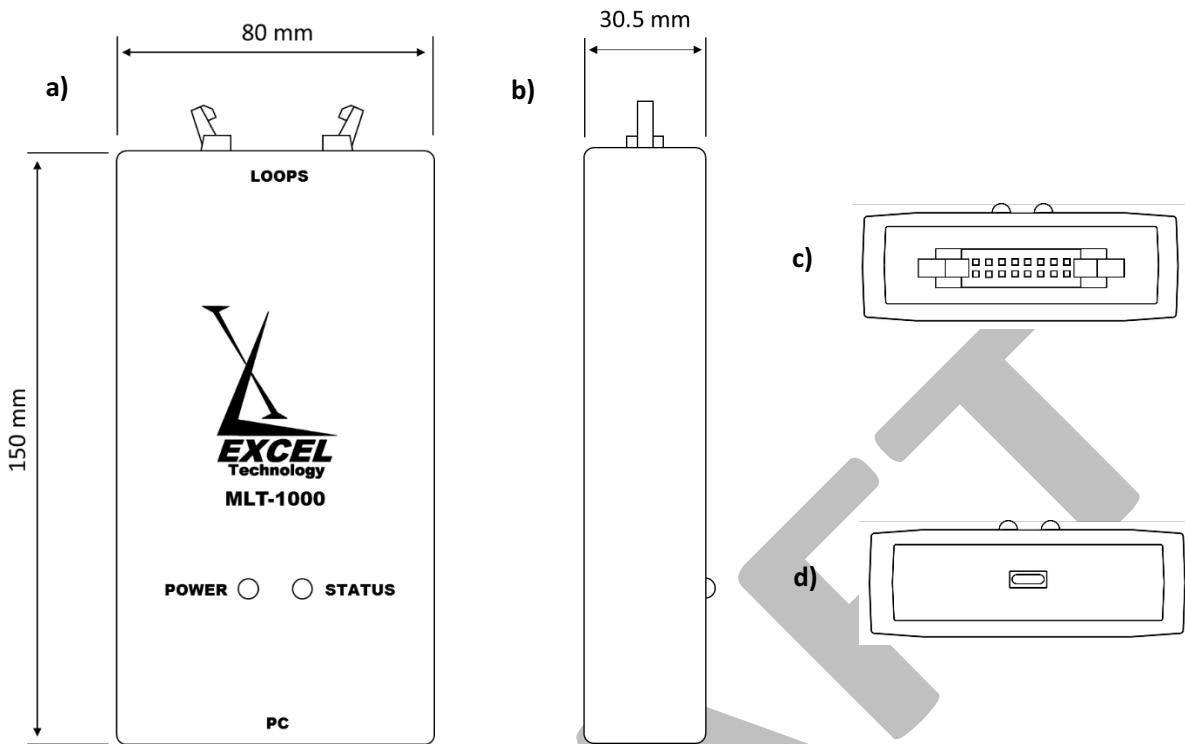


Figure 1.0: a) Top face, b) side face c) Loop end face d) PC end face.

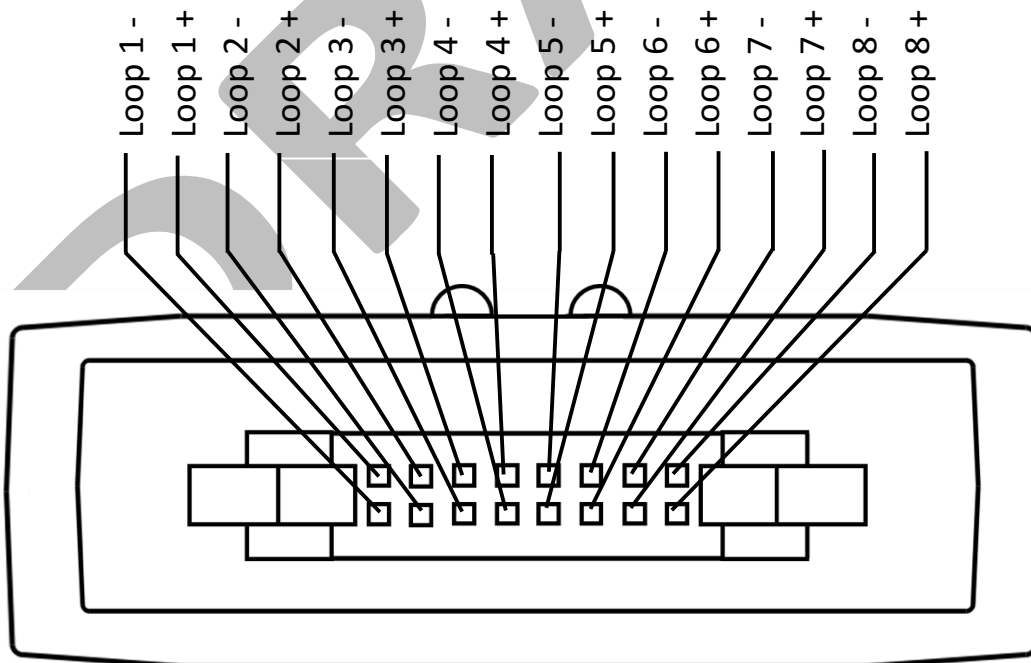


Figure 1.1: IDC connector pin layout.

The MLT-1000 has a micro-USB connector (Figure 1.0 d)) for connecting to a PC and an IDC16-latched connector (Figure 1.1). The MLT-1000 comes supplied with a 16-way twisted pair flat ribbon cable that interfaces with the IDC16 connector and is used to connect up to eight loop feeder cable pairs to the device via a loop termination panel (Figure 1.2). The MLT-1000 has provision for adapter boards which allow the device to be used with other companies' loop products.



Figure 1.2: Excel Technology Loop Termination Panel.

1.3 Usage

1.3.1 Connecting to the MLT-1000

The device is powered and controlled by accompanying PC software via a USB connection. The device automatically powers on and initialises when plugged into a USB port of a PC. Similarly, unplugging the device will cut the power and turn it off. The red Power LED, indicates whether power is being supplied to the device.

When connecting the MLT-1000 to a PC for the first time, it may be necessary to install additional device-drivers. If driver installation does not happen automatically, they can be manually downloaded and installed from:

<http://www.ftdichip.com/Drivers/VCP.htm>

Once the drivers are installed, the device can be accessed through the Multiple Loop Tester Interface software. To connect to the device, select the serial port corresponding to the MLT-1000, it will likely be the one with the highest number (most recently connected). The description will read "USB Serial Port". Click *Connect* to connect to the device (Figure 1.3). The status LED on the MLT-1000 will begin to flash, indicating that the device has successfully connected to the PC.

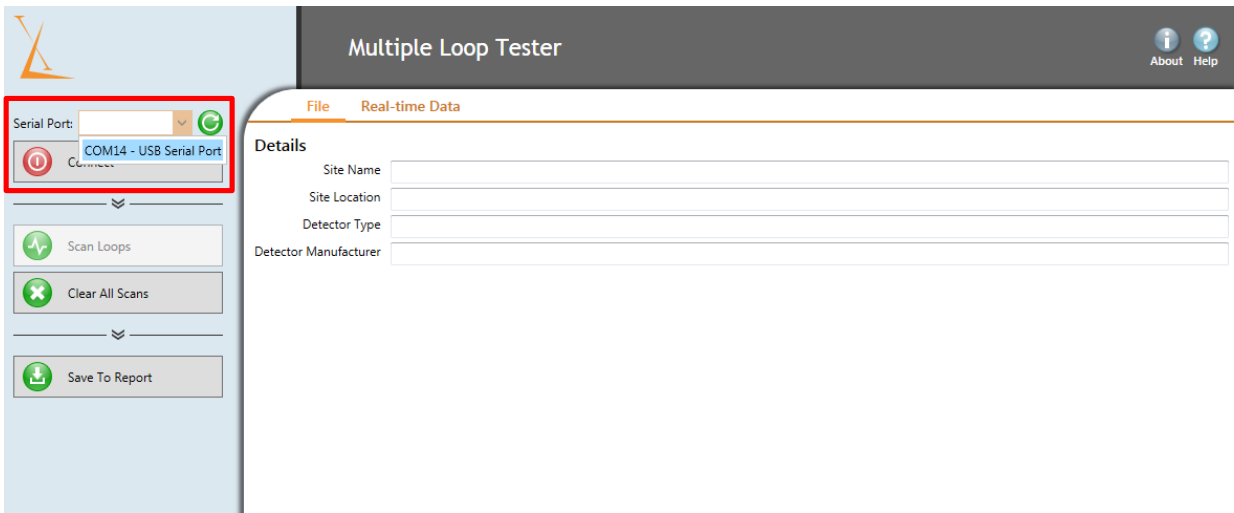


Figure 1.3: Selecting the appropriate COM port.

1.3.2 Scanning Using the MLT-1000

Before performing a scan the site name, site location, detector type and detector manufacturer can be entered. This metadata will be included when exporting the loop data to the report.

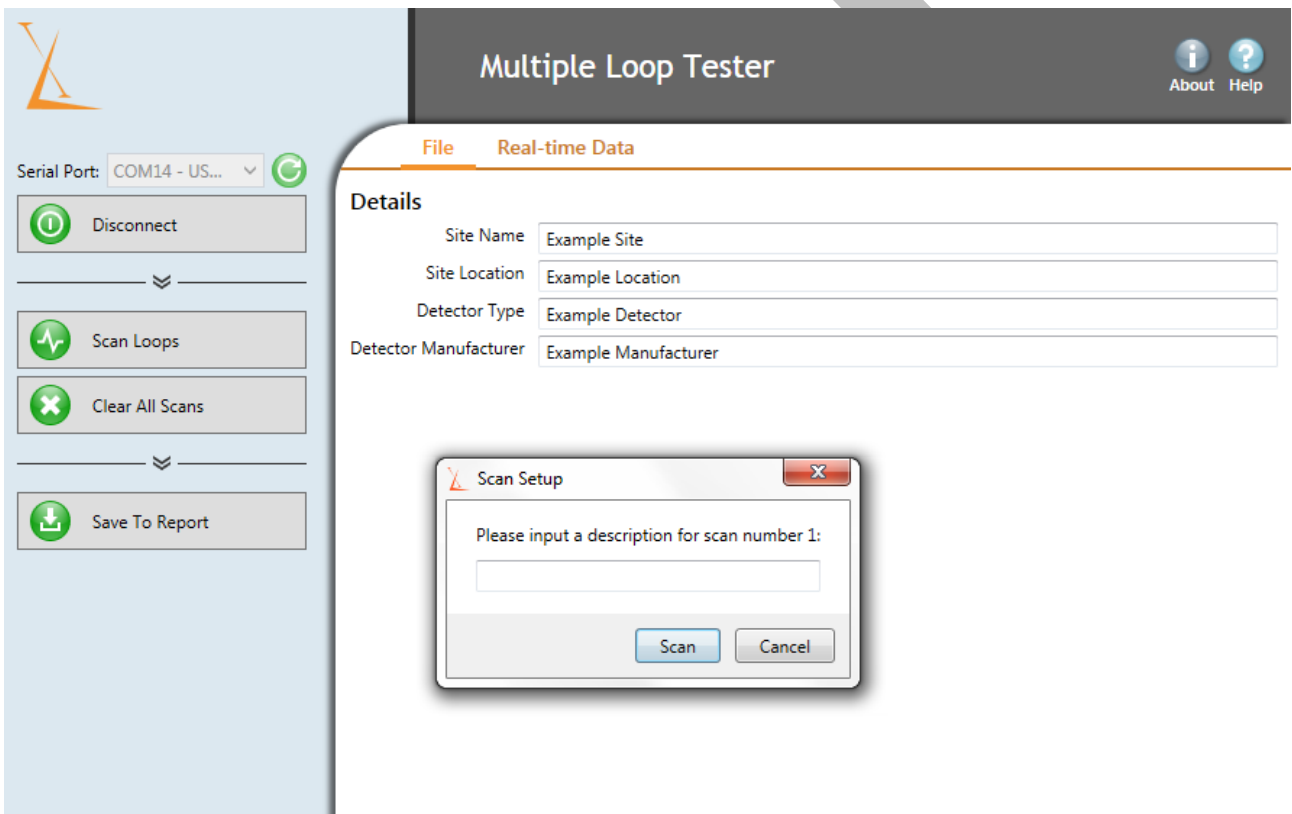


Figure 1.4: Scan description dialogue box.

Once the desired loops are connected to the device, to initiate a scan, click the *Scan Loops* button. The user will be prompted to enter a scan description (Figure 1.4) then a five second scan of all connected loops will begin (Figure 1.5). Any empty loop channels will read *Open Circuit*.

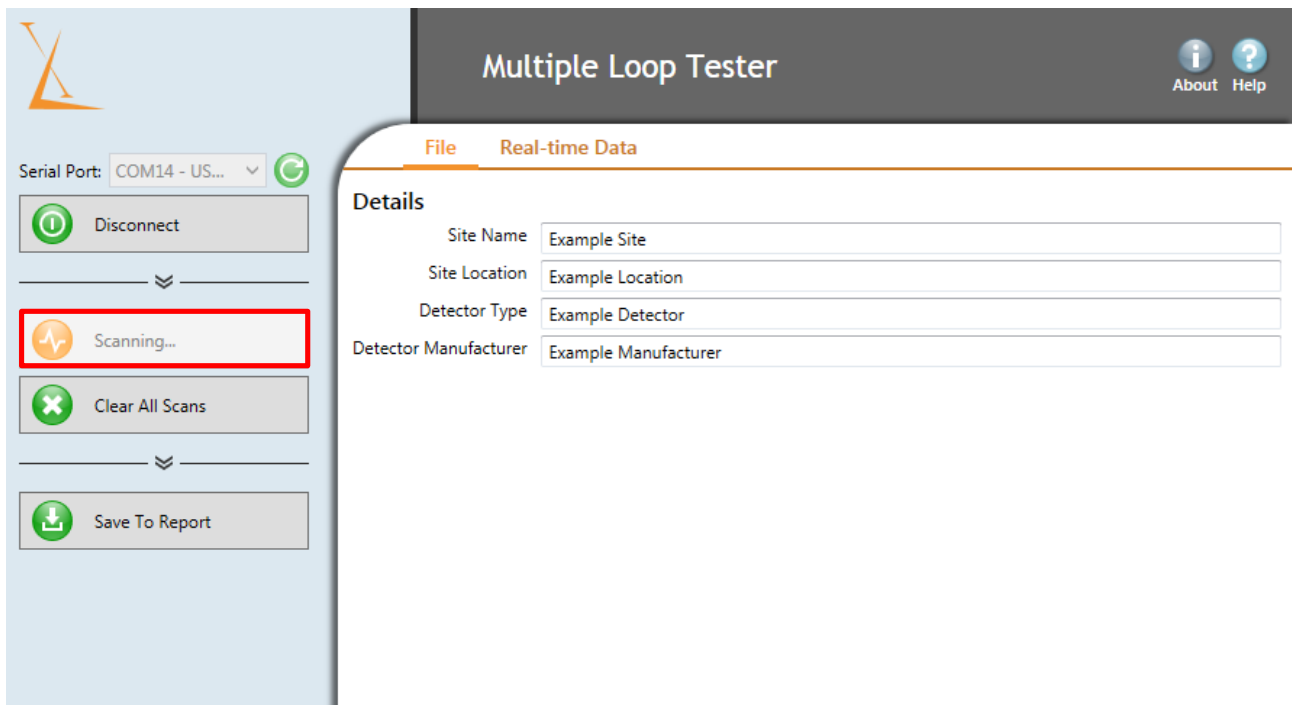


Figure 1.5: MLT Interface during a scan.

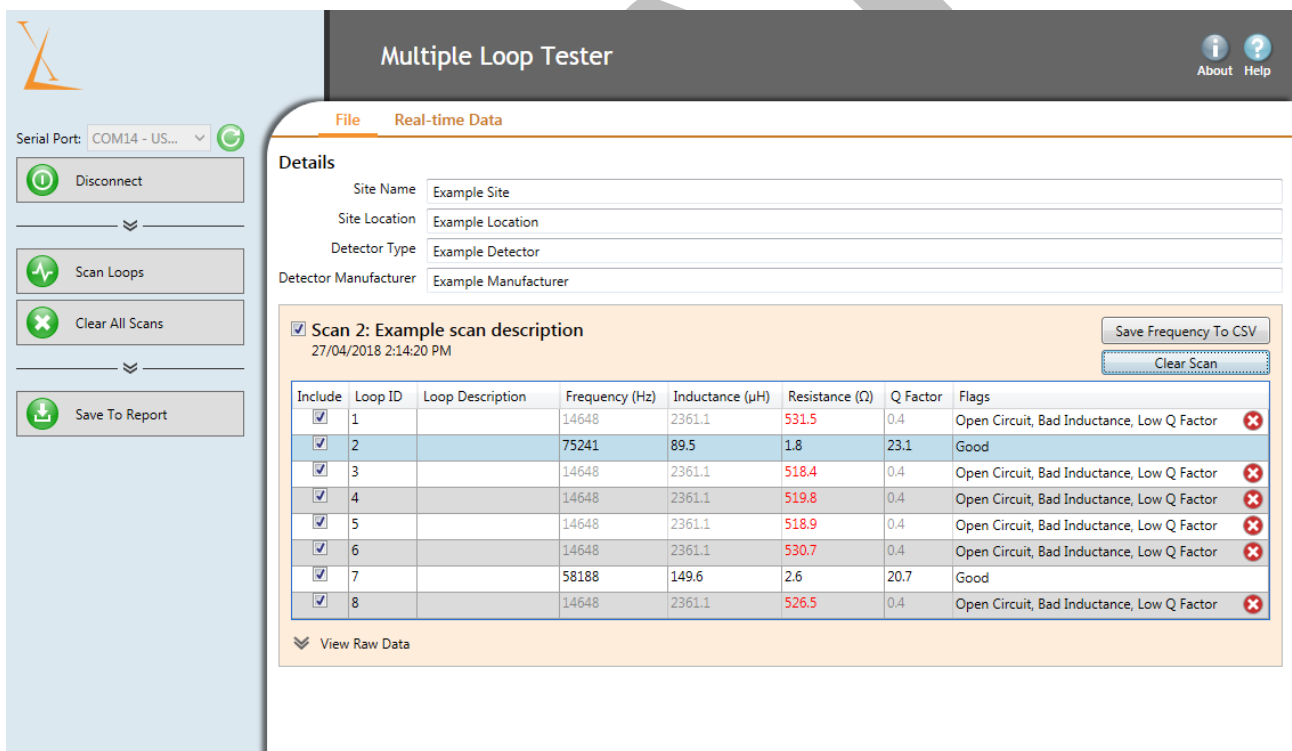


Figure 1.6: MLT Software Interface.

The MLT-1000 rapidly switches between all eight channels and measures frequency and resistance sequentially. The status LED will flash each time all eight channels have been scanned. This process is repeated 30 times per second for five seconds. Figure 1.6 shows the output after a single scan.

1.3.3 Configuring Data

If any data should not be included in the exported report, the "Include" checkboxes can be used to select whether or not it should be included. To discard an entire scan, the checkbox next to the scan name can be deselected. To exclude single data rows, use the checkbox on each row (see Figure 1.7).

Scan 2: Example scan description
27/04/2018 2:14:20 PM

Save Frequency To CSV

Clear Scan

Include	Loop ID	Loop Description	Frequency (Hz)	Inductance (μ H)	Resistance (Ω)	Q Factor	Flags
<input checked="" type="checkbox"/>	1		14648	2361.1	531.5	0.4	Open Circuit, Bad Inductance, Low Q Factor ✘
<input checked="" type="checkbox"/>	2		75241	89.5	1.8	23.1	Good
<input checked="" type="checkbox"/>	3		14648	2361.1	518.4	0.4	Open Circuit, Bad Inductance, Low Q Factor ✘
<input checked="" type="checkbox"/>	4		14648	2361.1	519.8	0.4	Open Circuit, Bad Inductance, Low Q Factor ✘
<input checked="" type="checkbox"/>	5		14648	2361.1	518.9	0.4	Open Circuit, Bad Inductance, Low Q Factor ✘
<input checked="" type="checkbox"/>	6		14648	2361.1	530.7	0.4	Open Circuit, Bad Inductance, Low Q Factor ✘
<input checked="" type="checkbox"/>	7		58188	149.6	2.6	20.7	Good
<input checked="" type="checkbox"/>	8		14648	2361.1	526.5	0.4	Open Circuit, Bad Inductance, Low Q Factor ✘

View Raw Data

Figure 1.7: MLT software scan output.

Each loop can optionally include a description. To add a description, click the empty box in the "Loop Description" column and enter a value. Press the "Enter" key or click out of the box in order to save the value. This value will then be exported along with the full report. This may be used to add identifying information to individual lanes – for example "Southbound 1". The *Flags* column indicates if a loop is faulty.

1.3.4 Removing Outlier Data (Optional)

If a vehicle is present over a loop during a scan, this may result in the data being skewed. In normal cases the software is able to automatically filter out vehicle events to prevent this. If in some extreme case this is unsuccessful, these samples can be filtered manually (see Figure 1.8).

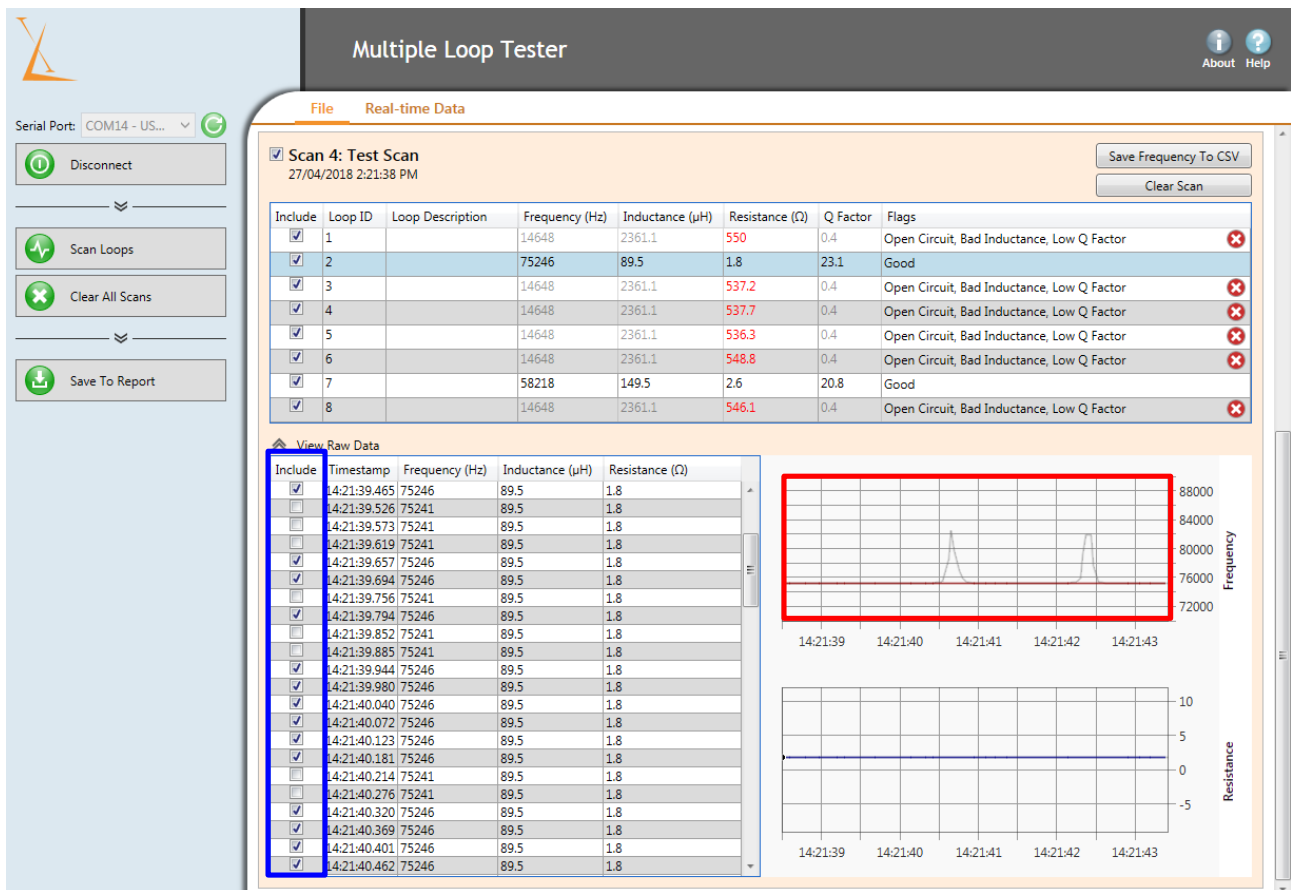


Figure 1.8: Scan outlier selection.

To do this, select the loop that requires manual filtering, then click the *View Raw Data* button at the bottom of the table containing the data. The greyed out data (highlighted red in Figure 1.8) shows where the software has automatically filtered out outliers. The user can include or exclude additional data points using the checkboxes (highlighted blue in Figure 1.8).

1.3.5 Exporting Data

To save the scan results to a report, click the *Save To Report* button. The report is generated as a comma separated value (CSV) file and can be viewed with any text or spreadsheet editor. The user will be prompted to choose a location to save the file and a filename. Select a save location and file name and click *Save*. The contents of the saved file will be all of the data marked for inclusion. If there is no data marked for inclusion, the program will display a warning. Figure 1.9 shows an example of the generated report.

	A	B	C	D	E	F	G
1	Site Name	Example Site					
2	Site Location	Example Location					
3	Detector Type	Example Detector					
4	Detector Manufacturer	Example Manufacturer					
5							
6							
7	Scan Number		1				
8	Scan Description						
9	Timestamp		28:45.6				
10							
11	Loop ID	Loop Description	Frequency	Inductance	Resistance	Q Factor	Flags
12	7		58901	146	9.1	5.93	None
13	6	Example Description	60764	137.2	11.5	4.57	High Resistance, Low Q Factor
14	5		57535	153	4.2	13.09	None
15	4		57157	155.1	3.4	16.19	None
16	3		58366	148.7	7	7.82	None
17	2		57679	152.3	4.8	11.55	None
18	1		57683	152.2	5.6	9.94	None
19	8		58190	149.6	7.2	7.57	None
20							
21							
22	Scan Number		2				
23	Scan Description						
24	Timestamp		28:53.5				
25							
26	Loop ID	Loop Description	Frequency	Inductance	Resistance	Q Factor	Flags
27	8		58546	147.8	8	6.77	None
28	7		58905	146	8.9	6.04	None
29	6		59758	141.9	10.2	5.24	High Resistance
30	5		57530	153.1	4.2	13.09	None
31	4		57153	155.1	3.4	16.19	None
32	3		58318	148.9	6.8	8.01	None
33	2	Example Description	57674	152.3	4.8	11.55	None
34	1		57665	152.3	5.5	10.02	None

Figure 1.9: An example of the generated CSV report.

1.3.6 Saving Raw Frequency Data

As an optional feature, it is possible to save the raw frequency data from a scan to assist in the diagnosis of faulty loops. To save the raw frequency data for a scan, click the *Save Frequency To CSV* button for the desired scan. The user will be prompted to choose a location to save the file and a filename. Select a save location and file name and click *Save*. The frequency file only stores frequency data for a single scan. To save data for multiple frequency scans, each file must be saved separately. The data saved in this file is only frequency data. For metadata such as loop descriptions, please refer to the scan results CSV.

1.3.7 Real-time View

To view the loop data for all eight channels in real-time, click the *Real-time Data* tab. Figure 1.10 shows this view. When the device is connected, this view updates dynamically with real-time loop data. This view can be used to track each loop's frequency in real time. In this mode, the scan rate is reduced to 10 times per second.

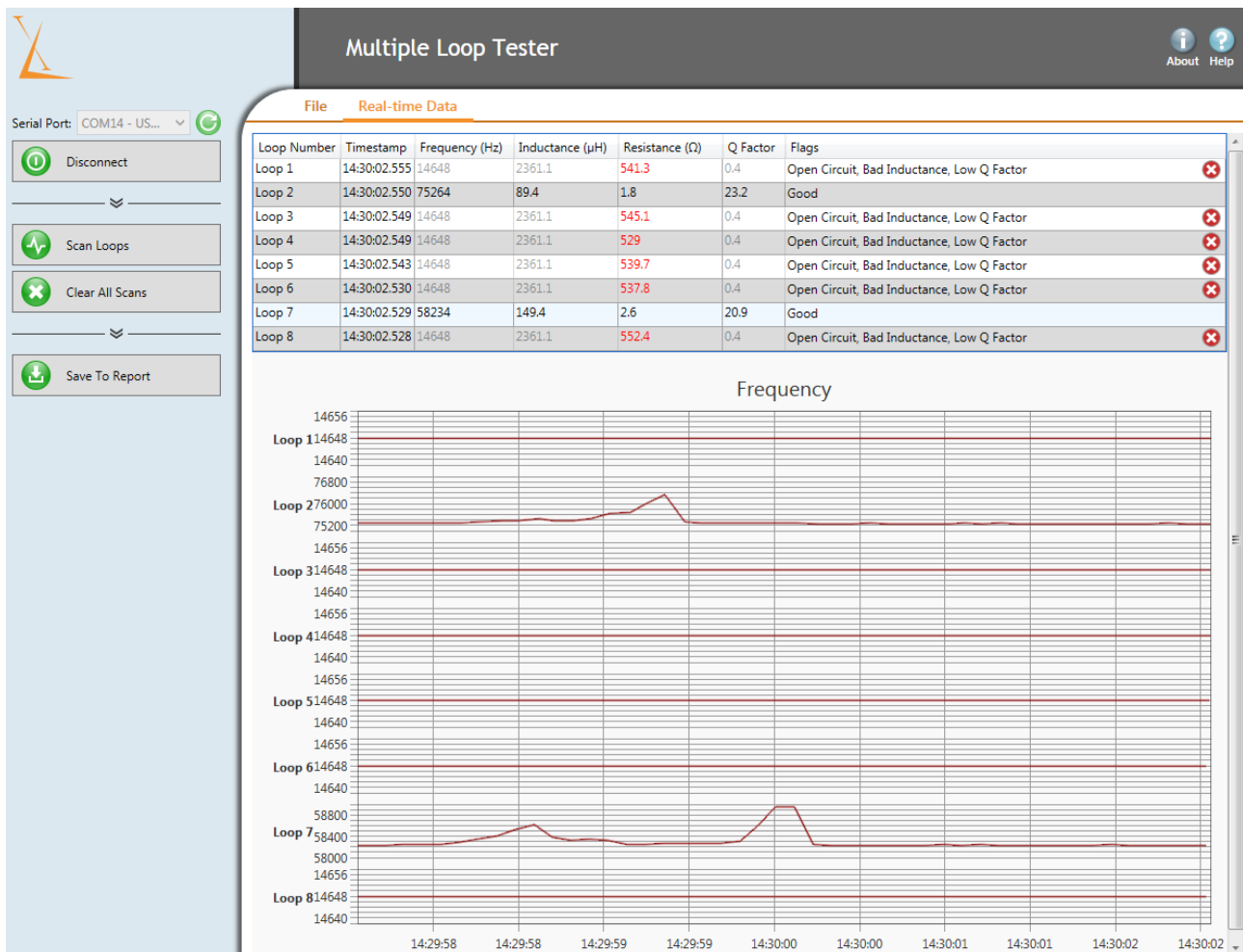


Figure 1.10: Real-time data view.

The real-time data view is for viewing data only, so data cannot be saved. In order to get a snapshot of data, perform a scan instead.

1.3.8 Quick Start Steps

1. Firmly connect one end of the 16 way flat ribbon cable to the loop termination panel with the other end connected to the MLT-1000.
2. Plug the micro-USB cable into the MLT-1000 and connect it to a PC USB port. The red *Power* LED will illuminate, indicating that the device is powered.
3. Open the Multiple Loop Tester Interface and select the device from the list of serial ports (press *Refresh* if the device is not visible). Click *Connect* and the green *Status* LED should flash three times, indicating that the device is connected to the PC.
4. Click *Scan Loops* to initiate a scan. After entering any useful/relevant information about the scan, the device will scan all connected loops (ten times per second for five seconds).
5. At any time the user may save the previously measured data. To do this, click the *Save to CSV* button and a report will be generated in a csv format containing the loop data acquired during that session.