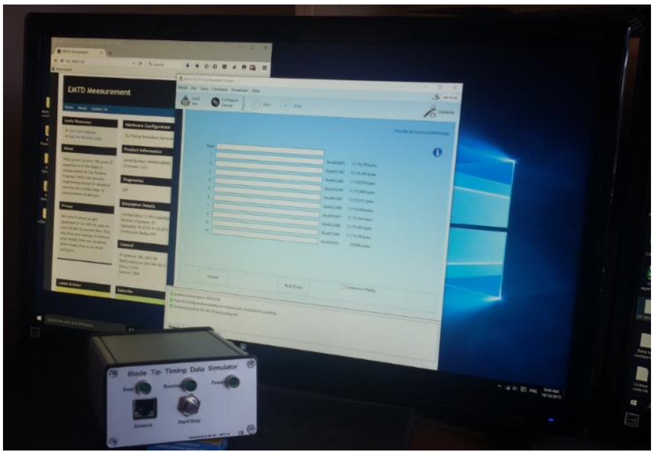
MultiTool Blade Tip Timing Acquisition, Analysis and Data Simulation Software

Acquisition Manual



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1. MultiTool Acquisition Mode

The acquisition mode of MultiTool allows the user to record and monitor in real time timing data taken from one of a range of acquisition systems. This operating mode can interface with the EMTD network acquisition system and the Rotadata BTT PCI card. Note however that MultiTool and the Rolls-Royce software sold by Rotadata are **not** compatible and cannot be installed on the same machine for acquisition due to driver incompatibilities.

Some MultiTool features are licensed separately. If the acquisition component of MultiTool has been licensed then it will be selectable from the Mode menu as shown in Figure 1. If this option is greyed and you believe that you have a valid license for acquisition then please email support@emtd-measurement.com

If the license has less than 30 days before expiry then a warning will be shown in the status area on application start up.

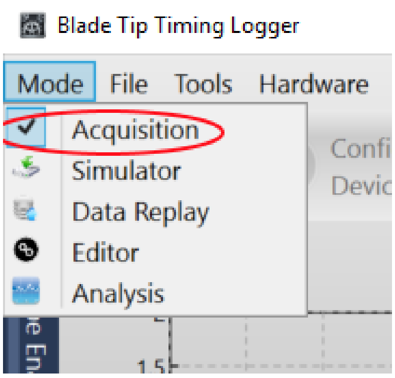


Figure 1 - Switching to Acquisition mode

1.1. Quick Guide to Acquiring and Recording Data

In order to acquire data the following steps must be completed. For information on each step refer to the relevant section of the manual.

- Probes must be connected to the system and the lasers switched on so that blade passing signals are being generated. A valid OPR signal must be connected to the system.

Or

- A simulator is connected and running or the internal simulator is on.

- The acquisition system must be connected to the computer and switched on.

- MultiTool must be in acquisition mode and configured for the type of hardware being used via the below.

- MultiTool must be configured with the correct test vehicle parameters by below.

Once the configuration file has been successfully loaded the Configure Device button will be enabled. The system can now be configured by pressing the Configure Device button.

Once the system has successfully configured the Start Acquisition button will be enabled. The acquisition can now be started by pressing this button and the displays will update as data are received. Pressing the stop button will stop the acquisition system.

The system has a sentry function built in to mitigate against losing data. It does this by always recording data while the acquisition is running (started). Either by logging data directly (logging data) or when not logging via a sentry file. The sentry file is a circular file of fixed size so older data will be overwritten as the file limit is reached and it wraps around. This means that if an event occurs while the acquisition is running but not logging the Sentry button can be pressed to write the data already captured in the sentry system to a logged file as if it were logged by the system in the first place. This also helps prevent huge datasets being recorded at vehicle idle speeds just in case an event occurs. Note the Sentry button should not be pressed until the event is over as during the brief unwrap and writing no data is being recorded.

While acquiring data the Start Logging button will become enabled. To start logging data to disk press this button. The Sentry system will now be disabled and so will the button. To stop the logging press the stop logging button which will re enable the Sentry.

1.2. Loading a configuration file

In order to configure the acquisition a configuration file is required which contains parameters that describe the probe configuration used in the test. This must be a MultiTool standard configuration file and typically there is one per test. If a configuration files has not yet been created then refer to the section on creating a configuration file in the Editor manual (EM100).

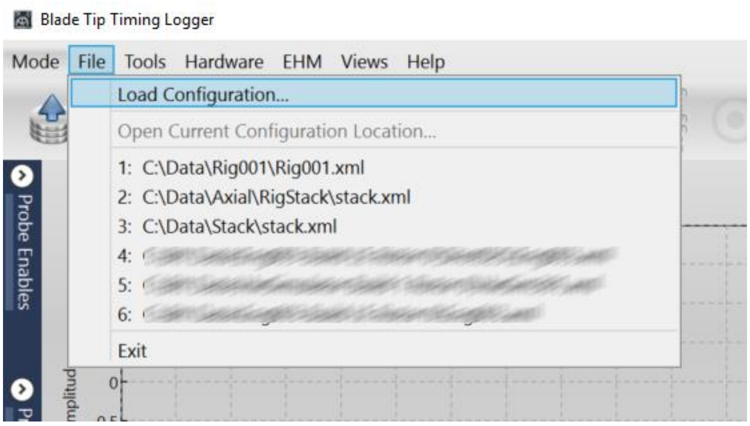


Figure 2 - Loading a configuration file

If the configuration file has been used before then it will appear in the Figure 2 - Loading a configuration file. Click on the file in the list it to load it. Note that the recent file list is different for each mode of the application so if you have loaded the file in the editor it will appear in the recent list for the editor but won't appear in the acquisition list until it has been loaded into the acquisition system once. This is the same for Replay and Analysis modes.

If the configuration file has not been loaded before select *Load Configuration* from the *File* menu and navigate to the configuration file.

1.2.1. Configuration File Location

Before MultiTool will load a configuration file it checks the location of the configuration file against the mode of operation. Any problems found will be reported in the status area at the bottom of the display. While some issues may be minor and are for information only any major issues will halt the process and must be fixed before the system can be configured. For example in Replay mode the configuration file must be in the same folder as the data but for acquisition this would create a recursive folder issue and would make keeping track of data almost impossible. For Acquisition the configuration file must be in the root folder of the test and that folder cannot contain data. If it is in a folder containing data the configuration will not load.

For Acquisition the configuration file must be in the root folder of the test and that folder cannot contain data.

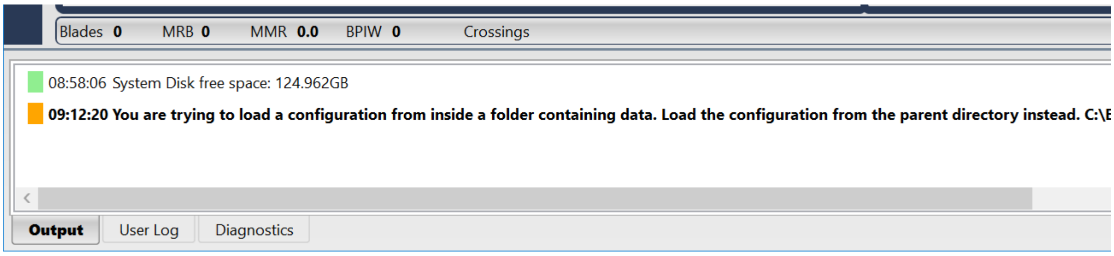


Figure 3 – Configuration File Location Validation

MultiTool has been designed so that it does not constrain the user to a specific data folder or naming convention. It is up to the user to create a folder on the disk and put a configuration file into it.

For example: C:\Data\My First Test\MyTest.xml

This configuration file is termed the root configuration file and a copy of this file will included with any recorded datasets. This copy of the file will be the one used during replay and analysis as the root configuration may need to be changed during a test to reflect hardware changes. In this case EMTD would recommend that a new test and folder structure be used but it is up to the user to decide.

When the acquisition system records data all data will be recorded into a folder under the root configuration and indexed by day and time.

1.3. Hardware Configuration Options

MultiTool can interface to more than one hardware system. Each system needs different configuration so the available options will vary depending on which system is specified. These settings are saved per computer and are not part of the test configuration files.

Extra help is available throughout MultiTool wherever there is an information icon. Hold the mouse cursor over these icons to display useful information.

1.3.1. Figure 4 – Configuring the

Selecting the entry Network101 will specify the EMTD Network hardware and allow the user to configure the system parameters. If the software cannot communicate with the hardware then it cannot configure it.

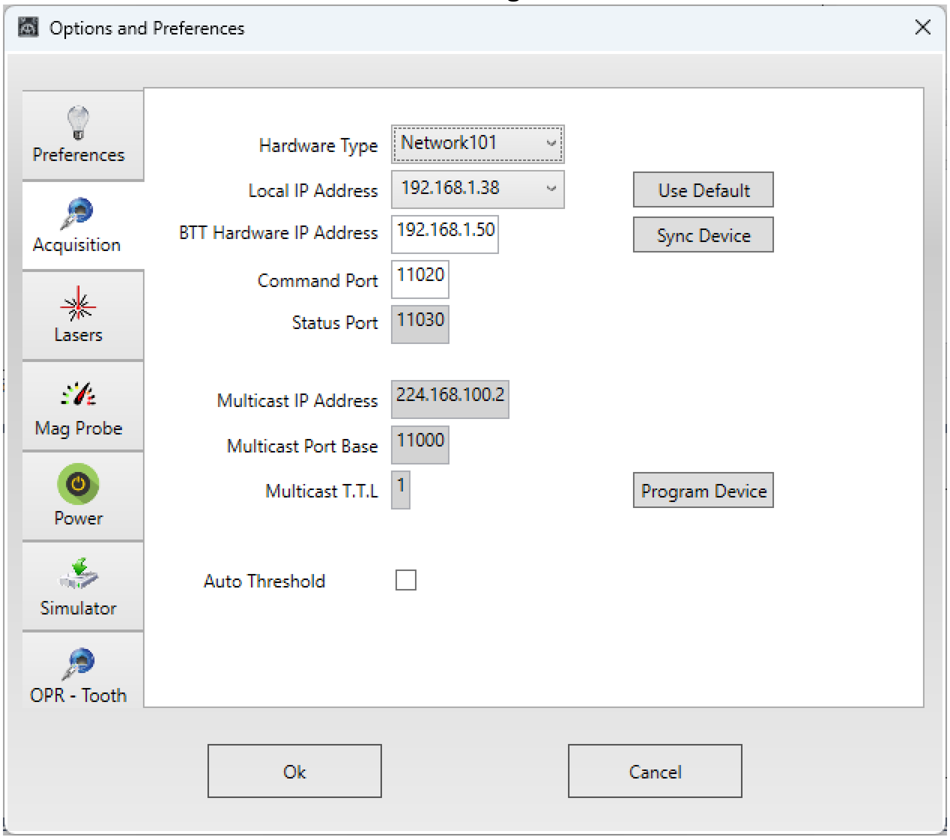


Figure 4 – Configuring the EMTD Network Acquisition Hardware

Local IP Address: If the computer contains a single network adapter then this will be automatically selected. If there are more than one network adapter then the correct one should be chosen from the list. The computer and the hardware must be on the same subnet.

BTT Hardware IP Address: The network address of the acquisition hardware. The default value is 192.168.1.50.

Command Port: The port number on which to send commands to the hardware. This and the IP address are essential in order to send a command to the system. The default value is 11020

Sync Device: Once the IP addresses and command port have been we can synchronise with the device to retrieve the other settings. These are editable and can be set using the Program device button.

Status Port: The port the hardware will send its status to. Not editable but programmable. Default value is 11030

Multicast IP Address: The IP address for the data. Unless there is a very good reason EMTD recommend that this is not changed. Not editable but programmable. Default value is 224.168.100.2

Multicast Port Base: The base port for the data channels. Each channel will transmit data on the multicast address and its own port incrementing from the base port. Not editable but programmable. Default value is 11000

Time To Live: The number of network hops for network TTL. Default value is 1.

Auto Threshold: When this is selected the acquisition hardware will ignore the threshold levels set from the threshold panel and automatically determine the optimal threshold level. As the blade passing frequency approaches 10KHz it may be better to use the manual thresholds.

Program Device: Warning. This feature can permanently program the device. See below

1.3.1.1. Programming the Device

Warning. This feature can permanently program the device. Make sure you know what you are doing before using this feature. It is possible to loose connection with the device by changing these values. If this should happen and the device's web page is not available then the only option is to factory reset the device.

Factory Reset the Device

To do this hold the factory reset button in for between 5 and 10 seconds with the device powered up. Then power the device off and on again. The hardware will revert to its default settings of 192.168.1.50 and Command port 11020 allowing MultiTool to synchronise with it again.

Note the factory defaults for the hardware are:
Acquisition: 192.168.1.50:11020
Simulator: 192.168.1.60:11020
Laser: 192.168.1.70:11020

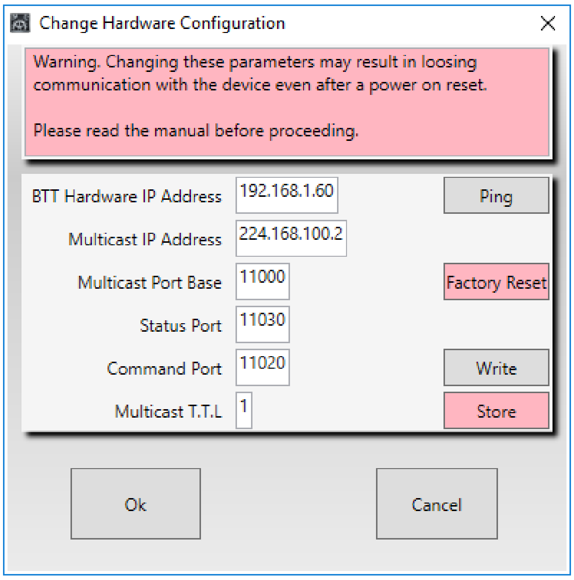


Figure 5 - Programming the Device

The following options are available to program the device. No validation is done on the values entered apart from correct formatting.

BTT Hardware IP Address: The network address of the acquisition hardware.

Multicast IP Address: The IP address for the data. Unless there is a very good reason EMTD recommend that this is not changed. Not editable but programmable.

Multicast Port Base: The base port for the data channels. Each channel will transmit data on the multicast address and its own port incrementing from the base port. Not editable but programmable.

Status Port: The port the hardware will send its status. Not editable but programmable.

Command Port: The port number on which to send commands to the hardware. This and the IP address are essential in order to send a command to the system.

Time To Live: The number of network hops for network TTL.

Ping: To check the device is still on the network.

Factory Reset: If the device is still available on the network a software factory reset will return it to the default settings. If the hardware is configured on a different address then you will lose connection. Switch the device off and on again.

Write: Writes the values to the hardware. This is not permanent and turning the hardware off and on again will revert the hardware back to the programmed values.
Store: Permanently program the current values into the hardware. Values should be written first using *Write*.

1.3.2. Configuring the Rotadata PCI Acquisition Hardware

Selecting the entry Sm301 will specify the Rotadata PCI timing hardware. As his is a PCI card fitted into the PC there is no external hardware configuration required.

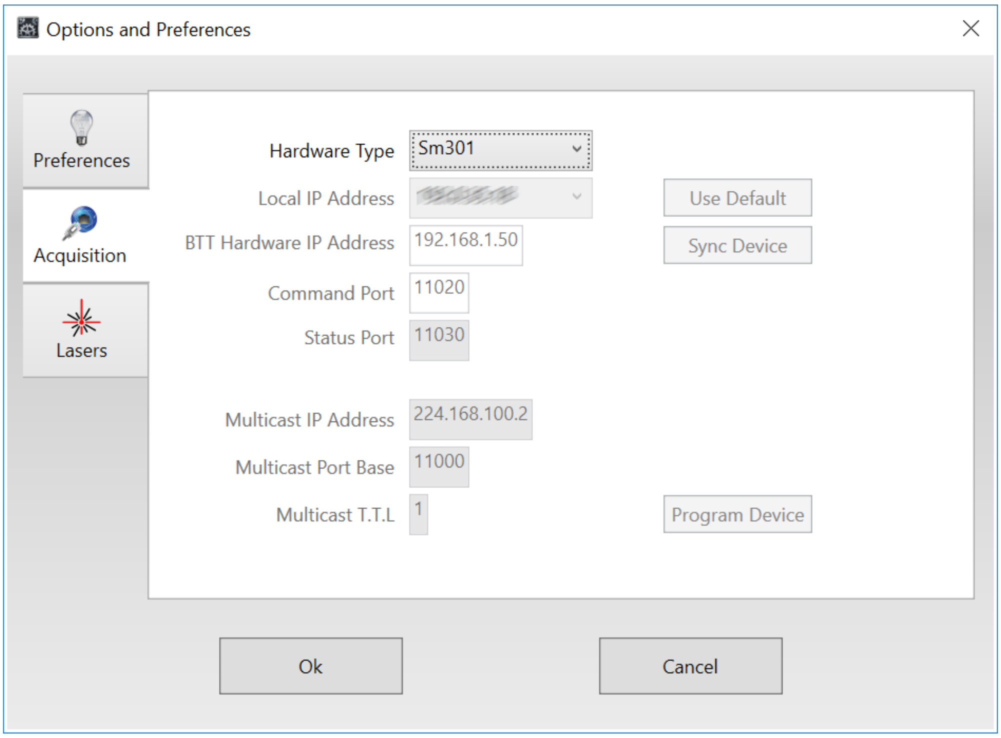
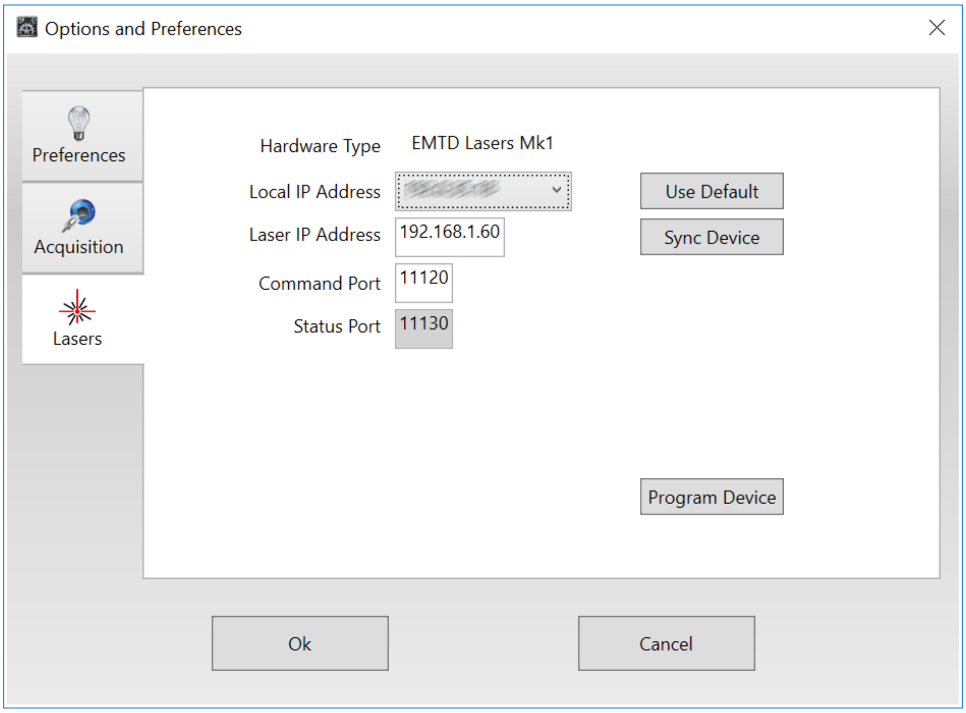


Figure 6 - Configuring the Rotadata PCI Acquisition Card

1.3.3. Configuring the Laser Hardware

Selecting the lasers tab allow the user to configure the EMTD laser hardware. If the software cannot communicate with the lasers then it cannot configure them. Currently only one standard of hardware is supported and this is the EMTD Lasers Mk1



Local IP Address: If the computer contains a single network adapter then this will be automatically selected. If there are more than one network adapter then the correct one should be chosen from the list. The computer and the laser hardware must be on the same subnet.

Laser IP Address: The network address of the laser hardware. The default value is 192.168.1.60.

Command Port: The port number on which to send commands to the laser hardware. The default value is 11120. This and the IP address are essential in order to send a command to the system.

Sync Device: Once the above three values have been entered we can synchronise with the device to retrieve the other settings. These are editable and can be set using the Program device button.

Status Port: The port the hardware will send its status to. Not editable but programmable. Default value is 11130

1.4. Acquisition Display Sections

Figure 7 - Acquisition Display Sections

Once the dataset has been loaded the display will update similar to that shown in Figure 7 - Acquisition Display Sections.

 Extra help is available throughout MultiTool wherever there is an information icon. Hold the mouse cursor over these icons to display useful information.

1.4.1. Disabling Probes for Display (A)

Displays such as the waterfall use data from several probes. If one of these probes is bad or noisy then this data may contaminate any calculations using that probe. For this reason probes may need to be disabled from being displayed but will still be recorded. To enable or disable a probe use the Probe Enables Expander shown below.

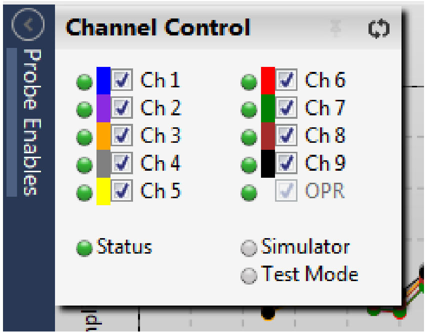


Figure 8 - Disabling Probes for Display

Probes that were not enabled in the configuration (because they don't exist) are greyed out and cannot be changed. Configured probes can be enabled or disabled by checking or unchecking the probe in the display. The OPR probe cannot be disabled.

The configuration file determines which probes are recorded and this panel determines which probes are used for the displays. Probes disabled from this panel by the user are still logged to disk.

Depending on which algorithms are being used a minimum number of probes will be enforced by the application and it will not let you disable a probe if it breaks this rule. In this case you may need to re-enable a disabled probe first in order to disable a different probe.

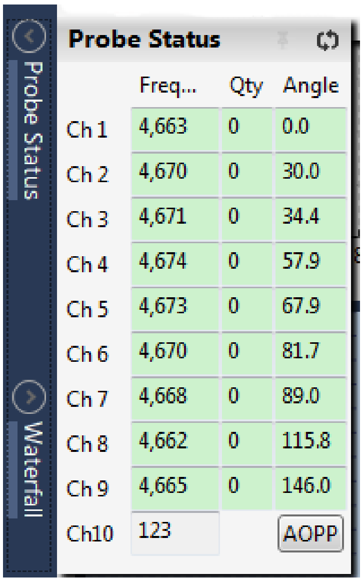
 The colour bands next to the channels correspond to the colours used in the main display for the live stack. (**D**)

 The green LED shows data is being taken for that probe. If the LED turns red there is a problem. For disabled channels the LED is grey.

1.4.2. Probe Status (**B**)

The probe status panel provides information on each probe. Channel 10 is always the Once per Rev (OPR) channel.

If there are problems and the panel is collapsed then the panel indicator itself will flash red.



Probe Status

	Freq...	Qty	Angle
Ch 1	4,663	0	0.0
Ch 2	4,670	0	30.0
Ch 3	4,671	0	34.4
Ch 4	4,674	0	57.9
Ch 5	4,673	0	67.9
Ch 6	4,670	0	81.7
Ch 7	4,668	0	89.0
Ch 8	4,662	0	115.8
Ch 9	4,665	0	146.0
Ch10	123		AOPP

Figure 9 - Probe Status

Blade passing frequency (Freq) – Is a gated sample probe frequency in Hz. This number should be the same for all probes. Noisy probes with surplus pulses will see a higher frequency and dirty probes missing blades will see a lower frequency. The blade passing frequency should be equal to the number of blades multiplied by the speed in Hz. If they are not then the relevant probe frequency will have a red background to indicate a possible problem.

Quality (Qty) - Positive numbers indicate that more pulses than blades were received during a revolution. This can indicate that too much laser power is being used causing multiple reflections. Negative numbers indicate that not enough blade passing pulses were recorded in a revolution and more laser power may be required.

Probe Angle (Angle) – The calculated probe angle (degrees) from the data. This should agree with the angles entered into the configuration editor. If they do not this indicates a problem and the background of any affected probes will be red.

AOPP – (Adjust Once per Rev Probe Position)
This button should rarely need to be used. The software will automatically adjust the OPR position internally for maximum blade detection efficiency. When it does this the following message will appear in the output window.

10:12:50 Switching to alternative blade position

The parameter that AOPP affects is Blade Position in Window (BPIW). Tis value should always be in the range 5-95. It is unlikely but possible that the OPR signal may be exactly coincident with a blade signal. In this scenario the automatic adjustments may not work correctly. If BPIW is zero and data is being taken (with speed working) then press this button. Pressing the button again toggles the effect.

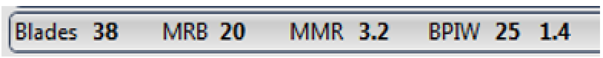


Figure 10 - Adjust Once per Rev Position

1.4.3. Waterfall Display (C)

The waterfall display is an all blade FFT display which scrolls from right to left. The newest data is displayed on the right side and then scrolls across to the left before disappearing. While data is visible on the display various parameters are tracked by the system to aid in calculations.

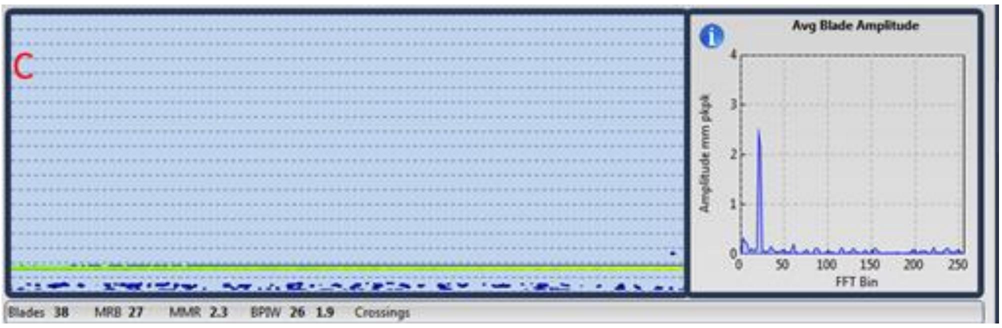


Figure 11 - Waterfall Tracked Response

Tracking

Clicking on a response in the waterfall display will perform a track analysis along the response (green line above). This will attempt to calculate the all blade frequency and amplitude of the response. Note that this is an all blade response so it will be an average value for frequency and amplitude for all blades. If the max to min blade response ratio is high then some blades may be vibrating at significantly higher amplitude. Check this by referring to the MMR section as shown below and in the 1.6 section.

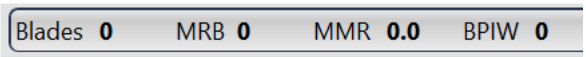


Figure 12 - Max to Min responding blade ratio

1.4.4. Waterfall Options

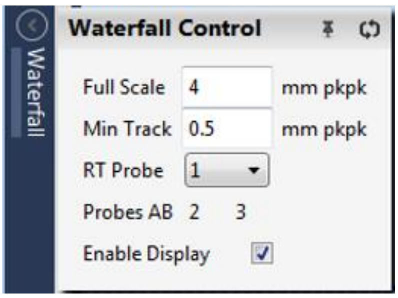


Figure 13 – Waterfall Options

Full Scale - Data at or above this value will be white on the graph.

Min Track - When a response is clicked on the software will track the response to the left selecting the maximum value found with a few bins until the amplitude of the data fall below this value and then the track will end.

RT Probe – The probe number (1-n) whose data is used for the display. If one probe is better than the rest then select this probe for display as it gives a cleaner picture. Disabling a probe will trigger a new probe to be selected if it was being used.

Probes AB – The software determines the best probes for calculation. The probes it uses are shown here and cannot be changed. This is for information only. Disabling a probe will update this display if it was being used.

1.4.5. Speed Display (E)

Figure 14 –Speed composite display.

The speed display is a composite of several different items. The main display is the current speed in Revolutions per Minute (RPM) . The graph in the background is a history of the speed with a full scale equal to the configurations max speed entry. The maximum speed entry is also displayed in the top left corner. The current speed as a percentage of max speed is displayed in the top right corner. The absolute time index of the file is displayed in the bottom left of the display. This is only absolute if the data was recorded with MultiTool and hence a start timestamp is present. If MultiTool does not find this time it will revert to 1st Jan 0001. Details of how to insert a start timestamp can be found in the Editor Manual.

1.4.6. User Logging Panel (F)

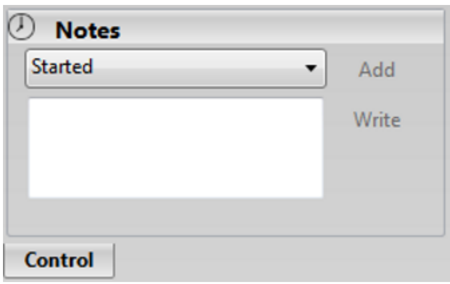


Figure 15 – User Logging Panel

During the recording of data user comments or notes can be entered here. For example the comments may refer to an event or a time or a deviation from a scheduled manoeuvre. They could be a reference to a schedule item in the test schedule. A predefined list of comments is available from the drop down menu and can be changed by editing the file PredefinedComments.xml in the *Bin* directory of the installation folder. Pressing *Add* will add the selected phrase to the window. Alternatively you are free to type whatever you want in the window. Pressing *Write* will write the comment to the log file UserComments.xml in the recording directory. This data is also displayed when replaying data.

1.4.7. Live Blade Stack (D)

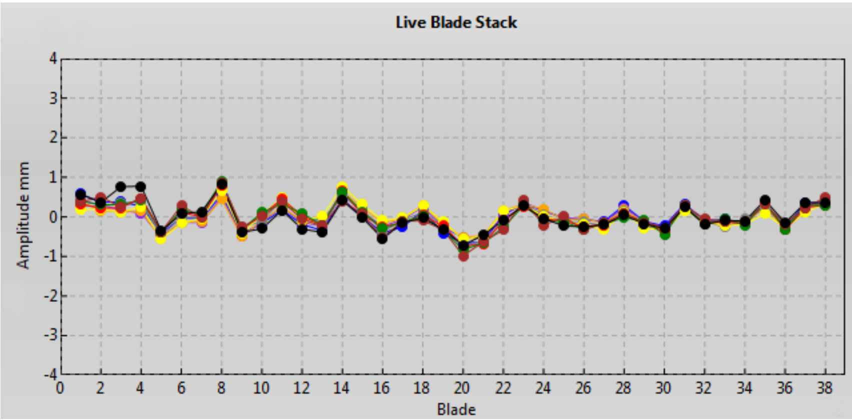


Figure 16 - Live Blade Stack display

The live stack display is a real time blade position indicator. A nominal DC position for each blade, per probe is calculated from the data. This display is very useful for detecting shifts in blade positions due to vibration and possibly FOD. It should be used in conjunction with the waterfall display.

The colour of the probe data matches the colour used in the Figure 8 - Disabling Probes for Display (A).

The pattern of blades from each probe should always be on top of each other as shown above. A shift of pattern for one or more probes to the left or right indicates a problem with the setup. See the section 1.6

The display's full scale is set from the Figure 13 – Waterfall Options. The waterfall display cannot be over ranged as this simply increases the colour value used for amplitude so full scale should be set to ensure that the live stack display is correctly ranged.

1.5. Channel Threshold Voltage (G)

In order to capture one pulse per blade the acquisition hardware allows for the input voltage threshold to be set. This can be done using the Thresholds panel shown below.

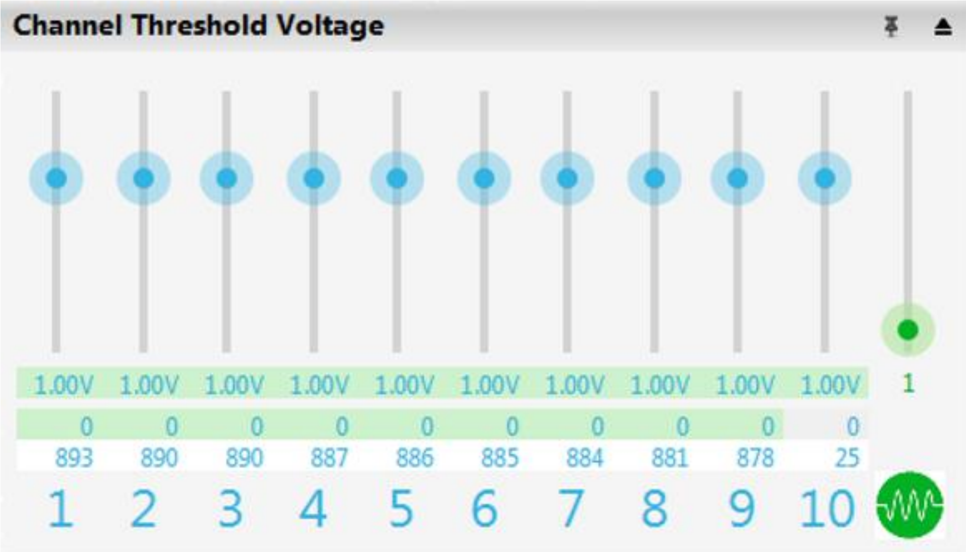
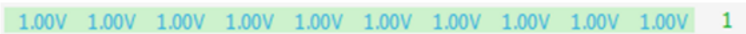
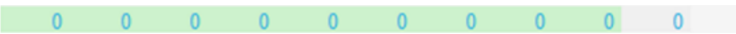


Figure 17 - Threshold Panel

This panel allows the input voltage for each hardware channel to be set between +/- 2.5 Volts using a slider. If the acquisition hardware supports selectable monitor channels then the green slider on the right can be used to select which input channel is routed to the monitor point. Mouse Tool Tips are available on each section to help identify what each set of numbers mean. The thresholds can only be adjusted when the acquisition is running.



The top set of numbers is the current threshold value for each channel as reported by the acquisition hardware and the same for the monitor channel. If this value has a green background (as shown) then the status reported by the hardware matches the requested value from the slider. If the background is red then the slider value and the hardware actual value do not match. It is normal for the values to momentarily go red when the slider is moved as the hardware needs to make adjustments and report back status. If the number goes red and stays red then the hardware may have encountered a problem and should be restarted.



The second set of numbers is a direct copy of the blade passing frequency from each probe taken from the Figure 9 - Probe Status. See that section for further information.

The bottom set reflects the current state of the input buffers for each channel. If the input buffer levels are constant then no data is being received. These numbers are very useful in determining the best threshold levels for a probe and whether data is being received or not.

⏏ The threshold panel and laser panels can be moved around inside the main window just like the other panels. However these two can also be given a window of their own and moved outside of the main window. Pressing this button will do this and closing the resulting window will reverse the effect.

To move multiple sliders at once hold the control key and adjust one of the sliders with the mouse. Note that ALL sliders to the left of the adjusted slider will move to the new value. All sliders to the right will remain the same.

1.6. Laser Power Control

Warning: Personnel should **not** be in the cell when the vehicle is operating and the lasers are on. If this is the case then it is up to the operator's organisation to conduct a laser safety review and put extra interlocks in place if required.

When using the EMTD laser system the intensity of the lasers can be adjusted from the laser control panel. Clicking the mouse on the on\off switch will switch the laser box to active. Desired laser values for each channel are set using the sliders with the actual laser value shown at the bottom of the slider. When these two don't match the actual value will have a red box around it. This is normal during the small period between requesting a new value and the laser adopting that value.

To move multiple sliders at once hold the control key and adjust one of the sliders with the mouse. Note that ALL sliders to the left of the adjusted slider will move to the new value. All sliders to the right will remain the same.

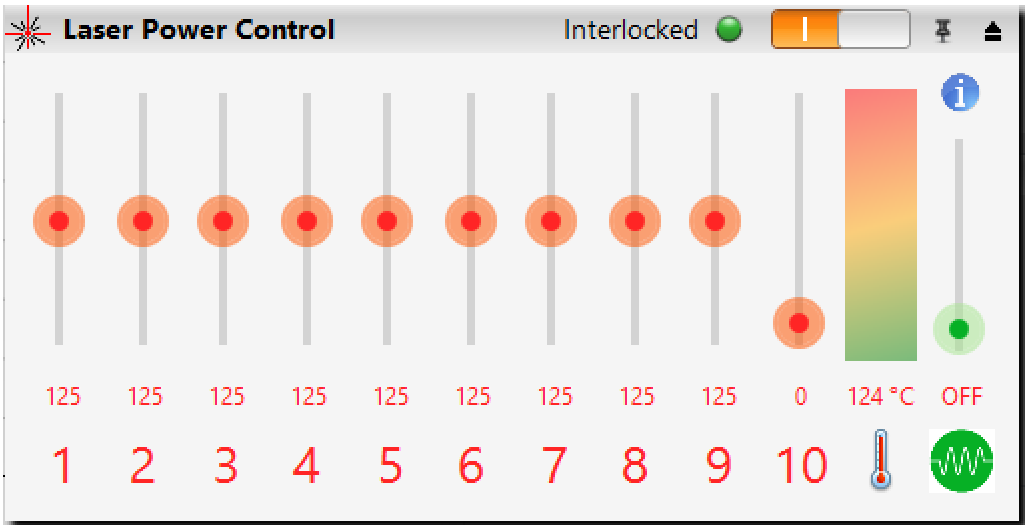


Figure 18 - Laser Power Control

If the sliders controls are grey or won't move then the software can't communicate with the lasers. In this case go to the options and check that on the laser tab that it is possible to Sync with the Laser hardware.

Interlock – The interlock light is initially red but will turn green when the vehicle speed is above a desired level. For laser safety the lasers cannot come on unless rotation is detected via the Once per Revolution signal into the acquisition. The minimum speed required to enable the lasers is 300RPM. However, if the system is using a derived OPR then the lasers need to be on so that the system can derive the OPR. This means we have to disable the interlock feature.

To do this a laser risk assessment should be done in accordance with the local health and safety laws to protect personnel from any possible laser injury. If this has been done and it is deemed safe to proceed then the system can be started with the laser interlocks disabled.

Using a shortcut to MultiTool.exe. In the shortcut target add the word nointerlock. For example

C:\Users\...\MultiTool.exe nointerlock

When operated in this mode the user will have to confirm it is safe to proceed each time the Acquisition Mode is used.

Communications Fail Safe – Even when the interlock conditions are met the laser system will only enable the lasers while in constant communication with the PC running MultiTool. This is in case the computer fails or the cables between the two are damaged. In the event of a communications loss between the two the laser system will automatically shut down after approximately 20 seconds. If it enters this mode a warning message will be shown in the status area.

Laser Monitor Channel – This functionality is intended to be used during the build process as a way of checking the probe and object under test prior to moving to the test stand. Changing this setting allows the returned light level for a specific channel to be monitored via the Signal Strength BNC connection on the front panel. The level will depend on the laser setting, the distance and the reflectivity of the blade. It is a good indication of how well the probe will perform in service.

1.7. Tacho Control Panel

EMTD Measurement also supply Tacho conditioning equipment. This equipment is controlled via the control panel shown below.

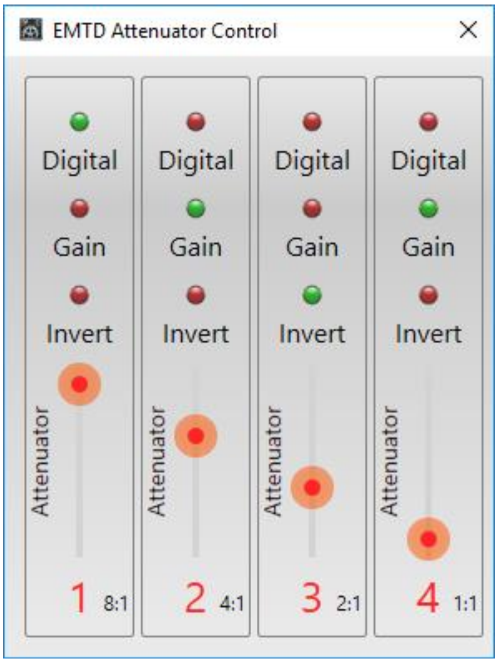


Figure 19 Tacho Control Panel

To access the Tacho Control Panel select the menu Hardware -> Tacho…
The tacho hardware has four identical channels and each channel can be independently controlled. Each channel has a number of independent functions and when these functions are enabled the corresponding button's LED will turn green. The hardware will remember it last setting so once set up can be powered off and on again and it will always use the stored settings.

If the Panel is greyed out then the computer cannot communicate with the hardware. In this case go to the options and check that on the tacho tab that it is possible to Sync with the tacho hardware.

Digital Input – When enabled the channel expects the electrical input to be a digital signal and not an analogue one. The hardware expects this to be zero crossing.

Attenuators – The attenuation can be set in four steps from 1:1 through to 8:1. Obviously at 1:1 there is no attenuation.

Invert – When enabled the input will be inverted. Note that the input is DC coupled.

Gain – When enabled the channel will have a x10 gain. This can be used in conjunction with the attenuators but you should always aim to achieve the best signal to noise ratio.

1.8. Power Supply Control Panel

EMTD Measurement also supply an intelligent power supply. This equipment can be controlled via the control panel shown below.

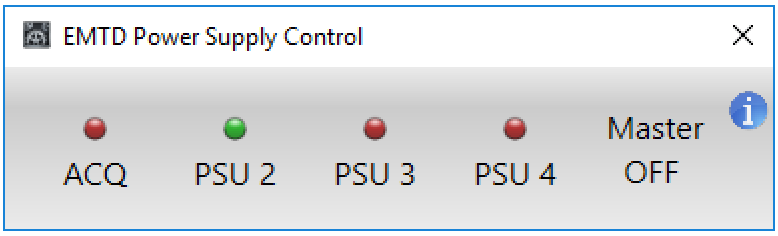


Figure 20 Intelligent Power Supply Control Panel

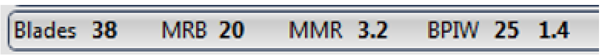
The power supply has four independent outputs capable of powering any of the EMTD Measurement hardware.

If the Panel is greyed out then the computer cannot communicate with the hardware. In this case go to the options and check that on the tacho tab that it is possible to Sync with the tacho hardware.

When the output is off the LED is red and when the output is on the LED is green. When the power supply is connected to the mains it will always start with all outputs off.

Each output can be assigned a custom label. To change the label right click the mouse on a buttons text and enter the new label in the field provided.

1.9. Info Bar - Live Data Validation



The info bar shows parameters and calculated values which can indicate both the quality of the data being taken and what that data might contain.

Blades: The number of blades as defined by the configuration.

MRB: The most responding blade out of all of the blades. This measure is taken from asynchronous information and may not be accurate for a pure synchronous mode at constant speed.

MMR: The max to min ratio is the ratio of the MRB to the least responding blade. There is no correct or wrong value for this parameter but it should be noted when using the waterfall amplitude display as this is an all blade display so the amplitude shown will be an average value. With a high MMR it could indicate that some blades are responding at significantly higher levels.

BPIW: The first number is the average position of a blade for all probes when windowed against the OPR. This number should be fairly constant for a good setup and good data. If this value is jumping around then there is a problem in the setup.

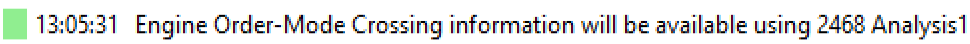
The second number after BPIW is the standard deviation of the probe positions as calculated from the data. If the probe angles are correctly entered in the configuration and the probes are positioned correctly and connected correctly to the system this number will be less than 5. It is possible for blade vibrations such as stall to take this number over 5 but that will be evident from the waterfall display (**C**).

With no large blade vibration if the number shown is over 5 it will turn red and this is an indicator that one of the following is incorrect and this should be rectified immediately.

- Probes are incorrect in the configuration.
- Probes are not fitted correctly or are loose.
- Probes have been connected in the wrong order to the hardware.

Mode and Engine Order Crossings

When a configuration file is loaded in either Acquisition or Replay then the system will also look in the configuration folder for an analysis file. If more than one is present it will pick the first one. If none are found then the feature will be disabled. If it does find n analysis file it will load it and inform the user in the status area



Once the system has the analysis configuration information it will check the current speed against the first 20 engine orders and any defined modes. When a match is found it is displayed in the Info Bar after *Crossings* as shown above. This is useful when acquiring data as it notifies the user that one of their analysis crossings is currently active.

1.10. Built in Hardware Simulator

The Rotadata PCI card has a built in facility to output a simulation of blade passing data. EMTD provide an external simulator for testing and training which is far more versatile but to test the card the internal one can be used. This can be enabled when the software is configured for the Rotadata PCI card by the following menu item.

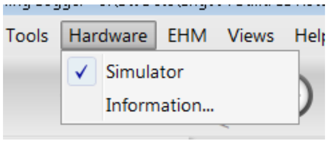


Figure 21 - Enabling the simulator

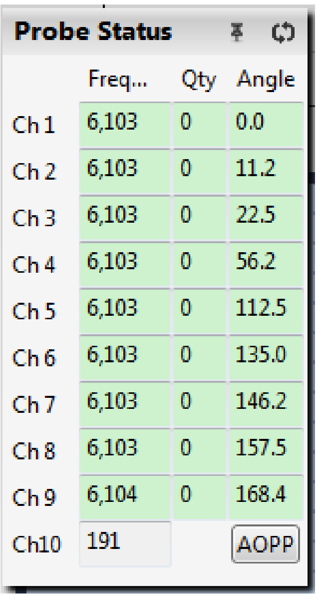
A configuration file is provided for the built in simulator.

HwSim301.xml

Warning: When the Rotadata PCI card's built in simulator is active the real input signals are disconnected from the inputs. If this is enabled while recording data then it is the simulator data that gets recorded and not the data.

The simulator is a constant speed simulation so it should be easy to determine if the simulator is running from the very distinctive speed trace at 11,444 RPM.

When the software and Rotadata simulator hardware are working correctly together then the following probe display will be shown. If it does not look like this then something is wrong and the setup should be checked.



Probe Status

	Freq...	Qty	Angle
Ch 1	6,103	0	0.0
Ch 2	6,103	0	11.2
Ch 3	6,103	0	22.5
Ch 4	6,103	0	56.2
Ch 5	6,103	0	112.5
Ch 6	6,103	0	135.0
Ch 7	6,103	0	146.2
Ch 8	6,103	0	157.5
Ch 9	6,104	0	168.4
Ch10	191		AOPP

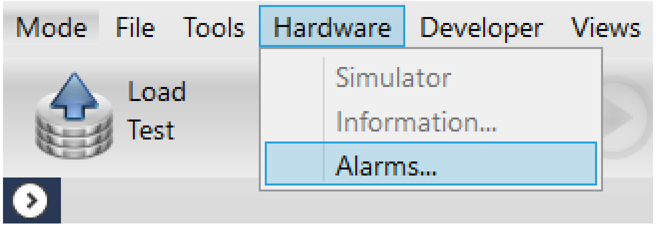
1.11. Alarms

MultiTool supports software and hardware alarms in both Acquisition and Replay modes. The Replay implementation has some limitations and is there purely for testing and limited replaying of events. Note that as the Replay mode does not have a blade stack display, these alarms cannot be tested.

The alarms are stored in a file called Alarms.xml. This is located in the configuration root folder for acquisition mode and in the individual data directory for replay mode. When logging data in acquisition this file is copied over to the data directory automatically.

Note. If you edit the alarms in replay mode and then want to use it in acquisition mode then you must copy the file from the replay directory and overwrite the root alarm file in the configuration folder. This can then be checked by running the Alarm Manager from the Acquisition Mode with the configuration file loaded.

The Alarm Editor is identical in either case so here we will use the Acquisition mode. The Alarm Editor is accessed via the Hardware menu shown below. This menu is only enabled when a configuration is loaded. For Acquisition hardware you do not need to configure the hardware in order to edit the alarms, just a loaded configuration.



The Alarm Editor will initially be empty unless some alarms were previously added.

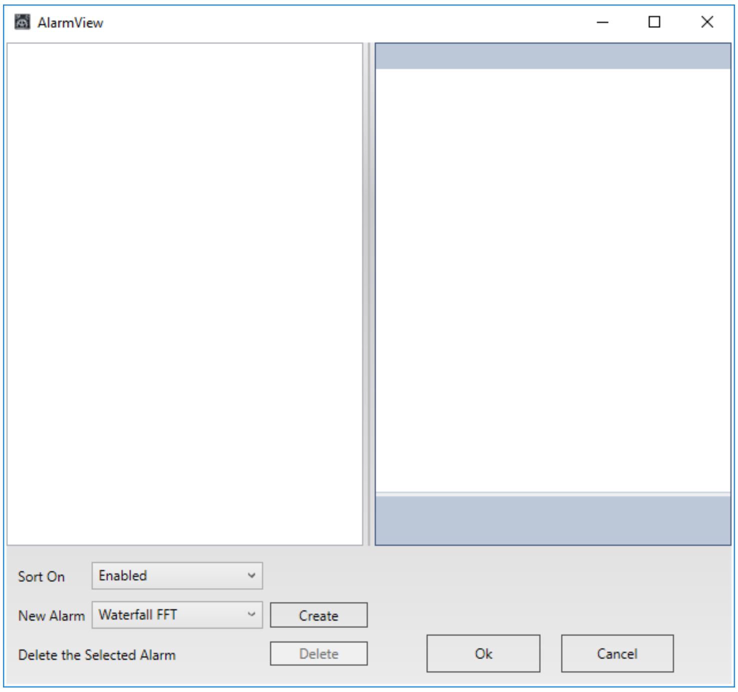


Figure 22 The Alarm Editor Window

To add an alarm select the new alarm type and click Create. Below we have added a Waterfall alarm and a Speed alarm. The Alarm Editor is split into two halves, a list of alarms is on the left and the individual alarms properties of the selected alarm are shown on the right.

Different alarm types have different properties but the Alarm section and the first two of the Settings section are common to all alarms. To get help on an individual alarm property simply select the alarm and then select the property as shown below. A description of the property will be shown at the bottom of the property page. In this case it is the help for the alarm warning level.

See Appendix 1 for a list of the properties.

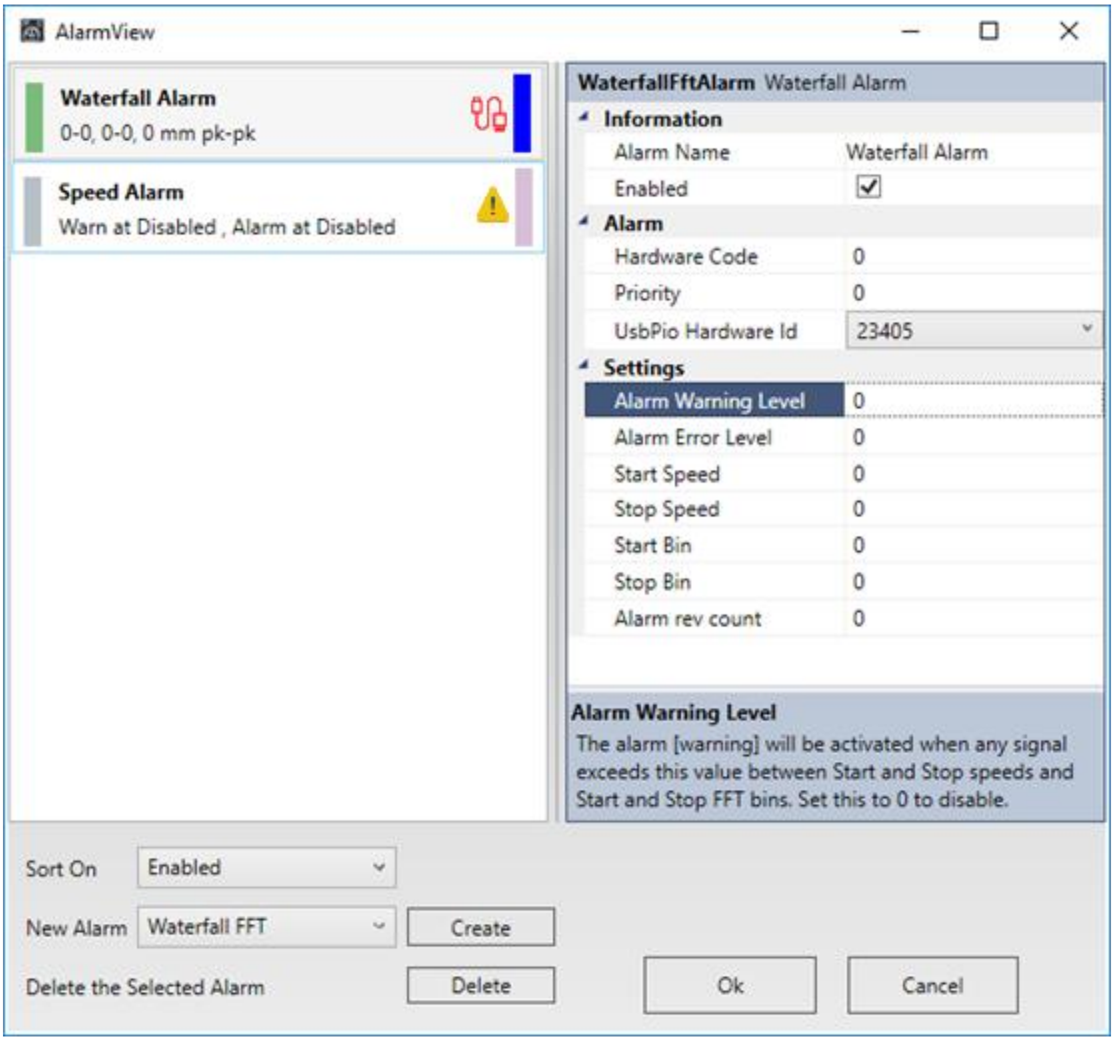
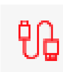


Figure 23 Alarm Properties

Visually the alarms are colour coded on the left and right hand sides. On the left an enabled alarm will be green while a disabled alarm will be grey. The right hand colour is to help differentiate between different alarm types but you can also sort the list on type (see below).

 An alarm that will be routed to the alarm hardware has the red hardware icon shown on the right hand side. This hardware is specified in the *UsbPio Hardware Id* field in the individual alarm properties window. See below for more information on Hardware Alarms.

 An enabled alarm that has no limits set and therefore no functionality will have a warning icon next to it as shown above. If this configuration is loaded then a further warning will be displayed in the status messages.

1.11.1. Alarm Properties

All alarms share some common properties which are under the headings *Information* and *Alarm*. Information defines the alarm type (which can't be changed) and whether or not the alarm is enabled. The Alarm section deals with the hardware so please refer to the 1.11.2 for more information.

Multiple alarms can be selected at the same time, in the alarm list which allows for the editing of common properties. This allows the setting of a common feature on multiple alarms in one go.

The Settings section is where the different types of alarms will expose their properties. In the example shown in Figure 23 Alarm Properties a Waterfall Alarm is shown. For information on what each property represents help will be displayed at the bottom of the property viewer when the property is highlighted. In this case the Alarm Warning Level.

Most Alarms have an Alarm and a Warning Level. Needless to say, the Alarm Level should be greater than the warning level. If it is not then a warning will be given. If a warning is not required then setting the Warning property to 0 will disable just that property. Again, see the individual help text for more information. When all of the conditions have been met for the alarm then an alarm will be triggered. Software only alarms will display a message in red text in the InfoBar. Hardware alarms will also display this message but will output the alarm to the specified device. The message will be shown as long as the alarm conditions are met.

If more than one alarm occurs at the same time then the system will check the given priority of the alarm and output the highest priority alarm. The priority of the alarm can be set by assigning a non-zero number in the priority property under the Alarm heading. The highest priority available is 255. As the system supports up to two hardware alarm devices then multiple hardware alarms can be output at the same time.

1.11.1.1. Waterfall Alarm

The Waterfall display**Error! Reference source not found.** shows an FFT slice derived rom all of the blades. The display scrolls from right to left allowing a history plot for a single probe. Any asynchronous activity will be represented by a colour change in the vertical slice. For the Waterfall alarm it is possible to alarm on the amplitude (colour) of the FFT bin with and without constraining conditions. For more information on individual properties simply highlight them and review the help text.

If the alarm needs to be constrained to a range of bins then the operator needs to know the bin number and therefore it is possible to display the current FFT bin number on the waterfall display. In Replay or Acquisition modes holding the SHIFT key while the mouse is over the waterfall will display the bin under the mouse in the top right corner of the chart. For example a waterfall alarm may be set to alarm if any amplitude exceeds a level of X mm pk-pk. It could also constrain that further by limiting it to bins 150-160 while between speeds of 6000 and 7000 RPM and the amplitude must have been over the alarm value for 50 successive revolutions. Each of these constraints can be disabled, again see the individual property help text.

1.11.2. Hardware Alarms

EMTD can supply, if requested, hardware alarm modules. These modules are USB Digital IO devices supplied by BMCM. The datasheet for these devices is supplied along with the drivers and the devices when ordered from EMTD. It can also be supplied on request to enquiries@emtd-measurement.com.

Each of these USB devices has a unique serial number printed on a label and this is the number which can be selected in the alarm editor.

The device itself consists of three 8 bit digital ports A through C, which output on a 25 way female D type connector. An example of a mating part from RS components is RS stock number 437-336. Each bit on the eight bit port is a 5V output capable of delivering 1mA. MultiTool has configured these as follows.

A0 [Pin 1] – Alarm. This output will go high whenever an alarm that has this particular hardware device specified, has been triggered at an alarm level.

A1 [Pin 2] – Warning. This output will go high whenever an alarm that has this particular hardware device specified, has been triggered at a warning level.

B0-B7 [Pin 5, 18, 6, 19, 7, 20, 8, 21] – Hardware Code
This is the 8 bit code that can be assigned to an alarm through the Hardware Code property in the alarm editor. This allows a connected device to know which of the alarms has been triggered.

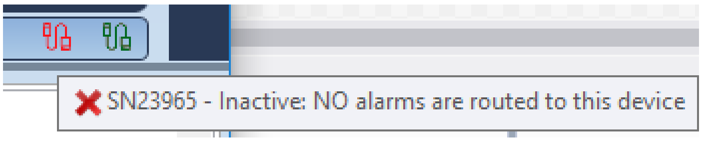
C0 [Pin 1] – Heartbeat. This output will pulse at 1Hz intervals whenever the system is active. Any connected system should monitor this pulse to be certain that the alarm system is running.

MultiTool displays the state of the alarm hardware on the right hand side of the InfoBar via two icons. For more information on the Information Bar see the section titled 1.9.

When a configuration is loaded MultiTool looks for the Alarms.xml file and if present will also load the alarms. It then scans for any connected USB hardware and compares the id's of the hardware with those defined, if any, in the alarm file. Each of these USB devices has a unique serial number printed on a label and this is the number which can be selected in the alarm editor.
If no hardware is detected then the two icons remain greyed.

If a device is located and at least one alarm references it then the icon will turn green.

If a device is located but no alarms reference it then the icon will turn red as a warning.



For diagnostics and testing EMTD also supplies a visualizer for the alarms which can be plugged into the alarm hardware. All three ports have an LED on each bit making it easy to see what individual outputs are doing.