Edinburgh Designs
Wave Generation Software Manual

Document Control

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Wave Generation Software Manual

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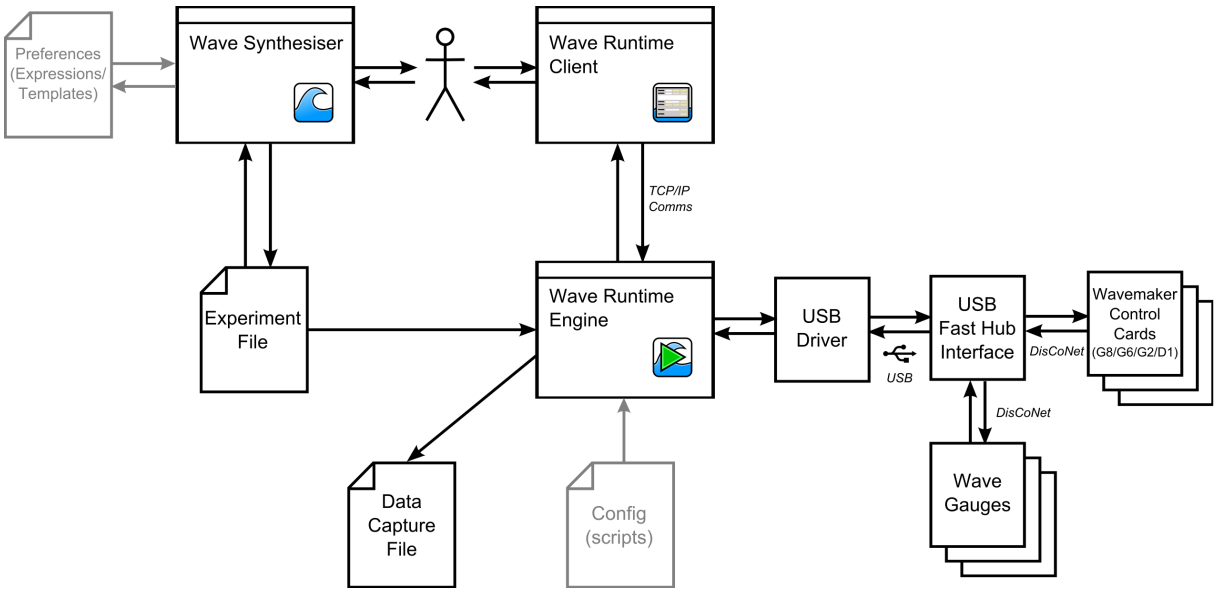
1 Software overview



The Edinburgh Designs wavemaker software suite consists of two main software applications and a collection of software tools for diagnostic and configuration purposes. The two main components are:

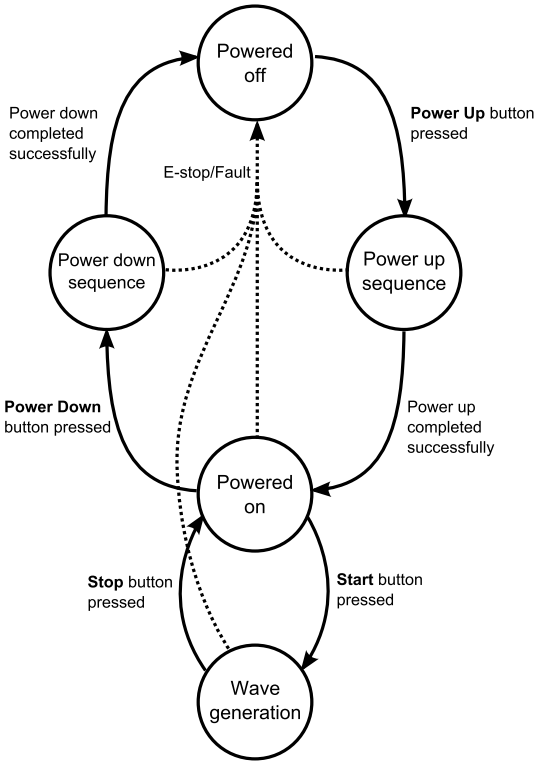
- **Wave Runtime** – this is the runtime software used to operate the wavemaker hardware. It provides the main human-machine interface, allowing the user to control the power state of the machine, generate or play back waves, capture operational data from the machine and monitor the state of the machine for maintenance or troubleshooting. It consists of two programs: the **Engine**, which performs the real time data processing, and the **Client**, which provides a graphical front end. The Client can communicate with the Engine via TCP/IP allowing it to be run remotely over a network if required. See section 2.
- **Wave Synthesiser** – this is a graphical application for creating wave designs to be run by a wavemaker. Waves are built by adding components, such as sine waves, spectra or angle spreading functions, to a tree structure. Components can be specified using mathematical expressions or data input allowing a large amount of flexibility. The software provides the ability to visualise the wave to aid in the design process. Wave files generated by the program are loaded by Wave Runtime to be played back by a wavemaker. See section 3.

Tools and other components:

- **USB drivers** – these are Windows device drivers for the USB Fast Hub Interface and are required for Wave Runtime to communicate with the wavemaker hardware.
- **USB Diagnostics Tool** – this tool provides detailed diagnostic information for Edinburgh Designs control electronics equipped with a USB diagnostics port. Currently this includes the **G8 Digital Wavemaker Controller** and the **G7/G11 Digital Force Transducer Amplifier** cards.
- **JHubRegTest** – this is an advanced diagnostic and debugging tool for probing the internal memory and operation of the control and communication electronics. It is intended for use only by Edinburgh Designs engineers.

1.1 Switch wave generator system on

- Start the **Engine** software for the machine you wish to use.
    - Shortcuts to the software components are in the Edinburgh Designs folder in the start menu programs.
- Start the **Client** software.
- Select the **Power** mode (context) to use.
    - For the most flap machines there is only one power mode.
    - For piston machines there may be different contexts depending on the water depth.
- If all devices are connected then the power status box should say "Ready to power up" and the **Power Up** button should become available.
- Click **Power Up**.
    - The context parameters window will appear – check that the parameters are correct. Parameters may include water depth or floor settings in some tanks.
    - The user should check if the tank is available and if it is safe to use the wavemaker. If so, they should press the green button on the safety cabinet when prompted to by the software.
    - Follow the dialog box prompts to power up the machine. The power up sequence uses the pneumatics to move the paddles through their back stop limit switches to calibrate their positions, then enables the motor drives and moves the paddles slowly up to their vertical position. It then measures the force offset before enabling the force absorption control.
    - Once this sequence is complete the wave machine is now powered on and actively absorbing waves.



- Use the **Input** radio buttons to select the wave source to use:
    - **Sine** – generate regular waves that can be adjusted on the fly – see section 2.2
    - **Synthesis** – load a file created by the synthesis software. – see section 2.3
- Click **Start** to start generating waves.

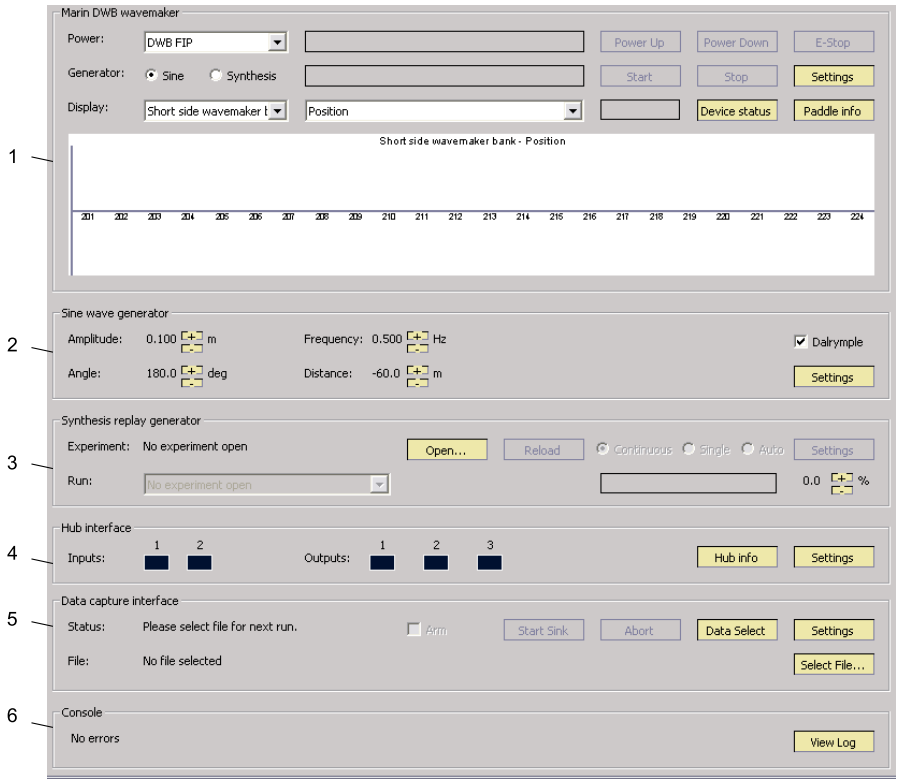
1.2 Switch wave generator system off

- If waves are running, press **Stop**. Wave generation will cease but the machine will still be powered on and actively absorbing waves. The paddles will be in their working position.
- Click **Power Down**, and follow the prompts to power down the machine. The paddles will be slowly returned to their back stops and then the motor drives powered off.
- Pressing the **E-Stop** button at any time will power off the motor drives immediately.

2 Wave Runtime software reference guide

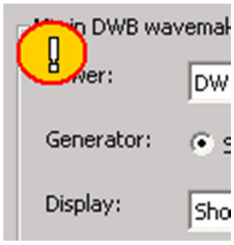
Wave Runtime software is used to control the wave maker. It consists of two parts: the **Engine**, which runs on the PC connected to the USB fast hub (and therefore the wave maker hardware), and the graphical **Client**, which displays the user interface and can be run over a TCP/IP network, thereby allowing remote control of the machine.

The software's main panel appears in the client when both parts of the software have started and are communicating.



The main components are:

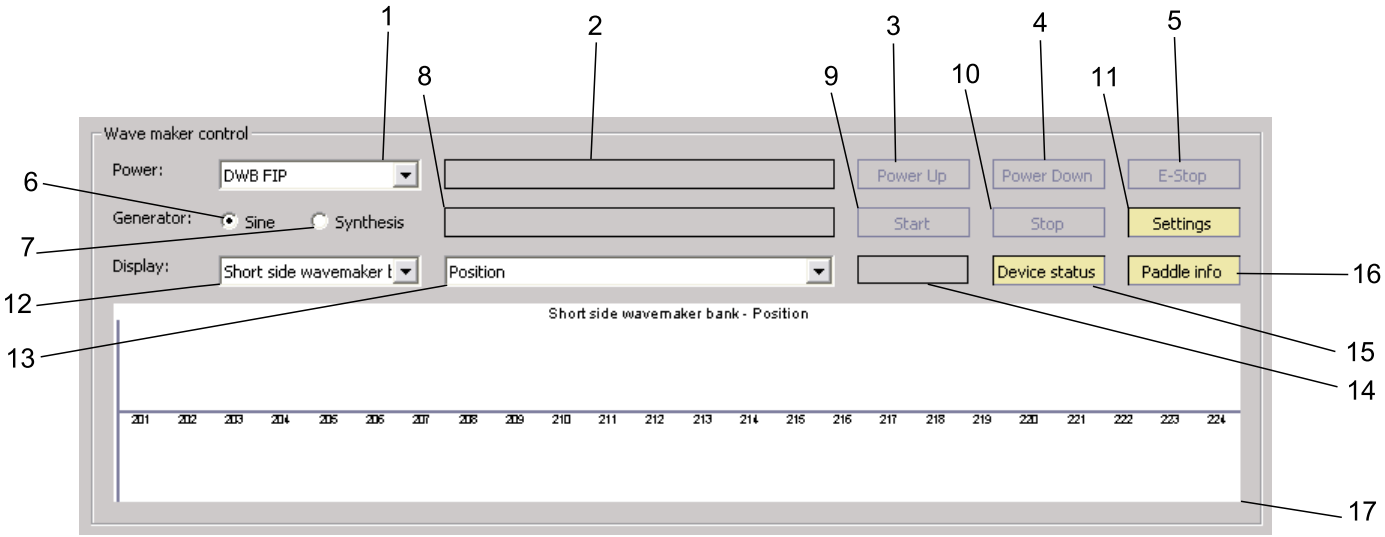
1. Wave maker control – interface for power up and down, wave source selection and diagnostic information. See section 2.1
2. Sine generator – allows live control of a single frequency sine wave. See section 2.2
3. Synthesis playback generator – allows files created by *Wave Synthesiser* to be opened and the wave runs they contain played back. See section 2.3 and also section 3 on *Wave Synthesiser*.
4. Hub interface – displays and configures the digital inputs and outputs on the USB Fast Hub. See section 2.7
5. Data capture interface – allows data to be captured to a file from the wave maker. See section 2.8
6. Log viewer – shows the error log. See section 2.9



If this symbol is seen, it indicates that the client has lost communication with the engine. This could be caused by the engine being closed or having crashed, or may be caused by network communication problems.

2.1 Main wave maker control panel

This panel provides the main interface to the wave maker hardware and controls power up/down, wave input source selection, wave start and stop control and access to detailed diagnostic information.

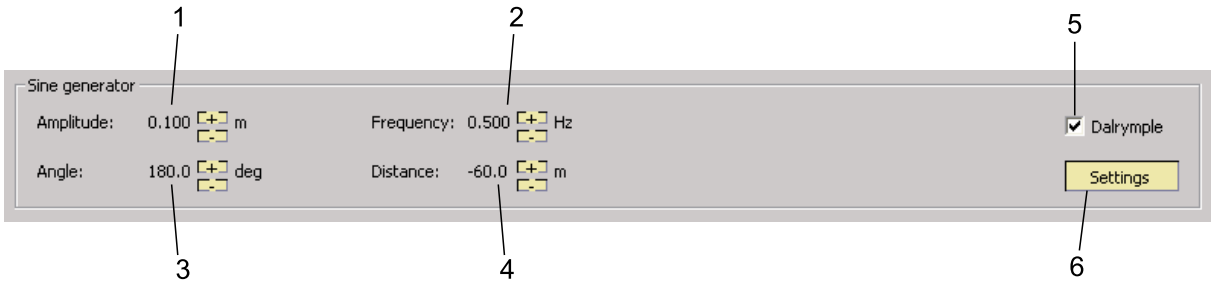


1. Power mode selection (context selection) – select the mode to power the machine up in.
2. Power status box.
3. Power up button – Start the power up sequence. Becomes available when powered down and all devices for the currently selected power mode are connected.
4. Power down button – Start the power down sequence. Available when powered up and not running waves.
5. E-Stop button – Immediately disable power to the motor drives. Available whenever the machine is not powered down.
6. Sine generator radio button – select the sine generator as the wave input source – see section 2.2
7. Synthesis generator radio button – select the synthesis generator as the wave input source – see section 2.3
8. Generator status box – displays the current status of the selected wave generator.
9. Start/Next button – start the selected wave generator, or skip to the next wave when in synthesis generator auto mode.
10. Stop button – stop wave generation.
11. Settings – change ramp up/down times.
12. Paddle bank display selection – changes which paddle bank is displayed in the **Paddle bank display area**, and changes which paddle bank the **Device status** and **Paddle info** buttons work with.
13. Display selection – changes which information is displayed in the **Paddle bank display area**.
14. Ramp display – displays a sliding bar showing the wave output ramp status. Wave generation will gradually ramp up when starting and gradually ramp down when stopping to prevent sudden motion of the paddles during these transitions. The ramp time can be set in the wave maker settings window.

15. Device status button – open the **Device status window** for the selected paddle bank. See section 2.4
16. Paddle info button – open the **Paddle info window** for the selected paddle bank. See section 2.5
17. Paddle bank display area – shows a graphical display of all of the paddles in the currently selected paddle bank. The **Display selection** drop down selects which information to show.

2.2 Sine generator panel

The sine generator can generate a single sine wave which can be adjusted on the fly as the machine runs. In tank configurations with one or more reflecting walls it can use the Dalrymple method to create an angled sine wave at any distance down the tank.

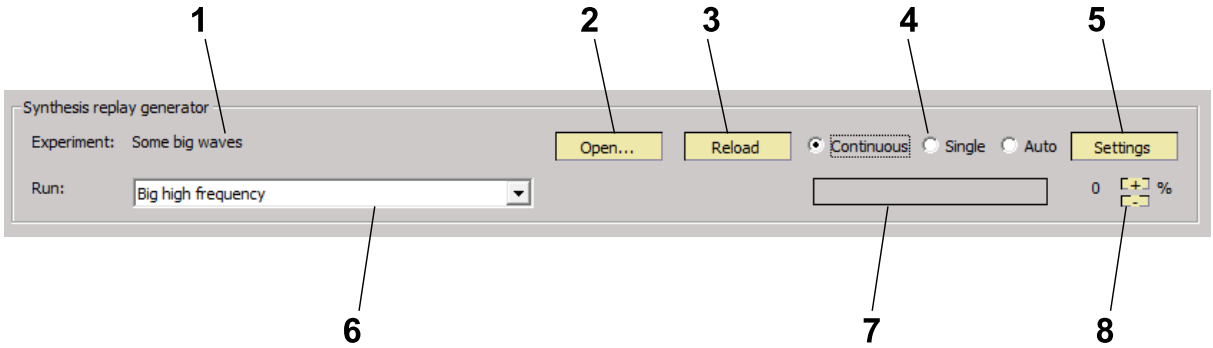


1. Amplitude spinner – adjust the amplitude of the generated wave in metres. Note that this is the amplitude about zero, i.e. the peak to trough wave height will be approximately double this value.
2. Frequency spinner – adjust the frequency of the generated wave, in Hertz.
3. Angle spinner – adjust the angle of the generated wave, in degrees.
4. Distance spinner – when the Dalrymple method is enabled, adjust the position in X that the wave will be generated at, in metres. Has no effect if Dalrymple is disabled.
5. Dalrymple check box – enable the Dalrymple method to create an angled wave at the specified position in X by using waves reflected off the tank walls.
6. Settings button – open a dialog allowing the step size of the spinners to be adjusted.

2.3 Synthesis generator panel

The **Synthesis generator** allows playback of waves created in the synthesis software tool. Wave data is loaded from an **experiment** file which must have been generated by the synthesis tool. Experiments contain one or more **runs** (or wave definitions) plus other settings, such as gain correction. Either a single wave can be run continuously (on endless repeat), a single time with duration specified in the run properties, or multiple waves can be run in an automatic sequence defined in the run properties.

The experiment file stores the wave information as a set of **fronts**: single sine waves each with a frequency, amplitude, angle and phase. This must be converted to a time series of demand for each paddle before the wave can be run. This conversion happens when both the experiment file has been loaded and the wave machine has been powered up (so the power mode and context settings are known). This requires a large number of calculations to be performed, and so for experiment files with many long repeat time runs it may take some time before the **Start** button becomes available after loading a file. During this calculation the maximum angular motion and torque demanded of each paddle is calculated – if this is determined to be outside the capabilities of the paddle, the amplitude of the wave will be restricted. If this occurs the amplitude spinner will be limited to a maximum value lower than 100% and detailed information as to the cause of the limit will be displayed in the run properties window info panel (section 2.3.1 item 6).

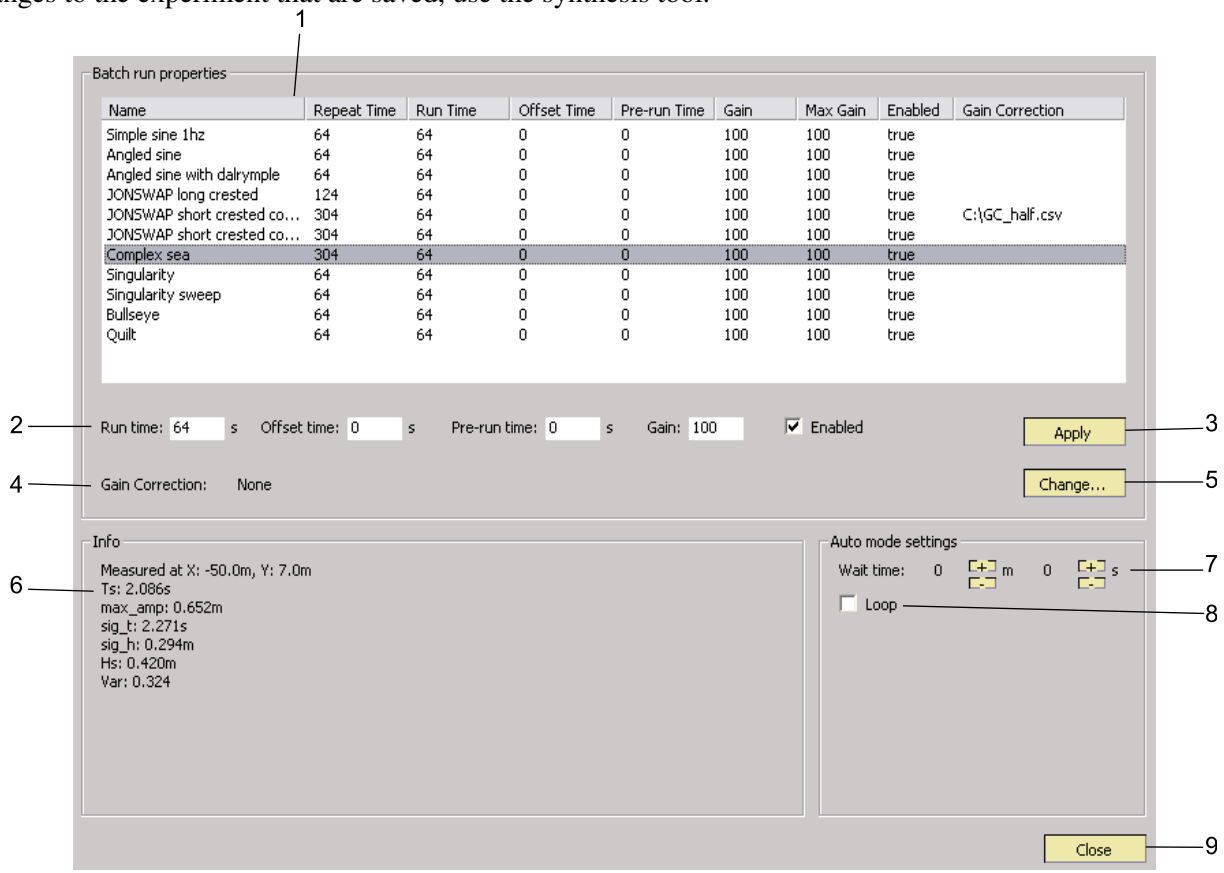


1. Experiment name – the name of the currently open experiment, if one is open. The name is set in the synthesis software.
2. Open button – opens a file browser that allows selection of an experiment file to open. Note that this file browser opens the file system on the machine where the **Engine** is running, not necessarily where the remote **Client** (graphical interface) is running.
3. Reload button – re-reads the currently open file from the disk (for loading changes made to the file since it was first opened).
4. Playback mode radio buttons – select the way waves will be played back:
   - **Continuous** – Runs the selected wave continuously, repeating after its **Repeat Time.**
   - **Single** – Runs the wave for the **Run Time** duration specified in the **Run properties**.
   - **Auto** – run all enabled wave runs in the experiment in order as defined in the **Run properties**.
5. Settings button – opens the **Run properties** window. See section 2.3.1
6. Run drop down – selects the wave run to use in **Continuous** or **Single** mode.
7. Progress bar – shows the progress of the current run in **Single** or **Auto** mode**.**

8. Amplitude spinner – Adjust the amplitude of the currently selected or running wave run, as a percentage of specified in the synthesis software. This can be adjusted on the fly as the wave is running.

2.3.1 Run properties window

The run properties window shows detailed information about the runs in the experiment. It allows viewing, and temporarily changing, the auto mode settings, gain and gain correction. To make changes to the experiment that are saved, use the synthesis tool.

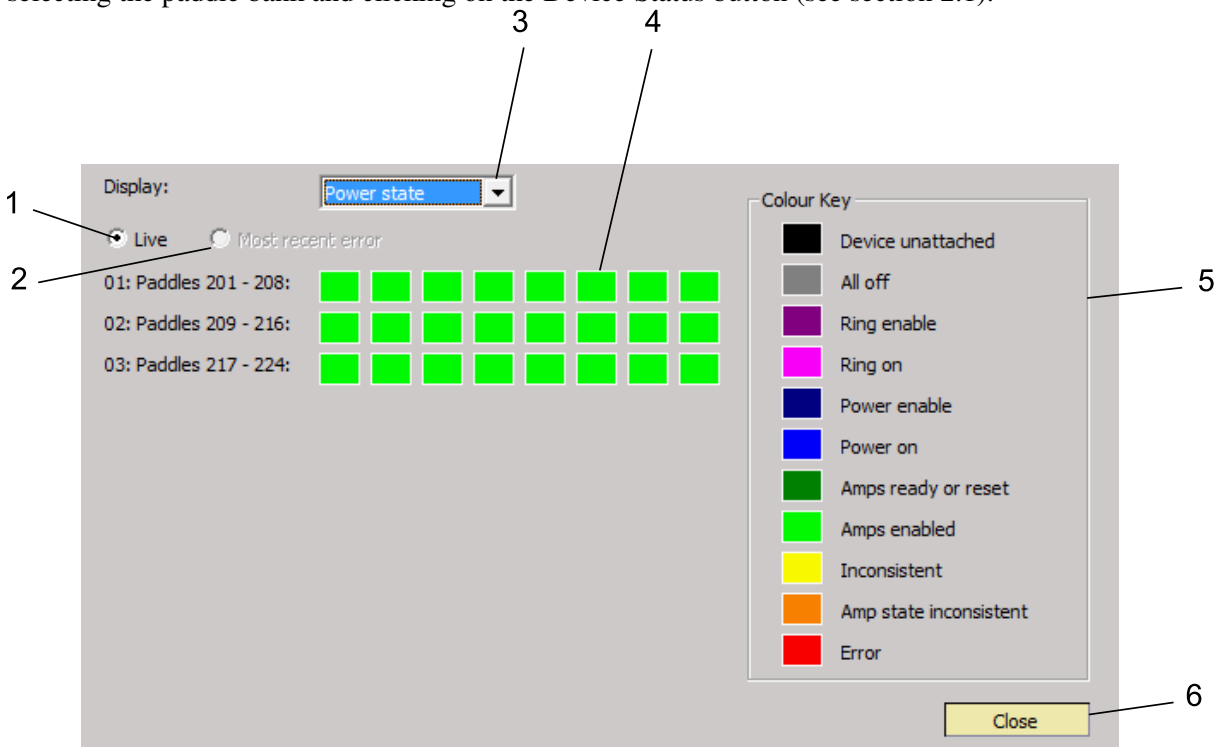


1. Run properties table – this shows detailed properties of each run:
    - **Repeat time**: the time until the wave repeats as defined in the synthesis software. All the waves generated by the synthesis software are deterministic and will repeat after this time.
    - **Run time**: how long the wave will run for in auto mode.
    - **Offset time**: the offset from the start of the repeat time to start at.
    - **Pre-run time**: how long to run the wave for before the offset time.
    - **Enabled**: whether the wave is included in the auto mode sequence.
    - **Gain**: amplitude multiplier.
    - **Max gain**: maximum limit of gain setting calculated from the capabilities of the wave paddles. This value will only be valid once the run data has been calculated.
    - **Gain correction**: the currently loaded gain correction settings.
    - Run time, offset time, pre-run time, gain and enabled settings can be changed when the machine is not running by selecting the run, altering the settings in the boxes that

appear below the table and clicking **Apply**. Note that these changes are only temporary and will be lost upon opening another file or closing the software. To make permanent changes to these settings alter the settings in the synthesis software.
    - All times are in seconds; gain is in percentage of the original as specified in the synthesis software.
    - The order of the runs in the table is the order they will execute in auto mode. This order can be changed in the synthesis software.
2. Run properties editors – make temporary changes to the run properties. Click **Apply** to apply the changes.
3. Apply button – apply any changes made in the Run properties editors.
4. Gain correction – gain correction can be applied by selecting the item in the table and clicking the **Change…** button to load a gain correction file. The run data will be re-calculated after the new gain correction is loaded and so the max gain may change. This gain correction is only temporary and will not be saved into the file. To save gain correction information into the experiment file use the synthesis tool.
5. Change gain correction button – load and apply a new gain correction file to the currently selected run.
6. Info box – displays the wave statistics (generated by the synthesis software) and any messages or errors when loading or building the run data (such as if the wave gain has been restricted) for the currently selected run.
7. Wait time spinner – set the wait time, or settling time, between wave runs in auto mode.
8. Loop check box – run auto mode continuously in a loop.

2.4 Device status window

The device status window displays the status of all devices (paddles or amplifiers, depending on the display selection) in a paddle bank. It can be used to watch the status of the whole machine for diagnostic purposes. The devices are shown as coloured indicator lights grouped in rows with each row representing a control card. Clicking on an indicator light brings up the **Paddle info** window for that paddle. The device status window for a paddle bank is displayed from the main panel by selecting the paddle bank and clicking on the Device Status button (see section 2.1).

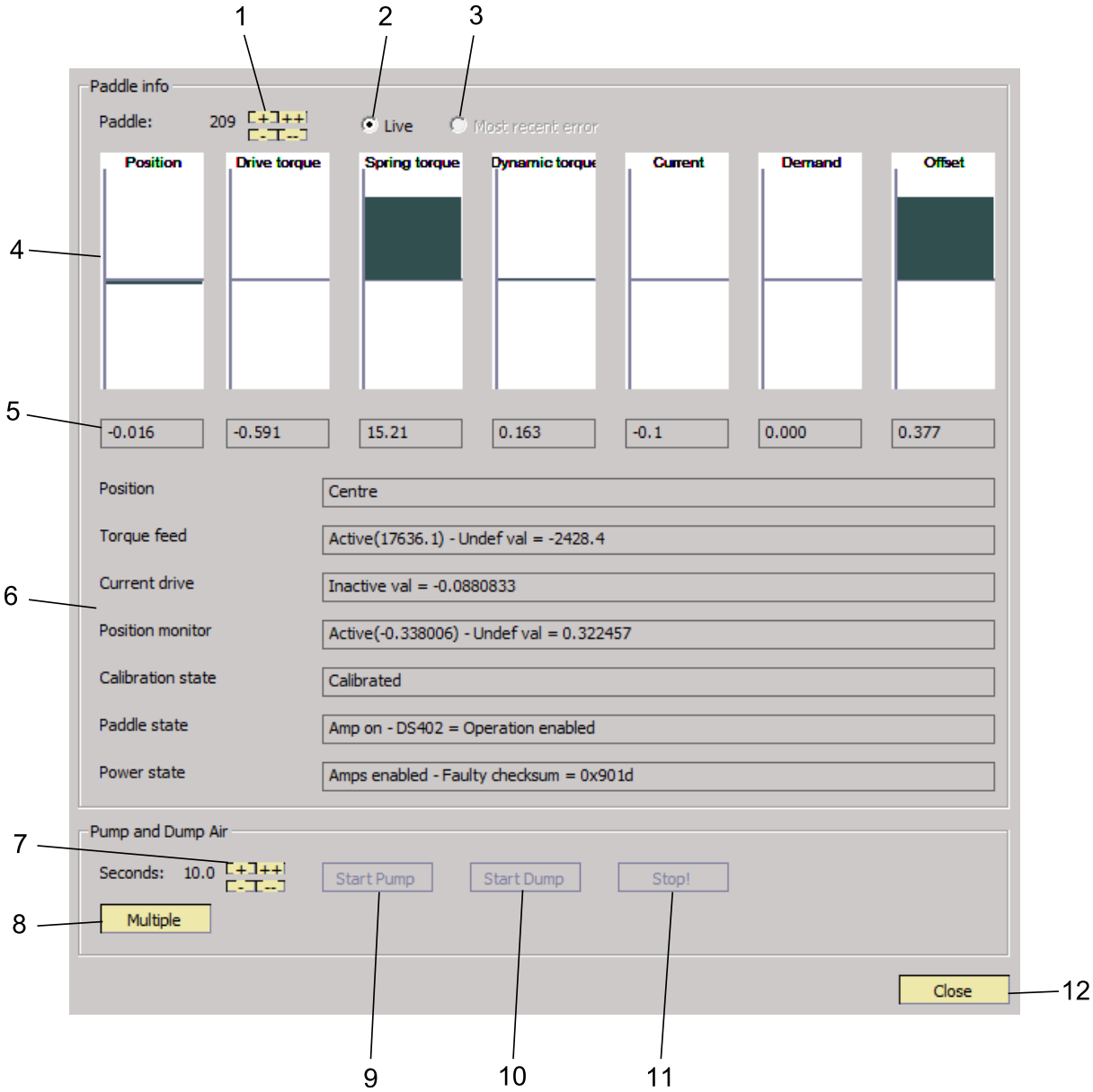


1. Live radio button – display the current status of the devices.
2. Most recent error radio button – display the status of the devices at the time of the most recent error.
3. Display selection – choose the information to display:
    - Pneumatic control – show the pumping and dumping of the pneumatic bellows. Pneumatic control information for the most recent error is not available and so the indicator will always display **Unknown** when the **Most recent error** radio button is selected.
    - Position – show the limit switch status, i.e. whether the paddles are on back stops, front stops, in their centre (working) position or whether the limit switch electronics has a fault.
    - Calibration state – During power up the paddles must move through their back stop limit switch to set their reference position. This displays the status of this calibration procedure.
    - Paddle state – Shows any errors associated with a single paddle, for example a force transducer or amplifier fault.

- Power state – Show the status of the control card power up sequence, and will display any error associated with the card. The power up sequence is described in more detail in the troubleshooting manual.

4. Device indicators – each indicator represents a paddle. Clicking on an indicator will open the **Paddle info** window for that paddle (see section 2.5). If the indicator is black, that usually means the control card for that machine is not communicating with the software, either because the USB hub is not connected to the engine PC or because the hub is not connected to the control card.
5. Colour key – describes what each colour represents.
6. Close button – Closes the device status window.

2.5 Paddle info window



The paddle info window displays detailed information for a single paddle. It can be used to monitor the paddles during operation, or to help diagnose faults with the machine. It also provides access to manual controls for pumping and dumping the pneumatics on the paddles. The Paddle Info window for a paddle bank is displayed from the main panel by selecting the paddle bank and clicking on the Paddle Info button (see section 2.1), or by clicking on an indicator in the Device Status window (see section 2.4).

1. Paddle selection spinner – selects the paddle to display detailed information for. Note that paddles can also be selected by clicking on the indicator lights in the **Device status** window.
2. Live radio button – display the current status of the paddle.

3. Most recent error radio button – display the status of the paddle at the time of the most recent error.
4. Paddle data graphical displays.
5. Paddle data numerical displays:
    - Position – the angular position of the paddle, in radians.
    - Drive torque – the torque measured by the drive force transducer on the sector. In kNm.
    - Spring torque – the torque measured by the spring force transducer on the air spring (bellows), in kNm.
    - Dynamic torque – the resultant torque applied to the paddle when in absorption mode, in kNm.
    - Current – the current demanded of the amplifier, in Amps.
    - Demand – the demanded wave output of the paddle, in kNm.
    - Offset – the angular offset position of the paddle from back stop to centre, in radians.
6. Paddle detailed state and diagnostic information – Display more information in the same categories as are visible in the **Device status** window.
7. Pump and dump seconds spinner – the time to activate the pneumatic pump or dump valve when the **Start Pump** or **Start Dump** button is pressed. Pump and Dump control will be disabled when a global e-stop is active.
8. Multiple button – opens the **Pump and dump multiple** window. This window allows manual pumping and dumping of air into the bellows of multiple paddles at once. Use the **Device status** window set to **Pneumatic control** in conjunction with the Pump and dump multiple window to watch the status of the manual pump/dump operation.
9. Start Pump button – opens the pump pneumatic valve for the time specified by the **Seconds** spinner.
10. Start Dump button – opens the dump pneumatic valve for the time specified by the **Seconds** spinner.
11. Stop! button – stops any pump or dump operation on this paddle.
12. Close button – closes the paddle info window

2.6 Trigger mechanism

The trigger mechanism is a part of the software allowing actions to be performed when certain events occur. For example, the wave machine can be started when a digital input changes, or data capture can start when the waves start. Each source trigger has a **start** and **stop** event which corresponds with the source event starting and stopping. The trigger mechanism is not configured from a central point, therefore no screenshot can be shown; instead it is configured from the components that can act as event sources or be triggered by the mechanism. The sources can be:

- **Wave maker** – the starting and stopping of waves.
- **Hub source** – the digital inputs on the hub – see section 2.7.1 for how to configure the digital inputs.
- **Data sink** – the starting or stopping of the data capture mechanism.

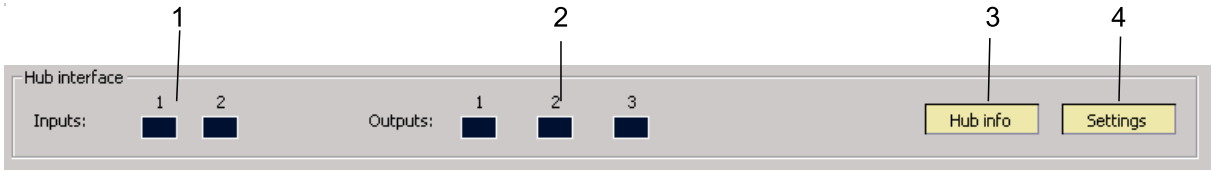
Actions that can be triggered include:

- Starting or stopping of waves.
- Hub outputs – see section 2.7.1 for how to configure the digital outputs.
- Data capture – see section 2.8.2 for how to configure the data capture mechanism.

Note that care should be taken to avoid creating a cyclic dependency.

2.7 Hub interface panel

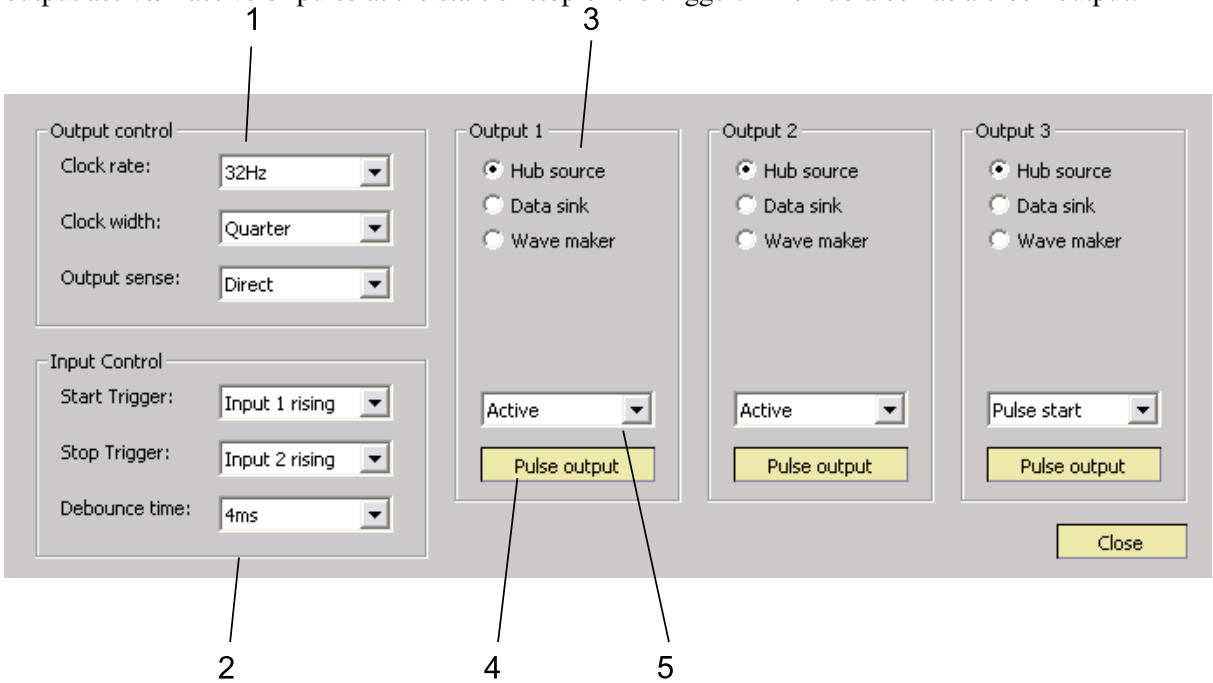
The fast hub interface panel displays the status of the digital inputs and outputs on the USB fast hub. The **Hub Info** button shows the status of the DisCoNet communications network, showing which hub ports have control cards connected.



1. Input display – shows the state of the digital inputs on the hub.
2. Output display – shows the state of the digital outputs on the hub.
3. Hub Info button – shows which ports on the main and satellite hubs have devices attached.
4. Settings button – configures the digital inputs and outputs. See section 2.7.1

2.7.1 Hub settings window

The hub settings window sets how the hub's digital inputs are interpreted and how the digital outputs are controlled. The hub has 2 inputs, which can be used to control the trigger mechanism (as the Hub source). The hub also has 3 outputs, which can be controlled by the trigger mechanism to set the output active/inactive or pulse at the start or stop of the trigger. The hub also has a clock output.

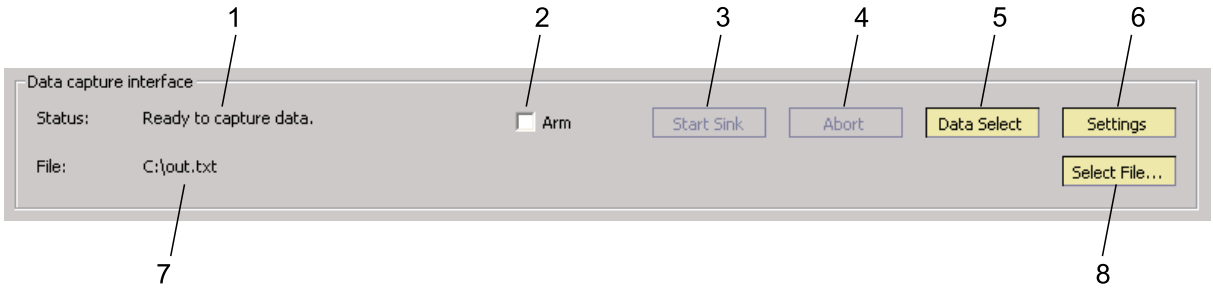


1. Output control – configure general output settings:
   - Clock rate – the frequency of the clock output on the hub.
   - Clock width – the duty cycle of the clock signal.
   - Output sense – whether the outputs are direct (high when active) or inverted.

2. Input control – configure the hub source trigger mechanism from digital inputs:
   - Start trigger – event to start the hub source trigger.
   - Stop trigger – event to stop the hub source trigger.
   - Debounce time – how long to sample the input for before determining that a change has taken place.
3. Output trigger source – which trigger to set the output from (for each output):
   - Hub source – the hub source itself, i.e. set the output based on the inputs.
   - Data sink – set the output from the data capture mechanism starting and stopping.
   - Wave maker – set the output from the waves starting and stopping.
4. Pulse output button – pulse the output for one second. For testing the output mechanism.
5. Output configuration – set the output based on the selected trigger:
   - Active – output will go active when the selected trigger starts, and will go inactive when the selected trigger stops.
   - Pulse start – output will be pulsed when the selected trigger starts.
   - Pulse stop – output will be pulsed when the selected trigger stops.

2.8 Data capture interface panel

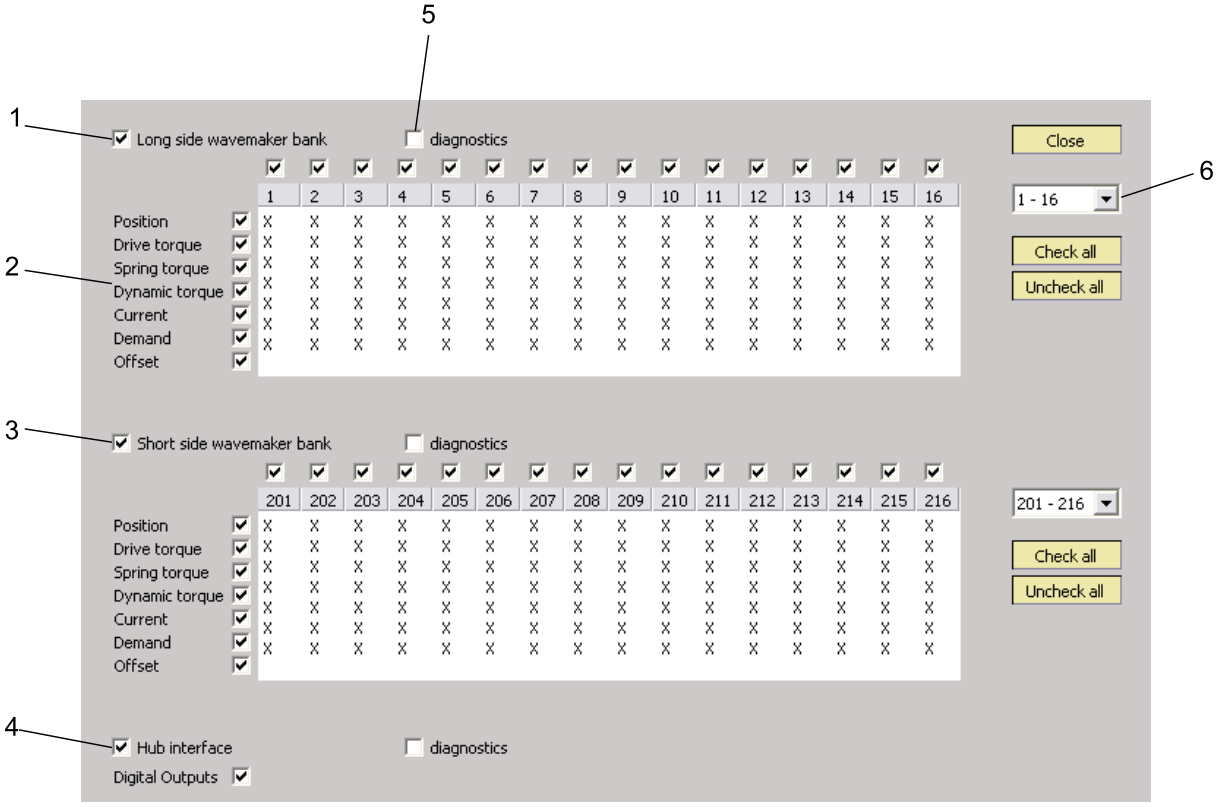
The data capture interface panel is used to capture data from the wave maker (such as position, demand, forces) for each paddle as the machine runs, or from the wave gauge interface.



1. Status display – shows the state of the data capture interface.
2. Arm check box – select to arm the data capture mechanism. Once armed data capture will begin based on the trigger set in the settings.
3. Start button – start data capture if set to trigger from data sink.
4. Abort/stop button – stop data capture.
5. Data select – select the data to capture. See section 2.8.1
6. Settings – set start and stop triggers. See section 2.8.2
7. File display – shows the name of the selected file to write data to.
8. Select file button – select the file to write to.

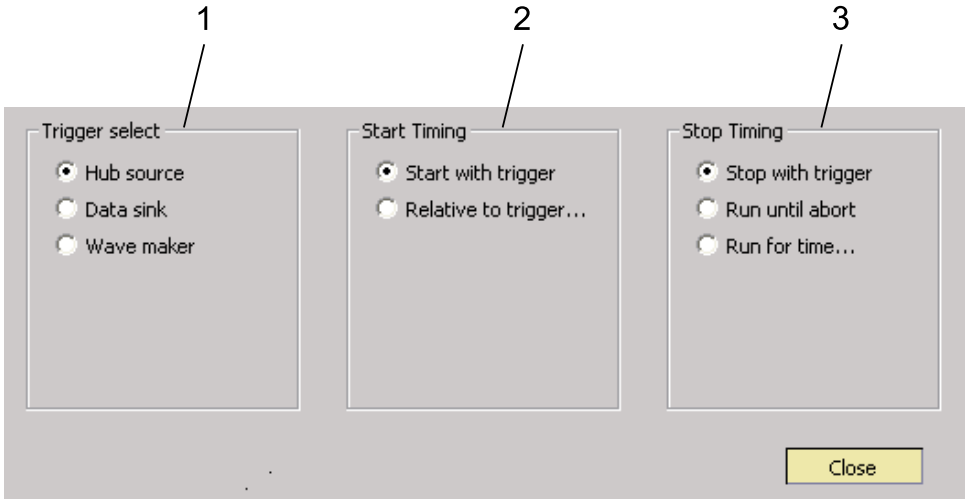
2.8.1 Data select window

The data select window is used to select which information is written to the data capture file. It contains a grid for each paddle bank or gauge array with the rows being the data channels and the columns being the paddle number or gauge number. An X in each position shows that the data for that channel and paddle/gauge will be captured and written to the file.



1. Section data selection – select data to capture from the wavemaker or gauge section.
2. Data select grid – select which data channels and paddles/gauges to capture.
3. Section data selection – select data to capture from the wavemaker or gauge section.
4. Hub interface data selection - select data to capture from the hub. This is limited to the digital inputs and outputs.
5. Diagnostics check boxes – capture diagnostic information on the section/hub.
6. Paddle/gauge range drop down – select which paddles or gauges to display in the table if there are a large number in the section (> 16).

2.8.2 Data capture settings window



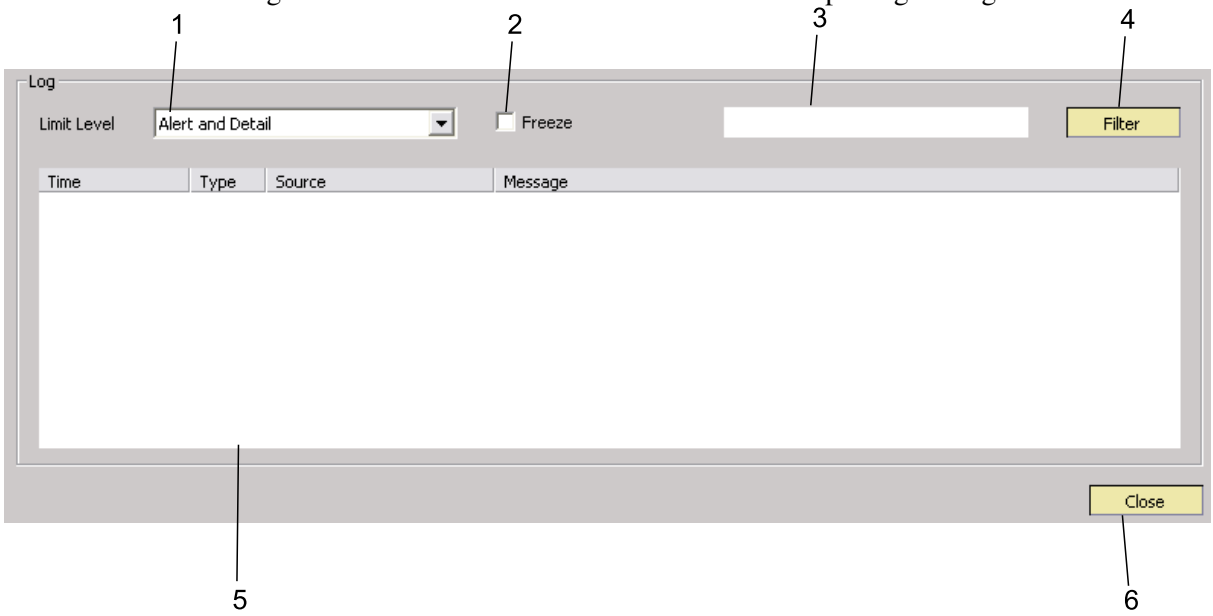
1. Select trigger source:
    - Hub source – the hub input trigger (see section 2.7.1).
    - Data sink – the Start Sink button in the data capture interface panel.
    - Wave maker – the start/end of wave generation.
2. Select start timing:
    - Start with trigger – start data capture at the same time as the selected trigger.
    - Relative to trigger – start data capture a specified number of seconds after the trigger.
3. Select stop timing:
    - Stop with trigger – stop data capture with the selected trigger.
    - Run until abort – stop data capture when the abort button is pressed.
    - Run for time – stop data capture after the specified amount of time.

2.9 Error log panel

The error log panel displays the most recent error, if any. It also has a **View Log** button to open the **Error log window**.

The **Error log window** can be used to view the contents of the log for troubleshooting. Each log entry contains a time stamp; a type (or severity); a source name, which describes which part of the machine the entry originated from; and a message which describes the entry. The window is limited to displaying the most recent 100 entries. The error log is also written to the disk and can be viewed in a standard text editor (such as Notepad).

See the troubleshooting section of the manual for information on interpreting the log.

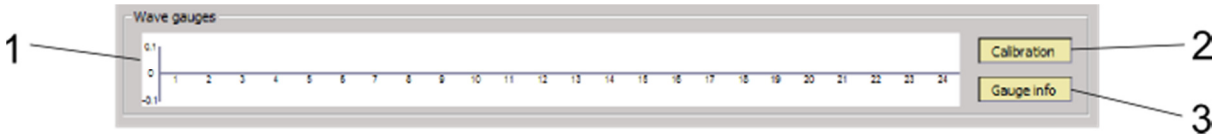


1. Limit level drop down – limit the level of the log types displayed:
   - Error and State – display only the most important messages – error messages and state changes.
   - Warning and Info – display also warnings and important information messages.
   - Alert and Detail – display also less important alerts and detailed information messages.
2. Freeze check box – prevent new items from being displayed, allowing easy scrolling through the log list.
3. Filter text box – enter a string here and click the **Filter** button to only display entries containing that string. Enter a blank string and click **Filter** to show all entries.
4. Filter button.
5. Log list – shows log entries after filtering.
6. Close button – closes the log window.

2.10 Wave Gauge interface

The wave gauge interface is used to view the status of the wave gauges and provides a link to the gauge calibration tools. The main wave gauge panel appears in the main window if gauges are configured in the scripts. Multiple gauge sections, which can be configured and calibrated independently, can be configured; these will appear as multiple wave gauge panels in the main window.

Captured gauge data is output to a file using the Data Capture interface – refer to section 2.8



1. Gauge display graph – displays the calibrated output of connected gauges. Clicking on the graph opens a pop-up window with a larger display and settings for the y-axis range of the graph.
2. Calibration button – opens the calibration window, see section 2.10.1.
3. Gauge info button – opens the single gauge info window for displaying detailed information about a single gauge.

2.10.1 Gauge Calibration

Wave gauges must be calibrated before use. The following procedure should be followed:

I. **Start Software**: Start the Engine and Client software and open the Calibration window.

II. **Check Hardware**: Ensure the gauge controller boxes are powered, connected to the USB fast hub, and set to the correct node address. Check in the calibration window to see when they are connected – the indicator lights should change from black (unattached) to another colour when the device is detected by the software.

III. **Clear Overloads**: Clear any overloads by selecting gauges with "Overload set" indicated and click Clear Overloads. Follow the on-screen prompts.

IV. **Set Cable Resistance** (optional): if long cables from the gauge controller box to the gauges are in use you may want to set the cable resistance. This can be done by selecting the gauges to use, clicking the Set Resistance button and following the prompts. The procedure will require you to short the cable at the far end before the gauge, detect the resistance and then remove the short. This step is optional and can be omitted if desired, in which case a zero cable resistance will be assumed.

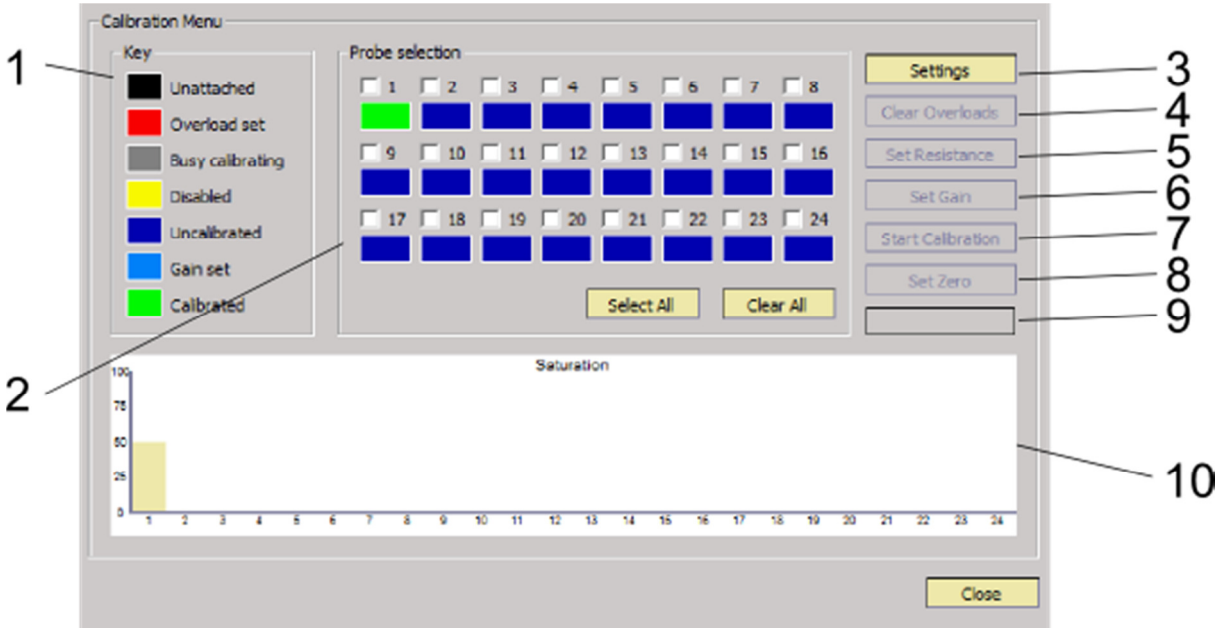
V. **Set Gain:** This step detects the optimal gain to use. Position the gauges at their normal working depth in the water, select the gauges to use in the Probe Selection panel, and click the Set Gain button. The optimal gain will be detected and, if successful, the gauge indicator will change to the Gain Set state. If the gain detection fails (for example if no gauge is connected) then the gauge will be set into a Disabled state.

VI. **Calibrate Gauges:** This step performs the actual gauge calibration in terms of detecting the wave height. Select the gauges to calibrate and click the Start Calibration button. Follow the prompts, which will ask the user to move the gauges to specific heights before measuring the gauge reading. The number and choice of calibration positions is set in the settings which can

be changed using the Settings button. At the end of the calibration position the readings are fitted to a line and, if the error is outside the tolerance set in the settings then the calibration fails and must be performed again. Calibration may need to be performed periodically due to corrosion on the gauges or changes in the conductivity of the water, e.g. due to temperature changes.

VII. **Set Zero:** Reset the zero point of the selected gauges. This updates the zero reading, for example if the water depth has changed slightly.

Calibration settings are saved to disk so they will be re-loaded when the software is next started. If the proceeding steps have been performed then later steps can be repeated without repeating the whole procedure from the start – for example, the cable resistance should only need to be set once as it is unlikely to drift over time.



1. Colour Key – displays the meaning of the colour indicators in the Probe Selection panel.
2. Probe Selection panel – Select the probes that the calibration operations will be performed on. The indicator light under each selection box displays the current state of that probe.
3. Settings button – open the calibration settings window.
4. Clear Overloads button – clears overloads on the selected gauges. Only enabled if all selected gauges are in Overload state.
5. Set Resistance button – start the set cable resistance procedure on the selected gauges.
6. Set Gain button – calculate the optimal gain for the selected gauges.
7. Start Calibration button – start the calibration procedure on the selected gauges.
8. Set Zero button – reset the zero reading on the selected gauges.
9. Progress bar – display the progress of the current operation.
10. Gauge Saturation readout – display the raw ADC saturation of the gauges.

3 Wave Synthesiser software guide

Wave Synthesiser is used to specify waves to be run in the tank using the Synthesis generator. This manual contains a guide to getting started with the basics of using Wave Synthesiser. It is recommended to refer to the online help (accessed via the help menu or by help buttons in the software) for context-sensitive detailed documentation. Many buttons and controls are annotated with **tooltips** – hover over a control or button with the mouse for a few seconds and a box will pop up describing its function.

3.1.1 Starting the software and creating an experiment

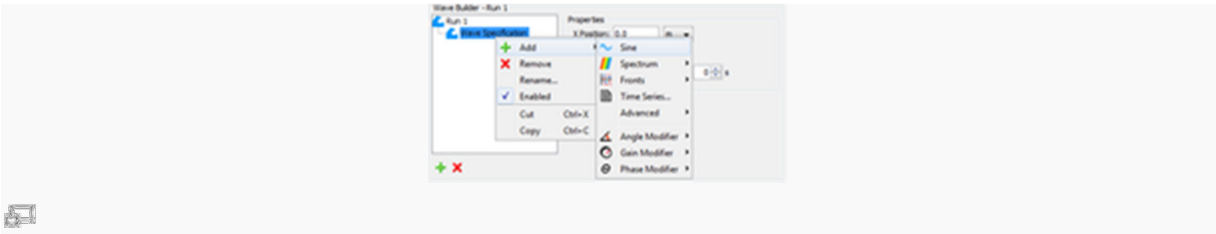
Wave Synthesiser's software file format is based around the concept of an "Experiment", which is a collection of one or more wave runs that will run in the tank. Grouping multiple wave runs in an experiment allows them to share a common name, tank configuration and allows automated operation of a sequence of tests with different wave environments to be run.

1. Start the software via the shortcut in the start menu.
2. The welcome page will appear. Click "New Experiment" to start the New Experiment wizard.
3. Enter a name for the experiment. This can be anything you want.
4. Select the tank configuration that the experiment will use. This step is required for sites that have more than one tank, or for tanks that have more than one operating mode.
5. Click **Create**. The **Add New Wave Run** window will appear.

3.1.2 Creating a new wave run

1. In the **Add New Wave Run** window, enter a name for the wave run.
2. Three options for initialising the wave run are available:
    1. Blank wave: This creates a wave run with no components added, allowing you to create a wave run from scratch.
    2. From template: Load one of the installed templates. Templates contain partially initialised wave runs which have components already added, meaning you only have to set a few parameters. See the section on Templates for more details.
    3. Import from file: Load a wave from a file. See Importing and Exporting Waves for more details.
3. Choose Blank wave for the purposes of this guide and click OK. The Main View will appear.

3.1.3 Building a sine wave



Adding a sine component

The simplest type of wave that can be created is a single frequency sine wave. This consists of a **wave definition** containing a single **wave specification** which in turn contains a single **sine** component. The blank wave you created in the previous section already contains a single **wave specification** component. To create a sine wave, you need to add a **sine** component to this wave specification.

1. Right click on the wave specification component in the Wave Builder tree. A popup menu will appear.
2. Navigate through to the **Add** menu and click **Sine**. This will add a new component called "Sine" to the tree, representing a single sine wave component (or *front*).
3. The properties of the selected component are shown to the right of the tree. Select the sine component you just added (it may already be selected immediately after adding it).
4. Change the frequency, amplitude, angle and phase to the desired settings for the sine wave you wish to create.

5. Try adding a second sine component at a different frequency: this will create a beat effect. Changing the angle of one of the sine components will create a quilt effect.
6. Observe the results in the visualisation pane.

3.1.4 Using the visualisation

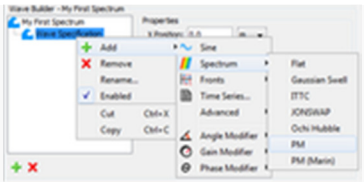
The visualisation pane at the bottom of the main window can be used to quickly check the wave you are building will give the expected output. There are four views, which are selected using the four buttons in the top left of the visualisation pane.

- The **time series** view shows the wave as it would be measured at a single point in the tank. It contains charts of the amplitude over the repeat time, the energy distribution over the frequency range and the angle distribution.
- The **fronts** view shows the fronts specified by the wave you have built. Fronts are shown as discs on a frequency/angle scatter plot. The size of the disc shows the amplitude of the front. If the **dalrymple method** is used the fronts before and after applying it are shown in different colours for comparison. Summary plots of angle and frequency distribution are also shown.
- The **energy density** view shows the same information as the fronts view in a different way: the fronts in areas of a grid are summed and this information is used to change the colour of that area to show the energy density at that frequency/angle.
- The **animate** view shows a 3D animation of the wave in the tank.

See Visualisation for more details.

3.1.5 Building a spectrum

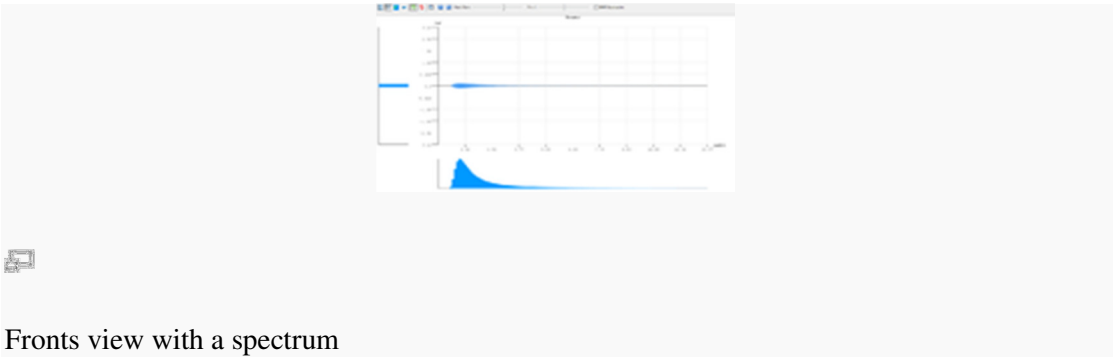
Spectrum waves are used to simulate real sea states based on a mathematically defined frequency distribution. Wave Synthesiser creates a spectrum by evaluating an expression for each harmonic frequency of the repeat time of the wave, and generating a single front at that frequency. The software does not contain any built in spectra; instead, the user can specify what spectra are available by adding Expressions to the options (for the purposes of this getting started guide, it is assumed that the PM spectrum included with the default installation is available).



Adding a spectrum component

1. Add a new blank wave run, by navigating through the main menu to **Run->Add Run**. This will open the Add New Wave Run window.

2. Add a **spectrum** component to the wave specification. This is done in the same way as adding a sine component, but navigating to the **Spectrum** sub-menu and selecting the type of spectrum to be added. Select **PM**.
3. The parameters of the spectrum are shown as a table to the right of the tree when it is selected. The PM contains one user parameter: frequency. This parameter has no default value set in the preferences, so it is highlighted in red (along with the path through the tree of components that lead to the uninitialised value). Enter a value for the frequency parameter and press enter. Select the **Fronts** view in the visualisation pane to view the output.
4. The **Fronts** view shows the fronts (or single frequency sine waves) that make up the wave, with each disc in the scatter plot representing a single front. One front is generated for each harmonic frequency of the **repeat time** of the wave. The repeat time determines how long the wave runs for before it repeats. The repeat time is a property of the **definition** component of the wave, which is at the top (or root) of the tree; to change it click on the **definition** component at the top of the tree (which has the same name as the wave run). Observe the effect changing the repeat time has on the number of fronts in the visualisation.



Fronts view with a spectrum

5. Change to the **Time series** view in the visualisation. This view shows how the wave will appear at a single position in the tank, which is specified at the top of the visualisation pane.
6. Select the Specification component in the wave builder tree. Changing the position here changes the position in the tank where the wave will be generated. The time setting here controls the offset from the start of the repeat time. Experiment with these settings (and the position settings in the visualisation pane) to see the effect they have (note that the Y position settings will have no effect as there is no angle component to the wave).
7. Note that the spectrum is not distributed over time: this is because the phase of all of the fronts is zero, the default value. To change this a **phase modifier** must be added.

3.1.6 Adding a phase modifier

Phase modifiers work by modifying the phase of the fronts in a specification. By default the fronts in a spectrum all have a phase of zero; this phase alignment causes a singularity effect. To get a randomly distributed spectrum, a random phase modifier must be added.

1. Right click on the specification containing the spectrum you want to modify and navigate to the **Add->Phase Modifier** menu. Select **Random**.
2. Set the **seed** parameter to initialise the random number generator.

The time series in the visualisation should now appear randomly distributed over the repeat time.

3.1.7 Changing the angle of the spectrum

As with phase, the default angle of the fronts in the spectrum is zero. In most tanks this will create waves in the direction away from the paddles towards the beach. However, tanks where 0 degrees is in the direction facing the paddles the angle must be changed by adding an angle modifier. This process is similar to adding a phase modifier.

1. Right click on the specification and navigate to the **Add->Angle Modifier->Change** sub menu. As with the spectrum types, the options here are defined by expressions in the options. An expression **Change** is available in the default install settings: this simply changes the angle on all fronts in the specification. Select this option.
2. Set the angle to the direction you want to create the waves in.

See Working with other coordinate systems for more details.

3.1.8 Adding angle spreading

The spectrum you have just created is a *long crested* sea state: all of the fronts have the same angle. To create a *short crested* sea state the angle of each front must be modified by adding an **angle modifier**. This process is similar to adding a phase modifier.

1. If you added an angle change modifier in the previous section, remove it by right clicking on it and selecting **Remove**. Only one modifier of each type may be added to a wave specification.
2. Right click on the specification and navigate to the **Add->Angle Modifier->Spread** sub menu. As with the spectrum types, the options here are defined by expressions in the options. The install default spreading expression is called **S**, select this option.
3. Enter the desired parameters, and select whether you want to use a Cos2S or CosS spreading function.

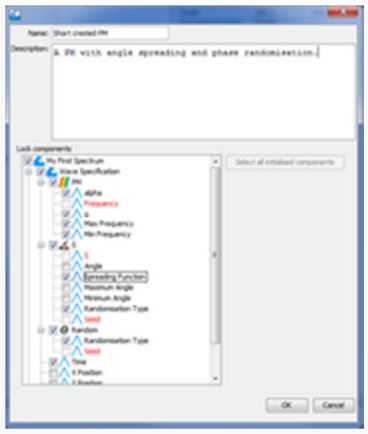
4. In a tank with a reverse coordinate system, you may want to enter 180 degrees in the **Angle** parameter, and set the maximum and minimum angle appropriately. See Working with other coordinate systems for more details.
5. Use the visualisation to check the results.

3.1.9 Using Templates

Templates are partially ready-made waves which can have components already added and parameters initialised. They are useful if you often need to create similar waves with only a small number of parameters that change.

For example, you may want to perform many tests using a randomised JONSWAP spectrum and only vary the frequency and random seed between tests. For this you could create a template called "Long crested random JONSWAP" which had the spectrum component and modifiers already added, and only the frequency and random seed parameters left uninitialised. The person setting up the experiment would then only need to create a wave run with a "Long crested random JONSWAP" wave (instead of adding a blank wave) and initialise the frequency and seed.

Templates also allow components or parameters to be **locked** (or made read-only) when they are created, preventing them from being modified. This can be used to reduce accidental errors when setting up an experiment.



Add Template window

Any wave can be made into a template. To create a template:

1. Build the components of the wave you want in the wave builder.
2. Initialise the parameters of the components as you want them in the template. If you want some parameters to be uninitialised when the template is added, delete the text of the parameter value (the parameter and components containing it will turn red indicating it is uninitialised).

3. Click on **Run->Add as Template...** in the main menu. The **Add as Template** window will appear.
4. Enter a name and description for the template.
5. Select components and parameters you want to lock in the tree below.
   - Locked parameters will be made read-only, meaning it will not be possible to modify their values and units. It is not possible to lock uninitialised parameters.
   - Locked components will not be able to be removed or added to.
6. Click OK.

To create a wave using a template:

1. Open the **Add New Wave Run** window.
2. Select the **Create a wave from a template** radio button.
3. Choose the template and click OK.

Templates can be deleted or renamed in the options.