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Emperor™ Force and Torque Testing Software

Operator Manual

Mecmesin
FORCE & TORQUE TEST SOLUTIONS
www.mecmesin.com

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Emperor™

This document relates to *Mecmesin Emperor™* system software V1.19-011. The integral software Help file is derived from this manual.

Mecmesin Force and Torque testing systems comprising MultiTest-*i*, Vortex-*i* and Helixa-*i* equipment, with Emperor™ software, have been designed as versatile and precision solutions for quality, design and production roles. This manual describes the operation of the software for control, data handling, and analysis. Before using a MultiTest-*i*, Vortex-*i* or Helixa-*i* system, you must read the accompanying manuals: *A Guide to the Safe Use of Mecmesin Mains Powered Test Frames* (431-398), and *Assembly and Installation of MultiTest-i and Vortex-i System Test Stands* (431-393), or *Assembly and Installation of the Helixa Precision Torque System* (431-396).

Scope

This reference manual covers the use of Emperor software with the following products and their derivatives:

Force testing stands		
Single-column stands	MultiTest	0.5-*i*
	MultiTest	1-*i*
	MultiTest	2.5-*i*
	MultiTest	5-*i*
	FPT-H1	Horizontal tester
Twin-column stands	MultiTest	10-*i*
	MultiTest	25-*i*
	MultiTest	50-*i*
Torque testing stands		
	Vortex-*i*	Torque cell capacities: 0.3, 1.5, 3, 6, 10 N.m
	Helixa-*i*	0.1, 0.2, 0.3, 1.0, 1.5, 3, 6 N.m

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Contents

1. Introduction

1.1 What is Emperor?

Emperor™ is Mecmesin's top-range software for use with Mecmesin force and torque test systems. With it, you will write test programs to control test stands through test sequences, gather detailed data from those tests, apply calculations to analyse the data, present the results, and deliver them, and/or the raw data, to other destinations.

1.2 Using this manual

The purpose of this manual is to get you up and running quickly by taking you through:

- installing the software and adding users
- configuring the system for the way you want to work
- understanding the testing environment
- configuring the test environment preferences and defaults
- configuring report and data export templates
- compiling and running test programs
- adding calculations

The appendices provide background information and explanations.

The following stylistic conventions are used in the text:

Onscreen Button or keyboard character to press.

Program Set-up > *Calculations* for directions via a sequence of menu options.

[Report Templates] for the tab name for a particular page of settings.

'Graph Title' for the name of a data entry field/box.

2. Setting-up the Emperor Software

2.1 Your system

A Mecmesin force or torque testing system comprises:

- Emperor™ control, data acquisition and analysis software on a PC

- a motorised test stand connected via USB to, and controlled by, the PC

- an intelligent loadcell (ILC) or torque cell (ITC) mounted on the test stand, which communicates with the Emperor software.

This manual covers the Emperor software. A separate *Assembly and Installation* guide covers the operation of test stands and loadcells, and a *Guide to Safe Use of Mains Powered Test Stands* must be referred to before operating any Mecmesin test system.

The minimum specification for the PC or laptop to be used is 2 GB RAM and 60 GB free space on the hard drive, running Windows™ XP Pro with SP1, or above. A CD drive is required for installation. At least one USB port or one RS232 port are required for attaching to the system.

Note: Emperor software is not available for Linux or Apple Macintosh operating systems.

2.2 Installing the Emperor software

2.2.1 Access to data folders

Emperor requires access to certain folders listed below. Before installing the program, please make sure that read and write access is granted for these folders. In particular, if the computer is part of a centrally-controlled Windows Domain system, it may be necessary to consult with your IT department to allow correct access to these locations.

Windows XP : User Data location	
Emperor Force	C:\Documents and Settings\All Users\Application Data\Mecmesin\Emperor\Force
Emperor Torque	C:\Documents and Settings\All Users\Application Data\Mecmesin\Emperor\Torque
Windows Vista or **Windows 7** : User Data location	
Emperor Force	C:\ProgramData\Mecmesin\Emperor\Force
Emperor Torque	C:\ProgramData\Mecmesin\Emperor\Torque
All Windows versions : Program files location	
Emperor Force	C:\Program Files (x86)\Emperor\Force
Emperor Torque	C:\Program Files (x86)\Emperor\Torque

2.3 Install from CD

Place the Emperor CD in the CD drive and close it. Emperor should start automatically and ask if you wish to proceed with the installation of the software. If not, and you see a permissions alert, you may need instead to right click the Setup file in File Explorer, and select 'Run as administrator'.

If the installation program does not start automatically:

- On your computer desktop, click on the shortcut to 'My Computer'

- Click on the CD drive that contains the Emperor software CD

- Navigate to the \Emperor folder

- Double click the 'Setup.exe' file

The InstallShield Wizard will now take you through the process with a series of prompts:

- When prompted to continue, click `Next >`

- Accept the terms of the license agreement.

- Select the language you need to have installed, or all languages.

Emperor will now be installed on the PC. When complete, remove the CD from the drive and store in a safe place.

2.4 Running the software

Before running the Emperor control software, your PC should be connected to a test stand with an appropriate ILC/ITC connected to it, and switched on. Before it loads, Emperor will check the following.

> Is the PC is connected to a test stand, switched on, and with an ILC/ITC connected to the test stand?

If not, a warning message is given. Using the `OK` button will still allow the software to load, but in 'limited functionality' mode. Any further attempt to address the test stand will produce an appropriate warning message, so while existing test data can be inspected and processed, new test data cannot be accumulated.

> Does the loadcell match the software?

Loading Emperor Force with a Torque stand attached, or Emperor Torque with a Force stand results in a warning message, and the `OK` button will close Emperor.

> Is the ILC/ITC still in calibration?

If the calibration for the attached loadcell has expired, a message will recommend that you contact Mecmesin or your authorised distributor.

> Is a significant (20% of loadcell capacity) residual load being registered by the ILC/ITC?

If a power failure occurs, or a system has been switched off whilst still under load, a warning message will ask how you want to respond (using either the software or hardware direction buttons). Click Yes to tare the load (display zero) or No to leave the current load reading; either will allow the software to continue loading.
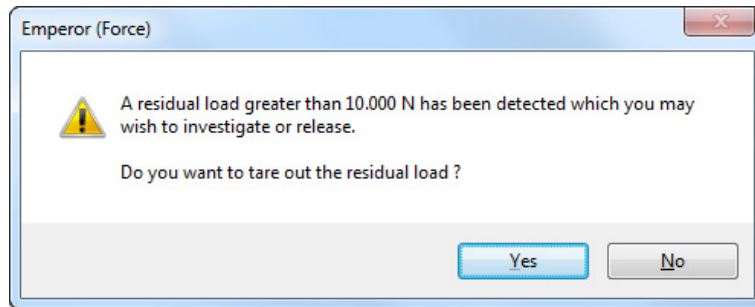
> Is the test stand reporting an unresolved fault condition?

Any other fault within the test stand will produce a message advising the operator to contact their Mecmesin agent.

When starting up, Emperor will also advise the operator if:

- an ILC/ITC is detected that has not previously been connected to the system. Emperor will then update its database of available loadcells.

- the capacity of the connected loadcell is less than the current software 'maximum load' setting. Emperor will automatically reduce this setting to the capacity of the loadcell.

2.5 Logging on as a user

Emperor initially loads a 'splash screen' showing the software version, and boxes for entry of a valid Operator name and Password. Emperor has two levels of user, Master and Operator. The current operator can be identified in test results and data files.

Masters have full access to all parts of the Emperor program, including creating new users, and may create as many new masters and operators as required.

**Operators** have access that can be restricted to certain parts of the system, to prevent accidental changes to settings and programs.

Until you set up your own user accounts, you will need to use the installed default usernames and passwords. These are case sensitive:

Status	User name	Password
Operator	operator	operator
Master	supervisor	supervisor

3. Console Mode

When you log on to Emperor, you are given a choice of operating mode:
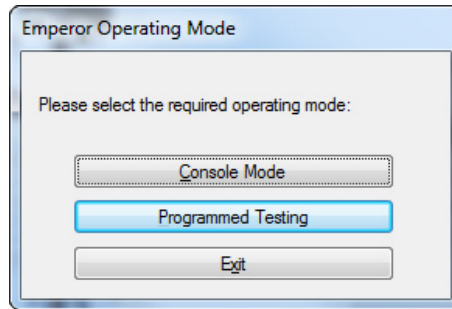
Normally you will use Programmed Testing, but Console Mode has been designed for routine operation of repeated standard tests by operators who will require minimal training. Programs to run under Console Mode can be written in this mode, or as a full program under Programmed Testing and then run in this mode.

Console Mode drives the Mecmesin-*xt* range of testers using their side-arm touch-screen tablets, and the documentation for this mode can be found in the manual *Emperor™ Programming for Mecmesin xt Force and Torque Test Systems* (431-389). Operation is described in terms of the touch-screen, but the keyboard and mouse may be used as normal. Opening and closing Console Mode is within Emperor, so the logon and shutdown procedures for *–xt* do not apply.

4. System Settings

4.1 Adding new operators and master user accounts

Log on as a master user and go to the top level menu: *Setup > System >* [User accounts].

To **create** a new user, add the user details of name (alphanumeric, no spaces), password and type, then click Add .

To **remove** a user, select the user on the left and click Remove .

> You cannot delete all Master user accounts, one must remain for full access. By all means rename the 'supervisor' account more securely, but add other master users by name.

To **change** the profile of a user, first select the name on the left, make the required changes, then click Change .

Automatically log on this user: If there is mainly one user, running mainly one test in Console mode, you can set Emperor to automatically open with this user account and optionally, with a Favourite test program. To operate differently, all that is required is to Log out (File menu), and you will be returned to the normal splash screen to log on as a different user and with no default test program. ('Query operating mode' means ask the user when they log on.)
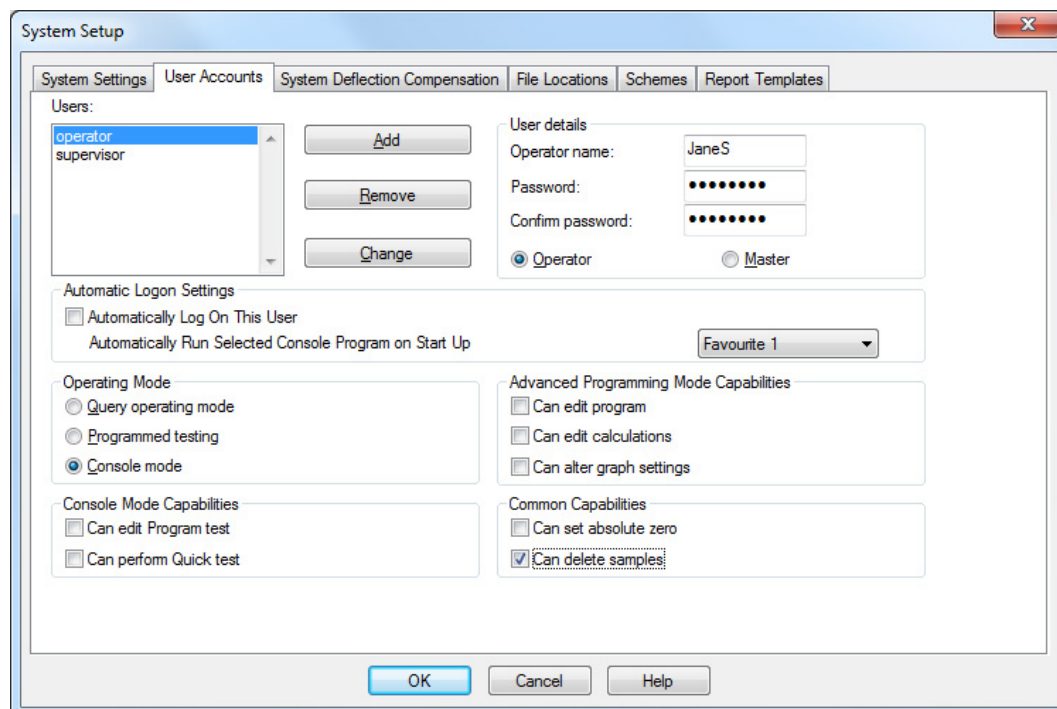
JaneS is being added as an Operator, using the Favourite 1 program, in console mode, with restricted capabilities

**Automatically Run Selected Console Program on Start Up**

In Console mode, the five most-used 'Favourite' programs can be allocated to single-button running. If one of these favourites is also chosen from the drop-down list as the default program, the user's operating mode must also be set to Console mode.

To change the automatically logged-on user, login as a Master user, select their name from the list on the left, then uncheck the automatic setting and then click Change .

Some system settings are important for initial installation and use. Others, such as data export schemes, reporting templates, and system deflection you will return to as your testing requirements evolve, but it is important to know about them from the start. think of System Settings as resources for different test scenarios.

4.2 Connecting to the test stand

Emperor must be set up for operation *with the attached stand and load/torque cell*.
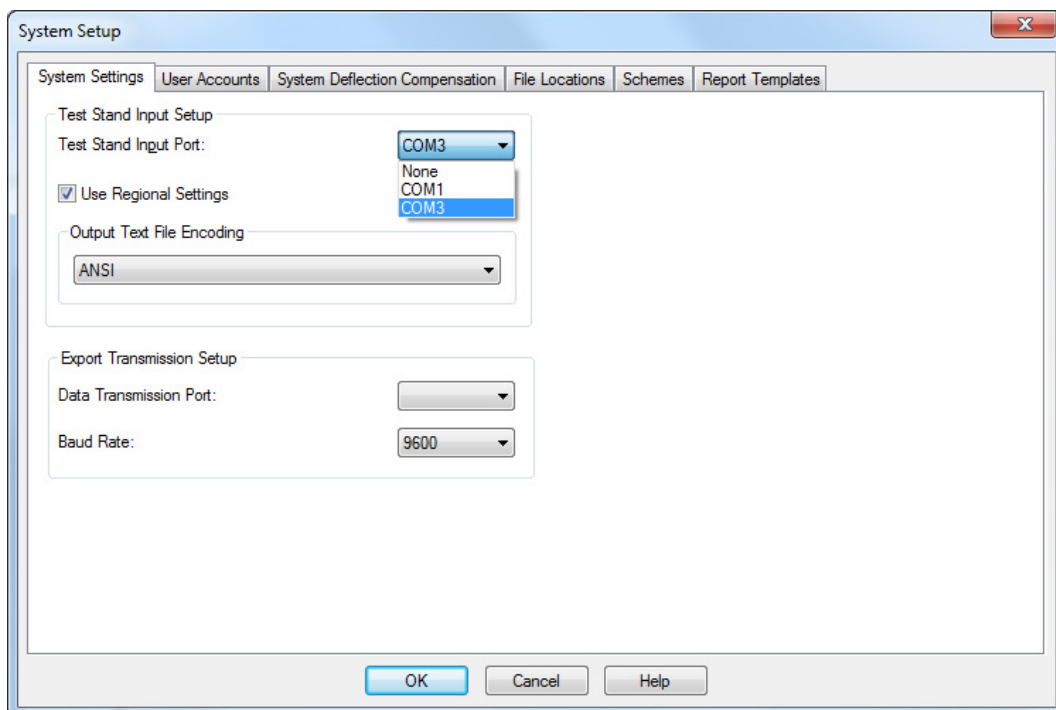
Setup Menu: System settings for communicating with hardware

The drop-down list against 'Test Stand Input Port' will include the PC port to which you have connected the stand. If you are unsure which port to select, your IT department should be able to advise.

You can also set up a port for data export here in the same way. This is only required if you need to stream data to an external device.

4.3 System Deflection Compensation (SDC)

Under high loads, a very small element of measured displacement may be due to flexing within the system (test stand, loadcell and fixtures) rather than in the sample under test. The force to create a given displacement may therefore be slightly over-indicated. This system deflection can be measured and compensated for. It can be important where deflection in the sample is similar in magnitude to that in the system, and where very accurate readings are required. SDC is mainly used in top-load testing.
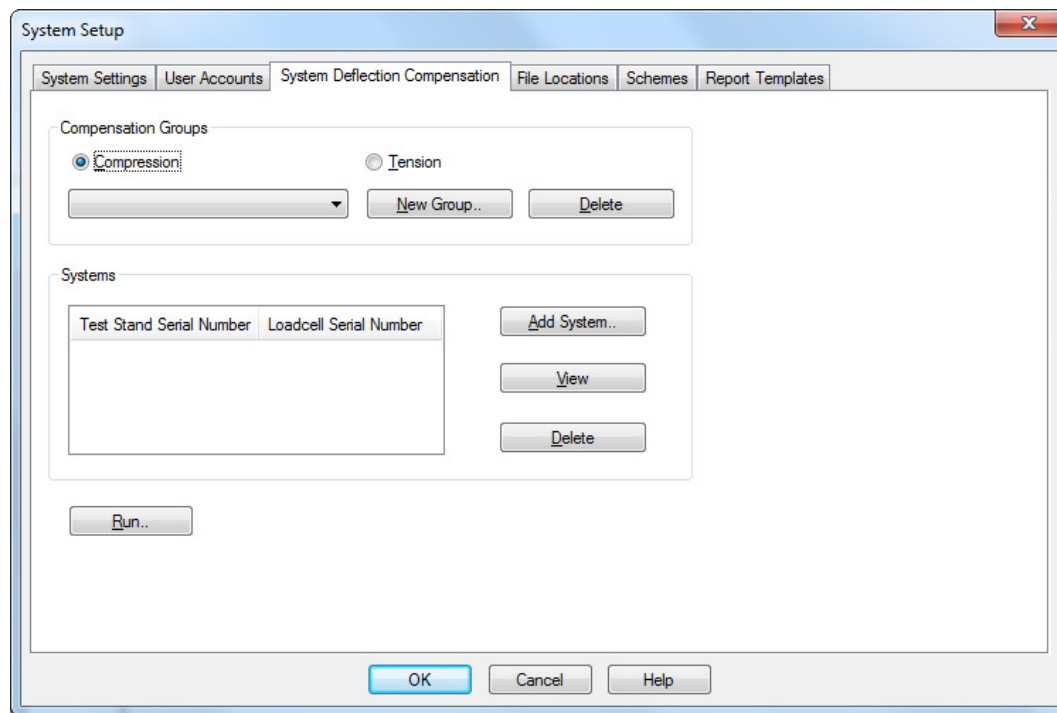
Emperor can store compensation data from different combinations of gripping accessories (called 'Groups') for different loadcells, and apply it to the setup in use.

To indicate if a sample has been measured with SDC turned on, add an INFORMATION command to the **calculations**, which will show the SDC status in the results.

4.3.1 SDC Groups and Systems

System Deflection Compensation becomes available once you have performed a calibration for each Group and System for which you want to use compensated results:

- A **Group** is a fixing assembly, which might be as simple as a compression plate and the anvil plate, or could be any combination of different gripping accessories fixed to the loadcell and the anvil plate. A Group can be used with several stand and loadcell combinations.

- A **System** is the combination of the test stand and a loadcell. In practice you might have one stand, with perhaps two or three loadcells. Each combination of test stand and loadcell is a different System.

Examples:

Group	System
50mm compression plate	Mt 1-i Stand, serial No. 10-1015-01 ILC 500N, serial No. 10-2056-10
	Mt 1-i Stand, serial No. 10-1015-01 ILC 1000N, serial No. 10-1080-20
Small Single-action vice plus multi-jaw grip	Mt 1-i Stand, serial No. 10-1015-01 ILC 200N, serial No. 10-1945-10
	Mt 2.5-i Stand, serial No. 10-1020-01 ILC 500N, serial No. 10-2056-10

Creating an SDC data file

- Attach the required stand accessories (grips, plate, probe) without a sample. For force stands requiring compensation corrections in the compression direction, place the compression plate or probe very close to the anvil.

- Go to *Setup* > *System* > [System Deflection Compensation] tab and click Run . This will introduce the built-in SDC program by requesting the direction of the test.

- If a previous file exists, you will be asked to Save or Discard. Click Discard . There may then be advisory alerts regarding adjusting certain parameters to the stand. Click OK for these.

- At the graph display, click Start to run the SDC test.

At this point, alerts are given to ensure you have assembled the SDC Group correctly.

- When prompted, add the maximum load in newtons up to which to test.

The SDC test will now run, with progress alerts indicating a bedding-in run to 90 per cent of the maximum load, followed by a second run to 95 per cent. The test will end with confirmation that the file has been saved.

- Return to *Setup* > *System* > [System Deflection Compensation] tab.

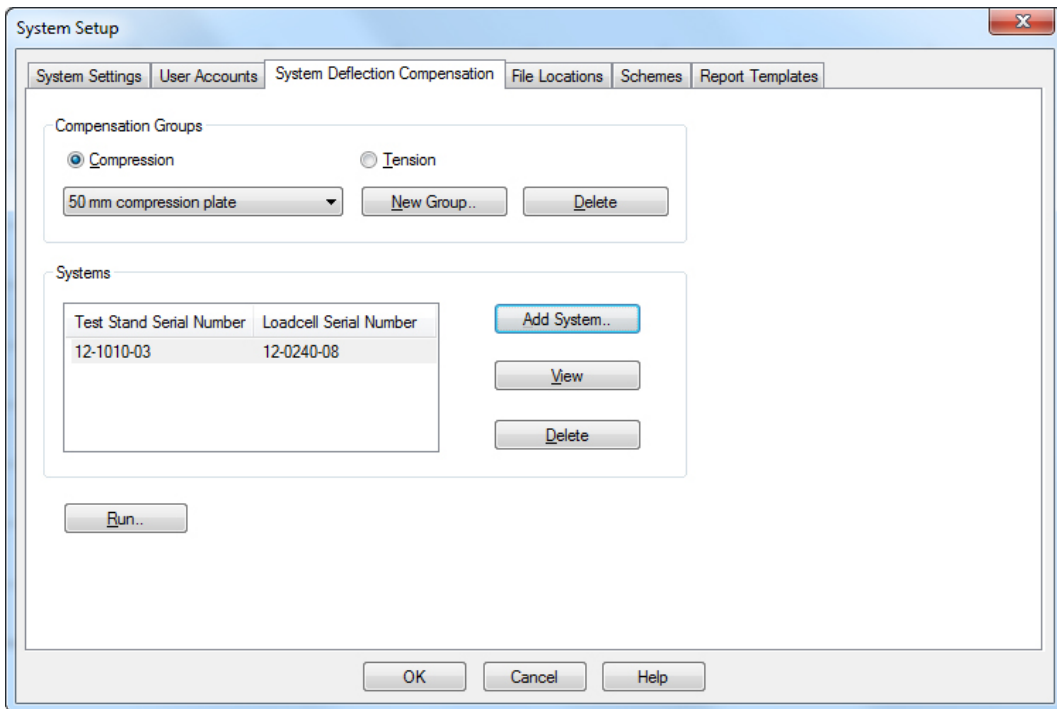You will now create a Group relating to the accessories used.

- Click New Group to name and create a new compensation Group (e.g. 50 mm compression plate):
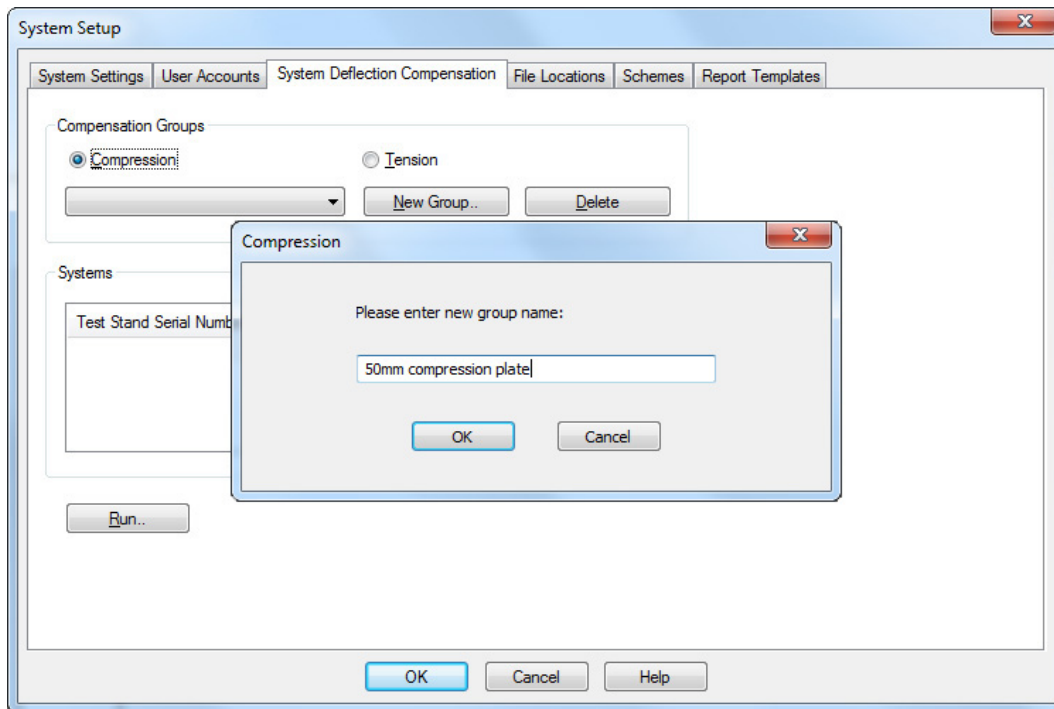
- Now add the System (test stand and loadcell):
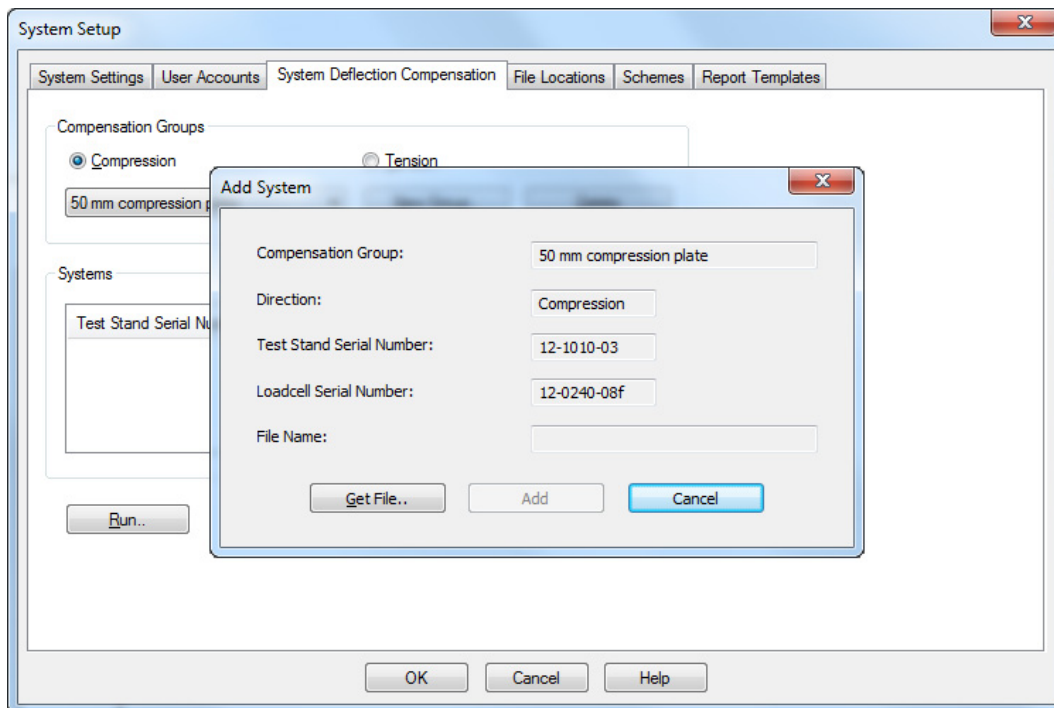
- Click Get File to access the System Deflect folder, and select the appropriate file (as just saved) for the direction of the SDC test, then click Add to complete the SDC setting:

SDC for 50 mm compression plate attached to loadcell 12-0240-08 on stand serial no. 12-1010-03

Using an SDC data file

To use the compensation data when writing a test program, tick the 'System Deflection Compensation' check-box in *Setup* > *Preferences* > [General] tab. All preference settings are stored with the test program library file. The relevant Available Groups for the direction of the test will be displayed in the drop-down box—choose the group you require.

Note: Emperor always knows which test stand and loadcell (System) are in use, but cannot automatically identify which fixing accessories (Group) are attached. It is important to check that the SDC Group selected matches the accessories fitted.

When adding results to a file where SDC has been used, the same stand, loadcell and fixtures must be used.

4.4 Setting file locations

You can leave the default file locations for these files (which will depend on your version of Windows), or allocate a different or networked location.

Change any file location, click OK and log off and on again for the change to take effect.
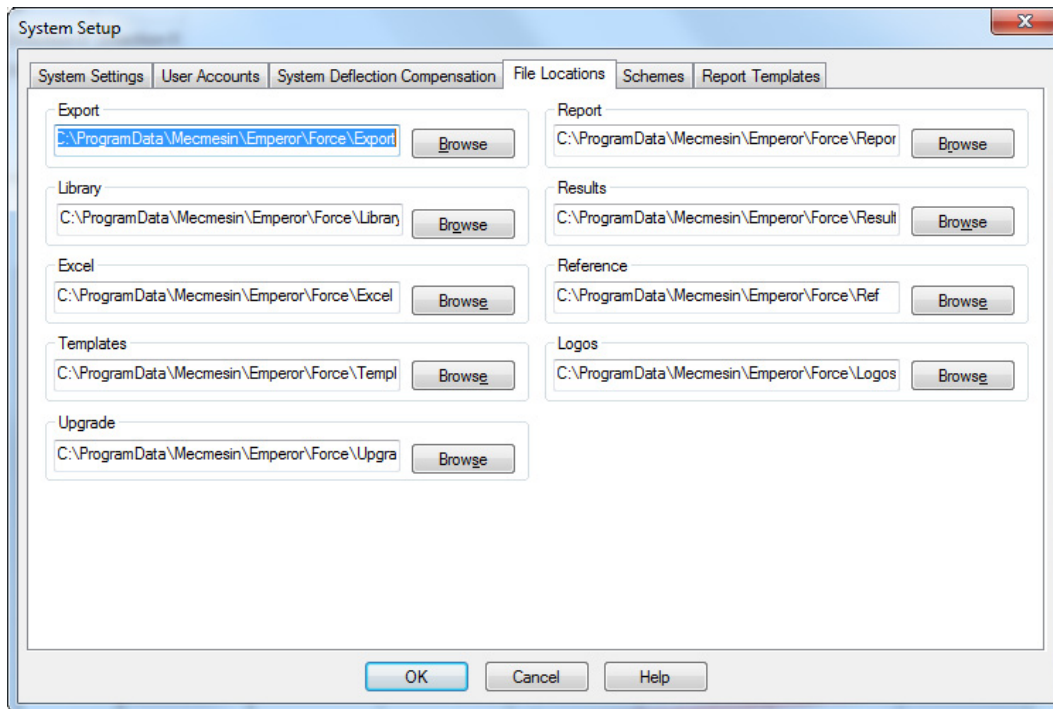
4.5 Using and creating data schemes

Data schemes are templates defining how results data are arranged for export. Data may be exported as raw data (all data points recorded) or as results (profile by sample). There are default templates available, but you can create and name schemes of your own.

To begin with you don't need to do anything; read through and come back here when you start to export real data. Use the defaults at first and then decide how you need to create your own schemes.

Choose to create a scheme for either Results or Raw Data , and select New Scheme from the drop-down list, then enter a name and confirm with OK .

Now profile what you require for the Scheme and click Update to save.

Results:

Sample Orientation   Arrange samples in rows or columns

Display Options   Include headers for results, samples and display units

Statistics Output Options Include the statistical information you require

Overall Result   Show 'Pass' and 'Fail' against combined criteria for all verified calculations. Hidden results are those results used in calculations that have been chosen not to be displayed (see Appendix D, *A Note on Overall Result and Hidden Results*).
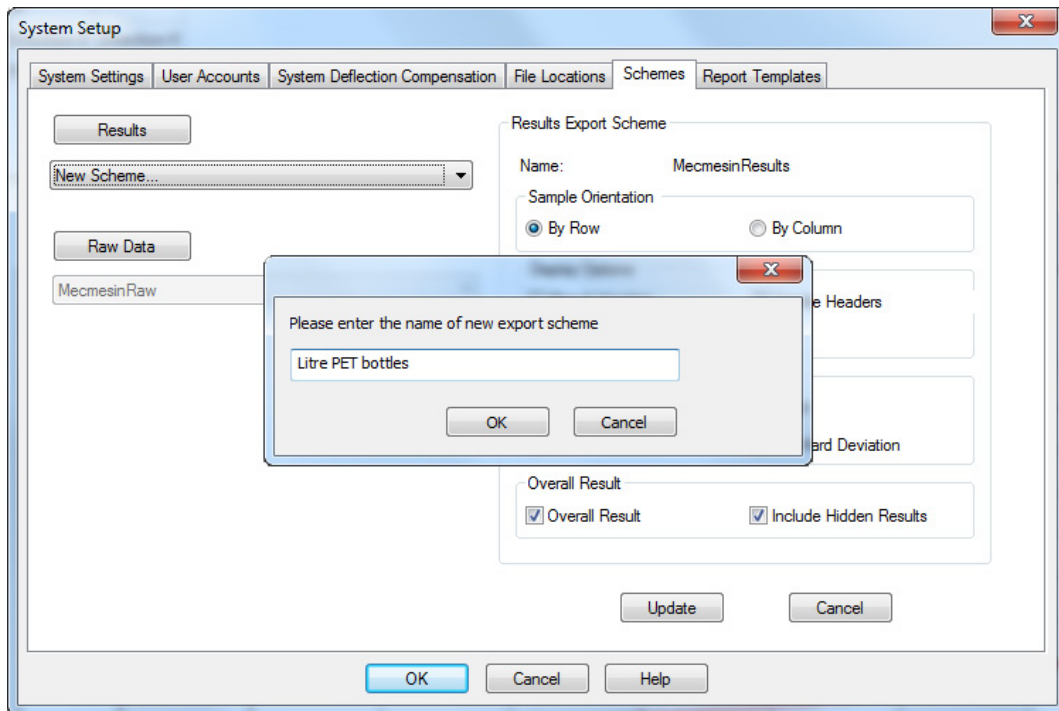
Raw Data:

Header Options   Include those header elements you require.

Display Options   Choose which elements to include (e.g. HHHH or distance may not both be important). Choose also the order in which data are exported (column sequence). This applies also to Excel exports, where Excel is used for further graphical presentation and column sequence will matter. To re-order, select an item and use the ⬆ and ⬇ arrow buttons to move it up or down.
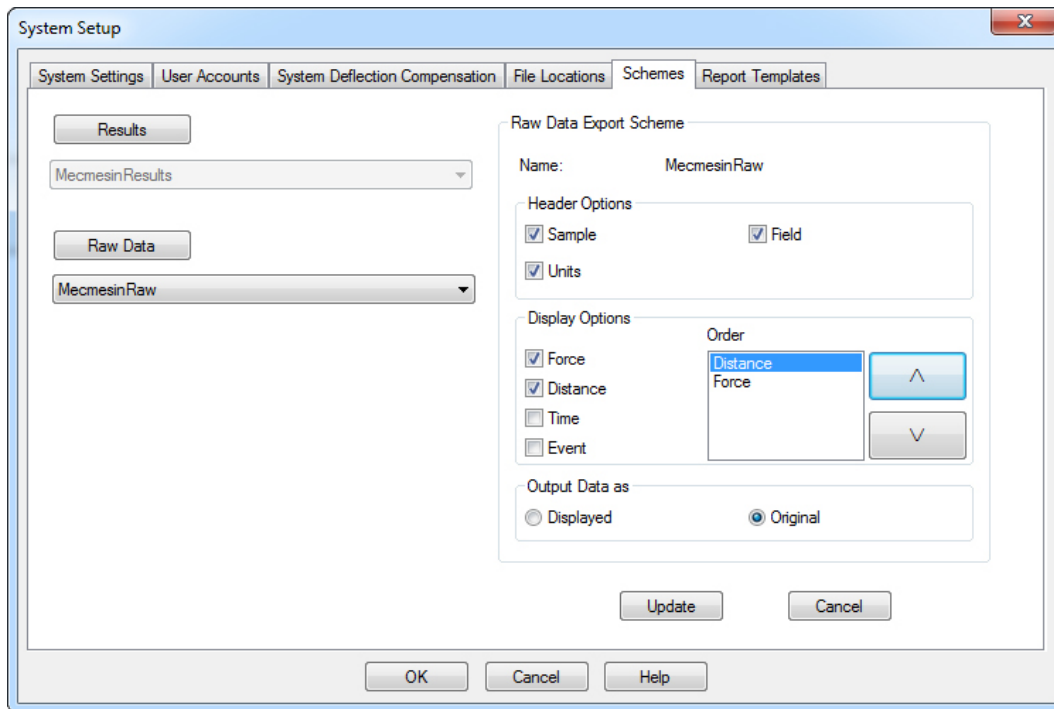
Output Data as   'Original' data is without display options, whereas 'Displayed' might include Preferences such as accumulative displacement under graph settings.

4.6 Report templates

Report templates enable you to customise the layout of printed reports of results. You can define two logos, headers and footers, the layout of the data itself, and whether to include a graph.

> To begin with you don't need to do anything; read through and come back here when you start to report real data. Use the default template at first and then decide how you need to create your own templates for different tests.

4.6.1 Add or edit a report template

You can edit a report template or add your own. You might prefer to leave the Mecmesin default template as a permanent reference.
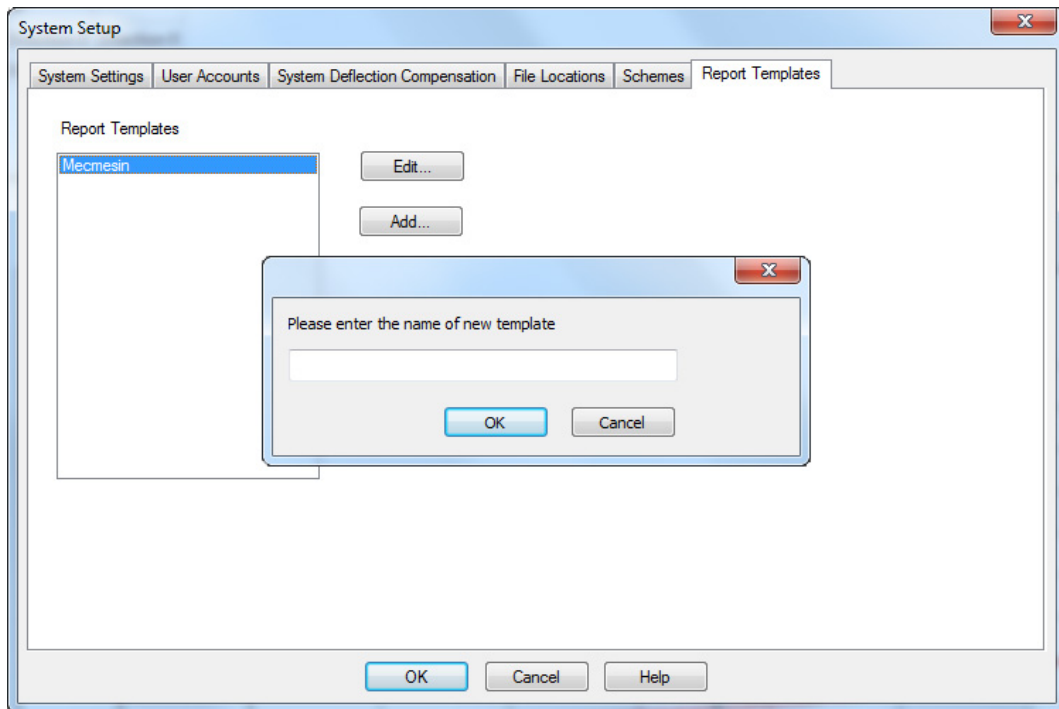
Add and name your template (or select a name and Edit) to bring up the Report Template Wizard.

Logos

The first option is to add logos top left and top right. You might choose to use your own along with that or a client or product. Double click either logo box for a Windows browser to list your images, which must be stored in the file location for Logos, as set in the *Set-up > System >* [File Locations] tab. Any images you use must be in bitmap format. You may need to resize images to avoid very large files.

> **No bitmap?**
>
> You can open any image you have in Windows Paint (in Windows, Accessories—or right click the file name in Windows Explorer and choose *Open With > Paint*), and Save As a 24-bit bitmap into the Logos file location.
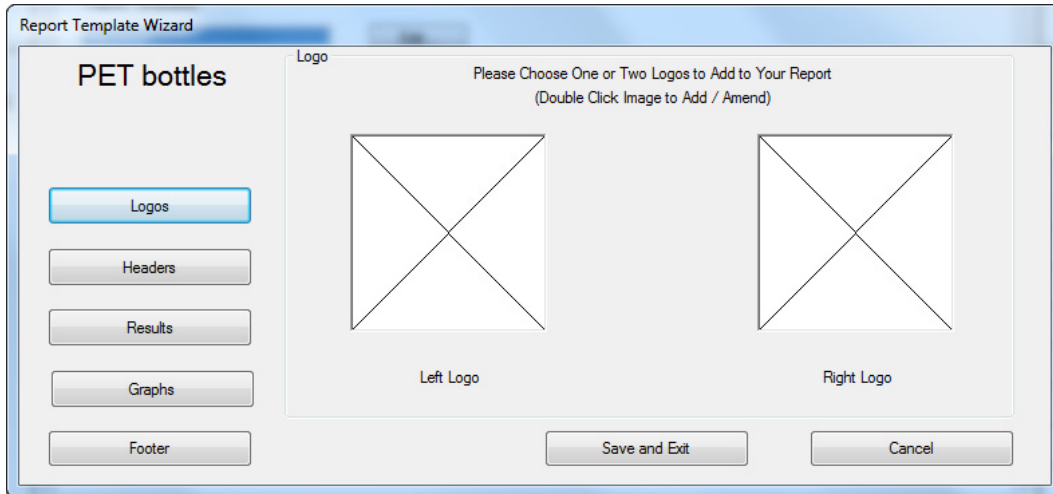
Note: Images cannot be linked from anywhere other than the defined File Location for Logos (see 4.4, *Setting file locations*).

Remember to Save and Exit before you leave the Wizard.

Headers and Footers

Headers and Footers both work in the same way. Available elements are listed in the box at the top, and the two boxes below represent left and right print areas. The content for each of these items is added before a test is run and the results saved, under *Test > Notes*.

Select each item you want to include and use the $\triangledown$ down arrow above the respective box to add it.

To move an item out of the used list, back into the available list, select the item and use the $\triangle$ up arrow.

To change the order of header or footer contents, left or right, select the item and use the $\triangle$ and $\triangledown$ arrows to the right of the box.
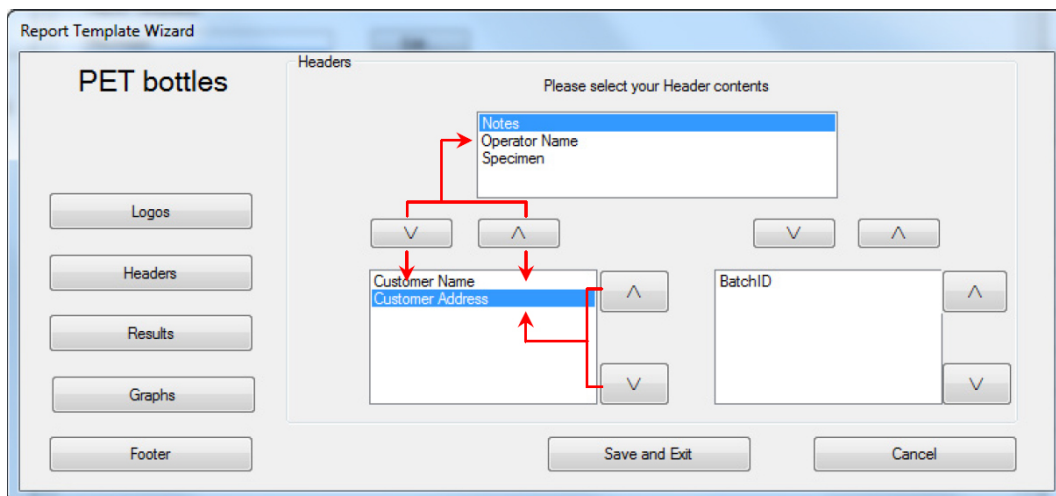
Remember to Save and Exit before you leave the Wizard.

Results

The title of your template now shows top left. You may now decide what you want to appear as a heading for the results section, what to include, and how to lay it out:

Note that if you choose to include bad samples, these will be listed in report results, so you may want to include a calculation line INFORMATION, showing 'Bad sample reason'.

Remember to Save and Exit before you leave the Wizard.

Graphs

This option simply allows you to choose whether to include a graph or not, and to give it a report section heading.

Printing

Report templates only define content, not final appearance. More often than not, a landscape paper orientation is required. This is set in *File* > *Print Set-up*.

4.6.2 Deleting a report template

To completely remove a report template, navigate to the Emperor data files and the \Templates folder, and locate the .xml file with the appropriate template name, for deletion.

5. The Programmed Testing Environment

5.1 Menus

5.1.1 File menu

New
: Opens a new, empty, program file. Any other file currently open will be closed with appropriate warnings to save.

Open
: Opens the last used folder for Results files (.for). Library Programs (.lif) are not 'opened', but 'loaded'.

Save
: Saves the current results file, if changed.

Save As
: Saves the current results to a new file name. Here you are invited also to manage file size by selecting 'Individual' samples or 'All the same', to Compress, Cut or Crop the data (See Appendix C.2, *Managing File Size*).
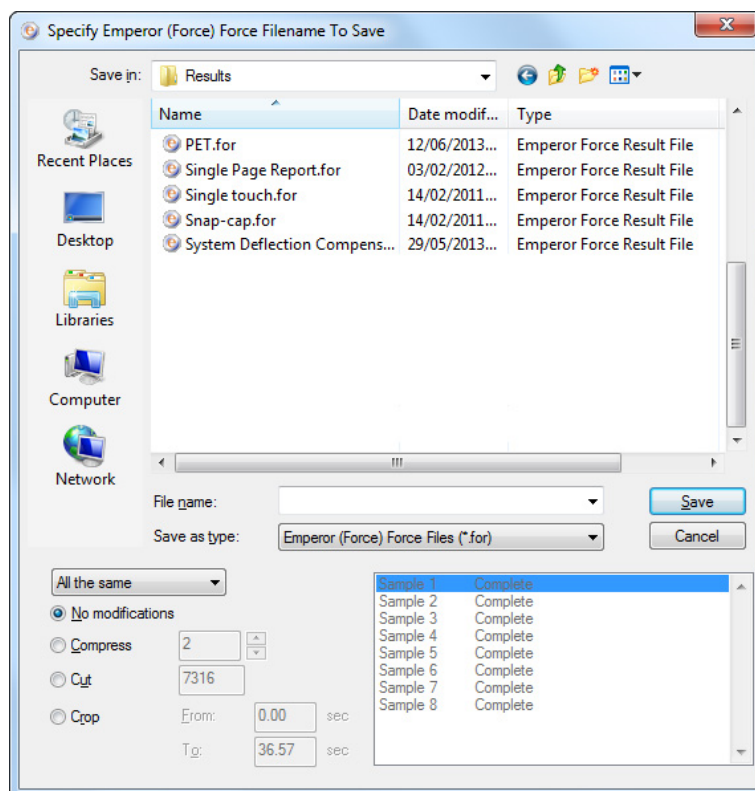
Load Library Program Loads a test program, ready to run.

Save Library Program Saves an edited program, with a prompt about overwriting the original Yes or creating a new file No .

Print Setup
: Select your printer, and print options, including paper orientation.

Print Report   Prints these results using the embedded report template.

Print Report Preview   Examine your results report before printing.

Print Graph   Just prints the currently displayed graph. Check your paper orientation in Print Setup: landscape may be more useful.

Export   Exports **raw data results** with options (below), when enabled for these results and a filename specified, in *Setup > Report and Data Export >* [Raw Data Export]
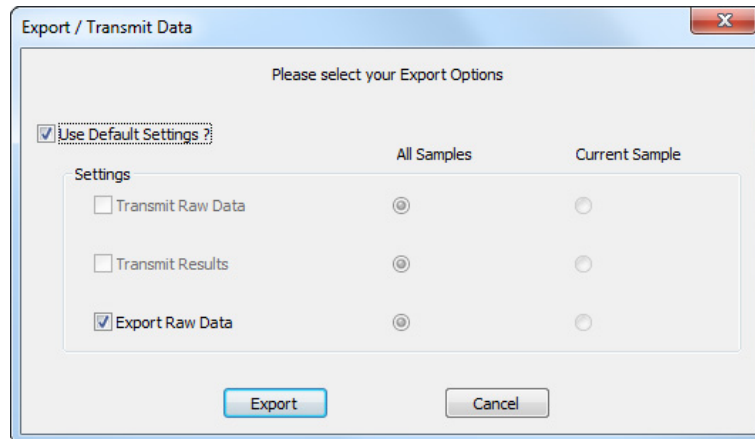
Transmit options are greyed out because *Setup > Report and Data Export >* [Transmission] options have not been enabled for these results.

Note: To export **results** only (see 7.2, *Results Data Export*):

1. *Setup > Reporting and Data Export >* [Results Data Export]
2. add the file name you want (or leave blank for a default name)
3. add the required samples to the results
4. click OK or Update to File and the file is automatically created (not by Export from the File menu)

Send to Excel   Exports raw data and/or results to Excel, with options (below), when enabled, in *Setup > Report and Data Export >* [Excel]
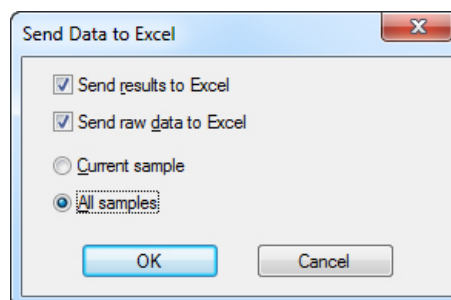
This example shows both results and raw data have been enabled. Remember that Excel has limits on its number of rows and columns that raw data can easily exceed. You may choose to cut or crop data in the Setup choices (see 7.3, *Raw Data Export*).

Recent Results Files   Links to the six most recent results files to have been used.

Recent Library Files   Links to the six most recent test programs to have been loaded.

Logout   Returns you to the Emperor splash (logon) screen.

Exit   Logs off and closes the Emperor software.

5.1.2 Test menu

Notes   Notes may be added to, and saved with, a results file and used in a report template.

The date shown is that of the last edit of the Notes. For the notes in the right-hand column, see Section 6.9, *Custom Notes*.

Program   Write (*File > New*) or edit (*File > Load Library Program*) a test program. If a results file is open, you can edit the underlying program but must save any new results to a new file.

See Section 8, *Writing an Emperor Test Program*.

Calculations   Add calculations to the data to produce results to evaluate and/or display. See Section 9, *Test Calculations*.

Results   Displays results one sample at a time, with print options
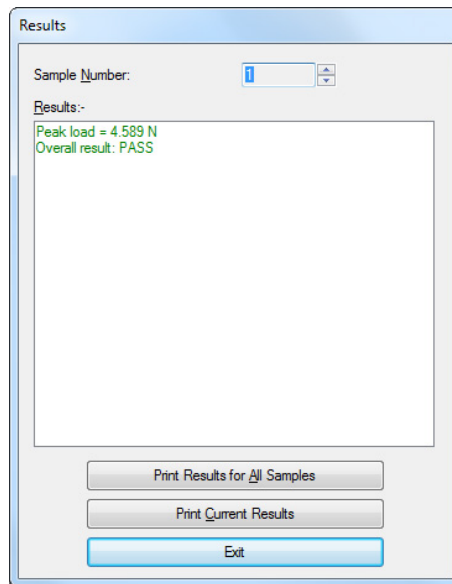
5.1.3 Display menu

Graph
Adds the Graph Toolbar (see page 28) for analysis and removes onscreen controls.

Settings
Displays the *Setup* > *Preferences* > [Graph Settings tab]. (See Section 6.4, *Graph Settings*.)

Overlays
For visual comparison, overlaying graph traces can be very useful. Overlay multiple traces from samples tested, or compare a trace with a reference file for tolerance (see Appendix: *Tolerance Bands*). Available to Master users only.

By shifting the horizontal axis for each plot, the lines can be separated in order to distinguish them better. Here an offset of 5 axis units (seconds, mm, etc.) is being set (*Display > Overlays*):
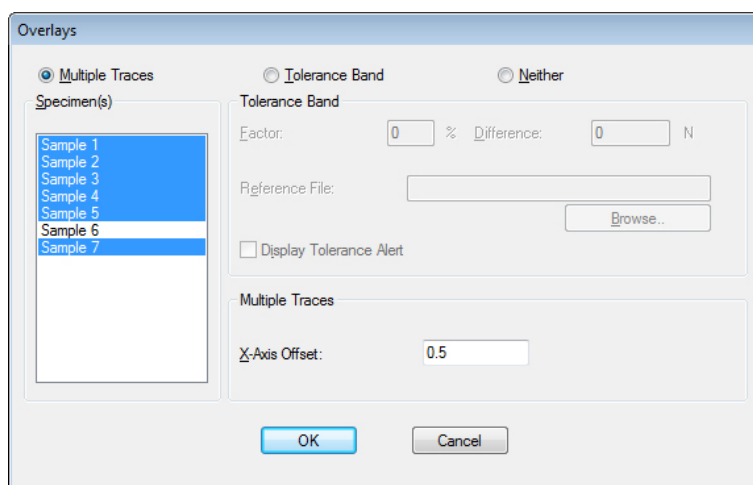
Compare the two examples below, the first without offset, the second with a 5 mm offset. (Taken from bevcan.for example results file, installed with the Emperor software.)

How offsets are displayed

- Every selected sample in the results file is assigned a sequential offset position. (In this example, Sample 6 is unselected).

- The current selected sample (displayed red) is copied out of its assigned offset position into the correct original axis position. In this way cursor snap can be applied and true values for any feature can be read.

Displayed samples	Offset position
Sample 1	1
Sample 2 (selected)	0 & 2
Sample 3	3
Sample 4	4
Sample 5	5
Sample 7	6

No overlay offset, all samples except 6 displayed:

Overlay offset, Sample 2 (blue) selected and also in (red) zero-offset display position, x-axis extended:
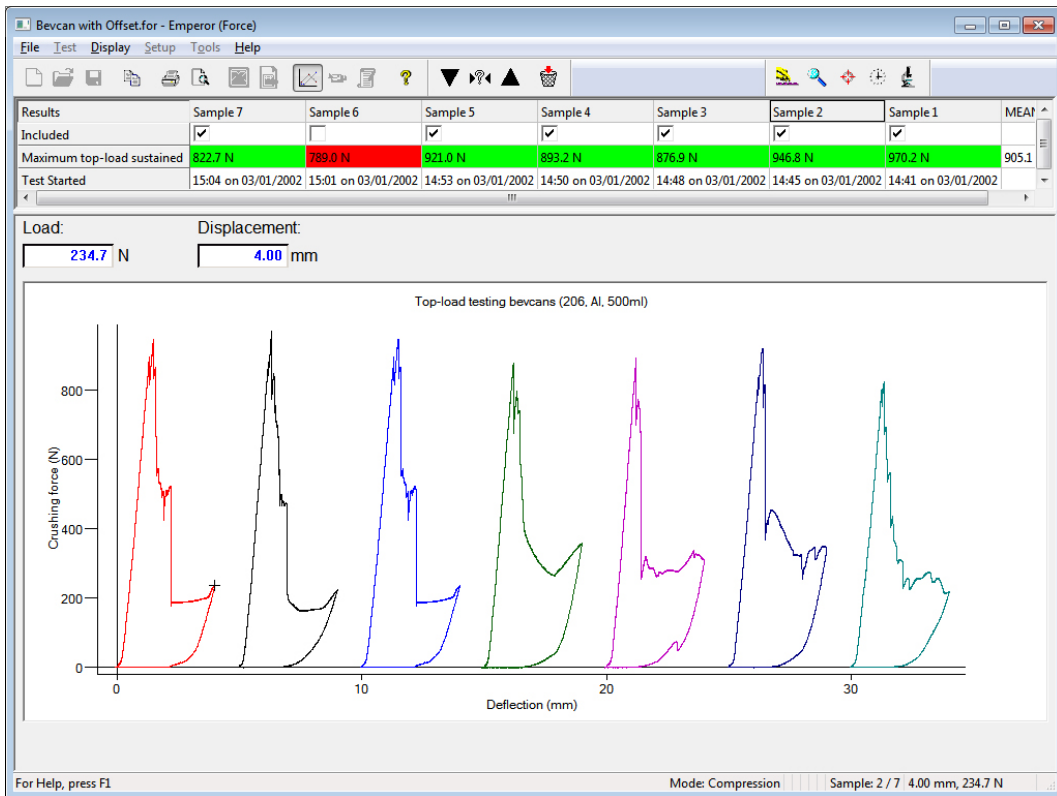
Any sample trace can also be compared against a reference file for tolerance (see Appendix: *Tolerance Bands*). Available to Master users only.

Data   Displays the data from a single sample, up to the first 32,000 points. These may be selected and copied and pasted into Excel.
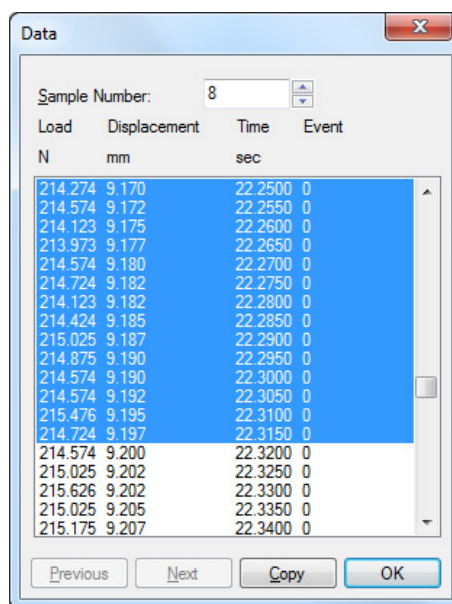
Replay	Presents the graph axes and an x-axis slider. This can be dragged across to 'replay' the graph trace whilst displaying Load, Displacement, Time and Events.
Copy Graph	In *Display > Graph* mode, this will copy the graph as an image to paste into a document elsewhere.
Interrogate	For Cursor Drop, Time Line, Review Results, see Graph Toolbar on page 28.
Summary View	Displays or hides the results panel above the graph.
Toolbars	You may choose not to display either the Standard, or the Load/Displacement (Angle) toolbar.
Status Bar	You may choose not to display the Status bar, which carries information on test mode, load, data rate, program line or cycle no., sample no., and cursor x/y co-ordinates.

5.1.4 Setup menu

Preferences

See Section 6, *Preferences*

System

See Section 4, *System Settings*

Language

Choose from the list of installed languages. Requires a restart of Emperor.

Report and Data Export

See Section 7, *Reports and Data Export*.

5.1.5 Tools menu

Service

As a troubleshooting aid, your distributor may ask you to run *Tools > Service > Diagnostic Report*. Tick to include the program and calculation details in the dialog box and save the diagnostic report to your PC desktop. Send this to them as an email attachment.

You may be asked by Mecmesin or your distributor to **Upgrade firmware** using a supplied file, with instructions.

Other **update options** may be recommended, again using distributor-supplied files.

Stand configuration provides information about your test stand and the currently attached loadcell, including its calibration dates, overload events, serial number etc.:
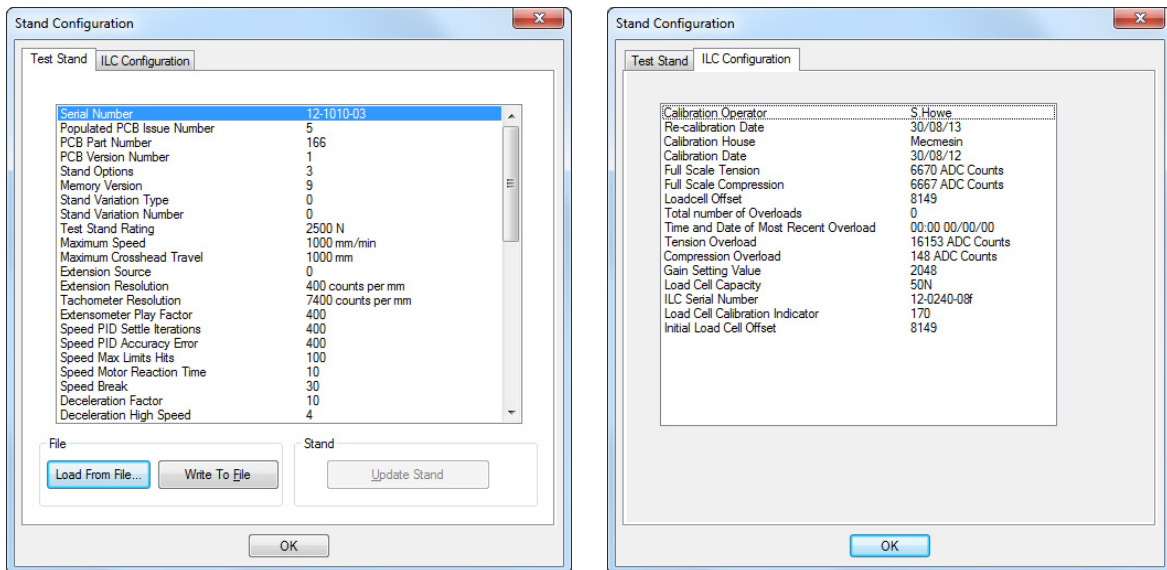
Reconnect

If the stand for any reason (e.g. overload) goes into 'limited functionality' the stand and cell have been protected by being disconnected. Remedy the situation using the stand controls and decide how to avoid the situation again, then use the Reconnect command to restore full functionality.

Recalculate Results

In most cases, when calculations are changed, you will be prompted and you will choose to recalculate results straight away, but recalculation can be done later or at any time by using this option.

5.1.6 Help
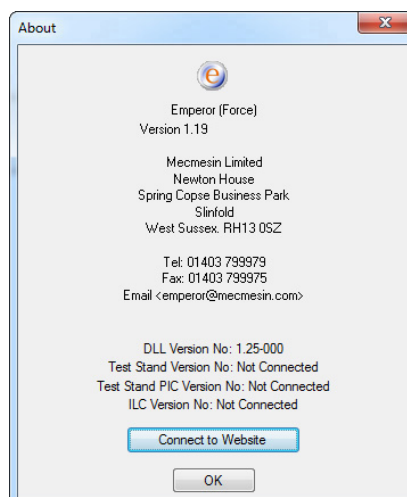
Help Topics raises the Emperor help file (based on this manual).

Email provides the appropriate address to seek technical advice from Mecmesin.

About provides version and contact information:

5.2 Test run area

The programming test screen for Emperor Force (upper) and Torque (lower, populated):
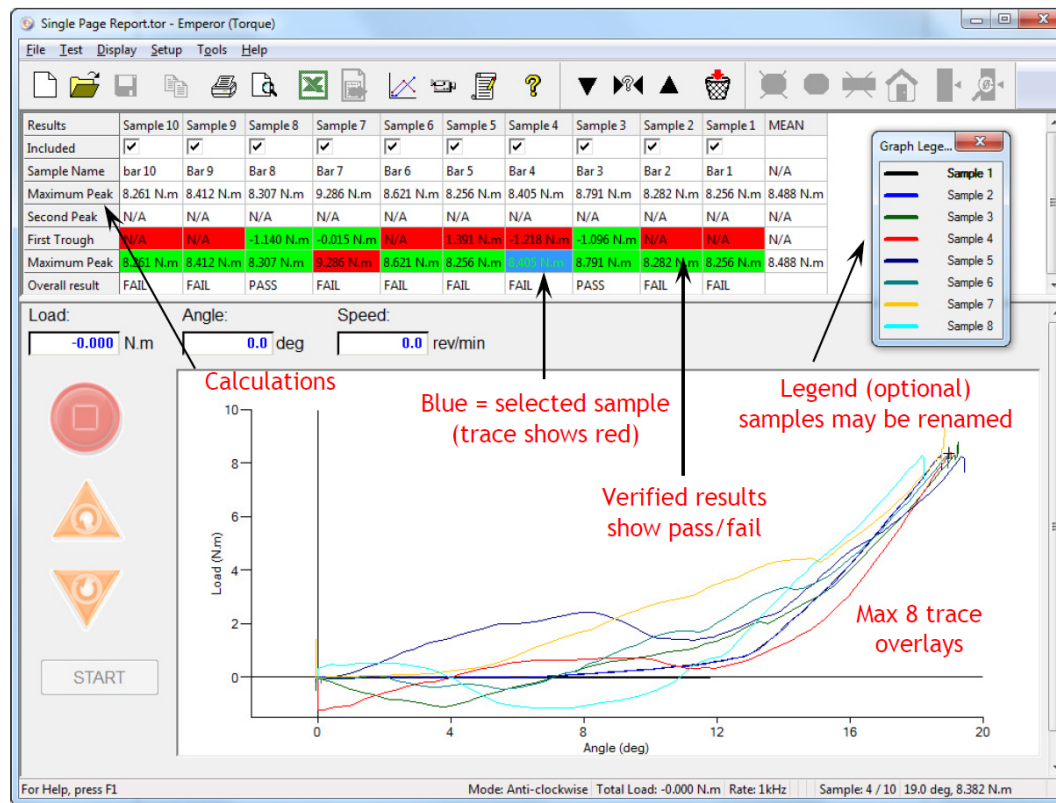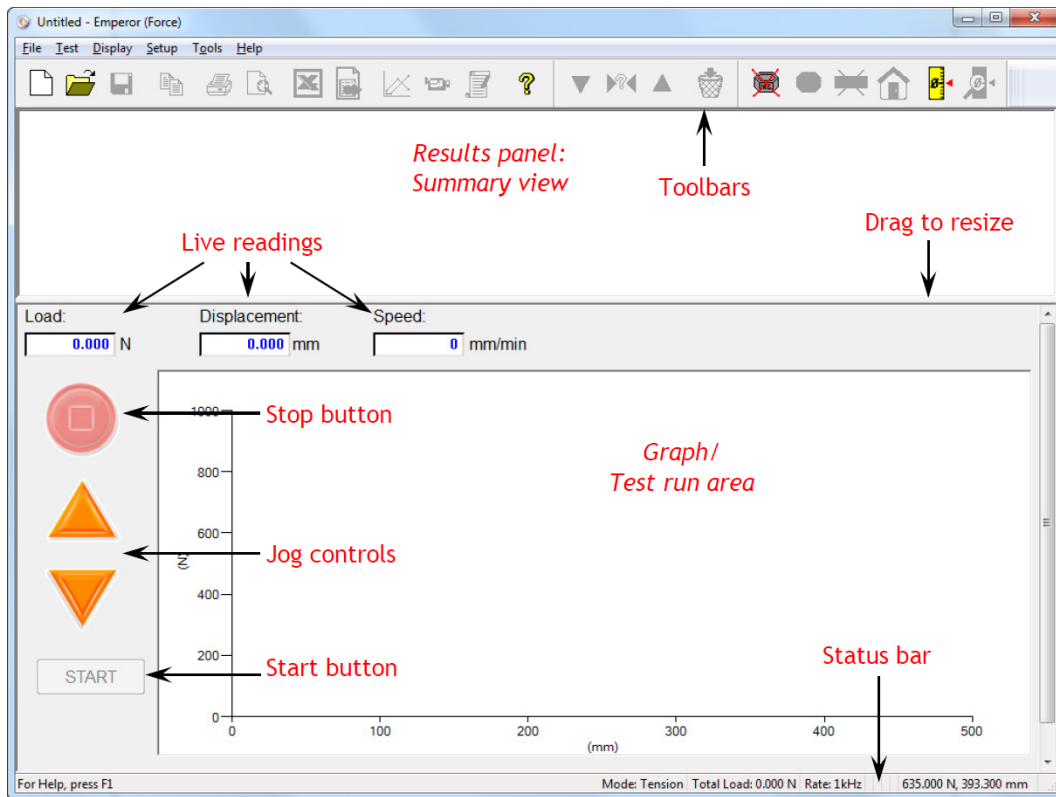
Double-click a column head to rename; 'Included' refers to reporting; selected statistics columns shown

The Programmed Testing screen can be used to control stand movement while a program is not running.

The **stop button** replicates the physical stop button. Note: `Esc` and `Space` also stop the crosshead.

The **jog controls** replicate the physical controls. **Jog Speed** is set to either Fixed (specify) or Variable in *Setup > Preferences > [General]*.

Note:

- on a *disconnected* test stand, the front panel jog buttons will move the crosshead (force) or platen (torque) a small amount at a time

- once *connected*, the crosshead or platen will move continuously to the front panel buttons

- when Jog Speed is set to *Variable*, the onscreen buttons are used to *accelerate* or *decelerate* the crosshead or platen incrementally, direction only changing at zero speed.

5.3 The Emperor toolbars
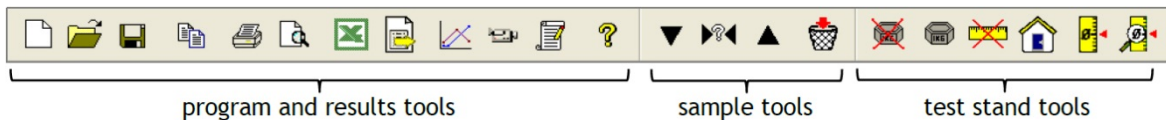
Toolbar buttons and segments are available or greyed out according to relevance. Here, for clarity, all are shown as available. Many are duplicated on the drop-down menus (e.g. *File > Open* is the first button) but also here for ease of use. Hover over a button to see its name.

The complete toolbar is in segments, with buttons for:

- managing the editing of programs and notes, handling results and files and help

- working through sample results and editing samples out

- setting baseline (zero point) parameters of the test stand and loadcell.

Program and results tools (Standard toolbar)
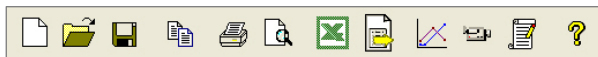
Left to right:

- **New** (also *File > New*, or Ctrl+n) gives a 'blank canvas' for writing programs.

- **Open** (also *File > Open*, or Ctrl+o) opens results files.

- **Save** (also *File > Save*, or Ctrl+s) saves results files.

Note: to load and save **Library (program) files**, use the File menu.

- **Copy Graph** is activated with the **Graph Analysis Mode** button (see below).

- The **printer** icon (*File* > *Print Report*) will send your results to print according to the default report preferences and default report template, or as amended under *Set-up* > *Report and Data Export*.

- Use the adjacent **Report Preview** button to see how your printout will look.

Printing note

On the screen graph display, the *current selected sample* trace is always picked out in red for clarity. When printing, red is not used. The first sample trace is restored to black. You may need to adjust your printer preferences as well for colour, orientation and margins.

- The standard **Excel** button and the adjacent **Export Data** button (for raw data only) become available when respective export destinations are defined in *Set-up* > *Report and Data Export*.

 Graph Analysis Mode adds the **Graph toolbar**:

 Graph Settings (also *Display* > *Settings*) allow the graph to be viewed in different ways

 Zoom allows you to drag a marquee with the mouse to select an area to examine in close-up. Click the button again to return to normal view.

 Cursor Drop (also *Display* > *Interrogate* > *Cursor Drop*) allows you to click on a data point, then click on a second position to drop in a text box with the co-ordinates. Right click the box to add a caption, move or delete the box.

Note: Cursor drop features cannot be saved, only used to annotate an immediate printout.

 The **Timeline** button (also *Display* > *Interrogate* > *Timeline*) adds an x-axis slider or sliders below the graph. (See illustration below.) This draws a vertical line for an accurate observation of the x-axis for an event along the current selected sample (always shown as a red line).

 Review Results (also *Display* > *Interrogate* > *Review Results*) allows you to click on any calculation cell for a given sample in the results panel, and see the position of this calculated value as a point, line or area on the graph. This allows the refinement of calculation values, such as limits, in line with the actual behaviour of test samples. In the case of limits, these may be repositioned with the slider controls beneath the graph to *change the calculation values in the test program* (not the test library file), which can then be saved.

Note that in Graph Analysis Mode, the cursor position in the graph is shown dynamically as coordinates in the Load, Displacement/Angle or Time boxes, and that a graph image can be copied to the Windows clipboard (right-click, Copy Graph).

The following illustrates Review Results, with Sample 5 selected, and 'Peak load 2' clicked to show the marker on the chart *within the data range set by the sliders*. Note the two sliders below the chart. This data range will be retained as the calculation limits in the results file.
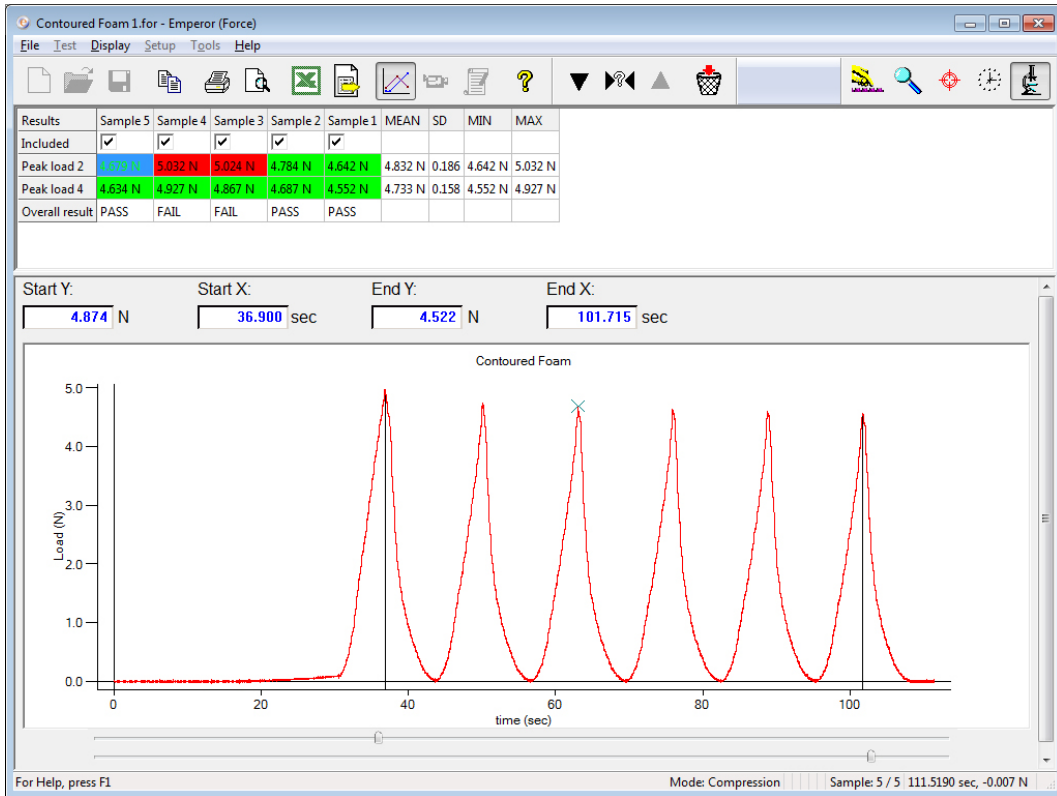
Replay

 This button switches on test replay mode, with the corresponding control toolbar:

 Play, Fast forward and Return to start, or pause (the Stop button). Alternatively, below the graph, there is a slider to progress through the test. This enables you to examine the course of a test in detail. Use Exit Replay, or click the Replay button to resume normal graph view.
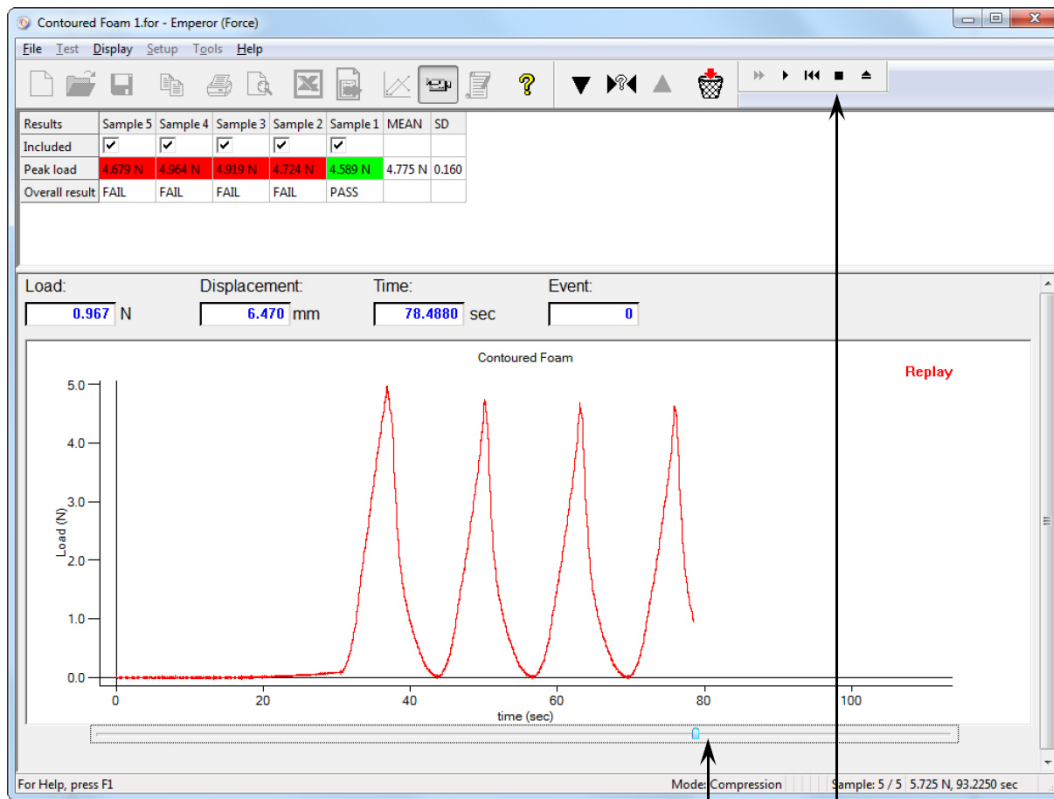
Use the slider, or replay controls

Results

 Click the **Results** button to view all results lines per sample, print any or all. **Note:** this sends results straight to the designated printer without any further print dialog.
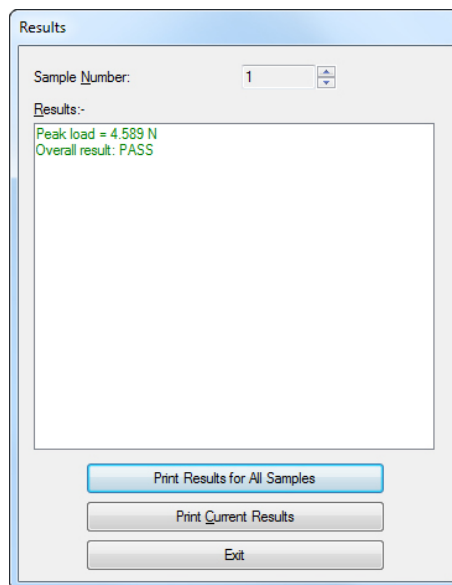
Sample tools (Specimen toolbar)

The down and up arrows take you to previous and next sample, the **?** allows you to select a sample by number:
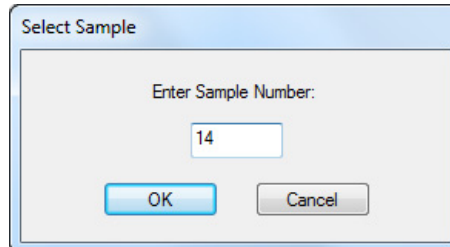
The basket button will delete the sample, i.e. remove the data. (This is a permission that has to be given explicitly to an operator in their profile.)

Test stand tools (Load/Displacement[Angle] toolbar)

This toolbar is useful for manipulating the test system and setting up tests. Most test programs will incorporate some or all of these actions as program commands.

(See also Appendix: *Relative and Absolute Positions*: Zero, Home and Start.)

Zero Load: this will set (tare) the current load reading to zero.

Restore Load: this will reset the current load reading to its true value.

Zero Displacement/Angle: this button will set (tare) the current crosshead/platen position to zero.

Home: this will return the crosshead to the Home position (relative to either last tare or to Absolute Zero as set in *Preferences*).

Set absolute zero: in relation to the current position, set Absolute Zero (stored in the system firmware, not in the software, so available after switching off and on again.)

Display absolute position: after zeroing displacement, this will restore the display to show current displacement from Absolute Zero.

> Remember, when you are changing fixtures of different dimensions, that Absolute Zero is stored in the test stand firmware, not the test program or software.

6. Preferences

Preferences are all about how your system behaves when running a test, and these parameters can only be edited by Master users, under *Set-up* **>** *Preferences*.

Preferences include:

Control

- direction of travel of the stand crosshead (force) or platen (torque)

- jog speed under software control

- crosshead/platen starting position

- limits for load, displacement, angle, time and speed

- setting the digital inputs and outputs from the test stand

Measurement

- profiling data acquisition rate and triggers from the loadcell

- choice of units for force, displacement, angle and time

Results

- settings for the display of results and graphs.

6.1 Default settings

As Emperor arrives 'out of the box', there are default settings, but your requirements may well be different, so you can edit and save your own default set of most common preferences. The parameters set in the Preference tabs will be the settings used for the current activity, and may be saved as default settings: `Save as Defaults`. These new defaults are the values to which `Restore Defaults` will go (i.e. not 'factory settings').

6.2 Test program settings

From those defaults, you can make further changes as required for writing a test program. These preferences will then be saved with the program without changing the defaults, so each program retains its own set of preferences. Use `OK` to save.

6.3 General preferences
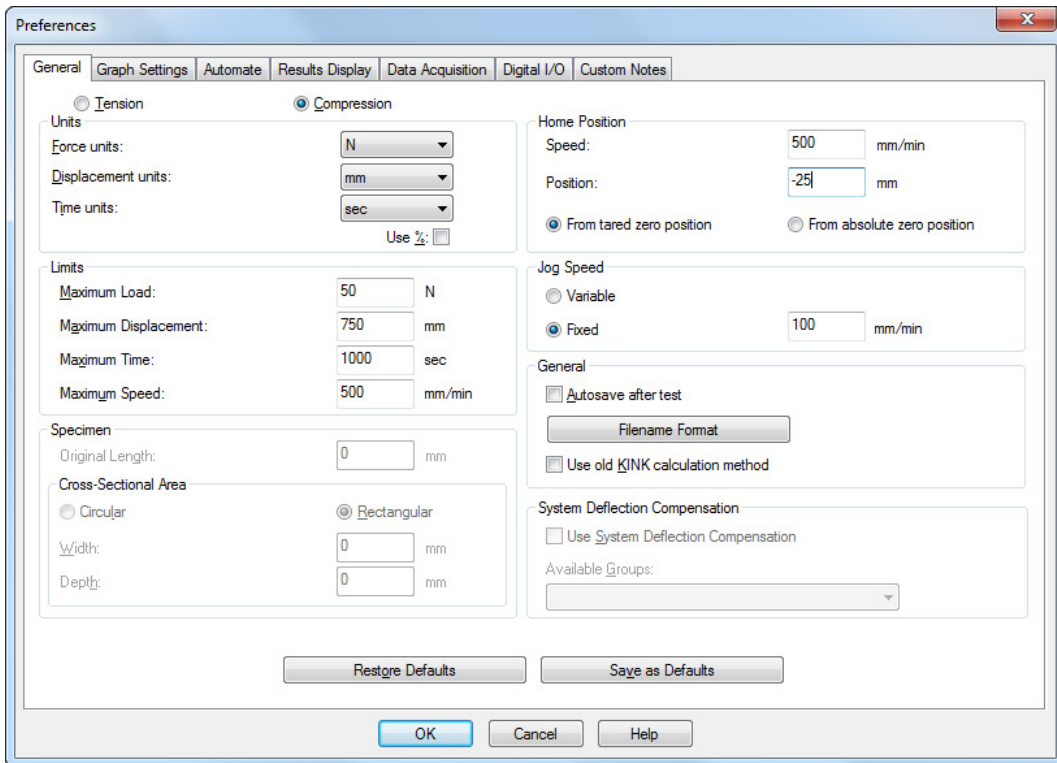
General preferences for Emperor force, above, and below, Emperor torque
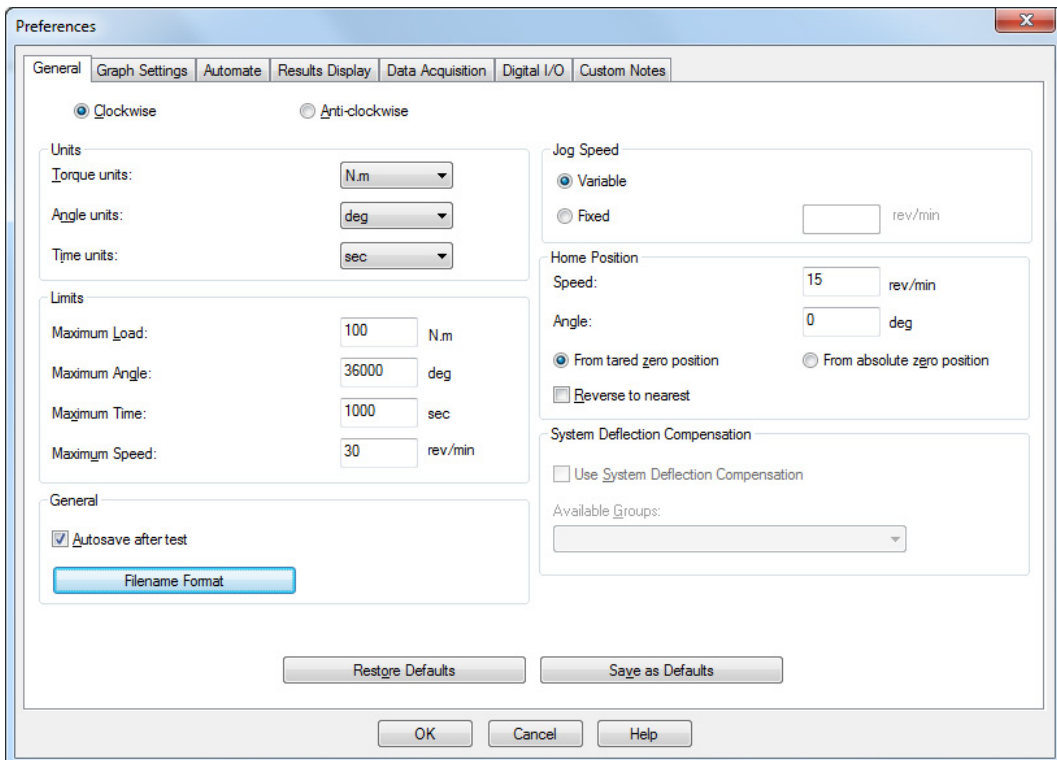
Direction of travel (tension/compression : clockwise/anticlockwise)

Your default preferences are set for one direction of travel. If your most common use is for either compression or tension (force tests) or clockwise or anticlockwise, make this your default. Note that all values here are entered as *positive in relation to this direction*. Positive values in programs or results, represent application in the named direction and negative values in programs or results represent release or reverse. See page 76, *Direction of Speed, Force and Displacement*.

As far as an operator or observer of the system is concerned, though, when a torque system rotates clockwise or a force system compresses, this is a positive operational direction, and anticlockwise or tension represents a negative direction. *Jog buttons therefore always do what they say*.

Units

Select the appropriate units from:

| Units	Force	Torque
Force/torque	kN, N, mN, kgf, gf, lbf, ozf, MPa, kPa, psi, N/mm^2	mN.m, N.cm, N.m, gf.cm, kgf.cm, lbf.ft, lbf.in, ozf.in
Displacement	mm, in If 'Use %' is selected, an original length of the sample must be entered.	rev, deg
Time	h, min, sec	h, min, sec

Scaling for other units such as radians or non-SI units is best done across a whole data file in Excel after export, rather than factoring each result by calculation within Emperor.

Use % In Emperor Force, ticking this check-box and entering the length of the specimen below, in 'Specimen Original length', allows the option of displaying the graph as '% displacement' (% elongation).

Specimen (Force sample)

When using pascals or psi stress units, you must add the cross-sectional area of the sample (diameter, or width and depth) before preferences can be saved.

What happens if you view test results on a different PC?

Units of measurement remain as recorded, even if viewed with Emperor on a PC with different default units. The second user can, if they wish, edit the results to read in other compatible units, and resave the file.

Limits

Your system is protected from overloads such that the loadcell capacity and stand load rating, whichever is the lesser, will be detected and the system will always stop with a warning that an overload has been reached. Similarly, the limit switches on a MultiTest force stand (see your *Assembly and Installation* guide) prevent travel beyond physical limits.

However, for reasons of safety, sample protection, or run-on, you may well want to set lower maximum values for load, displacement/angle, time or speed. Again, these can be set as system defaults, or per test program.

Note: in *Console Mode > Test Programs*, these are called 'Local limits'.

Home Position

The crosshead or platen can be sent to a 'Home' position. This can be in relation to a set **absolute zero** position (angle or height), so Home itself becomes an absolute position, which is retained when the test stand is switched off.

Alternatively, Home can be a position that is **relative to another** (e.g. 15 mm above a standard test sample height—when set as zero displacement—to provide clearance for insertion or removal). This position from 'tared zero position' depends on where and when displacement is zeroed, which includes being done in a test program.

This preference setting is either used for your defaults, or set when writing a test program to define the home position at the start.

Reverse to nearest	(torque) When a torque platen is returning to its Home, it can either reverse by the total amount of rotation in the test (perhaps several rotations) or, by preference, only as much of one rotation as required to reach the home-defined angle (defined as either relative or absolute).

Jog Speed

This option sets the speed of travel for the crosshead/platen from the PC only. It does not affect the stand front panel controls.

|	
Variable speed	means that for each click of the △ or ▽ button, speed in that direction will increase in increments to 5, 10, 25, 50, 100, 250, 500, 750 and 1000 mm/s, and that the opposite arrow will not reverse, but *decrease* the speed incrementally.
Fixed speed	means that each jog button starts movement at a value you decide, and the opposite button stops movement on the first click, and reverses direction on the second click, at the same speed.

General

Autosave	ensures that results files are saved after each test, as protection against data loss in the event of power interruptions.

Filename Format You can, if you choose, incorporate system information in autosave file formats. As well as system Time and Date stamps, and the logged-in operator name, four items from the *Test >* *Notes* option may be included (Test name, Specimen, Batch, Customer Name):
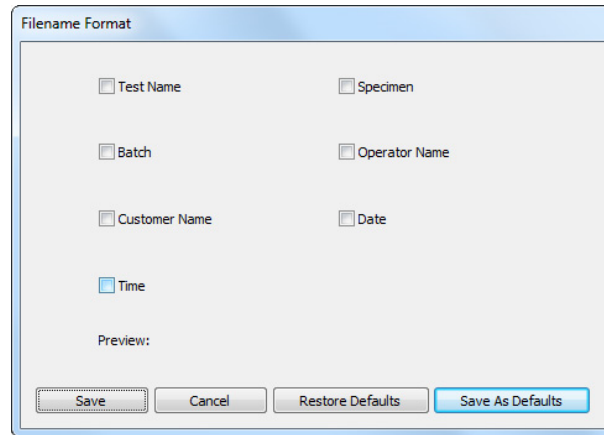
Choose only the most relevant items be used, since file names can become unnecessarily long. Notes data is retained in the results files in any case. This can be saved as a default for all autosaves, or just for the current test. `Restore Default` returns to the last `Save As Default` settings, not to a 'factory settings'.

Use old KINK ... allows for backward compatibility with the old KINK calculation method that was used in Emperor before version 1.17.

System Deflection Compensation (SDC)

See Section 4.3 for a full description of creating SDC files. SDC compensates for the very small deformations within a complete test system itself (stand, fixtures and loadcell) when under high load.

6.4 Graph Settings

This tab is used to set the options for how the results will be presented graphically. Use the radio buttons and drop-down boxes to choose the graph axes. This tab is also available under *Display > Preferences* so that operators who have also been granted permission to alter Graph Settings, have access for individual tests.
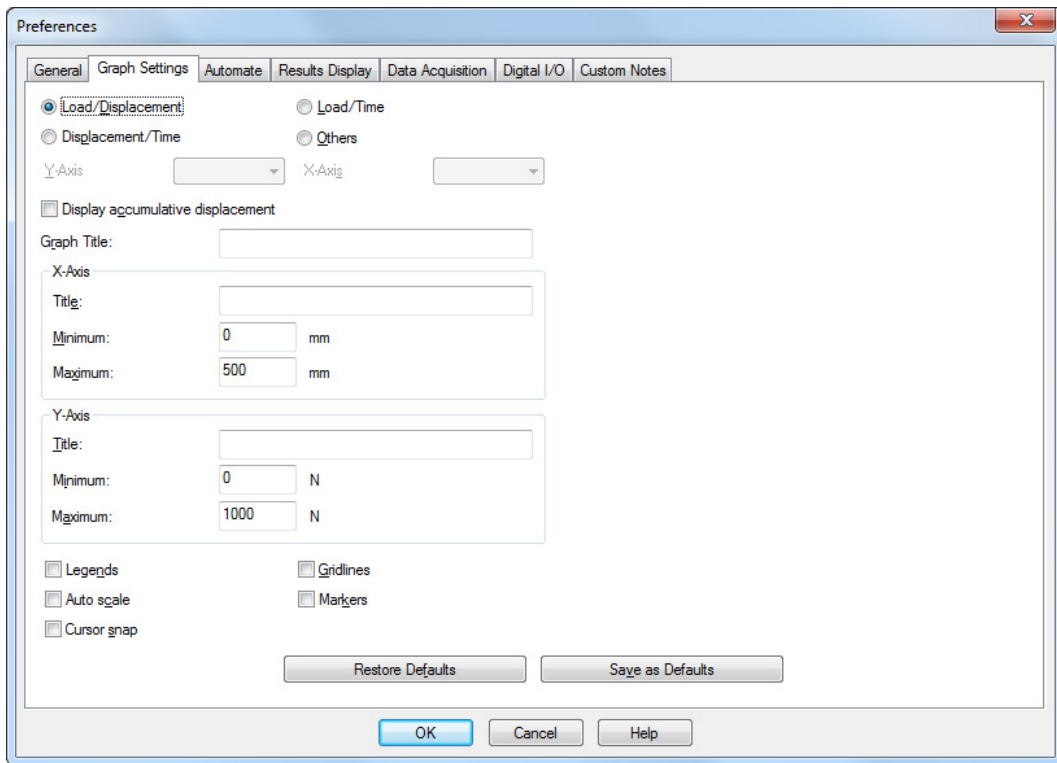
Emperor Force	**Display accumulative displacement.** Ticking the check box will plot the displacement on the graph from the beginning of the test, i.e. displacement will be shown as increasing regardless of the direction of travel of the crosshead. This is useful when calculating area, average and slope, and in cyclic tests.
Emperor Torque	**Display accumulative angle** can be used to show the total angle, regardless of the direction of travel or rotation, beyond 360 degrees.
Graph title	is optional. The X and Y **axis titles** will be filled in according to the radio button selected, but you can overwrite these if preferred.
Legends	for multi-trace graphs, can be added as required.
Gridlines and scale	Check to display gridlines.
Auto scale	When a test is running, the graph is auto-ranging—it will be re-drawn so that the trace is always visible. Ticking the Auto scale check box will cause the graph to be re-drawn *at the end of the test* with the axes scaled to display all the data collected (and the min/max settings here will be greyed out).
	If you un-tick the **Auto Scale** check box, the greyed-out boxes become available and you can manually enter the X and Y axes maximum and minimum scales. At the end of the test, the graph will be re-drawn using these scales.

Markers	adds a marker for every data point, which can be useful when zooming in on a trace.
Cursor snap	will make the cursor snap to the nearest data point, which makes visually obtaining exact co-ordinates easier.

6.5 Automate
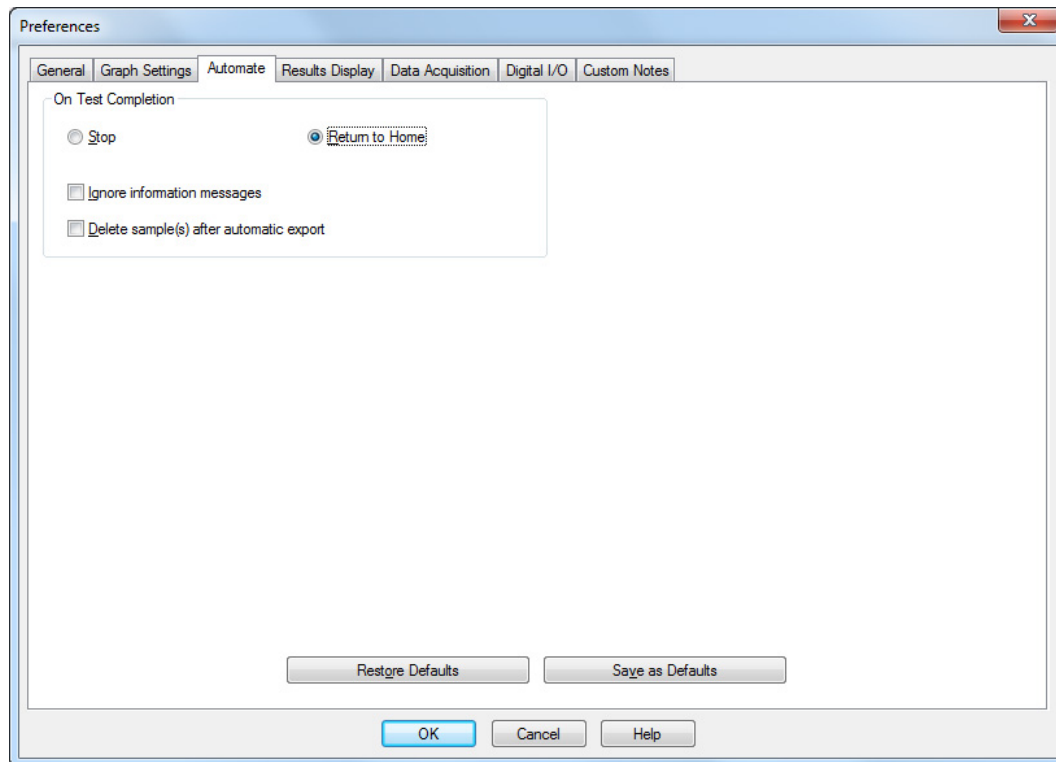
These preferences take place on completion of a successful test.

Stop	the crosshead stops
Return to Home	the crosshead returns to the **Home** position, but without recording the return travel on the graph. (For clarification of positions, see page 74, *Relative and Absolute Positions: Zero, Home and Start*.)

Ignore information messages

During an automated process, information messages may not be required or useful.

Delete sample(s) after automatic export

If you are automatically exporting data after test completion, instead of saving them in a results file, you can also automatically delete the sample data. **Note:** deleted samples cannot be recovered.

6.6 Results Display

In the results display panel above the test/graph area (*Display* > *Summary View*), Results can be seen, by default, one sample at a time or all at once, by choosing between 'Current Sample' and 'All Samples'. This default does not prevent any or all samples being viewed, only that if a large number of samples is usual, the statistical averages may all that are required.
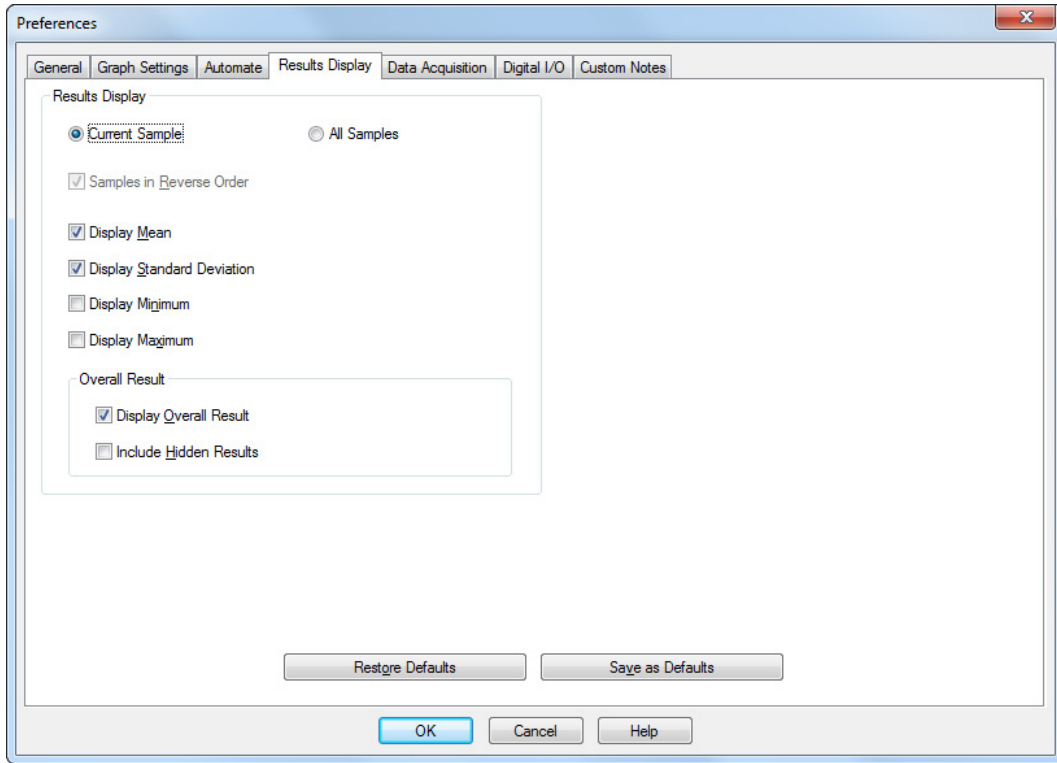
Tick any of: mean; standard deviation; minimum; maximum; to be displayed to the right of the result(s). By default, only the first two: 'Display Mean' and 'Display Standard Deviation' are ticked.

Display Overall Result   Overall result is the accumulated pass/fail assessments of all verified and included calculations. If only one verified calculation is crucial for pass/fail and others merely indicative, then the overall result may not be needed.

Include Hidden Results   Hidden results are usually hidden for a reason, but if some are verified, this can make an overall result appear confusing. Showing them can clarify this.

For Overall and Hidden results, see Appendix D: *A Note on Overall Result* and Hidden Results.

6.7 Data Acquisition

To obtain more detail from that part of a test that is of most interest, Emperor allows you to optimise your data acquisition.
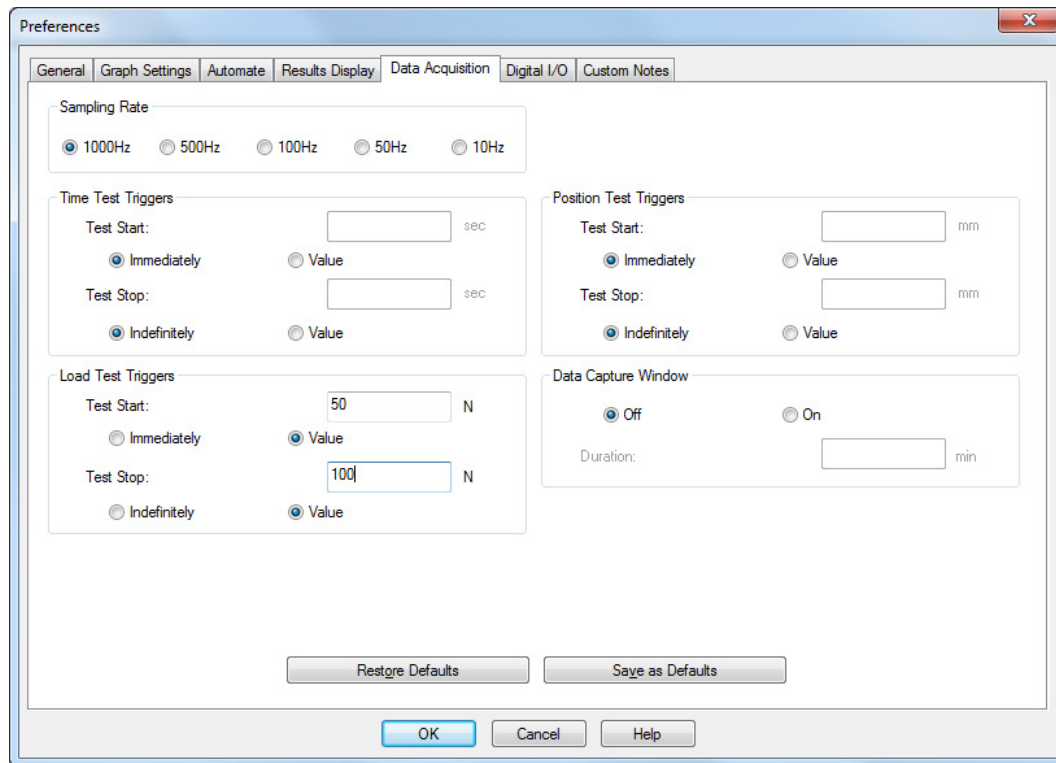
Sampling Rate	Select, in data points per second. Faster is not always better.
Triggers	Acquire data during the most relevant portion of a test, if known, by time, load or position (change in displacement/angle). Data acquisition will begin at the first trigger point, and will continue to the second value of that trigger, or until another trigger end point is reached, or until the test stops, whichever is reached first.
Data Capture Window	This sets the duration of a moving window during which data are collected. Example: a window of 60 seconds initially fills, and as subsequent data points are acquired, the earliest are dropped, so wherever the window stops, the last 60 seconds of data are retained.

6.8 Digital I/O

Mecmesin test stands have the facility for six digital inputs and six digital outputs that can be used to integrate the test stand with programmable logic controllers (PLCs) or other equipment. See Appendix F: *Digital Input Commands and* Output Notifications for details.

Select the Input or Output line, use the drop-down options bar to select the action, then click `Update`.
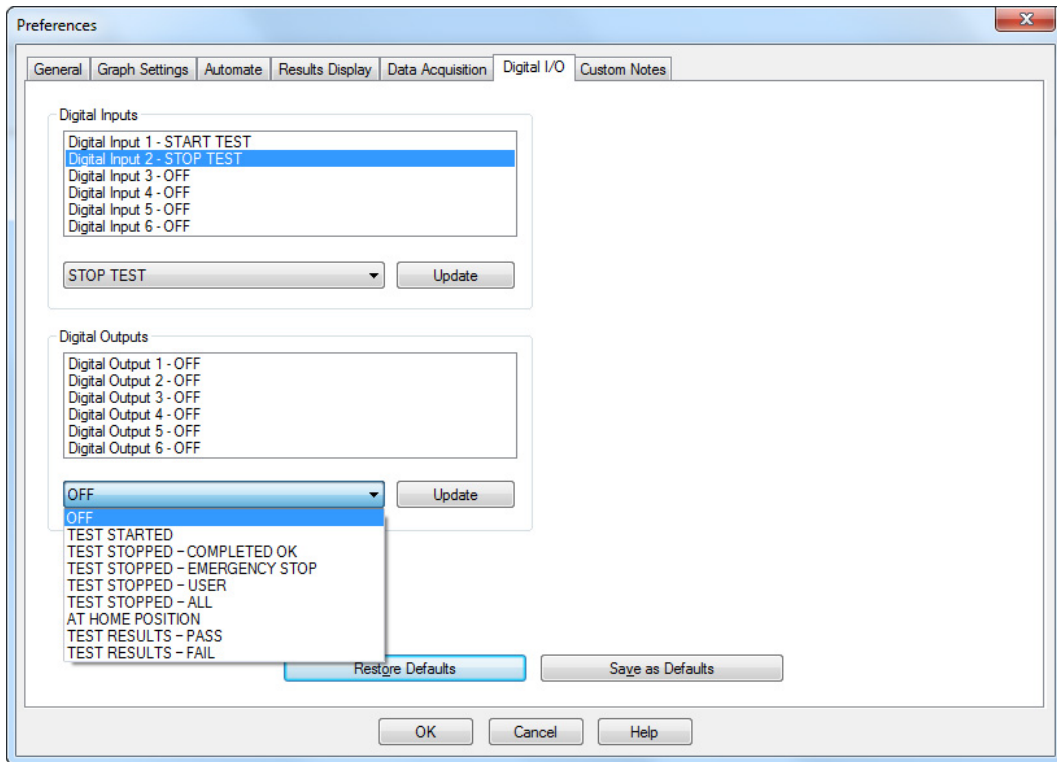
Digital inputs then can be used in test programs so that foot switches (for example) can be used. They can also be used to automatically suspend and restart data acquisition periodically on a many-cycle repetitive test of a sample.

Start and Stop data acquisition, as all I/O commands, can be used as many times as required, e.g. every time a foot switch is deployed—or triggered by cycle counts to capture spot values over many cycles. **Optimal use of this feature requires use of the Digital I/O Simulator Plug (part no. 432-663), enabling much more sophisticated and selective cyclic routines to be created** (see datasheet DS-1156).

6.9 Custom Notes

Custom Notes enables you to name five user-defined notes fields, stored with a program.
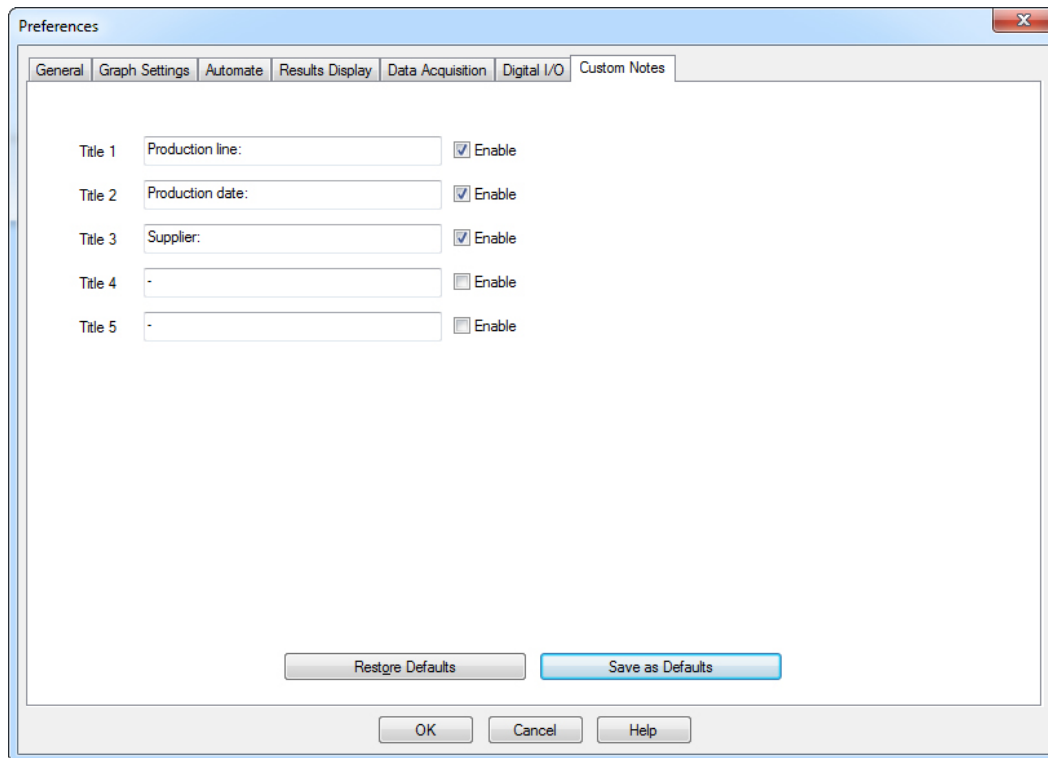
If you choose to use the Custom Notes feature, all five titles must have at least one character in them. Enable only those you wish to use by default, and enable them differently for each program if required. In the above example, a dash has been placed in the last two, since only three Custom Notes are required, and only the three titled notes have been enabled.

If you wish to save these as your default notes definitions, they will be presented as titles in a new program's Custom Notes, in the right-hand column, with an active field where also enabled:

'Enabled' means that the titled field will:

- be available to be used when a test is run

- appear in a report template that includes that custom note number (in the example above, 'Batch no.' is Custom Note 3)

- feature in results data sent to Excel, if 'Send Notes' is also checked in *Setup > Report and Data Export >* [Excel Settings].

These custom notes will be saved with the program and its results, or if changed for a particular test run, in their amended form with the results.

Custom Notes are not included in Results Data Export other than Excel.

If a Custom Note is enabled but not populated, then where notes are sent to Excel Results Data, or a report template includes that Custom Note, its title will still appear, but with its value empty.

7. Reports and Data Export

Choose how you want to share the results of a test run. Reporting (printed sheets or PDF) may be all you need, or you may need delimited files of results, or of raw data, or to transmit directly to another system (e.g. SPC).

7.1 Reports

Reports are straightforward and use templates you have already set up (*Setup > System >* [Report Templates]). Choose the detail you want to add: Title, page Header and Footer, the Results text and/or the graph. With a maximum eight samples per graph, if you want to overlay more samples they will be split over several graphs.
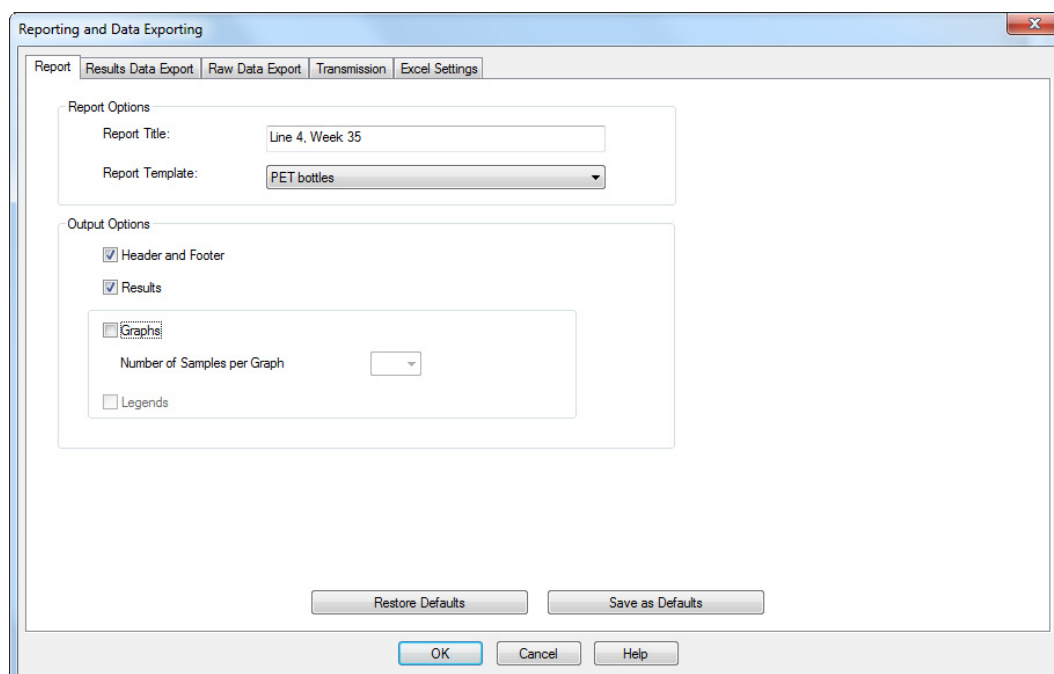
7.2 Results Data Export

If you are exporting data, decide if you want just the results of calculations per sample, or the raw data. Raw data means x/y figures for every data point. At 1,000 data points per second, data files can be very large, so options are added to cut down the amount of data.
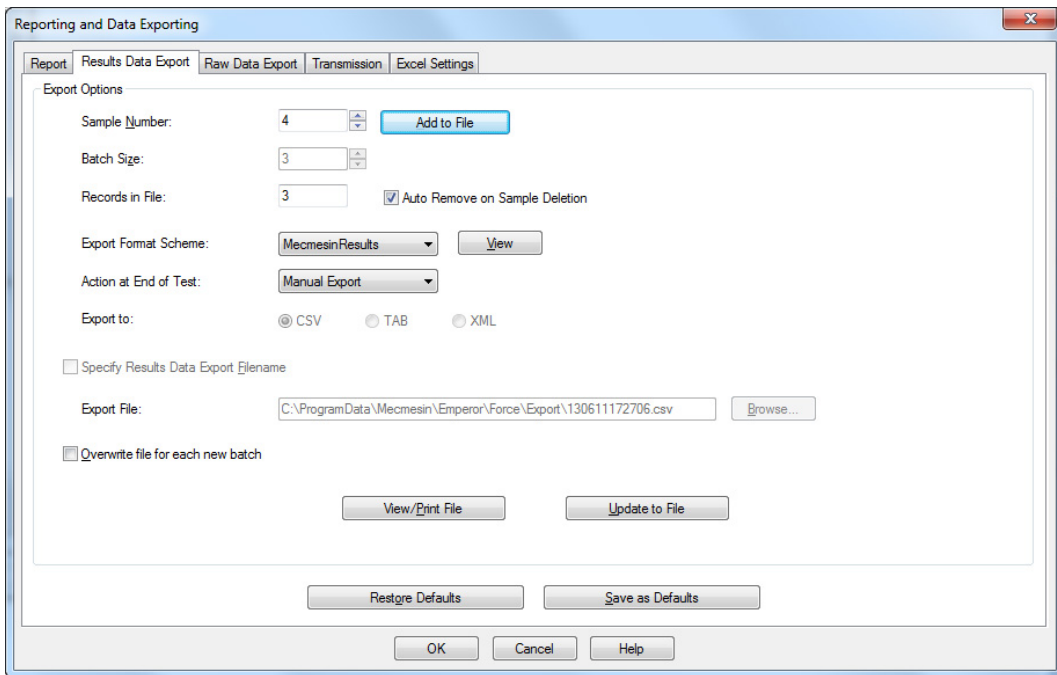
The sequence for setting up a non-default results export (or a new default profile) is:

1. Specify the File Type (CSV, TAB, XML)

2. Specify a file name (browse to destination folder and select or type a new file name, or allow an automatic filename to be applied).

3. Select Manual or Automatic as the end-of-test action

4. Select the export Scheme (View show the features from *System* > *Setup* > [Schemes])

5. Specify, or leave blank, the batch size (groups of samples)

6. Add samples to export.

When compiling your results export, the samples are listed by number. Select each one you want and click Add to File . Added samples may be removed. As you add samples, 'Records in File' will increment and the export file will be updated.

If a sample is deleted after export, **Auto Remove on Sample Deletion** will remove it from the export file automatically.

Batch results handling

When performing a number of tests on samples from a batch, you may want to limit how many are in one results file. Set your batch size, and when you have added the number of samples specified as a batch size, you will be alerted to start a new batch:
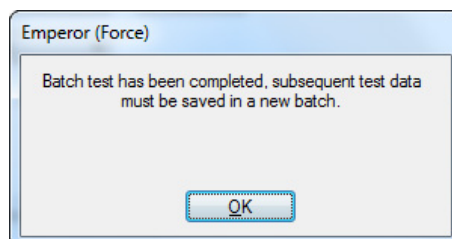
Click OK . If you now try to add a new sample:

Click Yes to start a new batch, and, if you are specifying your own file names, *begin by specifying or ensuring a new file name* that will not overw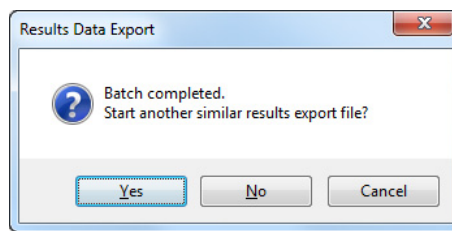rite the first. If you return to add new samples, click Update to File . The maximum number of samples per batch is 2,000.

7.3 Raw Data Export

Raw data export is similar, but there are no batches or selective sample adding, because it is assumed that the data are for full analysis elsewhere.

Choose if you want sample data exported in column groups across (arranged horizontally), rather than sequential samples in one set of time, displacement and load columns.

Choose if you want to be prompted about modification at the time of export.

Here you will rely on a Raw Data Export Scheme (*Setup* > *System* > [Schemes]). However, because the file size may be very large, you may choose to modify the content by reducing the amount of data. See Appendix C.2, *Managing File Size*.
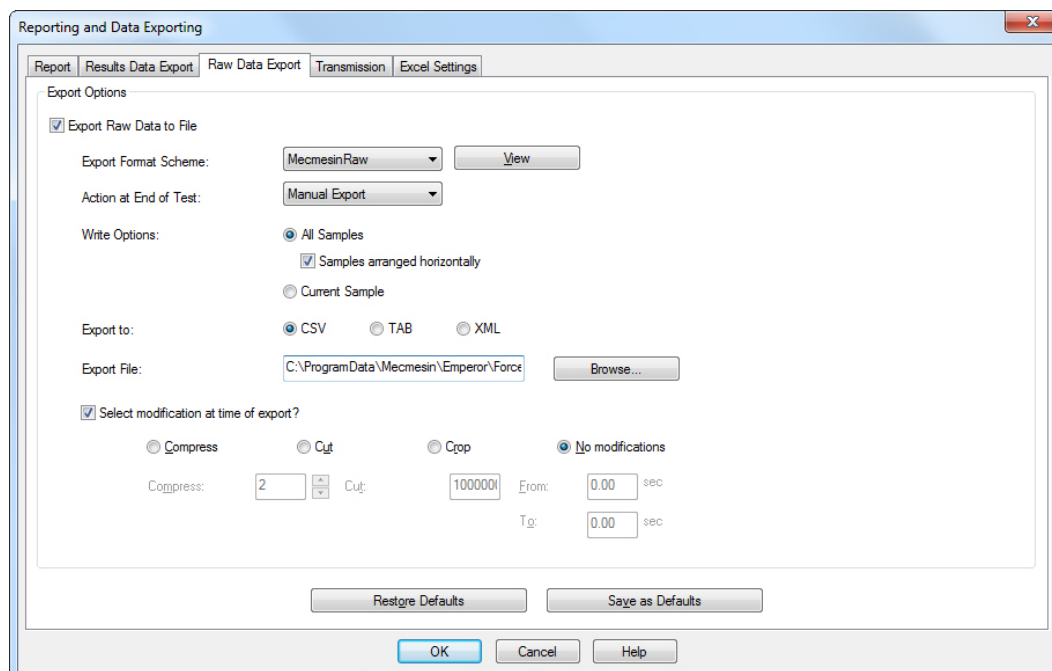
7.4 Transmission

Direct transmission to a communications port allows you to export Results, or Raw data, directly to another system. If you need to do this, set the parameters here, using a data export scheme as profiled in *Setup* > *System* > [Schemes]. The View button will show the structure of your selected Export Scheme.

7.5 Excel settings

If you want to export data to Excel, either set defaults here, or amend the default for the particular set of results. Note that the format of an Excel cell address is A1, not the absolute referencing style A1.

Things to remember

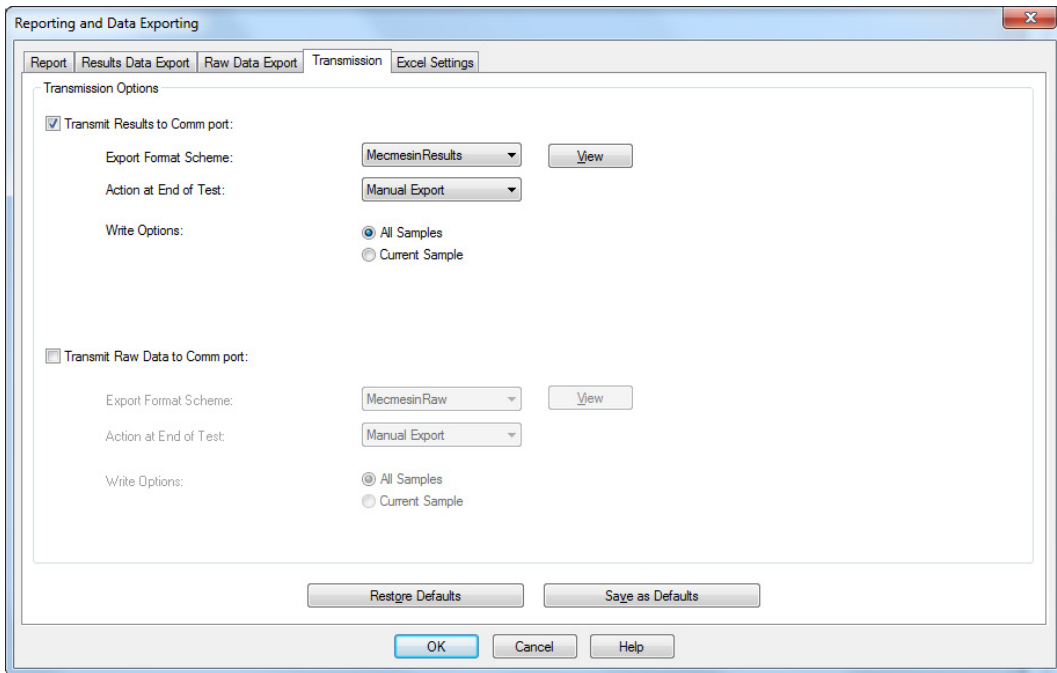- A default filename and worksheet will be overwritten if you have set a default and just use *File* > *Send to Excel* after running a test. Either open and resave Excel files to new files, or use this dialog always before exporting to Excel, *and* make the export action 'Manual after test'.

- Excel has limits to number of rows and columns that are easily exceeded by multi-sample raw data at higher data rates. Use Compress and Cut to reduce the data down (see Appendix: *Managing File Size*).

- Incrementing results start cell: unless you are repeatedly running a single sample test and discarding the Excel data, you will want to ensure each sample begins a new row in Excel, rather than overwriting the last.
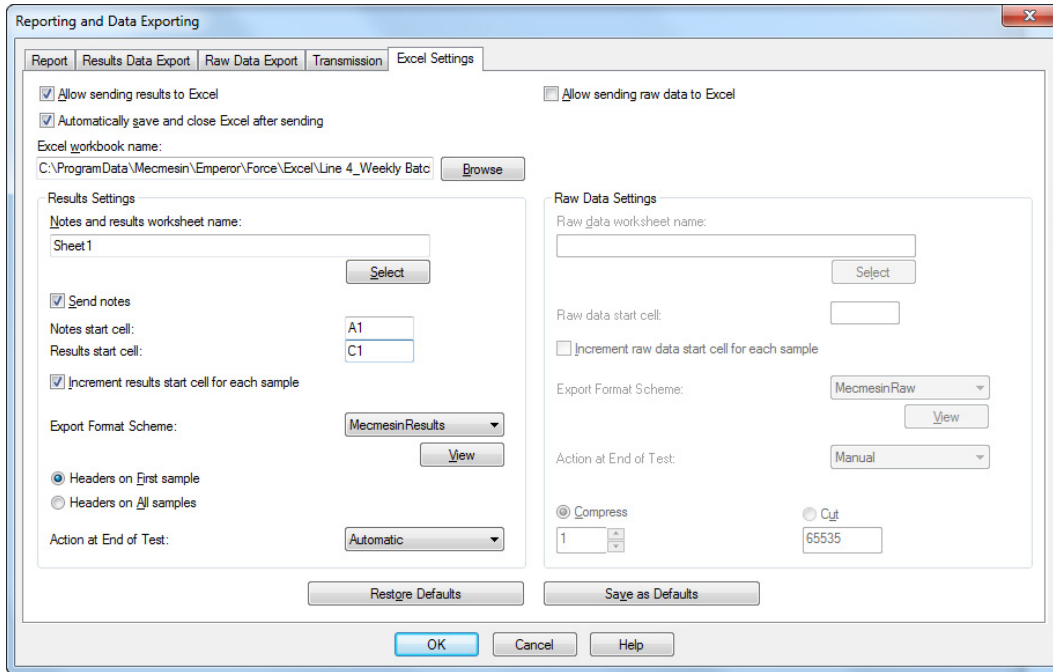
8. Writing an Emperor Test Program

8.1 Write or edit a test program

A test program is a sequence of commands and information to instruct a test stand precisely how to manipulate a sample in a way that captures required data. It may include requests for data entry. A good program is annotated so that both an operator and a programmer know what is happening and why at each stage.

After a program exercises a test sample or samples, calculations (Section 9, *Test Calculations*) are applied that turn the data into evaluated results.

Start a new program with *File > New*, then *Test > Program*, or edit an existing program with *File > Load Library Program*, then *Test > Program*. Here, an existing program has been loaded for editing, with line 18 selected:
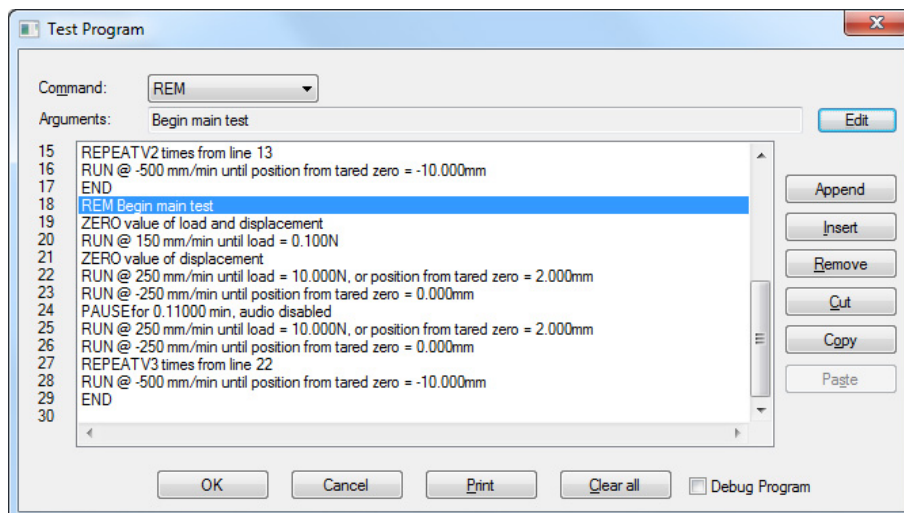
8.2 Saving library programs

Always save your library files at each stage of development. When writing complex test programs, it is good practice to save each stage of development as a new filename (e.g. MyTest1, MyTest2, etc.). When the final program is all correct, give it a final clear name and delete the working files.

File locations are set in *Setup > System >* [File Locations].

8.3 Use of variables

Emperor allows 100 variables (V0 to V99) that can be used in writing programs. Calculations can also be saved as variables. Their values can be SET (given within a program line), ASSIGNed (given a current load, displacement or time value), or

ENTERed (by an operator in response to a dialog box). In the case of displacement(angle), load, time and speed, units of dimension are added. Number and string (where an option) are, of course, dimensionless.

Wherever a value is inserted into a command, a variable name (V0 … V99) may be used instead.

8.4 Commands

Each command has an argument, for which a dialog is provided, with three options:

Append will add the command to the *end* of the program

Insert will add the command to the line *above* that currently selected

Update will *change* the arguments of the selected command

Commands operate in relation to *Setup* > *Preferences* (see Section 6). **Check these first**, since settings such as what happens at the end of a test, and whether the crosshead Home position is relative or absolute, will matter before reaching a results display. Other preferences may be altered afterwards.

> **Load and displacement preferences relative to absolute zero.** Absolute zero position is a value held within the test stand firmware, and may be altered between program runs or runs with quite different fixtures. Any program running with reference to absolute zero position may result in damage to the stand, loadcell, or fixtures.

Be especially careful with signs for load, speed and position (see Appendix: *Direction of Speed, Force and Displacement*). Check 'Debug Program' so that you can step through and observe a test program first, to ensure it is performing as expected:

Command	Argument and use
ASSIGN	places the current value of displacement, load or time into a variable, V0 to V99
CLEAR DATA	clears all current data from memory. This is useful if part of a test involves conditioning the sample before testing and taking measurements.
CLEAR MESSAGE	closes the message box
CLEAR VARIABLES	clears the current values of all variables. Use this at the start or end of a test to clear all values from memory, otherwise they can remain from the previous run.
CYCLE	repeats an action a given number of times. Here a compression test to a displacement of 10 mm (returning to tared zero) is being repeated six times (cycle 0 = the first; 1 = the first repeat; etc.).
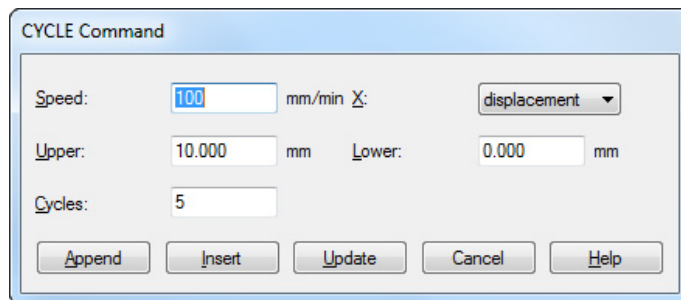
Example: conditioning a sample may be between two loads, repeated 50 times, followed by CLEAR DATA before testing.

DIGITAL I/O	When using external devices to digital inputs and outputs, a program may be made to wait for any or all signals, in or out. For I/O connections, see Appendix Appendix G: Pin-out Connections for Digital Inputs and Outputs and *Digital Input Commands and Output Notifications*.
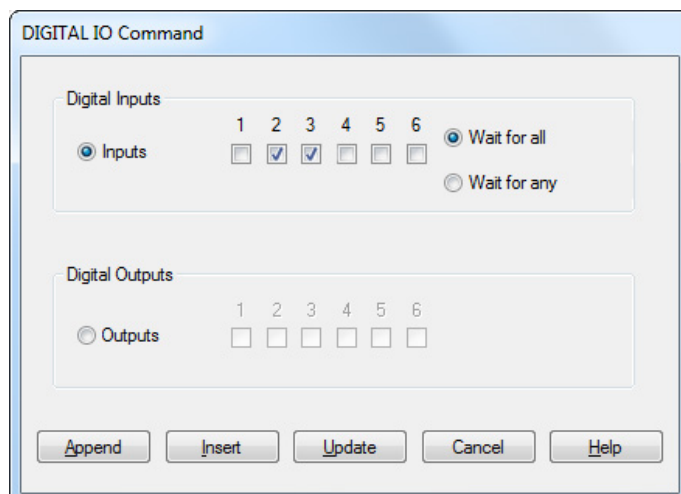
|	
END	stops the program running. This should be placed at the very end of any program, but also is used to terminate a test early if a condition (see IF command below) is met.
ENTER	Like ASSIGN, this places a value in a variable (Assign to), but displays an input box for user input, with the instruction (Title). The optional initial value is the default value to display, which the operator may accept or change.

The Parameter for ENTER allows not just load, displacement and time, but a dimensionless number, speed, and string (110 characters).

Example: use SET for an default batch number, or repeated prefix (string parameter) and assign to V0. Then, for each sample, use ENTER with V0 as the initial value, to place the batch number (confirmed or edited by the operator) in V1 for the actual batch number.
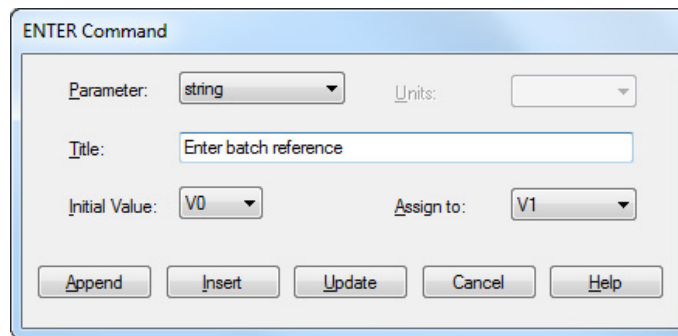
FORMULA	allows an equation to be written using the operators: + – / * ( )

Example: V15=(V5+V6+V7)/3

HOLD	A position or load can be held for a given period. This may allow for relaxation in the sample, or to condition for a recovery test, or simply to test performance under load. In order to maintain a load or position, the system will cycle. To make this effective, the **hardness** of the material under test, and therefore the speed of response by the crosshead or platen, needs to be taken into account.
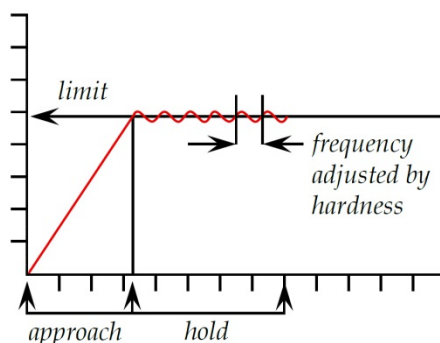
HOLD will need to be terminated if the sample **breaks** or deforms suddenly, and can be stopped by an **Event**, such as a foot switch connected to the digital I/O.
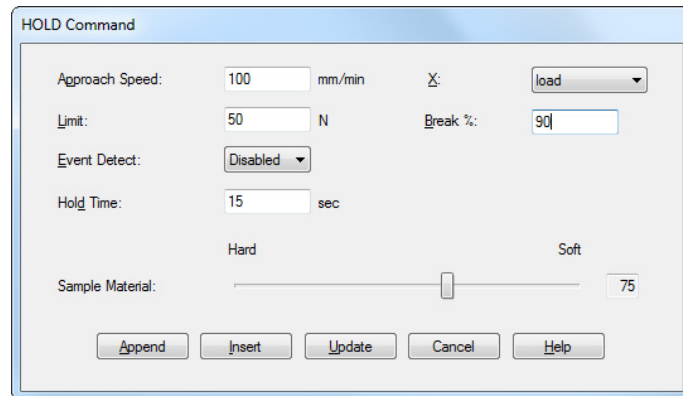
Approach Speed: crosshead speed to achieve the hold point

X-axis: which to hold—load or displacement(angle)

Limit: the load or displacement at which to hold

Break %: when the applied load falls to this percentage of the maximum load achieved during the operation of this command, either before or during HOLD, the current command will terminate and the program will progress to the next line after the HOLD command. (*Example:* a break percentage of 10% is a drop of 10%.)

Note: to avoid misinterpretation of system noise, break detection is not enabled within a threshold zone of 2% of the loadcell capacity (e.g. the first 20 N for a 1 kN ILC)

Event detect: 'On open' is a change in signal state from 0–1, 'On close' is a change in signal state from 1–0

Hold time: duration of an uninterrupted hold.

Sample material: this is a matter of judgement and experience. The number (1-120) is mm/min speed of crosshead response.

IF
Select the parameter (load, displacement, time, or any variable V0 to V99) the logical condition (<, <=, <>, = >, >=) and the test value for comparison.

If the result is True, set the program line number to go to; if the result is False (≡ELSE), set the program line number to go to. (These line numbers will automatically be corrected if program lines are edited in or out.)
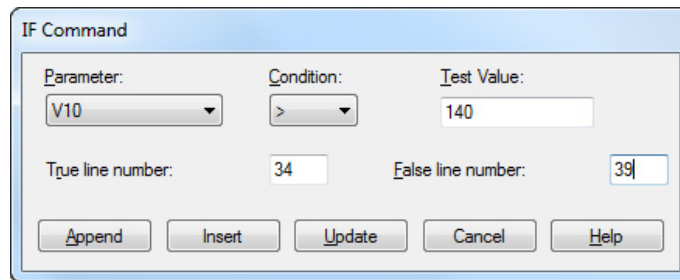
A test sequence can be made recursive (loop) using IF, until conditions are met and the False outcome moves to another sequence, or sample release and END, perhaps including a MESSAGE to the operator.

MESSAGE

Add the text of a message to appear in a yellow box to inform the operator. This can (for example) accompany events such as PAUSE or HOLD events ('Please wait …'), or instructions to load or remove a sample etc.

PAUSE

delays execution of the next program line by a given amount of time. Data will continue to be acquired (e.g. for a relaxation test) unless suspended (e.g. when time is given for an operator action to be taken).
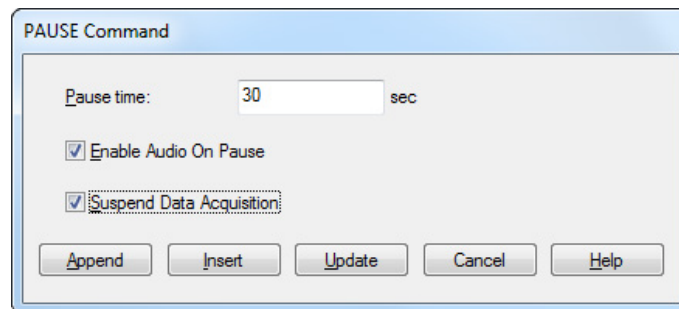

Note: during a pause, the load value may change (for example a sample may undergo relaxation or recovery). This will be seen in sharp, if small, peaks or troughs in the data and graphs.

For pauses greater than 10 seconds, Enable Audio On Pause will generate a sound towards the end of a pause, which accelerates towards the end. A visual equivalent could be a PAUSE followed by a MESSAGE (e.g. 'resuming in 5 seconds') announcing a second 5-second pause.

READ DEVICE

Only active when Integrator module installed. This command, when added to the Emperor program test sequence, will take a reading from an external device connected to the Integrator application and store it in a variable as either a number or a string (ASCII).

For Integrator and external devices, see manual 431-451, *Integrator User Guide*.
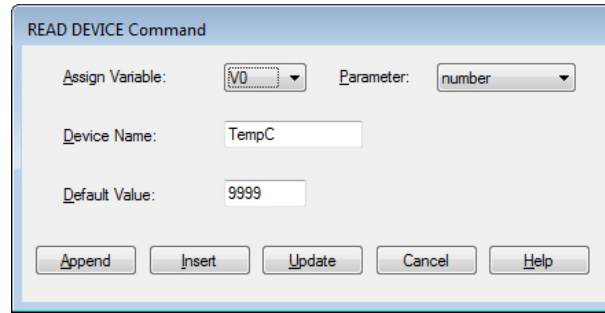
The READ DEVICE command can be used many times throughout the program to take either several readings from the same devices at different stages of the test or from different devices. Remember to use a different variable for each reading if each reading is to be used in the results display or calculations section of the test program.

Assign Variable: Select the variable to assign the reading from the device (V0 – V99).

Parameter: Select what type of parameter the reading from the device will be stored as, in the variable (Number or String).

Device Name: Enter the name of the device from which the reading is to be taken. This must be exactly the same name as set up for the device name in the Integrator application.

Default Value: Enter the value to be stored in the variable as a non-response indicator, if the device has failed to return a reading to the Emperor software.

REM   allows a REMark to be inserted into a program to explain a step or process

REPEAT   is a loop command; return to line number, and number of times:
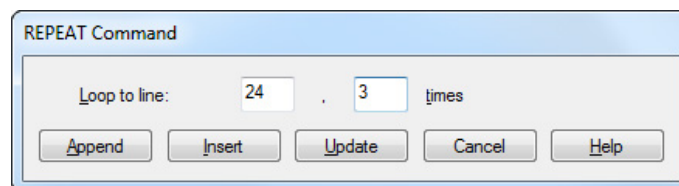
RESTORE   undoes a ZERO command for load or displacement

RUN   is the command to move the crosshead or platen, and decide when to stop. Set the **Speed**, and any of **Load**, **Displacement** (Angle) and **Time**. Whichever condition is reached first will end the RUN command. RUN may also be terminated by a switch event or by break detection.

Note: if you choose displacement 'From absolute zero position', remember that this setting is held in the stand firmware and if changed between program runs will alter the outcome, or cause damage to the system.

Break %: when the applied load falls to this percentage of the maximum load achieved during the operation of this command, the RUN command will terminate and the program will progress to the next line. (*Example:* a break percentage of 10% is a drop of 10%.)

Note: to avoid misinterpretation of system noise, break detection is not enabled within a threshold zone of 2% of the loadcell capacity (e.g. the first 20 N for a 1 kN ILC)

Event detect: 'On open' is a change in signal state from 0–1, 'On close' is a change in signal state from 1–0

SET   gives a value and dimensions to a variable (V0 to V99). It can therefore set an initial value, to be reused in other commands, or reset a value.

ZERO   sets either load or displacement to zero (tare). RESTORE will undo ZERO if used once. When used twice in succession, RESTORE will not undo ZERO; the displacement or load values are lost.

9. Test Calculations

9.1 About multi-valued functions

Consider the general equation:

y = f(x)

In a simple situation, when given the value of 'x' and asked to calculate 'y' there may be only one result—in this case the function is called 'monotonic'. For example:

y = ax + b

has only one solution, because for any value of 'x' there is only one possible value of 'y'.

Most functions, however, are either inherently multi-valued, or else noise on a signal can make an inherently single-valued dataset multi-valued. Consider a peel adhesion curve:
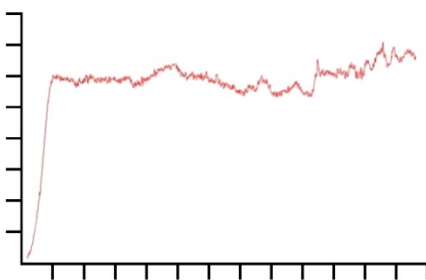
Load is on the 'y' axis and displacement is on the 'x' axis. If you need to know the displacement {x} at a certain load {y}, there may be more than one solution.

Similarly, consider the case of a cyclic test:
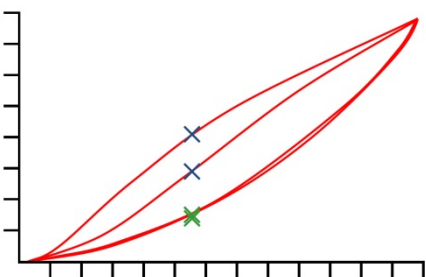
This graph shows load/displacement data obtained by applying two compression cycles to a block of polyurethane foam. For each value of load, there are four corresponding displacement values, and for each value of displacement there are four corresponding load values (illustrated). This is most obvious for the compression stroke (i.e. the top two curves) where, for a given displacement, the load on the first cycle was significantly greater than the load on the second, as illustrated by the blue crosses. It is not so obvious on the return cycle, as illustrated by the lower green crosses. The difference is due to the plastic deformation of the foam.

9.2 Selecting calculations

From the top menu, *Test > Calculations* these calculations are available:
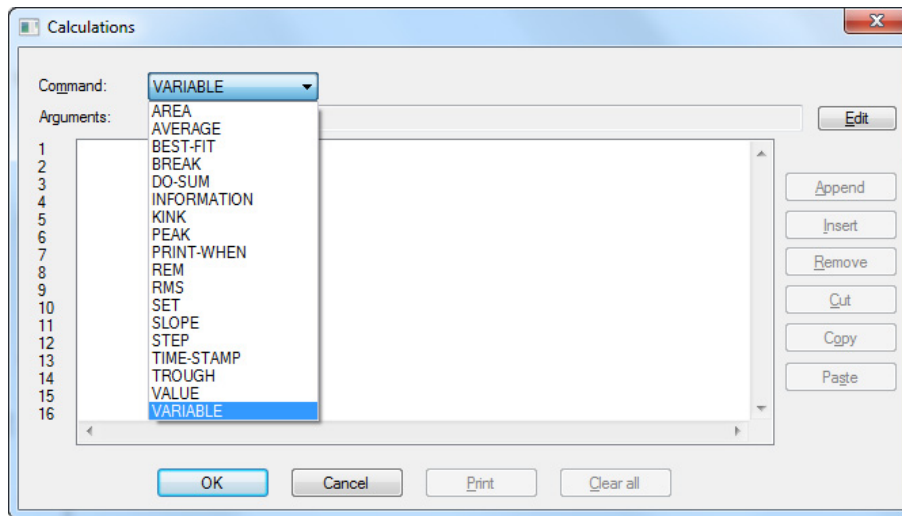
Select a calculation command from the drop-down box, and press Edit to add the calculation parameters. Here, for example is the Average command:
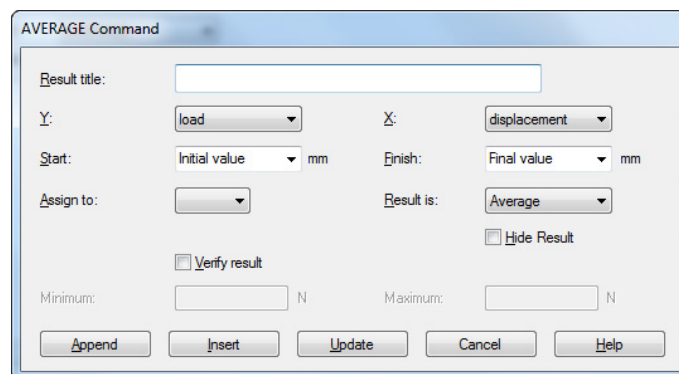
Append adds the calculation to the end row.

Insert adds the calculation to line above the selected row.

Update overwrites the selected row with the new edit.

When all calculation lines are complete, press OK to save, Cancel to revert to last save, Clear all to remove all calculation lines, or Print to send direct to the printer allocated under *File > Print Setup …*

9.2.1 Command functions

Trend lines   BEST-FIT; SLOPE

Change points   BREAK; KINK; STEP

Max./Min.   PEAK; TROUGH

Averages	AVERAGE; RMS
Explanation	REM; INFORMATION; PRINT-WHEN; TIME-STAMP; VALUE
Process	AREA; DO-SUM; SET; VARIABLE

9.2.2 Parameters common to many calculations

Result title

This will identify the line in the Results Grid (there may be more than one average in this overall calculation). It is also about the *reason* for the calculated line, so a SLOPE command used to determine a spring rate, is better described as that than the default title 'SLOPE'.

{X} and {Y}

These are assigned to load, displacement or time (displacement is 'angle' in torque systems). In some cases {X} can also be assigned to an event.

Start and Finish

are initial and final values for **X** (in the above example, this is the average load Y for **displacement span** X). Units are assigned accordingly for force and torque load, and for displacement/angle. Left blank, the value from the start and/or end of the test will be used. You may not know the best values for these until you have run some tests, so they are adjustable once you have some results, from the graphical display:

> **Drag-enabled points:** Start and Finish points may subsequently be dragged in *Display* > *Interrogate* > *Time Line* to adjust the original settings in the results file calculation. This file may then be saved with the adjustments. If you use this feature, when you exit Emperor you will be asked if you want to also save the changes to your program library file, under the same or a new name.
>
> **Note:** if you use Variables for the values in Start and Finish points in your program library file, these will be overwritten with numerical values if interrogated *and* the slider points are moved. Be careful not to overwrite your original program file.

Occurrence

Occurrence is a way of detecting change points in VALUE, KINK and STEP. In the case of VALUE and KINK, the interval between occurrences has a time limit.

Example: in a cyclic test, detect the first, second, fifth and sixth times the recorded load passes a certain point.

Since in any test there can be a degree of noise, change can be transient. There is therefore a requirement that between selected occurrences there needs to be an interval of at least one second so that Emperor 'knows' the change is a significant point, not a transient one.

In the following diagram, the trace is not visibly noisy, but compare the example requirement quoted above, for loads A, B and C. Imagine load B is the required load point.
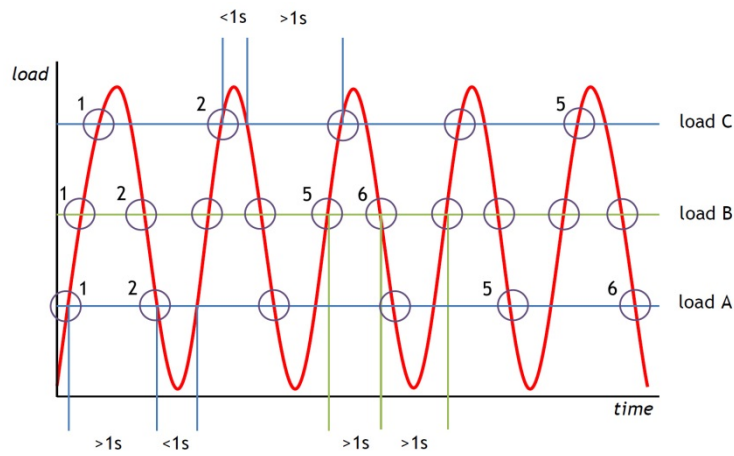
We can clearly see that each time the graph passes the required point, over one second has passed. Occurrences 1, 2, 5 and 6 are all present and in order.

Next imagine that load A is the required load point. Here actual transits of this value (3, 5 and 7) are missed because they are at less than 1 second after the previous occurrence, and so are not detected as change points (i.e. occurrences). Occurrences 1 and 2 are as expected, but 5 and six are not.

Finally, imagine load C is the required load point. Here every second pass of the load value will be ignored, because the period between occurrences at the peak is always less than 1 second. Here occurrence 6 is not even present, so the test will fail.

Assign to (Variables)

In most calculation commands, results can be **assigned to variables** (V0 to V99 are available), on which further calculations can be performed.

Hide Result

If the result is only a part of an extended calculation, and has no particular importance in itself, use **Hide Result** and it will not appear in the Results Grid.

Verify result

Ticking this check box and entering **minimum** and **maximum** values, allows the calculation line to also yield a true/false result, which can be interpreted as a pass/fail marker. If the calculated result lies between the minimum and maximum, the result will be printed with a green background in the Results Grid, and in green text in a report. Results that are below the minimum or greater than the maximum will be printed with a red background in the Results Grid, and in red text in a report.

Overall result

If at least one calculation is to be Verified, then a final row can be added to the list of calculations on the Results Grid, called **Overall Result**. Overall result is 'Pass' if all the

included verified results are met. If *any* of the included verified results are not met, then Overall Result is also 'Fail'. Whether to show the Overall result, and whether to include hidden results in the overall result for a particular results file, are set up in *Setup* **>** *Preferences* **>** [Results Display]. These settings can also be made for **Report Templates** and **Export Schemes**. (See Appendix D: *A Note on Overall Result and Hidden Results.*)

9.3 Calculations

Command	Argument and use
AREA	The AREA calculation returns the area under the curve for defined 'start' and 'finish' values of {X}, for example to measure total energy exchange over a period of time or for a given change in displacement.
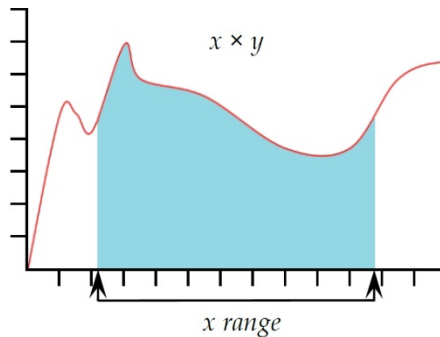
Note: if the curve drops below a zero value of {Y}, the area does not become negative. All area is regarded as accumulative.

AVERAGE
The **AVERAGE** calculation returns the average value of {Y} for chosen 'start' and 'finish' values of {X}. You can derive the result as the 'Average', i.e. the arithmetic mean, or as the 'RMSE' value from Average (see next below).
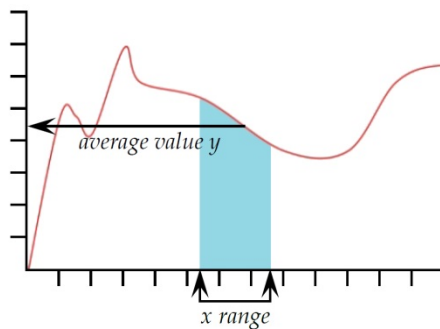
Result is: Choose between Average (Units) and RMSE (unitless)

RMSE: The root mean square error (RMSE) is a frequently-used measure of the differences between values predicted by a model or an estimator and the values actually observed. RMSE

is a good measure of accuracy. These individual differences are also called residuals, and the RMSE serves to aggregate them into a single measure of predictive power.

BEST-FIT

(Linear Regression)

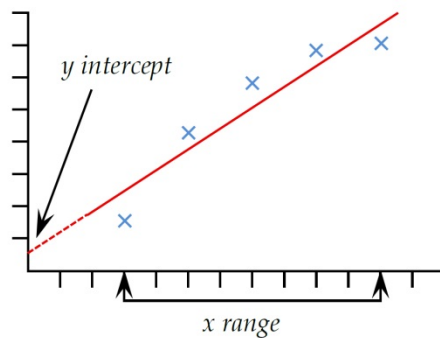**Result is**: From the BEST-FIT command you can obtain a result for the straight line of best fit through all the data points within an x-range, that will give the **gradient**, the **y-intercept**, or the **RMSE** (see above).

The SLOPE command is similar, but SLOPE is the gradient of a line passing through the start and finish data points.

y intercept

x range

BREAK

This returns the value (of load, displacement or time) when a sample break has been detected. The break can be defined as either a 'sharp' break, or as a 'percentage' break. A sharp break is typically chosen when the sample suffers a sudden fracture or the break occurs near-instantaneously. A percentage break is more suitable when the sample stretches slowly, and the break occurs progressively over time (explained more fully below).

Calculations after a break are made by comparing consecutive data points, according to the criteria given below. This may not necessarily be at the same point as where the break detector has operated.

Result is: Choose 'Load' or 'Displacement/Angle' or 'Time'.

Type: Choose 'Sharp' or 'Percentage'. 'Threshold' is the % of loadcell capacity below which break will not be detected, in order to avoid misinterpretation of system noise.

Sharp:
   Change factor—default value is 5 (range 2 to 20)
   Threshold %—default value is 3 (range 1 to 90)

Percentage:
   % Drop—default value is 40 (range 1 to 99)
   Elongation—default value is 1.25 (range 0.01 to 1,000)

Sharp break
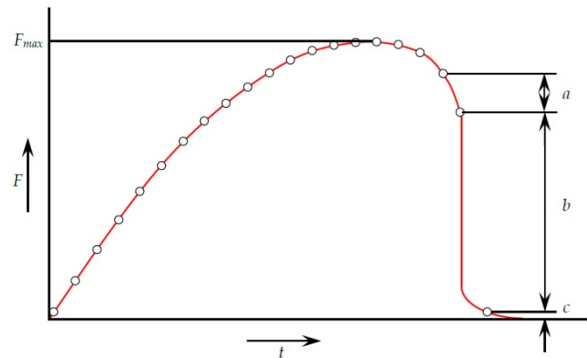
Sharp break is detected when analysing a set of three data points a, b, c, and the following criteria are met:

b > {change factor} × a

c < {break %} × F$_{max}$

Where

a = the change in load between the first set of data points

b = the change in load between the second set of data points

c = the load value above zero of the last data point

F$_{max}$ = maximum load

Percentage break
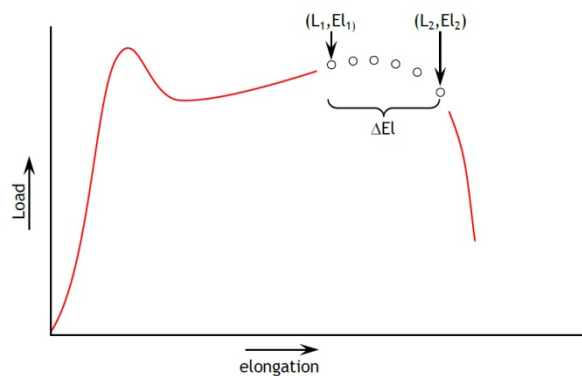
Percentage break is detected when analysing a set of data points and the following criteria are met:

$El_2 \geq El_1 + \Delta El$

$L_2 \leq L_1 \times (1 - \% drop/100)$

Where

L_1 = first load point

L_2 = second load point

El_1 = Elongation at L_1

El_2 = Elongation at L_2

ΔEl = required change in elongation = {elongation}

%drop = percentage drop in load required between L_1 and L_2. = {%drop}

DO-SUM   DO-SUM allows for calculations using Variables. Add units for your own clarity, and for dimensionless results, insert a space.
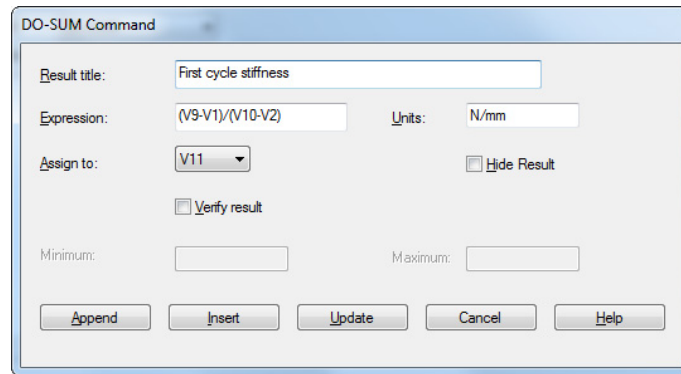
Expression: Valid operators are: + - / * ( ), and the string must be free from dimensional conflict (see VARIABLE).

INFORMATION   This will add additional information to the sample results.

Information: Use the drop-down box to select:

Bad sample reason: This will give the reason why a test run was not completed satisfactorily, e.g. 'Emergency Stop button pressed'.

Operator's name: This is taken from the User name logged on when the sample was run. It links the sample result to the operator.

SDC Status: Whether a system deflection calculation was included in the results.

KINK   Kink is based on Slope. If an abrupt change in Slope is detected, such as when a test sample disintegrates suddenly, a KINK point where the two Slope lines intersect is recorded.
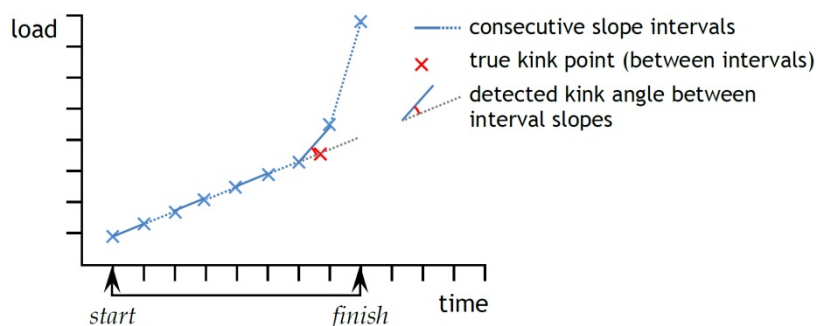
The diagram shows data points at the selected time **interval** in the KINK command between **start** and **finish**.

A SLOPE calculation is made at each of these intervals and compared with the last.

If the angle between consecutive slopes exceeds the **minimum angle** selected, the KINK point is determined to be *the data point at the end of the previous interval*.

Interval: A time period over which the direction may be seen to change (default 0.3 s, minimum 0.01 s). A comparison is constantly made between the slope of the previous and following set of data points in the chosen interval.

Occurrence: There may be more than one abrupt change (for example after a take-up tension, a slippage release). See note in Section 9.1 on occurrence intervals.

Minimum angle: The change in angle that determines that a KINK has been detected rather than noise or regular variability (default 10°).
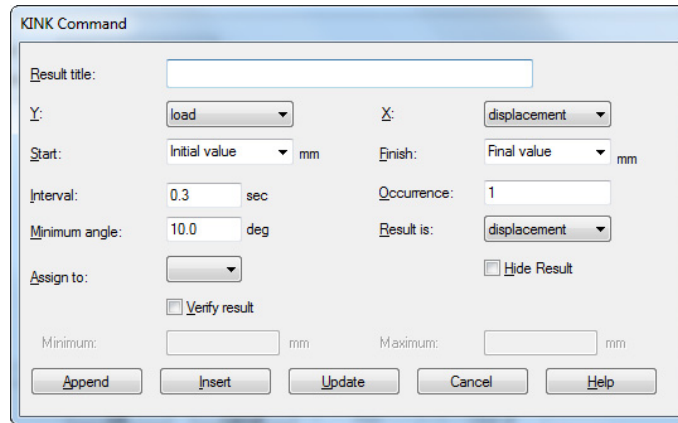
Result: Define location of KINK as the time, displacement or load, at the point of detected slope change.

PEAK

Returns the maximum {Y} value of the chosen parameter, 'Load', 'Displacement' or 'Time', for a defined range of {X} values. You can choose to report the highest of all the {Y} values, or select a peak of interest by setting 'Start' and 'Finish' values, and by inserting values in the 'Order' and '%' boxes.

Order: Order 0 = max. value within the range of {X}, which may or may not be a peak with downturn.

Order 1 = highest peak value within the range of {X}, defined as a peak with downturn, by the % value.

Order 2 = second highest peak value within the range of {X}, defined as a peak with downturn, by the % value, and so on.
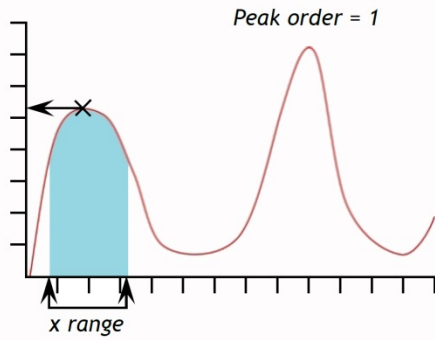
Peak order = 1

x range

%: The per cent field allows the PEAK calculation to distinguish between small spikes that are a genuine signal, and background noise. If after the peak the {Y} value does not fall by at least the selected percentage of the total range of {Y} values, then that spike is not a genuine peak. If, however, there are two peaks that are very close together, it may be necessary to experiment with different values in the '%:' box.

PRINT-WHEN

The PRINT WHEN calculation applies a test to the value of the result from a line number in the Selected Calculations list and returns text that depends on the result of a conditional test. **Note:** the PRINT-WHEN calculation must be used after the calculation to be tested.

Result title: This is a free-form text entry field that allows you to re-name the test result. This title will appear as the row header in the results grid.

Calculation no.: This is the line number of the calculation to be tested as they appear in the 'Selected Calculations' list on the [Calculations] tab.

Condition: Choose the Boolean test to be applied from the drop-down list:

<, <=, <>, =, >, >=

Test value: Enter the test value

True text: Enter the text to be displayed if the test condition is met.

False text: Enter the text to be displayed if the test condition is not met.

REM

REM is the facility to add a comment (remark) line in the program, typically to explain a subsequent program step.

RMS

(Root Mean Squared) Where an average is required over values where negative displacement/angle are involved (e.g. in a bidirectional cyclic test), AVERAGE cannot be used. RMS must be used instead.

The RMS calculation returns the RMS value of {Y} for chosen 'start' and 'finish' values of {X}. You can derive the result as the RMS average, or as the RMSE value from RMS.

SET

The SET command is used to give values to Variables.
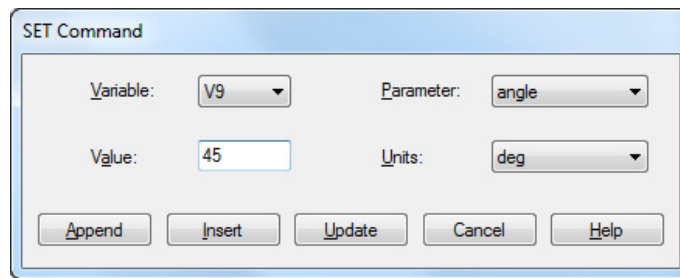
Here Variable V9, in a torque program calculation, is being given the value for an angle of 45 degrees. (Choosing the parameter will then bring up the range of appropriate units for selection.)

SLOPE

Result is: From the SLOPE command you can obtain a result for the straight line joining the first and last data points within an x-range, that will give the **gradient**, the **y-intercept**, or the **RMSE** (see under 0 above).

The BEST-FIT command is similar, but BEST-FIT is the gradient of a line passing equally through all the data points.
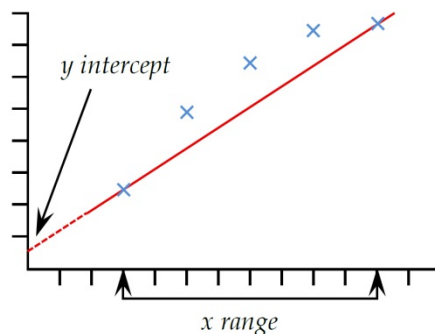
STEP   STEP returns the value of {X} when the value of {Y} changes
                                 sharply from one steady value to another.
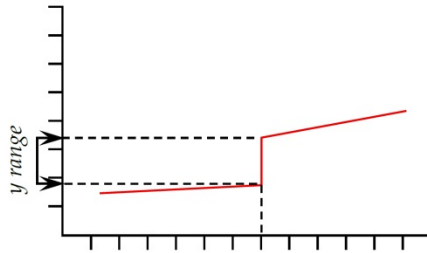
'From' and 'To': The lower and upper limits of the range of {Y}
to be assessed. {X} is the displacement, load or time to return
for the step change.

%: The step line will not be perfectly vertical, so the 'moment'
of the step change can be set at the first {Y} point in the range
(0%), the last {Y} point (100%) or somewhere between (50% is
halfway).

Occurrence: There may be several step changes or slippage
points, in either direction. Occurrence allows you to specify the
one of interest.

TIME-STAMP   Used to add the date and time the test started and/or finished.
   Use the Radio button to select the time: Start time is taken when
                                the blue 'Start' button is pressed. The End time is recorded
                                when the test has finished, or if terminated by pressing the red
                                'Stop' button. You can display both start and end times by
                                adding two Time-Stamp calculations. TIME-STAMP is
                                displayed in HH:MM:SS format.

TROUGH   The TROUGH calculation returns the minimum value of {Y} of
                                the chosen parameter of 'Load' or 'Displacement' or 'Time'
                                within a defined 'Start' and 'Finish' value of {X}. You can
                                choose to report the lowest of all the {Y} values (deepest
                                trough), or select the area or trough of interest by setting the
                                'Start' and 'Finish' values, and by inserting values in the
                                'Order' and '%' boxes.
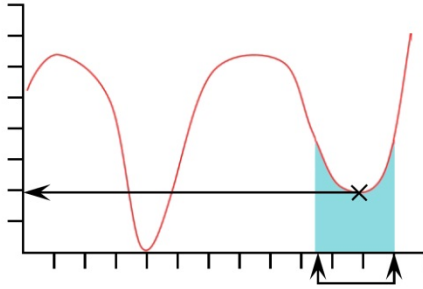
Order: Order 0 = min. value within the range of {X}, which may or may not be a trough with upturn.

Order 1 = lowest trough value within the range of {X}, defined as a trough with upturn, by the % value.

Order 2 = second lowest trough value within the range of {X}, defined as a trough with upturn, by the % value, and so on.

%: The per cent field allows the TROUGH command to distinguish between small dips, which are a genuine signal, and background noise. If after the trough the {Y} value does not climb by at least the selected percentage of the total range of {Y} values, then that dip is not a genuine trough. If, however, there are two troughs that are very close together, it may be necessary to experiment with different values in the '%:' box.

VALUE
The VALUE calculation returns the value of {Y} for a specified value of {X}. {Y} can be 'Load', Displacement/Angle' or 'Time'. {X} can be 'Load', Displacement/Angle', 'Time' or an 'Event'. See the discussion at the beginning of this section, on Multi-valued functions.
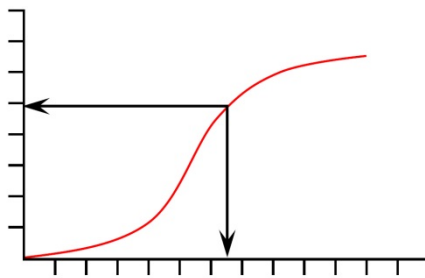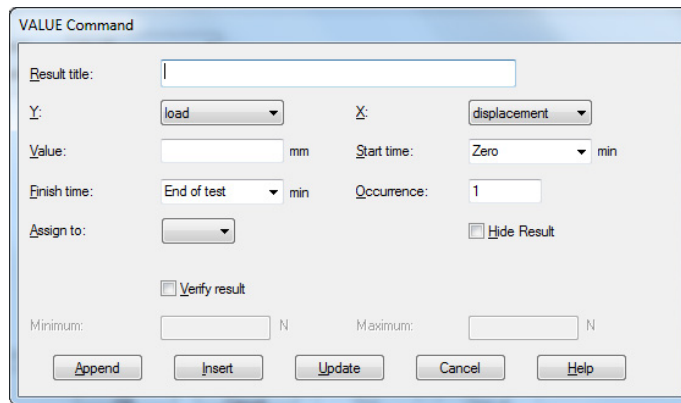
Value: Enter the desired value of {X} at which point the Value of {Y} will be recorded. If 'Event' has been chosen for the {X} parameter, then the options for value are on 'open' or on 'close'. In this case, when an I/O event signal changes from 0 to 1 (open) or from 1 to 0 (close), the Value will be recorded.

*Drag-enabled: Value may be dragged in Graphical display*

Occurrence: Enter a number to return the value of {Y} corresponding to the occurrence of the {Y} value of interest. E.g. if you want to find the load {Y}, at its third occurrence, at a displacement of {X}, then enter 3 in the occurrence entry box. See note in Section 9.1 on occurrence intervals.

VARIABLE

Variables V0 to V99 are available to be described (limit of 50 characters) and to which values or calculation results can be assigned (limit of 40 characters).
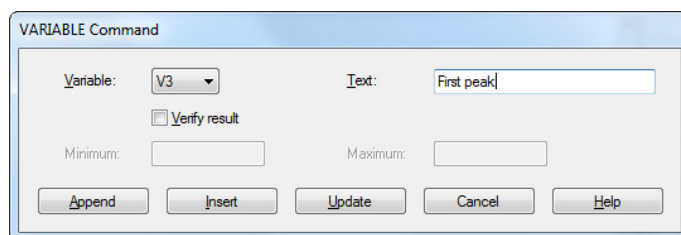
Dimensional conflict:

Care must be taken in compiling calculations and assigning them to variables for further calculation. Emperor will alert you to errors that lead to a conflict in dimensions, such as an instruction for speed in units of force. To derive numerical quantities from dimensioned values they must be divided by values of equal dimension. 125 N divided by 5 is 25 N, whereas 125 N divided by 25 N is simply 5, by normal mathematical convention.

10. Running Emperor Programs and Saving Results

10.1 Preparing

Check your stand, fixtures and sample are secure, and that if you use absolute zero position in your programs, that this is set correctly. Check the appropriate loadcell is in place for the test to be run.

Absolute zero

If position relative to absolute zero is used in *any* programs, it is important to have a standard procedure, which could involve making a strict rule:

1. Absolute zero is an *unchanging* position and can be set by procedure routinely.

   or:

2. Absolute zero is *always* a touch-together position between fixtures that is taken into account by every program that references an absolute position.

   or:

3. Absolute zero is *never* used as a relative point in any programs.

10.2 Running

Load the required program. If another test has been previously run, make sure that if results are still present on the system, these have been saved or exported. If appropriate, run the crosshead and fixtures manually to a safe initial position, or for securing your first sample.

Position the first sample within the fixtures, click START and follow the test run through with each sample in turn. At any point you can choose to:

- display multiple traces for comparison (*Display* > *Overlays*)
- view the current or all samples in results (*Setup* > *Preferences* > [Results Display])
- include or remove individual samples from the overall statistics
- interrogate individual samples (*Display* > *Interrogate*)
- delete individual samples (Specimen toolbar: requires permission at operator level)

10.3 Including and discarding samples

The inclusion of samples in the statistics is stored with the file. It does not remove any data. Discarding samples is done by using the 'Delete' basket on the Specimen toolbar. This deletion is irretrievable.

10.4 Saving results

The first time you save results (unless you have *Setup* > *Preferences* > [General] set to 'Autosave'), you must use *File* > *Save As*. Thereafter, *File* > *Save* (or Ctrl+S) will overwrite the same file. You can at any time save your results file, run further samples and save again.

To split results into more than one file, save the results, then reload the library file. This will close the previous results file.

To add samples to an existing results file, *File* > *Open* the results file, insert a new sample, run the test, and save. If you do not wish to save with new samples (and are not using autosave), either delete the new sample(s) or use *File* > *New* to close the previous results.

10.5 Exporting results

Unless you have automatic export at the end of each test, you can choose to export raw data to file (defined in *Setup* > *Report and Data Export* > [Raw Data Export]), and use *File* > *Export*.

Appendix A
Relative and Absolute Positions:
Zero, Home and Start

Absolute Zero	Tare at Touch-on	Home position	Start position

Absolute Zero could be set where the attachment meets the anvil plate (or anywhere consistent you choose).

Touch-on tare defines a zero position as the top of a sample. It can be used to measure sample size with a FREE HEIGHT calculation, or just to set the test starting position as zero.

Home could be set as an end-of-test position relative to Absolute Zero or relative to Touch-on, for example, to provide clearance for changing samples. See *Setup > Preferences* > [General], Home Position.

A **Start** position could be set as a displacement to pre-compress a sample, relative to Touch-on, and this position also tared as a new zero point for starting measurements. Home as a position to return to, may be better set relative to Absolute Zero than to Tared positions.

A.1 Absolute Zero position

You can set an Absolute Zero position of a force-system crosshead or torque-system drive spindle. This can be used as a reference point in any program, and any program that has reference to an Absolute Zero requires this to be set in order to run. This setting is held in the firmware of the test stand, so remains even when the system is switched off.

How to set the Absolute Zero position of the crosshead or platen

Move the crosshead or platen to the required reference position.

- In the Programmed Testing screen, click the button.

- Set Absolute zero, either as zero (0) for the current position, or as an offset away from the current position (shown in the example below as 15 mm *above* the current position), then press Set and Exit . **Note:** here is where you can also Clear Absolute zero, reposition the crosshead or platen, and reassert a new Absolute zero.
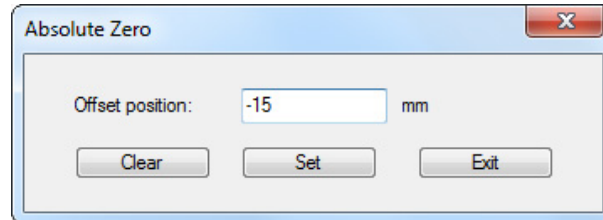
> **Caution!** If you position the crosshead, with or without fixtures, in contact with the anvil plate (MultiTest) *you must not use a positive offset*: this is always in a downwards direction irrespective of test direction!

A.2   Tare positions

Tare positions mean 'treat this as the reference point for the next measurement'. Tare position setting does not alter an Absolute Zero setting. A tare positions can be:

- a temporary tare position (e.g. set Zero Displacement in the toolbar). This is overwritten by tare positioning within a program.

- a point in any program where the ZERO command is used for position.

A.3   Home

Home is defined in Setup > Preferences > [General], and for each program, as being either relative to Absolute zero, or relative to the latest tared zero. An instruction to 'Return to Home' may, for example, be used to provide clearance for the exchange of samples or grips.

A.4   Taring load

When measuring the difference between loads, as when pre-tensioning a spring, or measuring consistency in mid-travel compression, or simply to eliminate the touch-on detection load, you will need to also tare a load in the same way as position.

> **Caution:** When manually taring the load while a large force is being applied to the sample, the display will show the force to be zero, but the sample will still be under tension or compression. Use the Jog buttons to release the load before attempting to remove the sample.

Appendix B
Direction of Speed, Force and Displacement

Displacement, rotation, load and speed all increase in a test's direction of travel as defined in *Setup* > *Preferences* > [General] (i.e. compression/tension, clockwise/ anticlockwise). Negative values are always away from the direction of travel. Sign of speed must follow sign of displacement:

example: RUN @ –100 mm/min until position from tared zero = –20.00 mm

The following tables show how speed, displacement and force appeared in compression and tension tests.

Force

	Compression test	
Crosshead direction	⬇	⬆
Position, load and speed are:	increasing	decreasing
	Tension test	
Crosshead direction	⬆	⬇
Position, load and speed are:	increasing	decreasing

Torque

In an *anticlockwise* test (e.g. to release a screw cap), the spindle will move *clockwise* so that the sample moves *anticlockwise* with respect to the torque cell.

Clockwise test	Anti-clockwise test
The spindle moves anticlockwise and:	The spindle moves clockwise and:
spindle angle increases (goes to a positive angular displacement from zero)	spindle angle decreases (goes to a negative angular displacement from zero)
Instruction to run to a positive angle will rotate the spindle anticlockwise at a positive speed.	Instruction to run to a positive angle will rotate the spindle clockwise at a positive speed.
Instruction to run to a negative angle will rotate the spindle clockwise at a negative speed.	Instruction to run to a negative angle will rotate the spindle anticlockwise at a negative speed.

Appendix C
Handling Data Files

C.1   Where Results Go

Familiarise yourself with the movement of data and its destination, so that you can establish a way of working that organises your files well.

Action with results	Destination of data
RUN a test	Sample results accumulate in memory.
Save results of run 1	A default filename is presented comprising the test name and a current date-time stamp. You may choose an alternative file name. The file is saved to the Emperor\Force[Torque]\Results folder.
Export results of run 1	Sample data are sent to file *as specified for the test* (*Setup > Report and Data Export*). You may not choose a new file name, and an existing file of this name will be overwritten. The file is saved to the Emperor\Force[Torque]\Export folder.
RUN a test again	Sample results accumulate in Console memory.
Save results of run 2	A default filename is presented comprising the test name and a current date-time stamp. You may choose an alternative file name. The file is saved to the Emperor\Force[Torque]\Results folder.
Export results of run 2	Sample data are sent to file *as specified for the test* (*Setup > Report and Data Export*). You may not choose a new file name, and an existing file of this name will be overwritten. The file is saved to the Emperor\Force[Torque]\Export folder.
OPEN results file	Select a file from the Results library and Edit or Run.
RUN the test again	The test program is loaded with the previous results, and further samples tested will be *added to* the previous results.
Save results after run 3	The previous filename as opened is presented. Save to this file to overwrite the previous version, or choose a different filename. A new date-time stamp is not offered. The file is saved to the Emperor\Force[Torque]\Results folder.
Export results after run 3	Sample data are sent to file *as specified for the test* (*Setup > Report and Data Export*). You may not choose a new file name, and an existing file of this name will be overwritten. The file is saved to the Emperor\Force[Torque]\Export folder.

C.2   Managing File Size

File size is directly proportional to the total number of data points acquired. The higher the data acquisition rate (*Setup* > *Preferences* > [Data Acquisition]) and the longer the test duration, the larger the Results file becomes.

Data acquisition should be selected for the degree of detail required and precision of interpretation. For exporting results, however, or after seeing test results, less detail may be required and a smaller file can be obtained by compressing, cutting or cropping the data.

Data acquisition rate

Determines the total number of data points per sample test (sample tests may have different durations). This and the number of samples per results file, dictates the saved file size.

Compress

To reduce file size, if some detail can be sacrificed, every third or fourth data point (for example) can be saved. In the data modification dialogs, 3 means only include 1 in 3 data points, 4 means 1 in 4 (a quarter of the file size) and so on.

Cut

Enter the number of data points (span) to which you want to limit the raw results. This may eliminate a long tail but be careful not to lose essential features or individual samples with more data points than the rest.

Crop

Define a time span that limits the data to an area of interest (e.g. the last 30 seconds).

Appendix D
A Note on Overall Result and Hidden Results

A **verified calculation** is one where upper and lower criteria are set, and the result is a Pass (within limits) or Fail (outside limits).

An **Overall Result** is a Pass or Fail status based on all *included* verified calculations.

A **Hidden Result** is one that you choose not to *show* in the results. Perhaps its value is not of importance in itself, but where also verified, it can still influence the Overall Result if you choose, in which case you must **Include Hidden Results** in calculating the Overall Result. If you hide some verified results but not others, this could potentially be confusing. Here is an example of five calculation steps and an Overall Result.

● = 'yes', ○ = 'no', ⌐ = contributes to overall result

Calculation step	verified	hidden	where the result is:	Result visible	☒ do not include hidden results	☑ include hidden results
1	●	●	Fail	○		⌐
2	○	○	—	●		
3	○	●	—	○		
4	●	○	Pass	●	⌐	⌐
5	●	○	Pass	●	⌐	⌐
Overall Result					Pass	Fail

This feature is mainly useful for hiding all the verified criteria whilst leaving the Overall Result visible. There are three locations where this matters:

Set-up > *Preferences* > [Results display]

Set-up > *System* > [Schemes] (for data export)

Set-up > *System* > [Report Templates] (for printing results as reports)

In each, you decide whether to show an overall result, and in each, any hidden results will not be shown.

Note: inclusion of samples in a results file or display is quite separate; individual samples can be included or not in the statistics of a batch, in export and in reporting. This is not the same as hiding calculation results.

Now examine the following Results Grids carefully. We hide verified result 2 and then don't include it. This affects the overall result, but in the second grid we can't see why the sample has failed.

Example Results Grid: if any verified result fails, the overall result is fail:

Results	Sample 3	Sample 2	Sample 1
Included	☑	☑	☑
unverified result	### Units	### Units	### Units
verified result 1	🟩	🟩	🟥
verified result 2	🟩	🟥	🟩
verified result 3	🟩	🟩	🟩
Overall result	PASS	FAIL	FAIL

The second verified result is now hidden; hidden results have been included, sample 2 fails:

Results	Sample 3	Sample 2	Sample 1
Included	☑	☑	☑
unverified result	### Units	### Units	### Units
verified result 1	🟩	🟩	🟥
verified result 3	🟩	🟩	🟩
Overall result	PASS	FAIL	FAIL

The second verified result is hidden; hidden results are now *not* included, sample 2 passes:

Results	Sample 3	Sample 2	Sample 1
Included	☑	☑	☑
unverified result	### Units	### Units	### Units
verified result 1	🟩	🟩	🟥
verified result 3	🟩	🟩	🟩
Overall result	PASS	PASS	FAIL

You may choose to hide all verified results, but still include them:

Results	Sample 3	Sample 2	Sample 1
Included	☑	☑	☑
unverified result	### Units	### Units	### Units
Overall result	PASS	FAIL	FAIL

Note:

- In the Results Grid view, Overall result for bad samples are always set to fail, but automatically not included.

- For digital output (e.g. set output on FAIL) the digital output is synchronised to the Overall Result as displayed in the Results Grid view.

Appendix E
Tolerance Bands

Test data can be visually compared with a reference specimen by using the Tolerance Band overlay option (*Display* > *Overlays*). This requires a tab- or comma-delimited text file containing the reference data. There must be two columns representing the y-axis and x-axis respectively, with units in row 2 and data beginning in row 3, as in this example:

```
y-axis,x-axis
mm,N
0.30,1.00
0.50,1.40
0.70,1.85
etc.
```

The data may be derived from theoretical results, or from a reference test, and must be in the same units as the results to be compared. There should be no more than 100 data points.

With a Results file open, browse to the reference file in *Display* > *Overlays*:
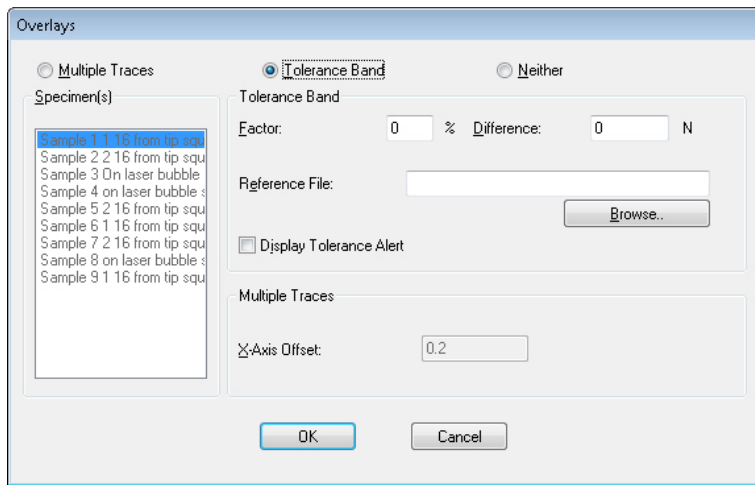
Two types of tolerance bands can be generated. Typing a number into the **Factor** box (20%, for example) will generate a factor-based tolerance band:
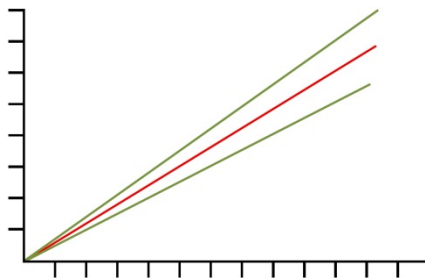
The data in the reference file are shown in red, and the tolerance limits that will appear on the graph are shown in green.

Typing a number into the **Difference** box (5 N/N.m, for example) will generate a difference-based tolerance band:
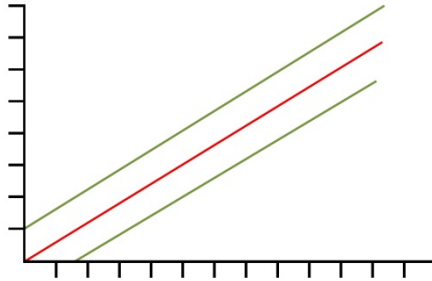
Note: tolerance bands are calculated on the basis of there being an acceptable range of values for the parameter plotted on the y-axis. If, for example, data have been plotted as Load/Displacement(Angle), but you need to work with a specification that requires test data to be within ± 5 mm(degrees) of the data for a reference specimen, then use the 'Others' option in *Display* > *Settings* to generate a Displacement(Angle)/Load plot.

It can be awkward to devise the calculation(s) necessary to detect when a sample is not within tolerance, but Emperor can do this automatically. Check the 'Display Tolerance Alert' box, to display a warning in the Results screen when tolerances are exceeded.

Data that 'fail' (i.e. fall outside the y-axis limits of the tolerance band) are plotted in red, but data that 'pass' (i.e. fall within the y-axis limits of the tolerance band) are plotted in green. Data that fall outside the x-axis limits of the tolerance band) are plotted in black.

Appendix F
Digital Input Commands and Output Notifications

Mecmesin test stands have the facility for six digital inputs and six digital outputs that can be used to integrate the test stand with programmable logic controllers (PLCs) or other equipment.

Setting up the inputs and outputs is done in the [Test Settings] tab of the Program Test Set-up screen. To allocate a function to the input or output, first select a Digital Input or Digital Output. Then choose a function from the drop-down box to the right of the selected input or output. The alternative functions are:

F.1   Available commands for digital inputs

OFF
START TEST (Idle mode event)
STOP TEST (Testing mode event)
START ACQUISITION Testing mode event)
STOP ACQUISITION (Testing mode event)
TARE LOAD (Idle mode event)
TARE POSITION (Idle mode event)
TARE BOTH (Idle mode event)
GO HOME (Idle mode event)

F.2   Available notifications for digital outputs

OFF
TEST STARTED (Testing mode event)
TEST STOPPED - COMPLETED OK (Testing mode event)
TEST STOPPED – EMERGENCY STOP (Testing mode event)
TEST STOPPED – USER (Testing mode event)
TEST STOPPED – ALL (Testing mode event)
AT HOME POSITION (Testing mode event)
TEST RESULTS – PASS (Idle mode event)
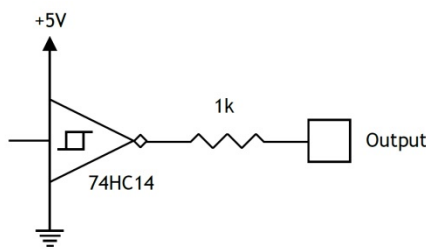TESTRESULTS – FAIL (Idle mode event)

Appendix G
Pin-out Connections for Digital Inputs and Outputs

G.1   Digital inputs

- Input voltage range is 0 to +5V

- The input pins are normally high (+5V) and should be pulled low (0V) for a minimum of 100 ms to trigger an operation

G.2   Digital outputs

- Normally low (0V)

- When set the appropriate output pin is pulsed high (+5V) for 500ms

Digital Output circuit

25-Way D-type pin	Function		25-Way D-type pin	Function
1	Not connected		14	Digital output 1
2	Auxiliary receive		15	Digital output 2
3	Auxiliary transmit		16	Digital output 3
4	Not connected		17	Digital output 4
5	Not connected		18	Digital output 5
6	Not connected		19	Digital output 6
7	Ground		20	Not connected
8	Not connected		21	VCC (+5V)
9	Digital input 1		22	Not connected
10	Digital input 2		23	Event input
11	Digital input 3		24	Digital input 6
12	Digital input 4		25	Ground
13	Digital input 5			

Appendix H
RS232 protocol

H.1 Comm port settings:

Data bits: 8

Parity: None

Stop bits: 1

Flow control: None

Appendix I
Bad Sample Messages and Error Codes

If a test does not complete, it will be marked as 'Bad' in the sample status in the sample management section on the Info/Help screen. Bad results are not included in 'Mean' and 'SD' calculations in the Results grid, but can be printed in a report. You can get more information on the cause of the problem by adding an 'Information' calculation in a program test. This will then show the Reason code in the 'Bad sample reason' line displayed in the Results grid.

I.1   Error messages

Error message	Cause
'Stopped by operator'	The run has been stopped by pressing the red 'Stop' button on the Live Test Run screen
'Aborted by test system [0x0000000N]'	The system has stopped the run. By adding an 'Information' calculation line to a Program Test, a Reason code will be displayed in the Results grid. See below for a list of the Reason codes.
'Stopped by external input'	Test stopped due to a digital input
'No data acquired'	No data has been acquired
'Program not completed'	Program not finished, typically this will happen when a communication error occurs and aborts program execution

I.2   Reason codes

These codes indicate the reason for the test not finishing successfully. The codes displayed can be for a single reason, or if more than one failure has occurred the codes will be added together. For example, in the case of a single fault, the code [0x00000001] means 'Motor current limit Encountered'.

In the case of a multiple fault, a code of [0x00000003] would be displayed if both [0x00000001] 'Motor current limit Encountered' and [0x00000002] 'Motor drive has been disabled' had occurred at the same time.

Fault code	Reason
0x00000001	Motor Current Limit Encountered
0x00000002	Motor Drive Has Been disabled
0x00000004	Test stand has recovered from reaching the upper limit of travel
0x00000008	Test stand has recovered from reaching the lower limit of travel
0x00000020	Emergency Stop Button Pressed
0x00000040	Overtravel Switch Encountered
0x00000080	Overload detected, automatic recovery
0x00000100	Intelligent Load Cell not present, Switch test stand off and check the link. Allowing limited access.
0x00000200	Test Stand Data Buffer Overflow
0x00000800	Tachometer Failure
0x00001000	PID Overflow Too Many Times
0x00002000	PC Comms watchdog has timed out. Allowing limited access.
0x00004000	Failed holding the motor
0x00008000	Motor deceleration failure
0x00010000	Intelligent Load Cell receive load error
0x00020000	Test Stand transmit buffer is full
0x00040000	Invalid parameter in Test Stand PIC
0x00080000	Real Time Controller PIC failure, Switch test stand off, contact your Agent/Distributor. Allowing limited access to stand
0x00100000	Overload detected.
0x00200000	Test Stand has not been calibrated. Allowing limited access.
0x00400000	Extensometer jump detected
0x00800000	Invalid parameter sent to Test Stand

Appendix J
Setting up an -*i* Series Test Stand to Run as an -*xt* System

Test stands are normally configured to run either from a touch-screen console (-*xt* systems) or PC (-*i* systems), but can be run from either, via this update.

If you have an –*i* series test stand and wish to connect your PC as a console, or add a console to the stand, you will have been supplied with a memory stick containing a folder named Advanced Program Builder Option and which contains a single file to upgrade the test stand.

> **Note:** the Advanced Builder Option files are supplied for a specified stand serial number, and can only be installed on that stand.

Check that the file name is identical to the serial number of your stand, (an example of the format is 12-1046-07). The serial number can be found on the rear of the stand (or on the right-hand side of twin-column MultiTest stands). Contact your authorised Mecmesin distributor if the serial number in the file name is different.

Copy this numbered file, open your desktop shortcut to the Emperor (Force / Torque) Data folder, open the subfolder named \Upgrade and paste the file in.

Now open Emperor, log in as a Master user and go to the top menu to select: *Tools > Service > Update Options:*
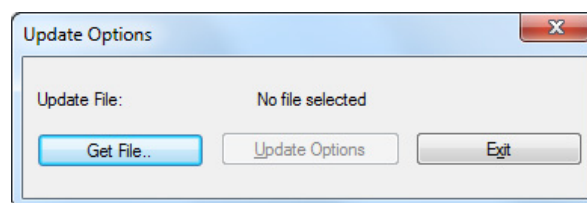
Click Get File and your update file will be visible. Select it and click Open . Your stand serial number now shows above the Update Options button, which is now live; click it:
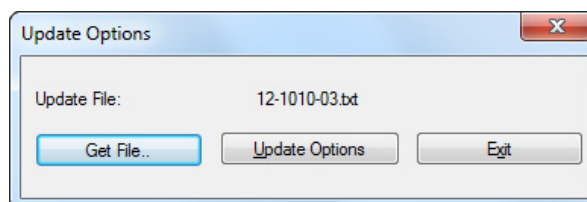
Your stand is updated.

You can see whether an -*i* stand connected to Emperor is updated for –xt operation by checking *Tools > Service > Stand Configuration* where Stand Options should read 3.

Index

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