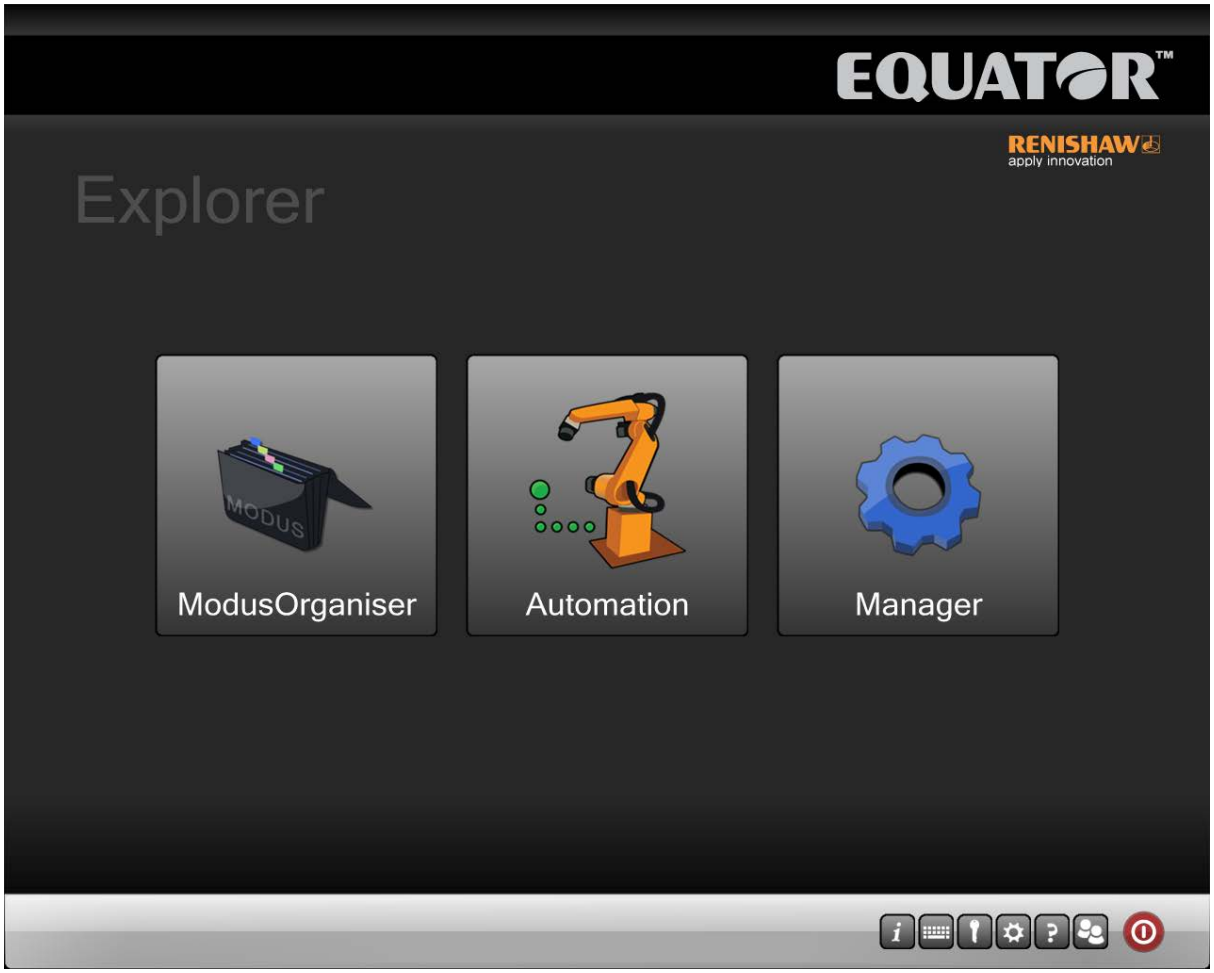
User guide

RENISHAW
apply innovation™

Equator™ Software Suite 1.x



www.renishaw.com/gauging

#renishaw

Contents

Introduction . . . 6
Starting the system . . . 7
Core Software . . . 8
Explorer . . . 9
Taskbar . . . 10
System information . . . 11
Language settings . . . 12
System licence . . . 13
System settings . . . 14
Time and Date . . . 15
System Park (EQ300 only) . . . 16
Startup Application . . . 17
Help . . . 18
User accounts . . . 19
System shutdown . . . 22
Manager . . . 24
Applications . . . 25
Updater . . . 26
Verifying an update . . . 27
File system . . . 29
Diagnostics . . . 30
Ethernet . . . 31
Organiser . . . 32
Administrator overview . . . 33
Settings . . . 35
General Settings . . . 36
Startup Program . . . 37
Deflection Check Settings . . . 38
Initial Movement . . . 39
EQ-ATS Overide Warnings . . . 40
Import / Export . . . 41
Creating a folder . . . 43
Creating a sub-folder . . . 44
Creating a part program . . . 45
Editing a folder or part program . . . 47
Using shared Master Data . . . 48
Opening part programs . . . 49

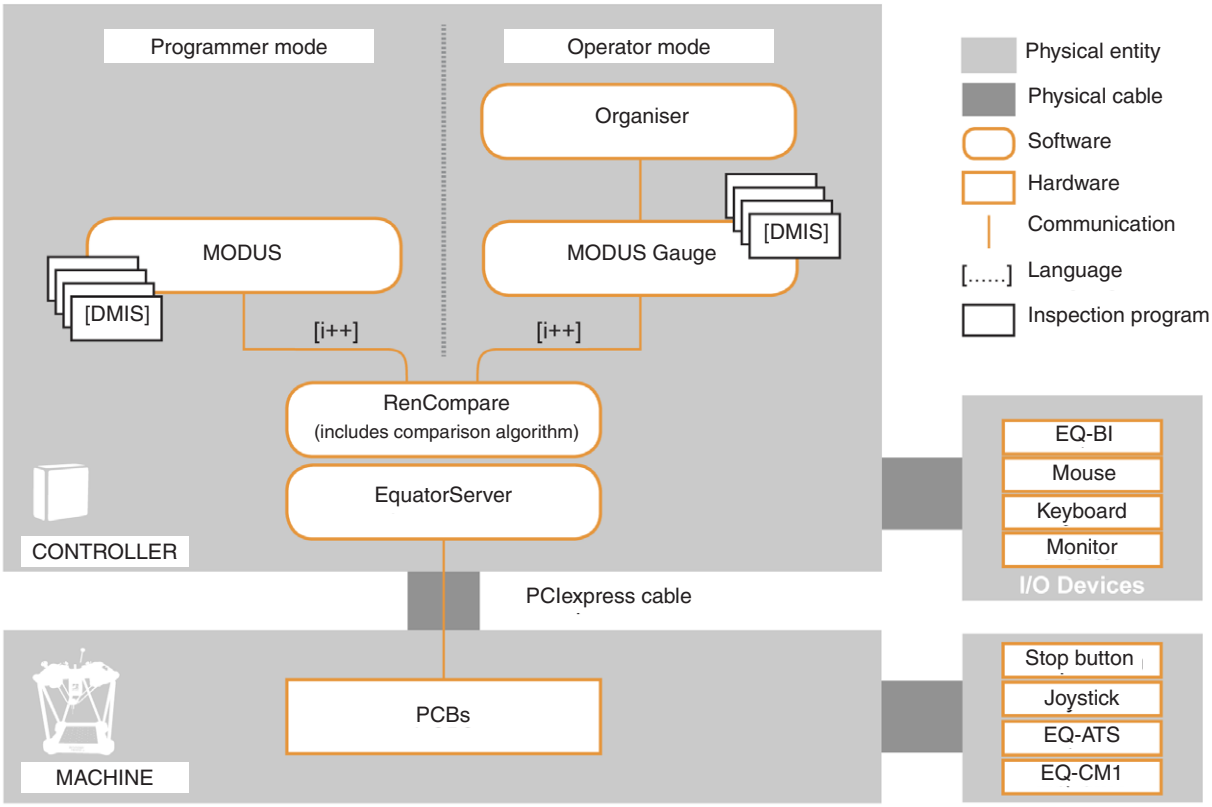
EquatorServer 50
Comparator mode 52
Inspection program screen functions 54
Process Monitor 56
Process Monitor overview 57
Process Monitor admin settings 61
Choosing a re-mastering process 64
Running a program using Golden Compare 65
Running a program using CMM Compare 68
Running a program using Feature Compare 71
Running a program using Dimension Compare 76
DMIS commands 80
File types and extensions 82
Software add-on - Intelligent Process Control 84
Setting up the system 85
Using IPC 87
Starting IPC 87
Managing Machine Tools 89
Adding tool offsets 92
Tool Offset in Process Monitor 96
Impact on IPC when editing DMIS 97
Best practice when editing DMIS: 97
Software add-on - Automatic Transfer System 98
Hardware setup 99
Running a diagnostic test 100
Adding EQ-ATS functionality to a part program 102
Running a part program with EQ-ATS 103
EQ-ATS inspection screen options 107
Manually moving the EQ-ATS 109
Manually moving the fixture plate in 109
Manually moving the fixture plate out 109
Changing EQ-ATS warning messages 111
Using EQ-ATS in Automation 113
Software add on - Automation 114
Opening Automation 115
Automation main window 116
Administrator options 120
Reset 122
I/O Monitor window 124

Maps 126
Input Map 127
Output Map 129
DMIS Map 131
Custom Signal Map 134
Logs window 137
Settings 138
Connection to a TCP/IP client 141
EZ-IO scheduler 145

Introduction

Our gauging hardware is controlled via the front-end software Organiser on the shopfloor. On a lower level, Organiser communicates with MODUS Gauge. This in turn, communicates with RenCompare via an I++ DME interface. This is where the comparison takes place. Rencompare communicates with EquatorServer which instructs the hardware's movements while registering the probe position in space.

Software / hardware communication



Once the system has been set up, it is recommended that the system is backed up to an external hard drive. The following parts of the system should be backed up:

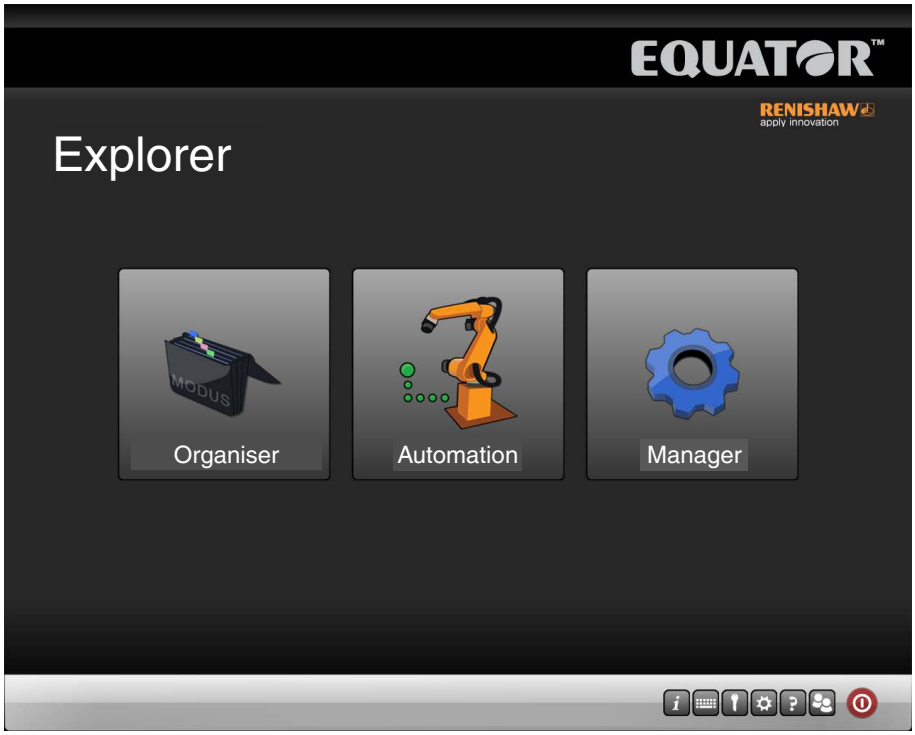
- Organiser database - Export database from within Organiser.
- EquatorServer environment - Export environment from within EquatorServer.
- Part programs - Export part programs using File system.

NOTE: The customer is personally responsible for backing up the data. In the event that the data is lost, Renishaw accepts no liability.

For further inquiries, please contact your local Renishaw subsidiary.

Starting the system

Switch on electrical power to the display (VDU) and the controller unit. The software will start to load automatically and the start-up screen will be displayed. Please wait until all the software has loaded before you continue.



Core Software

Operator mode

In Operator mode, the user can access Organiser to select and run inspection routines and generate results.

Administrator mode

Administrators can set up the system for operator use which includes generating customised screens containing text and graphics for each component.

Programmer mode

Programmer mode is activated by the use of a USB dongle. In programmer mode, the user has access to MODUS which is used to program an inspection routine.

Explorer

- Explorer is the start-up screen for the system.
- From here operators can access Organiser, Automation and the taskbar.
- Open applications will have buttons placed centrally on the taskbar.

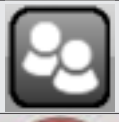
If no users have been set up on the system, or an administrator is logged in, the following extra options are available.

- Manager
- Expanded taskbar

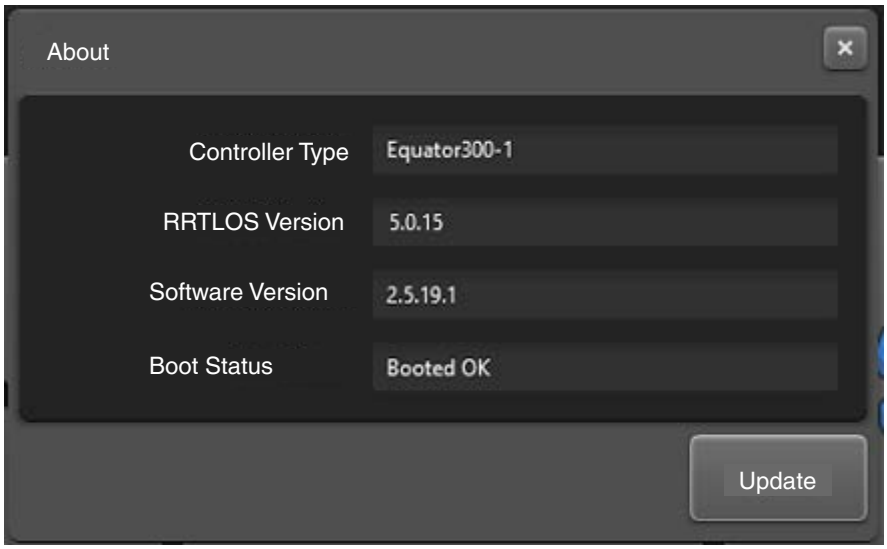
Taskbar

Operator taskbar

Administrator taskbar

	System information including controller type, RTLOS version, software version and boot status.
	Language setting.
	Licensing (only used on the system's first start-up).
	Settings gives an overview of the current system as well as the ability to change the current date and time.
	Help.
	Users button - provides access to a menu to control user accounts.
	System shut-down button.

System information



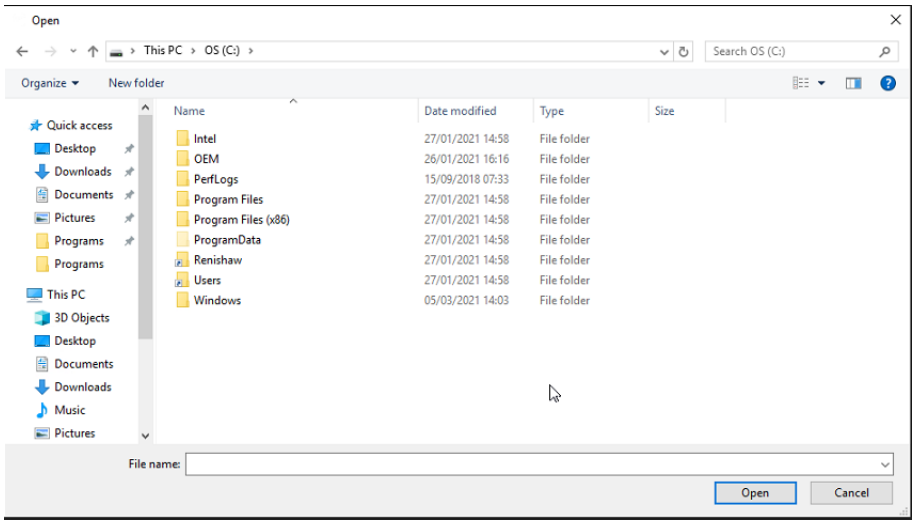
Language settings

- Use the drop down menu to select the required “System Language”.

NOTE: The system will reset once the language has been changed.

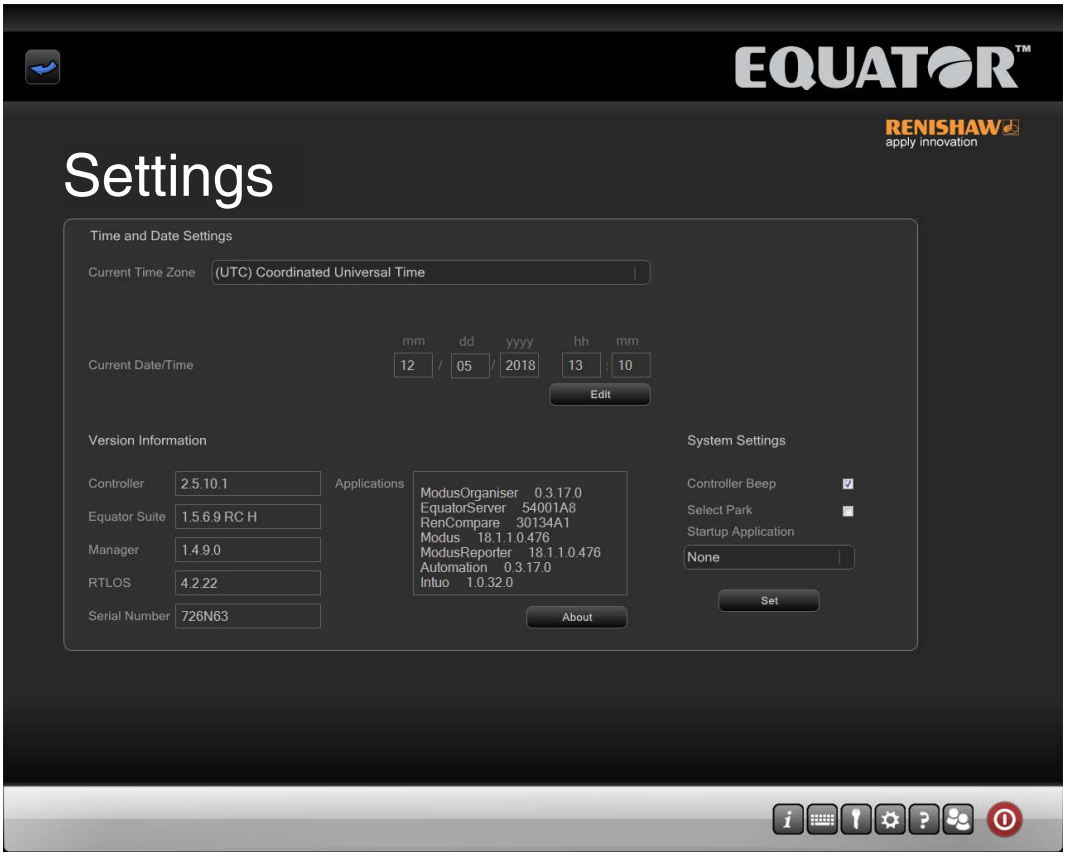
System licence

- To activate a system license, browse to the licence key file on the USB flash drive.

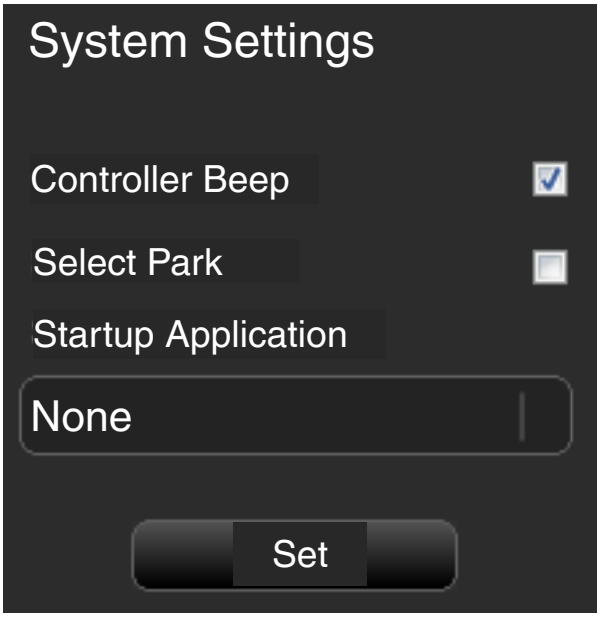


- Click “Activate licence”.

System settings

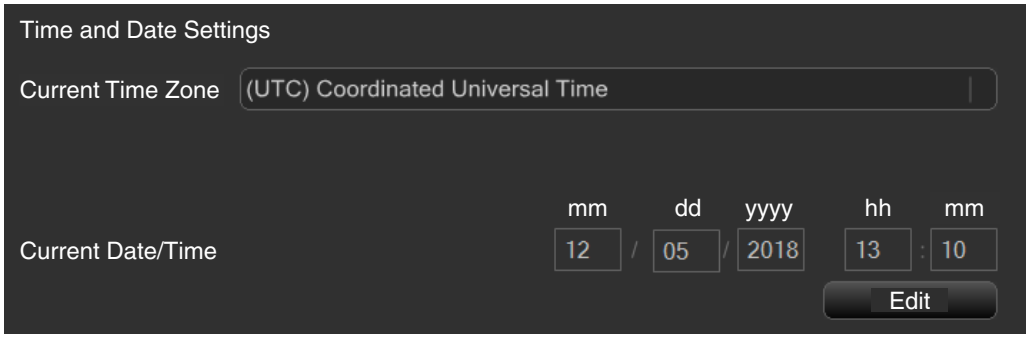


- You can turn on/off the “Controller Beep” by checking/unchecking the relevant tick box.



Time and Date

- You can change the “Time and Date” settings here.



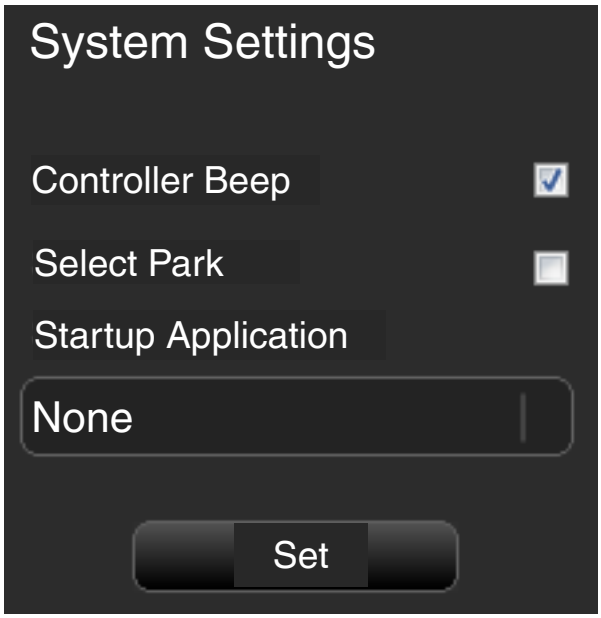
System Park (EQ300 only)

Equator 300 gauging systems with software version 1.4.5 or higher, have the ability to park the probe. This parking position prevents the floating platform from slowly dropping under gravity during controller shutdown.

A docking mechanism is provided to park and hold the floating platform when the controller is shutdown.

When a user shuts down the system or whenever an automatic shut down is triggered by the system (rebooting during change in Ethernet settings / date and time settings / software update), the floating platform will move to the park position as part of its shutting down routine.

- To turn on the park function, check the “Select Park” box.
- To turn off the park function, uncheck the “Select Park” box.



CAUTION: To avoid crashes, make sure that any parts/fixtures are clear of the working volume before parking the system.

NOTE: During a power-cut, the floating platform will move down unless it is already in the park position.

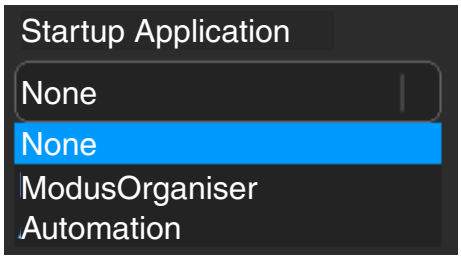
NOTE: The joystick cannot be used when in the park position as it is outside of the working volume.

NOTE: The system will only park if it has previously been homed.

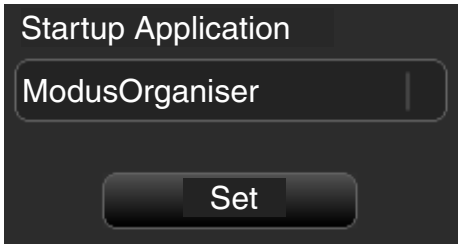
Startup Application

It is possible for the Administrator to set which application loads upon startup of the system.

- Click on the Startup Application drop down menu and choose the desired application. If the requirement is for the system to startup ready for gauging parts, select “Organiser” at this stage.



- Click on the “Set” button.



Startup Program

The Administrator can also set a program to startup automatically when Organiser is loaded.

- See “Startup Program” section.

Help

User accounts

Setting up user accounts is optional and is only required if you need to set up users with different levels of access. An Administrator would be given full access and an Operator would have restricted access.

Please note there is no password verification within the system unless a user account is set up.

Setting up a user account

- Click on “Users”.

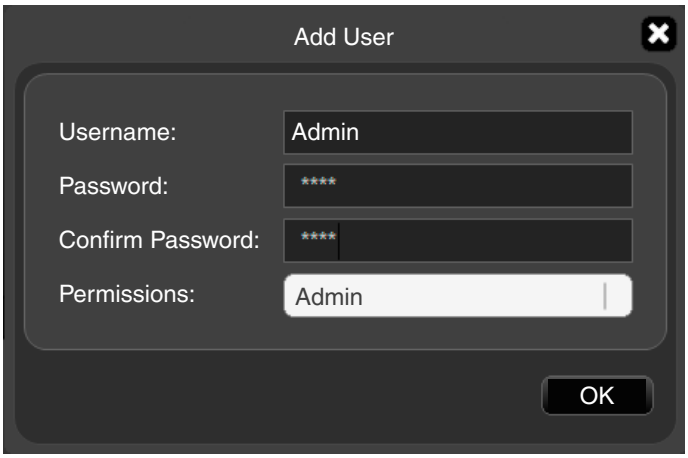
- In the “Username” field, input a name for the user.
- The default password is set to “password”. To change the default, overtype a new password into the “Password” field and confirm the password in the “Confirm Password” field.

NOTE: The password field is case sensitive.

- In the “Permissions” field, select either “Administrator” or “Operator” from the drop down menu as applicable.

NOTE: An Administrator must be created before adding any Operators. If this is the first user account being created, the user role is automatically set to Administrator and this cannot be changed.

- To save the user account, click “OK”.



- Repeat this process for all required Administrators and Operators. The Administrators and Operators set up in Organiser are displayed in the Users dialog box:

- Click “Edit” to edit the selected user.

- Click “Delete” to delete the selected user.

- Click “Logout” to logout the selected user.

NOTES: If you are an Administrator in Organiser you are an Administrator for the entire system. If all administrators forget their password, please contact your Renishaw representative for instructions on how to reset the password system.

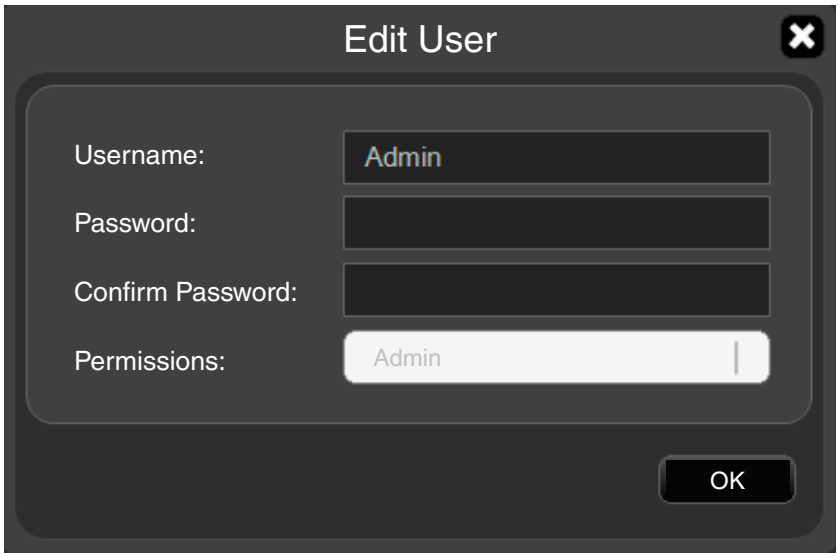
Changing the user password

- To change your password, select the required user, and click “Edit”.

- Input your new password in the “Password” field, then click in the “Confirm password” field and type in your new password.

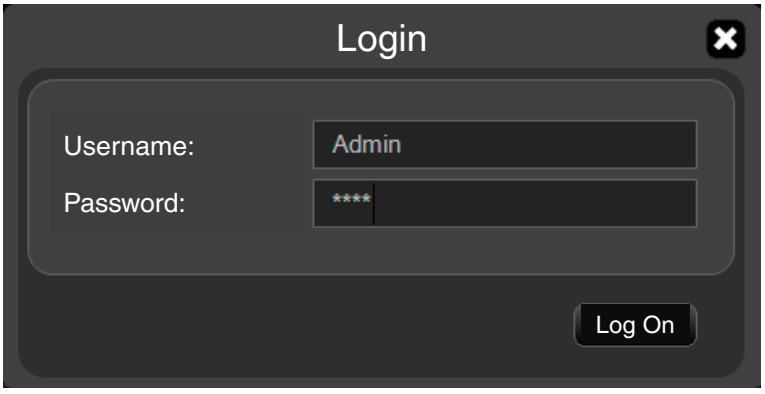
NOTE: The password field is case-sensitive.

- Click “OK” to save the changes.



Logging into a user account

- If a user account has been set-up, a log on prompt is displayed when Organiser is started.

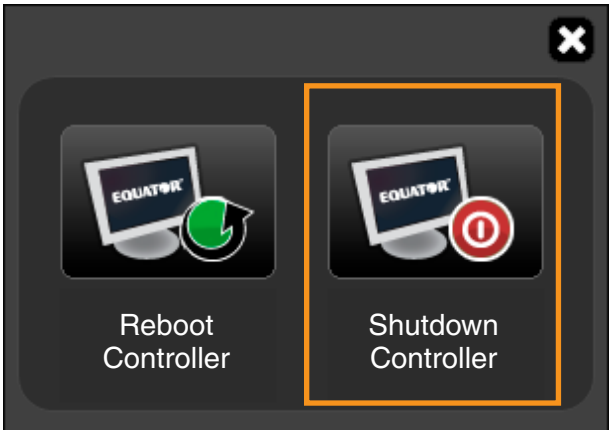


System shutdown

NOTE: Prior to shutting down the system, if there is a fixture plate fitted to the system, it must be removed. If you are unable to remove the plate due to the location of the probe assembly, move the probe assembly clear, then remove the fixture plate.

- To shutdown the system, click on the “system shutdown” button within the taskbar.

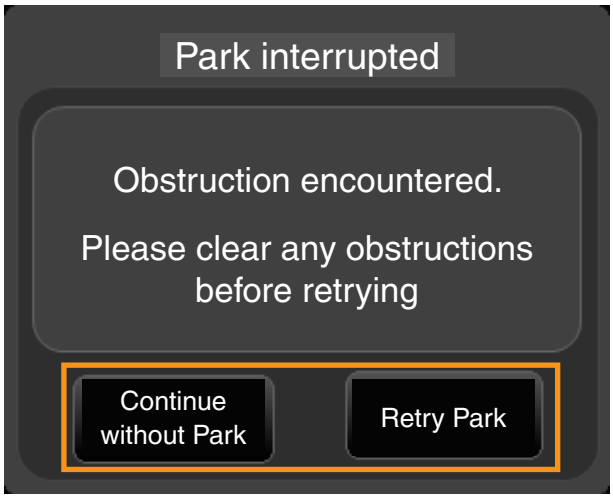
- Click on “Shutdown Controller” button.



- The following message is displayed (Are you sure that you want to shutdown the Controller?).
- Click “Yes” and the system will shutdown.

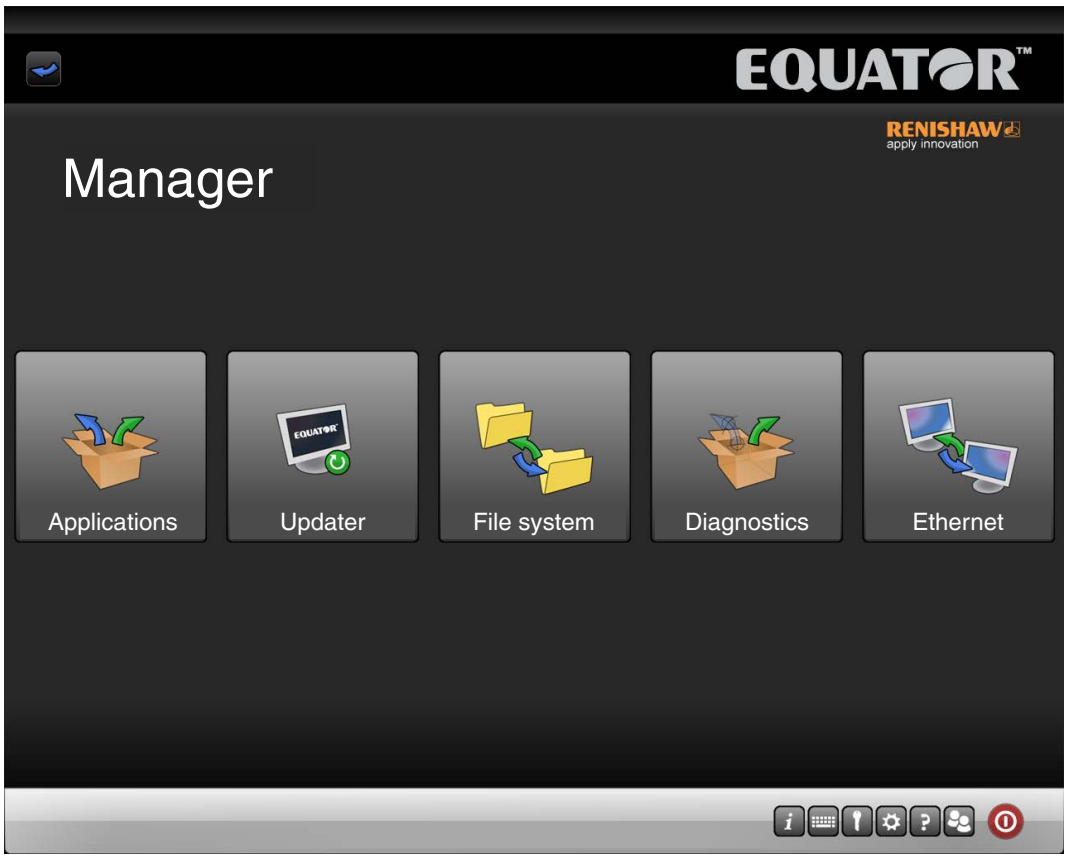
NOTE: If park is enabled and the docking mechanism is present, the Equator 300 system will park prior to shutting down.

- If a collision with the part occurs when parking, the following message is displayed (Obstruction encountered. Please clear any obstructions before retrying).
- Clear any obstructions and either “Retry Park” or “Continue without Park”.



- If the stop button is engaged when parking, the following message is displayed (Stop button is engaged. Please disengage Stop button before retrying).
- Disengage the stop button and either “Retry Park” or “Continue without Park”.

Manager



Applications

Provides access to the Applications screen.

Updater

The Updater function provides you with the ability to update your system to the latest software version.

Filesystem

The File System function is used to transfer files to and from the system.

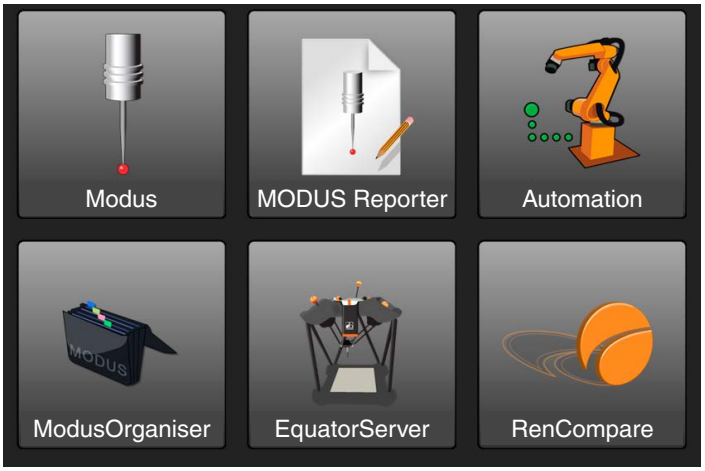
Diagnostics

The Diagnostics screen is designed for engineers to investigate the performance of the system.

Ethernet

This application is used to set up and control the Ethernet (network) functions within the system.

Applications



ModusOrganiser

This option loads the Organiser software, allowing Administrators to edit the menus within Organiser.
See MODUS Organiser for more information.

EquatorServer

This option loads the Equator machine control server. This menu provides access to the machine environment, probe tip calibration, machine error reports etc.
See the EquatorServer help file for more information.

RenCompare

This option starts the RenCompare software, which controls the mathematics required to compare production components to the Master component.

Modus

This option only appears if a suitable dongle (USB security key) is installed into the controller. It loads Renishaw MODUS metrology software, allowing programmers to create or edit part programs.
See the MODUS help file for more information.

ModusReporter

This option only appears if a suitable dongle (USB security key) is installed into the controller. ModusReporter is a program which can create reports based on the data/results collected by running part programs.

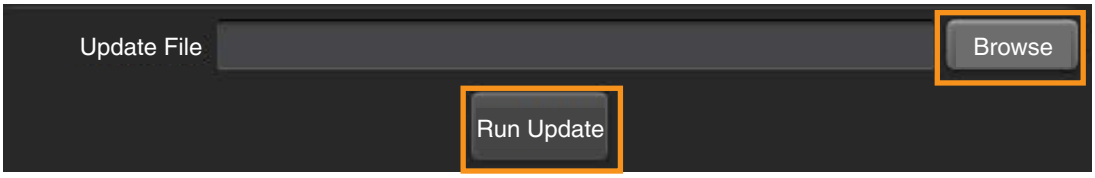
Automation

This option loads the Automation software which provides an interface between the system and external equipment e.g. PLC's (Programmable Logic Controllers), machine tools, robots, loading systems, etc.

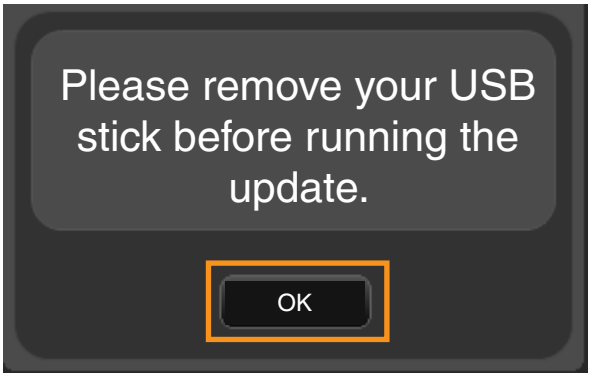
Updater

NOTE: Before updating the system, we recommend that you use the File system function to create a suitable folder on your system e.g. C:\Renishaw\Updates

- To update a system, browse to the system folder where you have saved the update file.
- Then click “Run Update”.

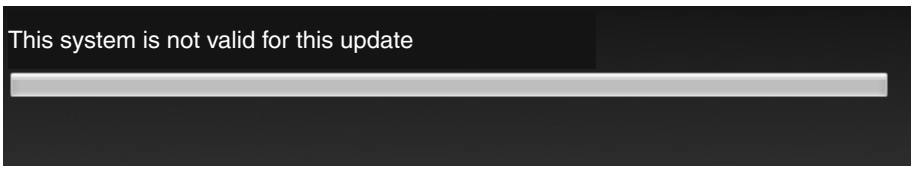


- The following message is displayed if a USB stick is still connected to the Controller (Please remove your USB stick before running the update).
- Remove the USB stick if needed and click “OK”.



- If the update is compatible with the current Software Suite, the system will now run the update procedure.

- If you are trying to install the update on top of a non-compatible Software Suite version or the update is corrupted, the following message will be displayed (This system is not valid for the update).
- Click “Restart” and install a compatible Software Suite version.

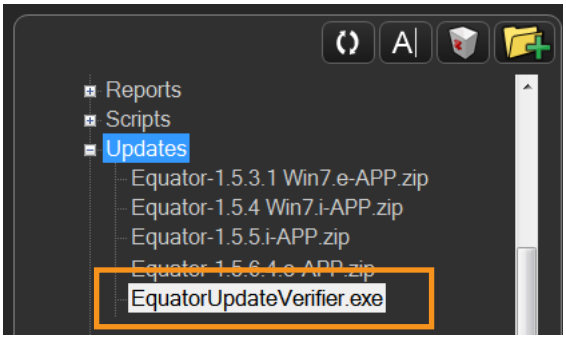


- You can check if an update is corrupted by verifying the update.

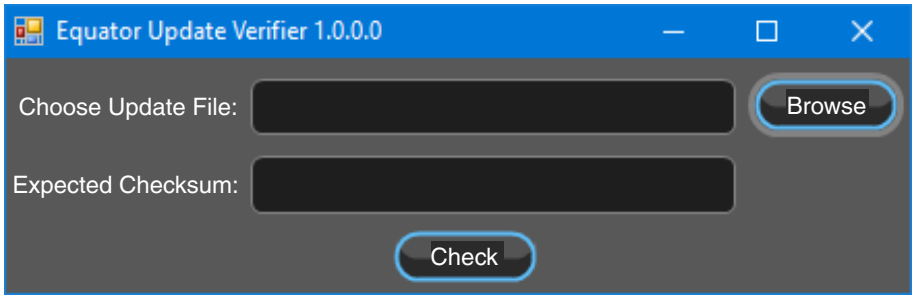
Verifying an update

You can use the tool “EquatorUpdateVerifier.exe” to verify that the update package is valid and hasn't been corrupted when downloading or copying via USB stick.

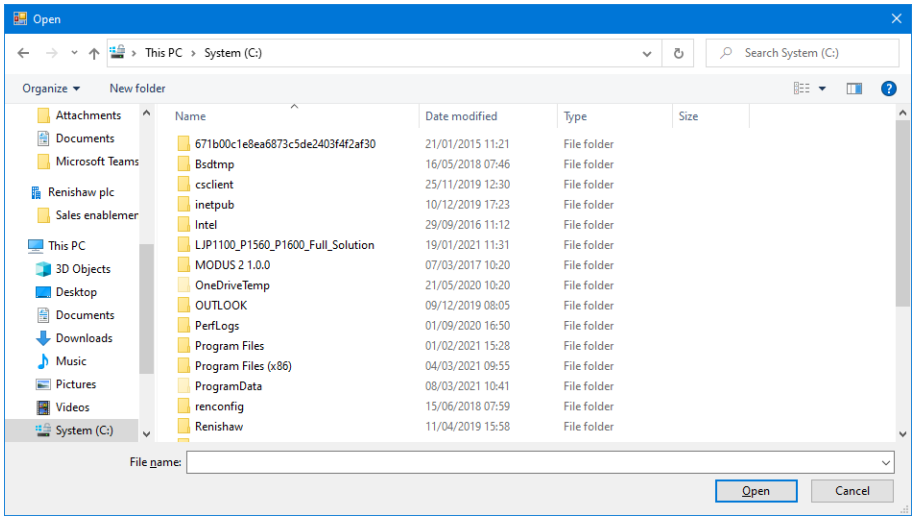
- To use "EquatorUpdateVerifier.exe" follow these steps:
- Double click on “EquatorUpdateVerifier.exe” located on a USB stick or on the system.



- The following window is displayed.
- Click “Browse”.

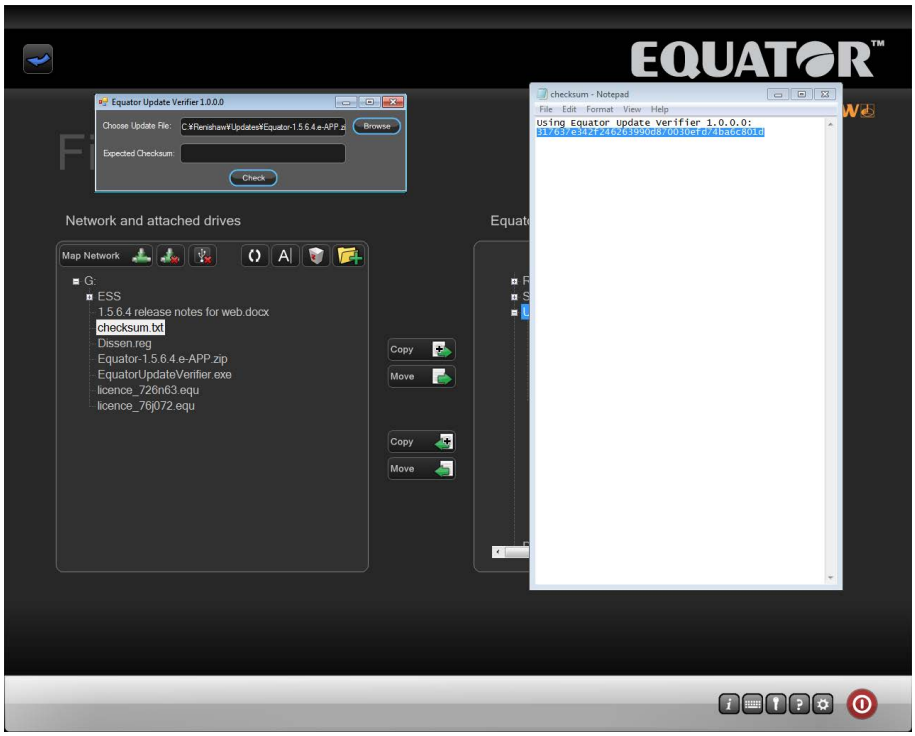


- Navigate to the update to check e.g. “Equator-1.5.8.1.e-APP.zip”.

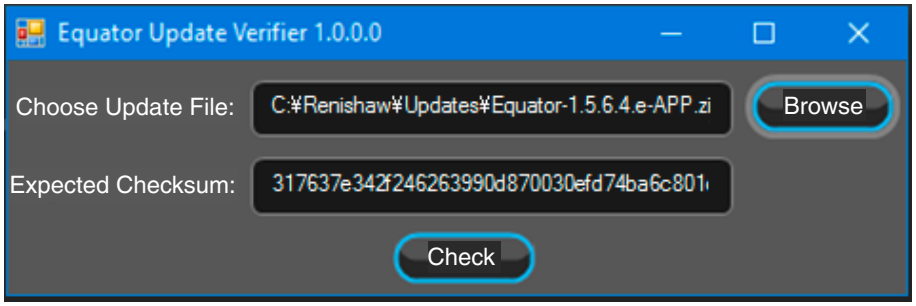


- Open or double click on the update to check.

- Double click on “checksum.txt” to open it in Notepad.

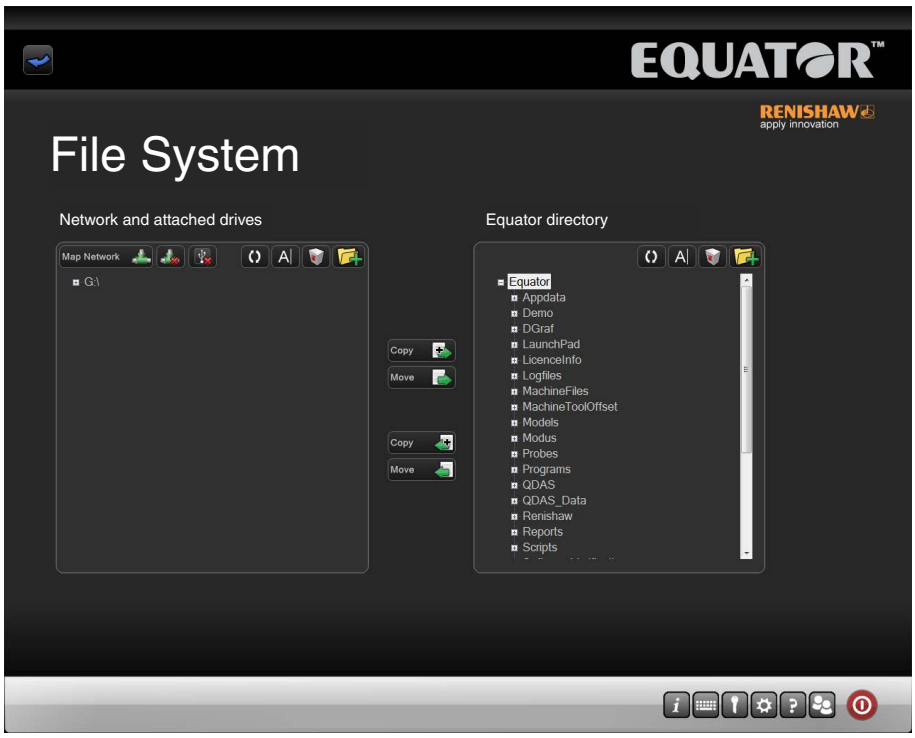


- Copy the checksum into the “Expected Checksum” text box.
- Click “Check”.
- Wait for the update to be checked against the checksum (it will take a number of seconds to complete this check).



- The result will either be a “tick”, which indicates a match, or a “cross”, which indicates that the update is corrupted and needs to be downloaded again.

File system

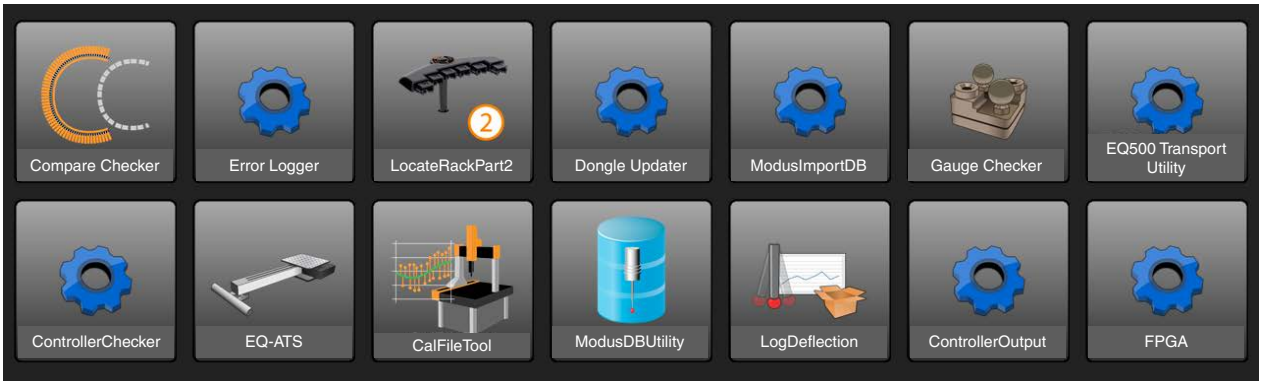


The following functions are available:

	Map a network drive
	Unmap a network drive
	Safely remove a flash drive
	Refresh the current drive display
	Rename a file or folder
	Delete a file or folder
	Create a new folder

IMPORTANT NOTE: When using this application it is the user's responsibility to ensure that suitable back-up copies are maintained.

Diagnostics



- Compare Checker - Utility to visualise .dmi, .cal and .mst point data.
- Error Logger - Shows connection status and saves error logs to C:\Renishaw\Logfiles\ErrorLogger.
- Locate Rack Part 2 - Applies measured rack position to EquatorServer.
- Dongle Updater - Utility to manage MODUS dongles licenses.
- ModusImportDB - Utility to import MODUS databases.
- Gauge Checker - Utility to perform metrology checks for machine health.
- EQ500 Transport Utility - Utility to release the drive brakes to enable machines to be packed securely.
- Controller Checker - Utility to check the status of the controller.
- EQ-ATS - Utility to check the function and communication of the EQ-ATS.
- Cal File Tool - Utility to check, average and filter .cal files.
- ModusDBUtility - Utility to manage Modus inspection databases.
- Log Deflection - Utility to record probe deflection.
- Controller Output - Utility to monitor and record commands sent to the machine controller.
- FPGA - Utility to check and update FPGA for various machine components.

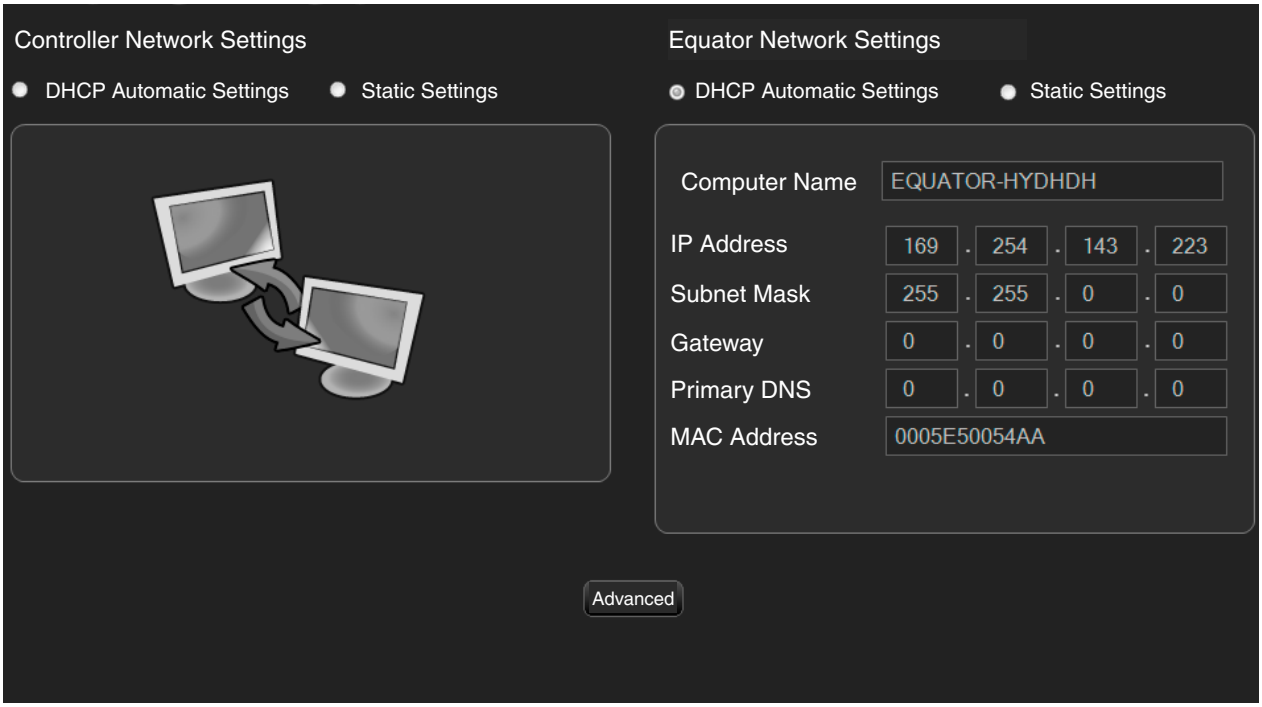
Ethernet

This application is used to set up and control the Ethernet (network) functions within the system.

CAUTION: The menu should only be accessed with caution and only then by qualified IT personnel, as the controller communicates through Ethernet connections; if invalid addresses are defined, they can stop the system operating.

- The first page is read-only and allows you to review the settings without changing them.
- To edit the Ethernet connection, access the application, then click the advanced button to change the settings.

NOTE: Both Ethernet ports (LAN 1, LAN 2) cannot be connected to the same network.



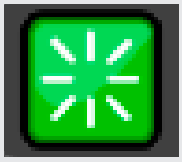
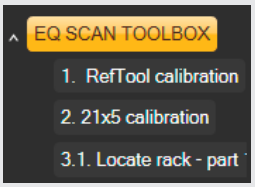
Organiser

Organiser provides a simple user interface for loading and running component programs. A customised part program window is created for each component.

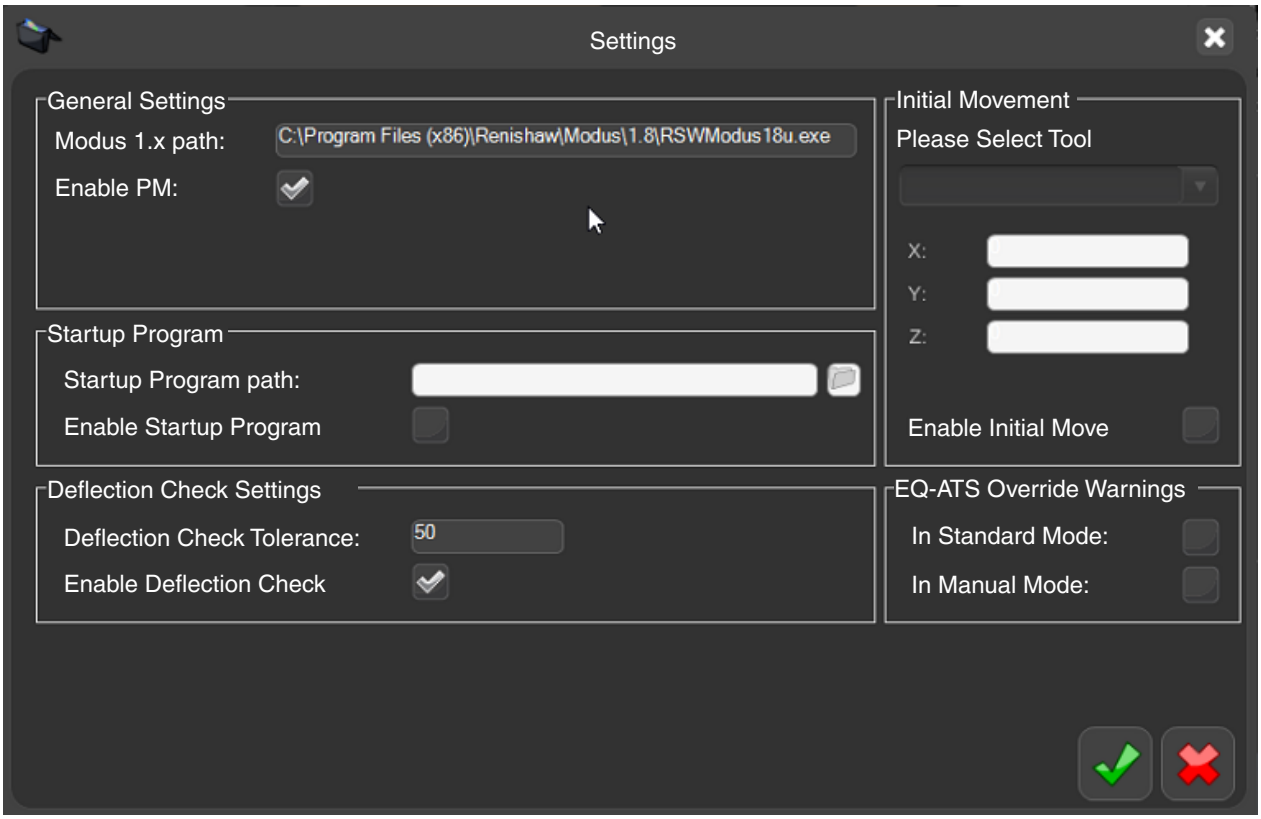
Administrator overview

- Display the Organiser options by clicking on the “Administrator” button

Administrator options		
Icon	**Name**	**Function**
	New folder	Used to create new folders and sub-folders.
	New inspection	Used to create a new inspection entry. A dialog box appears that allows you to link part programs, images and instructions.
	Edit	Allows editing of the folder or part programs.
	Folder	Allows reordering of the folder structure. To reorder part programs within a folder, highlight the inspection program button and then drag and drop it to its new location.
	Bin	Deletes folders/part programs from the Organiser environment. CAUTION: Deleting a folder will delete its entire contents. There is no undo facility.
	Settings	Provides access to some of the system settings, including the path and filename for Organiser, the TCP/IP sockets, and command line arguments. These options are defined at installation and usually never need to be changed. CAUTION: Users should NEVER edit the settings, unless prompted by a Renishaw engineer.

Administrator options		
Icon	**Name**	**Function**
	Show MODUS	Shows if MODUS is running in the background.
	Hard Reset	This restarts MODUS and the associated utilities (e.g. EquatorServer and RenCompare) without having to switch the controller off. CAUTION: Any unsaved data may be lost.
	Import / Export	Displays the Database Operations dialog box to allow the import and export of Organiser folder structures. This function provides the capability to transfer Organiser data between different Equator gauges. The file has a .sdf file extension.
	Logs	Displays communications with MODUS.
	Administrator tools	Shows administrator level buttons.
	Folder tree	Displays the current structure and contents of Organiser.
	Navigate folders	Two quick access buttons that allow the user to move up to the top folder level or up one folder level.

Settings

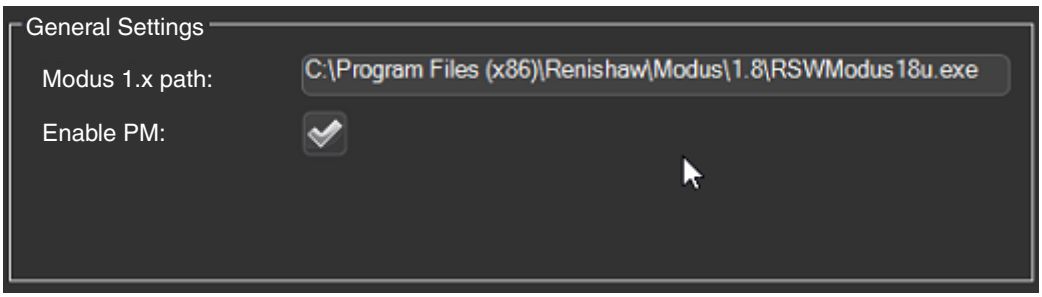


The System button provides access to some of the system settings, including:

- General Settings.
- Startup Program.
- Deflection Check Settings.
- Initial Movement.
- EQ-ATS Override Warnings.

These options are defined at installation and usually never need to be changed.

General Settings



MODUS 1.x path

- This is the filename and location of the MODUS 1.x .exe file.

Enable Process Monitor

- By default Process Monitor is automatically enabled. To enable or disable PM, check or uncheck the “Enable PM” box.

Startup Program

The Administrator can set a program to startup automatically when Organiser is loaded.

- Click “Enable Startup Program”.

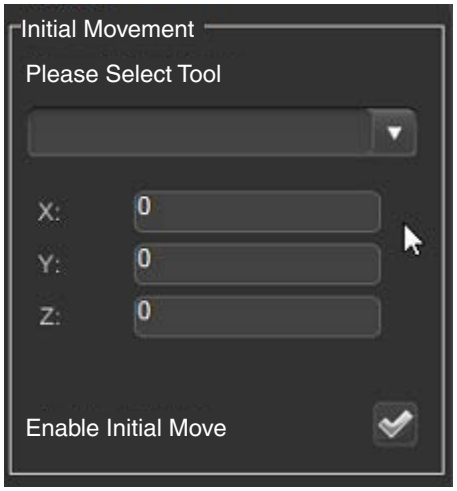
- Click on the “file” icon and select the desired .btc file.

- When Organiser restarts, the chosen program will open automatically.

Deflection Check Settings

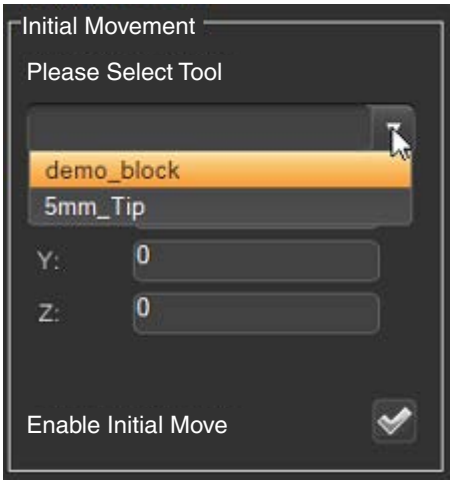
- The system has the ability to check the probe for over deflection. This setting can be turned on or off via the “Enable Deflection Check” tick box.
- A tolerance value can be added. If the deflection value goes over this tolerance value, then the system will force the user to recalibrate the probe.

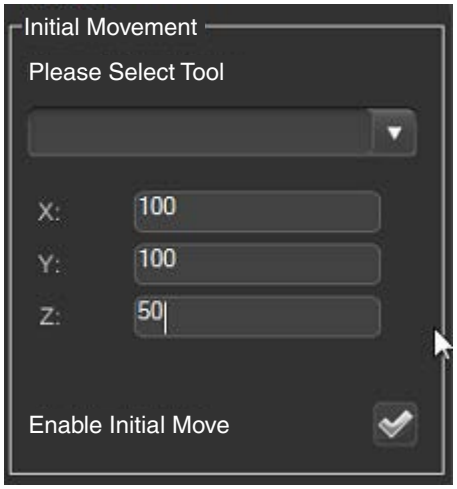
Initial Movement



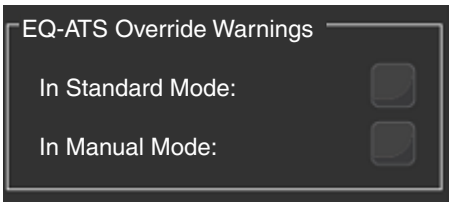
- An initial move can be used to move the machine on the starting of the Organiser software.
- This setting can be turned on or off via the “Enable Initial Move” tick box.

NOTE: Care should be used when using this function.



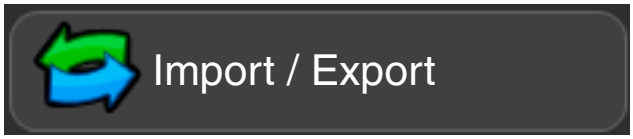


EQ-ATS Overide Warnings



- See: “Changing EQ-ATS warning messages”.

Import / Export



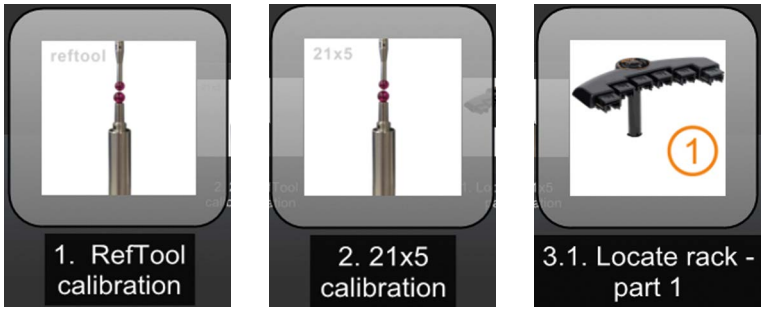
Organiser databases can be imported or exported. Default Organiser databases can be accessed here:

- Scanning: C:\Renishaw\Programs\OrganiserToolbox\Scanning_Toolbox.ent
- Touch Trigger: C:\Renishaw\Programs\OrganiserToolbox\TT_Toolbox.ent

Scanning Toolbox

The Scanning Toolbox contains the following programs:

- RefTool calibration
- 21 × 5 calibration
- Locate rack - part 1



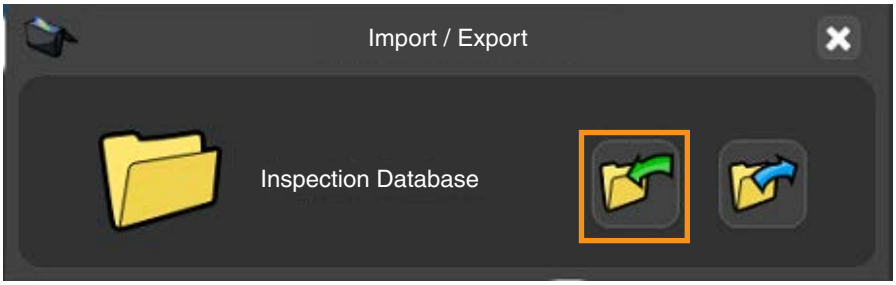
Scanning Toolbox

The Scanning Toolbox contains the following programs:

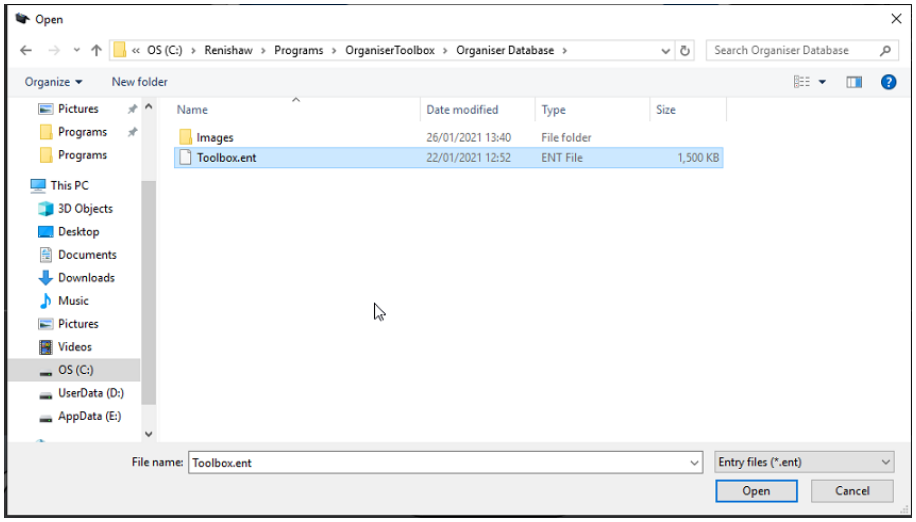
- RefTool calibration
- Locate rack - part 1

Import

- To import an Organiser database, select the “Import Inspection database” button.



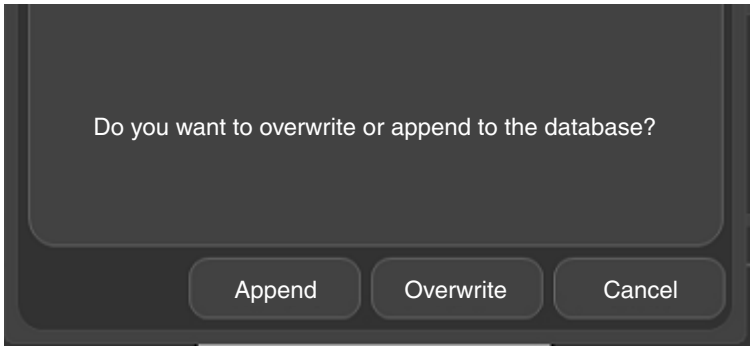
- Browse for the required Organiser database file and click “Open”.



A message will appear: “Do you want to overwrite or append to the database?”.

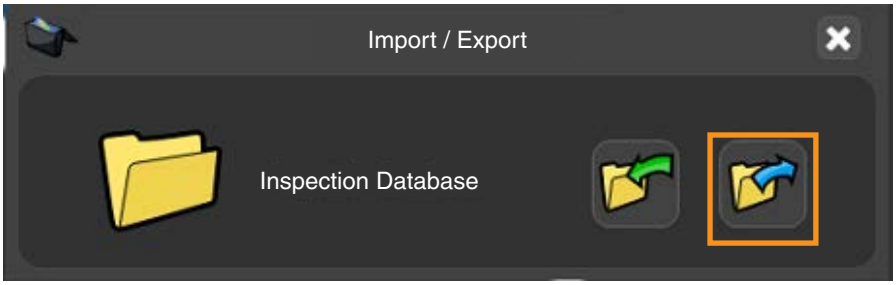
- Append - appends the existing Organiser database.
- Overwrite - overwrites the existing Organiser database.
- Cancel - cancels the importing of the Organiser database.

NOTE: Selection of “Overwrite” will overwrite any existing programs.



Export

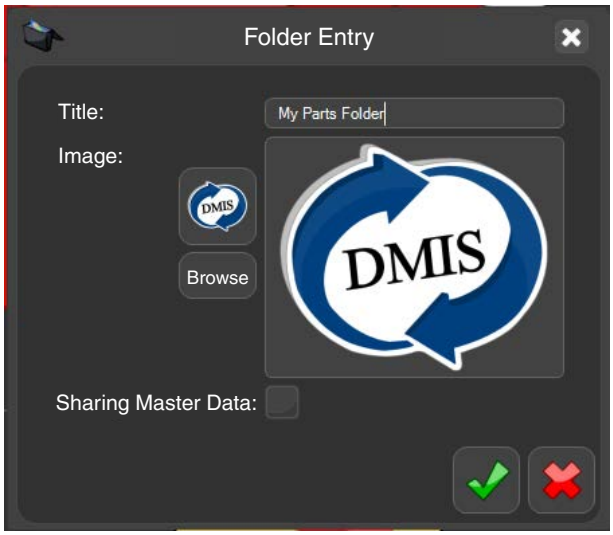
- To export an Organiser database, select the “Export Inspection database” button and save to the required location.



Creating a folder

- Double-click on the folder icon in the bottom left hand corner of the screen.

- Select the "Title" input field and type in a title (name) for the folder e.g. My Parts Folder.
- Select an image for the folder. Alternatively, select the “Browse” button to browse for a previously created image (.jpg, .png, .bmp, or .gif.).
- Click the “green tick” to proceed.



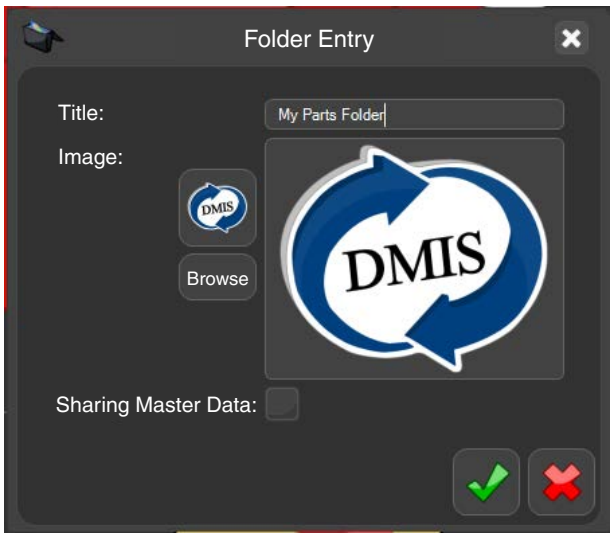
- The folder will be created within Organiser. The folder tree will be displayed on the left hand side of the screen.

- If required, the folder can be repositioned using the folder relocation function shown below.

Creating a sub-folder

- You can now add a sub-folder to the folder. Click on the open folder icon at the bottom left of the screen and drag it onto the “My Parts Folder” folder.

- Select the "Title" input field and type in a title (name) for the sub-folder e.g. “Demo Part_1”.
- Select an image for the folder.
- Click on the “green tick” to proceed.

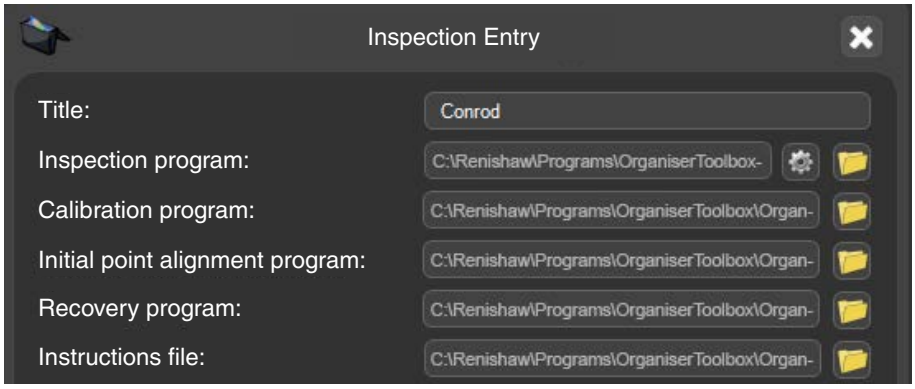


- The folder will be created within Organiser. The folder tree will be displayed on the left hand side of the screen.

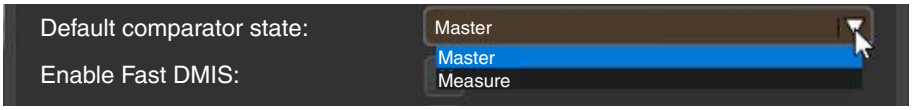
Creating a part program

- To add a part program to a folder, click on the “new inspection entry” button from the bottom left of the screen.
- Drop the button onto the folder.

- Input the “Title” for the part program.
- You can browse for the required programs by clicking on the relevant “folder” icon.
- Select the required files for “Inspection program”, “Calibration program”, “Initial point alignment program”, “Recovery program” and “Instruction file”.

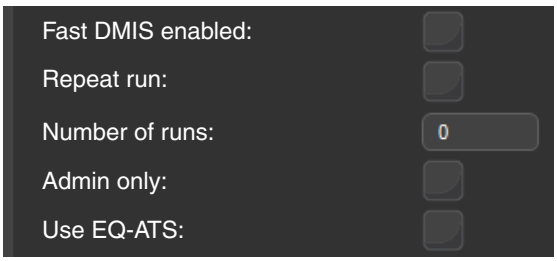


- Use the “Default comparator state” drop-down menu to select “Master” or “Measure”.



A number of options can be turned on/off by using the follow tick boxes:

- Fast DMIS enabled - If the part program uses Fast DMIS, tick this option (MODUS 1.X only).
- Repeat run - Allows the user to run the part program on a loop.
- Number of runs - Defines the number of runs when running in “Repeat run” mode.
- Admin only - Defines if the part program is admin password protected.
- Use EQ-ATS - If the part program uses the EQ-ATS, tick this option.



NOTE: The “Admin only” option allows administrators to set password protection on the program. When selecting the program from the main organiser screen, the user will be required to enter the correct login details to run the program.

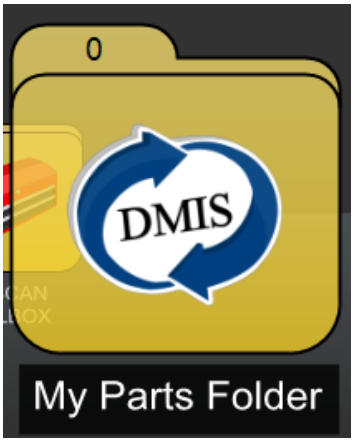
- Choose an “Image” for the program if needed.

- On completion of all inputs, click on the “green tick”.

- The part program will be created within Organiser.

Editing a folder or part program

- Select the folder or part program that needs editing.



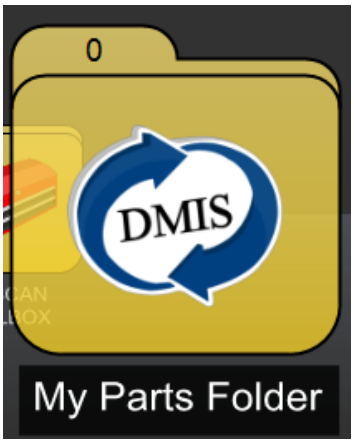
- Click on the “Edit” button.

- The “Folder” or “Inspection” Entry windows will appear.
- Make the required changes then click the “green tick”.

Using shared Master Data

- If you have two or more part programs that need to share the same master data:
- When creating a new folder or editing an existing one, make sure that the “Sharing Master Data” option is ticked.

- Click the “green tick” and the folder will appear in the Organiser window.



- Now either create new part programs and add them to the folder, or add previously created part programs that require shared master data into the folder.
- When one part program is mastered, all of the other part programs in the folder will share the same master data.

Opening part programs

- Double click on the part program.

- The inspection program screen will be displayed.

EquatorServer

If programs are being supplied to you, new environments for EquatorServer and for Organiser need to be imported.

NOTE: Always import the EquatorServer environment before importing the Organiser environment.

- From the Manager screen, click on “Applications”.

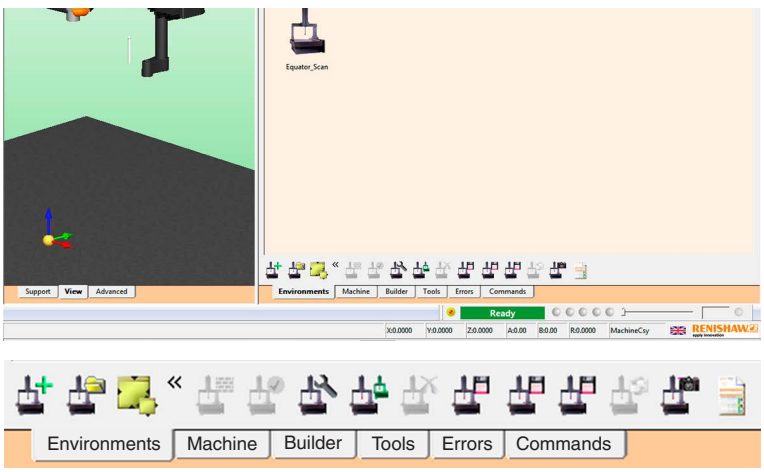
- Click on “EquatorServer”.

Default EquatorServer environments

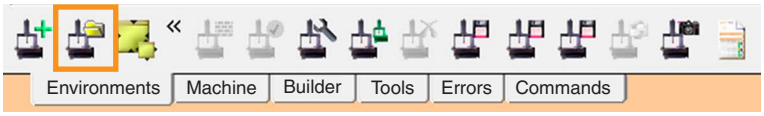
- Scanning: C:\Renishaw\Programs\OrganiserToolbox\Equator_Scan.mzp

To import a EquatorServer environment

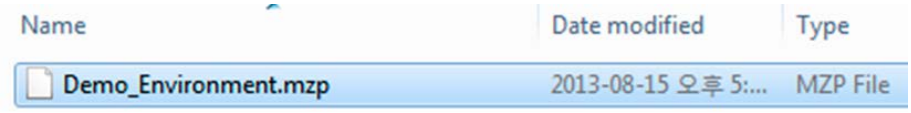
- Once EquatorServer has loaded, navigate to the “Environments” tab.



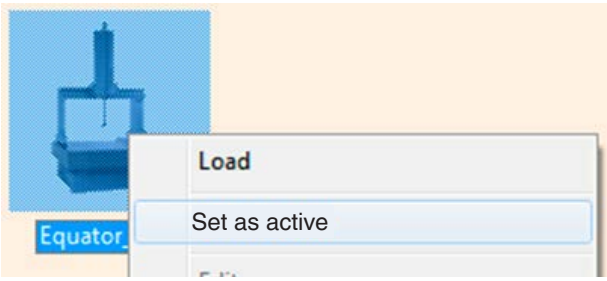
- Click on the “Import Environment” button.



- If the environment is on a USB flash drive, insert the drive now.
- Browse for the environment file (file extension *.mzp) then click “Open”.



- The environment will then need to be set as active. Right click on the imported environment and select “Set as active”, which will cause EquatorServer to shut down. Next time EquatorServer is loaded, this environment will be used.

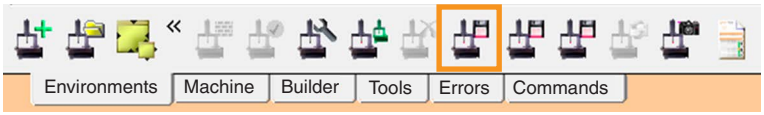


- The procedure is the same if you already have an EquatorServer environment that you wish to transfer to another system. You will need to export it and then import it on to the other system.

NOTE: After importing a new environment and restarting EquatorServer, all probing tools must be calibrated to prevent unexpected movement and give good quality data.

To export a EquatorServer environment

- Once EquatorServer has loaded, navigate to the “Environments” tab.
- Click on the “Export Environment” button.



- Browse to the location you want to save the environment file (file extension *.mzp) then click “Save”.

Comparator mode

The principle of Equator is to gauge or compare data and components. The comparison is carried out between a Master component and the production components.

Programs can be run in two modes: Master, to set the Equator, or Measure, to compare (measure) the production components.

There are four different compare processes available.

Golden Compare

- Golden Compare uses a Master (Golden) part, manufactured as close to drawing nominals as possible, to calibrate the Equator.
- Firstly a DMIS part program is created and proven on the Equator.
- A Golden Master part is mounted on its fixture on the Equator and the part program is then run in Master mode. This produces a Master (.mst) file. The production parts are then measured in Measure mode and the Equator reports the dimensional difference between the nominal Master and the production parts.
- The procedure presumes that the Master part is produced at drawing nominal. This means that any deviation of the Golden Master part to drawing nominals will be included in measurements. For example, if the drawing nominal is 50.000 mm, and the Golden Master part actual is 50.050 mm, although the Golden Master part measures 50.050 mm, it is reset to the drawing nominal value of 50.000 mm.
- If Equator measures the production part to be 50.025 mm, this means the actual measurement of the production part is 50.075 mm (i.e. 50.050 mm [Golden Master part actual] + 0.025 mm [difference between production part and Golden Master part] = 50.075 mm).
- In effect, the Master part should be produced at drawing nominal dimensions.

CMM Compare

- CMM Compare uses data collected from a CMM (Coordinate Measuring Machine) to “calibrate” the Equator to the Master component. With this compare method, the Master part does not need to be manufactured to drawing nominals, therefore any production piece part can be selected to be the Master part.
- With CMM Compare, the comparison uncertainty is dependent on the accuracy of the CMM used to measure the Master part.
- Any production piece part can be selected to be the Master part.
- Firstly a DMIS part program is created and proven on the Equator.
- A Master part is selected and the part program is then run on a reference instrument, for example a CMM. During the CMM measurement of the Master part, a calibration (.cal) file is generated. The calibration (.cal) file is then transferred to the Equator.

- The Equator is set to Master mode and the part program is run on the Master part. The calibration (.cal) file is read during the “Mastering/Measuring” of the part. Once the part has been mastered, the Equator is set to Measure mode and the production parts are measured.

Feature Compare

- Feature Compare follows a similar calculation process to Golden Compare, however it differs in that for Feature Compare, the Master Part must be produced to drawing nominal values; for Feature Compare, deviations of feature size, position and orientation can be taken into account during the Compare process.
- Prior to using the Compare using calibrated data process, the required features on the Master component are accurately measured using any suitable measuring method, for example CMM, optical projector, micrometer or caliper. The size, position and orientation of each of the features should be recorded.
- Next the part program is produced and verified.
- On completion of a part program run in Master mode, the EZ-Offset module will be displayed to allow the input of the previously measured actual values.

Dimension Compare

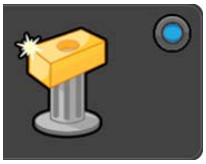
- Dimension Compare is designed to provide an automated alternative to measurement normally carried out using hand tools, for example micrometers, calipers and dial test indicators.
- Master dimensions are produced using any available measurement method, for example CMMs, hand tools, calipers etc.
- Once the component part program is complete and proven, it can be integrated into Process Monitor.
- Following a program run, the previously measured values of the Master component are input via Process Monitor.

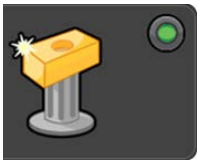
An advantage of the Equator comparative measurement technique is that it does not require precision part fixturing. The part needs to be repeatably located within the fixture and not displaced during measurement or when the fixture plate is moved. Fixtures and parts should relocate within the Equator’s volume to an approximate tolerance of ±1 mm (±0.040 in) to ensure a successful comparison process.

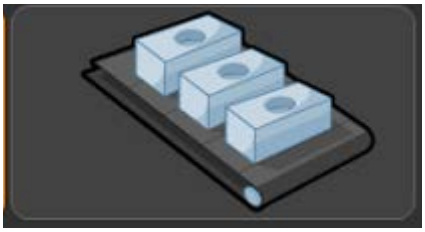
Inspection program screen functions

The screen can be customised by the Administrator to suit each inspection part program. The functions include the following:

- **Master mode:** Set the system to Master mode. This is used to create a master (.mst) file using the Master component. To display the current status of the Compare process, there is a virtual LED.







- **Measure mode:** Set the system to Measure mode.

- **Image:** Return to the default view displaying the image of the component (Administrator defined).

- **View DMIS:** View the DMIS coding of the part program. The coding cannot be edited.

- **Results:** View the measurement results from previous runs of the part program.

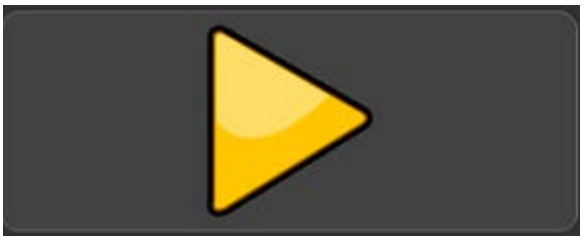
- **View results folder:** Browse results files from previous runs of the part program.

- **Process Monitor button:** Open the Process Monitor window.

- **EQ-ATS:** View EQ-ATS options.

- **Instructions:** Display operator instructions related to the individual component set-up for the inspection part program. Text file types Notepad (.txt), Wordpad (.rtf) and .pdf are supported and image files in formats .jpg, .png, .bmp, and . gif are also acceptable.

- **Zero point alignment:** Run a previously generated zero-point alignment program to locate the component in the working volume. A zero point part program is a part program that generates an initial component co-ordinate system, thereby allowing automatic operation via Organiser.



- **Run:** Run the inspection program.

- **Error recovery:** Run a previously generated error recovery program.

- **Calibrate probes:** Run a previously generated part program to calibrate the probing tool tips required by the inspection part program.

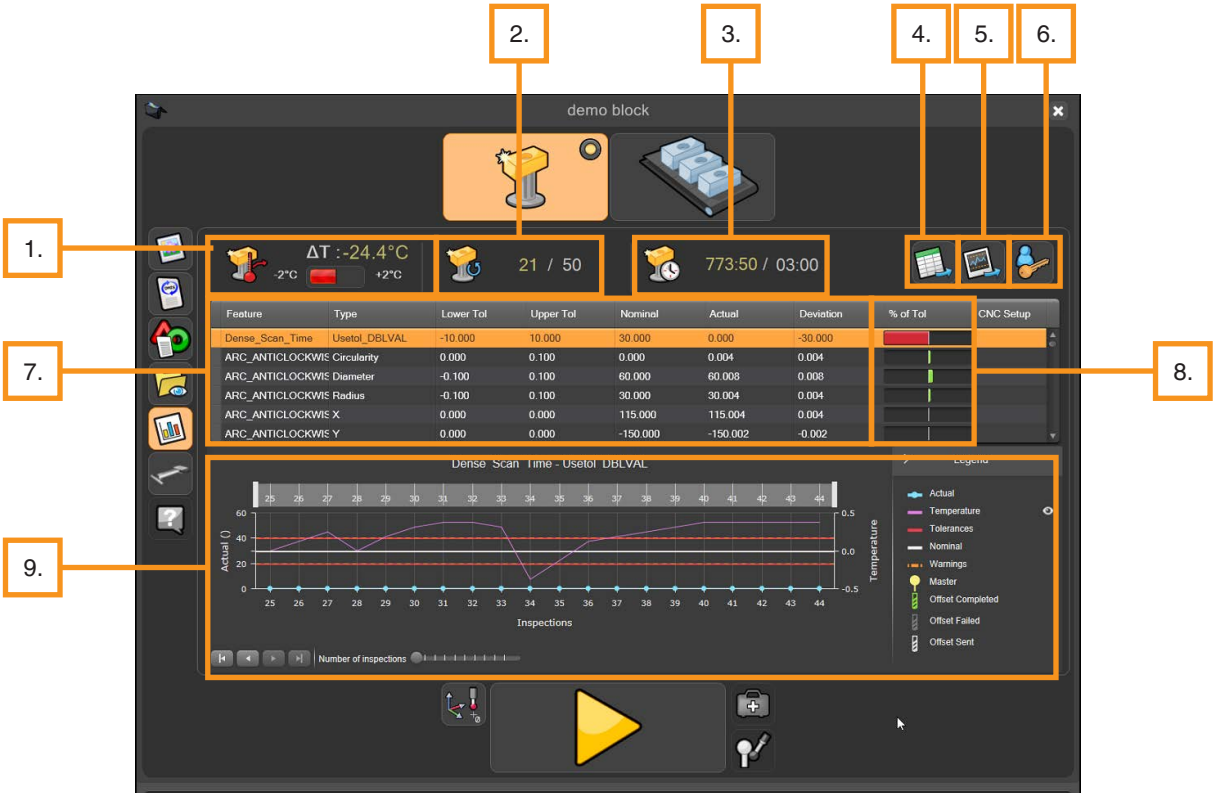
Process Monitor

Process Monitor (PM) instantly displays measurement results of inspected features to the operator on a bar chart display. It also shows the history of measurement on each feature so that process trends can be seen.

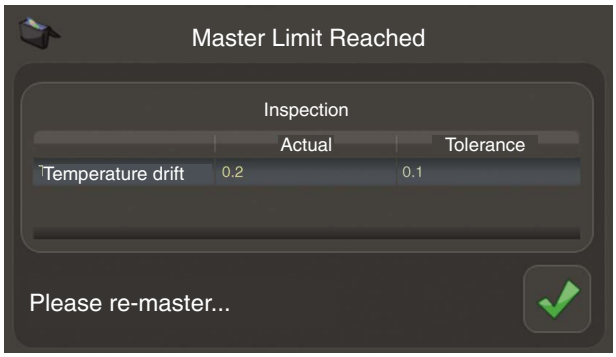
- The PM window can be accessed from the Organiser window by selecting the PM button as shown below:

Process Monitor overview

1. Temperature drift since last mastering procedure
2. Number of runs since last mastering procedure
3. Time since last mastering procedure
4. Export data to CSV for use in other applications
5. Export graph to image
6. Administrator login
7. Table with list of features that have been measured
8. Bar graph view of proportion of tolerance
9. Graphical display of the history of measurement of the feature selected in the table



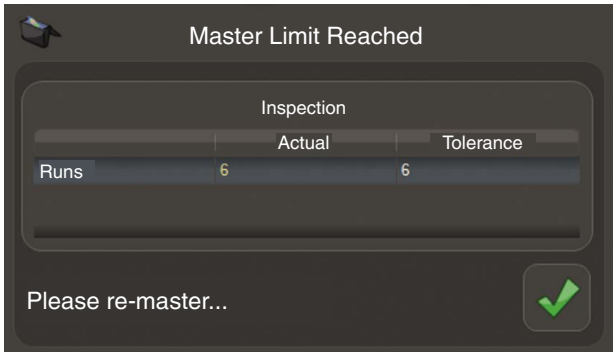
Temperature drift since last mastering procedure



This icon shows the temperature change since the last mastering procedure.

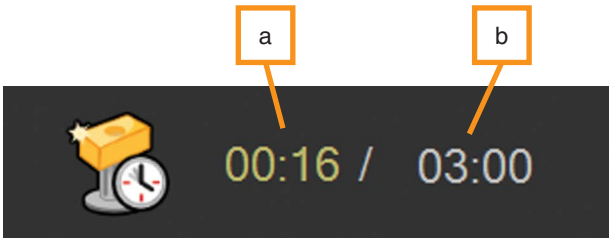
When the green bar turns red, the set temperature drift limit has been exceeded and a warning message will appear when the Play/Run button is selected. Once the operator selects the green tick, Organiser automatically switches from measure mode to master mode. It is advised that the operator re-masters at this point.

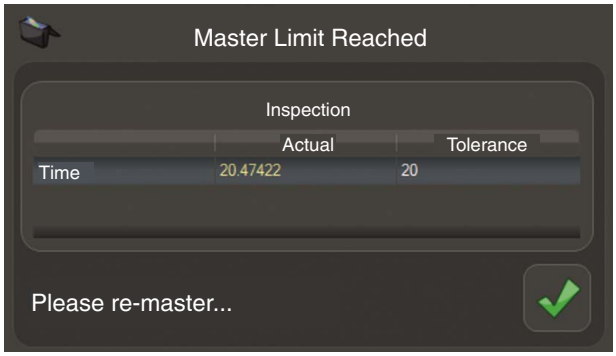
Number of runs since last mastering procedure



This icon shows how many parts have been measured. Once the actual (a) is equal to the limit set (b), a warning message will appear. Once the operator selects the green tick, Organiser automatically switches from measure mode to master mode. It is advised that the operator re-masters at this point.

Time since last mastering procedure





This icon shows the current time elapsed in hours and minutes. Once the actual (a) is equal to the limit set (b), a warning message will appear. It is advised that the operator re-masters at this point.

Admin and export buttons (4,5,6)

- **Admin login:** To adjust the tolerance settings of each feature, temperature tolerance limit, time tolerance limit and runs tolerance limit, click on the Admin login button. This will open the admin window.

- **Export feature data:** This button allows the user to export the information within the feature table as a CSV file. Once selected, a window will appear.

- **Export graph image:** This button allows the user to export the currently displayed graph as an image file. The graph can be saved as a JPEG, BMP or GIF image.

Feature table

- This table contains the following fields:

Feature	Type	Lower Tolerance limit*	Upper Tolerance limit*	Nominal	Actual	Deviation	% of Tolerance	CNC Setup
Dense_Scan_Time	Usetol_DBLVAL	-10.000	10.000	30.000	0.000	-30.000		
ARC_ANTICLOCKWIS	Circularity	0.000	0.100	0.000	0.004	0.004		
ARC_ANTICLOCKWIS	Diameter	-0.100	0.100	60.000	60.008	0.008		
ARC_ANTICLOCKWIS	Radius	-0.100	0.100	30.000	30.004	0.004		
ARC_ANTICLOCKWIS	X	0.000	0.000	115.000	115.004	0.004		
ARC_ANTICLOCKWIS	Y	0.000	0.000	-150.000	-150.002	-0.002		

*As defined in measuring program (.dmi in MODUS™)

- The lower tolerance, nominal and upper tolerance are defined for each individual feature by values given in the measuring program (.dmi in MODUS). Data shown in the “Actual” and “% of Tolerance” columns is from the last measurement cycle. By clicking on an individual feature within the table, the individual feature's measurement history is represented graphically underneath.

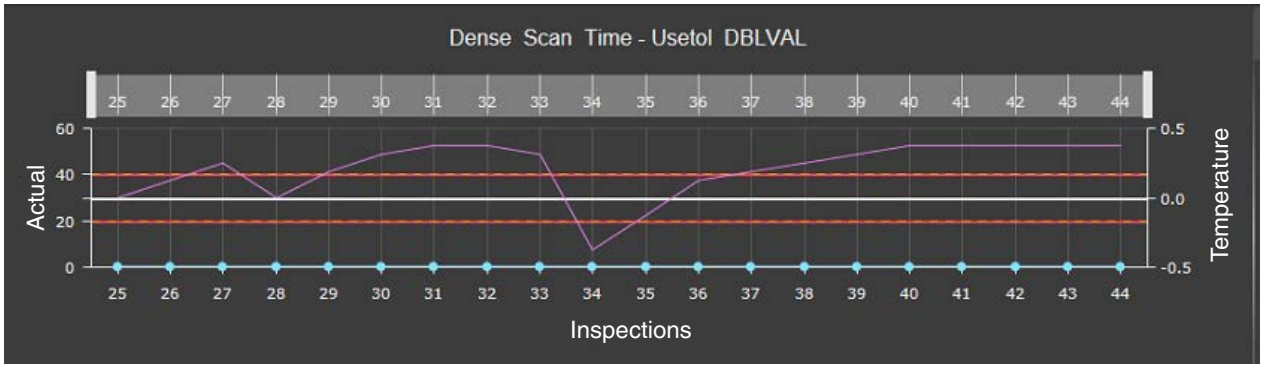
Status monitor bar graph

- The status monitor bar graph only applies to the last measured part. The “% of Tolerance” column of the table shows whether the feature is in tolerance by using green bars (in tolerance) or red bars (out of tolerance). When the measured value reaches the upper or lower warning limits the bar turns orange, allowing the operator to adjust the process before parts fail.

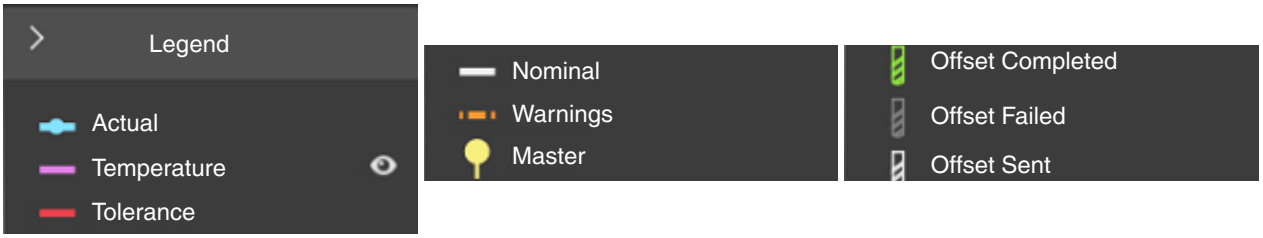
Graphical display of historical results

- Information about an individual feature's historical measurement is displayed in this graph. The graph displays “Inspections” on the X-axis and the “Actual dimensions” of that particular feature and “Temperature” on the Y-axis.

- The lower and upper warnings can be set for each individual feature within the Admin window.



Legend

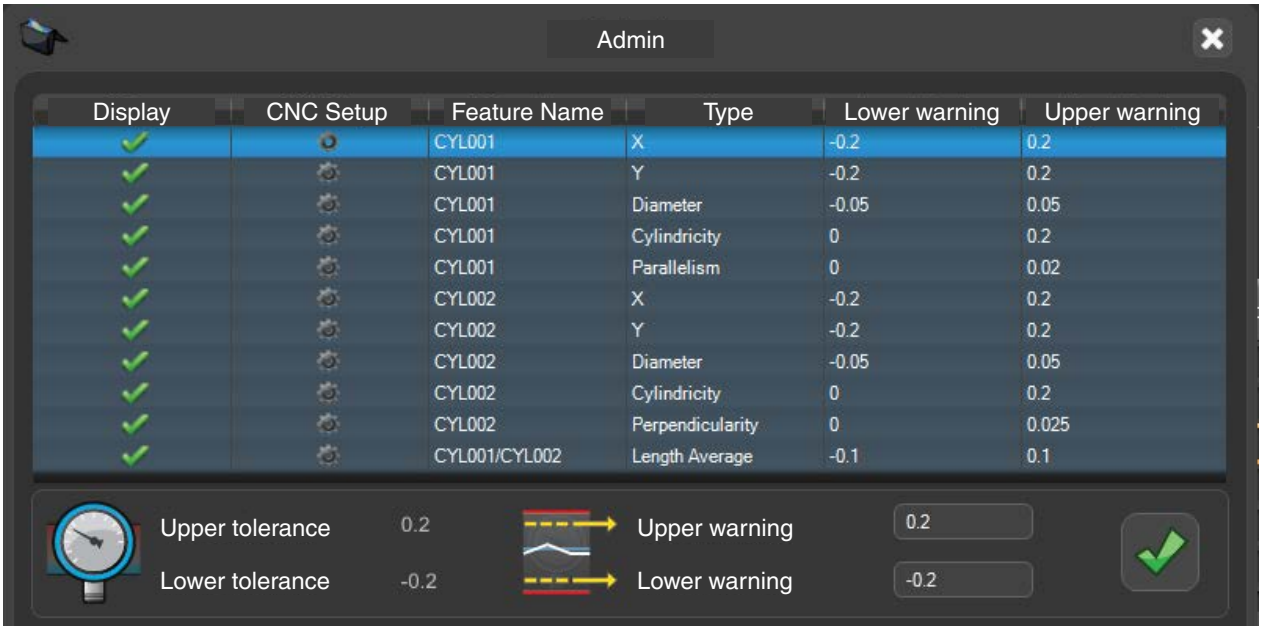


Process Monitor admin settings

- Settings within Process Monitor (PM) can be adjusted in the Admin window. To access the Admin window, click on the “Admin” button in the Process Monitor window.

Admin window

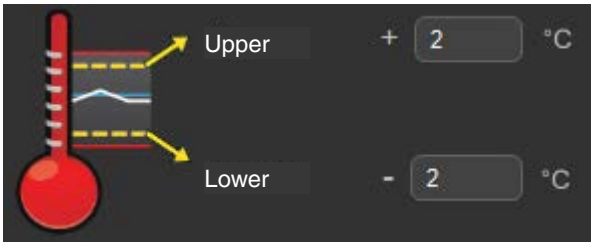
- The Admin window displays a table of each individual feature. This table contains the following fields:



- The “Display” column allows the user to choose whether to display or to not display an individual feature within the PM window.
- Selecting an individual feature will allow changes to the individual feature's upper and lower warning limits.
- For changes to take effect, the “green tick” must be clicked.

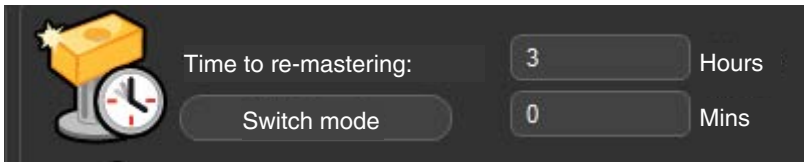
Temperature

- To set the upper and lower warning limits for temperature drift, select the boxes and change to the desired value. This re-mastering procedure is based on temperature. The controller will record the temperature at the time of mastering and PM will notify the operator once the temperature has exceeded either limit.



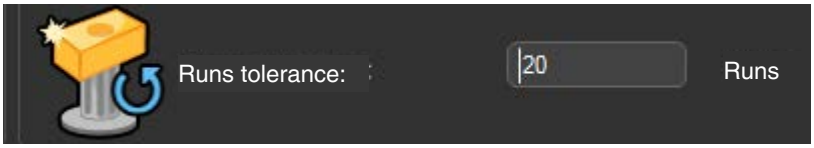
Time to re-mastering

- In this section, the operator can set the number of minutes between each re-master. This re-mastering procedure is time based. The software monitors the time and will prompt the operator to re-master once the set limit has been exceeded.



Runs tolerance

- In this section, the user can set the number of runs the system will perform between each re-master. This re-mastering procedure is based on the number of parts. The software will prompt the operator to re-master once the set limit has been exceeded.

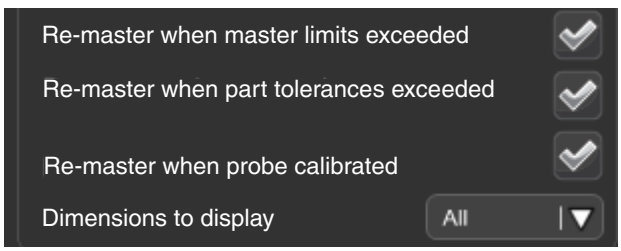


Re-master settings

- In this section, the user can choose to re-master when master limits are exceeded or when part tolerances are exceeded.

Dimensions to display

- In this section, the user can change this value to suit what dimensions that they wish to be displayed within the graph.



Clean database

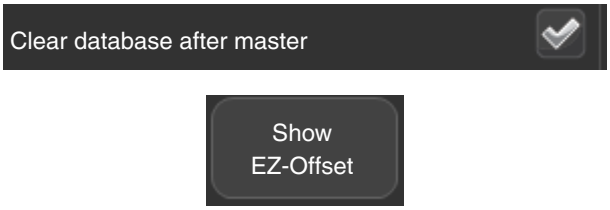
- To clean the database, click on the button.

Saving admin settings

- For changes to take effect, click the “green tick”.

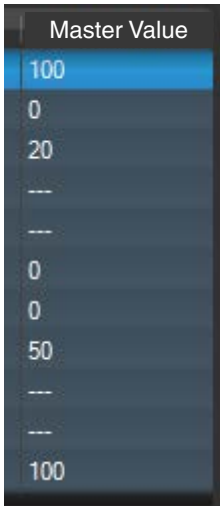
Admin window - Feature Compare

- When the system has been configured to use Feature Compare, the following extra options are shown within the PM Admin window.



Admin window - Dimension Compare

- When the system has been configured to use Dimension Compare, the following extra options are shown within the PM Admin window.



Choosing a re-mastering process

To determine the re-mastering frequency, the customer needs to perform a study on their own parts in the production environment. The limit for re-mastering can be set on the basis of temperature drift, time until next re-mastering, or by number of parts measured. PM will then prompt the operator when re-mastering is due and automatically swap to master mode.

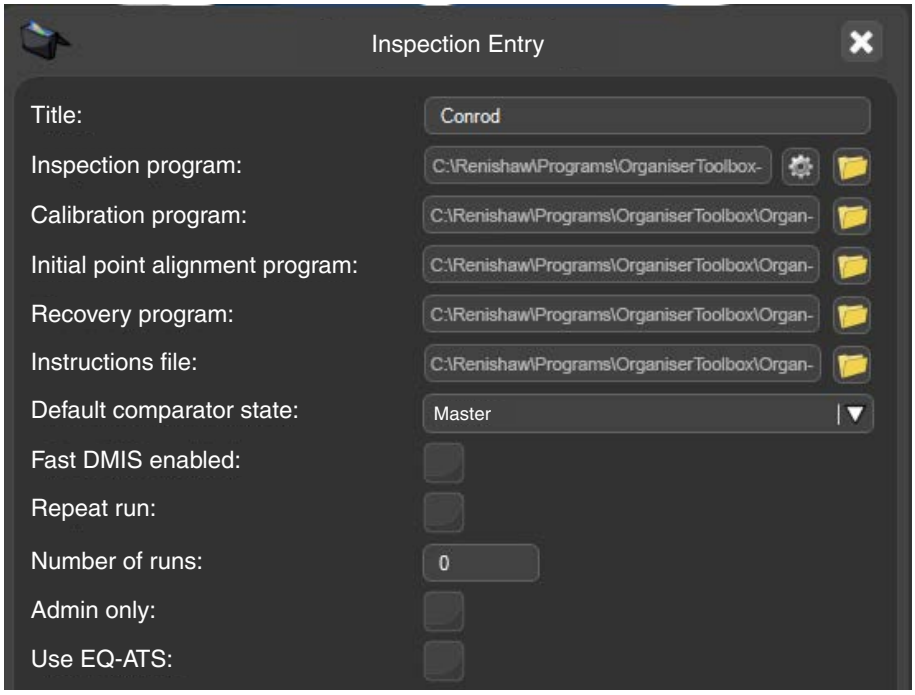
To determine the limit for temperature drift in PM:

- A study of multiple part measurements on a single part needs to be done over an extended time period, including representative temperature variations.
- Plot gauging results against the change in reported temperature, until an unacceptable change in results is observed (usually a low percentage of the tolerance).
- The temperature drift limit is specific to the part and features being measured, so a study needs to be done for each different part.

The study must be repeated if the measurement program is changed to measure new or differently sized features.

Using the repeat function

- You can turn on the “Repeat run” function in the program’s “Inspection Entry” window.
- Click the “Repeat runs” box and a tick will appear.
- Click the “green tick” at the bottom of the window and the program will now run on repeat.

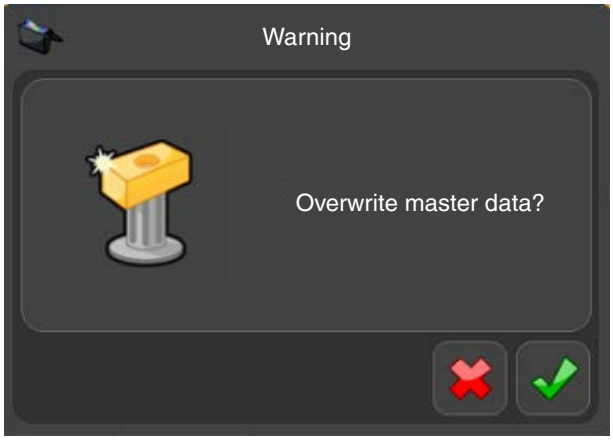


Running a program using Golden Compare

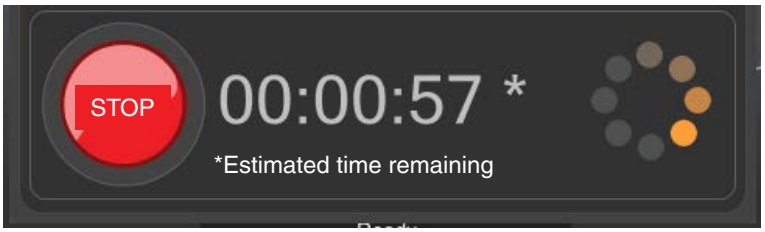
- Double click on the part program.

- Make sure that the part program is in “Master mode”. The virtual LED will be yellow.
- Move the cursor over the “yellow play” button and run the part program. Click to start the part program running.

- If in Master mode, the user will be warned (Overwrite master data?). Click on the “green tick” to continue.



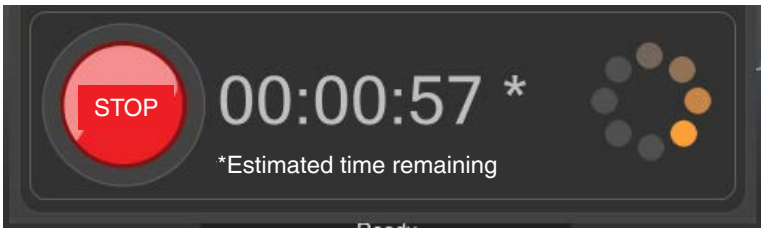
- The part program will now run and generate a Master file. While the part program is running, all functions are inactive apart from the “STOP” button.



- After the part program has run in Master mode, Organiser will automatically change to Measure mode. The Measure button in the top right hand corner of the window is now active.

- Remove the Master component and replace it with the production component.
- Move the cursor over the “green play button” and click to start the part program running.

- While the part program is running, all functions are inactive apart from the “STOP” button.



Once the inspection is finished, the result summary is automatically displayed in one of three ways, depending on the set-up in MODUS.

1. The system displays either “PASS” or “FAIL”, together with the number of dimensions that were within tolerance and the number of dimensions that were out of tolerance.

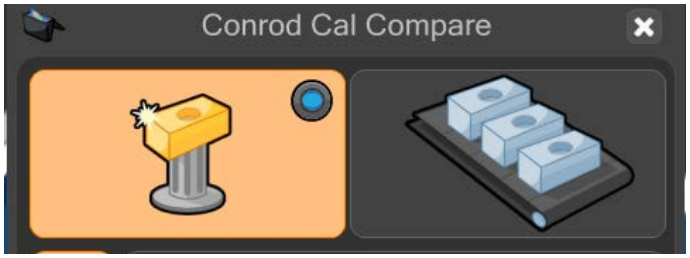
2. The system displays either “PASS” or “FAIL”

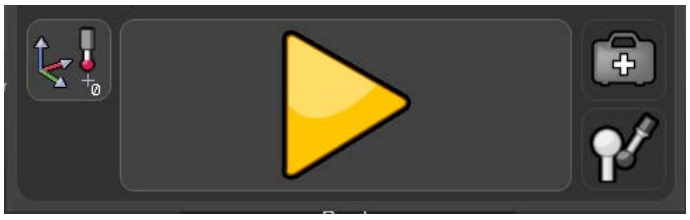
3. The system displays nothing.

Running a program using CMM Compare

- Ensure the .cal file from the CMM is in the same folder as the component's DMIS part program e.g. C:\Renishaw\Programs\MyParts\Conrod
- Ensure that the name of the .cal file and the name of the Equator .dmi file are identical. e.g MyPart. dmi and MyPart.cal
- Double click on the part program.

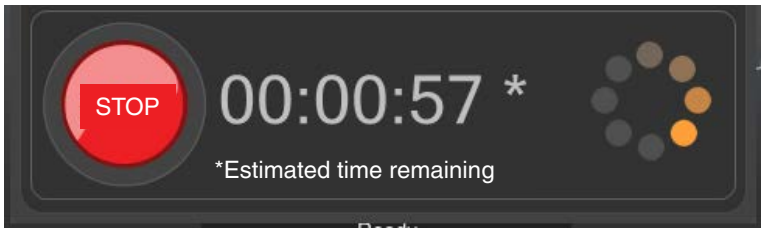
- Make sure that the part program is in “Master mode”. The virtual LED will be blue.
- Move the cursor over the “yellow play” button and run the part program. Click to start the part program running.





- If in Master mode, the user will be warned (Overwrite master data?). Click on the “green tick” to continue.

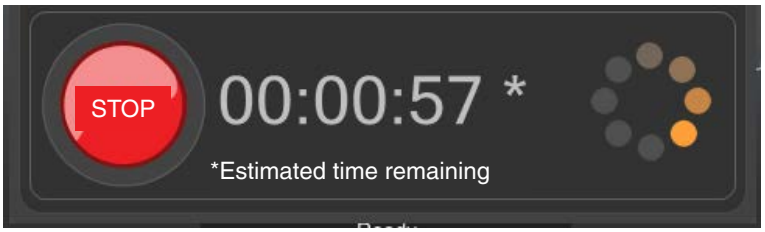
- The part program will now run and generate a Master file. While the part program is running, all functions are inactive apart from the “STOP” button.



- After the part program has run in Master mode, Organiser will automatically change to Measure mode. The Measure button in the top right hand corner of the window is now active.

- Remove the Master component and replace it with the production component.
- Move the cursor over the “green play button” and click to start the part program running.

- While the part program is running, all functions are inactive apart from the “STOP” button.



Once the inspection is finished, the result summary is automatically displayed in one of three ways, depending on the set-up in MODUS.

1. The system displays either “PASS” or “FAIL”, together with the number of dimensions that were within tolerance and the number of dimensions that were out of tolerance.

2. The system displays either “PASS” or “FAIL”

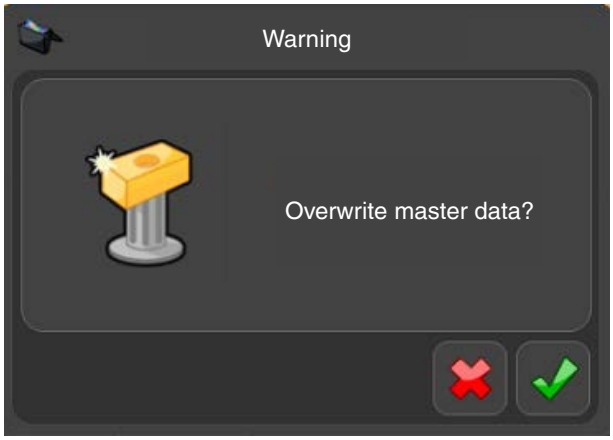
3. The system displays nothing.

Running a program using Feature Compare

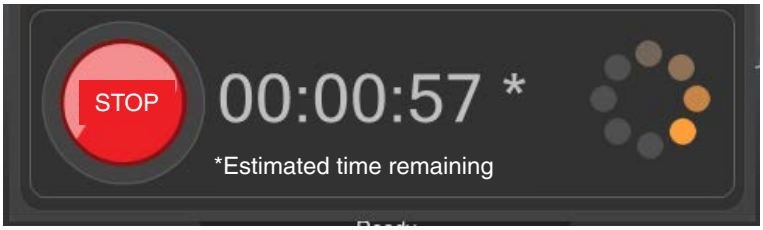
- Double click on the part program.

- Make sure that the part program is in “Master mode”. The virtual LED will be purple.
- Move the cursor over the “yellow play” button and run the part program. Click to start the part program running.

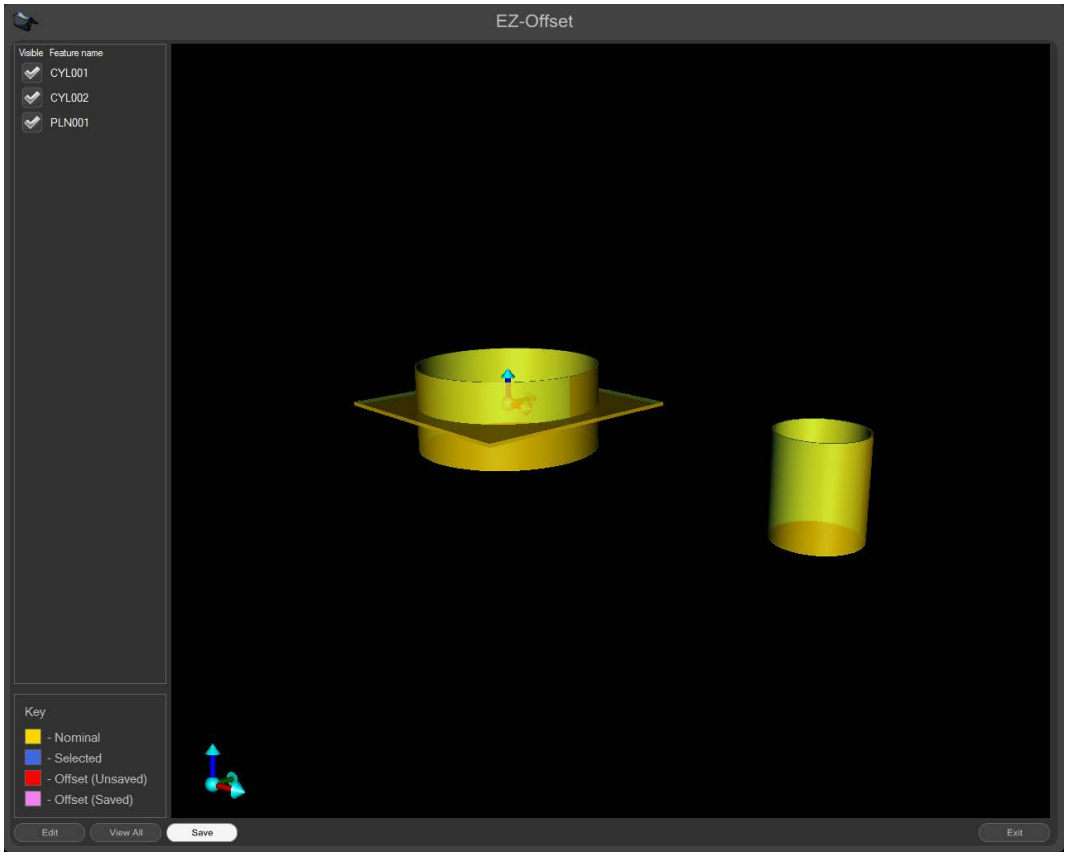
- If in Master mode, the user will be warned (Overwrite master data?). Click on the “green tick” to continue.



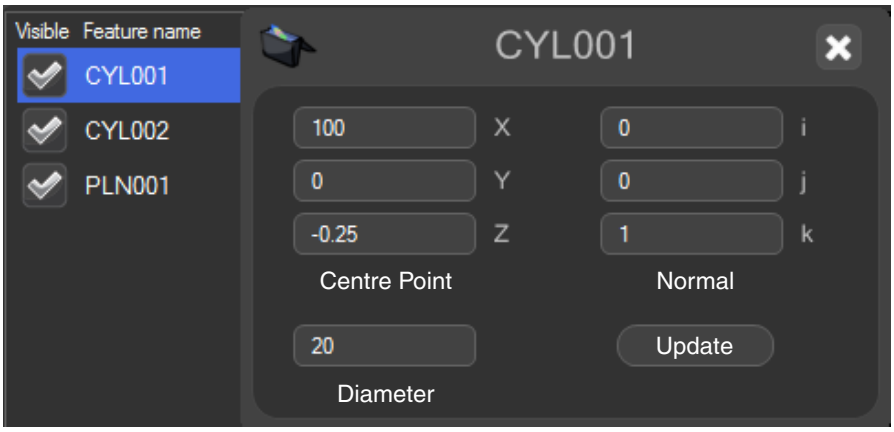
- The part program will now run and generate a Master file. While the part program is running, all functions are inactive apart from the “STOP” button.



- At the end of the Master run, EZ-Offset will appear. EZ-Offset allows the user to modify the size, position and orientation of features.



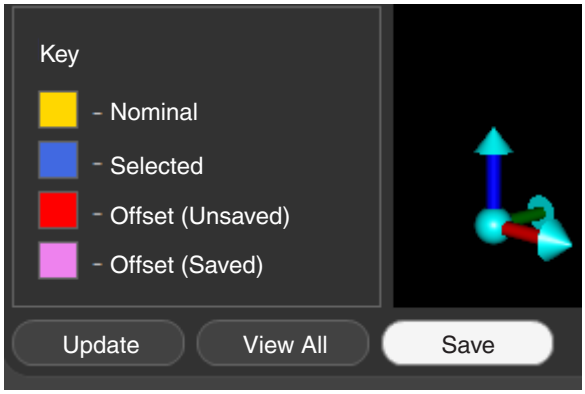
- Double click on one of the features found in the list on the left side of the window and an edit box will appear.



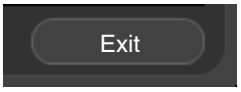
NOTES: Do not type in offset values from nominal values, the actual values are required.

EZ-Offset will automatically display all features from multiple Feature Compare blocks simultaneously

- Repeat for all features
- EZ-Offset allows the user to keep track of what has been edited by showing features in graphical form. Please refer to the key in the bottom left hand corner of the window.
- Once all edits have been made, click the “Save” button found at the bottom of the window



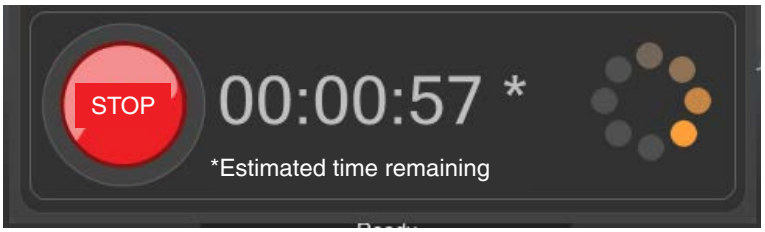
- Close EZ-Offset by clicking the “Exit” button in the bottom right corner of the window



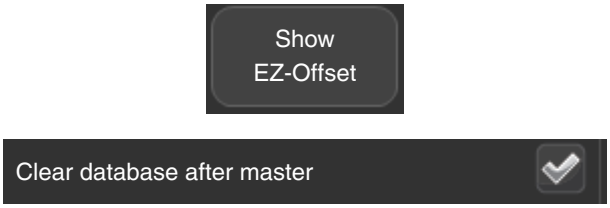
- After the part program has run in Master mode, Organiser will automatically change to Measure mode. The Measure button in the top right hand corner of the window is now active.

- Remove the Master component and replace it with the production component.
- Move the cursor over the “green play button” and click to start the part program running.

- The part program will now run and generate a Master file. While the part program is running, all functions are inactive apart from the “STOP” button.



- On completion of the Measure run, the results found in Process Monitor and any results files have been adjusted.
- To re-launch EZ-Offset, click on the “EZ-Offset” button within the Process Monitor Admin window.
- To stop EZ-Offset appearing at the end of a Master run, un-check the “Offset features after master” option.



Once the inspection is finished, the result summary is automatically displayed in one of three ways, depending on the set-up in MODUS.

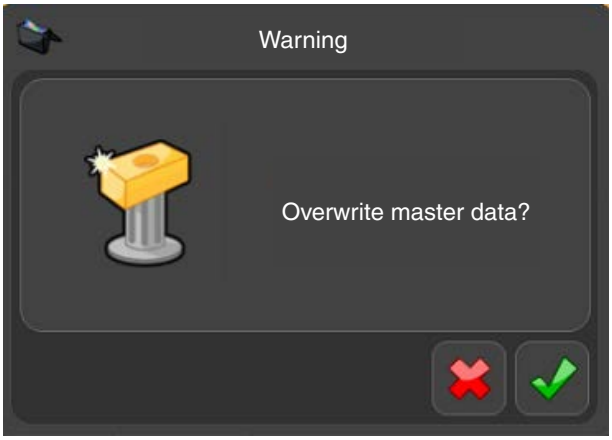
1. The system displays either “PASS” or “FAIL”, together with the number of dimensions that were within tolerance and the number of dimensions that were out of tolerance.
2. The system displays either “PASS” or “FAIL”
3. The system displays nothing.

Running a program using Dimension Compare

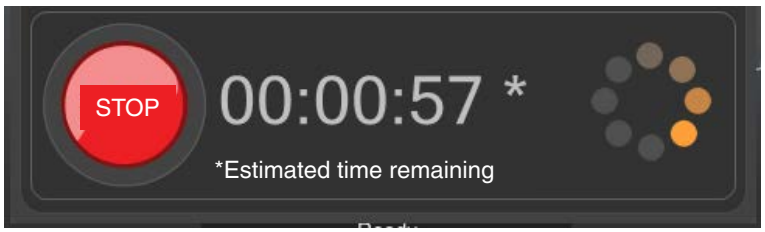
- Double click on the part program.

- Make sure that the part program is in “Master mode”.The virtual LED will be green.
- Move the cursor over the “yellow play” button and run the part program. Click to start the part program running.

- If in Master mode, the user will be warned (Overwrite master data?). Click on the “green tick” to continue.



- The part program will now run and generate a Master file. While the part program is running, all functions are inactive apart from the “STOP” button.



- On completion of the Master run, open the Process Monitor Admin window.
- Click on the “PM” button.

- Click on the Admin button in the Process Monitor window.

- The Admin window is displayed.
- A list of dimensions will appear at the top of this window. When an Equator is configured to use Dimension Compare, an additional “Master Value” column can be seen.

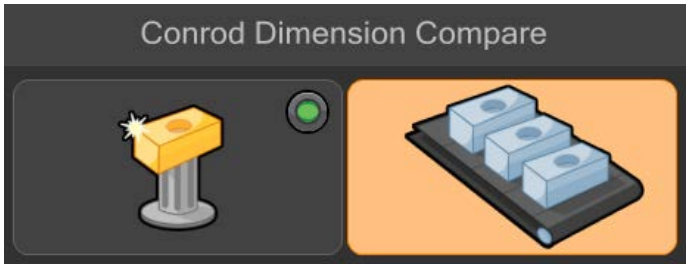
Display	CNC Setup	Feature Name	Type	Lower warning	Upper warning	Nominal	Master Value
✓		CYL001	X	-0.2	0.2	100	100
✓		CYL001	Y	-0.2	0.2	0	0
✓		CYL001	Diameter	-0.05	0.05	20	20

- Double click on the Master value for each of the dimensions that require changing. Change the value then hit “Enter” to accept.

Display	CNC Setup	Feature Name	Type	Lower warning	Upper warning	Nominal	Master Value
✓		CYL001	X	-0.2	0.2	100	100
✓		CYL001	Y	-0.2	0.2	0	0
✓		CYL001	Diameter	-0.05	0.05	20	20.02
✓		CYL001	Cylindricity	0	0.2	0	---

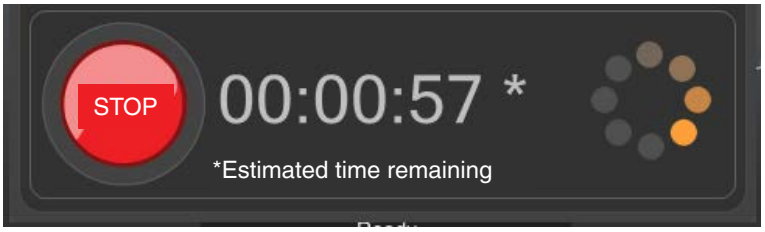
- When all edits have been made,click the “green tick” at the bottom of the window to close the Admin screen.

- After the part program has run in Master mode, Organiser will automatically change to Measure mode. The Measure button in the top right hand corner of the window is now active.



- Remove the Master component and replace it with the production component.
- Move the cursor over the “green play button” and click to start the part program running.

- The part program will now run and generate a Master file. While the part program is running, all functions are inactive apart from the “STOP” button.



- On completion of the Measure run, the results found in Process Monitor and any results files have been adjusted.

Once the inspection is finished, the result summary is automatically displayed in one of three ways, depending on the set-up in MODUS.

1. The system displays either “PASS” or “FAIL”, together with the number of dimensions that were within tolerance and the number of dimensions that were out of tolerance.
2. The system displays either “PASS” or “FAIL”
3. The system displays nothing.

DMIS commands

Compare commands

As a consequence of the Compare process, the DMIS programming for Equator can require different procedures to those generally used on a CMM (Co-ordinate Measuring Machine).

Equator uses extra commands (COMPARE commands) within the DMIS code to carry out the Master component/Production component comparison process.

The COMPARE/ON command will instruct RenCompare to store all measured/compared points - this will continue until the COMPARE/OFF or the ENDFIL statement.

When a program that is running through MODUS Organiser is stopped, for whatever reason, the COMPARE/OFF command is automatically processed.

Golden Compare with a single master .MST file produced:

COMPARE/ON

CMM Compare, used to stimulate the production of a .cal file on a CMM, or inform an Equator that a .cal file from a CMM is available, single master .MST file:

COMPARE/ON,CAL

Golden Compare with multiple master files in one part program e.g.

COMPARE/ON,MST,'C:\RENISHAW\PROGRAMS\TRAINING\SPH003CAL.MST'

CMM Compare with multiple master files in one part program e.g.

COMPARE/ON,CAL,MST,'C:\RENISHAW\PROGRAMS\TRAINING\SPH003CAL.MST'

Feature Compare

COMPARE/ON,FEATURE

Dimension Compare

DIMENSIONCOMPARE/ON

DIMENSIONCOMPARE/OFF

Switch Compare process off, may appear once or multiple times in a part program

COMPARE/OFF

- To ensure that Compare feature touch points are collected in an identical order on both the CMM and the Equator, features should NOT be measured using DMIS part program code AUTO, e.g. MODE/AUTO,PROG,MAN.
- Mode MUST be set to MODE/PROG,MAN

System Park (EQ300 only) - part programs

To park the floating platform at the end of a part program, the following commands should be added to the end of the MODUS program:

FROM/DME,PARKMODE

GOHOME

To unpark the floating platform at the beginning of a part program, a GOTO statement should be added to the beginning of the MODUS program:

GOTO/CART, X position, Y position, Z position

NOTE: Please see the MODUS help file located in the MODUS software for more information.

File types and extensions

Equator and MODUS use several file types, some of which are listed below by file extension. For more detailed information on the files used within the system check the File types section of MODUS Help.

.btc

Part program batch file. This file records the settings of the “Open Inspection” dialog box. If it remains unedited, all following runs of the same part program will use the same settings.

.cal

Calibration file of point data generated when a part program is run on compatible CMM software. The generation of a .cal file is an integral part of the CMM Compare process.

.csv

This is an ASCII text output file that can be selected in the “Open Inspection” dialog box. It is formatted so that it can be easily read by external software packages e.g. SPC software.

.dmi

DMIS part program file.

.mst

Master file of point data generated when a part program is run in Master mode. The generation of a .mst file is an integral part of both the Golden and CMM Compare process.

.out

Part program result file in DMIS output format. This can be viewed using Notepad (.txt) or Wordpad (.rtf).

.pdf

Text and image files for operator instructions.

.res

Part program result file in ASCII text format. This can be viewed using Notepad (.txt) or Wordpad (.rtf).

.rpd

MODUS Reporter file.

.rtf

Rich text file that may be viewed using Wordpad.

.txt

ASCII text file that may be viewed using Notepad.

.xml

An .xml format file that can be created if selected in the “Open Inspection” dialog box.

Software add-on - Intelligent Process Control

IPC software allows the system to automatically correct the machining process by sending update values for geometry and wear offsets directly to the Machine Tool Controller.

The IPC software:

- Corrects for tool wear or thermal drift
- Is fully integrated with Process Monitor
- Controls offsets by % of tolerance or standard deviation
- Can set control limits at which corrections are made
- Can set maximum adjustments to prevent overcorrection
- Can handle 1-sided and 2-sided features
- Can invert offsets for internal features
- Can use averaging to handle spikes

Setting up the system

Plug one end of an Ethernet cable into the back of the system controller and one end into the Machine Tool Controller.

NOTE: This configuration can be made with LAN 2 on ESS 2.0, allowing the system to be connected to a network along with an automation cell/machine tool. Use the “Automation Network Tool” in “Manager > Diagnostics” to achieve this.

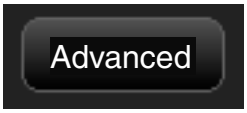
- Turn on the Machine Tool Controller.
- Turn on the controller.

NOTE: Turning on the controller before the Machine Tool Controller will result in the system not being able to connect to the Machine Tool Controller.

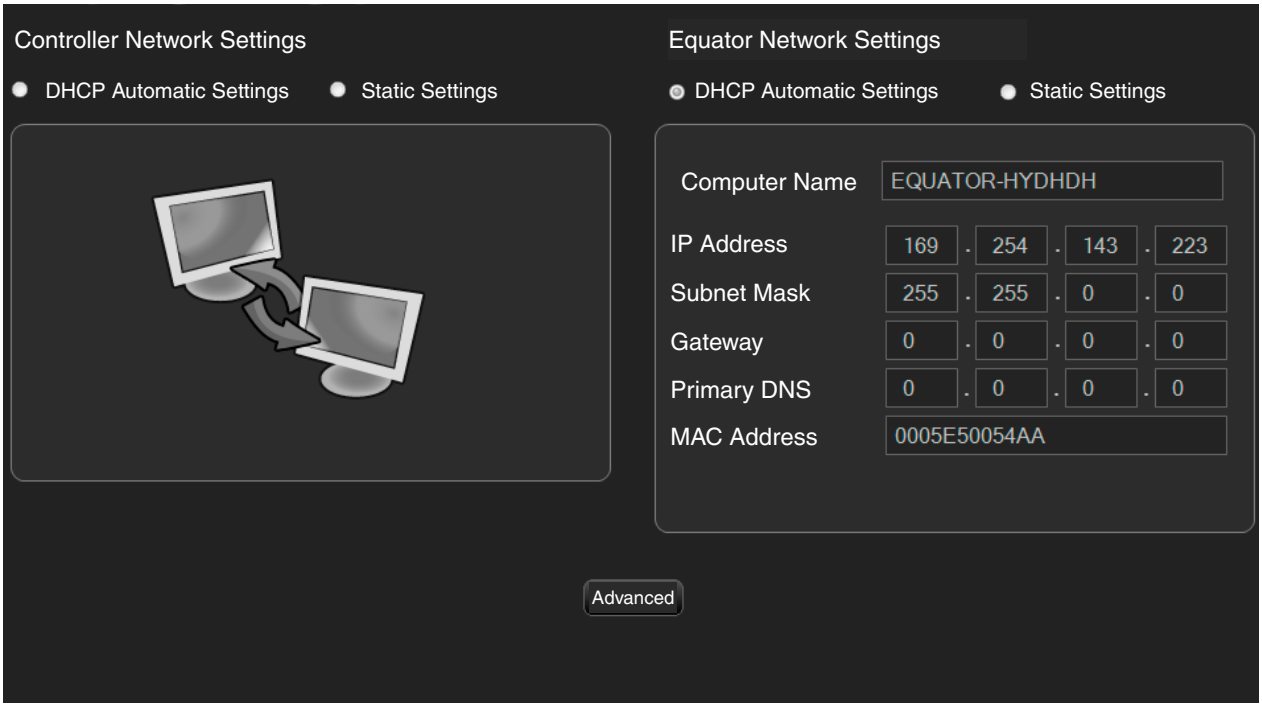
- Once the software has loaded go to “Manager > Ethernet”.

CAUTION: The menu should only be accessed with caution and only then by qualified IT personnel, as the controller communicates through Ethernet connections; if invalid addresses are defined, they can stop the system operating.

- The page is read-only and allows you to review the settings without changing them.
- To edit the Ethernet connection, click the “Advanced” button to change the settings.



- Change the IP Address of the system to be one less or one more than that of the MT Controller.
- Change the Subnet Mask to match that of the MT Controller.



- The system will now restart automatically.

Using IPC

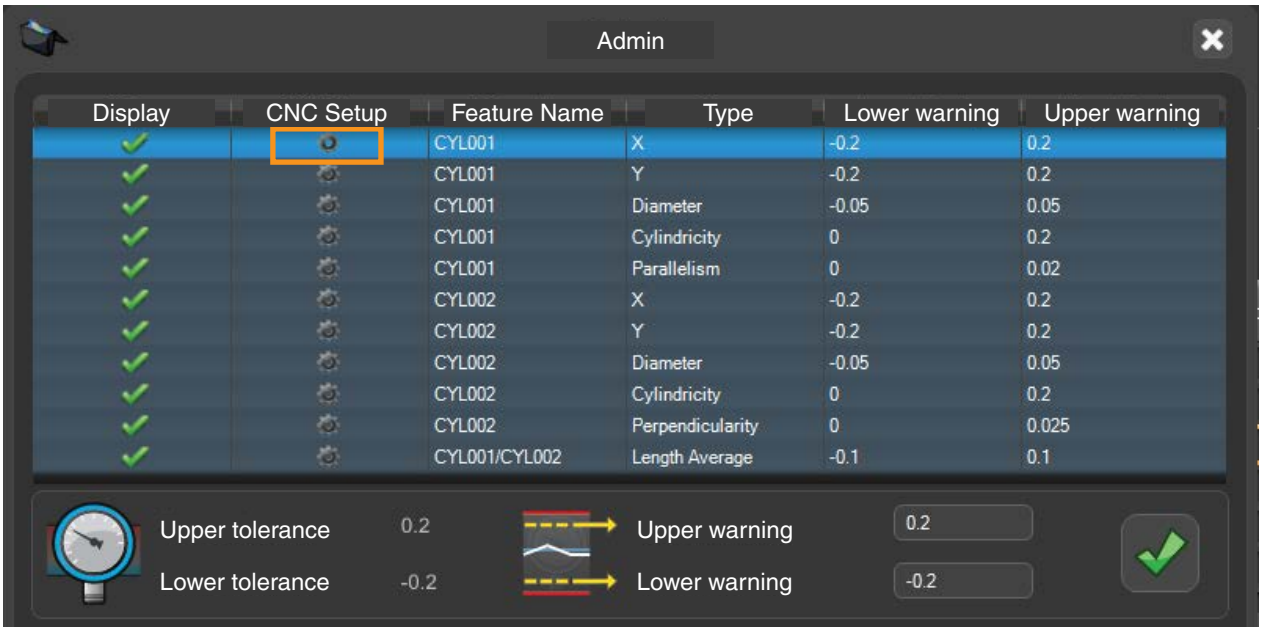
Starting IPC

To start IPC, firstly open the “Part program” that requires IPC from the Organiser window.

- The Process Monitor window can be accessed from the above window by selecting the “PM button” as shown below:

- Click on the “Admin” button.
- This will open the Process Monitor Admin window.

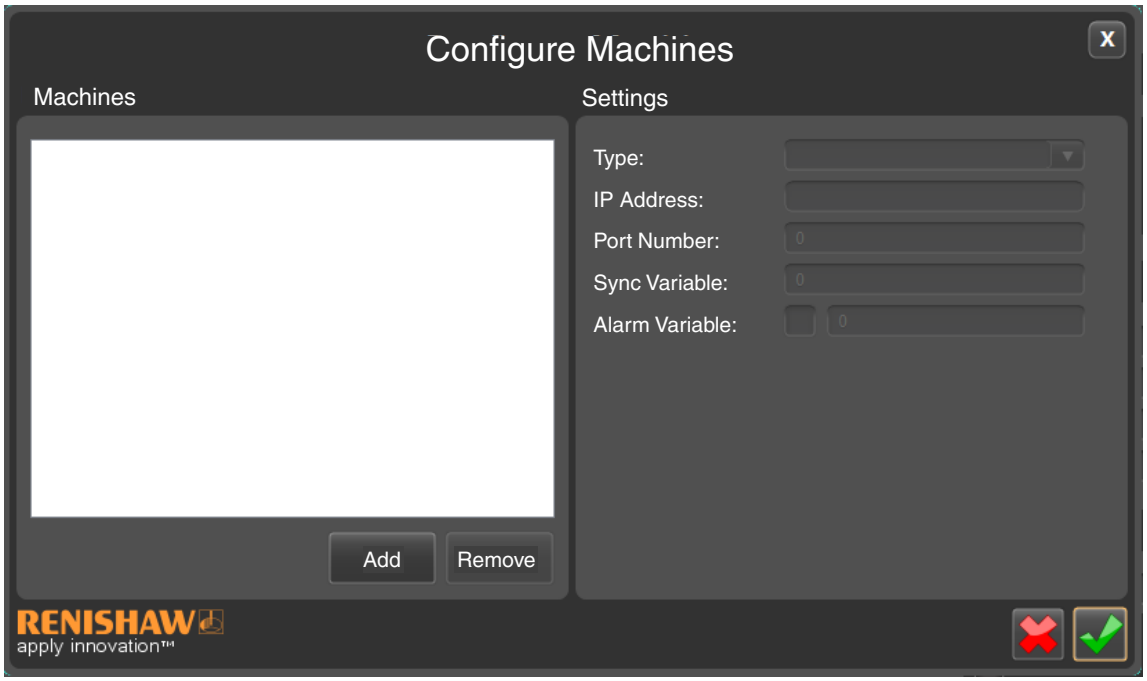
- Hover over the feature that you want to offset.
- A settings button will appear.
- Click on the “settings button”, which will open the CNC Setup screen for that feature.



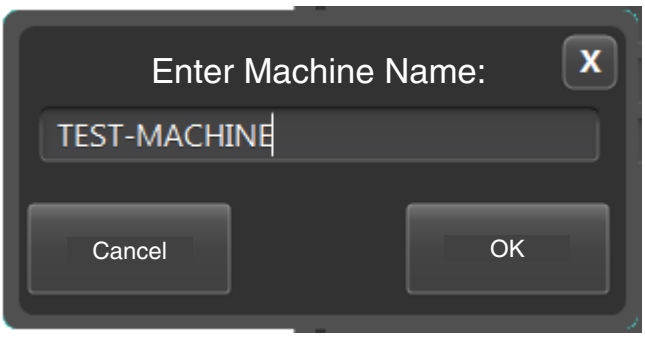
Managing Machine Tools

- To setup a new connection to a machine, click on the “Configure Machines” button.

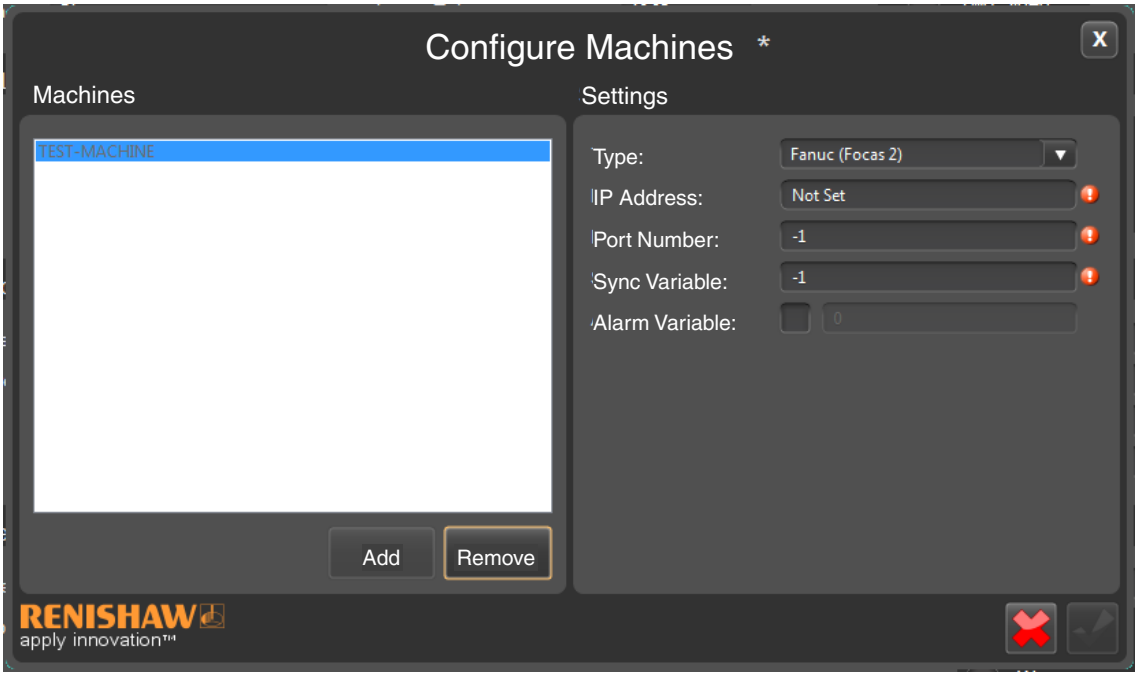
- This will open the Configure Machines window.
- Click on the “Add” button.



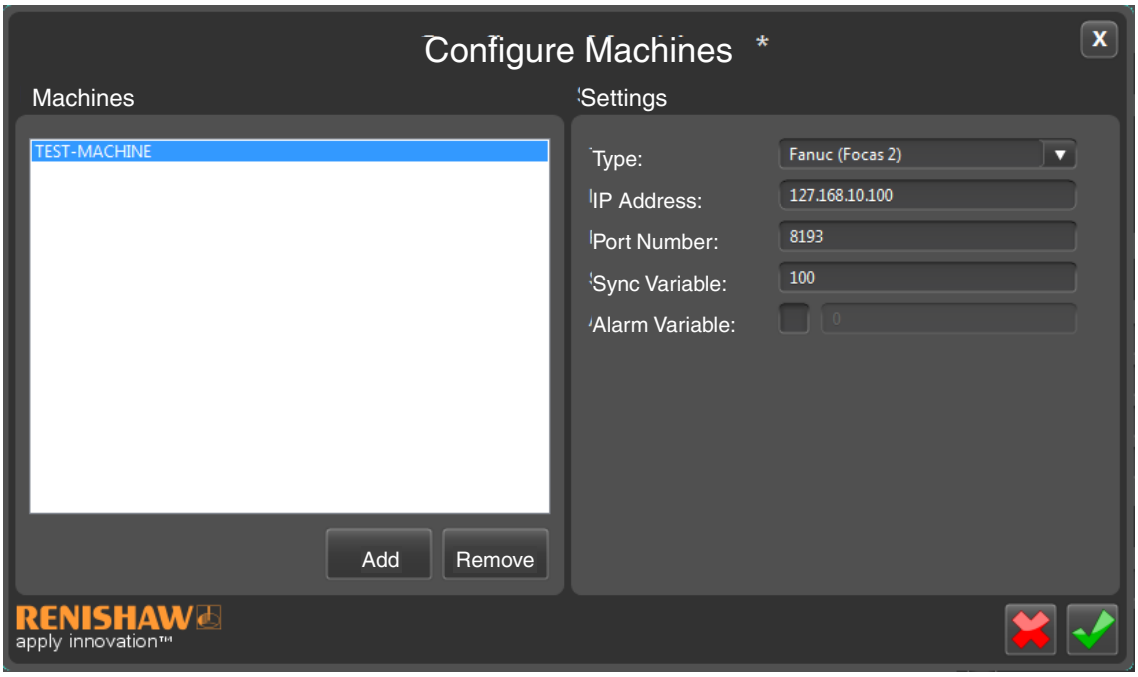
- Give the machine a name. Best practice is to give a unique name for each individual machine.



- Using the drop down menu, choose the machine controller type.

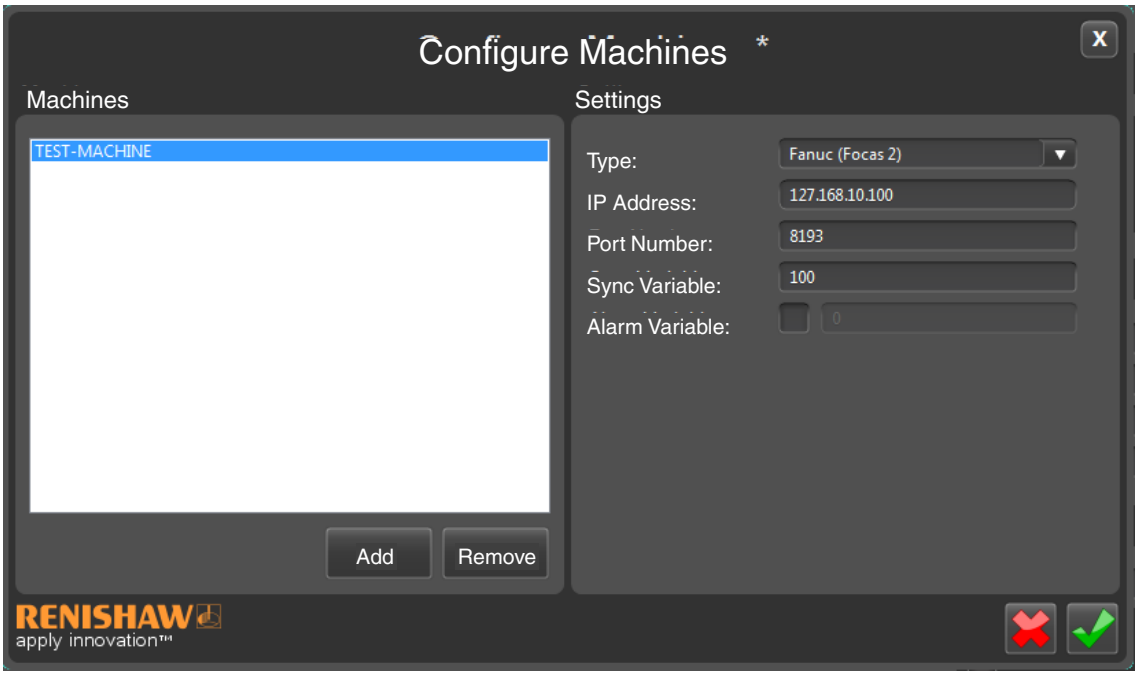


- Input the IP Address and Port Number of the Machine Controller.



NOTE: IPC screens have built in validation. If values are entered incorrectly, a warning will appear.

- You can add a new machine or remove a machine using the buttons below. To edit a machine, click on the machine name and then edit the values under “Settings”



Adding tool offsets

- This window allows the user to enter the specific tool offset for the feature selected within the Process Monitor window.
- Enter in the specific values for the offset in sections 2 - 4.
- Once finished, click the “green tick” located within section 7. The window will close and the user will be returned to the Process Monitor screen.

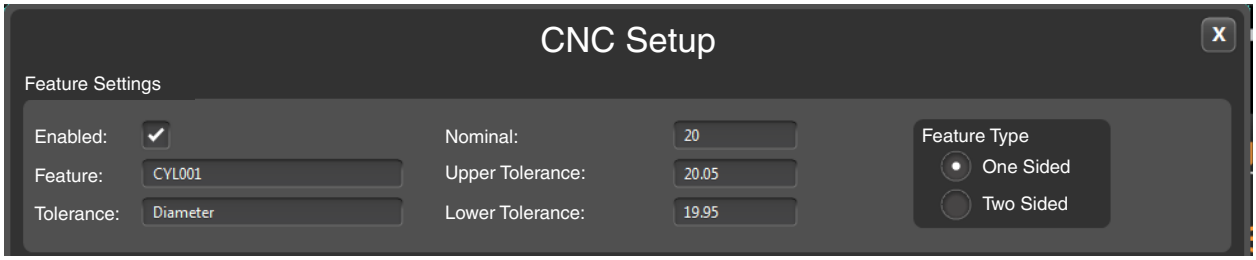
1. Feature Settings

- Enabled - Tick box to either enable or disable the offset associated with the feature.

This rest of this section is read only information which comes from the information provided in Process Monitor.

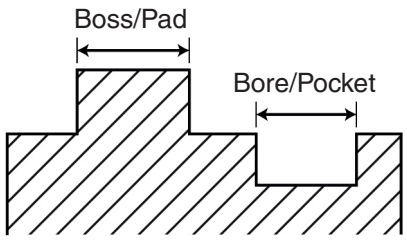
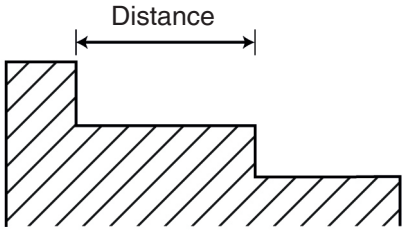
2.Feature Type

- The “Feature Type” tick box enables the user to choose whether the feature is one-sided or two-sided.



When to use two-sided

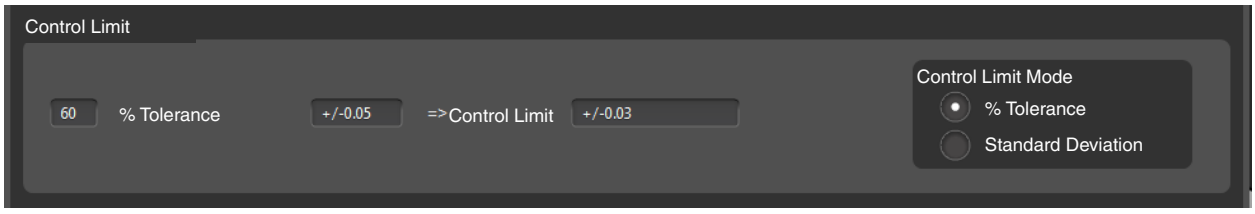
- When your tool size is controlled in terms of radius.
- When the surfaces of the feature that the dimension is controlling are opposite and machined with the same tool.

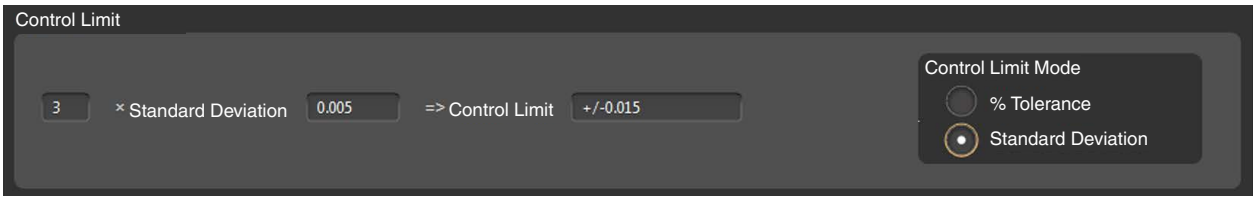
Dimension/Feature	Machine	Offset	Type	Offset sent
	Mill	R	Two-sided	1/2 error
		D	One-sided	Full error
	Lathe	X (Radial)	Two-sided	1/2 error
		X (Diametric)	One-sided	Full error
	Mill	R	One-sided	Full error
		D	One-sided	Full error
		L	One-sided	Full error
	Lathe	Z	One-sided	Full error

3. Control Limit

The control limit can be based on:

- % of Tolerance - The user can enter a % of Tolerance value.
- Standard Deviation - The user can enter a historical Standard Deviation value.



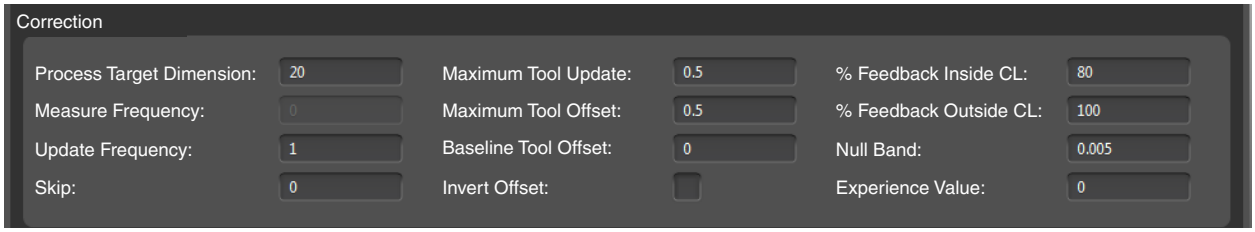


4. Correction

- Process Target Dimension* – This is the target value for the adjustments, which could be different from the nominal. This allows an over-adjustment if the user knows that the feature is only going to get bigger or smaller.
- Update Frequency – The number of parts over which a rolling average is taken. This allows smoothing to avoid an adjustment based on one “rogue” part. For example, if the update frequency is 5, IPC will calculate the offset from the average of the last 5 parts. The “counter” will be reset by a master run or when a tool offset correction is made. Note that if a feature goes out of tolerance then the tool will be corrected immediately, irrespective of whether 5 parts have been measured.

- Skip – The length of the queue of parts to be measured. If an offset is sent to the CNC, all parts made before that adjustment (ie. the queue of parts to be measured) have to be ignored for adjustment purposes. Otherwise a number of parts could all be too big, and multiple adjustments sent, which then over adjust etc.
- Maximum Tool Update* – Maximum individual tool update that can be sent.
- Maximum Tool Offset* – Maximum offset of tool (total).
- Baseline Tool Offset* – Shows the initial offset read from the CNC after a tool change has been detected.
- Invert Offset - Inverts the offset.
- % Feedback Inside CL – Inside the Control Limit the machine offset can be changed by a percentage of this adjustment.
- % Feedback Outside CL – Outside the Control Limit can be changed by a different percentage, which allows bigger adjustments outside the CL than inside the CL.
- Null Band* – The software ignores anything within this band, ie. offsets will not be sent to the Machine Tool.
- Experience Value* – Allows an adjustment value to be applied for any other reason.

***NOTE:** Units in IPC will be the same as used in the part program (millimeters, inches etc.) Units should be consistent across the part program, IPC and the MT Controller.



5. Machine Tool

- Machine/Operation - Drop down menu to select the Machine Tool associated with the offset.
- Write to macro - If selected, allows IPC to write to a CNC macro variable.
- Tool Number - Number of the tool within the Machine Tool.
- Turret/Path ID - Number of the turret within the Machine Tool.
- Offset Location - Drop down menu.
- Offset Type - Choose whether the offset type is “Geometry” or “Wear”.

6. Configure Machines

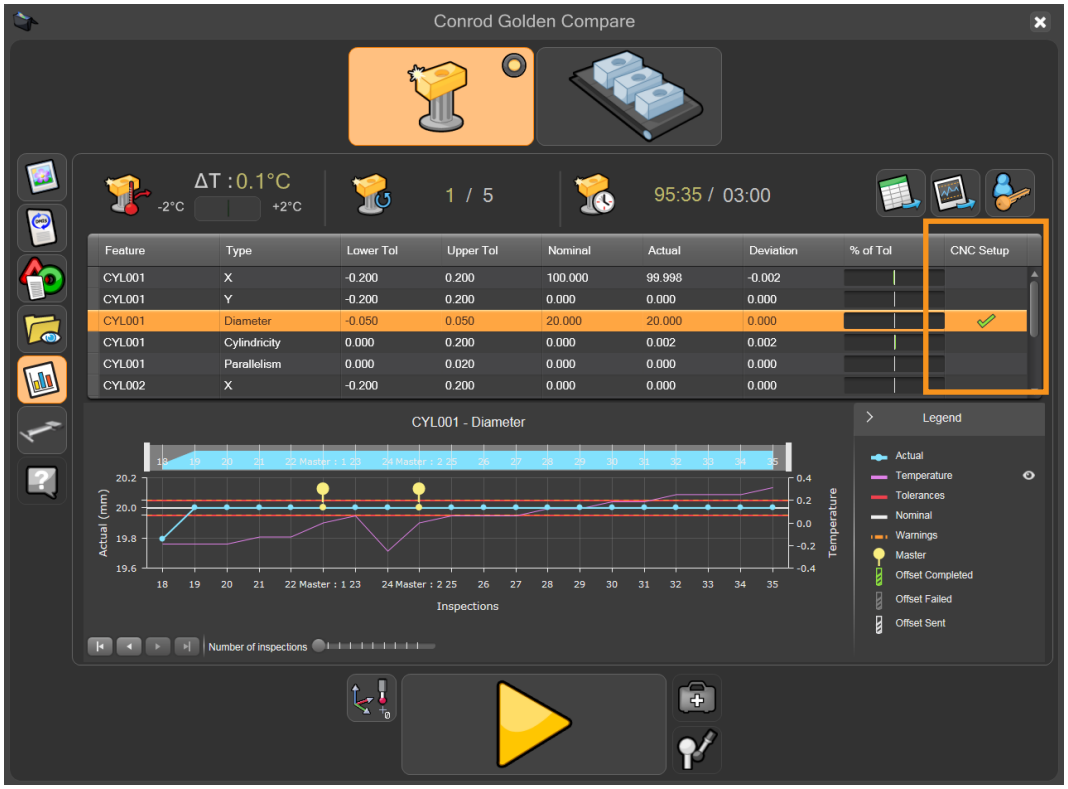
- This button opens the “Configure Machines” window.

7. Remove Offset, cancel changes and apply changes

- Remove Offset using the “Remove Offset” button.
- Apply all changes using the “green tick”.
- Cancel all changes using the “red cross”.

Tool Offset in Process Monitor

- It is easy to see if a feature has an offset applied to it in Process Monitor by looking at the following column. If there is a green tick in the column, then there is an offset being applied to that feature.



Impact on IPC when editing DMIS

Best practice when editing DMIS:

1. Change the DMIS
2. Remove the old offset
3. Create a new offset
4. Run inspections and IPC will operate as expected

Activity	Outcome
Rename feature in DMIS	IPC will not act on the new feature name until an offset is created that targets the new name. The original offset will still be active but shouldn't be triggered because no new inspection data will be received for that feature name. In this case, it would be good practice to remove the offset with the old feature name to ensure no spurious updates are made.
Modify nominal, upper tolerance or lower tolerance in DMIS	The new values for these parameters will be used for the current inspection and all future inspections but only if all these conditions apply at the point where the parameter is changed: • The inspection is a measure not a master • The current offset could be read successfully from the CNC • The offset has a machine associated with it • The offset is enabled • IPC is not skipping inspections Additionally, if the nominal has changed (and the above conditions are met) then the process target parameter will be reset to be the same as the new nominal value. The offset calculations that IPC has in progress are not reset by the above changes so changing the design tolerances may have unexpected consequences on the quality of any offset corrections made until the averaging window has moved beyond the point where the tolerances were changed.

Software add-on - Automatic Transfer System

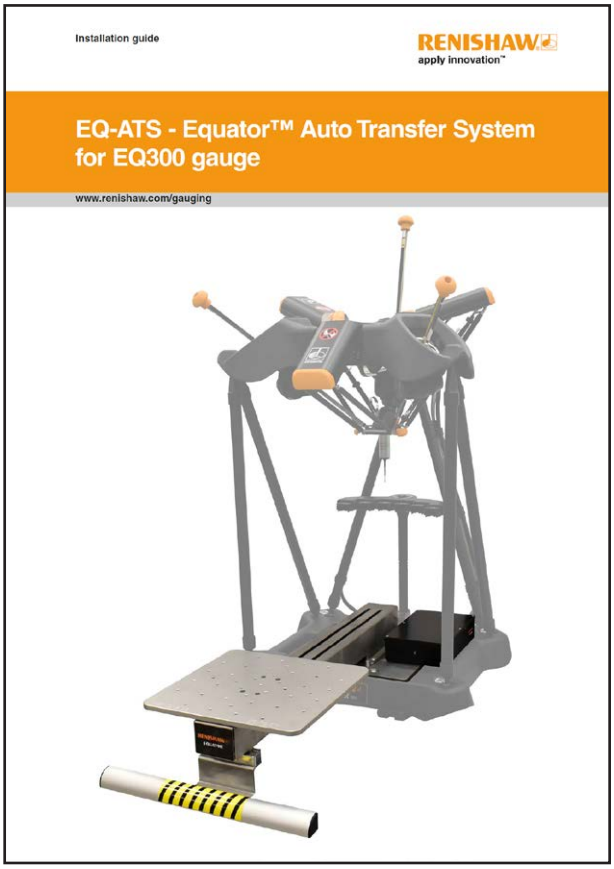
The EQ-ATS improves consistency and reliability of loading large parts into the working volume of the Equator gauging system, as well as offering better access for loading parts to fixture plates outside the working volume.

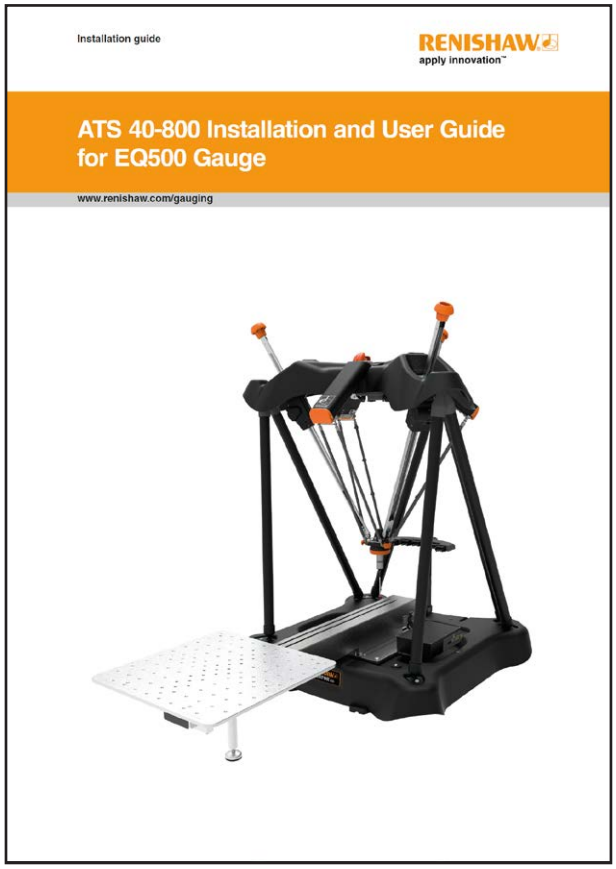
The EQ-ATS transfers the loaded part from outside the Equator working volume into the working volume for inspection to take place. Once inspected, the part is then transferred back outside the working volume to allow removal / replacement of the part.

The part can be loaded onto the EQ-ATS manually or by robot.

The EQ-ATS can easily be integrated with either the Equator 300 or Equator 500 gauging system.

Hardware setup





To install the hardware please see the following user guides:

- H-6242-8500 (Equator 300 gauging system)
- H-6242-8502 (Equator 500 gauging system)

NOTE: Before using this guide, please make sure that the hardware is correctly installed and plugged in to the Equator gauging system.

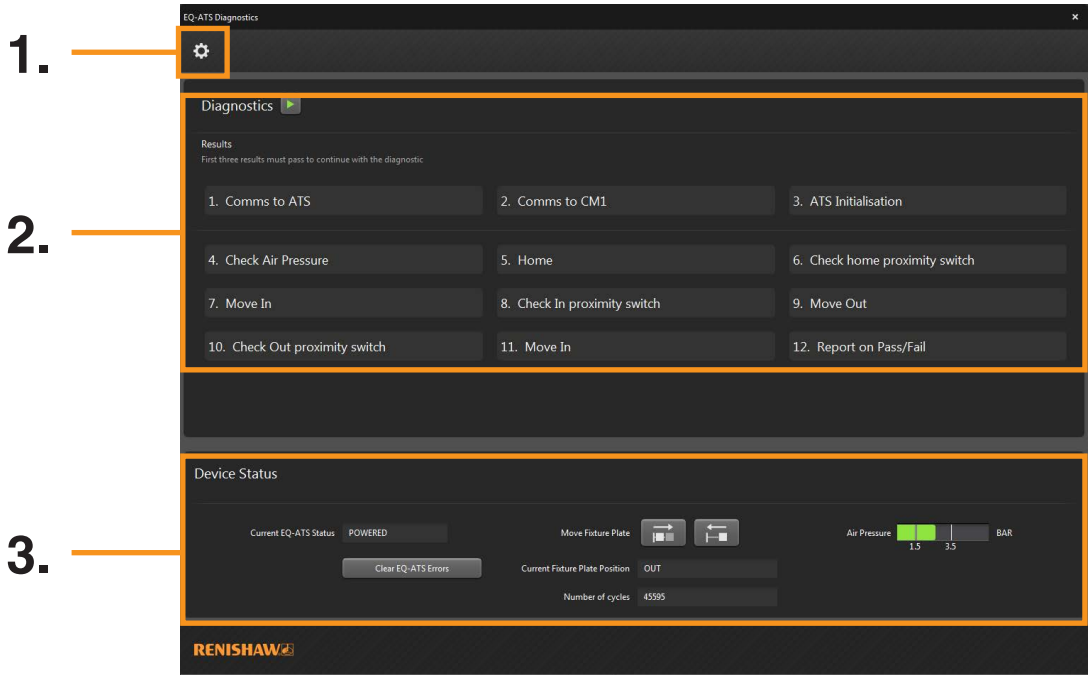
Running a diagnostic test

Before using the EQ-ATS, a diagnostic test can be used to check that everything is working correctly.

- Click “Manager”.

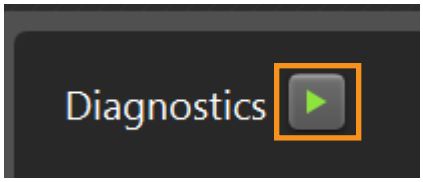
- Click “Diagnostics”.

- Click “EQ-ATS”.



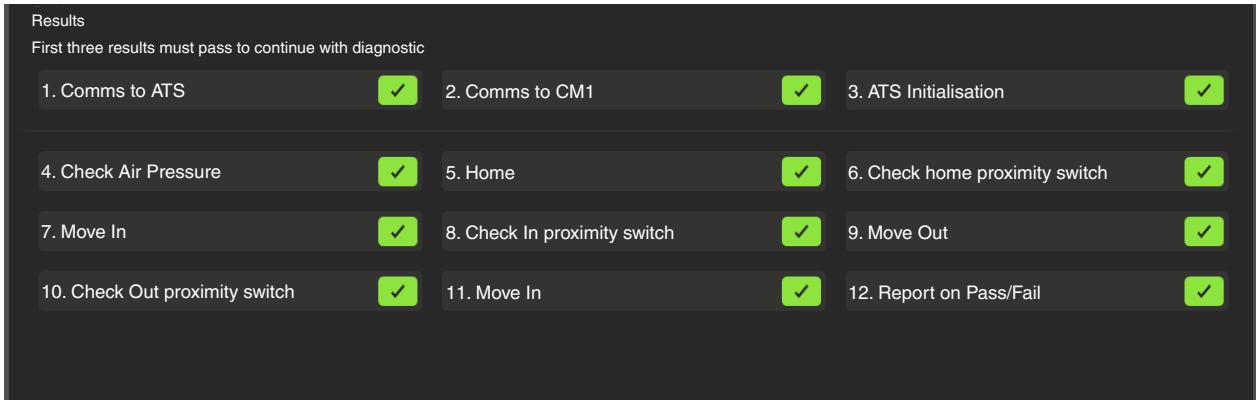
1. Settings button.
2. Diagnostics.
3. Device status.

- Click on the “run” button to run the test.



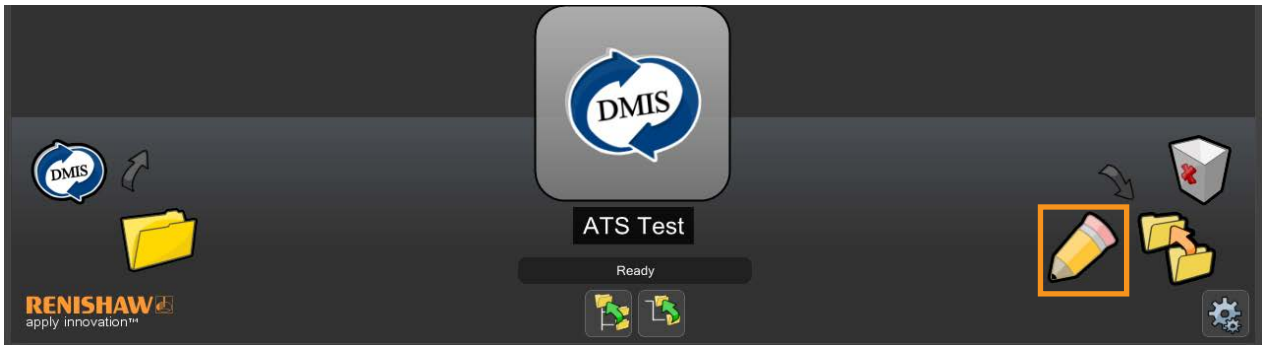
- The test will run and the results are shown. If the test has passed, a green tick will appear next to each test result.

NOTE: The first three results must pass to continue with the diagnostic test.

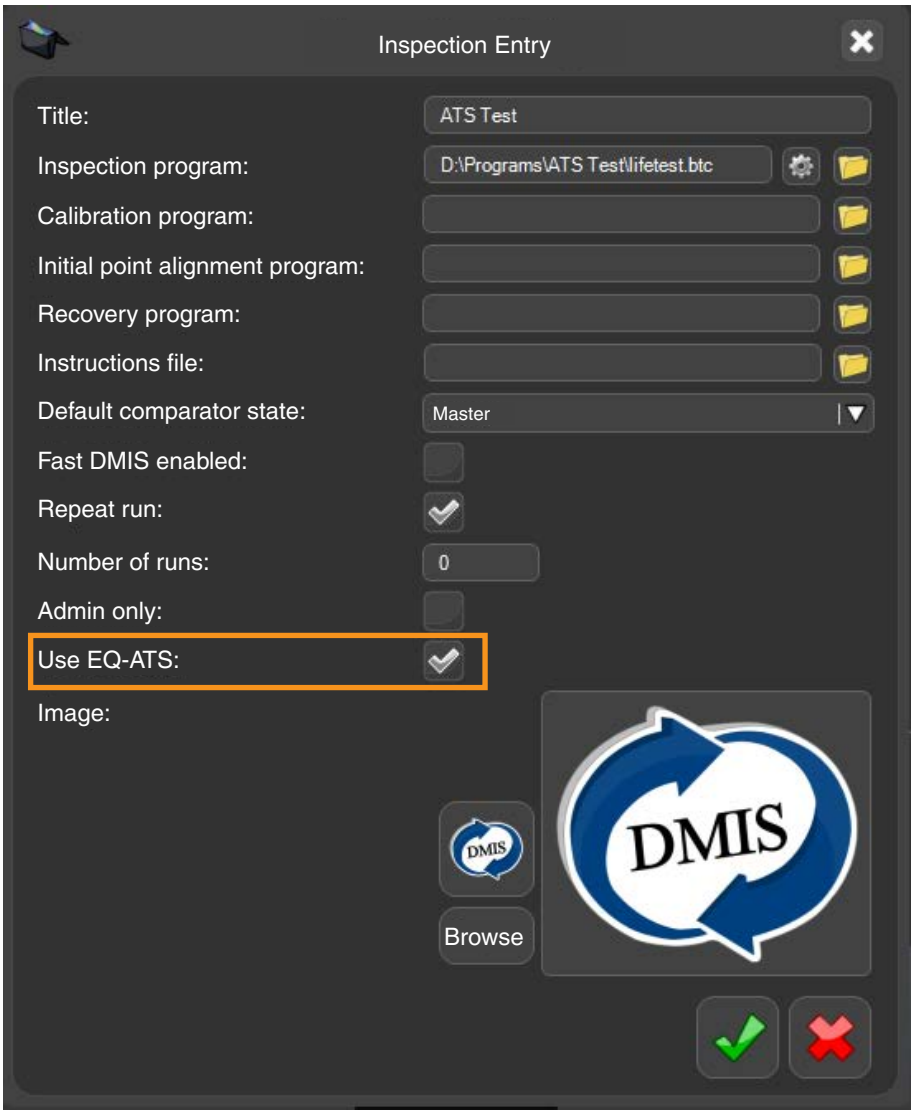


Adding EQ-ATS functionality to a part program

- To add the EQ-ATS functionality to a Part Program, firstly scroll to the required program.
- Click the “pencil” button.



- Click the “Use EQ-ATS” tick box then click the “green tick” to apply the changes.

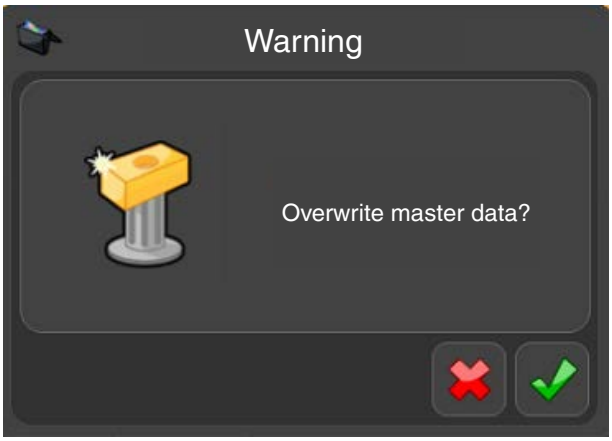


Running a part program with EQ-ATS

- To run a part program with EQ-ATS functionality, firstly double click on the part program.

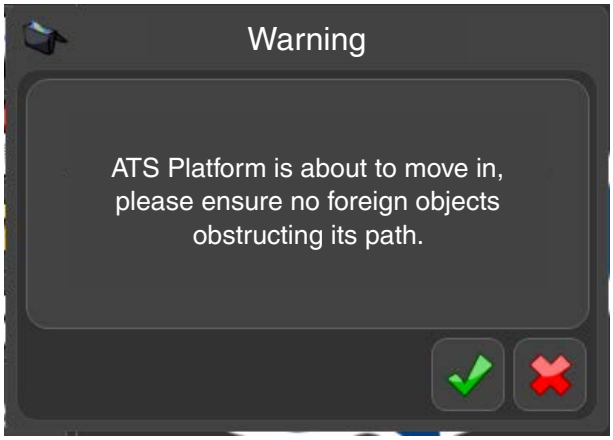
- Make sure that the program is set to “Master mode”. Click the “yellow play arrow” to run.

- If in Master mode, the user will be warned (Overwrite master data?).
- Click on the “green tick” to continue.

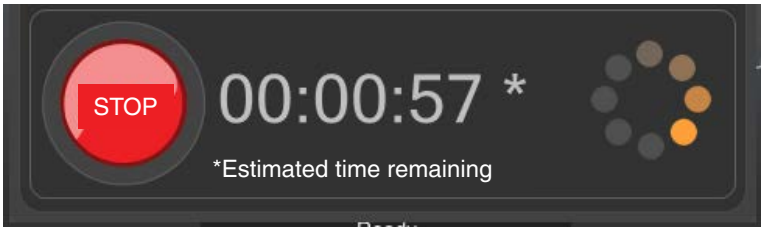


NOTE: When using an EQ-ATS with Organiser, the EQ-ATS will automatically move the fixture plate in before inspecting a part and out after inspecting the part.

- The following warning message is displayed (ATS Platform is about to move in, please ensure no foreign objects obstructing its path).
- Click the “green tick” to continue.



- The fixture plate will now move inside of the system to perform a Master run.
- The part program will now run and generate a Master file. While the part program is running, all functions are inactive apart from the “STOP” button.

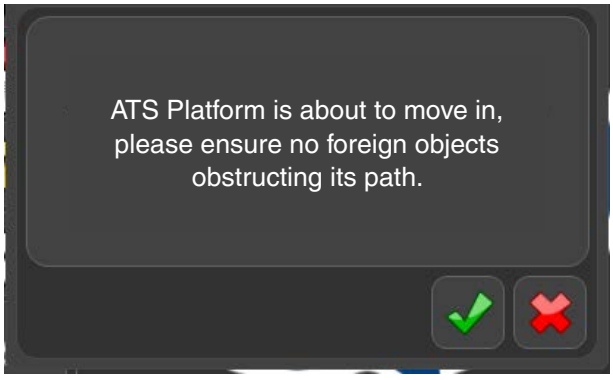


- Once complete, the following warning message is displayed (ATS Platform is about to move out, please ensure no foreign objects obstructing its path).
- Click the “green tick” to continue.

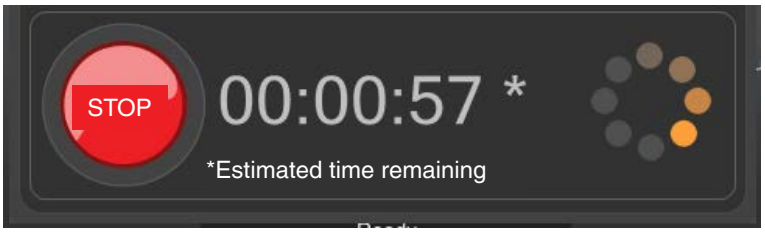
- After the part program has run in Master mode, Organiser will automatically change to Measure mode. The Measure button in the top right hand corner of the window is now active.

- Remove the Master component and replace it with the production component.
- Move the cursor over the “green play button” and click to start the part program running.

- The following warning message is displayed (ATS Platform is about to move in, please ensure no foreign objects obstructing its path).
- Click the “green tick” to continue.



- The fixture plate will now move inside of the Equator to perform a Measure run.
- While the part program is running, all functions are inactive apart from the “STOP” button.



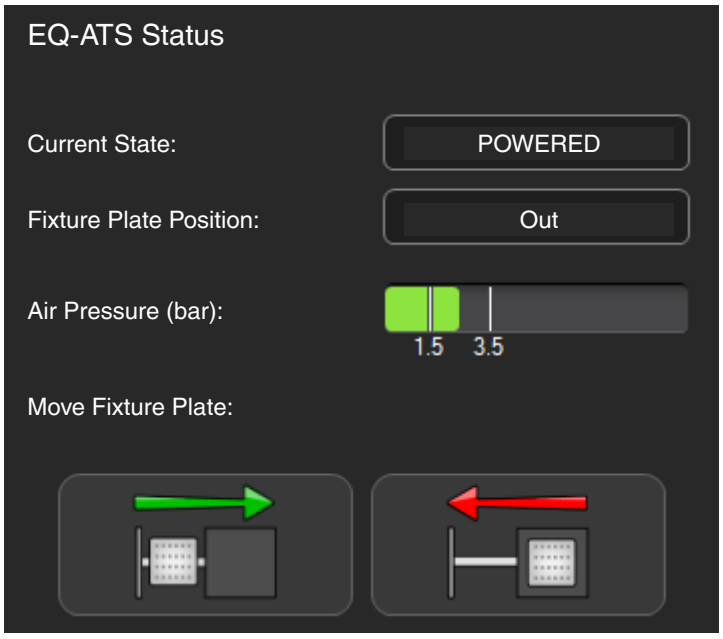
- Once complete, the following warning message is displayed (ATS Platform is about to move out, please ensure no foreign objects obstructing its path).
- Click the “green tick” to continue.

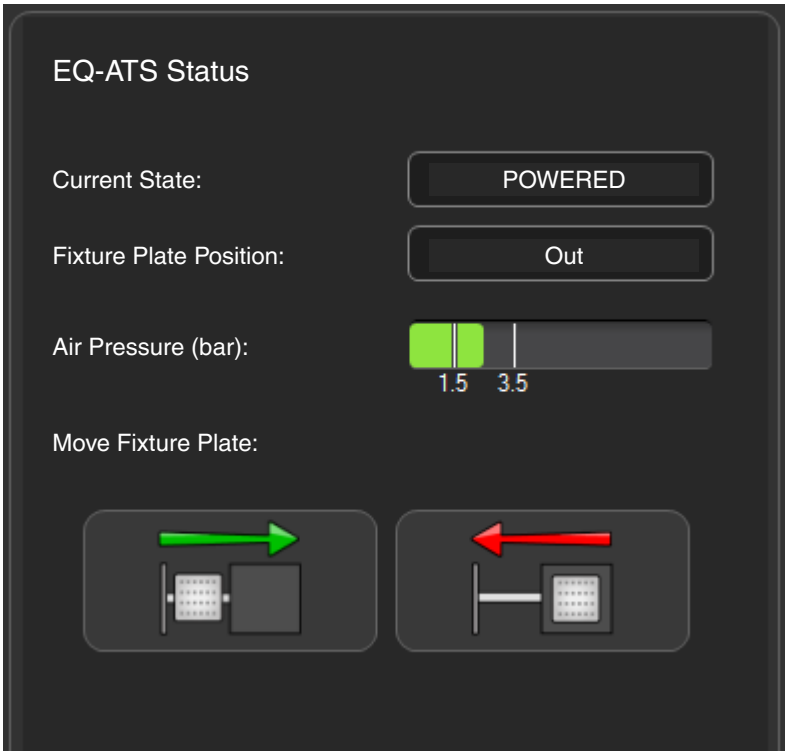
- Continue with measuring parts.

EQ-ATS inspection screen options

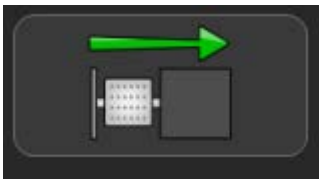
- Click on the button to open the EQ-ATS options.

- The following options are displayed.

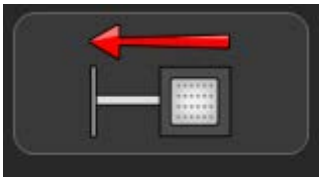




- Current State - Shows the current state of the EQ-ATS.
- Fixture Plate Position - Shows whether the fixture plate is currently inside or outside of the system.
- Air Pressure - Shows the current air pressure value.
- Manually move fixture plate in button



- Manually move fixture plate out button.

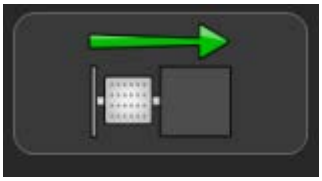


NOTE: These buttons can be used for a manually operated system or if you need to move the fixture plate manually rather than automatically.

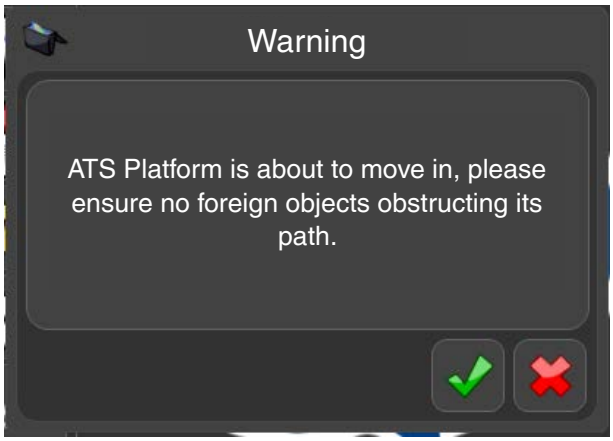
Manually moving the EQ-ATS

Manually moving the fixture plate in

- To move the fixture plate in, click on the “Move fixture plate in” button.



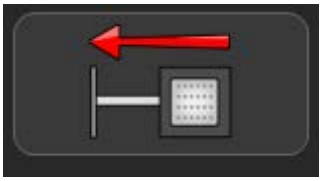
- The following warning message is displayed (ATS Platform is about to move in, please ensure no foreign objects obstructing its path).
- Click the “green tick” to continue.



- The fixture plate will now move inside of the system ready to run the part program.

Manually moving the fixture plate out

- To move the fixture plate out, click on the “Move fixture plate out” button.

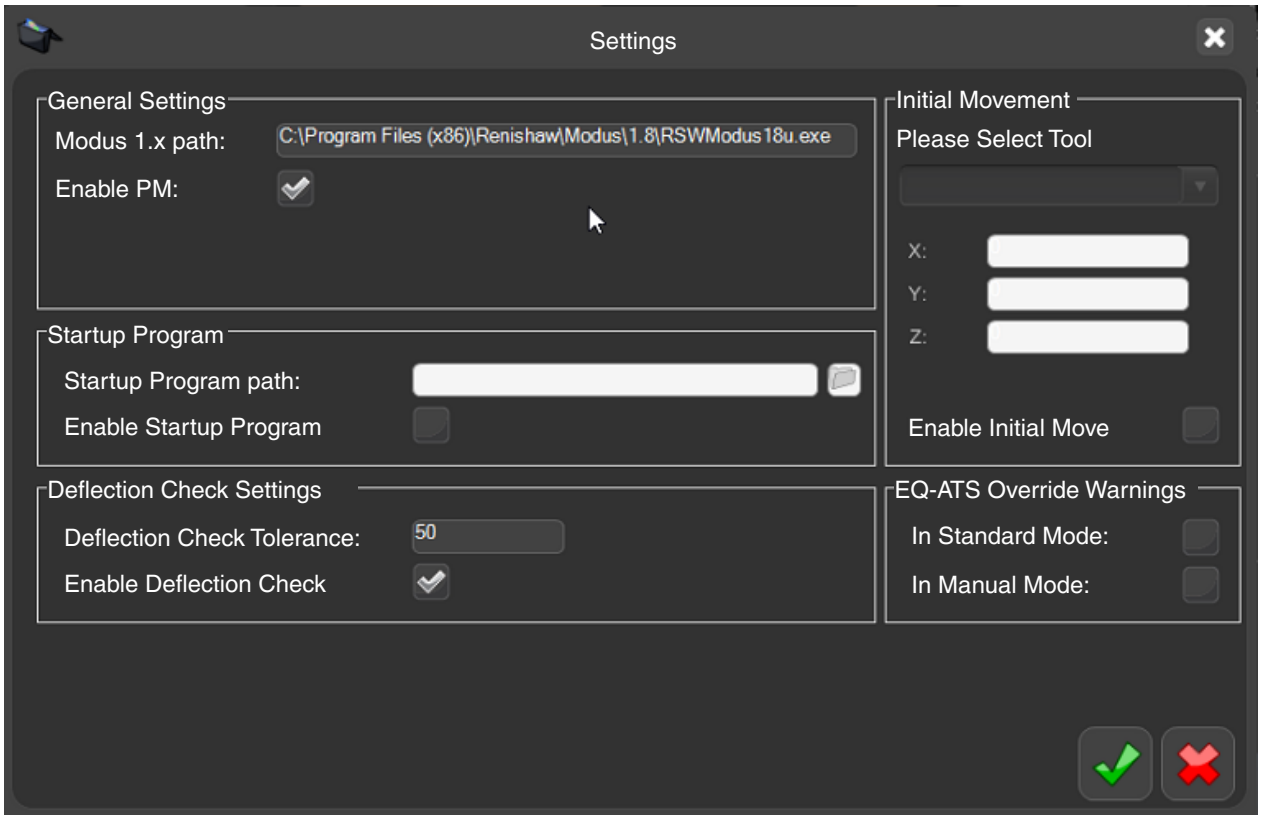


- The following warning message is displayed (ATS Platform is about to move out, please ensure no foreign objects obstructing its path).
- Click the “green tick” to continue.

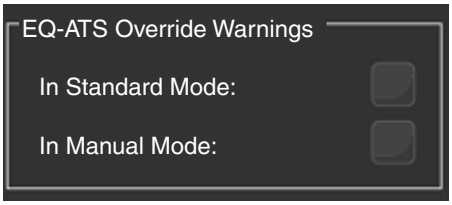
- The fixture plate will now move outside of the system ready to change the part.

Changing EQ-ATS warning messages

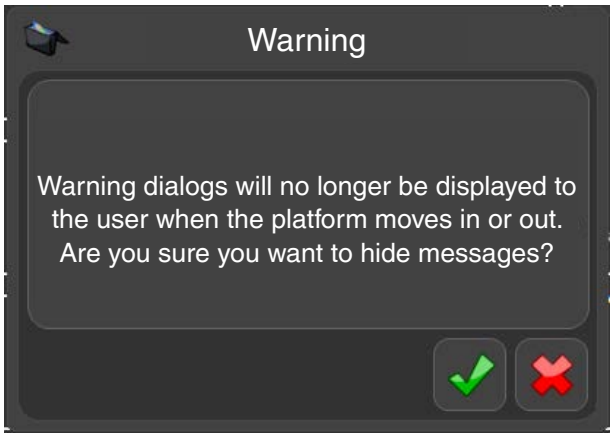
- Warning messages are displayed in Organiser when the EQ-ATS is about to move.
- In Organiser, click on the “Settings” button.



- You can turn off EQ-ATS warning messages by clicking in the relevant tick box.



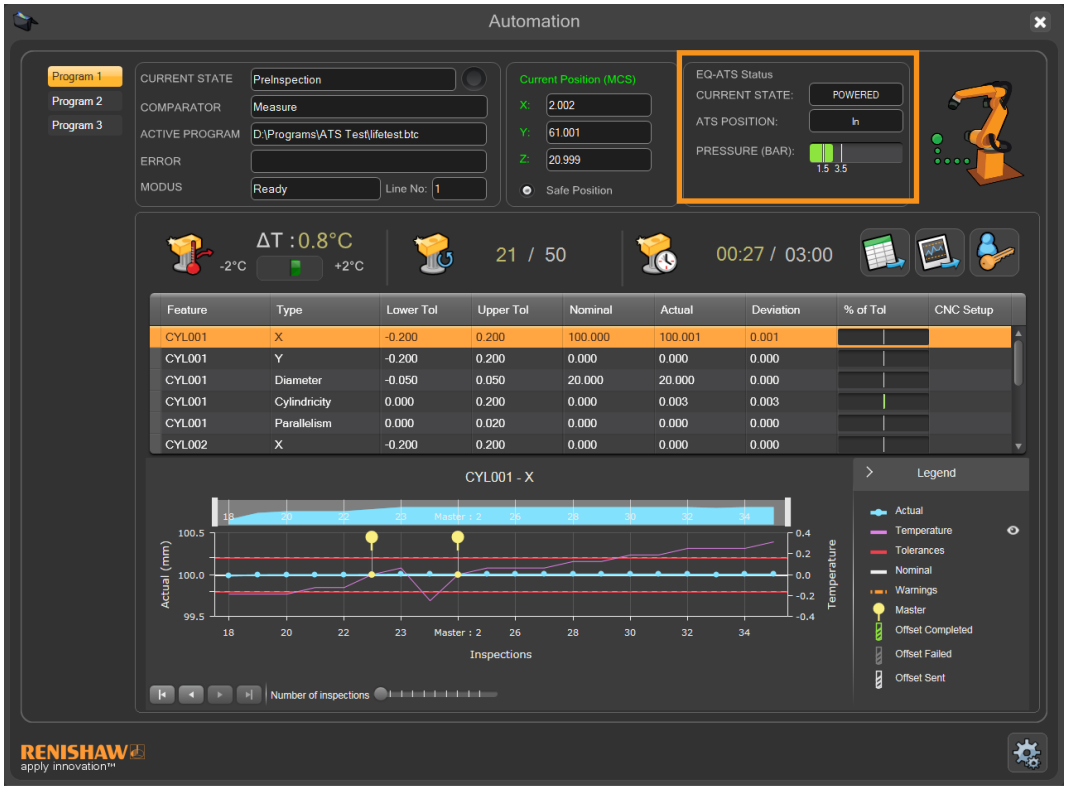
- The following message is displayed (Warning dialogs will no longer be displayed to the user when the platform moves in or out. Are you sure you want to hide messages?)
- Click the “green tick” to accept the changes.

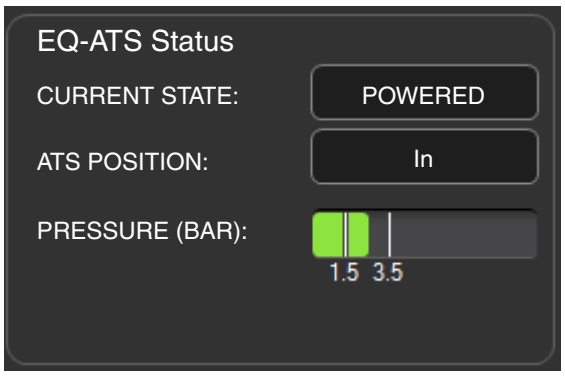


Using EQ-ATS in Automation

NOTE: When using an EQ-ATS with Automation, the EQ-ATS will automatically move the fixture plate in before inspecting a part and out after measuring the part.

- The EQ-ATS will move in on the “PRE-INSPECTION” state.
- The EQ-ATS will move out on the end of the “INSPECTING” state
- The status of the EQ-ATS is displayed here in Automation.





- CURRENT STATE - Shows the current state of the EQ-ATS.
- ATS POSITION - Shows the current position of the fixture plate.
- PRESSURE (BAR) - Shows the current EQ-ATS pressure.

Software add on - Automation

The automation kit consists of interface units and the EZ-IO software which runs on the controller.

The kit is designed to provide an interface between the system and external equipment e.g. PLC's (Programmable Logic Controllers), machine tools, robots, loading systems, etc.

The flexibility of a digital I/O connection allows the system to be commissioned on a variety of different types of automated work-cells. Common applications include part loading and unloading performed by a robot.

In these applications, a pneumatic or electrically driven fixture is often used to ensure that the part being loaded is placed in the correct position and orientation in order to achieve highly repeatable measurements. Once the part has been measured, the EZ-IO software signals whether the part is inside or outside the specified tolerances. Based on this information, the robot can take different actions.

If required, a PLC may be programmed to handle manual selection of operations. In this case, a button console would be used to send signals to the system to start the measurement cycle. As an alternative, a button console could be connected to the system to control component loading/unloading.

EZ-IO's built in custom signal facility allows for customisation of digital I/O to allow inputs and outputs to be directly controlled from the DMIS program. This could be for switching outputs such as status lights, audible alarms etc. or inputs such as start buttons or to other devices such as PLCs or Machine Tool Controllers.

Input and output signals interpreted by MODUS only, are not subject to the same signal checks that are within EZ-IO.

Opening Automation

- The EZ-IO software provides two modes, Operator and Admin mode.
- Operator mode provides a simple user interface to allow the operator to operate the system.
- Admin mode allows the system administrator to configure the system and to use additional tools for setup and testing purposes.
- EZ-IO software can be accessed from the main Explorer screen.

CAUTION: Clicking the “Automation” button will cause the following system behaviour:

1. If the CLEAR OF GAUGE signal is on: The system will home without warning, if the system is un-homed.
2. If the CLEAR OF GAUGE signal is off: The user will get the error “An error occurred whilst trying to home, limited functionality will be available” or “Failed to start correctly: could not establish socket connections.” The user will only be able to access the Automation settings options.

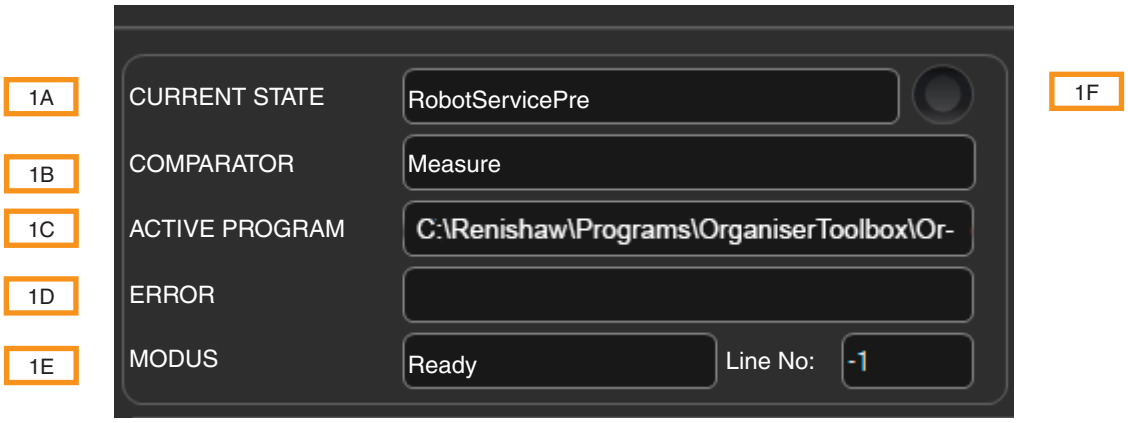
NOTE: The CLEAR OF GAUGE signal is used as an acknowledgement that the system is permitted to perform it’s homing routine. Please make sure that the homing path is free from any hardware or parts so a collision does not occur.

Automation main window

- This section describes the functions available in the main window.

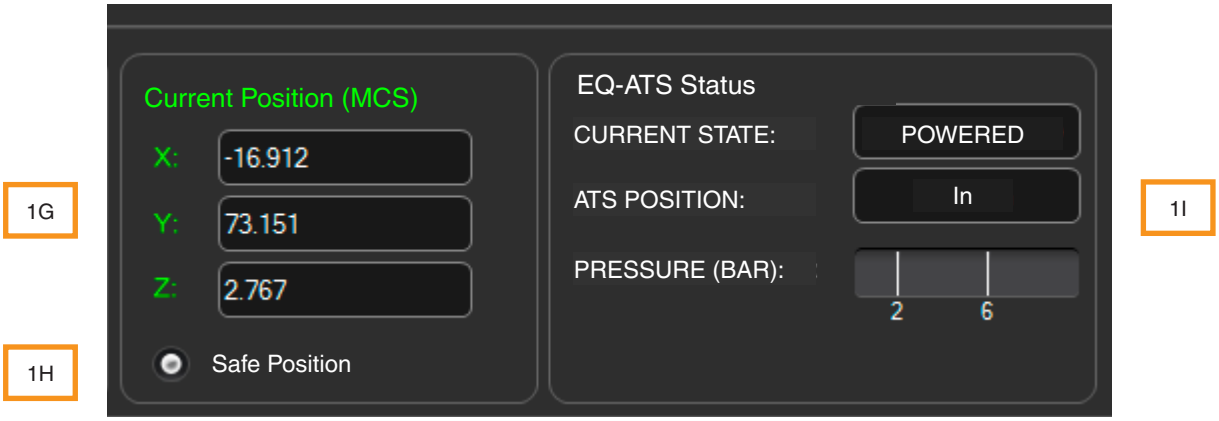
Number	Title	Function
1	Automation	This section contains information on the status of the Automation software and connections.
2	Process Monitor	This section contains information on the current inspection.
3	Admin button	Provides access to the Automation “Administrator” options.

Automation section functions



Number	Title	Function
1A	CURRENT STATE*	Displays the current status of the EZ-IO scheduler. Please refer to the EZ-IO scheduler section for more detailed information.
1B	COMPARATOR	Shows the current system compare status, i.e. whether the DMIS part program is being executed in master or measure mode.
1C	ACTIVE PROGRAM	Displays the filename of the current DMIS part program.
1D	ERROR	Displays the last error that occurred until the user clicks the RESET button.
1E	MODUS	Displays the current MODUS state. The state can be: Disconnected, Ready or Busy. When in the Busy state, the current DMIS part program line number is displayed. Otherwise, Line No: -1 is displayed to show that no program is running.
1F	Heartbeat LED	If the LED is pulsing, it indicates that the EZ-IO system is running.

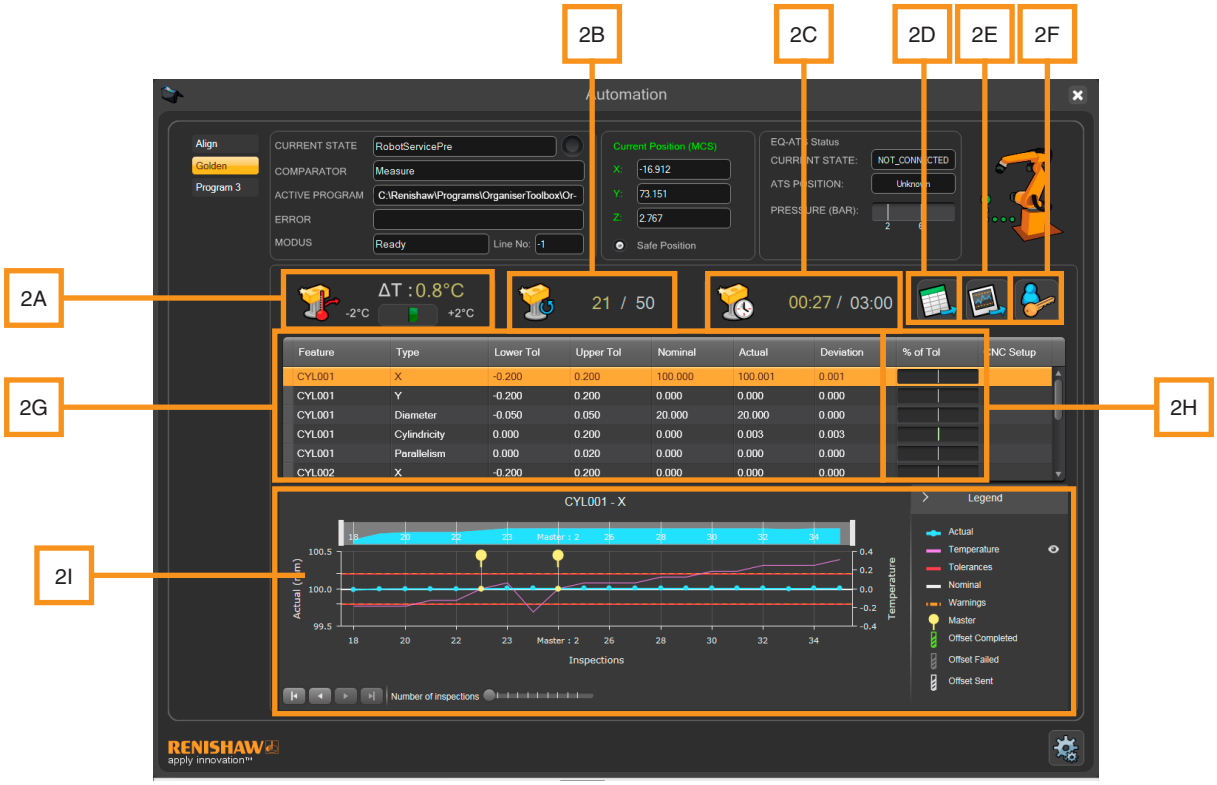
*Displayed CURRENT STATES	Meaning
SWITCHED OFF	The EZ-IO scheduler is not running and the system is not ready to run automatic operations. By pressing the Initialise button, the initialisation procedure is carried out.
INIT	System initialisation is under way, once completed the system is ready for communication with the automation cell's master controller (robot/PLC etc.).
ROBOT_SERVICE_PRE	In this state, the scheduler is giving the signal that it is ready to receive a part from the master. It is waiting for the start signal from the master to begin the inspection cycle.
PRE-INSPECTION	The scheduler has received the start signal from the automation cell's master controller. In this state, the scheduler checks if the system is clear to measure. It then loads the part program that is being selected by the automation cell's master controller and checks whether it has to run a compare master or a measure cycle. If everything is correct, it will start the inspection part program.
INSPECTION	The system is inspecting the part. The scheduler is awaiting completion.
ROBOT_SERVICE_POST	Signals to the automation cell's master controller that the inspection has finished and that the part is ready to be unloaded. The scheduler then awaits the signal from the automation cell's master controller that the part is being unloaded. Once the unloaded signal is received, the scheduler goes back to ROBOT_SERVICE_PRE state.
GOOD-PART	Displayed to indicate that the comparison cycle has completed and that the component is acceptable, i.e. within tolerances defined in the DMIS program. GOOD-PART is also communicated to the automation cell's master controller, which can take the appropriate action.
BAD-PART	Displayed to indicate that the comparison cycle has completed and that the component is un-acceptable i.e. outside of tolerances defined in the DMIS program. BAD-PART is also communicated to the automation cell's master controller, which can take the appropriate action.
ERROR	Any error that occurs is reported to the scheduler and then the scheduler performs the error procedure. The scheduler stays in this state until the reset procedure has been called and completed.
TOOL RECOVERY	If the scheduler is in an error state and the tool is not in the safe position, after resetting the error, the scheduler goes into the Tool Recovery state. In this state, it is possible to move the tool back to the safe position manually (using joystick) or automatically by selecting the appropriate DMIS program that takes the tool back to the safe position. Manual or automatic tool recovery is set up in the Configuration options window.



Number	Title	Function
1G	Current Position	Displays the position of the current tool in the Machine Coordinate System (MCS).
1H	Safe Position readout	The safe position radio button is checked when the probe is in a safe position. The text will also appear in green. The probe is deemed to be in a safe position when it is situated behind and above the three planes defined by the X, Y and Z values in the Configuration options window.
1I	EQ-ATS status	Shows the current status of the EQ-ATS if connected.

Process Monitor section functions

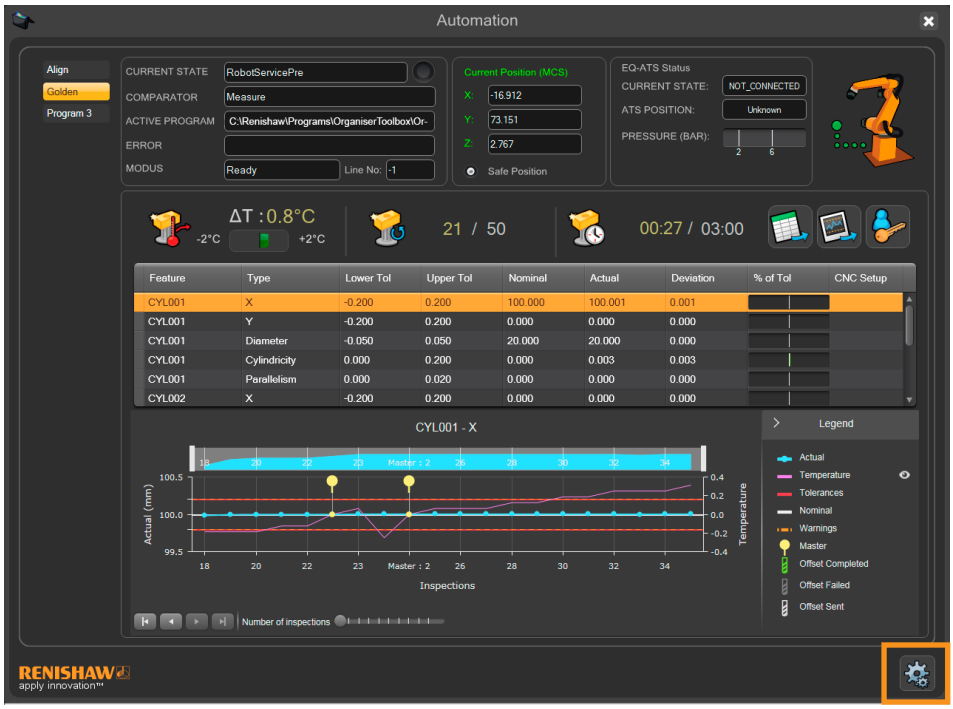
Process Monitor includes an instant monitor bar chart of the last measured part, historical results for selected feature, and three status displays allowing management of re-mastering.



Number	Function
2A	Temperature drift since last mastering procedure.
2B	Number of runs since last mastering procedure.
2C	Time since last mastering procedure.
2D	Export data to CSV for use in other applications.
2E	Export graph to image.
2F	Process Monitor Administrator login.
2G	Table with list of features that have been measured.
2H	Bar graph view of proportion of tolerance.
2I	Graphical display of the history of measurement of the feature selected in the table.

Administrator options

- Admin mode provides the tools to configure and debug the EZ-IO software.
- To access the options, click on the “Administrator options” button.

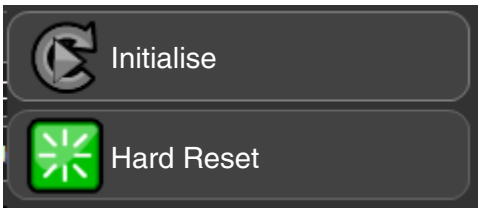


NOTE: Users can be set up from the taskbar. If a user is not set up, admin rights are automatically granted.

Operator options

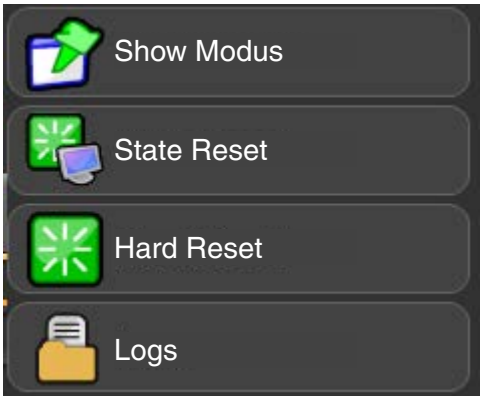
When an Operator has logged in, the following options are available:

- Initialise
- Hard Reset



When an Administrator has logged in, the following extra options are available:

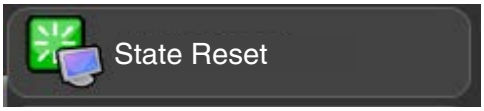
- Settings
- Maps
- I/O
- Show/Hide Modus
- State Reset
- Hard Reset
- Logs



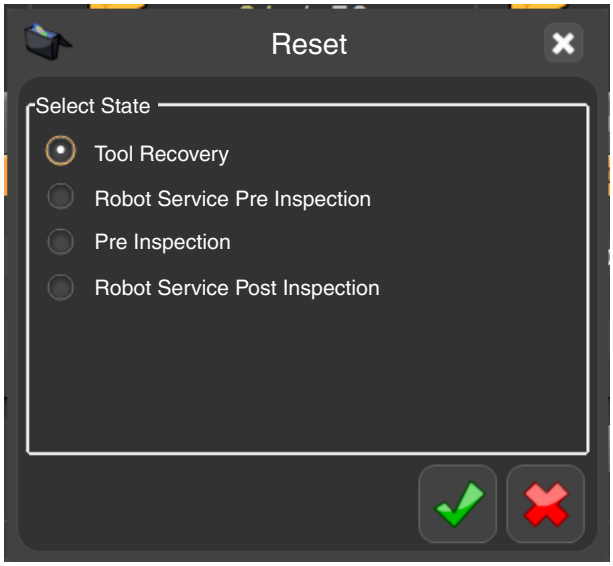
Button	Function
Initialise	Starts the initialisation procedure. Once completed, the system is ready for communication with the automation cell's master controller (robot/PLC etc.).
Settings	Displays the configuration options window.
Maps	Displays the Maps window allowing mapping of inputs and outputs.
I/O	Displays the I/O window, showing the current state of the inputs and outputs.
Show/Hide MODUS	Shows and hides MODUS..
State Reset	If the EZ-IO scheduler is in an error state, selection of this button will clear the error. A dialog box will appear allowing the user to reset the EZ-IO scheduler.
Hard Reset	Closes and reopens connections from MODUS, RenCompare and EquatorServer. After Hard Reset, the user will need to select the Initialise button.
Logs	Displays the Logs window. Showing logs from EZ-IO Scheduler, EquatorServer and MODUS.

Reset

- If the EZ-IO scheduler is in an error or stop state, selection of the RESET button will clear the error.



- The window shown below will appear, allowing the user to reset the EZ-IO scheduler. This procedure allows the user to re-enter the gauging procedure at a pre-defined location as specified by the four options detailed below. The four options available are:



TOOL RECOVERY

- Allows the operator to move the tool back to the safe position manually (using joystick) or automatically by selecting the appropriate DMIS program that takes the tool back to the safe position.

ROBOT SERVICE PRE INSPECTION

- Re-starts the gauging procedure at the start of the cycle and waits for the start signal.

NOTE: Ensure that the component is not present in the fixture since the master is going to load a new component.

PRE INSPECTION

- Re-starts the gauging procedure at the component measurement stage, without the need of the start signal from the automation cell's master controller.

NOTE: Ensure the component is present in the fixture.

ROBOT SERVICE POST INSPECTION

- Cancels the current measurement and because the component's PASS/FAIL status is unknown, EZ-IO will signal “bad part” to the automation cell's master controller. The “bad part” can then be recovered and returned to the queue of components awaiting gauging.

NOTE: Ensure that the component is still present in the fixture as the master is going to unload it.

I/O Monitor window

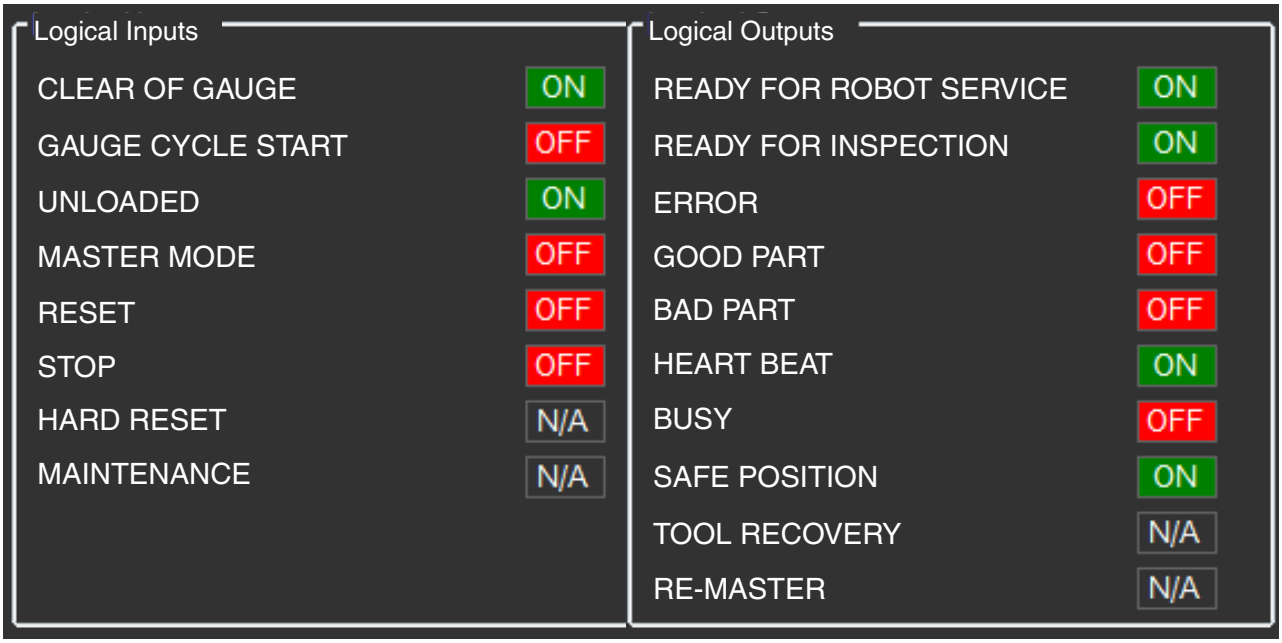
- This window shows the actual state of both the physical and logical input/output (I/O).
- To open this window click on the I/O button.

Logical Inputs

- The “Logical Inputs” section shows the current state of the EZ-IO inputs received from the interface unit and external device. This can be overwritten by simulating the individual signals within the “Maps” window.

Logical Outputs

- The “Logical Outputs” section shows the current states of the EZ-IO outputs. This will give an indication of the current state of the EZ-IO scheduler.



Machine I/O interface

- The “Machine I/O Interface unit” shows the live current states of the machine interface unit and which inputs are being received or which outputs are being sent. The background colours reflect those of the physical LEDs on the interface unit.

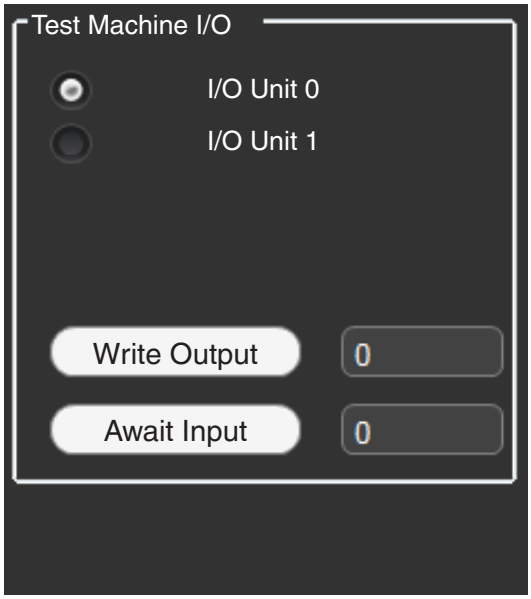
Test Patterns

- The “Test Patterns” section within the I/O Monitor window allows the physical inputs and outputs to be tested. There are three methods within the “Test Patterns” section that physically turn on the interface unit outputs in a predefined order, see the table below.

Title	Function
Run Test	Tests outputs based on which method has been chosen.
Pattern 1	Sends output signals to each bit in turn.
Pattern 2	Sends output signals as binary values, 0-255.
Pattern 3	Sends output signals sequentially in pairs.
Test speed	Changes the speed of the signals of the chosen “Pattern”.

Test Machine I/O

- The “Test Machine I/O” section gives the option to test the input and output connections independently.
- “Write Output” allows the user to select the desired outputs using a binary format. For example, by inserting 11110000 into the “Write Output” box and clicking the “Write Output” button, the interface unit will turn on outputs SSR0-SSR3 and turn off SSR4-SSR7.
- “Await Input” allows the inputs to EZ-IO to be tested. Inserting binary values into the “Await Input” box and clicking the “Await Input” button, will cause EZ-IO to wait for inputs to be received. EZ-IO will then provide the user with a message informing whether the test passed or failed.
- Before running the system in automatic mode, the “Test Machine I/O” function in EZ-IO should be used to test individual I/O lines, preventing any wiring mistakes to cause unwanted motion.



Maps

- To open the Maps window, click on the Maps button:

The Mapping window has the following functions:

1. Input Map
2. Output Map
3. DMIS Map
4. Custom Signals Map

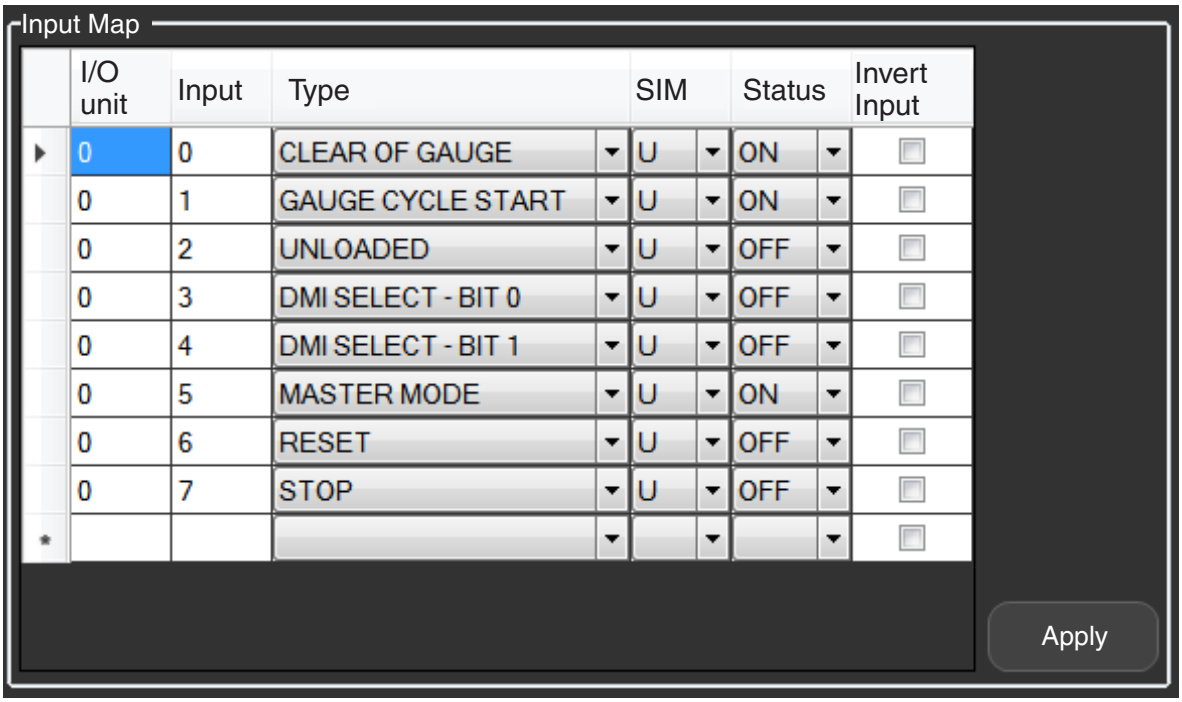
- The Mapping window allows mapping of the 8 physical inputs and 8 physical outputs, thereby assigning logical inputs or outputs to any line of the I/O interface unit.
- If more than 16 lines are required, it is possible to connect an additional interface unit to the controller.
- High/Low signals are normally interpreted as a TRUE/FALSE value, but if required, it is possible to swap them in the Configuration window. See the I/O Polarity group section within Configuration options.

WARNING: Outputs must be wired so that there is no external/system motion in the open state. Inputs must be wired so that there is no system motion in the undriven state.

- Four types of configuration MUST be carried out.

1. Mapping logical to physical digital inputs
2. Mapping logical to physical digital outputs
3. Assignment of DMIS programs
4. General configuration

Input Map



- The image above shows an example of an Input mapping configuration.

I/O unit

- 0 signifies I/O Unit 0 in the I/O unit serial number section in the Configuration options window.
- 1 signifies I/O Unit 1 in the I/O unit serial number section in the Configuration options window.

Input

- The physical inputs are the SSRx (Series Solid State Relays) input channels of the I/O interface unit.
- In the online, un-simulated mode (SIM option U), the acceptable input values are integers from 0 to 7.
- In the offline, simulated mode (SIM option S), input can be any integer value.

Type

- Use the drop down menu to select the type of signal associated with the I/O line.

Type	Function
CLEAR OF GAUGE	The robot maintains this state whilst it is operating outside the working volume of the system. Renishaw recommend having a safe zone (or plane) just outside of the system's working volume. If the robot breaks the plane, the signal should be inverted to stop the system's measurement cycle. The EZ-IO scheduler will not move into its next state if the robot is not clear of the system, i.e in the CLEAR OF GAUGE state. If during the measurement cycle, the status changes to false, the EZ-IO scheduler will set itself into an ERROR state.
GAUGE CYCLE START	The robot must be programmed to deliver the component to the system and then move away to the safe zone (or plane). Once clear of the system, the GAUGE CYCLE START message should be sent by the robot to initialise the start of the measurement cycle on the system.
UNLOADED	Once the system has finished its measurement cycle, it will signal to the robot the component's PASS or FAIL status. On receiving the signal, the robot will be required to unload the part and place it in a pre-defined location. When the robot is clear of the system, the robot should signal the system to allow the EZ-IO scheduler to re-set the system for the next inspection cycle.
DMI SELECT - BIT 0-7	The robot signals to the system which part program is required, as defined in the DMIS Map.
MASTER MODE	The MASTER MODE signal from the robot informs the EZ-IO scheduler whether a Master or Measure component is being loaded into the system. The robot must send this message prior to signalling GAUGE CYCLE START.
STOP	Interrupts immediately the execution of the current I++ instruction, by sending the I++ AbortE() command to Equatorserver. If the system is moving and this signal occurs, the stylus tool will not reach its target position. The stop causes an event, AbortE() command, that Equatorserver manages in the fast execution queue.
RESET	Re-sets the EZ-IO scheduler from an error state. It also sets the system to ROBOT_SERVICE_PRE_INSPECTION status.
MAINTENANCE	Runs the Maintenance Script located within the configuration window. MAINTENANCE also closes and restarts Equatorserver, Rencompare, MODUS, error logger and then starts the initialisation procedure within EZ-IO.
HARD RESET	Stops the EZ-IO scheduler, restarts all background programs (MODUS, Equatorserver, etc.) and reverts to the SWITCHED OFF state.

SIM

- Defines if the Input is set to offline, simulated (S) or online, un-simulated (U) mode.

STATUS

- The status can be set to either ON or OFF if the input is simulated (S).
- If the Input is un-simulated (U), the status will be ignored.

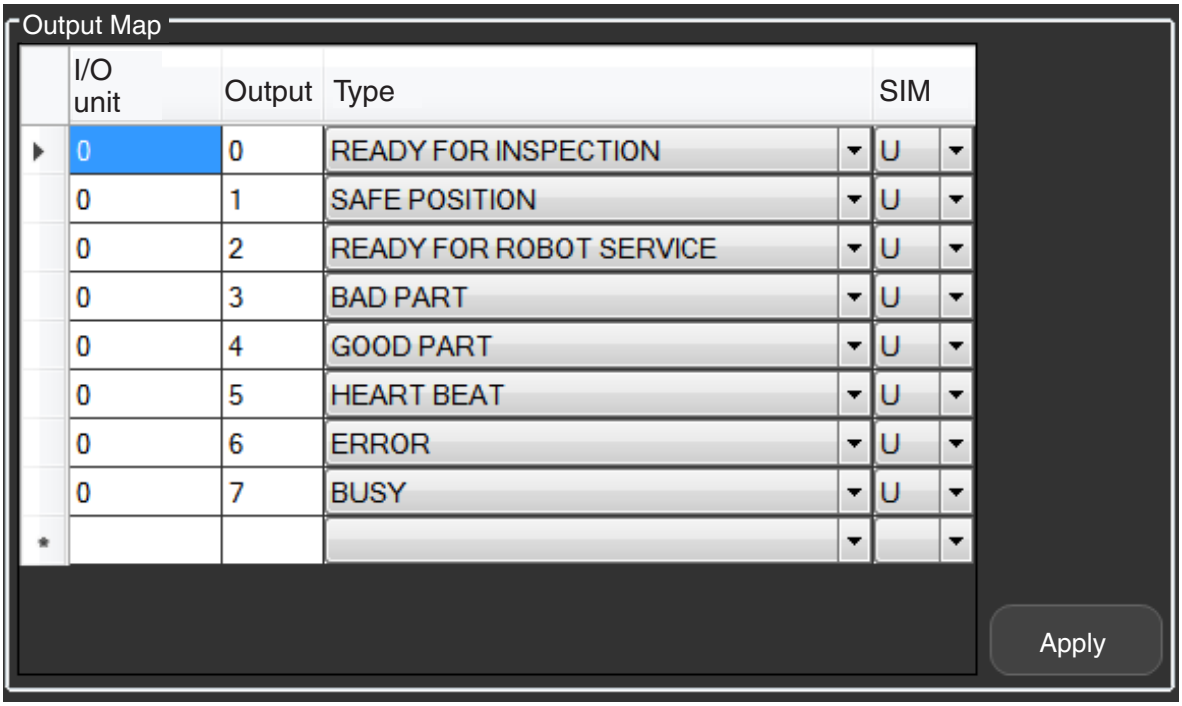
APPLY

- Saves Input Map configuration.

Output Map

The image below shows an example of an Output mapping configuration when using two I/O interface units. The Output Map will need to be configured differently for each application by using the different Output types. Use the “Type” drop down menu to select the required Output types.

NOTE: If more than 8 Output lines are needed, a second I/O interface unit will be required.



I/O unit

- Defines which I/O interface unit is assigned to each signal.
- If only one I/O interface unit is being used, then only the integer value “0” must be mapped.
- If two I/O interface units are being used, then integer values can be “0” or “1” depending on the user configuration.

Output

- The physical Outputs are the SSRx (Series Solid State Relays) output channels of the I/O interface unit.
- In the online, un-simulated (U) mode, the acceptable input values are integers from 0 to 7. In the offline, simulated (S) mode, input can be any integer value.

Type

Type	Function
ERROR	If an error occurs to the system, the EZ-IO scheduler sends output signals to the automation cell's master controller that the system is in an error state.
HEARTBEAT	This pulse signal will be present if safety equipment is fitted to an automated cell. As soon as the EZ-IO software is activated, the signal repeatedly switches high/low (4-5Hz) and a Safety PLC (Programmable Logic Controller) should continuously monitor the signal.
READY FOR ROBOT SERVICE	The EZ-IO scheduler maintains this state when it is ready for input signals from the automation cell's master controller. Whilst this signal is maintained, the robot or other equipment should be allowed to enter the system working volume. When the signal ceases, the robot or other equipment must not enter the system's working volume.
READY FOR INSPECTION	This signal is held whilst the EZ-IO scheduler is awaiting confirmation of a component being delivered to the system. Once the system starts the inspection cycle, this signal ceases so the automation cell's master controller knows that the system is busy.
GOOD PART	Sent at the end of the measurement cycle to notify the automation cell's master controller that the inspection is complete and that the component has passed inspection.
BAD PART	Sent at the end of the measurement cycle to notify the automation cell's master controller that the inspection is complete and that the component has failed inspection.
BUSY	Sent whilst the system is inspecting or initialising. Indicates that the system is currently completing a process.
RE-MASTER	If using Process Monitor, this signal will be sent when the system needs to re-master. The re-master point is defined (by either time, temperature change or number of parts measured) within the Process Monitor admin window. Once the part has been re-mastered, the RE-MASTER signal ceases to be active.
SAFE POSITION	Sends an output when the probe is in the predefined safe position.
TOOL RECOVERY	Sends an output when the current state is TOOL RECOVERY.

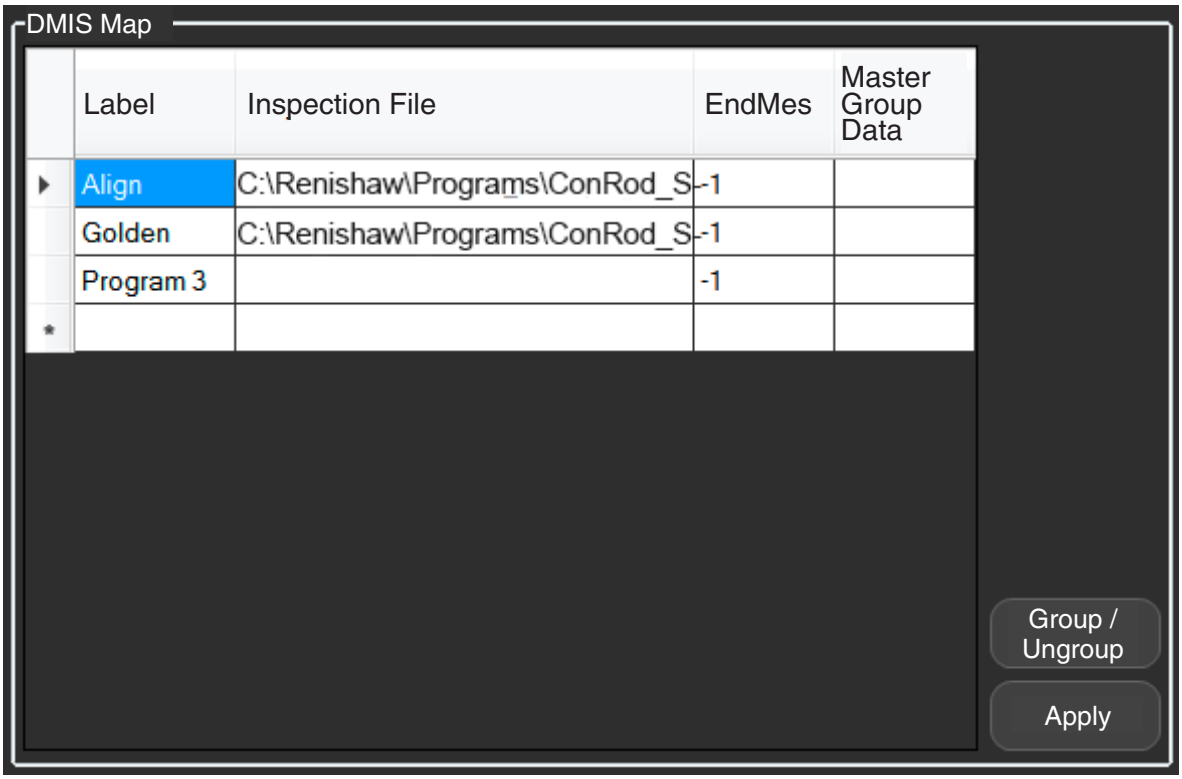
SIM

- Defines if the Output is set to simulated (S) or un-simulated (U) mode. If the mode is simulated (S), the values are not sent to the output path.

APPLY

- Saves Output Map configuration.

DMIS Map



- The image above shows the window for DMIS (Dimensional Measuring Interface Standard) part program assignment.

Program and Inspection File

- To select the part program (via its associated .btc file path), double click in the required text box.
- To delete a line, highlight the whole line by selecting the rectangle on the left hand side of the Program number column, then press “Delete” on the keyboard.
- The number of DMIS part programs available for selection depends on how many inputs of Type “DMI Select” have been allocated in the “Input Map” window. DMIS selection works in a binary format.
- For example, if “DMI Select Bit 0”, “DMI Select Bit 1” and “DMI Select Bit 2” are selected in the “Input map” window, seven fields will be available to assign DMIS part programs.

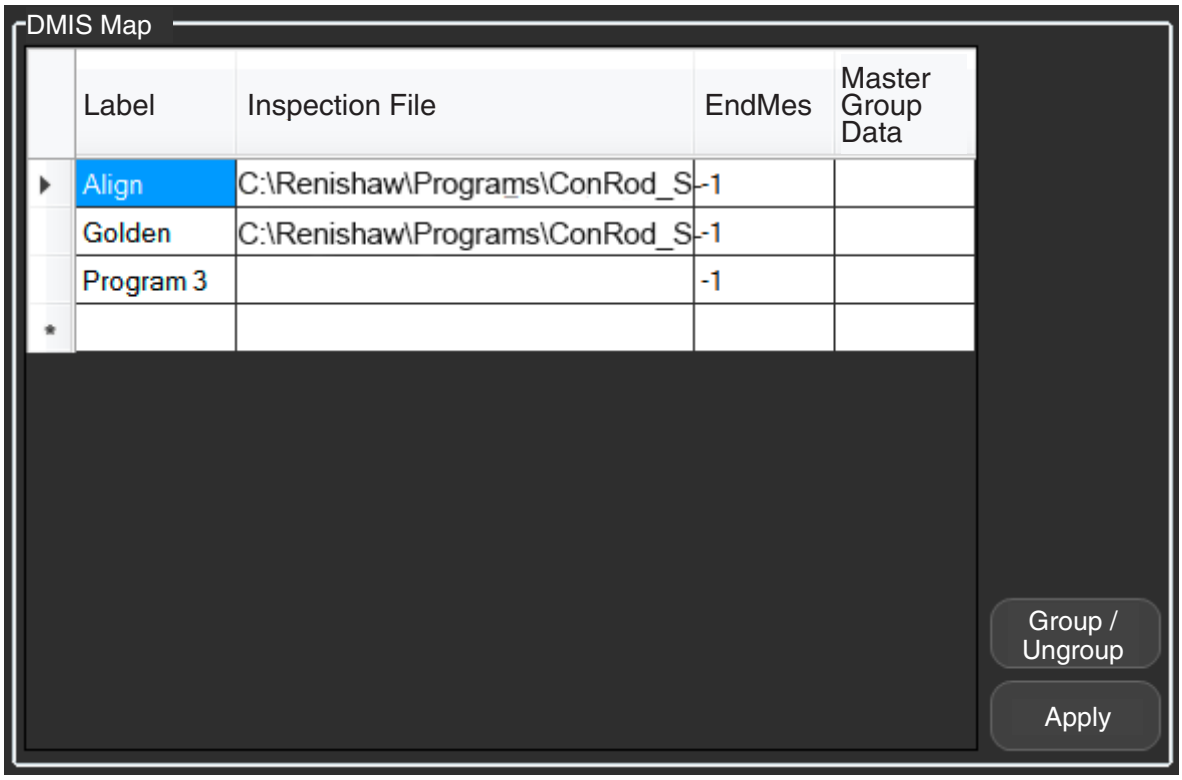
1 input	Only 1 DMIS file can be selected
2 inputs	Up to 3 DMIS files can be selected
3 inputs	Up to 7 DMIS files can be selected
4 inputs	Up to 15 DMIS files can be selected
5 inputs	Up to 31 DMIS files can be selected
6 inputs	Up to 63 DMIS files can be selected
7 inputs	Up to 127 DMIS files can be selected

NOTE: If required, an extra I/O interface unit can be added to the system to provide additional fields; thereby making up to 127 part programs available for selection.

- The software will allow you to have up to 12 DMI input bits, resulting in a possible 4096 mapped inspection programs. This is assuming configuration with the minimum number of compulsory inputs (GAUGE CYCLE START, UNLOADED, MASTER MODE, CLEAR OF GAUGE).

EndMes

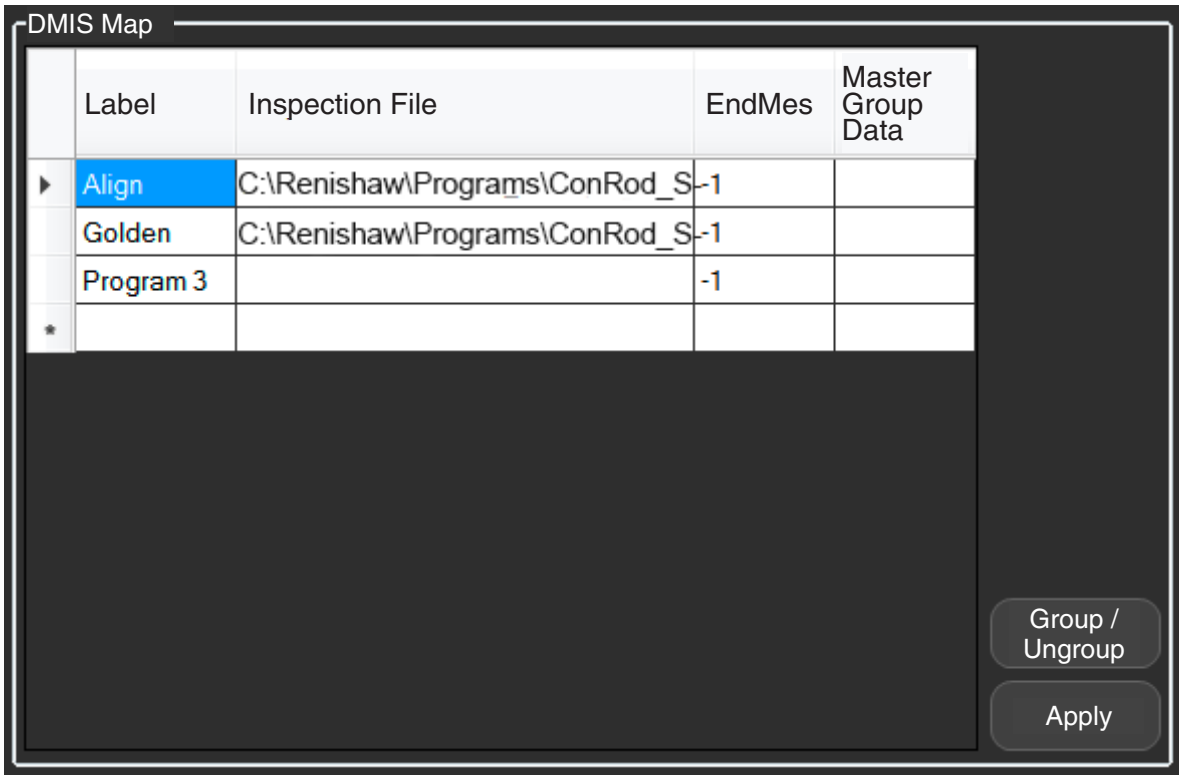
- The “EndMes” column is used when fast DMIS execution is being used. See “Fast DMIS execution” within “Settings”.



NOTE: The EndMes column line number will not accept an empty value. The value must be set as “-1” if not being used.

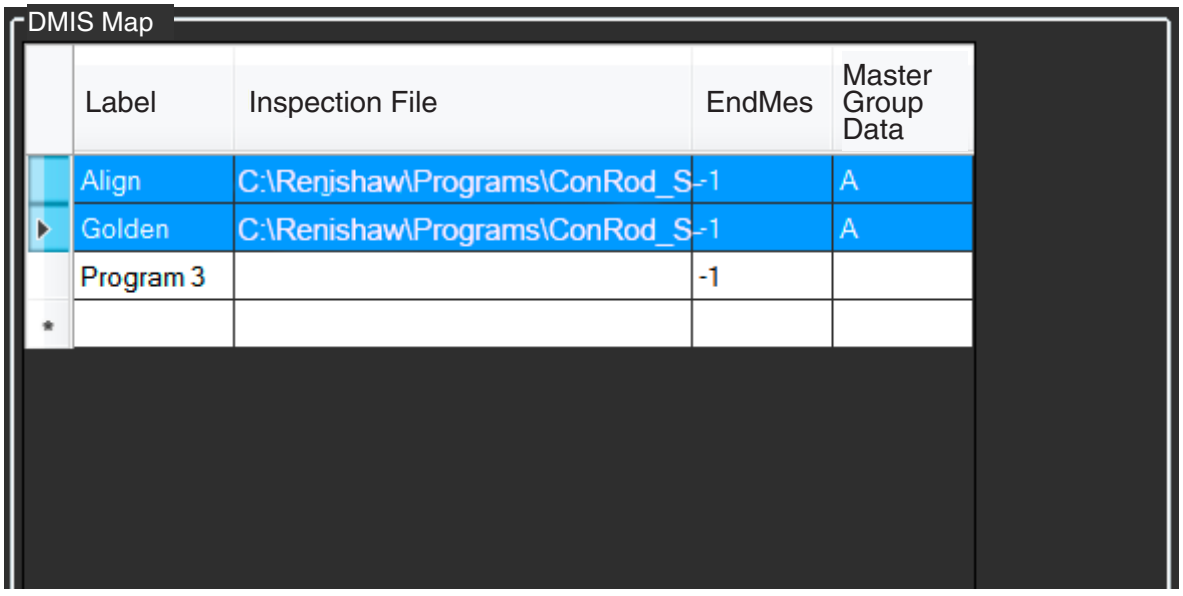
Sharing Master Data

If you have two or more part programs that need to share the same master data, you can use the “Master Data Group” column.

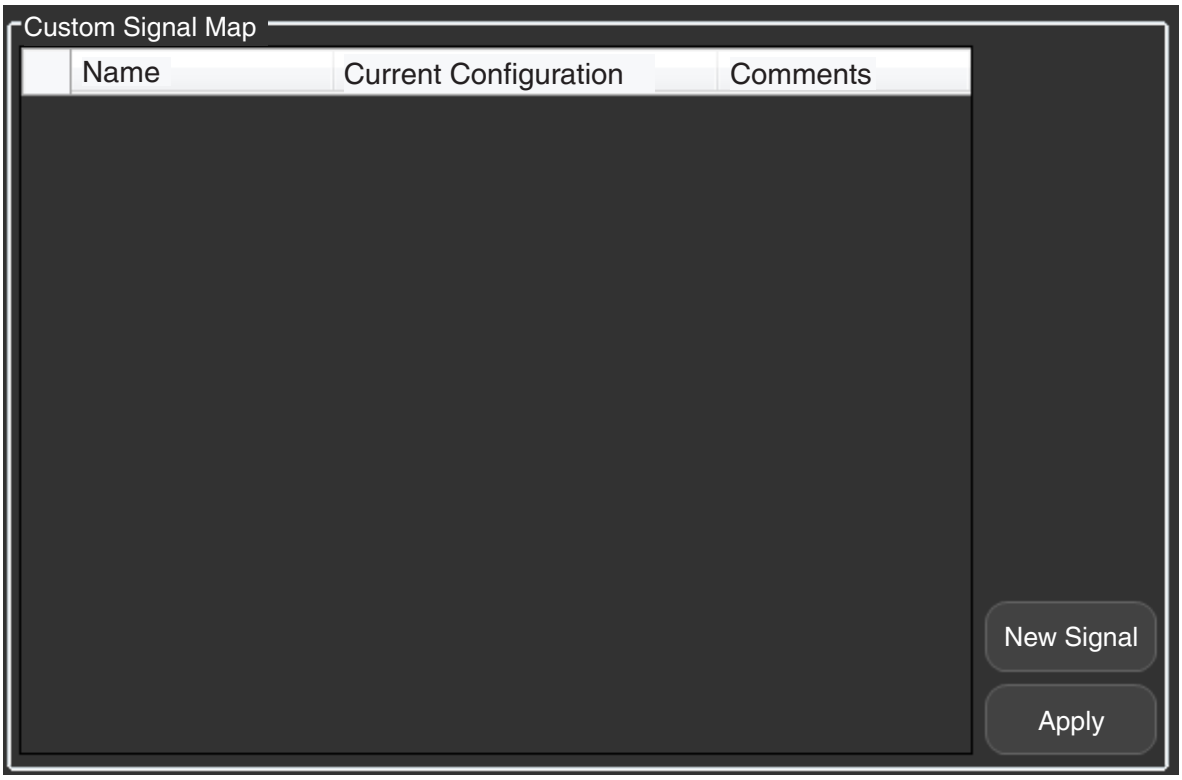


- Select the part programs that require shared master data.
- Click the “Group/Ungroup” button
- This will group the part programs together so that they share the same master data.

NOTE: The first group will be labelled “A”. Subsequent groups will be called “B”, “C” etc.



Custom Signal Map



Name

- Name of the custom signal

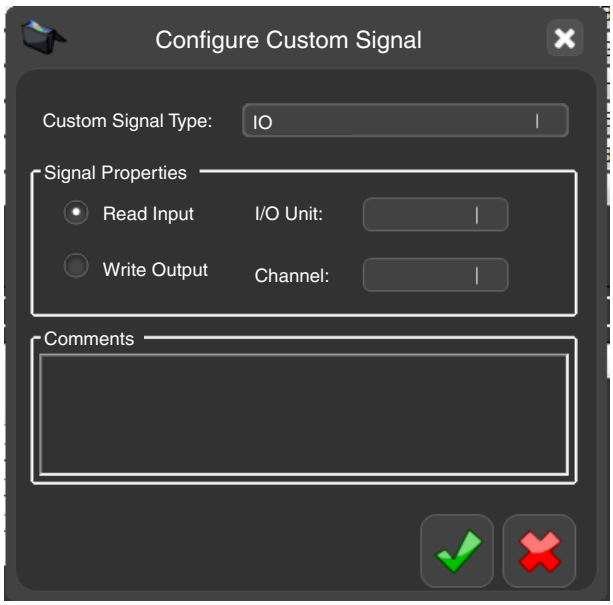
Current Configuration

- Custom Signal type - IO: Shows the current signal properties
- Custom Signal type - Script: Shows the file path location of the defined script.
- To edit a custom signal, double click on the required signal within the “Current Configuration” column.

Comments

- Shows the comments defined in the “Configure Custom Signal” window.
- To set up a custom signal, click on the “New Signal” button. The “Configure Custom Signal” window will appear.

Custom Signal type: IO



Signal Properties

- Defines if the signal is Read Input or Write Output.

I/O Unit

- Defines which I/O unit the signal refers to.

Channel

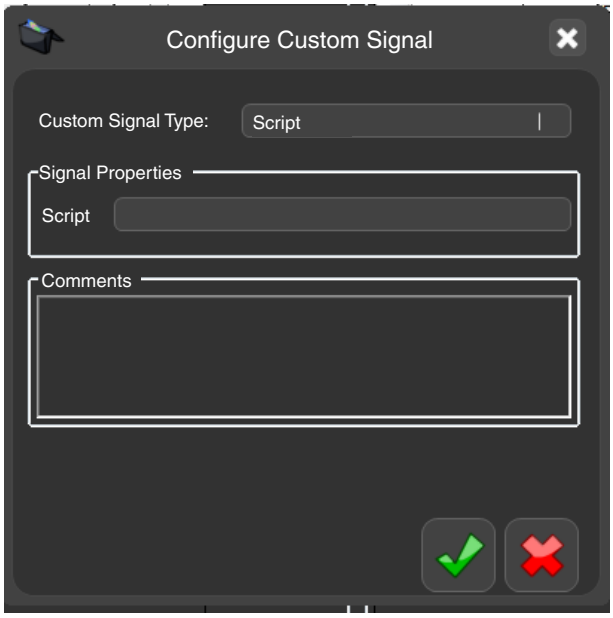
- Defines the number of the input or output connection of the I/O unit.

Comments

- Provides a place to add comments.

NOTE: If you map a channel which is already taken, the Input/Output associated with that channel will take priority over the custom signal.

Custom Signal type: SCRIPT



Script Properties

- Navigate to script file location and define script file. Script files can be VBScript (.VBS) or Batch (.BAT).

Comments

- Provides a place to add comments.

Example MODUS programming

To Read an Input:

Declare a variable-

DECL/LOCAL,BOOL,IOREADSTATUS

Read the Input-

CALL/EXTERN,DME,'AUTOMATIONEVENT',CUSTOMSIGNAL,CUSTOMINPUT_0,IO,READ,IOREADSTATUS

True or false value will be assigned to the variable.

To Write an Output:

To turn the output on-

CALL/EXTERN,DME,'AUTOMATIONEVENT',CUSTOMSIGNAL,CUSTOMOUTPUT_0,IO,WRITE,ON

To turn the output off-

CALL/EXTERN,DME,'AUTOMATIONEVENT',CUSTOMSIGNAL,CUSTOMOUTPUT_1,IO,WRITE,OFF

To run a script:

To pause the MODUS program until the script has completed-

CALL/EXTERN,DME,'AUTOMATIONEVENT',CUSTOMSIGNAL,CUSTOMSCRIPT_0,SCRIPT,SYNC

To continue the MODUS program while the script runs-

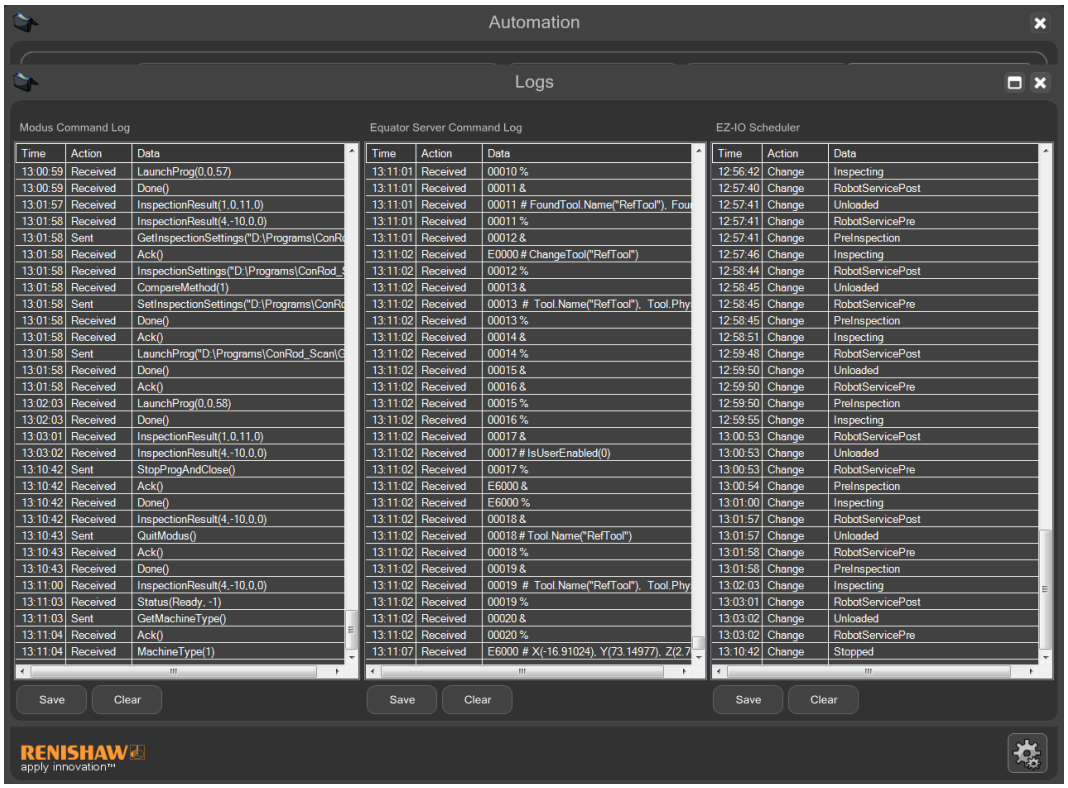
CALL/EXTERN,DME,'AUTOMATIONEVENT',CUSTOMSIGNAL,CUSTOMSCRIPT_0,SCRIPT,ASYNC

Logs window

- To open this window, click on the Logs button.

- The left section shows the log for MODUS, the middle section shows the communication with the EquatorServer and the right section shows the communication with the EZ-IO scheduler.

NOTE: If required, each of the three log files can be cleared or saved by selecting the appropriate button.

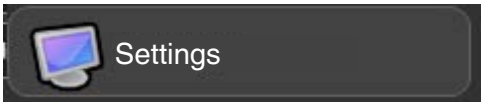


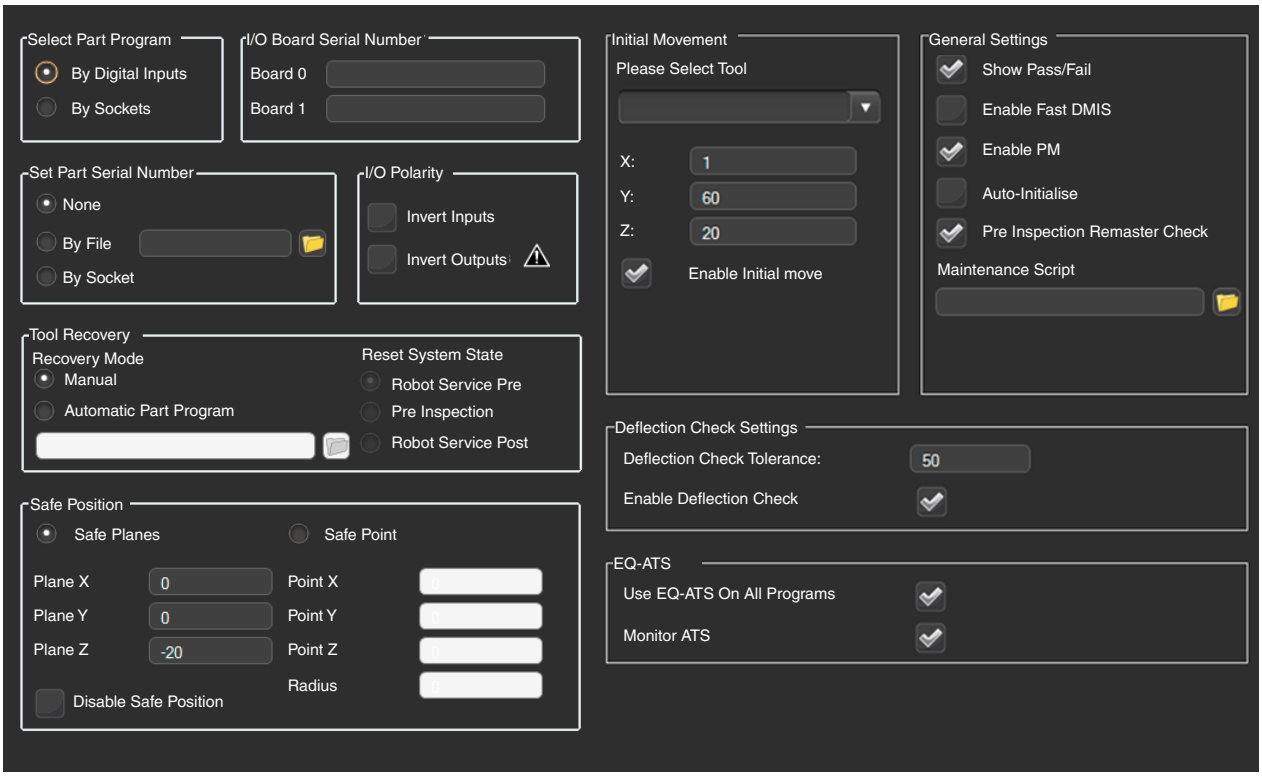
Settings

- The image below shows the Settings window of the EZ-IO software.

NOTE: The window can only be accessed whilst in Admin mode (password protected).

- To open this window, click the ‘Settings’ button:





Title	Function
Select Part-Program options	Defines the method to be used for part program selection. **by Digital Inputs** - If by Digital Inputs is active, the part program will be selected from the list of part programs defined in the DMIS Map window, please see the DMIS Programs Assignment section. **by Sockets** - If by Sockets, please see TCP/IP section.
I/O Board Serial Number	When using two I/O interface units, users must enter the serial numbers in their respective text boxes. The top box refers to 0 and the bottom box refers to 1 in the Maps window. NOTE: If only one I/O interface unit is being used, the text boxes must be left blank.
Set Part Serial Number	Defines the source from which the component serial number is to be read. The serial number can then be input into the MODUS inspection report filename. **None** - The serial number will not be read. **by File** - Reads the required serial number from the text (.txt) file defined in the field. **by Socket** - If by Socket, please see the TCP/IP section.

I/O Polarity	Inverts the polarity of the digital input and/or output. The EZ-IO scheduler interprets high voltage (>9 V) as signal ON, and low voltage (<7.6 V) as signal OFF. If a high signal needs to be interpreted as OFF, then the polarity must be inverted. Warning: When using this feature, considerations of failure conditions should be taken into account to ensure that the system can fail safely.
Tool recovery	This option provides the capability for automatic or manual tool recovery. The tool recovery state is activated when a system error is reset whilst the stylus is outside of the safe position. **Manual** • The current state will change to tool recovery and manual movement may now be used to move the stylus tool into a safe position. **Automatic part program** • Automatically runs a predefined tool recovery DMIS part program when the tool recovery state is activated. Once the part program has executed, the EZ-IO state will change to the pre-selected system state. • ROBOT_SERVICE_PRE resets the EZ-IO scheduler back to a state where it is ready for a program / part to be loaded. • PRE_INSPECTION will automatically re-run the previous part program. • ROBOT_SERVICE_POST will automatically set the part as BAD.
Safe Position (MCS)	Sets the current tool's safe position (by Safe Planes or Safe Point) with reference to the Machine Coordinate System (MCS). When Safe Position is active, the EZ-IO scheduler checks to ensure that the tool has reached the safe position prior to proceeding with either READY_FOR_ROBOT_SERVICE_PRE or READY_FOR_ROBOT_SERVICE_POST procedures. During initialization, when using safe planes, the tool will move to the position specified in the Configuration window, Initial movement, plus 1 mm in both X, Y and Z to ensure that the probe is not situated on the boundary of the safe volume defined by the X plane, Y plane and Z plane. When using safe position, the tool will move to the position specified within the Configuration window. NOTE: Best practice is to ensure the system returns to a safe position at the end of the inspection program.
Disable safe position	If this box is ticked, the EZ-IO scheduler will not ensure that the tool has reached the safe position prior to proceeding to the next procedure. Warning: Disabling safe position may result in collisions and should be done with care.
Initial Movement	Defines the tool and the initial X, Y, Z position that the tool will move to when the software is initialised. NOTE: 1 mm is automatically added to the X, Y, Z position to ensure that the safe position is maintained.
Show Pass/Fail	If this box is ticked, following the measurement cycle, the components PASS/FAIL status will be displayed.

Enable Fast DMIS (MODUS 1.X only)	The purpose of Fast DMIS is to try and minimise the time that the production cell is static by allowing simultaneous operation of the robot and Equator. This is a global setting within Automation, so applies across all inspection programs called. With Fast DMIS enabled a faster transition between inspection cycles will occur by pre-emptively loading the same part program into Modus. The result of this is a more responsive start to part measurement upon the GAUGE CYCLE START signal turning ON. NOTE: It is a condition of using this function, that the part program contains a DMESW/DELAY,'Wait' command prior to the first machine movement (GOTO) command. Fast DMIS can also enable part retrieval from the Equator before the inspection program has completed. This can save cycle time in instances where there is considerable time taken to perform constructions, calculations or write output result data in Modus. To use this function, the command **CALL/EXTERN,DME,'AUTOMATIONEVENT',CUSTOMSIGNAL,R4RS** should be written into the inspection program after the final GOTO move. Alternatively, a Modus program line number can be inserted into the EndMes column in the DMIS Maps window. The result of either of these methods is the READY FOR ROBOT SERVICE output being turned ON before the inspection program has completed. NOTE: This action should still be subject to checking that the SAFE POSITION output is ON, so should only be invoked after the final GOTO move.
Enable PM	When this option is ticked, Process Monitor will start when EZ-IO software is started.
Auto-Initialise	With this option checked, the scheduler will start immediately upon opening the software.
Pre-Inspection Remaster Check	By default, Automation will check the status of the temperature deviation, inspection count and time elapsed since the part program was last mastered at the point the GAUGE CYCLE START signal is turned ON. If any of these criteria have exceeded their limits (as defined in Process Monitor), the part will not be inspected and will result in the ERROR, REMASTER and BAD PART outputs turning ON. Upon receiving a RESET input, the scheduler will immediately step into the ROBOT SERVICE POST state, where the part can be removed without having been inspected. The check of the remaster criteria also takes place at the end of the inspection cycle, but in this case the ERROR signal will not be turned on and the part status (GOOD PART / BAD PART) will reflect the inspection result. The REMASTER output will turn ON based on the same criteria check. The REMASTER output will turn OFF once a Master inspection cycle has been run for that particular program. With the Pre-Inspection Remaster Check disabled, the temperature deviation, inspection count and time elapsed since the part program was last mastered will only be checked at the end of the inspection cycle. **NOTE: Disabling this option could cause erroneous measurement data in the event of performing an inspection in 'Measure' mode after an extended period of inactivity.**
Maintenance Script	This is the VBScript or Batch (.bat) file which runs when the MAINTENANCE input signal is received. See 'Input map'.
Deflection Check	If this box is ticked, the system will check for deflection. A deflection tolerance can also be applied.

EQ-ATS	Allows the monitoring of the EQ-ATS. If "Monitor ATS" is checked, the status panel on the main page will be updated with ATS state regardless of whether "Use EQ-ATS On All Programs" is checked. If "Use EQ-ATS On All Programs" is checked as well, the EQ-ATS state will be monitored and the EQ-ATS will also be controlled by Automation when parts need to be loaded / unloaded. If "Monitor ATS" is not checked but "Use EQ-ATS On All Programs" is, the status panel on the main page will still be updated.

Connection to a TCP/IP client

- EZ-IO implements a TCP/IP (TRANSMISSION CONTROL PROTOCOL/INTERNET PROTOCOL) server that listens for equipment (clients) e.g. robots or CNC machine tools to establish communication with them.
- The purpose of the communication is to enable remote monitoring and some control of the system controller during its operations.
- Clients of this type can be a SCADA, a work-cell supervisory system, a machine tool, or any industrial devices that can establish this type of connection.

Handshake protocol

- Each time the client sends a command (a specific string code), the server will follow a 3-step response procedure:

1. Confirmation Message: Confirms the client's command has been received – this is just a duplicate of the message that the client sent.
2. Acknowledgement: This is a confirmation that the message that the client sent follows the protocol for communications with EZ-IO (i.e. it is one of the message types defined in the “Send method” column in the “Client commands” table below).
3. Response: Finally the server sends a response to the client's query following the protocol defined in the “Response method” column of the table below.

- The only communications that do not follow this protocol are those driven by the EZ-IO server, i.e. the events. The only event that is currently implemented is the evtDeviceStatusChanged event which fires whenever the Device status (system) changes.

Client commands

- The available and accepted commands that a client can send (in the form of a string) are listed below, along with the response that the client will receive from the EZ-IO server after the confirmation message and the acknowledgement:

Message Type	Send Method	Response Method
Get Methods:	getDeviceStatus()	resDeviceStatus([DeviceStatus])\r\n\0
	getActiveProgram()	resActiveProgram([ProgramPath])\r\n\0
Set Methods:	setProgram([ProgramPath])	resSetProgram([ReturnCode])\r\n\0
	setSerialNumber([SerialNumber])	resSerialNumber([ReturnCode])\r\n\0
Acknowledgement:	None	Ack()\r\n\0
Events:	None	evtDeviceStatusChanged([DeviceStatus])\r\n\0

NOTES: When the EZ-IO server sends commands to clients, the commands will end with the characters: \r\n\0 (so clients need to handle this).

When clients send commands to the EZ-IO server, the server does not expect any characters at the end (so clients shouldn’t append any).

- [ProgramPath] = path where the .btc is located in the system controller file system.
- [SerialNumber] = the component serial number that is assigned to the report filename once the inspection of the actual part has finished.
- [DeviceStatus] = The status of the controller:

Number	Text
-1	SWITCHED OFF
0	IDLE
1	RUNNING
2	STOPPED
3	FINISHED
4	ERROR
5	UNKNOWN

- [ReturnCode] = Return code indicating success or error:

Number	Text	Meaning
0	SUCCESS	The command completed successfully.
11	FILE NOT FOUND	The program specified in the “setProgram” command does not exist.
12	FILE ERROR	The program specified in the “setProgram” command exists but cannot be read.
13	NOT IN IDLE STATE	Attempted to perform a “setProgram” or “setSerialNumber” command but Automation is not ready to accept it.
14	MISFORMED COMMAND STRING	The command is not in the correct format.
15	NOT USING SOCKETS	Attempted to perform a “setProgram” or “setSerialNumber” but Automation is not configured to use sockets for that field.
16	NO ACTIVE PROGRAM	Attempted to perform a “setSerialNumber” command but there is no program configured (this is important because the serial number gets saved to a file in the program’s directory).
17	FAILED TO SAVE SERIAL NUMBER	Attempted to perform a “setSerialNumber” command but Automation was unable to create the serial number file.

Example communications

- The below describes an example situation where the client is aiming to set the program that should be executed.

Client		Server
setProgram(D:\Programs\TestProg.btc)	→	Command received
Confirmation received	←	setProgram(D:\Programs\TestProg.btc)\r\n\0
Acknowledgement received	←	Ack()\r\n\0
Response received (Success)	←	resSetProgram(0)\r\n\0

Programming example

- This example describes how to create a client that connects to, and communicates with, EZ-IO server in C# (C sharp) programming language.
- It is mandatory for the programmer to understand a few basics about TCP/IP sockets and the server-client communication model.
- The example uses the TCPClient class located in the System.Net.Sockets namespace.

NOTE: This code only gives a rough idea of how the client should be implemented – in the actual implementation the code must be made robust by including more error handling and following good structural practices.

Creating and establishing a connection with the EZ-IO server

```
<Code>
TcpClient Client = new TcpClient();
IPEndPoint ServerEndPoint = new IPEndPoint(IPAddress.Parse(IP_Address), PortNumber);
Client.Connect(ServerEndPoint);
</Code>
```

- IP_Address is a string containing the IP address of the controller on the LAN.
- PortNumber must be 3141 as this is the port the EZ-IO server listens on.

Sending messages to the EZ-IO server

```
<Code>
ASCIIEncoding Encoder = new ASCIIEncoding();
byte[] Buffer = Encoder.GetBytes(Message);
NetworkStream ClientStream = Client.GetStream();
ClientStream.Write(Buffer, 0, Buffer.Length);
ClientStream.Flush();
</Code>
```

- Message is the message that the client wishes to send to the EZ-IO server. First this message gets serialised into an array of bytes, and then it gets written to the stream associated with the TCPClient.
- These messages are defined in the “Send Method” column of the “Client Commands” table.
- Example: To send a message requesting the current Device status, the client would use:

```
<Code>
string Message = “getDeviceStatus()”
</Code>
```

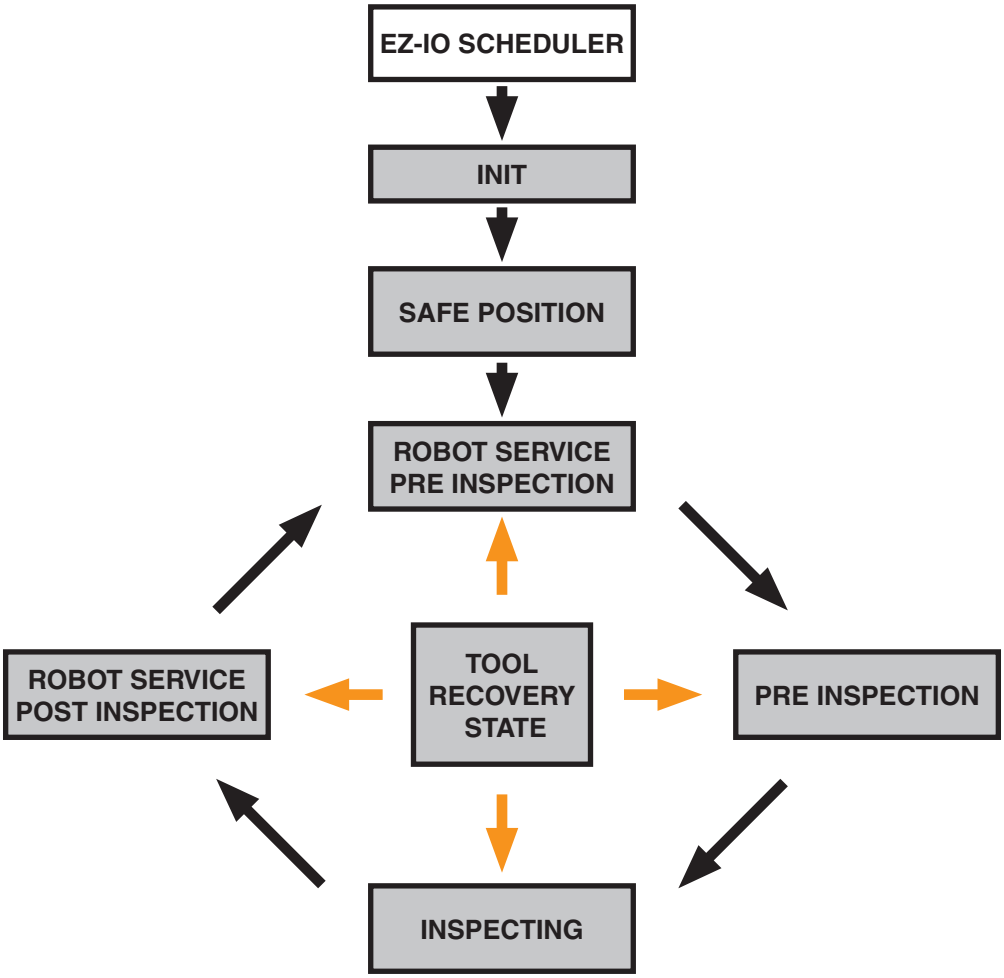
Listening to messages

```
<Code>
NetworkStream Stream = null;
while (!CloseConnection)
{
        Try
        {
                // Get the stream for the TCPClient and check for data.
                Stream = Client.GetStream();
                if (Stream! = null)
                {
                        byte[] Message = new byte[BUFFER_SIZE];
                        int BytesRead = Stream.Read(Message, 0, BUFFER_SIZE);
                        ASCIIEncoding Encoder = new ASCIIEncoding();
                        string Msg = Encoder.GetString(Message, 0, BytesRead);
                        // Send this message off to the handler and continue listening.
                        HandleMessage(Msg);
                }
        }
        catch (Exception)
        {
                //Exit the message loop when an error occurs.
                CloseConnection = true;
        }
}
//Clean up the resources when message loop ends.
Stream.Close();
m_Client.Close();
</Code>
```

- To capture messages from the EZ-IO server, the client must have a loop constantly watching for messages (this would typically be implemented in a separate thread).
- On each loop iteration, the client application ‘gets’ the stream for the TCPClient. If the stream is empty, then proceed to the next iteration, else read the bytes from the stream and convert them into a readable string. The string then gets passed on to an implementation defined message handler function (called **HandleMessage** in the above code), in which the client can parse the message as appropriate.

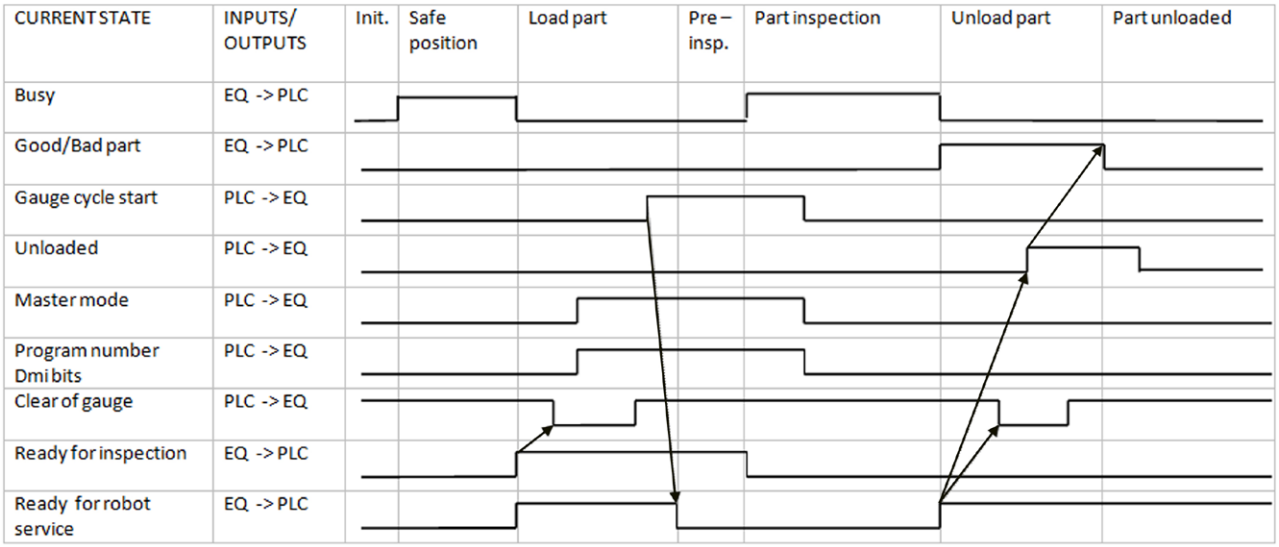
EZ-IO scheduler

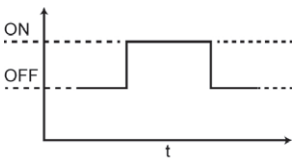
- The EZ-IO scheduler is composed of a finite number of states associated to transitions.
- A transition is a set of actions that starts from one state and ends in another (or the same if looping). A transition is started by a trigger; the input signal to the Equator and/or the buttons in the EZ-IO main window.
- Each state can be identified by the robot reading the output signals from the Equator. For this reason, the state's name is associated with the name of the output line.
- The EZ-IO scheduler sets the output signal as soon as a state is reached; it then performs appropriate actions and waits for the input to signal to transition into another state. The possible CURRENT STATES are described detail in the EZ-IO main window section.
- The diagram below provides a graphical explanation of how the EZ-IO scheduler has been implemented.
- Normal transitions are indicated with black arrows; the associated table describes the condition of the digital outputs for each state.



		OUTPUTS					
		Ready for Robot Service	Ready for Inspection	Busy	Good Part	Bad Part	Tool Recovery
STATES	Switched off	OFF	OFF	OFF	OFF	OFF	OFF
	Initialisation	OFF	OFF	ON	OFF	OFF	OFF
	Robot Service Pre Inspection	ON	ON	OFF	OFF	OFF	OFF
	Pre Inspection	OFF	ON	OFF	OFF	OFF	OFF
	Inspecting	OFF	OFF	ON	OFF	OFF	OFF
	Robot Service Post Inspection	ON	OFF	OFF	ON/OFF	ON/OFF	OFF
	Tool Recovery state	OFF	OFF	ON	OFF	OFF	ON

PLC/robot EQ system handshake (running an inspection program)



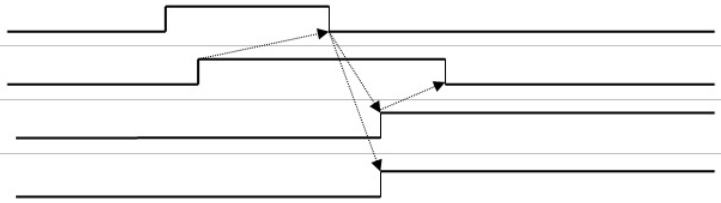


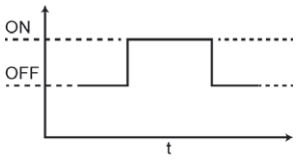
- Sending the “Unloaded” signal resets the “Good/Bad part” signal. To avoid a race condition, the “Good/Bad part” signal should be read before sending “Unloaded”.

Error conditions

- Any error will push the EZ-IO scheduler into the ERROR state. It stays in the ERROR state until the RESET button is pressed or the reset digital input is received.
- If the RESET button is pressed, a dialog window appears as described in the “Reset” section.
- During the ERROR state, it is possible to enable manual movement by pressing the corresponding button on the main window to recover the position of the probe.

PLC/Robot EQ handshake (error state and reset condition)

CURRENT STATE	INPUTS/OUTPUTS	
Error	EQ <-> PLC	
Reset	PLC <-> EQ	
Ready for inspection	EQ <-> PLC	
Ready for robot service	EQ <-> PLC	



RENISHAW
apply innovation™

www.renishaw.com/gauging

#renishaw

+44 (0) 1453 524524 uk@renishaw.com

© 2022 Renishaw plc. All rights reserved. RENISHAW® and the probe symbol are registered trade marks of Renishaw plc.
Renishaw product names, designations and the mark 'apply innovation' are trade marks of Renishaw plc or its subsidiaries.
Other brand, product or company names are trade marks of their respective owners.
Renishaw plc. Registered in England and Wales. Company no: 1106260. Registered office: New Mills, Wotton-under-Edge, Glos, GL12 8JR, UK.

WHILE CONSIDERABLE EFFORT WAS MADE TO VERIFY THE ACCURACY OF THIS DOCUMENT AT PUBLICATION, ALL WARRANTIES, CONDITIONS, REPRESENTATIONS AND LIABILITY, HOWSOEVER ARISING, ARE EXCLUDED TO THE EXTENT PERMITTED BY LAW.

Original language instructions
Part no.: H-5504-8650-04-A
Issued: 02.2022