

Power Focus 6000

Printed Matter No. 9839 1023 01

Valid for Version No. 2.7
2018-01-30

Configuration guide

Software version	2.7
Valid from	2017-11



⚠ WARNING

Read all safety warnings and instructions
Failure to follow the safety warnings and instructions may result in electric shock, fire and/or serious injury.
Save all warnings and instructions for future reference

Atlas Copco

Table of Contents

- Overview 9**
 - Notice 9
- Introduction 10**
 - About the Configuration Manual..... 10
 - Revision history 10
 - Target group..... 11
 - Prerequisites 11
 - Typographic conventions 12
 - Terms and definitions 12
- Power Focus user interface 13**
 - Operating and handling 13
 - Front panel..... 13
 - Web GUI 14
 - Menu overview 14
 - Tightening menu 14
 - Batch sequence menu 15
 - Sources menu..... 15
 - Tool menu 15
 - Virtual station menu 15
 - Controller menu 16
 - Configurations menu 16
 - Reports menu 16
 - Settings menu 16
 - Help menu..... 17
 - Configuration overview Power Focus 6000..... 17
- System settings..... 18**
 - Network configuration..... 18
 - Accessing the controller on LAN..... 19
 - Accessing the controller through the web GUI..... 19
 - Protocol configuration..... 19
 - Configuring ToolsTalk communication..... 20
 - Configuring ToolsNet communication 20
 - Configuring a license manager 21
 - Preferences..... 21
 - Setting the date and time 21
 - Setting the displayed controller language 22
 - Setting the displayed torque unit..... 23
 - Setting the startup screen 23

PIN settings	24
Activating the PIN	24
Configuring new users and assigning PINs	24
Accessing the controller when locked by PIN	25
Tool alarms.....	25
Tightening settings	25
Wireless.....	26
Events settings	26
Fieldbus.....	26
Results	27
Factory reset	27
Tool configuration.....	29
Tool information.....	29
Tool TAG information.....	29
Connection	30
Health	30
Tool temperature.....	30
Maintenance.....	30
Calibration	31
Preparing the calibration	32
Calibrating the tool	32
Motor tuning	32
Starting the motor tuning.....	32
WLAN and Bluetooth for wireless tools	33
Bluetooth requirements.....	33
Wireless tools restrictions	33
Putting an STB tool into pairing mode	33
Putting an ST Wrench in pairing mode	33
Pairing a wireless tool to a controller	34
Troubleshooting: WLAN and Bluetooth.....	35
Controller menu - Tightening.....	36
Tightening.....	36
General Tightening program settings	36
Name	37
Strategy.....	37
Target.....	38
Time monitoring (elapsed time)	38
Residual torque correlation factor	38
Trigger Lost.....	40
Attachment tuning	40

Tightening program validation and validation error reporting.....	41
Validation error reporting	42
Validate a tool with a tightening program.....	42
Start step	42
Direction	43
Soft start.....	43
Rehit detection	44
Current monitoring	44
True angle compensation	45
Rundown step	46
Selftap.....	46
Rundown torque limits	47
Rundown angle limits.....	48
Post view torque	49
Rundown complete	50
Tightening step.....	50
Tightening strategies.....	50
Target torque limits	56
Target angle limits.....	57
Torque compensation	59
Stop step	59
Soft stop.....	59
Loosening step.....	59
Pulse tightening with direct driven electrical tools	60
TensorPulse tightening program	61
Tightening using the TensorPulse program	64
Impulse single step tightening program.....	66
Four Step tightening strategy	70
Introduction to the four step tightening strategy	70
Overview of the four step tightening strategy	70
Parameter definition	72
Parameters for four step tightening - start step	72
Parameters for four step tightening - rundown step	75
Parameters for four step tightening - first tightening step of the tightening step	77
Parameters for four step tightening - final tightening step.....	79
Parameters for four step tightening - stop step	83
Multistep tightening strategy	84
Description	84
STB Tools and multistep	84

Restrictions.....	84
Monitors.....	84
Multistep GUI interface.....	85
Adding a multistep program	85
Deleting a multistep program	85
Multistep tightening program properties	85
Building a multistep program.....	87
Multistep Steps.....	89
Multistep monitors and restrictions.....	93
Tool compatibility for multistep	98
ST Wrench	102
STwrench introduction.....	102
STwrench start step parameters	102
STwrench rundown step parameters	103
STwrench tightening step parameters.....	104
STwrench loosening.....	106
STwrench stop step parameters	106
Batch configuration	108
Batch sequences.....	108
Batch sequence settings.....	108
Batch configuration	109
Virtual station	110
Virtual station - Creating a virtual station.....	111
Virtual station - Tool settings.....	111
Tool connected to a virtual station	111
Virtual station - Task.....	114
Virtual station - manual mode	115
Virtual station - Protocols	116
Virtual station - Accessories	117
Digital signal diagnostics.....	117
Diagnostics configuration.....	117
Normal operations	119
Monitor digital signals	119
Force digital signals	119
Virtual station - Fieldbus.....	120
Sources	121
Introduction to sources	121
Tightening.....	121
Creating a Source Tightening	121
Batch	122

Creating a Source Batch	122
Significant positions	123
Configuring Significant positions to read in barcode string	123
Combining identifier strings	124
Saved positions	124
Configurations	126
Digital signals	126
Input signals	126
Output signals	126
Tool configuration	127
Tool LEDs	129
Function button	131
Buzzer	132
Direction switch	132
Start condition	133
Accessory bus	135
Configure QIF accessories	138
Connecting QIF accessories to a virtual station	138
Disconnecting QIF accessories from a virtual station	138
Scanner configuration	139
Configuring the scanner	139
Valid scanners	139
Selector configuration	139
Digital input information	139
Socket selector configuration	139
Setting up a socket selector via I/O bus	140
Setting up a Selector 6 via Ethernet cable/Wireless ..	140
General Virtual Station	143
Tightening results	145
Live results	145
Result view - Numbers	145
Result view - High-Low result	145
Result view - Extensive results	146
Result view - Identifier strings	146
Result view - Trace	147
Stored results	147
Tightening error reporting	148
Status for NOK results	148

System administration.....	149
IAM.....	149
Hardware.....	149
Health.....	149
Software	150
Updating controller software through USB.....	150
Updating controller software through Web GUI	151
Software activation	151
License manager.....	151
Functionality management system introduction.....	152
Functionality management system - manual distribution of feature items	152
USB flash drive	154
Export/Import configuration	154
Exported information and file format.....	155
Exporting or importing from web GUI.....	157
Exporting or importing from controller.....	157
Export and Import between controllers	157
Events	158
Reading the information given in an event.....	158
Event types.....	158
Information event	158
Warning event.....	159
Error event	159
Configure events	159
Event codes in Power Focus 6000.....	160
NOK Results List.....	172
References.....	176
Terms and definitions	176
Input signals	179
Input signals used by locking	181
Output signals	181
Input/Output signals	184
Appendix A – Controller connections.....	185
Front connections.....	185
Appendix B – Remote start and EM Stop	186
Remote start configuration	186
Emergency stop in Power Focus 6000.....	186
Cabling.....	186
PIN configurations for emergency stop.....	187

Appendix C - DIG IN/OUT connectors	190
Digital output connector.....	190
Digital output connector for Power Focus 6000	190
Digital output connector for Power Focus 4000	191
Digital input connector.....	191
Digital input connector for Power Focus 6000	191
Digital input connector for Power Focus 4000	192
Third party licenses	193
List of Third Party Softwares	193
Apache Software License, Version 2.0	200
BSD Software License, Version 2	205
BSD Software License, Version 3	206
bzip2 Software License	207
Eclipse Public License, EPL V1.0	208
GNU C License	211
GNU General Public License, GPL V1.0.....	218
GNU Free Documentation License, Version 1.2	222
GNU General Public License, GPL V2.....	232
GNU General Public License, GPL V3.....	240
GNU Lesser General Public License, LGPL V2.1	257
GNU LESSER GENERAL PUBLIC LICENSE.....	270
ICU Software License.....	273
Libpng License	274
MIT Software License.....	277
Ntp Software License	277
PD Software License.....	282
zlib Software License	283

Overview

WARNING Risk of Property Damage or Severe Injury

Ensure that you read, understand and follow all instructions before operating the tool. Failure to follow all the instructions may result in electric shock, fire, property damage and/or severe bodily injury.

- ▶ Read all Safety Information delivered together with the different parts of the system.
- ▶ Read all Product Instructions for installation, operation and maintenance of the different parts of the system.
- ▶ Read all locally legislated safety regulations regarding the system and parts thereof.
- ▶ Save all Safety Information and instructions for future reference.

NOTICE Changing parameters may lead to a decrease in tool performance and may also slow down the production.

Notice

Many events in the operating environment may affect the tightening process and shall require a validation of results. In compliance with applicable standards and/or regulations, we hereby require you to check the installed torque and rotational direction after any event that can influence the tightening result. Examples of such events include but are not limited to:

- initial installation of the tooling system
- change of part batch, bolt, screw batch, tool, software, configuration or environment
- change of air- or electrical connections
- change in line ergonomics, process, quality procedures or practices
- changing of operator
- any other change that influences the result of the tightening process

The check should:

- Ensure that the joint conditions have not changed due to events of influence.
- Be done after initial installation, maintenance or repair of the equipment.
- Occur at least once per shift or at another suitable frequency.

Introduction

This section describes the Configuration guide.

About the Configuration Manual

This configuration manual describes how to set up and configure the Power Focus 6000.

Revision history

Revision	Change
1.6	This is the first official release of the configuration guide for Power Focus 6000.
2.0	Added or updated sections: • Settings: Tool alarms • Tool configuration: Tool connection, Tool maintenance, Internal Wlan for wireless tools • Tightening setup: Loosening step • Tightening results: Live results, Stored results, Status for NOK results • Virtual station • Event codes in Power Focus 6000
2.1	Added or updated sections: • Settings: Fieldbus • Controller menu - Tightening: Current monitoring and True angle compensation • Four step tightening • System administration: Exported csv file format • Virtual station: I/O diagnostics and Fieldbus • Appendix A: Emergency stop
2.3	Added or updated sections: • System settings: network configuration • System settings: preferences • System settings: protocol configuration • System settings: tightening • Tightening: Time monitoring and Torque tuning factor • ST Wrench • Sources • Accessory configuration: tool configuration, start condition, and socket selector configuration • System administration: Export/Import • Tool configuration; ST Wrench • Appendix A: Front connections

Revision	Change
2.4	Added or updated sections: • Settings: License manager • Settings: PIN code • Settings: Configure start screen • Tightening: Disable tightening, Measure angle to, Trigger lost, Torque tuning factor • Tool health and battery check • Controller health and battery check • Pulse strategies • 3-step tightening • Device: Accessory bus • Device: Led ring • Device: EHMI • Device: Fieldbus diagnostics • Export/Import
2.5	Added or updated sections: • Multistep tightening strategy • Selector confirm • Saved positions • General virtual station • Wifi socket selector • Multiple PINs • External OK • Service alarms for pulse tools • Manual mode virtual station
2.6	Added or updated sections • Multistep tightening strategy (Editor) • WLAN and Bluetooth for wireless tools
2.7	Added or updated sections • Updated multistep steps • Source Batch (barcode scanning) • Updated Event Codes for SRB and TBP tools

Target group

This configuration guide is intended for anyone operating or servicing a Power Focus 6000 system.

Prerequisites

Anyone interested in learning more about Power Focus 6000 can benefit from reading this guide.

For a complete understanding of the technical aspects in the guide we recommend the following:

- Knowledge about tightening techniques
- Experience of working with the previous versions of Power Focus

Typographic conventions

The following table describes typographical and naming conventions used in this document:

Format	Explanation
GUI Object	Menu options, GUI objects, and buttons.
<i>Parameter</i>	Parameter names, event codes and fault codes.
<Input>	Placeholder representing information that you must supply (input).
GUI Path >	Navigation aid to help you keep track of the location in the graphical user interface.

Table 1: Conventions

Terms and definitions

For a list of terms and definitions, see References.

Power Focus user interface

This section describes how to get started using the controller interface and gives an overview of the controller functionality.

Operating and handling

The Power Focus 6000 is set up and configured by using the controller front panel. It is also possible to access the controller interface through a web GUI by browsing to the controller's IP address on a connected PC. See *Accessing the controller through the web GUI [Page 19]*.

Front panel

The front panel contains a touch-screen display and special buttons.

	Name	Description
	1. Display	A color display with touch screen showing configuration views and results.
	2. Special buttons	Special function buttons

Front panel buttons

These buttons are available as clickable icons in the web GUI.

Button	Name	Description
	Home	Go to the Home screen.
	Result	Go to the live result view.

Touch screen buttons

Button	Name	Description
	Add	Adds an additional item.
	Back	Return to previous view.
	Scroll up / Scroll down	Move in a list that is too long for the screen.
	Maximize / Minimize	Maximize or minimize a section with parameters.
		

Button	Name	Description
	Back (in a list)	Back (and forward) between pages of a list.
	Close	Tap to close the window.
	Notice	Sign showing that a parameter is configured wrong.
	Home	Go to the Home screen. Only available in the web GUI.
	Go Result	Go to the live results screen. Only available in the web GUI.

Navigation

To navigate in the controller GUI either tap on a menu item or move a finger (drag) across the display to scroll through items.

Options are selected by tapping the required option.

To enter data into a text box, tap the text box and a keyboard appears on the display.

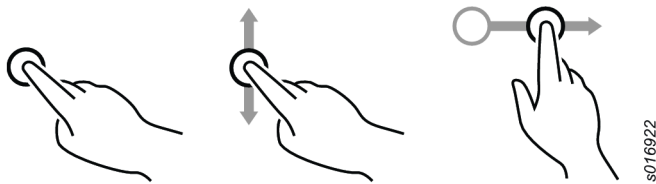


Illustration 1: Navigation using fingers

Web GUI

The web GUI is almost identical to the controller display. It enables configuration and programming of the controller by using a web browser on a computer connected to the controller. See *Network configuration [Page 18]*.

-  Users can program the controller from the controller and the web interface at the same time.

Menu overview

The controller has several menus available to configure tightening and hardware accessories, perform tool maintenance, administer software, and view reports.

Tightening menu



The **Tightening** menu lists the Tightening programs stored on the controller that are available for an individual tightening. Tightening configurations are described in the **Tightening** menu.

See Controller menu - Tightening to learn more about how to set up and configure a tightening.

Batch sequence menu



The **Batch** menu lists the batch sequences stored in the controller. A Batch sequence is one or more repetitive tightening programs in various combinations. Batch sequences are created and configured in the **Batch sequence** menu.

See Batch configuration to learn more about how to set up and configure a batch sequence.

Sources menu



The **Sources** menu lists available options for controlling the selection of a tightening program, for example a tightening program or a batch sequence, via digital input from different hardware. Scanner configurations are done in the **Sources** menu.

See Sources to learn more about how to set up and configure tightening tasks controlled by various digital inputs.

Tool menu



The **Tool** menu provides information about the tools connected to the controller. This menu is also where wireless tools are attached to the controller. Tool reference product, when the tool was serviced and calibrated are some of the data available in the **Tool** menu.

See Tool configuration for more information.

Virtual station menu



The virtual station is a software abstraction of a controller system. In the **Virtual station** menu the different resources, accessories, tools and tasks are assigned to a virtual station. The virtual stations are configured in the **Virtual station** menu.

See Virtual station for more information about virtual stations.

Controller menu



The **Controller** menu lists hardware and software components.

The software versions stored and used in the controller are listed and can be updated. The license manager for additional features is handled. It is also possible to import or export settings to and from the controller.

See System administration to learn more about the administration of the controller.

Configurations menu



A list of accessory configurations are given in the **Configurations** menu. Accessories like tool accessories, I/O Expander, Internal I/O, Stacklight, Operator Panel, and Socket selectors can be configured. Digital I/O signals are mapped to buttons, lamps, switches and connectors.

See Accessory configuration to learn more about how accessories are configured.

Reports menu



In the **Reports** menu the tightening results and events are listed.

See Tightening results for more information about reporting results.

Settings menu



In the **Settings** menu is used to set up the controller specific settings such as language, pin code, wireless network, fieldbus in use.

See System settings to learn more about general settings.

Help menu



The **Help** menu contains useful help sections about the controller. PDF-files in several languages are available for download.

Configuration overview Power Focus 6000

To create a better overview of the system, this instruction lightly goes through the different steps required to get started using the system. This section does not cover every feature of the system, but instead focuses on the most basic features.

1. Decide on what kind of tool to use. The kind of tool being used affect the availability of tightening strategies.
2. The main purpose of the tool is to perform a tightening. This is done by defining a **tightening program** which contains all relevant parameters of a tightening, for example target angle and target torque. See Controller menu - Tightening for details on creating a tightening program.
3. One or several tightening programs can be added to a **Batch Sequence** which works as a series of tightening programs. A batch sequence can for example be a certain number of tightenings with a tightening program, or a sequence of different tightening programs. See Batch configuration for details on creating a Batch Sequence.
4. Create a **Virtual Station** and assign a tool to it. The virtual station acts as an interface between the controller and the tool, allowing for several tools to be connected to a single physical controller. A virtual station is required even if only one tool is connected to the controller.
5. Assign a task to the Virtual Station. The task can be either a tightening program, a batch sequence, or a specified digital input (from for example a barcode scanner). The tool assigned to the station will now be able to perform the task. See Virtual station for details on setting up a Virtual Station.

System settings

Network configuration

Settings > Network

The Power Focus 6000 can be set up to be accessed from the Atlas Copco software ToolsTalk or from a web browser on a Local Area Network (LAN). It can also be accessed directly from a connected PC. It uses the IPv4 protocol.

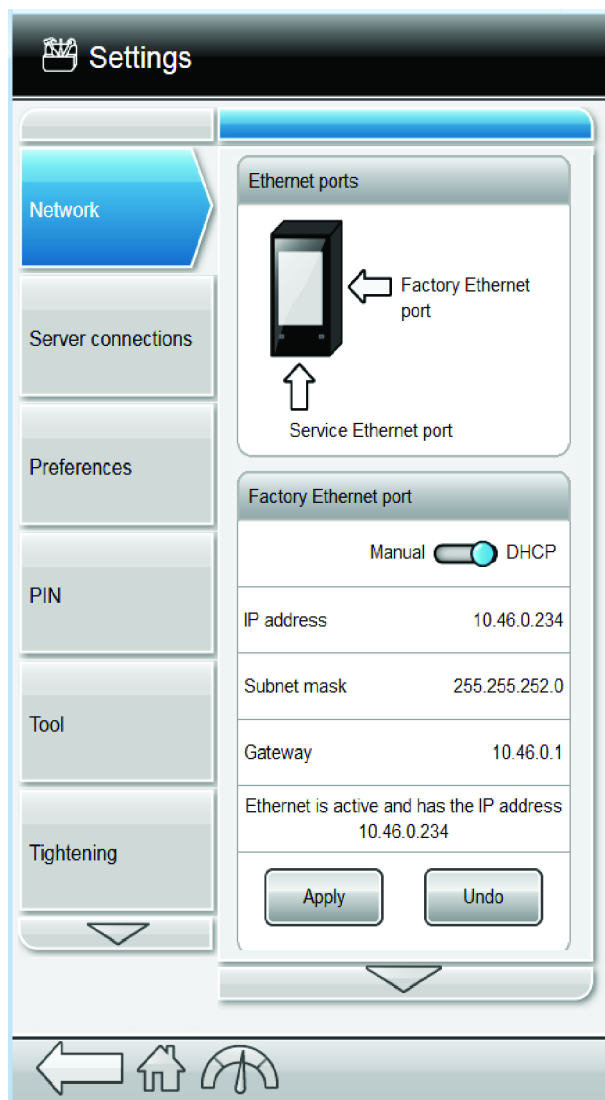


Illustration 2: IP address of the controller.

- ❗ Only the Factory Ethernet port can be configured. The Service Ethernet port has a designated IP address, 169.254.1.1, that must not be connected to the local network.

Accessing the controller on LAN

Connect the network cable to the Factory Ethernet port and then either manually specify the required information or, if available, use the information provided by the DHCP server. Required information is:

- IP address
- Subnet mask
- Gateway

This information is provided by the local system administrator.

When using the manual option there are optional settings available for the use of **DNS servers**.

The screenshot shows the 'Settings' application with the 'Network' tab selected. The 'Manual' radio button is chosen over 'DHCP'. The configuration fields are as follows:

Field	Value
IP address	192.168.1.1
Subnet mask	255.255.255.0
Gateway	0.0.0.0
Optional settings	
DNS Server 1	0.0.0.0
DNS Server 2	0.0.0.0
Domain name	
Search domain 1	
Search domain 2	
Search domain 3	
Ethernet is active and has the IP address 10.46.0.234	

Illustration 3: DNS server configuration

Accessing the controller through the web GUI

Connect the PC with a straight-through Ethernet cable (RJ45) to the Service Ethernet port. Access the controller with the IP address from a web browser.

Protocol configuration

Settings > Server connections

Power Focus 6000 can be set up to communicate with servers running an Atlas Copco license manager as well as the two Atlas Copco softwares ToolsTalk and ToolsNet. ToolsTalk is used to configure one or several controllers. ToolsNet is used to handle result reporting.

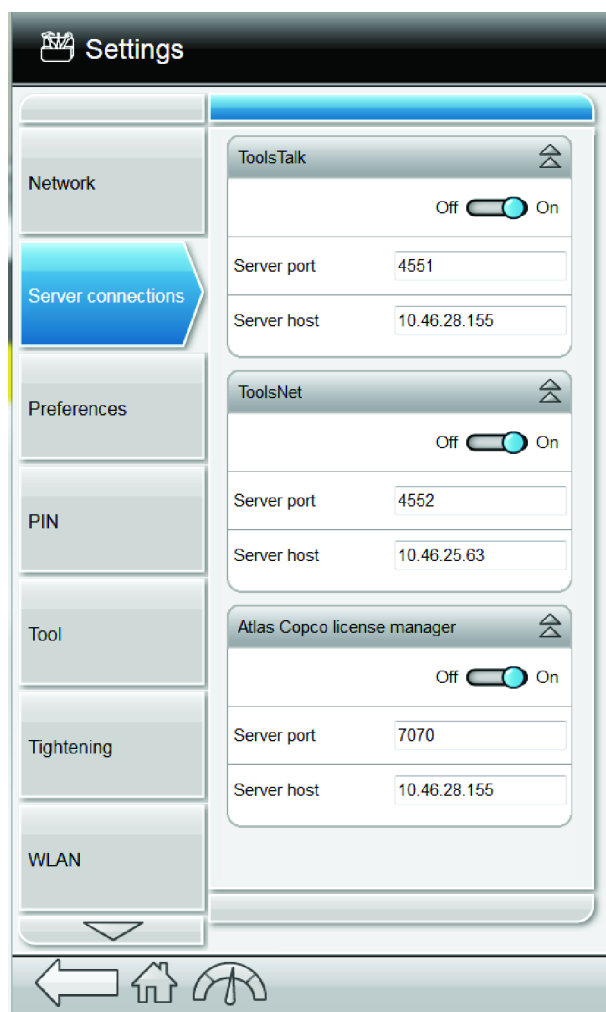


Illustration 4: Server settings

Configuring ToolsTalk communication

To connect a controller to ToolsTalk, configure and activate the ToolsTalk protocol settings on the controller.

Field	Description
On/Off	Enables/Disables communication with the ToolsTalk server
Server host	ToolsTalk server IP address
Server port	ToolsTalk server port

Table 2: Parameters for ToolsTalk communication

Configuring ToolsNet communication

To connect a controller to ToolsNet for collection of tightening results, configure and activate the ToolsNet protocol settings in the controller.

Field	Description
On/Off	Enables/Disables communication with the ToolsNet server
Server host	ToolsNet server IP address

Field	Description
Server port	ToolsNet server port

Table 3: Parameters for ToolsNet communication

Configuring a license manager

The Atlas Copco license manager is connected to a controller and the protocol settings are activated on the controller from the **Server connections** tab in the **Settings** menu.

Field	Description
On/Off	Enables/Disables communication with the Atlas Copco license manager.
Server host	Atlas Copco license manager server IP address
Server port	Atlas Copco license manager server port

Table 4: Parameters for the Atlas Copco license manager

Preferences

Settings > Preferences

Preferences contains general settings such as date and time, language, torque unit, and startup screen.

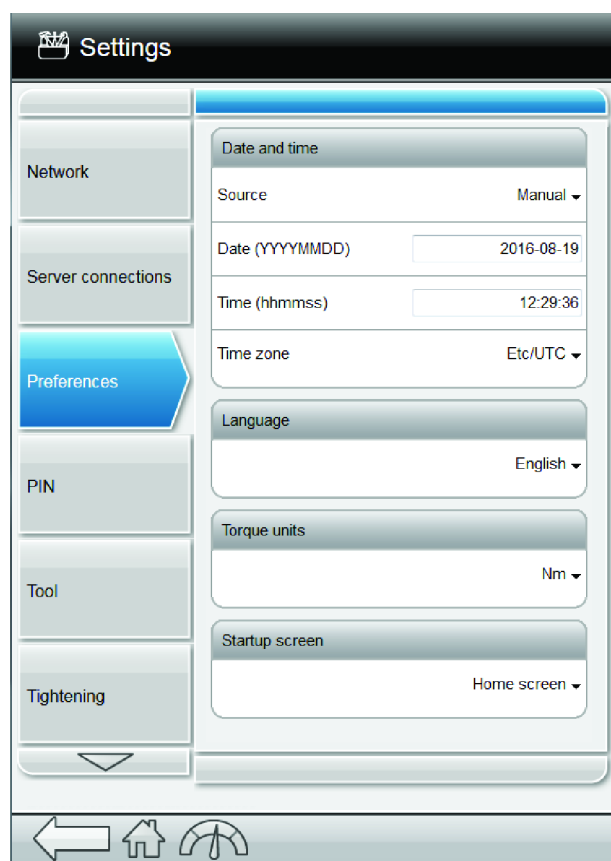


Illustration 5: Settings with manual date and time

Setting the date and time

Date and time must be set in order for events and results to get the correct time stamp for when they occurred.

The time is retrieved from one of three available sources:

- **Manual**
- **NTP**
- **ToolsNet**

When the source is set to **Manual** the date, time, and time zone are set manually.

When the source is set to **NTP**, the date and time is retrieved from an NTP server defined in the GUI.

When the source is set to **ToolsNet**, the date and time is retrieved from the ToolsNet server.

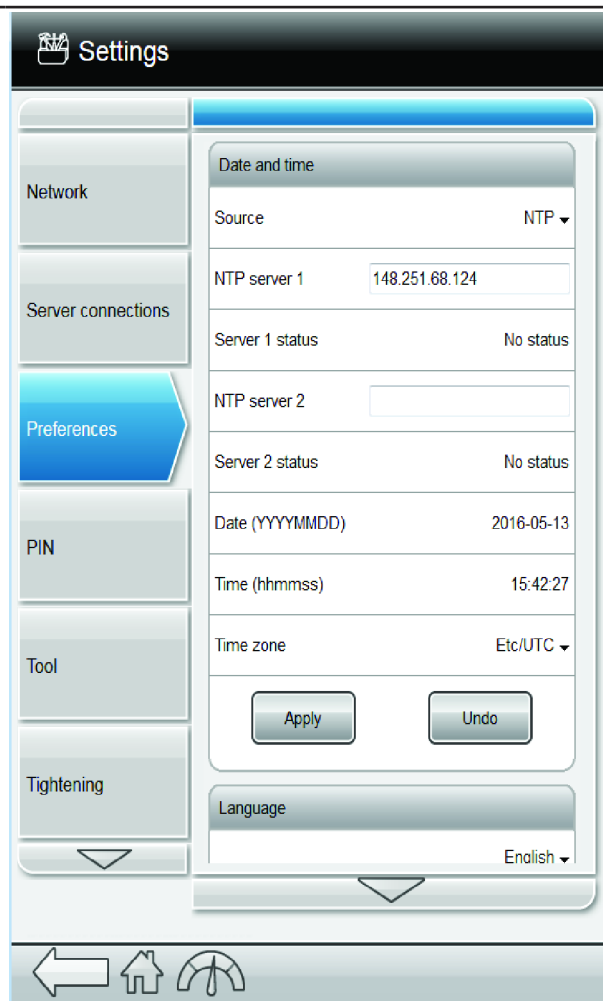


Illustration 6: Setting the date and time with NTP as source

Field	Description
Source	Source to retrieve the time from.
Date	Date entered manually if the source is set to manual.
Time	Time entered manually if the source is set to manual.
Time zone	The time zone; either the location or a standard time zone such as UTC (coordinated universal time)
NTP Server	IP-address of an NTP server providing date and time for the controller.

Table 5: Parameters to set date and time

Setting the displayed controller language

The controller GUI is translated into twelve languages. To change the language of the GUI:

1. Tap or click on the arrow beside the name of the language currently in use.
2. Choose a language from the list.

The language change will take effect immediately.

Language	As displayed in controller
English	English
Czech	Čeština
German	Deutsch
Spanish	Español
French	Français
Korean	한국어
Italian	Italiano
Japanese	日本語
Portuguese	Português
Russian	Русский
Swedish	Svenska
Chinese	中文

Table 6: Available GUI languages

Setting the displayed torque unit

Choose the unit to use for torque values and results. Torque results are displayed in the chosen unit both after a tightening is performed and when stored in the results list.

To change the torque unit used in the controller GUI:

1. Tap or click on the arrow beside the name of the unit currently in use.
2. Choose a unit from the list.

The torque unit change will take effect immediately.

Unit	Description
cNm	centinewton metre
dNm	decinewton metre
Nm	newton metre
kNm	kilonewton metre
in·lbf	inch-pound force
ft·lbf	foot-pound force
in·ozf	inch ounce-force
ft·ozf	foot ounce-force
gf·cm	gram-force centimetre
kgf·cm	kilogram-force centimetre
kgf·m	kilogram-force metre

Table 7: Available torque units

Setting the startup screen

The default screen at startup of the controller is the Home screen. It is possible to change startup screen to the Result screen.

A change of startup screen in the settings requires a restart of the controller or a refresh of the web GUI.

PIN settings

Settings > PIN

Using a PIN prevents unauthorized usage of the controller or accidental changes. Multiple users can be added to the PF6000, each with its own PIN. Note that PIN are not linked to controller configuration and are used mainly for logging reasons.

When PIN is activated a PIN code is required when accessing the controller

- from the controller GUI
- from the web GUI

Activating the PIN

1. Go to the Settings menu and in the navigation select on PIN. Click on Configure.
2. In the PIN window, set the switch to On.
 -  The PIN can only be activated when at least one user/PIN in the list is enabled. If no user/PIN is enabled, a warning will pop up.
3. Set the Inactivity timeout (in seconds) to set when the controller will be locked in case of inactivity.
 -  Default value for Inactivity timeout is 20 seconds. Note that this is a global setting, and cannot be set on a per user basis.

Configuring new users and assigning PINs

The PIN must be a four-digit number in the range 0000–9999. When PIN is enabled, the controller locks automatically after the configured inactivity time. Note that currently a maximum of 10 users can be added to each controller.

Adding new users

1. In the PIN window, click on the **plus** icon at the bottom of the list.
2. Click on the **Name** field to edit the entry.
3. In the user name window, enter the name and the PIN for the user.
 -  All user names must be unique.
 -  The PIN in both fields (Enter PIN and Confirm PIN) need to match for the changes to be applied. Note that by default PINs (dots) are indicated in both fields, but these are just placeholders and need to be replaced with actual PINs.
4. Click **Apply**.

Enabling/Disabling users

1. In the list of users, select the check box to the left of the user name you want to enable.
2. To disable a PIN, clear the check box to the left of the user name you want to disable.
 -  Note that PINs can also be enabled and disabled by clicking on the user name and setting the **Enabled** switch to On or Off, respectively.

Deleting a user/PIN

1. In the list of users, click the red Delete icon to the right of the user name.

Accessing the controller when locked by PIN

When accessing the controller with PIN enabled a prompt asking for the PIN will appear. This is the case whether the controller is accessed via the web GUI, the controller GUI, or from Tools Talk.

See also

📖 Accessing the controller through the web GUI [19]

Tool alarms

Settings > Tool

Alarms are set to control when to perform maintenance or calibration on the tools connected to the controller.

The tool service interval and other information are found in the tool view on the **Tool** menu.

Field	Description
Service indicator alarm	Enables an alarm for when the service interval for the tool is reached.
Tool lock after alarm	Lock the tool when the service interval is reached.
Calibration alarm	Enables the tool calibration alarm for all tools connected to the controller.

Table 8: Different tool alarms

Tightening settings

Settings > Tightening

The tightening settings in the settings menu configures when to disable loosening and when to disable tightening after a tightening.

Disable loosening	Description
Off	Disable loosening is Off. It is always possible to loosen a fastening.
On OK tightening	Disable loosening for an OK tightening. It is not possible to loosen a fastening that terminated with tightening OK.
On NOK tightening	Disable loosening for an NOK tightening. It is not possible to loosen a fastening that terminated with tightening NOK.
Always	Disable loosening is always ON. It is never possible to loosen a fastening.

Table 9: Settings for loosening

Disable tightening	Description
Off	Tightening is not disabled after a tightening.
On OK tightening	Tightening is disabled after an OK tightening.
On NOK tightening	Tightening is disabled after an not ok (NOK) tightening.

Disable tightening	Description
After every tightening	Tightening is disabled after every tightening.

Table 10: Settings for tightening

For information about other settings for tightening, see Controller menu - Tightening.

Wireless

Settings > Wireless

The Wireless settings in the controller activates the use of a WLAN and Bluetooth.

Enabling WLAN and Bluetooth

1. In the **Settings** menu, click on the **Wireless** tab.
2. Depending on your tool (WLAN-equipped tools are marked IRC-W, while Bluetooth-equipped tools are marked IRC-B) set **Enabled** to **On**.

For more information about configuration of wireless tools in the controller, see the Tool configuration section.

Events settings

Settings > Events

It is possible to configure the events available in the controller as either or several of:

- Acknowledged
- Logged
- Displayed

For more information about events, see the Events section.

Fieldbus

Settings > Fieldbus

The fieldbus section consists of information about the fieldbus type in use. This part is hardware dependent and read-only. The configuration section with general settings for the fieldbus in use is possible to edit.

The fieldbus mapping and the assigning of fieldbus maps to virtual stations are done with ToolsTalk. For more information refer to the ToolsTalk configurations manual.

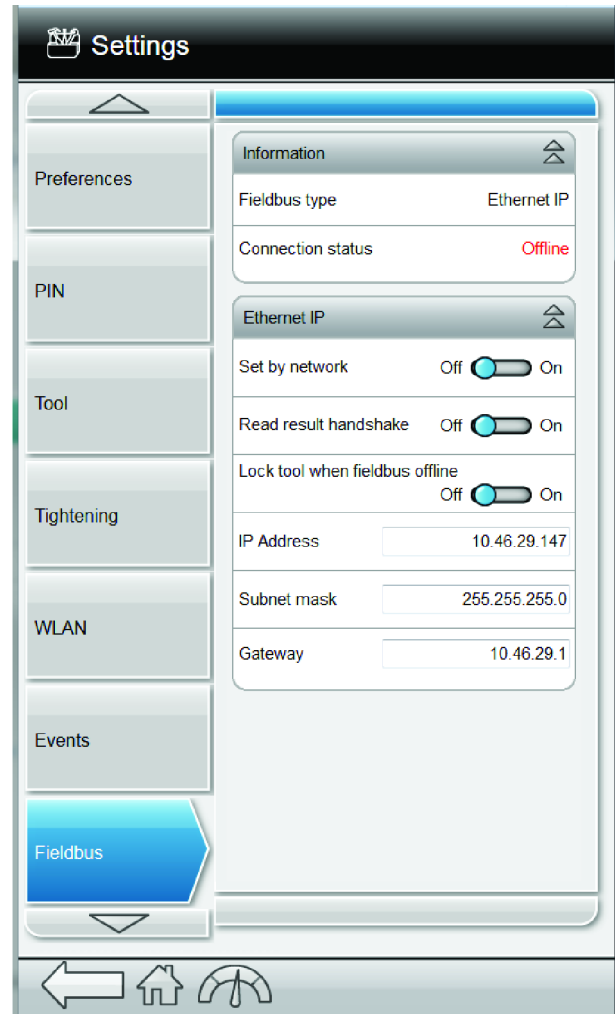


Illustration 7: Fieldbus settings

Results

Settings > Results

The Results menu allows the user to configure the label names for results displayed in the Results list (found under **Reports > Results**).

Changing Result Status names

1. Go to **Settings**, then **Results**, and click on **Customized detailed status**.
2. Find the Status name you want to alter.
3. Write the new name in the corresponding field in the *New status name* on the right.

Factory reset

Settings > Factory reset

The controller can be reverted back to its original factory settings.

- ⓘ All settings, configurations and historical data will be deleted when the controller is reset. Only perform a factory reset when you are completely sure that this course of action is required.

Performing a controller Factory reset

1. Go to Settings, Factory reset and click on the **Reset** button
2. A pop-up window will appear warning that all data will be deleted. Click Yes.

The controller will perform a reboot to activate the new settings.

Tool configuration

 A tool must be connected to the controller for the **Tool** menu to show information.

Tool information

The Tool information view contains information used for giving service personnel accurate information about the tool connected to the controller, so that they can give adequate help and support, or for operators to see what tool is connected to the controller.

Information	Description
Model	Tool model denomination.
Max torque	The maximum torque the tool can use for a tightening.
Max speed	The maximum rotation speed of the tool.
Gear ratio	The ratio of the angular velocity of the input gear to the angular velocity of the output gear.
Serial number	The tool's serial number may be needed when the correct version of the Product instruction is required, in order to get the correct spare parts or service instructions.
Software version	Tool software version.
Product number	The tool's Product or Ordering number.

Table 11: Tool information

Tool TAG information

This tool information is only available if the tool type is a STwrench.

Information	Description
TAG id	The programmable RFID TAG identification number that is programmed into the End-fitting tool (Socket).
Torque correction coefficient	In certain cases extensions may be needed to fit the application. In this case the wrench measurement must be compensated to show a correct value. To calculate the correction coefficient, please refer to the STwrench user guide, printed matter nr 9836 4134 01 edition 2.12. The parameter is stored in the RFID TAG in the End-fitting tool .
Angle correction coefficient	In certain cases extensions may be needed to fit the application. In this case the wrench measurement must be compensated to show a correct value. To calculate the correction coefficient, please refer to the STwrench user guide, printed matter nr 9836 4134 01 edition 2.12. The parameter is stored in the RFID TAG in the End-fitting tool .
Nominal torque	The smartHEAD of the STwrench contains the torque transducer and defines the wrench's nominal torque, please refer to the STwrench user guide, printed matter nr 9836 4134 01 edition 2.12.

Table 12: STwrench tool information

NOTICE The correction coefficients alter the STwrench measurement. It may cause an improper reading. Please refer to the STwrench user guide, printed matter nr 9836 4134 01 edition 2.12, before making any corrections.

Connection

The tool connection area shows which virtual station the tool is connected to. To set up the tool with a virtual station, see the section *Connecting a tool to a virtual station* [Page 112].

Health

The Health view contains information about tool temperature

Tool temperature

Tool temperatures (both for cabled and battery tools) are monitored continuously by the PF6000. Supported temperature units are degrees Celsius (°C) and degrees Fahrenheit (°F), with Celsius being the default unit. It is possible to switch between the two units without requiring a controller restart. When the tool motor temperature or tool electronics temperature exceeds max temperature, the tool is locked and an alert (2014) will be shown. The tool is once again unlocked when the tool temperature drops below the temperature limit.

Tool temperature is not available for STwrench tools.

Tool temperature monitoring

From the display or through the web GUI, users can access the latest tool electronics- and tool motor temperatures measured together with the timestamp when the measurement was taken.

1. Click on Tool
2. Both tool electronics temperature and tool motor temperature are listed under Health. For pulse tools, the Tool pulse unit temperature is also listed.
3. Click on either entry to access a list of peak temperatures and their timestamps.

Maintenance

The tool stores a service interval number and counts how many tightenings can be performed before a tool maintenance or service is needed.

Setting a maintenance alarm

1. Go to Settings, then tool.
2. Set the **Service indicator alarm** to **On**
3. Go to Tool, then choose the tool you wish to set the alarm for.
4. Write a value in the Service interval field.
 - ❗ These can only be set in multiples of 10 000. Any number other than multiples of 10 000 will be rounded off to the nearest multiple of 10 000.
 - ❗ When working with pulse tools, both service intervals for number of tightenings and number of pulses will be set. Whichever interval is reached first will trigger the alarm.

Field	Description
Last service	Date and time when last service was performed. The Last service date is set at the repair workshop. The Last service date is set to current date and time when the Reset service count button is pressed.
Total tightenings at service	Total number of tightenings performed by the tool since it was used for the first time. This value is made available at service, and will remain the same until next service.
Remaining tightenings	Total number of tightenings left until the service interval is reached.
Service interval	Number of tightenings to be performed between two service events. Can be set in multiples of 10 000.
Total pulses at service	[pulse tools only] Total number of pulses performed by the tool since it was used for the first time. This value is made available at service, and will remain the same until next service.
Remaining pulses	[pulse tools only] Total number of pulses left until the service interval is reached.
Service interval	[pulse tools only] Number of pulses to be performed between two service events. Can be set in multiples of 10 000.
Reset service counter	Reset of the Remaining tightenings counter and sets Last service date to current date.
Reset service data	[pulse tools only] Reset of the Remaining tightenings counter as well as oil status and sets Last service date to current date.

Table 13: Maintenance parameters

Calibration

Tool calibration is used to control how well a tool corresponds to a reference transducer.

The calibration value stored in the tool memory is used to adjust the torque value given by the tool's torque transducer so that the correct torque value is displayed on the controller. The controller displays the date when the tool was last calibrated.

Field	Description
Last calibrated	Date and time when last calibration was performed.
Calibration value	Torque value to calibrate against.
Next calibration date	Date when the next calibration of this tool is needed.

Table 14: Calibration parameters

Preparing the calibration

Make sure the tool and controller are set up to perform tightening. Set up the tool with a torque reference transducer such as an STanalyser, ACTA or BLM Bench. Refer to the torque reference transducer's user guide for set-up instructions.

Choose a Tightening program with a target torque corresponding to a tightening normally used with your tool.

See Basic Tightening setup for a tutorial on setting up and activating a suitable tightening program.

Calibrating the tool

To calibration value to use for the tool is calculated from the torque readings from the controller and the torque reference transducer by using the equation below.

$$\text{New calibration value} = \text{Old calibration value} * \text{Mean}\left(\frac{\text{Reference values}}{\text{Power Focus values}}\right) \quad \text{PF6-026}$$

1. On the **Tool** menu, select the tool to calibrate and go to **Calibration**.
2. Note the old calibration value found in the **Calibration value** text box.
3. Make at least three tightenings and use the torque values read from the controller and the reference transducer (ACTA or similar) for calculating the mean torque values.
4. Calculate the new calibration value using the **New calibration value** equation.
5. Store the new calibration value in the tool memory by entering the calculated value in the **Calibration value** text box and tapping **Apply**.

Motor tuning

A motor tuning adjusts the tool's motor control unit to optimize the performance and minimize loss. For cable tools a motor tuning should be performed on each specific combination of controller and tool together. STB tools can be moved to another controller without the need to perform a new motor tuning.

Starting the motor tuning

Before performing the motor tuning, make sure the tool is connected to a virtual station and that the controller is set up to perform tightening.

-  The motor tuning will take approximately 1 minute to perform and will rotate the spindle in both clockwise and counterclockwise directions before it is finished.

1. On the **Tool** menu, tap the tool to be motor tuned and go to **Motor tuning**. Press the trigger on the tool and then select **Perform** in the GUI.
2. Tap **OK** to start the **Motor tuning**.

Follow the instructions on the screen and keep pressing the tool trigger until the motor tuning is done.

- If the motor tuning was successful an OK event will be displayed.
- If the motor tuning was not successful, or the tool trigger was released before the motor tuning was finished, an NOK event will be displayed.

WLAN and Bluetooth for wireless tools

The Power Focus 6000 controller has built-in wireless LAN and Bluetooth radio modules that enable the connection of wireless tools to a controller using a pairing process. When the pairing is established, the tool will connect to the controller automatically as soon as the tool is in range of the controller. A tool paired with a controller is only able to connect to that specific controller even if another controller is set up to use the same radio channel.

The WLAN radio module in the controller can connect to three tools at a time, while the Bluetooth module allows for six simultaneous connections.

Bluetooth requirements

In order to use Bluetooth with the PF6000, the following requirements need to be met:

- PF6000 software 2.6 or higher
- A wireless tool equipped with a Bluetooth module
- Tool software boot version 9.1.6 or higher
- Tool software app version 3.6.1 or higher

Wireless tools restrictions

When all WLAN (3) or Bluetooth slots (6) are filled, additional wireless tools paired with the controller will replace existing paired tools. There are a few rules governing this replacement.

In the case of WLAN, one of the previously paired tools will be replaced at random.

In the case of Bluetooth, offline tools will be replaced first, followed by online tools. Tools linked to a Virtual Station will never be replaced. When pairing an additional Bluetooth-equipped tool to a controller that already has six wireless Bluetooth tools linked to Virtual Stations, make sure to remove one of the paired tools from one of the Virtual Stations before pairing the additional tool. The tool disconnected from the Virtual Station will then be replaced by the new tool.

Putting an STB tool into pairing mode

1. Disconnect the (charged) battery from the tool.
2. Press the tool trigger while reattaching the battery.
3. When the tool LEDs are off, release the tool trigger.
4. When the tool LEDs are on again, press the tool trigger.
5. When the tool LEDs are off again, release the tool trigger. Both LEDs start to flash (after approximately 10 seconds).
6. The tool is now in pairing mode. The LEDs keep flashing when the tool is in pairing mode.

 Do not start the Power Focus pairing procedure before both LEDs on the tool are flashing. Initiate pairing within 30 seconds or the tool might time out.

Putting an ST Wrench in pairing mode

Turn off the ST Wrench before starting the pairing.

1. Turn on the ST Wrench.
2. During the automatic adjustment press the following buttons:
 - UP
 - RIGHT
 - BARCODE
3. At the end of the adjustment the wrench is in pairing mode.

Pairing a wireless tool to a controller

Before you start the pairing process:

- Make sure WLAN or Bluetooth is enabled (Depending on the wireless tool you want to pair)
 - Make sure there are slots available to pair (3 for WLAN and 6 for Bluetooth)
 - Check which radio channel to use
 - Check how to put the tool into pairing mode. See the STB user guide (9836 3043 01) for instructions on how to do this, or follow the instruction below
 - If possible, have a clear line of sight between tool and controller
 - Make sure no other tools are being paired with the controller at the same time
1. Enable the internal WLAN by putting Enabled to On: Go to the **Settings** menu, and then tap **Wlan**. Drag the **Enabled** switch to **On**
 - ❗ If the WLAN Enabled switch is set to Off it is not possible to pair a tool to the controller. Tools already connected to the internal WLAN are disconnected when the Enabled switch is put to Off.
 2. Set the radio channel to use when pairing the wireless tool with the controller: Go to the **Settings** menu, and then tap **WLAN**.
 3. In the Radio channel area, tap the channel list and choose the channel.
 - ❗ Changing the channel will permanently disconnect all wireless tools paired with the controller.
 4. Go to the **Tool** menu and tap the pairing icon in the upper right corner.

 5. Put the tool in pairing mode. See Putting the wireless tool into pairing mode.
 6. In the **Pairing** dialog box, tap **Perform** to start the pairing process.

7. The pairing process will end with one of the following results:
- **Pairing successful** - The tool has been paired to the controller using the selected channel.
 - **Pairing unsuccessful** - This is due to any of the following reasons:
 - No tool detected during the pairing process. Make sure the tool is in range and in pairing mode, and then tap Close and try again.
 - More than one tool was found during the pairing process. Make sure no other tool is in pairing mode, and then tap Close and try again.
 - Pairing already in progress. Make sure no one else is performing the pairing process on the controller, and then tap Close and try again.
 - Pairing failed. Tap Close and try again.

Troubleshooting: WLAN and Bluetooth

Problem	Possible cause	Solution
Failed pairing (WLAN)	Other tools are being paired at the same time	Make sure other tools have exited pairing mode
Failed pairing (WLAN)	Tool is out of range	Move the tool closer to the controller and make sure you have a clear line of sight to the controller
Failed pairing (Bluetooth)	Other tools are being paired at the same time	Make sure other tools have exited pairing mode
Failed pairing (Bluetooth)	Tool is out of range	Move the tool closer to the controller and make sure you have a clear line of sight to the controller
Failed pairing (Bluetooth)	Interference from other tools	The Bluetooth module can be sensitive; make sure to move other Bluetooth further away from the controller
Failed pairing (Bluetooth)	All six slots have been filled and all six tools have been assigned to a Virtual Station	Remove one of the existing paired tools from the Virtual Station (in the Virtual Station menu, in the Tool field)
Tool disappeared from the Tool list (Bluetooth)	When pairing additional tools, existing tools will disappear from the connected tools list (in the Tools menu)	Press the tool trigger to make it appear again in the list.
Tool disappeared from the Tool list (Bluetooth)	Tools may disappear from the list when the tool has been outside radio coverage	Make sure to be inside the radio coverage area and press the tool trigger to make it appear again in the list

Controller menu - Tightening

Tightening

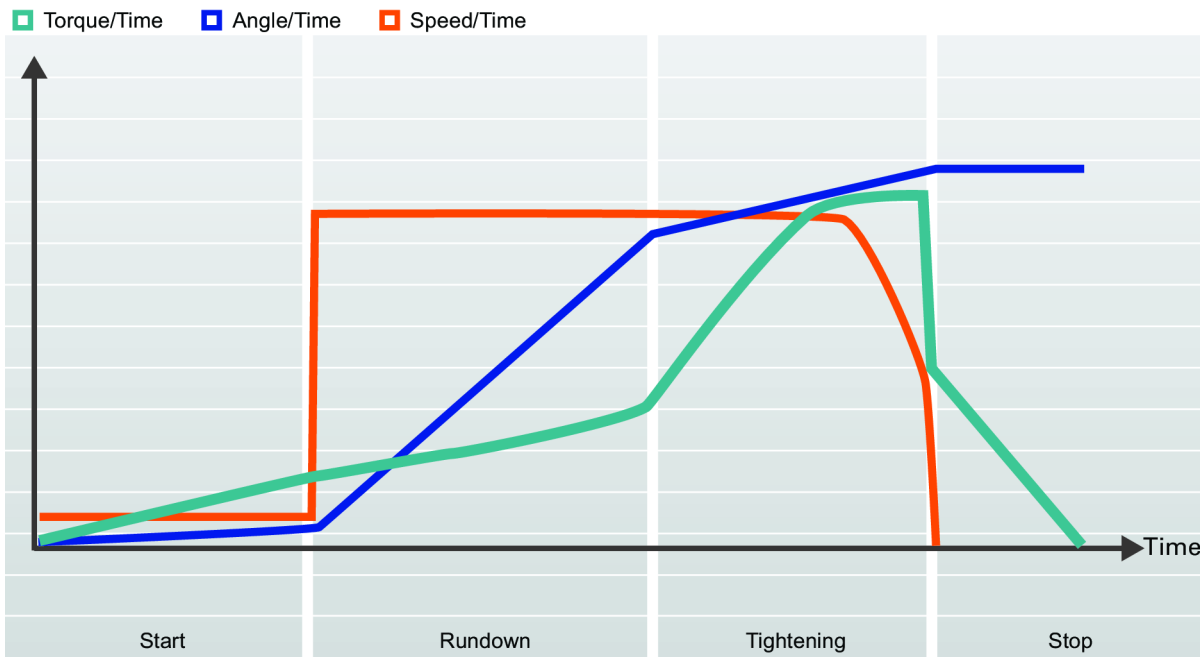
⚠ WARNING Risk of injury

A change in configuration to the tightening program may cause unexpected torque, rotational direction, or speed in the system(s) where the tightening program is currently in use. This could result in severe bodily injury and/or property damage.

- Check the tightening program configurations after adding a new program or after applying changes to an existing program.

The Power Focus 6000 tightening programs need parameters to be set in order to perform tightening. Selecting a Strategy and either the **Target torque** or **Target angle** are mandatory. Other settings are optional, such as **Soft start**, **Selftap**, and **Torque compensation**. It is also possible to monitor the tightening as it progresses by adding limits within which the torque, or angle the nut turns, must remain.

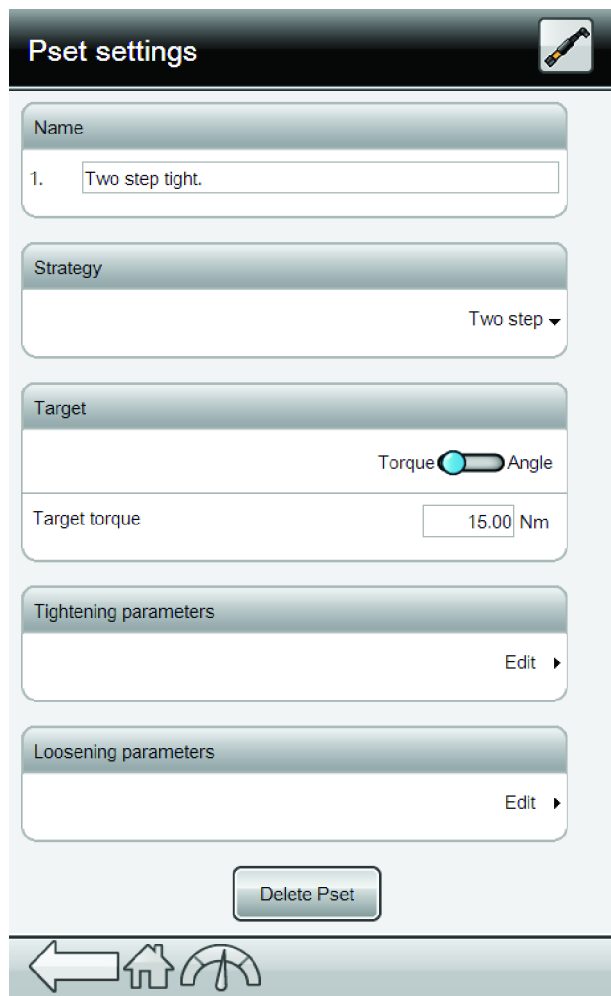
The tightening procedure is divided into four steps: Start, Rundown, Tightening and Stop.



General Tightening program settings

The general Tightening program settings is used to set up and manage the tightening programs by naming tightening programs, to make general tightening settings such as choosing tightening strategy, Manual or Quick prog mode, and to set the **tightening program target value**.

For Tightening parameters, see the sections *Start step [Page 42]*, *Rundown step [Page 46]*, *Tightening step [Page 50]*, and *Stop step [Page 59]*. For Loosening parameters, see *Loosening step [Page 59]*.



Pset settings

Name

1. Two step tight.

Strategy

Two step ▼

Target

Torque ☒ Angle

Target torque 15.00 Nm

Tightening parameters

Edit ►

Loosening parameters

Edit ►

Delete Pset

Name

Use the **Name** field to give the tightening program a name. This name will be stored with the tightening results and sent to ToolsNet (if applicable). The name can be maximum of 32 characters long.

Strategy

Strategy sets the tightening strategy to use with the tightening program. The available strategies and their parameters are described in the section *Tightening strategies* [Page 50].

Configuration mode when using TurboTight

When using the TurboTight strategy, it is possible to switch the configuration mode between Quick programming (Quick prog) or Manual configuration. When Quick prog is chosen, it will reset and recalculate all parameters except **Target torque**. The recalculation of the tightening parameters is based on the built-in parameter rules, the tool max torque and speed, as well as how different parameters depend on each other.

Configuration of four-step tightening strategy

For information about configuration of four-step tightening, see the section Four-step tightening strategy.

Configuration of ST Wrench

For information about configuration of an ST Wrench, see the section ST Wrench.

Target

The Quick step, Two step, and Three step strategies enable the choice of tightening towards either a Target torque or a Target angle value. When TurboTight is activated, only the Target torque option is available.

Time monitoring (elapsed time)

Time monitoring is available for all tightening strategies except Rotate. Time monitoring can be activated when angle limits are activated. Time monitoring is available for the rundown step and the final step of the tightening step.

- ❗ To minimize the risk of unexpected jerk at the end of the tightening when using the TurboTight tightening strategy, make sure to activate Time monitoring.
- ❗ Since handling the trace takes time, there is always a short difference between the Program elapsed time compared to Step elapsed time. This is especially noticeable in programs containing only one step.

When using an STB tool it is not possible to use time monitoring if all monitoring options are switched on.

Residual torque correlation factor

The term Residual torque correlation factor is similar to a calibration and adjusts between the dynamic torque, measured in the electrical tool, and the residual torque, measured by a control tool.

The *Residual torque correlation factor* is available for all tools running the TurboTight strategy and the Tensopulse tightening strategy. It is also available for the battery pulse tools that are supported by the controller.

- ❗ When using a *Residual torque correlation factor* that differs from 100, the reported **Final torque** is no longer the dynamic torque measured by the tool transducer.

The dynamic torque measurement uses an internal torque transducer that constantly measures the torque. When the target torque is reached, the tool stops and the result is evaluated and reported. The measured final torque in the transducer is affected by the joint condition, the tool speed, gears and sockets.

The residual torque is measured after the tightening is completed. It is the torque needed to continue or restart the tightening to a higher level. The residual torque is determining the clamping force in the joint.

A dynamic torque measurement is highly repetitive but may differ between tool type and tool speed.

A handheld calibrated torque wrench provides high accuracy measuring the residual torque but has higher variations due to joint relaxation, torque decay, friction or operator technique.

The *Residual torque correlation factor* is a compensation between the dynamic torque and the residual torque. The factor should be determined by experiments. The selected tightening program is performed a few times and the dynamic torque is recorded. The tightenings are also manually measured to determine the residual torque.

$$\text{Residual torque correlation factor} = \frac{\text{Residual torque}}{\text{Dynamic torque}}$$

The *Residual torque correlation factor* can be calculated by dividing a residual torque by a dynamic torque. The *Residual torque correlation factor* is presented as percent and is by default 100%. This means the reported dynamic torque value has not been modified.

Parameters	Function
Target torque	The tool target torque set for the tightening using the TurboTight strategy.
Final dynamic torque	The final torque reported as the result of the performed tightening.
Dynamic torque	The dynamic torque measured by a reference transducer.
Residual torque	The desired residual torque that ensures the desired clamping force.
Residual torque correlation factor	The compensation factor between residual torque and dynamic torque

An example is given how torque tuning is used.

The TurboTight strategy is selected. The joint shall be tightened to 12 Nm to reach the desired clamping force. The following set up is made

Example settings	Value	Function
Target torque	12 Nm	The programmed desired target torque in the controller
Residual torque correlation factor	100	The compensation factor between residual torque and dynamic torque

A number of tightenings are made. After each tightening the joint is checked with a calibrated torque wrench. The average is calculated and the following result has been found:

Initial parameters and results	Value	Function
Target torque	12 Nm	The programmed target torque in the controller.
Final torque	12 Nm	The final torque reported as the result of the performed tightening.
Dynamic torque	12 Nm	The uncompensated measured torque from the tool transducer.
Residual torque	10 Nm	The residual torque measured with a calibrated torque wrench or an other test tool.
Residual torque correlation factor	100 %	The compensation factor between residual torque and dynamic torque

The testing shows that the residual torque is too low to produce the desired clamp force. The Residual torque correlation factor is calculated to 0.83, which is 83 %. An adjustment of the tuning factor is made and the following result is obtained

Final parameters and results	Value	Function
Target torque	12 Nm	The programmed target torque in the controller.
Final torque	12 Nm	The final torque reported as the result of the performed tightening.
Dynamic torque	14.5 Nm	The uncompensated measured torque from the tool transducer.
Residual torque	12 Nm	The desired residual torque that ensures the desired clamping force.
Residual torque correlation factor	83 %	The compensation factor between residual torque and dynamic torque.

This means in reality, that we need to tighten a bit harder than the target, to compensate for differences and to reach the desired torque in the joint.

 It is important that the correlation is made with the same tool type and parameter configuration that will be used in production.

Trigger Lost

NOK on trigger lost is a tightening program setting, which controls whether or not it is allowed to release the tool trigger before the target condition has been reached. The setting can be set to On or Off. Below is a description of the two states.

Switch setting	Description
On	Releasing the trigger before reaching the target condition will result in a NOK tightening.
Off	Releasing the trigger before reaching the target condition will result in an OK tightening as long as all other conditions have been met.

 The default behavior is that premature trigger release shall not be allowed. The NOK on trigger lost setting is only available for the Rotate strategy, with the default value On. All other strategies shall behave with the setting set to On.

Attachment tuning

Attachment tuning gives the possibility to compensate for front attachments on the tool. The compensation can be made for each tightening program.

An operator can hot swap an attachment and then select a tightening program tuned for that specific attachment.

Attachment tuning is available for all conventional strategies except for the STwrench.

1. In **Tightening program settings**, set **Attachment tuning enabled** to **Yes**
2. Click on Tightening parameters > **Edit**
3. Click on the start step.
4. Under **Attachment tuning**, set **Use attachment tuning** to **Yes**

5. Set the necessary parameters for **Gear ratio** and **Efficiency tuning** (see table below).

Attachment tuning	Description	Default
Attachment gear ratio	The <i>Attachment gear ratio</i> is needed to compensate the angle. Minimum: 0.5 Maximum: 3.6 Socket rotation speed = Tool speed / gear ratio	1.0
Efficiency tuning	Attachment gear ratio combined with the <i>Efficiency tuning</i> is needed to compensate the torque. Minimum: 0.5 Maximum: 1.0 For example 0.9 means 10% efficiency loss.	1.0

Table 15: Parameters for Attachment tuning

Tightening program validation and validation error reporting

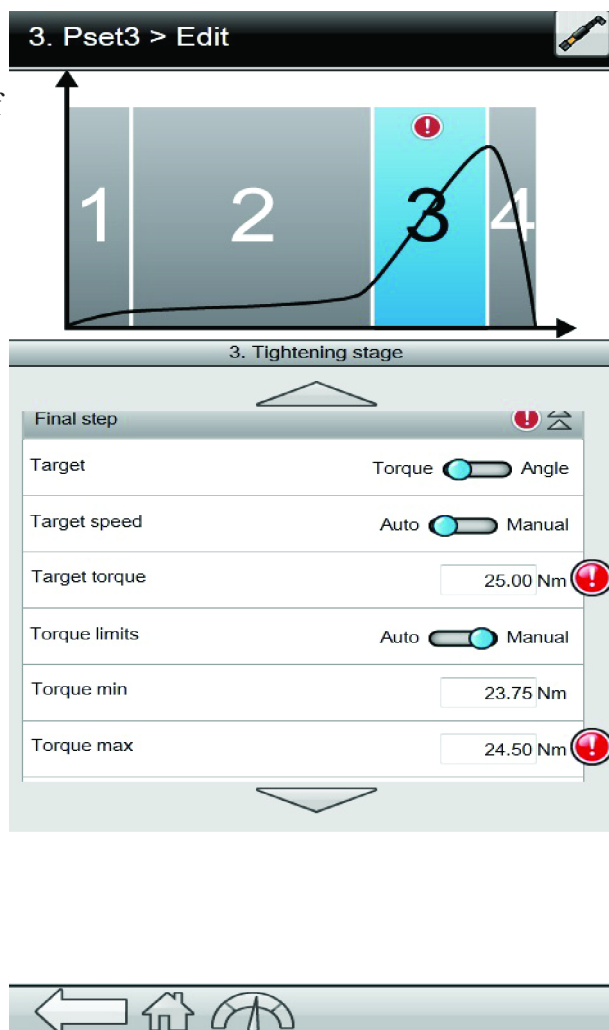
The tightening program automatically validates with the parameter rules and tool properties as soon as new values are entered or changes are made to a tightening program. If the validation detects any errors they are reported with an error description.

Validation error reporting

If the validation gives an error, it is displayed with an icon next to the parameter or parameters causing the error. When you tap on the icon, a short description of the error is given.

Example (See image):

1. **Target torque** is set to 25 Nm with Final torque limits set to **Torque min** 23.75 Nm and **Torque max** 24.5 Nm (this value is hidden by the pop-up window in the image).
2. When you tap on the validation error icon next to the **Torque max** parameter, a short description of the error is given, saying that **Target torque** is greater than **Torque max** (Torque max $\leq$ Target torque).
3. To fix the error, adjust the **Torque max** value so that it is greater than **Target torque**, and the error icon will disappear.



Validate a tool with a tightening program

1. In the Tightening menu, choose Tightening program library or Multistep program library. If required, select a specific program in the list. Note that validation can be performed both for the entire list of programs, or for individual programs.

2.  Click on the **tool icon** in the upper right corner.
3. In the pop-up window, choose the tool to validate the tightening program against, and click **Validate**.

If a tightening program is not compatible with the selected tool, it will be indicated by a red circle with an exclamation point.

Start step

The optional Start step initiates the tightening, enables socket and thread finding, and the option to detect rehits.

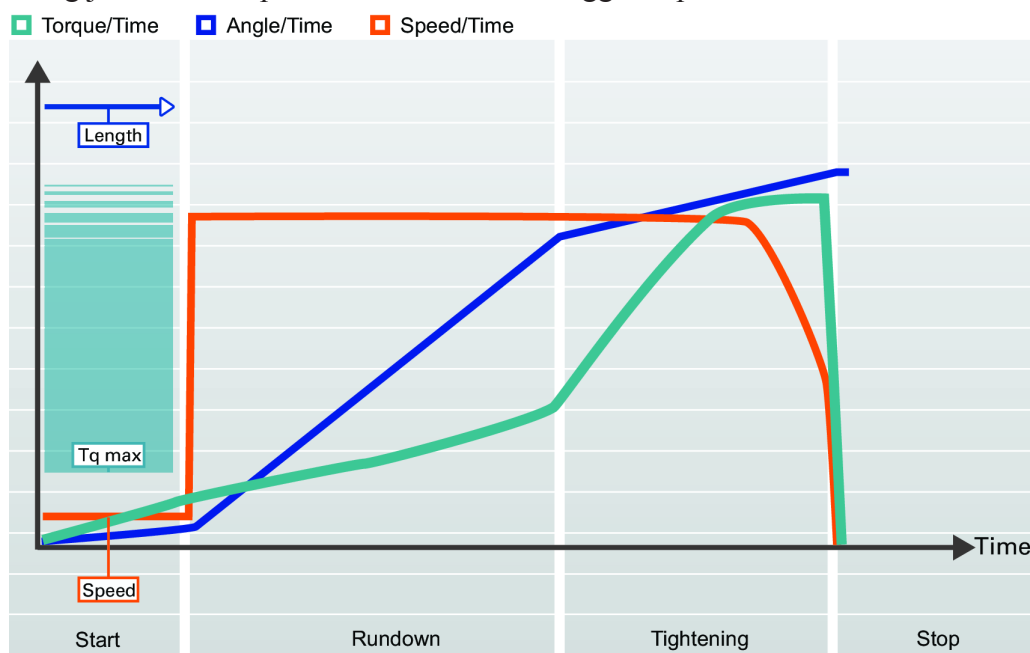
Direction

Direction defines the tightening direction of the spindle to clockwise (CW) or counterclockwise (CCW). The rotation of the spindle will always be in this direction, except when loosening and during the conditioning step used in the **Three step** strategy.

Parameter	Description	Default value
Thread direction	Defines the tightening direction of the spindle.	Clockwise

Soft start

During **Soft start** it is possible to set the speed, the maximum torque and the rotation angle to help the screw to enter the thread, and to prevent the tool being jerked out of position when the tool trigger is pressed.



Parameter name	Description	Default value
Soft start	Enables setting of the tool's speed, angle and maximum torque to facilitate the screw entering the thread. Off: Soft start is turned off. On: Soft start is turned on.	On
Speed	Defines the speed during Soft start.	35 rpm
Angle	Defines the angle to turn the spindle for the screw to enter the thread.	90°
Torque max	Defines the upper torque limit during Soft start. If Torque max is exceeded, the tightening is aborted and an error message is given. The tightening will be considered NOK.	1.25 Nm

Rehit detection

When **Rehit detection** is activated, it is possible to detect a screw that already has been tightened.

Parameter	Description	Default value
Rehit detection	Detects attempts to tighten an already tightened screw. Early: Terminates the tightening immediately when a rehit is detected. The tightening will be considered as NOK. Requires that Soft start is activated. Complete: The tightening is not terminated until all tightening steps have been executed. The tightening will be considered as NOK. Off: No rehit detection will be performed.	Early

Rehit detection – Early

The Rehit detection Early option will terminate the tightening immediately when a rehit is detected and end the tightening in the most ergonomic way possible. To be able to use the **Rehit detection Early** option, Soft start must be set to On. This is because the **Soft start torque max** value is used as the torque limit beyond which the tightening is considered a rehit, and a rehit error will be indicated.

 To use **Rehit detection Early**, Softstart must be set to On.

Rehit detection – Complete

To make a rehit detection when Soft start is not used, the Rehit detection Complete option must be used. **Rehit detection Complete** will not terminate the tightening until all tightening steps have been executed and consequently takes longer. The tightening will be considered a rehit if the speed never reaches half the rundown speed, and a rehit error is indicated.

Current monitoring

Current monitoring provides an extra security to monitor the tightening torque and is a complement to the torque sensor in the tool.

At final target torque, the rotor current is measured and converted to a torque value. If the calculated torque is within 10% of the measured torque, the tightening is considered to be **OK**.

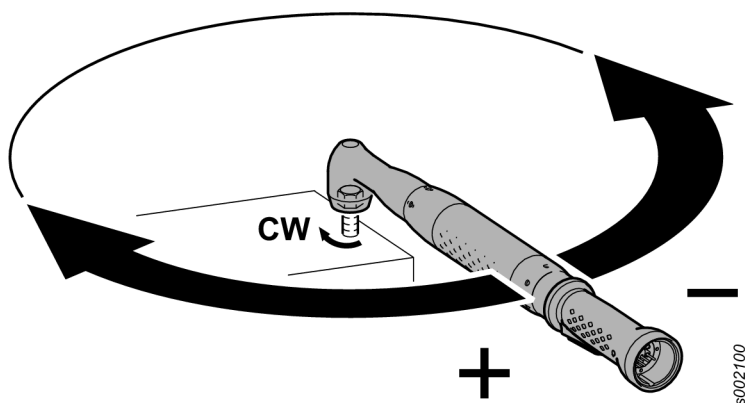
Parameter	Description	Default
Current monitoring	Switch with On - Off position Off: Current monitoring is disabled and the tool torque is measured by the torque sensor. On: the current is measured at final torque target and converted to a torque value. The calculated torque is compared to the measured torque. If the difference is within 10%, the tightening is considered OK	Off

True angle compensation

Certain tools are equipped with a gyro and measure the tool rotation during tightening. If the tool is rotated during tightening, the angle measurement may be corrupted. This leads to faulty tightening if made to angle references. For variations within specified limits, the controller can compensate for these rotations and make a correct tightening.

If the tool rotation is outside specified limits, the tightening is aborted and the error **NOK** is reported. Additional information reports **Tool movement exceeded**.

Parameter	Description	Default
True angle compensation	Available for all tightening strategies except Rotate .	On
Negative angle limit	Defines the maximum negative rotation of the tool. If the value is exceeded the tightening is terminated and an error is reported. Expressed in a numeric angle value. • Min value: 1 • Max value: 180	30
Positive angle limit	Defines the maximum positive rotation of the tool. If the value is exceeded the tightening is terminated and an error is reported. Expressed in a numeric angle value. • Min value: 1 • Max value: 180	30



 Only tools with gyro have the capability to measure the tool movement.

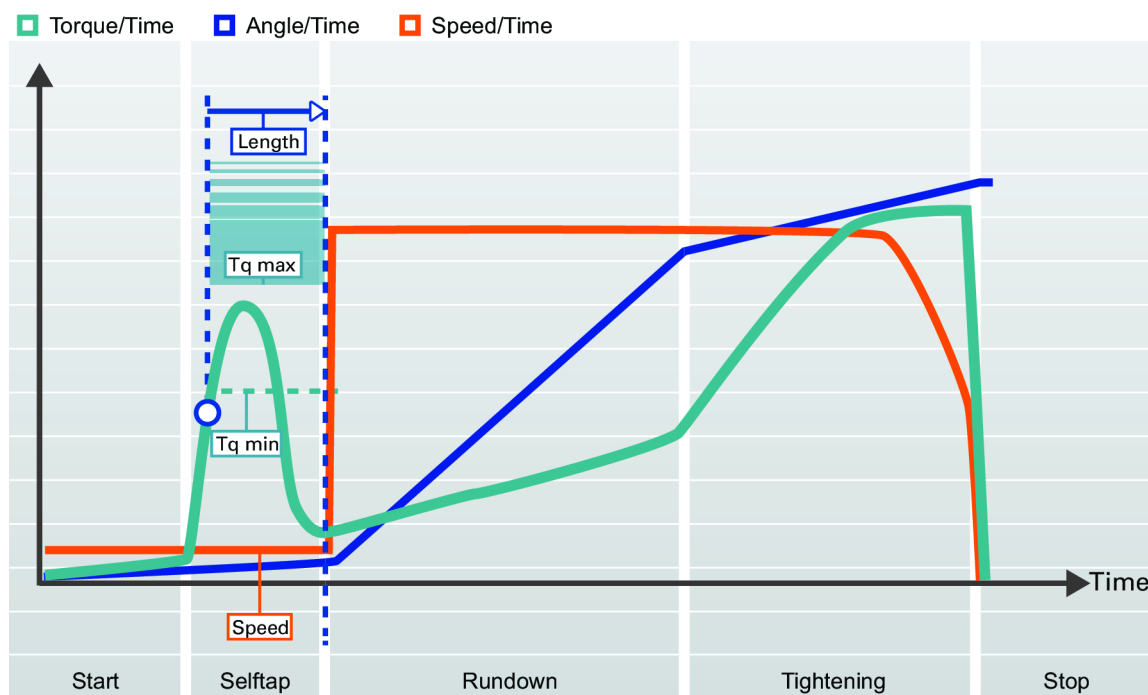
Rundown step

The part of the tightening from when the screw enters the thread until just before the screw head touches the underlying surface and snug is reached. The torque required during rundown does not contribute to any clamping force.

Parameter	Description	Default value
Rundown speed	Defines the speed during the Rundown step	Tool max speed

Selftap

The Selftap step enables tightening where the rundown torque required is greater than the **Rundown complete** torque, for example when tightening thin layers of metal using self-threading (or self-tapping) screws. The selftap window starts when the torque value reaches SelftapTorqueMin/2. The torque must reach over SelftapTorqueMin, but not pass SelftapTorqueMax, during the angle window.

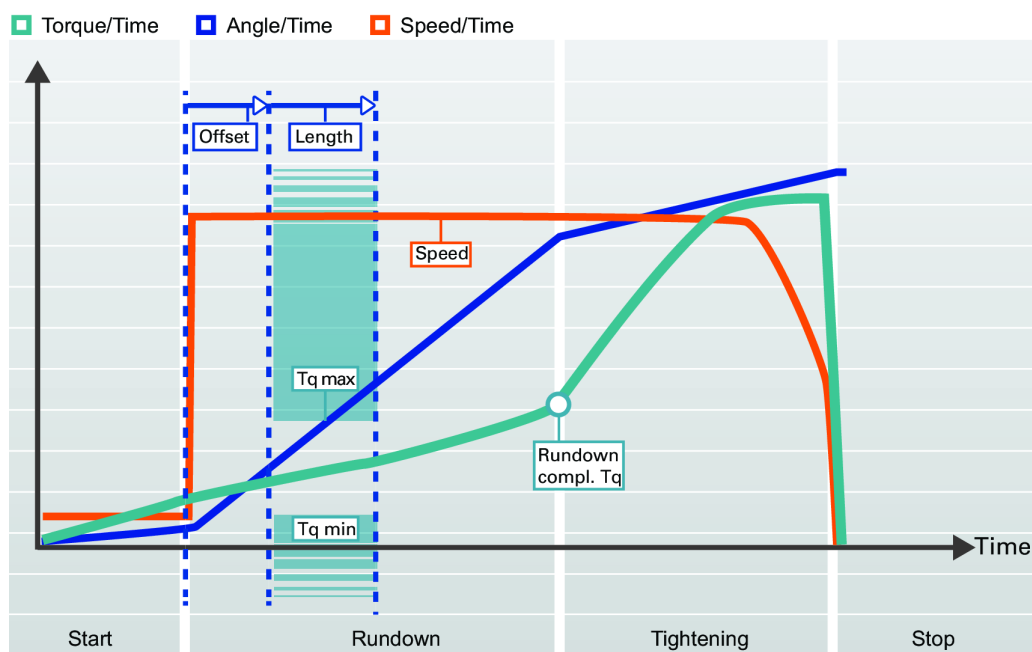


Parameter	Description	Default value
Selftap	Activates the Selftap step.	Off
Speed	Defines the speed during Selftap.	Soft start speed or 5% of Tool-MaxSpeed
Length	Defines the angle to turn the socket during Selftap. Measured from the end of the Start step.	360°
Torque min	Torque value for lower Selftap limit.	0 Nm
Torque max	Torque value for upper Selftap limit.	Tool max torque

Rundown torque limits

The friction between the nut and joint can vary. This can cause the torque needed to run a nut down a thread, before engagement with the joint surface takes place, to vary as well. These effects could be, for example, hole interference, prevailing torque or varying lubrication.

Monitoring the rundown torque can be useful when running down a lock nut which has a plastic insert in the threads to help the fastener resist vibration. This will require a higher torque, known as prevailing torque, to overcome the interference.

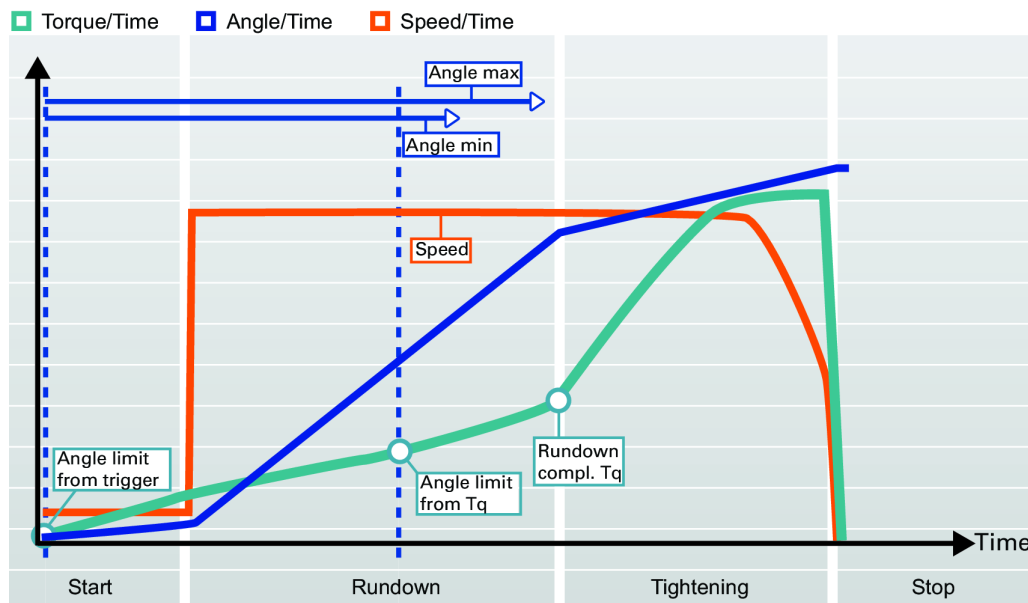


Parameter	Description	Default value
Rundown torque limits	Sets Rundown torque limits to On or Off. Off: No limits are set. On: Torque limits and angle interval are set.	Off
Offset	Angle offset before the Angle interval begins.	0°

Parameter	Description	Default value
Length	Angle defining the Rundown torque limit section.	360°
Torque min	Torque value for lower Rundown torque limit.	0 Nm
Torque max	Torque value for upper Rundown torque limit.	19% of Target torque

Rundown angle limits

By monitoring the angle of rotation during rundown, errors such as missing washers or screws with incorrect thread size or length can be detected. For example, threads that are too long would require a greater turning angle for the screw to reach snug.



Parameter	Description	Default value
Rundown angle limits	Activates Rundown angle limits. The angle limits are set relative to when the tool trigger is pressed or when a specified torque value is reached. Angle limits will not be checked during Selftap if Selftap is activated. Off: No limits are set. From trigger: The system starts to monitor the tightening angle as soon as the tool trigger is pressed and reports if angle or time limits are violated. From torque: The system starts to monitor the tightening angle from the specified <From torque> value and reports if angle or time limits are violated.	Off

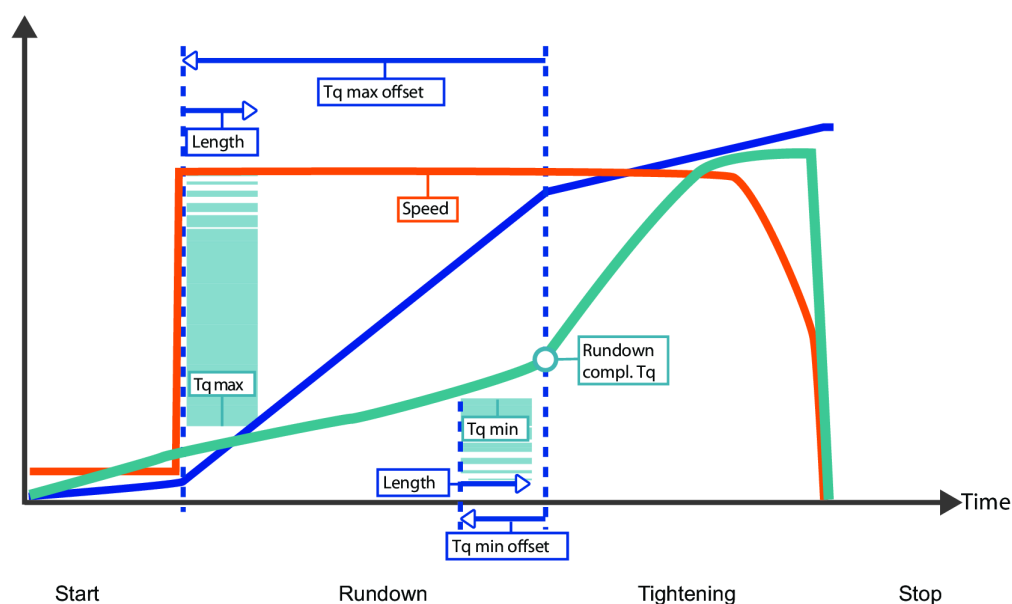
Parameter	Description	Default value
<From torque>	Torque value from where Run-down angle limits are set.	10% of Target Torque
Angle min	Angle value for lower angle limit from starting point.	100°
Angle max	Angle value for upper angle limit from starting point.	1000°
Time min	Minimum time (in milliseconds) for the step. Measured from the start of the step.	10 ms
Time max	Maximum time (in milliseconds) for the step. Measured from the start of the step.	5000 ms

Post view torque

Some joints have a torque peak prior to Rundown complete. Post view torque makes it possible to monitor torque values during two specified angular intervals. The interval starts are defined as an angle prior to Rundown complete and torque is then monitored for a specified angular interval.

Post view torque is therefore similar to Rundown torque limits except that the maximum and minimum limits can be positioned independently of each other and can differ in length to better control the outcome of the rundown step.

■ Torque/Time
 ■ Angle/Time
 ■ Speed/Time



Parameter	Description	Default value
Post view torque	Post view torque makes it possible to monitor torque values during two specified angular intervals.	Off
Torque min	Torque value for lower Post view torque limit.	
Torque min offset	Angle offset before the Post view torque min interval begins.	720°

Parameter	Description	Default value
Torque min length	Angle length defining the Post view torque min section.	90°
Torque max	Torque value for upper Post view torque limit.	
Torque max offset	Angle offset before the Post view torque max interval begins.	360°
Torque max length	Angle length defining the Post view torque max section.	90°

Rundown complete

Rundown complete sets if the screw has reached snug. It ends the Rundown step so that the tightening step can be entered.

Parameter	Description	Default value
Rundown complete	Specifies how to control when snug is reached. At torque: Specifies the torque value for when the rundown step is completed.	At torque
<At torque>	Defines the torque value for when snug is reached and the rundown step is completed. Rundown complete must be smaller than First torque in multi-step strategies or Target torque in the TurboTight strategy.	

Tightening step

The tightening step applies clamping force to the joint by one or more tightening steps, depending on the strategy selected.

Tightening strategies

By selecting the tightening strategy it is possible to choose the method for applying clamping force (or pre-load) to the joint. Different joints require different strategies for how to apply the desired clamping force and to minimize unwanted in-service effects.

The TurboTight strategy enables the option to use Manual programming or Quick prog. See the section *TurboTight [Page 52]*.

The Quick step, Two step, and Three step strategies enable the choice of tightening towards a Target torque or a Target angle value. See the section *Target [Page 56]*.

The Four step strategy is a configurable strategy where it is possible to choose to use all or just a few of the available steps. See the section *Four-step tightening strategy*.

The External result strategy is used when OK tightenings are indicated by an external digital signal. See the section *External result [Page 56]*

All tightening strategies require that you at least set the **Target torque** or **Target angle** value.

Parameter	Description	Default value
Strategy	Available tightening strategies. TurboTight: No additional tightening behavior is used as default. Only target values are used. Quick step: Adds an initial tightening step to reduce pre-load scatter. Two step: Adds a pause between the first and final tightening step to further counteract short-term relaxation effects. Three step: Tightens to a defined First torque value, then loosens the screw and immediately retightens it to Target torque. Four step: Tightening strategy divided into four separate steps. It is possible to switch off the steps separately. Wrench - production: Tightening strategy to use with an ST Wrench. Wrench - quality: Strategy used for quality test of tightenings with an ST Wrench. Rotate: Rotates the spindle a specified speed and angle. External result: presents a predetermined tightening result instead of measured torque/angle. Multistep: Tightening strategy consisting of multiple configurable steps, with restrictions and monitors.	TurboTight
Target type	Defines the type of the target value in the final step. Target torque: The tightening aims towards the specified target value when performing the final step. Target angle: The tightening aims towards the specified target value when performing the final step.	
Target torque	Defines the target torque of the tightening of the final step.	

Parameter	Description	Default value
Target angle	Defines the target angle of the tightening of the final step.	
Target speed	Activates setting the tool speed for the final step manually or using the default speed. Auto: Uses a value that is calculated based on the Tool max speed . Manual: Specify the tool speed manually.	Auto
<Manual>	Tool speed during tightening or during the final step.	

TurboTight

TurboTight is the default tightening strategy and it is designed to perform a very fast and ergonomic tightening based on the maximum speed of the tool (Tool max speed). This strategy has two options:

- **Quick prog**, that requires only the **Target torque** to be set to perform the tightening. Time monitoring is not activated.
- **Manual**, that allows the user to configure several tightening parameters.

 To minimize the risk of unexpected jerk at the end of the tightening when using the TurboTight tightening strategy, make sure to activate Time monitoring.

Depending on the joint properties, for example if the joint is very stiff or very soft, a different tightening strategy than TurboTight might be needed.

 TurboTight is not available for Joint Control.

Fine-tuning the TurboTight strategy

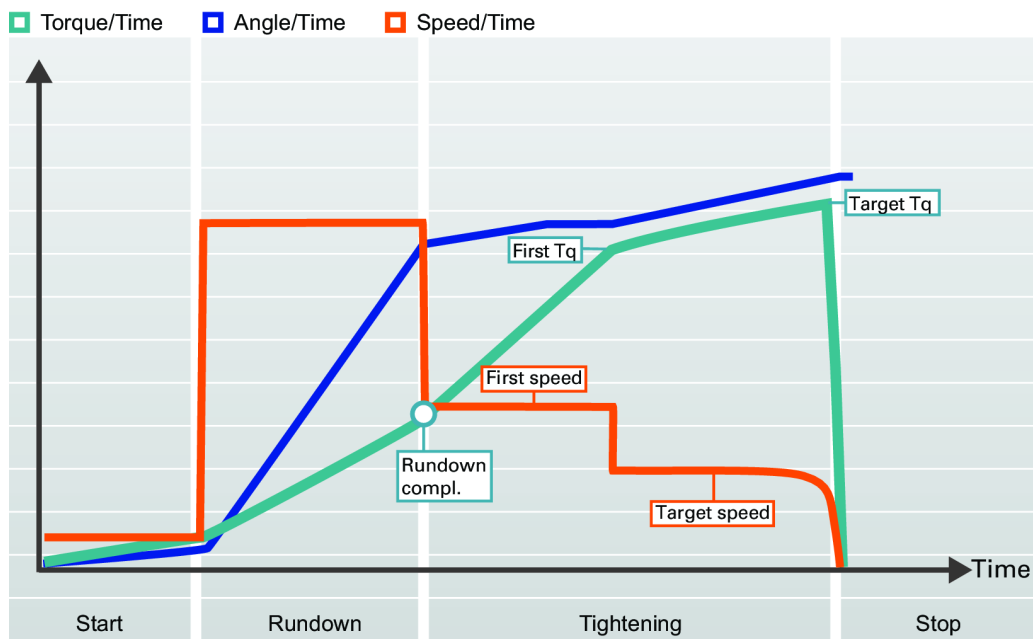
If the TurboTight strategy gives unwanted results a tip is to look at how the Rundown complete is set. A Rundown complete set too high could give the TurboTight strategy too little time to work on the needed calculations in the Tightening step and result in an overshoot. The ambition should be to set the Rundown complete as close to snug as possible.

A Rundown speed set too high could also cause the TurboTight not to have enough time to work on the needed calculations in the Tightening step resulting in an overshoot. This is even more important if the joint is very stiff.

The parameter *Time max* used with time monitoring must be set as low as possible, without stopping the normal tightening.

Quick step

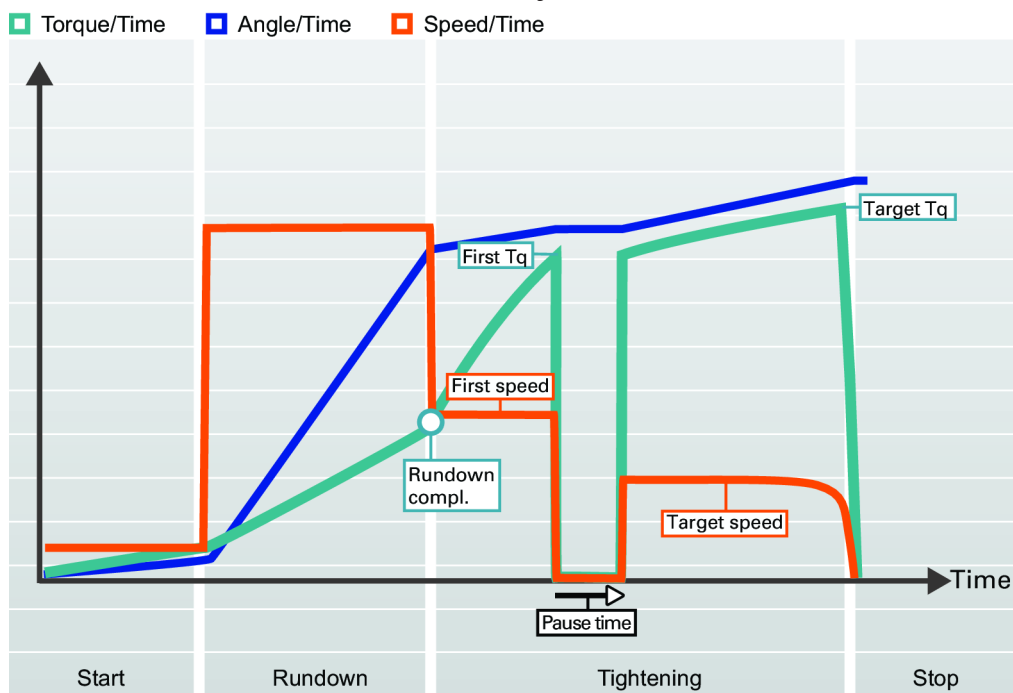
Quick step is a tightening strategy used to reduce the joint's preload scatter by adding an initial step with a given torque and speed, and then reducing the target speed in the final step.



Parameter	Description	Default value
First torque	Target torque for the first step.	
First torque	Torque during first step.	80% of Target Torque
First speed	Target speed for the first step.	
First speed	Tool speed during first step.	50% of Tool max speed

Two step

The Two step strategy is very similar to the Quick step strategy except that it adds a small time delay between the first step and the final step, to further counteract short-term relaxation effects in the joint.



Parameter	Description	Default value
First torque	Torque during first step.	80% of Target Torque

Parameter	Description	Default value
First speed	Target speed for the first step.	
Pause time	Time between first and second step.	50 ms

Fine-tuning the Two step strategy

When the First target is reached, the tool makes an immediate stop for a specified time before it continues with the final step. The First torque value and the Pause time should be chosen to improve ergonomics for hand-held tools.

Three step

The Three step strategy adds a loosening step between the first step and the final step, to overcome short-term relaxation effects due to embedment, and reduce preload scatter. This is sometimes used to condition the joint. This can be useful in, for example, joints with many adjoining surfaces and will have a greater effect on new parts than on reused ones, due to the smoothing of surfaces, which reduces embedment.

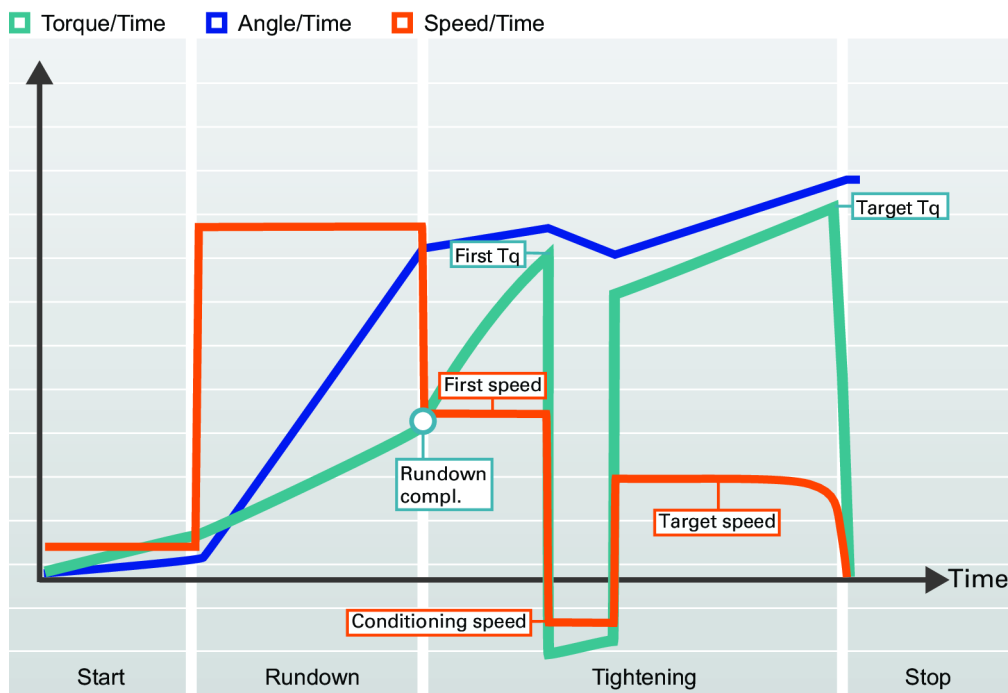
Conditioning the joint is done by tightening the first step to a given torque, **First torque**, and then releasing the load by turning the nut a specified **Conditioning angle** and then retightening the nut to its **Target torque**.

The target torque can be lower than the torque reached during the first step after rundown. In order for the target torque to be lower than the first torque, set target torque (Tightening parameters > Tightening step > Final step > Target torque) to a value lower than First torque (Tightening parameters > Tightening step > First step > First torque).

If Angle is used as a target in the tightening program, the Target angle is measured from the position at the end of the loosening step (conditioning).

Behavior of Measure torque at, and Measure angle to

The **Max torque value** and **Value at peak torque** measured under Result evaluation for Measure torque at and Measure angle to, respectively, represent the highest values measured over the entire tightening. This means that if the Target torque is set lower than the First torque, the Result evaluation value will be higher than the end value. In order to view the tightening's final value, both Measure torque at, and Measure angle to should be set to Value at shutoff.



Parameter	Description	Default value
First torque	Torque during first step.	80% of Target Torque
First speed	Tool speed during first step.	50% of Tool max speed
Conditioning speed	Tool speed during the conditioning step.	50% of Tool max speed
Conditioning angle	Angle to turn the socket during the conditioning step.	180°

Fine-tuning the Three step strategy

When the First target is reached and the conditioning step is entered, the tool makes an immediate stop and reverse before it continues with the final step. This conditioning step may need to be fine-tuned to improve ergonomics for hand-held tools.

Four step

Information about four step is available in the section Four-step tightening strategy.

Wrench - production and Wrench - quality

Information about the two strategies used with the ST Wrench is available in the section ST Wrench.

Rotate

The Rotate strategy is primarily a strategy for testing and demonstration purposes. When the tool is allowed to rotate freely, it turns the socket the specified angle using the lowest torque possible.

Parameter	Description	Default value
Target speed	Target speed for the Rotate strategy.	

Parameter	Description	Default value
<Target speed>	Manual tool speed during the Rotate strategy.	16.5% of Tool max speed
Target angle	Angle to turn the spindle.	360°

External result

External result is a strategy used when an OK tightening is indicated by an external digital signal (and not by torque or angle values measured during tightening). This external signal can be provided through any means that can provide a digital signal into the Power Focus 6000 (e.g through the I/O bus).

When the signal is sent, the Result view will show the value of the Target parameter provided in the tightening program (specified torque value, angle value, or text string). These (torque and angle) values do not represent actual measured values, but only inserted text.

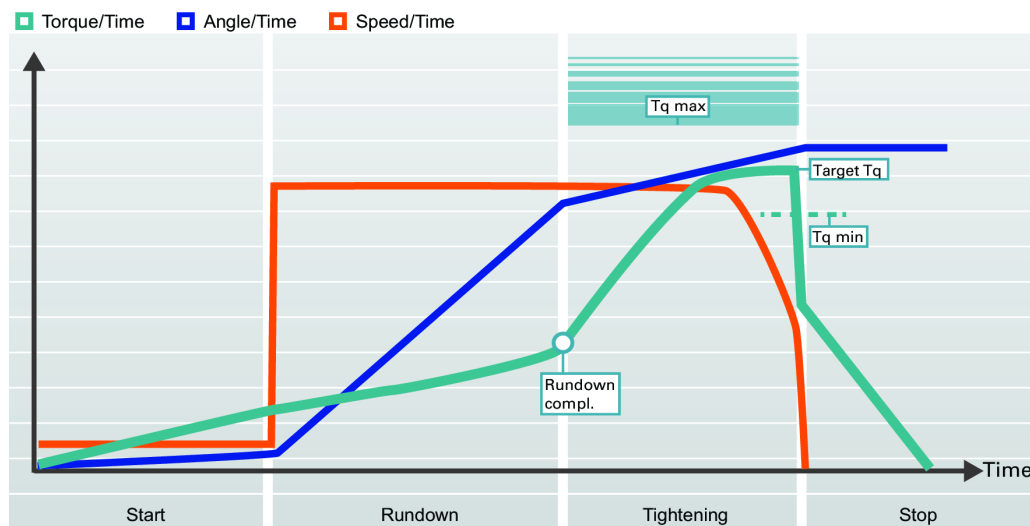
Parameter	Description	Default value
Torque <Target torque>	Numerical value for desired displayed target torque value	0.00
Angle <Target angle>	Numerical value for desired displayed target angle value	360°
Text	Alphanumerical string for desired displayed text.	

Multistep

Information about multistep is available in the section Multistep tightening strategy.

Target torque limits

By setting the **Target torque limits**, it is possible to discard a tightening should the torque result not fall within the specified torque limits. A too high torque can cause the screw to deform as a result of passing the yield point, and can even break, or can cause the stripping of threads. Not enough torque result in the clamping force not being enough to withstand the forces for which the joint is designed.



Parameter	Description	Default value
Torque limits	The tightening is considered as NOK if the torque result is outside the range defined by Torque min and Torque max. Auto: Torque limits are automatically set to the default values specified for Torque min and Torque max. Manual: Enables the Torque limit values to be set manually.	Auto
Torque min	Torque value for lower torque limit. Can be entered if Manual has been selected.	95% of Target torque
Torque max	Torque value for upper torque limit. Can be entered if Manual has been selected.	120% of Target torque

The parameter **Measure torque at** can have different values. By default the torque is measured at torque peak. The possible values of the parameter are listed in the table below.

Name	Description
Max torque value	Measures the highest torque value during the tightening.
Value at peak angle	Measures the torque value at the highest angle value.
Value at shutoff	Measures the last torque value before entering the break step.

Target angle limits

With Target angle limits set, it is possible to monitor whether the nut is turned the desired angle during the tightening.

Parameter	Description	Default value
Angle limits	Choose the section of the tightening, in degrees, in which to monitor the angle. Off: No limits are checked. From Rundown complete: The monitoring window is set from when the Rundown complete torque is reached. From torque: The monitoring window is set from when the specified torque value is reached. Torque must be greater than Rundown complete torque. From First target: The monitoring is set from when First target is reached. This option is not available if TurboTight is chosen. Auto: The angle monitoring limits are automatically calculated by the controller Manual: The angle monitoring limits are manually entered.	Off
<From torque>	Torque value from where angle limits are set.	
<From torque>	Torque value from where angle limits are set.	75% of Target Torque
Angle min	Angle value for lower angle limit	90°
Angle max	Angle value for upper angle limit	720°
Time min	Minimum time (in milliseconds) for the step. Measured from the start of the step.	10 ms For TurboTight: 0 ms
Time max	Maximum time (in milliseconds) for the step. Measured from the start of the step.	1000 ms For TurboTight: 40 ms

 Position 1-4 are valid if the target is torque. Position 5-6 are valid if the target is angle.

The parameter **Measure angle at** can have different values. The parameter is only available when angle monitoring is turned on for the tightening program used. By default the angle is measured at Max angle value. The possible values of the parameter are listed in the table below.

Name	Description
Value at peak torque	Measures the angle at the highest torque value.
Max angle value	Measures the highest angle during tightening.

Name	Description
Value at shutoff	Measures the last angle value before entering the break step.

Torque compensation

By using torque compensation, the actual clamping force applied to the joint can be better determined and the scatter in the applied clamping force can be reduced.

The torque compensation point is set by referring back to a specified angle from Rundown complete and calculating a value for the torque used during rundown. This is then compensated for when creating the preload in the screw by adding the torque value calculated in the torque compensation point to the Target torque.

Parameter	Description	Default value
Torque compensation	Enables adjustment if the Target torque for torque used in the run-down step. Off: No compensation is made. On: Manually sets the Torque compensation point.	Off

Stop step

The Stop step terminates the tightening so that the socket can be released.

Soft stop

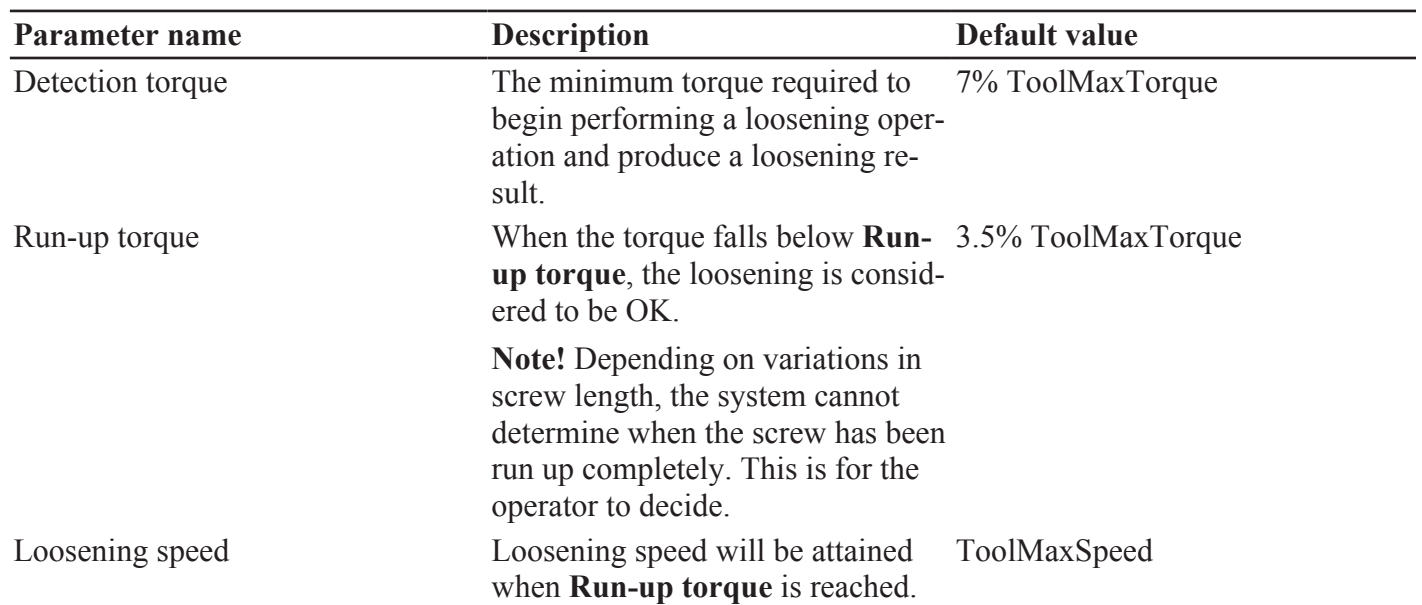
Soft stop makes the tightening stop in a more ergonomic fashion.

Parameter	Description	Default value
Soft stop	Turns the Soft stop on or off. Off: No Soft stop is used. On: Soft stop is activated. When target torque is reached, the tool speed is immediately decreased to 75%. Then the speed is decreased to zero in at most 40 ms.	Off

Loosening step

By setting the loosening parameters, you can control the behavior of loosening for a specific tightening program. Specify the loosening speed and torque to ensure that the screw is unscrewed as desired, so that the screw thread does not break, regardless of what tool you use.

-  A loosening is considered OK when **Run-up torque** is reached. However, the screw will probably not have been fully run up by then. The screw should now be able to be turned using a low torque and the speed can be increased. The operator will need to proceed with the loosening until it is considered finished.



- An action current that adds positive torque in the tightening direction.
- A reaction current that creates a comfort reaction by applying a reverse torque.

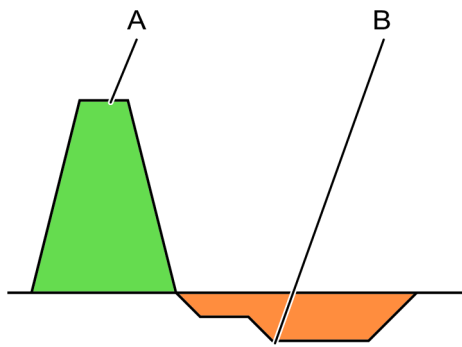


Illustration 8: Pulse tightening principle

A	Action pulse to apply tightening force.	B	Reaction pulse for comfort
---	---	---	----------------------------

i The figure shows the general principle of a current pulse tightening strategy. The detailed curve depend on the tool type and the tightening algorithm.

The pulse period consists of two phases as shown in the figure with an action current and a reaction current. Each action pulse adds torque to the tightening until the final target is reached. Each reaction pulse creates a counterforce that provides a comfortable reaction.

The energy level of the action phase and the reaction phase are configurable parameters. The combination of these two parameters create an efficient tightening combined with operator comfort.

TensorPulse tightening program

The **TensorPulse** tightening strategy is available for pulsing tools. The strategy can be selected if the controller software version supports the tightening program. Pulsing tools can achieve a higher torque compared to continuous driving tools.

The table lists all the parameters for the **TensorPulse** tightening strategy. Some parameters are mandatory, some are optional and some are conditional.

The conditional parameters are not shown in the configuration menu if the condition is not valid. which is the same as a certain function is disabled.

Parameters for TensorPulse start

During the start step, the tool rotates in a speed mode without any pulsing.

Parameter name	Description	Default value
Soft start	Enables setting of the tool's speed, angle and maximum torque to facilitate the bolt entering the thread. Selected by radio buttons. Off: Soft start is turned off. On: Soft start is turned on.	On
Speed	Defines the speed during the soft start.	34 rpm

Parameter name	Description	Default value
Angle	Defines the target angle to turn the spindle for the bolt to enter the thread.	90°
Torque max	Defines the upper torque limit during the soft start. If Torque max is exceeded, the tightening is considered NOK.	1.25 Nm
Rehit detection	Early: Terminates the tightening immediately when an already tightened screw/bolt is detected. The tightening will be considered as NOK. Requires that Soft start is activated. Complete: Even though an already tightened screw/bolt is detected, the tightening is not terminated until all tightening steps have been executed. The tightening will be considered as NOK. To make a rehit detection when Soft start is not activated, the Rehit detection Complete option must be selected. Rehit detection Complete will not terminate the tightening until all tightening steps have been executed. The tightening will be considered a rehit if the speed never reaches half the rundown speed, and a rehit error is indicated. Off: No rehit detection will be performed. Combination Soft start = Off and Rehit = Early is not allowed.	Early
Positive	The TrueAngle compensation can detect tool rotation and make angle compensations within the set limits.	30°
Negative	The TrueAngle compensation can detect tool rotation and make angle compensations within the set limits.	30°
Use attachment tuning	Attachment tuning is selected by radio buttons.	
Gear ratio	Socket rotation speed = Tool speed / gear ratio.	1.0
Efficiency tuning	For example 0.9 means 10% efficiency loss.	1.0

Parameters for TensorPulse rundown

During rundown, the tool can use either speed mode, with a constant motor speed, or pulse mode. The selection is done depending on the encountered torque and the given torque limits in the configuration.

Parameter name	Description	Default value
High-speed rundown	The rundown step can be done in high-speed in order to minimize the time, without overshooting. This is achieved by letting the tool run with a high speed for a specified angle length. When the angle has been reached, the speed will change to the lower speed specified in Rundown speed parameter. Only available for SRB tools. Length: Default 3600°, max 99999° Speed: <i>Tool max speed</i> must be higher than <i>Rundown speed</i> (rpm).	
Rundown speed	Rundown speed can be set to either Max or Manual. If Rundown speed is set to Manual; enter the tool speed in rpm.	Max

Parameter name	Description	Default value
Rundown angle limits	Off: Rundown angle limits is turned off. From Trigger: Rundown angle limits is turned On. The system starts to monitor the tightening angle as soon as the tool trigger is pressed and reports if angle limits are violated. From torque: Rundown angle limits is turned On. The system starts to monitor the tightening angle from the specified torque value and reports if angle limits are violated.	Off
Rundown angle monitoring torque	Torque value from where Rundown angle limits are set.	
Angle min	Angle value for lower angle limit from starting point.	100°
Angle max	Angle value for upper angle limit from starting point.	1000°
Time min	Minimum time for the step.	10 ms
Time max	Maximum time for the step.	5000 ms
Rundown pulse limits	Selected from a shortcut menu: Off: Rundown pulse limits is turned off. From Trigger: Rundown pulse limits is turned On. The system starts to monitor the pulses as soon as the tool trigger is pressed and reports if the pulse limits are violated. From torque: Rundown pulse limits is turned On. The system starts to monitor the pulses from the specified torque value and reports if the pulse limits are violated.	Off
Rundown pulse monitoring torque	Torque value from where the Rundown pulse limits monitor starts. The value must be set to a value greater than <i>Continuous max torque</i> .	2.5 Nm
Pulses min	Minimum number of pulses to reach the <i>Rundown complete torque</i> value.	2
Pulses max	Maximum number of pulses to reach the <i>Rundown complete torque</i> value.	50
Rundown complete torque	Defines the torque value for when snug is reached and the rundown is completed. The program proceeds with the tightening and starts with pulse mode, if not already done so during rundown.	5 Nm

Parameters for TensorPulse tightening

Parameter name	Description	Default value
Target torque	Final target torque for the tightening.	
Pulse Energy	The <i>Pulse energy</i> delivered in the action pulse expressed in a percentage of the maximum energy the tool can deliver in each pulse.	80%
Reaction force factor	The energy delivered by the tool expressed in a percentage value. The <i>reaction force retention factor</i> is based on the action energy and results in a comfortable reaction.	25%

Parameter name	Description	Default value
Residual torque correlation factor	The term Residual torque correlation factor is similar to a calibration and adjusts between the dynamic torque, measured in the electrical tool, and the residual torque, measured by a control tool.	100%
Torque limits	Limits can be Automatically or Manually selected.	
Torque min	Minimum torque for the step.	
Torque max	Maximum torque for the step.	
Angle limits	Off: Angle limits is turned off. From Rundown complete: Angle limits is turned On . The system starts to monitor the tightening angle as soon as <i>Rundown complete</i> is reached and reports if angle limits are violated. From torque: Rundown angle limits is turned On . The system starts to monitor the tightening angle from the specified torque value and reports if angle limits are violated.	Off
Rundown angle monitoring torque	Torque value from where Rundown angle limits monitoring starts.	
Angle min	Angle value for lower angle limit from the starting point.	100°
Angle max	Angle value for the upper angle limit from starting point.	1000°
Time min	Minimum time for the step.	10 ms
Time max	Maximum time for the step.	5000 ms
Pulse limits	Off: No pulse limit monitoring. From rundown complete: The monitoring starts when the Rundown complete torque is reached. From torque: The monitoring starts when the specific torque value is reached.	Off
Final pulse monitoring torque	Torque value from when the pulse limits are monitored.	
Pulses min	Minimum number of pulses to reach the final target.	
Pulses max	Maximum number of pulses to reach the final target.	
Premature torque loss detection time	A constant increase in torque is assumed when moving from run-down to tightening. A socket slip off, or a broken screw head can cause the torque decrease. This may be detected in a monitoring window.	200 ms

Tightening using the TensorPulse program

 The principle below is applicable for direct driven electrical tool. It is applicable to the Atlas Copco SRB series of tools.

After each pulse period the resulting torque in the screw is increased. After a series of pulses, the final torque target is reached.

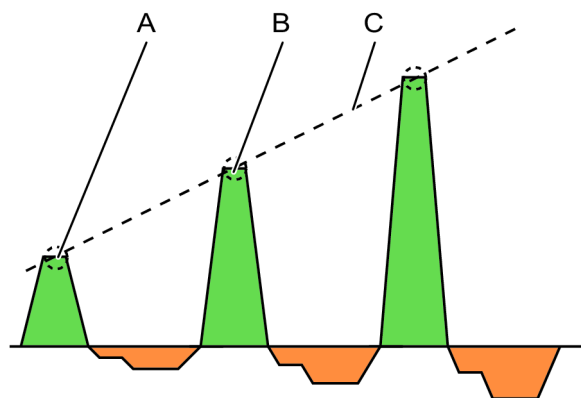


Illustration 9: TensorPulse with maximum pulse energy

A	Maximum positive energy in pulse N	B	Maximum positive energy in pulse N+1
C	Increase in energy (torque)		

The energy level in the action phase and reaction phase are user configurable parameters. The combination of these two parameters create an efficient tightening combined with operator comfort. It is possible to set the amount of energy in the two phases as a percentage of the maximum energy that can be delivered in each period:

- *Pulse energy*; The amount of energy that is applied to each positive pulse as a percentage of the maximum energy that can be applied in the pulse period. The value is between 10-100%.
- *Reaction force retention factor*; The amount of energy that is applied to each reactive pulse as a percentage of the maximum energy that can be applied in the pulse period. The value is between 0-75%.

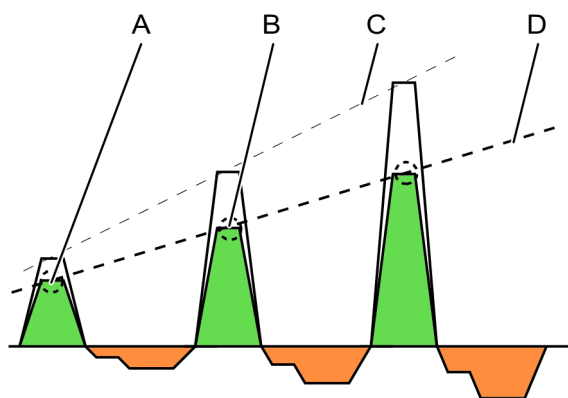


Illustration 10: TensorPulse with reduced positive pulse energy

A	Reduced positive energy in pulse N	B	Reduced positive energy in pulse N+1
C	Resulting curve for torque build up using maximum pulse energy.	D	Resulting curve for torque build up using reduced pulse energy.

- A small **Pulse energy** (reduced energy) requires more pulses to reach the target torque as the torque is increased in smaller steps. Smaller steps provides better accuracy to terminate the tightening when the target is reached. Smaller pulses decrease tool movement and increases operator comfort.

- A correctly tuned the *Reaction force retention factor* will create the desired operator comfort. If the factor is too high the operator feels a clock wise rotation of the tool. If the factor is too low, the operator feels a counter clock wise rotation of the tool.
 - In an ideal configuration, the reaction energy does not create any loosening force. If the amount of pulses to reach the target value increases, the value is set too high and a small loosening occurs at each pulse.
- ❗ The optimum values for the *Pulse energy* and the *Reaction force retention factor* need to be tuned for optimum performance of the tool and best operator comfort.

Impulse single step tightening program

The **Impulse - single step** tightening strategy is available for pulsing tools. The strategy can be selected if the controller software version supports the tightening program. Pulsing tools can achieve a higher torque compared to normal rotating tools.

The table lists all the parameters for the **Impulse - single step** tightening strategy. Some parameters are mandatory, some are optional and some are conditional.

The conditional parameters are not shown in the configuration menu if the condition is not valid. which is the same as a certain function is disabled.

Parameters for the Impulse - single step start

During the start step, the tool rotates in a speed mode without any pulsing.

Parameter name	Condition	Description	Default value
Soft start		Enables setting of the tool's speed to facilitate the bolt entering the thread. Selected by radio buttons. Off: Soft start is turned off. On: Soft start is turned on.	On
Speed	Soft start = On	Defines the speed during the soft start.	300rpm
Time	Soft start = On	Defines the <i>Soft start</i> duration.	400ms
Rehit detection		Selected from a shortcut menu: Detects attempts to tighten an already tightened bolt. Complete: The tightening is not terminated until all tightening steps have been executed. The tightening will be considered as NOK. Off: No rehit detection will be performed.	Early
Use attachment tuning	<i>Attachment tuning enabled</i> in the Properties menu	Attachment tuning is selected by radio buttons.	
Gear ratio	<i>Use attachment tuning</i> = Yes	Socket rotation speed = Tool speed / gear ratio.	1.0

Parameter name	Condition	Description	Default value
Efficiency tuning	<i>Use attachment tuning = Yes</i>	For example 0.9 means 10% efficiency loss.	1.0

Table 16: Parameters for the **Impulse - single step** start**Parameters for the Impulse - single step rundown**

Parameter name	Condition	Description	Default value
Rundown speed		Selected by radio buttons. Rundown speed can be selected between Max or Manual .	Max
Rundown speed	Rundown speed = manual	Specifies the tool speed during the rundown step.	
Rundown time limits		Selected from a shortcut menu: Off: Rundown time limits is turned off. From Trigger: Rundown time limits is turned On. The system starts to monitor the time as soon as the tool trigger is pressed and reports if the time limits are violated. From torque: Rundown time limits is turned On. The system starts to monitor the time from the specified torque value and reports if the time limits are violated.	Off
Rundown time monitoring torque	Rundown time limits = from torque	Torque value from where Rundown time limits monitor starts.	
Time min	Rundown time limits = On	Minimum allowed time for rundown.	10ms
Time max	Rundown time limits = On	Maximum allowed time for rundown.	5000ms
Rundown pulse limits		Selected from a shortcut menu: Off: Rundown pulse limits is turned off. From Trigger: Rundown pulse limits is turned On. The system starts to monitor the pulses as soon as the tool trigger is pressed and reports if the pulse limits are violated. From torque: Rundown pulse limits is turned On. The system starts to monitor the pulses from the specified torque value and reports if the pulse limits are violated.	Off
Rundown pulse monitoring torque	Rundown pulse limits = from torque	Torque value from where the Rundown pulse limits monitor starts.	2.5Nm
Pulses min	Rundown pulse limits = On	Minimum number of pulses to reach the target.	2

Parameter name	Condition	Description	Default value
Pulses max	Rundown pulse limits = On	Maximum number of pulses to reach the target.	50
Rundown complete torque		Defines the torque value for when snug is reached and rundown is completed.	5Nm

Table 17: Parameters for the Impulse - single step rundown

Parameter name	Condition	Description	Default value
Target torque		Final target torque for the tightening.	
Pulse Energy		The <i>Pulse energy</i> delivered in the action pulse expressed in a percentage of the maximum energy the tool can deliver in each pulse.	
Residual torque correlation factor		The term Residual torque correlation factor is similar to a calibration and adjusts between the dynamic torque, measured in the electrical tool, and the residual torque, measured by a control tool.	100%
Torque limits		Selected by radio buttons. Limits can be Automatically or Manually selected	
Torque min	Torque limits = manual	Minimum torque for the step.	
Torque max	Torque limits = manual	Maximum torque for the step.	
Time limits		Selected from a shortcut menu: Off: Time limits is turned off. From rundown complete: Time limits is turned On. The system starts to monitor the time as soon as <i>rundown complete</i> is reached and reports if the time limits are violated. From torque: Time limits is turned On. The system starts to monitor the time from the specified torque value and reports if the time limits are violated.	Off
Time monitoring torque	Time limits = from torque	Torque value from where the Time limits monitor starts.	
Time min	Time limits = On	Minimum allowed time for tightening.	10ms
Time max	Time limits = On	Maximum allowed time for tightening.	1000ms
Pulse limits		Selected from a shortcut menu: Off: No pulse limit monitoring. From rundown complete: The monitoring starts when the Rundown complete torque is reached and reports if the number of pulses is outside the limit. From torque: The monitoring starts when the specific torque value is reached and reports if the number of pulses is outside the limit.	Off

Parameter name	Condition	Description	Default value
Final pulse monitoring torque	Pulse limits = from torque	Torque value from when the pulse limits are monitored.	
Pulses min	Pulse limits = on	Minimum number of pulses to reach the final target.	2
Pulses max	Pulse limits = on	Maximum number of pulses to reach the final target.	50
Premature torque loss detection time		A constant increase in torque is assumed when moving from rundown to tightening. A socket slip of, or a broken screw head can cause the torque decrease. This may be detected in a monitoring window.	200 ms

Table 18: Parameters for the **Impulse - single step** tightening

Four Step tightening strategy

Introduction to the four step tightening strategy

WARNING Risk of injury

A change in configuration to the tightening program may cause unexpected torque, rotational direction, or speed in the system(s) where the tightening program is currently in use. This could result in severe bodily injury and/or property damage.

- Check the tightening program configurations after adding a new program or after applying changes to an existing program.

The four step tightening strategy is divided into separate steps, that can be switched **On** or **Off**, to customize the tightening task.

Each step has a target value and may monitor other values and is divided as follows:

Step	Function
Start	The start step is used to engage the threads and to detect if a tightening has already occurred.
Rundown	The rundown step is used to run down a screw to the snug level.
Tightening	The tightening step is used to tightening the screw to a defined torque level, and may be divided into several steps. This final target value may be either a target torque or a target angle.
Stop	The stop step is to finalize the tightening in an ergonomic way.

Example 1: If the start and rundown steps are used to tighten a screw to the snug level, a final tightening can be made in a later step.

Example 2: If the tightening steps are used in a previous snug level tightening, a final assembly can be made to tighten the joint to the final target value.

Overview of the four step tightening strategy

A graphical representation of the different steps and curves for speed, torque and rotation angle seen over time.

-  The graphical representation is used in the documentation to describe the configuration setting and the meaning of the parameter values. The graphs are not used in any GUI.

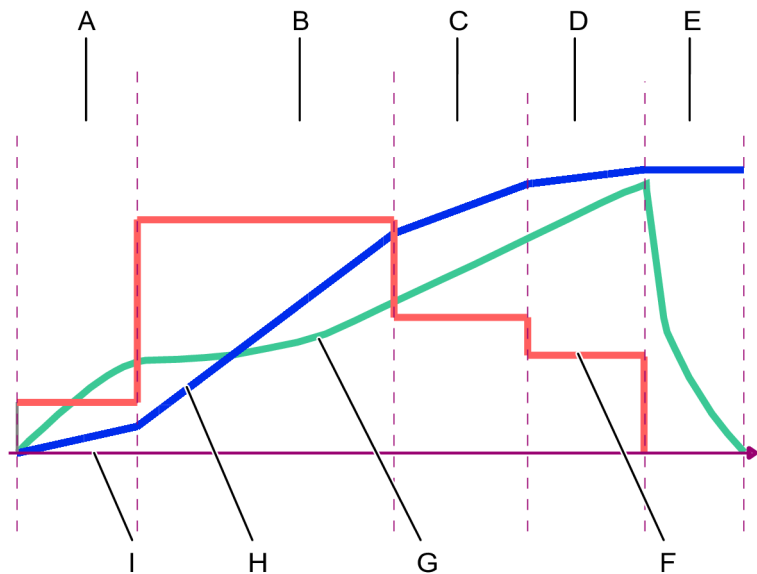


Illustration 11: The four step tightening strategy

A	Start step	B	Rundown step
C	First step of the Tightening step	D	Final step of the Tightening step
E	Stop step	F	Speed over time curve
G	Torque over time curve	H	Angle over time curve
I	Time direction		

Each step is configured with respect to torque, angle, time and tool speed. Each step has one target value which is either torque or angle, and monitors the other values.

The different steps and their target values are:

Step	Function
Start	Target = Angle The step is used to engage the threads and to detect if a tightening has already occurred. Time, angle and torque limits can be monitored.
Rundown	Target = Torque The step is used to run down a screw or a nut to the snug level, with a defined torque value. Time, angle and torque limits can be monitored.
Tightening	The tightening step is divided into two steps: first tightening and final tightening . First tightening target = Torque. The step is used to tightening the screw or nut to a defined first target torque level. Final tightening target = Angle or Torque. The step is used to continue the tightening from the first tightening target to a final target angle or to a higher final target torque. Time, angle and torque limits can be monitored.
Stop	The Stop step terminates the tightening so that the socket can be released.

Parameter definition

Different parameters control the four step tightening. To illustrate the parameters and their position they are shown in the combined speed-over-time curve, angle-over-time curve and torque-over-time curve.

- ❗ The graphical representation is used in the documentation to describe the configuration setting and the meaning of the parameter values. The graphs are not used in any GUI.

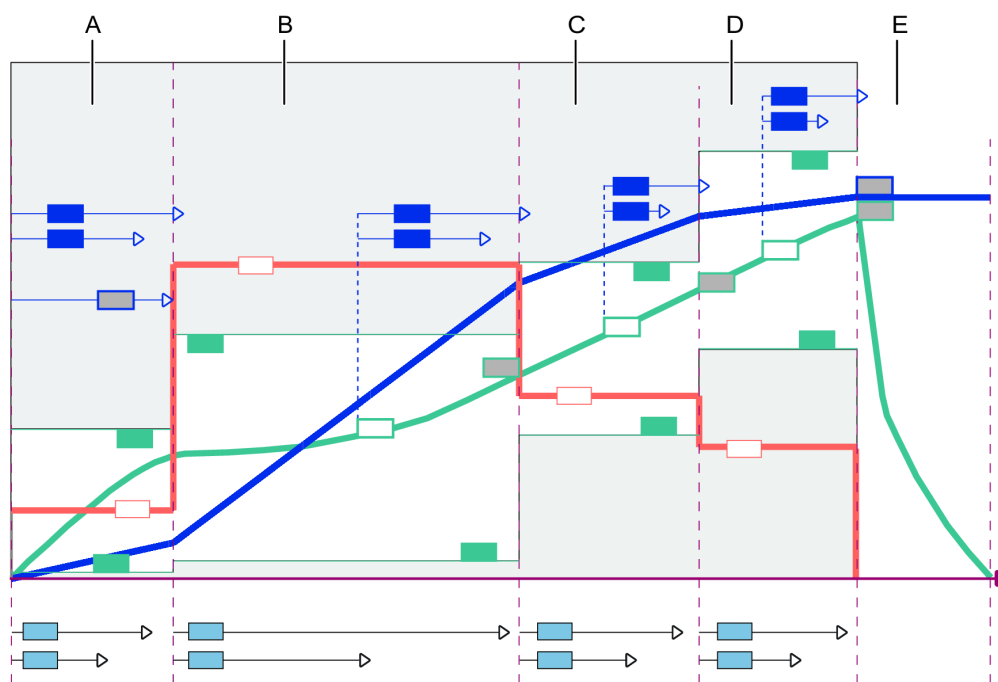


Illustration 12: Four step tightening strategy - all parameters

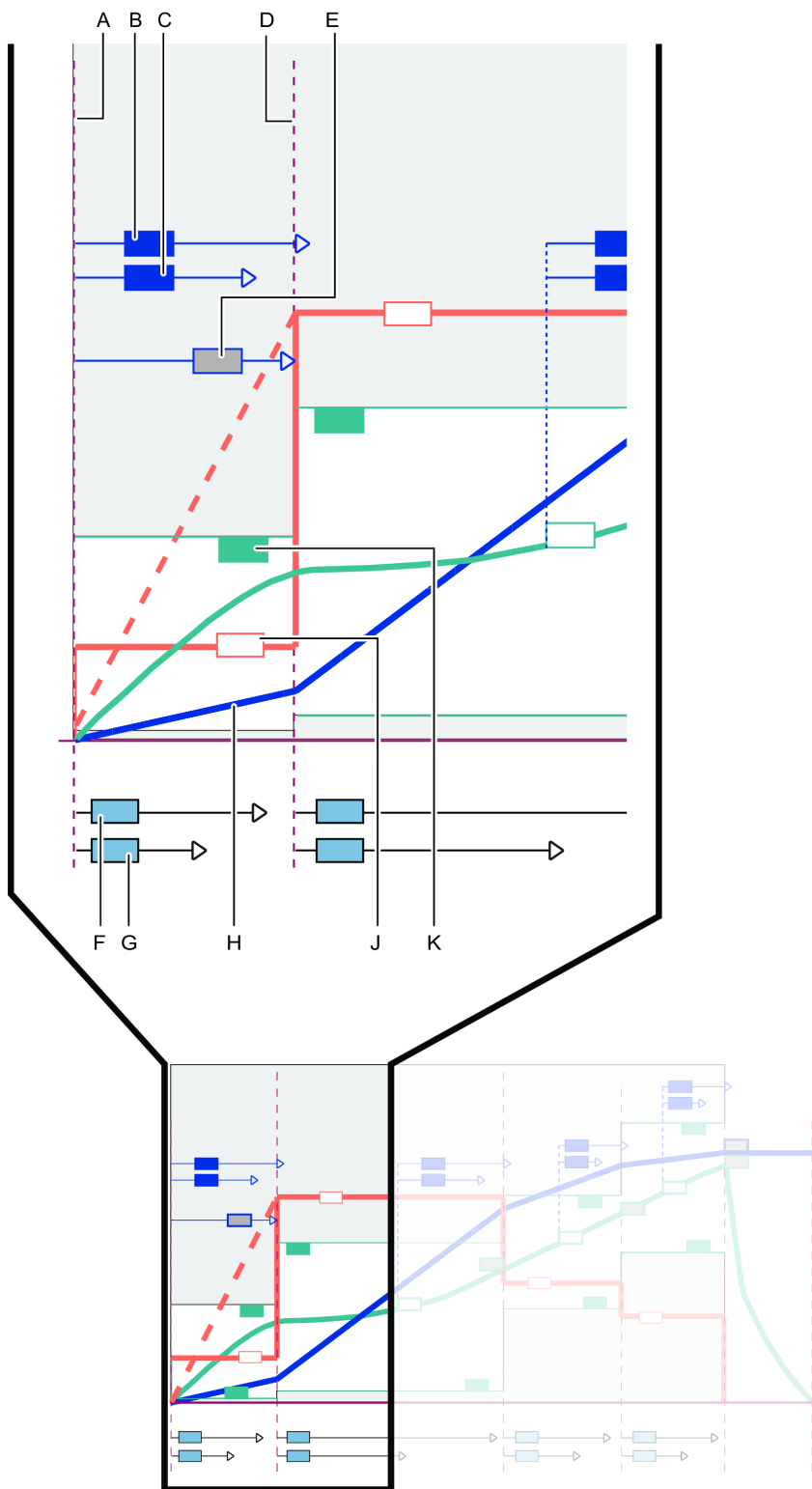
A	Start stage
B	Rundown stage
C	Tightening stage: First step
D	Tightening stage: Final step
E	Stop stage

Parameters for four step tightening - start step

The time, torque and angle are monitored during the start step. This step has an angle as target.

- ❗ The graphical representation is used in the documentation to describe the configuration setting and the meaning of the parameter values. The graphs are not used in any GUI.

The step is defined from trigger pressed until the specified target angle is reached.



52938667

A	Trigger pressed
B	Angle max (monitor)
C	Angle min (monitor)
D	End of start step
E	Target angle for start step
F	Time min (monitor)
G	Time max (monitor)

H	Angle curve
J	Speed curve
K	Torque max value (monitor)

 The tables list all available parameters. Some parameters are only available and visible for specific functions.

Parameter	Description
Direction	Rotation direction for the tightening. CW: Clockwise CCW: Counter clockwise
Current monitoring	Off: Current monitoring is disabled and the tool torque is measured by the torque sensor. On: the current is measured at final torque target and converted to a torque value. The calculated torque is compared to the measured torque. If the difference is within 10%, the tightening is considered OK
True angle compensation	Switch with On or Off position.
Soft start	On: The soft start allows a smooth start at slow speed. It is used to engage the thread. Off: The tool speed ramps up to the rundown speed as quickly as possible.

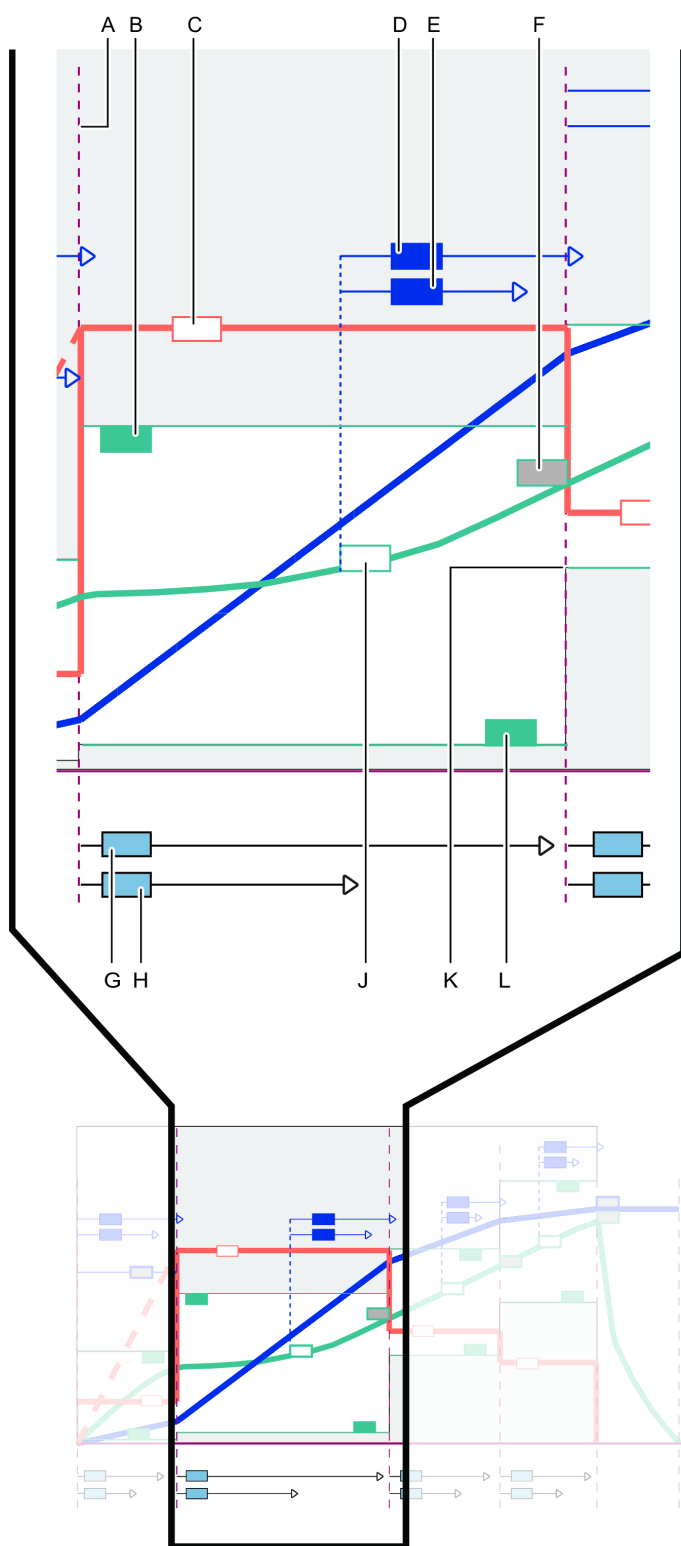
Parameter	Description
Speed	Defines the speed during Soft start.
Angle	Target angle for the step. End of step is defined at this point, when the target has been reached.
Angle min	Monitors the angle value and checks that the result is within the limit.
Angle max	Monitors the angle value and checks that the result is within the limit.
Torque min	Defines the lower torque limit during Soft start. If Torque min falls below the limit, the tightening is aborted and an error message is given. The tightening will be considered NOK.
Torque max	Defines the upper torque limit during Soft start. If Torque max is exceeded, the tightening is aborted and an error message is given. The tightening will be considered NOK.
Time min	Minimum time for the step. measured from trigger pressed. Expressed in a numeric millisecond value.
Time max	Maximum time for the step. measured from trigger pressed. Expressed in a numeric millisecond value.
Negative	Only visible if True angle compensation = On . Defines the maximum negative rotation of the tool. If the value is exceeded the tightening is terminated and an error is reported. Expressed in a numeric angle value.

Parameter	Description
Positive	Only visible if True angle compensation = On . Defines the maximum positive rotation of the tool. If the value is exceeded the tightening is terminated and an error is reported. Expressed in a numeric angle value.

Parameters for four step tightening - rundown step

The **Rundown** step is from thread engagement until the screw head reaches the snug level. During rundown; time, torque and angle are monitored. The target value for the step is when the **Rundown complete torque** level is reached.

-  The graphical representation is used in the documentation to describe the configuration setting and the meaning of the parameter values. The graphs are not used in any GUI.



52942891

Illustration 13: Four step tightening - parameters in the rundown step

A	Start of Rundown step
B	Maximum torque level (monitor)
C	Speed curve
D	Minimum angle (monitor); Measured from Rundown angle monitoring torque
E	Maximum angle (monitor); Measured from Rundown angle monitoring torque
F	Rundown complete torque value
G	Time max (monitor)

H	Time min (monitor)
J	Torque curve and Rundown angle monitoring torque reference point
K	End of rundown step, when target value is reached
L	Minimum torque level (monitor)

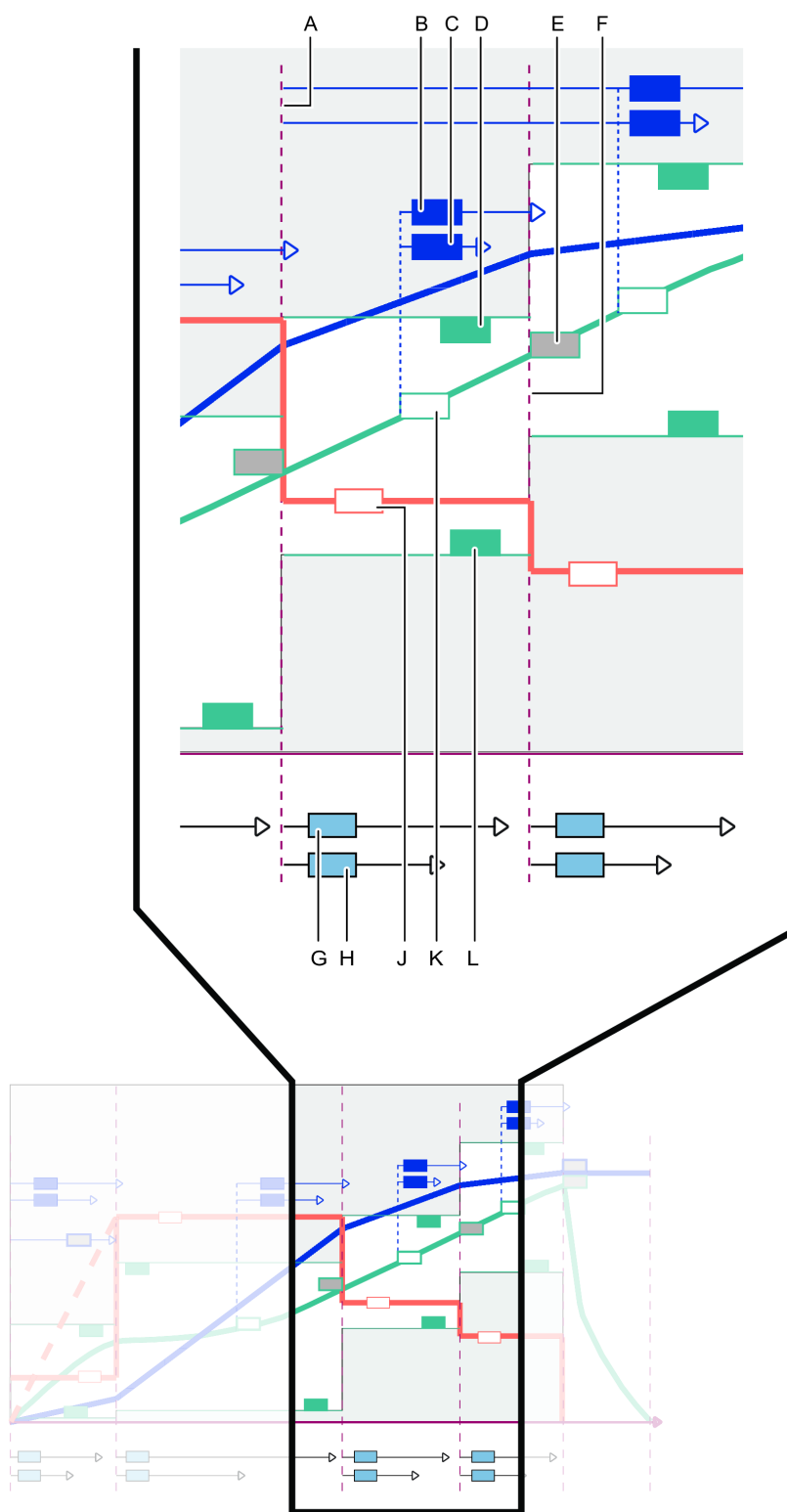
Parameter	Description	Default value
Rundown	Switch with On or Off position. If the switch is in the Off position, the step is not executed and all other parameters are invisible and are ignored. If both the start step and the rundown step are switched off, a final tightening can be performed as a separate task.	On

Parameter	Description	Default value
Rundown speed	If Max position, the speed is the set to full tool capability. If Manual position, the speed is set manually.	Max
Rundown speed (parameter entry box)	This parameter entry box is only visible when Manual speed setting is selected. The spindle rotation speed during the step.	690 rpm
Torque min (monitor)	Minimum torque value during the step.	0 Nm
Torque max (monitor)	Maximum torque value during the step.	6 Nm
Rundown angle monitoring torque	A specified torque value. From this point in time the angle monitoring starts.	0 Nm
Angle min (monitor)	Minimum spindle rotation for the step. Measured from Rundown angle monitoring torque .	100 degree
Angle max (monitor)	Maximum spindle rotation for the step. Measured from Rundown angle monitoring torque .	5000 degree
Time min (monitor)	Minimum time for the step. Measured from the start of the step.	10 ms
Time max (monitor)	Maximum time for the step. Measured from the start of the step.	5000 ms
Rundown complete torque	Defines the target torque for the rundown step. End of step is defined at this point, when the target value is reached.	5 Nm

Parameters for four step tightening - first tightening step of the tightening step

The tightening step is divided into two steps, first step and final step. The **First tightening** step is from rundown complete until the **First torque** target level is reached. During the first tightening; time, torque and angle are monitored.

-  The graphical representation is used in the documentation to describe the configuration setting and the meaning of the parameter values. The graphs are not used in any GUI.



52847115

Illustration 14: Four step tightening - parameters in the first step of the tightening step

A	Start of the First tightening step in the tightening step
B	Min angle (monitor); Measured from First angle monitoring torque
C	Max angle (monitor); Measured from First angle monitoring torque
D	Maximum torque level (monitor)
E	First tightening torque value; Defines the target value and the end of the step
F	End of step
G	Time max (monitor)

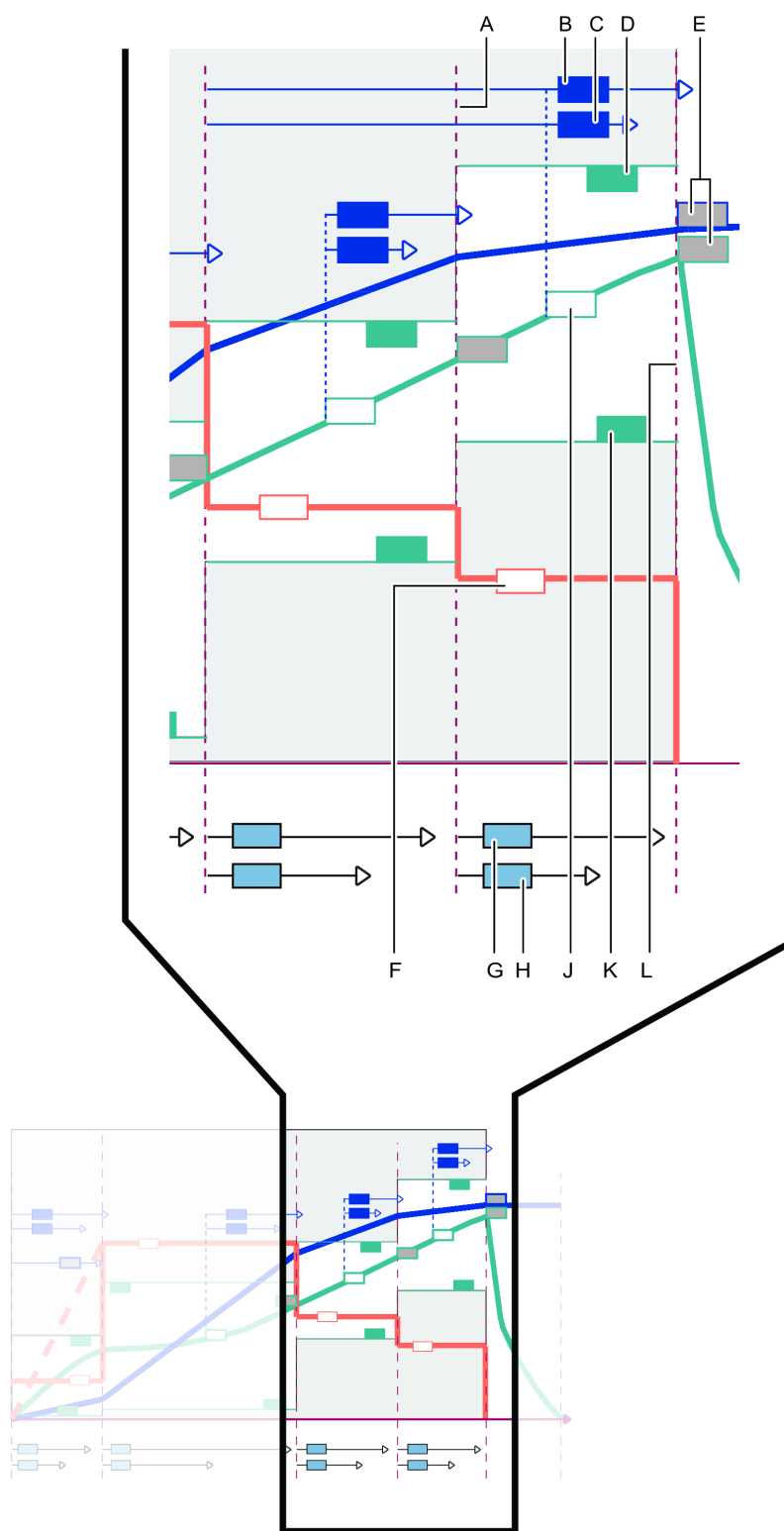
H	Time min (monitor)
J	Speed curve
K	Torque curve and First angle monitoring torque reference point
L	Minimum torque (monitor)

Parameter	Description	Default value
First step	If the switch is in the Off position, the step is not executed and all other parameters are invisible and are ignored.	On
First torque	Defines the target torque for the step. End of step is defined at this point, when the target is reached.	
First speed	If Auto position, the speed is set automatically. If Manual position, the speed is set manually.	20 Nm
First speed (parameter entry box)	This parameter entry box is only visible when Manual speed setting is selected.	345 rpm
	The spindle rotation speed during the step.	
First torque min	Minimum torque value during the step.	19 Nm
First torque max	Maximum torque value during the step.	21 Nm
First angle monitoring torque	A specified torque value. From this point in time the angle monitoring starts.	5 Nm
First angle min	Minimum spindle rotation for the step. Measured from First angle monitoring torque .	0 degree
First angle max	Maximum spindle rotation for the step. Measured from First angle monitoring torque .	500 degree
Time min	Minimum time for the step. Measured from the start of the step.	10 ms
Time max	Maximum time for the step. Measured from the start of the step.	500 ms
Measure torque at	Max torque value Value at peak angle Value at shut off	

Parameters for four step tightening - final tightening step

The tightening step is divided into two steps, first step and final step. The **First tightening** step is from rundown complete until the **First torque** target level is reached. During the first tightening; the time, torque and angle are monitored. The **Final tightening** step is from **First torque** until the final target level is reached. During the final tightening; the time, torque and angle are monitored. The target value for the step is either when the **Target torque** or the **Target angle** level is reached.

-  The graphical representation is used in the documentation to describe the configuration setting and the meaning of the parameter values. The graphs are not used in any GUI.



52851339

Illustration 15: Four step tightening - parameters in the final step of the tightening step

- | | |
|---|--|
| A | Start of Final tightening step |
| B | Minimum angle (monitor); Measured from a selectable reference point |
| C | Maximum angle (monitor); Measured from a selectable reference point |
| D | Maximum torque level (monitor) |
| E | Final target is either the Target torque or the Target angle ; angle reference point is measured from a selectable reference point |
| F | Speed curve and speed value |

G	Time maximum (monitor)
H	Time minimum (monitor)
J	Torque curve and Final angle monitoring torque reference point
K	Minimum torque (monitor)
L	End of step

The parameters differ between **Target torque** and the **Target angle** selection.

Parameter	Description	Default value
Target	Pull-down selection of final target. Torque: The final target in the tightening step is a torque value. Angle: The final target in the tightening step is an angle value.	
Final target speed	Switch with Manual or Auto position. If the switch is in the Auto position, the speed is the set automatically by the tightening algorithm. If the switch is in the Manual position, the speed is the set manually.	Auto
Final target speed (parameter)	This parameter is only visible when Manual speed setting is selected. The spindle rotation speed during the step. Expressed in a numeric value in rpm.	113
Final target torque	Defines the target torque for the step. End of step is defined at this point, when the target has been reached.	
Torque limits	Switch with Manual or Auto position. The switch is only visible if the final target value is set to Torque . If the switch is in the Auto position, the torque limits are set automatically by the tightening algorithm. If the switch is in the Manual position, the maximum and minimum torque limits are set manually.	Auto
Final torque min	The parameter is only visible if Manual torque limits have been selected. Minimum torque value during the step. Expressed in a numeric torque value.	Final target torque - 5%
Final torque max	The parameter is only visible if Manual torque limits have been selected. Maximum torque value during the step. Expressed in a numeric torque value.	Final target torque + 20%
Angle limits	Pull-down menu to select the reference point for angle limits. • From torque: Angle monitoring is measured from the Final angle monitoring torque point, which must be higher than the First torque value and lower then Final target torque.	
Final angle monitoring torque	A specified torque value. From this point the angle monitoring starts. The value must be higher than the First torque value and lower then Final target torque .	

Parameter	Description	Default value
Final angle min	Minimum spindle rotation for the step. Reference point for the measurement is selected from the pull-down menu Angle limits . Expressed in a numeric degree value.	324 degree
Final angle max	Maximum spindle rotation for the step. Reference point for the measurement is selected from the pull-down menu Angle limits . Expressed in a numeric degree value.	396 degree
Time min	Minimum time for the step. Measured from the start of the step. Expressed in a numeric milli second value.	10ms
Time max	Maximum time for the step. Measured from the start of the step. Expressed in a numeric milli second value.	1000 ms
Measure torque at	Max torque value Value at peak angle Value at shut of	

Table 19: Parameters if Final target = torque

 The values specified in the table assumes that the first step of the tightening step is switched on.

Parameter	Description	Default value
Target	Torque: The final target in the tightening step is a torque value. Angle: The final target in the tightening step is an angle value.	
Final target speed	If Auto position, the speed is the set automatically by the tightening algorithm. If Manual position, the speed is the set manually.	Auto
Final target speed (parameter)	This parameter is only visible when Manual speed setting is selected. The spindle rotation speed during the step.	113
Final torque min	The parameter is only visible if Manual torque limits have been selected. Minimum torque value during the step. Must be above First target torque .	
Final torque max	The parameter is only visible if Manual torque limits have been selected. Maximum torque value during the step.	
Min torque at final supervision	The value is used to monitor and to ensure that a minimum torque level is maintained during the entire final step. The level is normally set below the final torque minimum but higher than the rundown torque level. It can be used to verify that the screw is not broken during the tightening.	18 Nm
Final target angle	Defines the target angle for the step. The reference point for the target angle is measured from the end of the previous activated step or step. End of step is defined at this point, when the target has been reached.	

Parameter	Description	Default value
Angle limits	Pull-down menu to select the reference point for angle limits. • Auto. Sets a window of plus/minus 10% of the final target value. • Manual. Allows manual setting of maximum and minimum values. Sets a window of plus/minus 10% of the final target value as default value.	
Final angle monitoring torque	A specified torque value. From this point the angle monitoring starts. The reference point depends on previous activated steps or steps.	
Final angle min	Minimum spindle rotation for the step. Reference point for the measurement is selected from the pull-down menu Angle limits . Expressed in a numeric degree value.	324 degree
Final angle max	Maximum spindle rotation for the step. Reference point for the measurement is selected from the pull-down menu Angle limits .	396 degree
Time min	Minimum time for the step. Measured from the start of the step.	10ms
Time max	Maximum time for the step. Measured from the start of the step.	1000 ms
Measure torque at	Max torque value Value at peak angle Value at shut off	

Table 20: Parameters if Final target = angle

Parameters for four step tightening - stop step

Soft-stop [Page 59] is used to finish the stop step in an ergonomic way.

Parameter	Description
Soft-stop	Pull-down menu with On or Off selection. If soft stop is Off, the tool stops as fast as possible after the final target has been reached. When the tool speed is reduced as fast as possible it can cause a reaction force. A reaction force can corrupt an angle measurement, which can be compensated with a True-angle compensation. If soft stop is On the tool breaks the tightening speed to a comfort stop.

Multistep tightening strategy

Description

WARNING Risk of injury

A change in configuration to the tightening program may cause unexpected torque, rotational direction, or speed in the system(s) where the tightening program is currently in use. This could result in severe bodily injury and/or property damage.

- ▶ Check the tightening program configurations after adding a new program or after applying changes to an existing program.

A multistep tightening is a tightening done in several steps. The number of steps and the type of steps vary depending on the tightening to be done. A multistep tightening program is highly configurable, including monitoring function and restrictions.

 The multistep tightening strategy has not been implemented for STB tools.

STB Tools and multistep

Due to the wireless nature of STB tools, some multistep functions and behaviors may be different. Besides the general limitations listed here, descriptions of multistep functions will carry additional information on STB tools where necessary.

Program Validation

All tightening programs will be validated for compatibility with STB tools before the program is downloaded to the tool. If the chosen tightening program is not compatible with the tool, the tool will be locked. When the error occurs, it will trigger event 5030, "Configuration complexity exceeded".

To unlock the tool, reduce the complexity of the tightening program, or choose a different tightening program altogether.

Restrictions

Restrictions are used to make sure the tightening stops if something unexpected occurs. These restrictions could, for example, test that a maximum torque is not reached or that a part of the multistep tightening does not take too long to run. Every step can have up to 4 restrictions. Every step has its own set of mandatory step restrictions and optional step restrictions. The mandatory restrictions are included automatically when dragging a new step to the multistep program.

Monitors

Monitors are used to verify that the tightening was made according to the specification. These can be, for example, angle limits or torque limits. Every step can have up to 8 monitors. Each step has its own set of mandatory step monitors and optional step monitors. The mandatory monitors are included automatically when dragging a new step to the multistep program.

Multistep GUI interface

 While multistep tightening programs can be selected from the controller screen, **editing** programs can only be done in the web GUI.

The interface for multistep programs can be divided into three main areas.

On top there is a drop-down menu containing the Properties of the multistep tightening program. Here general properties such as program name, overall program monitor and validation can be filled out.

To the right there are three tabs containing the steps, monitors and restrictions that can be used to build the multistep program. To use any of the items, click on the appropriate tab, and drag the item in the list to the tightening area. Depending on its function, either drop the item between the beginning and the end of the program (for steps), or on top of a particular step (for monitors and restrictions).

The main area of the interface is made up of the **tightening area**. This is the area that includes all the steps in the tightening program.

At bottom left of the screen there are zoom buttons (+ and -), as well as a Delete button. Use the zoom buttons to zoom in and out on the tightening area.

Adding a multistep program

1. In the **Tightening** menu, click on the **Multistep program library**.
2. Click on the **Plus** icon top right and choose the appropriate type of program in the pop-up window (Tightening or Loosening).

Deleting a multistep program

1. In the **Tightening** menu, click on the **Multistep program library**.
2. In the list, click on the multistep tightening program you want to delete.
3. In the program itself, at the bottom left, click on **Delete**.
4. Click **Yes** in the pop-up window to confirm your choice.

Multistep tightening program properties

General settings

Parameter	Description
Name	A user defined name for the multistep program.
Thread Direction	Direction of the threads, either Clockwise or Counter Clockwise
Loosening Program	Indicate if a loosening program is available. Choose from the list of available loosening programs in the controller
Type	Type of program, either Tightening or Loosening
Program Start	Sets the torque level for generating a result. If left blank, the result is generated every time the tool is started; otherwise result is only generated from the set torque level.

Parameter	Description
True Angle Compensation	Turns True Angle Compensation on or off (default is Off)

Program Monitor

Parameter	Description
Angle	Turn angle monitoring On or Off for the entire program. If <i>Active in steps</i> and <i>Trigger Torque</i> are left blank, angle monitoring will start at program start.
Active in steps	Sets a range of steps the angle monitoring is valid for. If no end step is specified, angle monitoring will stop at the last step of the program that is not a <i>Socket Release step</i> .
Type	Type of angle monitoring. Choose between: • Peak Angle: the highest angle reached during the monitor • Angle at Peak Torque: the angle at the point where the highest torque was reached during the monitor (Not available for STB tools) • Shut Off Angle: the angle at the shut-off point of the step • Angle at End: the angle at the end of the monitor, including the brake, if active.
Trigger torque	Sets the value of the trigger torque for angle monitoring. For STB tools, Trigger Torque will only activate in the tightening direction when executing a tightening program; and only in the loosening direction when executing a loosening program.
Low limit	Sets angle monitoring (program) lower limit
High limit	Sets angle monitoring (program) higher limit

Program restrictions

Parameter	Description
Maximum Time Limit	Set amount in seconds. This restriction checks the total time for the tightening and if it exceeds the Time High limit the tool is stopped immediately. The time is measured from the start of the program.
Maximum Torque Limit	This restriction checks the torque and if the measured torque exceeds the Torque High limit the tool is stopped immediately.

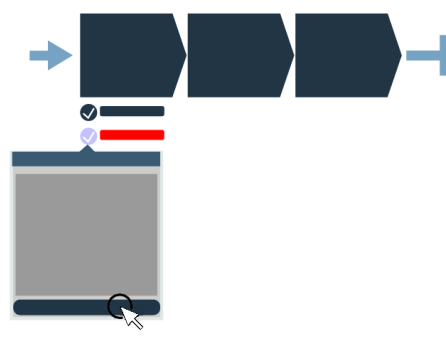
Validation

Parameter	Description
Validate against tool values	Use On if tool is known and set Max Torque and Max Speed . Use Off if tool is not known.
Max torque	Max torque of the tool to validate against.
Max speed	Max speed of the tool to validate against.

Building a multistep program

In order to build a multistep program, drag and drop steps, monitors and restrictions in the tightening area. Note that steps can only be placed between the start and end points of the program. Monitors and restrictions can only be placed on steps.

Function		Description
Start and end points		Start and end points of the multistep program. All steps must be placed between these two points.
Adding a step		Drag a step from the list and drop it in the desired position between the start and end points.
Moving a step		Click and hold a step and move it to the desired position
Showing step properties		Click on the step to reveal the properties
Closing step properties		Click anywhere in the tightening area to close the properties menu

Function		Description
Deleting a step		Open the step properties and click Delete at the bottom of the menu
Adding a restriction/monitor		Drag a restriction/monitor from the list and drop it on the appropriate step.
Moving a restriction/monitor		Click and hold the icon (checkmark for monitor, stop sign for restriction) and drag and drop it on the appropriate step
Showing restriction/monitor properties		Click on the restriction/monitor icon to reveal the properties menu
Closing restriction/monitor properties		Click anywhere in the tightening area to close the properties menu
Deleting a restriction/monitor		Open the restriction/monitor properties and click on Delete at the bottom of the menu
Step error		When a validation error occurs in a step, that step will be marked. Note that when the step properties are opened, the parameter causing the error will also be marked.

Function		Description
Monitor/Restriction error		When a validation error occurs in a monitor or restriction, that monitor or restriction will be marked. Note that when the monitor/restriction properties are opened, the parameter causing the error will also be marked.
Forbidden placement		When a particular placement (of a step, monitor or restriction) is not allowed, the placeholder icon will not be shown.

Multistep Steps

Name

It is possible to rename each step, if needed.

Rotational direction

Each of the tightening steps can run either **forward**, i.e. make a tightening, or **backward**, i.e. loosen the screw a bit. The arrows indicate this direction. Many of the tightening steps have a direction hard coded to forward, e.g. Tighten to Angle, Tighten to Torque. Steps such as Loosen to Angle or Loosen to Torque have their direction automatically set to backward.

Step category

For each step, there is an option to choose a **step category**. By selecting step category, the NOK tightenings will be listed in the event result view with related detailed status together with the corresponding multistep error information. If no selection is made, the detailed status will be set to "uncategorized multistep error". The related detailed status can be customized.

Angle window

A joint is considered **Hard** if the screw is tightened to its full torque and it rotates 30 degrees (or less) after it has been tightened to its snug point. A **Soft** joint rotates 720 degrees or more after it has been tightened to its snug point. The hardness parameter defines the **Angle Window** for the gradient calculation. The harder the joint - the smaller the angle window.

Speed Ramp / Acceleration

For most of the steps it is possible to specify how the acceleration to the target speed should be done. Three different settings are possible; Hard, Soft and Manual. The acceleration defined will be used whenever a step is started. It doesn't matter if the tool is already running with some speed at the beginning of the step, the ramp will be used to accelerate to the target speed of the step anyway. It also does not matter if the speed at the start of the step is higher or lower than the target speed.

Speed ramp - Hard and Soft mode:

Acceleration	Speed ramp used
Hard	2000 rpm/s (Speed Ramp between 1000 and 10000 rpm/s is a Hard acceleration.)

Acceleration	Speed ramp used
Soft	500 rpm/s (Speed Ramp between 200 and 1000 rpm/s is a Soft acceleration.)

Speed ramp - Manual mode:

Parameter	Default value	Minimum limit	Maximum limit
Speed	60 rpm	Must be > 0	Must be ≤ Tool Max Speed
Acceleration	500 rpm/s	Must be > 0	Must be ≤ Tool Max Acceleration

Using speed shifts

You can define 1-5 angle triggers or torque triggers during a step, where the speed will shift.

-  Within one step, all the speed shift triggers are based on the same property, i.e. either torque or angle. They cannot be mixed within one step.

To add a speed shift:

1. In the dialog box of a step that can have speed shifts, click **Add speed shift** and choose an angle range or a torque range. The Speed Shift Angle/Torque fields open.
2. Add values according to the table below.

Parameter	Description
Angle/Torque trigger	Must be > 0.
Speed	Must be > 0.
Speed ramp type	Hard or soft.

The Torque triggers and Angle triggers must be less than the step target, depending on the type of the step and the trigger type.

The Torque trigger and Torque speed also validate against the Max torque and Max speed **of the tool**. A warning or error indicator occurs whenever the Speed Shift settings exceed either the tool max values or step max values.

-  It is possible to push the settings to the controller when a tightening program has a warning, but not when a tightening program has an error(fault) indicator.

W – Wait

The tool waits the specified time. If the hold position is set to **On** the tool holds the position during the **Time target**.

SR - Socket Release

This step runs the tool in the backward direction until the target angle is reached. The target angle is measured from the start of the step.

This step is only allowed to use as the last step in the tightening path of a multi-step tightening program.

DI – Run until Digital Input

This step runs the tool until digital input is received. Select which digital input to stop the tool and select stop condition: Falling edge, rising edge, any edge, signal low or signal high.

A – Tighten to Angle / Loosen to Angle

This step runs the tool until the target angle is reached. The target angle is measured from the start of the step and must be set to > 0 .

TrR – Loosen to Trigger Release

This step runs until the tool trigger is being released.

For STB tools, this step can only be added to loosening programs.

T - Tighten to Torque / Loosen to Torque

This step runs the tool until the target torque is reached. Forward direction to tighten, backward direction to loosen. The target torque must be set to > 0 . For the Loosen to Torque step to be active, the torque must first exceed 110 % of the target.

T+A – Tighten to Torque Plus Angle

This step runs the tool until the target torque is reached. From this point it continues to run an additional target angle. The target torque and the target angle must be set to > 0 .

T|A – Tighten to Torque or Angle

The tool runs until either target torque or target angle is reached, depending on which target is reached first. The target torque and the target angle must be set to > 0 .

T&A – Tighten to Torque and Angle

The tool runs until both target torque and target angle are reached. The target torque and the target angle must be set to > 0 .

DT – Tighten to DynaTork

This step runs the tool until the **Target Torque** is reached. The tool will then hold the current constant at the **DynaTork Percentage of Target Torque** during the **DynaTork time**.

 To avoid overheating of the tool, it is strongly recommended to never run DynaTork to more than 40% of the maximum torque of the tool.

Y – Tighten to Yield

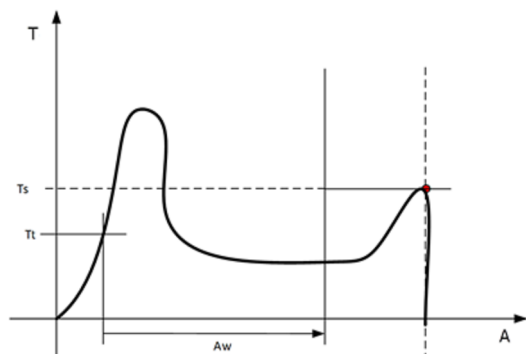
This strategy runs the tool with the speed in the forward direction until the yield point is detected. The yield point is found by monitoring the torque gradient from the point where the torque goes above the **Trigger Torque** level, calculated based on Torque and Angle distance measurements. The Angle distance parameter is set according to the specified hardness of the joint.

Set the **Gradient angle window** (for hard joint, for soft joint or for manually setting of the Angle window). If **Manual** is selected, the **Angle Window** must be set. A joint is considered **Hard** if the screw is tightened to its full torque and it rotates 30 degrees or less after it has been tightened to its snug point. A **Soft** joint rotates 720 degrees or more after it has been tightened to its snug point. The hardness parameter defines the Angle Window for the gradient calculation. The harder the joint - the smaller the angle window.

ThCT – Thread Cutting to Torque

The **Thread Cutting to Torque** function enables tightening where the rundown torque required is greater than the **Rundown complete** torque, for example when tightening thin layers of metal using self-threading (or selftapping) screws. The tool runs in forward direction until the **Thread Cutting Angle** (A_w) is reached. The thread cutting angle window is measured from when the torque passes **Thread Cut Trigger Torque** (T_t) for the first time. From the point where Thread cutting angle is reached, the step continues to run until the **Target Torque** (T_s) is reached.

T = Torque, A = Angle



RD – Rundown

Rundown step is the part of the tightening from when the screw enters the thread until just before the screw head touches the underlying surface and snug point is reached. The torque required during rundown does not contribute to any clamping force.

This step runs the tool in forward direction and stops either at a specified **Target Torque** or at **Snug** level. If **Rundown type to Snug** is selected, the parameters **Trigger Torque**, **Angle Delta** and **Torque Slope** must be set.

E – Engage

This step runs the tool in both directions until the socket engages the screw. The step continues until **Target Torque** or **Target Angle** is reached, provided that **Continue if not Engaged** is set to **Yes**. If Target Angle is reached in any direction, the direction is reversed. Limit the search iterations by entering **Maximum Engage Attempts**. If Target Torque is reached in any direction the step will finish with **OK** status.

Ext - External Result

External result is a strategy used when an OK tightening is indicated by an external digital signal (and not by torque or angle values measured during tightening). This external signal can be provided through any means that can provide a digital signal into the Power Focus 6000 (e.g through the I/O bus).

When the signal is sent, the result view (logged data) will show the value of the Target parameter provided in the tightening program (specified torque value, angle value, or text string). These (torque and angle) values do not represent actual measured values, but only inserted text.

Parameter	Description
Torque <Target torque>	Numerical value for desired displayed target torque value. A signal could for example come from a Click Wrench and display <Target torque>.
Angle <Target angle>	Numerical value for desired displayed target angle value. A signal could for example come from a Click Wrench and display <Target angle>.

Parameter	Description
Text	Alphanumerical string for desired displayed text. For example: "Oil has been changed".

Multistep monitors and restrictions

Step Monitors

The step monitors are used to verify that the tightening was made according to the specification, for example, angle limits or torque. Each step has mandatory step monitors and optional step monitors. The mandatory monitors are included when dragging a new step to the multistep program. The optional monitors are flexible and can be placed as needed in the multistep program. Every step can have up to four monitors each.

The following monitors are automatically added to every step that is added to the multistep tightening program.

Step Monitor	Applicable steps
Angle	All
Peak Torque	All

Table 21: Default steps monitor

PT – Peak Torque

This step monitor measures the maximum torque reached during the monitor, including any over shoot, and checks that it is between **High Limit** and **Low Limit**.

SOT – Shut Off Torque

The shut off point is the point where the step reaches its target. With the step monitor Shut off Torque the torque is measured at the shut off point and checked to be between **High Limit** and **Low Limit**.

TRD – Torque Rate and Deviation

This step monitor measures and checks the torque rate, i.e. the ratio of torque vs. angle. The calculated torque rate is checked if it is within the torque rate limits defined by **High Limit** and **Low Limit**.

Parameter	Description	In illustration
TorqueStart	Torque from where AngleStart starts	Tstart
TorqueStop	Torque where the measuring of the torque is stopped.	Tstop
AngleStart	When AngleStart has been measured from TorqueStart the torque starts to be measured.	Astart
AngleStop	Angle point where the measuring of the torque is stopped.	Astop
Low Limit	Defined lowest torque.	TRL
High Limit	Defined highest torque.	TRH



tor are based on the mean torque value, calculated over **Number of Samples**. If the total angle of the step is less than Start Angle plus Angle Window Length the monitor will report NOK.

PVTL – Post View average Torque Low

Same as monitor **Post View average Torque High** but the monitor checks that all torque values in the **Angle Window Length** are above **Torque Limit Low** instead.

YA – Angle from Yield

The angle is monitored after finding the yield point. The Yield point is found by monitoring the torque gradient, calculated based on Torque and Angle distance measurements. The Angle distance parameter is set according to the specified hardness of the joint.

SSD - Stick Slip Detection

This monitor detects and reports stick slip effects during a step. The detection is done by counting number of times the torque falls below the **Trigger Level**, and if the number of times is larger than **Maximum Number of Oscillations** the stick slip error is reported. The monitor operates in two different modes, **Dynamic** or **Fixed**. The difference between the modes is the way Trigger level is calculated.

Dynamic Torque: Trigger Level is dynamically calculated as **Peak Torque Percentage** of the current max torque that has been reached so far during the monitor. The monitoring is started as soon as the torque passes the **Trigger Torque**.

Fixed Torque: Trigger Level is the fixed **Trigger Torque** specified by the user. In this mode the percentage is not needed.

If the torque never reaches the **Trigger Torque** the monitor is not started, this will result in status NOK.

PrT - Prevailing Torque

The monitor calculates the prevailing torque value in the **Window Length** and checks that it is between the Torque limits. The Angle Window starts at the angle degrees set in **Start Angle** in backward direction from the shut-off point, and spans for angle degrees set in Angle Window Length in backward direction. If **Start Angle** is left blank the angle window starts at the shut-off point. The calculated prevailing torque value is the mean torque value during the **Window Length**. The calculated value is saved as result data **Prevailing Torque Measured**. If **Torque compensation** is set to **On** the Prevailing Torque Measured will be subtracted from all torque result values in consecutive steps. Any previously calculated prevailing torque compensation values will no longer be subtracted from torque result values. If **Torque compensation** is set to **No**, no subtraction will be made in consecutive steps.

If the total angle of the step is less than Start Angle plus Angle Window Length the monitor will report NOK.

Ti – Time

Measures the elapsed time during the monitor and checks that it is between the time limits. The time measurement starts at the start of the monitor and, if the Trigger Torque is specified, at the point where the torque passes Trigger Torque for the first time during the monitor.

Restrictions

To make sure the tightening stops if something unexpected happens, it is possible to add restrictions to the multistep tightening program. Each step has its own set of mandatory step restrictions and optional step restrictions. The mandatory restrictions are included when dragging a new step to the multistep program. All steps can have up to four restrictions each.

The following restrictions are automatically added to every step that is added to the multistep tightening program.

Step Restriction	Applicable steps
Step Restriction Time High	All
Step Restriction Torque High	• Tighten to Angle • Tighten to Torque+Angle • Turbo Loosening • Wait • Socket release
Step Restriction Angle High	• Run until Digital Input • Tighten to Torque • TurboTight • Turbo Loosening • Tighten to DynaTork • Wait • Run until Digital Input • Loosen to Torque • Thread Cutting to Torque • Rundown • Tighten to Yield • Pulsing Rundown Snug • TensorPulse

Table 22: Default steps restrictions

Ti – Time high

This restriction checks the time. If **Maximum Limit** is reached the tool is stopped immediately.

A – Maximum Angle

This restriction measures the angle. If the measured angle reaches the **Maximum Limit** the tool is stopped immediately. The angle is measured from the start of the restriction or, if specified, from the point where the torque passes **Torque Trigger** for the first time during this step.

Parameter	Description
Trigger Torque	If specified, this is the torque from where the angle is measured.
Maximum Limit	If this limit is reached the tool is stopped immediately.

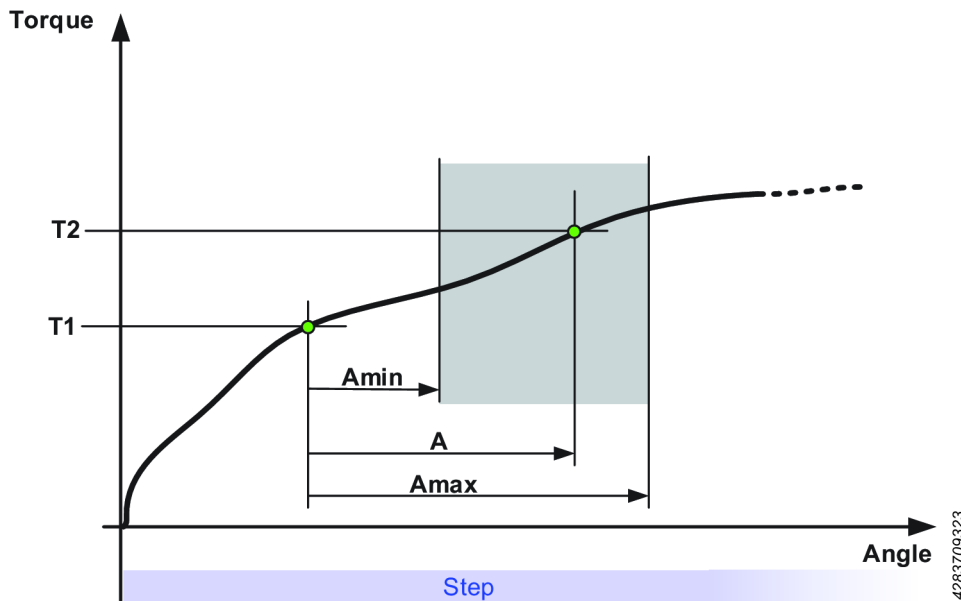
T - Maximum Torque

This restriction checks the torque and if the measured torque exceeds the **Maximum Limit**, the tool is stopped immediately.

CTh – Cross Thread

This restriction checks the angle from the point where torque passes **Start Torque** (T1) to the point where the torque passes **End Torque** (T2). If the angle measured from **Start Torque** (T1) is higher than **Maximum Angle Limit** (Amax), the tool is stopped immediately.

When the torque passes **End Torque** (T2), the measured angle is checked against the limit **Minimum Angle Limit** (Amin). If the angle is lower than this limit, the tool is stopped immediately.



RT - Rescinding Torque

This restriction checks the torque, and if the measured torque is lower than the **Rescinding Torque Limit** the tool is stopped immediately and the program jumps to the end of the program. For the restriction to be active, the torque first must exceed 110 % of the Rescinding Torque Limit.

Cable tools have the option of choosing Rescinding Torque for Angle. This restriction is controlled by two parameters: *Percentage* and *Time Below Limit*. Percentage sets the downward deviation from the last peak torque, and Time Below Limit sets the duration (between 5 and 500 ms) of that deviation. Only when both conditions (equal to or lower than the indicated percentage for the set duration) are met, will the program be interrupted and jump to the end.

TG - Torque Gradient

This restriction checks the gradient and if it is outside the **Gradient limits**, the tool is stopped immediately and the program jumps to the end of the program. The first gradient is calculated **Angle Window** after **Trigger Torque** has been reached, and a new gradient is calculated every time a new torque and angle sample is available.

If the end of the step is reached before passing **Trigger Torque** this restriction is considered OK and no tightening errors are reported.

TCD - Torque vs Current Deviation

The restriction verifies that all current measurements converted to the corresponding torque at most **Maximum deviation** away from the actual torque measured with the torque transducer. The restriction starts when the torque reaches **Trigger Torque** for the first time during the step and is active until the step reach its target.

If Trigger Torque is never reached, the monitor will report OK.

TAW - Torque in Angle Window

This restriction checks that the measured torque in the **Angle Window Length** is between the **Torque limits**. If the measured torque is outside the limits the tool is stopped immediately and the program jumps to the end of the program. The Angle Window Length start at the **Start Angle** from the point the torque first passed the **Trigger Torque**. If Trigger Torque is not set, Start Angle begins at the start of the restriction.

If the end of Angle Window Length is not reached, the status of the restriction is NOK.

Tool compatibility for multistep

The table below shows which steps, monitors and restrictions are available for the various tool types.

Step Type	ES	ST	STR	SR	STB	QST	Tightening Type
Tighten to Angle	X	X	X	X	X	X	Both
Tighten to Torque	X	X	X	X	X	X	Both
Tighten to Torque + Angle	X	X	X	X	X	X	Both
Tighten to Torque AND Angle	X	X	X	X	X	X	Both
Tighten to DynaTork	X	X	X	X	X	X	Both
Wait	X	X	X	X	X	X	Both
Socket Release	X	X	X	X	X	X	Both
Run until Digital Input	X	X	X	X	-	X	Both
Tighten to Torque or Angle	X	X	X	X	X	X	Both
Loosen to Angle	X	X	X	X	X	X	Both
Loosen to Torque	X	X	X	X	X	X	Both

Step Type	ES	ST	STR	SR	STB	QST	Tightening Type
Loosen to Trigger Release	X	X	X	X	X	-	Handheld
Thread Cutting to Torque	X	X	X	X	X	X	Both
Synchronization Point	-	-	-	-	-	X	Fixtured
Engage	X	X	X	X	-	X	Both
Rundown	X	X	X	X	-	X	Both
Tighten to Yield	X	X	X	X	-	X	Both
Tighten to Yield M2	-	-	-	-	-	X	Fixtured
External Result	X	X	X	X	X	X	Both

Step Monitoring Type (Evaluated at End of Step)	ES	ST	STR	SR	STB	QST	Tightening Type
Time	X	X	X	X	X	X	Both
Angle	X	X	X	X	X	X	Both
Peak Torque	X	X	X	X	X	X	Both
Shut Off Torque	X	X	X	X	X	X	Both
Torque Rate Deviation	X	X	X	X	-	X	Both
Post Thread Cut Angle	X	X	X	X	X	X	Both
Post Thread Cut Peak Torque	X	X	X	X	X	X	Both
Torque in Angle Window	X	X	X	X	X	X	Both
Post View average Torque High	X	X	X	X	X	X	Both
Post View average Torque Low	X	X	X	X	X	X	Both
Yield Angle	X	X	X	X	-	X	Both

Step Monitoring Type (Evaluated at End of Step)	ES	ST	STR	SR	STB	QST	Tightening Type
Stick-Slip detection	X	X	X	X	-	X	Both
Prevailing Torque	X	X	X	X	X	X	Both

Step Restriction Type (Immediate Stop)	ES	ST	STR	SR	STB	QST	Tightening Type
Torque High	X	X	X	X	X	X	Both
Angle High	X	X	X	X	X	X	Both
Time High	X	X	X	X	X	X	Both
Cross Thread	X	X	X	X	X	X	Both
Torque Gradient	X	X	X	X	-	X	Both
Rescinding Torque - Torque control process	X	X	X	X	X	X	Both
Rescinding Torque - Angle control process	X	X	X	X	-	X	Both
Torque Vs Current Deviation	X	X	X	X	-	X	Both
Torque in Angle Window (restriction)	X	X	X	X	X	X	Both

Program Monitor Type (evaluate at end of program)	ES	ST	STR	SR	STB	QST	Tightening Type
Program Monitor Angle	X	X	X	X	X	X	Both

Program Restriction Type (Immediate Stop)	ES	ST	STR	SR	STB	QST	Tightening Type
Program Re- striction Torque High	X	X	X	X	X	X	Both
Program Re- striction Time High	X	X	X	X	X	X	Both

ST Wrench

STwrench introduction

The STwrench is connected to a controller using a wireless connection. The STwrench is configured through the controller GUI or the web GUI.

The STwrench is configured under the tightening menu in the same way as the other tightening strategies.

The STwrench has a Rapid Backup Unit (RBU). The RBU defines the wrench function and stores the tightening programs. The controller supports currently only the RBU of the type **Production**.

The STwrench **End-fitting tool** (socket) contains a RFID TAG with a programmable number. This wrench uses this number to automatically recognize the tool and which program that can be used. The RFID TAG also stores the torque and angle correction coefficients.

The STwrench has several programs both for production tightening and for quality control. More details about the programs, strategies and the parameters are given in the STwrench user guide, document number 9836 4134.

 The STwrench can only support tightening programs which are supported by the tool and which are *Wrench - production* or *Wrench - quality*.

STwrench start step parameters

The parameters shown in the tables are available if one of the STwrench strategies are used. There are several combinations of strategies. Some of the parameters are only available for certain strategies and may not be visible in other strategies.

Parameter rules are automatically checked. If a violation occurs, the error indicator  is displayed beside the incorrect parameters. Place the cursor on the error indicator to display more information about the error.

 Switching between strategies can result in the error indicator being shown. This indicates that the chosen combination is invalid, and needs to be corrected.

More details about the parameters are given in the STwrench user guide, document number 9836 4134.

Parameter name	Condition	Description	Default value
Tag number		On: a correct TAG number is required to run this tightening program. Off: The TAG number is not checked.	Off
Required tag number	Tag number = On	The required TAG number for this tightening program.	1
Rehit detection		The parameter options are: Complete or Off .	Off

Parameter name	Condition	Description	Default value
Torque correction coefficient		In certain cases extensions may be needed to fit the application. In this case the wrench measurement must be compensated to show a correct value. To calculate the correction coefficient, please refer to the STwrench user guide, printed matter nr 9836 4134 01 edition 2.12. The parameter is stored in the RFID TAG in the End-fitting tool.	1.0
Angle correction		In certain cases extensions may be needed to fit the application. In this case the wrench measurement must be compensated to show a correct value. To calculate the correction coefficient, please refer to the STwrench user guide. The parameter is stored in the RFID TAG in the End-fitting tool.	0°

Table 23: Parameters in the STwrench start step

NOTICE The correction coefficients alter the STwrench measurement. It may cause an improper reading. Please refer to the STwrench user guide, printed matter nr 9836 4134 01 edition 2.12, before making any corrections.

STwrench rundown step parameters

The parameters shown in the tables are available if one of the STwrench strategies are used. There are several combinations of strategies. Some of the parameters are only available for certain strategies and may not be visible in other strategies.

Parameter rules are automatically checked. If a violation occurs, the error indicator  is displayed beside the incorrect parameters. Place the cursor on the error indicator to display more information about the error.

-  Switching between strategies can result in the error indicator being shown. This indicates that the chosen combination is invalid, and needs to be corrected.

More details about the parameters are given in the STwrench user guide, document number 9836 4134.

-  **Rundown complete** is in the STwrench documentation defined as **Cycle start** which is when the tightening step begins.

Parameter name	Description	Default value
Rundown complete	Selected from a pull-down menu. The parameter options are: At torque.	

Parameter name	Description	Default value
Rundown complete torque	Definition of the Rundown complete point.	Depends on the smarthead min-load (usually 5% of nominal torque) in Nm
Ratchet time		5000 ms

Table 24: Parameters in the STwrench rundown step

STwrench tightening step parameters

The parameters shown in the tables are available if one of the STwrench strategies are used. There are several combinations of strategies. Some of the parameters are only available for certain strategies and may not be visible in other strategies.

Parameter rules are automatically checked. If a violation occurs, the error indicator  is displayed beside the incorrect parameters. Place the cursor on the error indicator to display more information about the error.

 Switching between strategies can result in the error indicator being shown. This indicates that the chosen combination is invalid, and needs to be corrected.

More details about the parameters are given in the STwrench user guide, document number 9836 4134.

Parameter name	Condition	Description	Default value
Target		Selected from a pull-down menu. The parameter options are: Torque or Angle.	torque
Target Torque		Defines the target torque for tightening step.	
Target Angle	Target = Angle	Defines the target angle for tightening step.	0°
Torque limits	Target = Torque	Selection made by a switch. Auto or Manually position.	
Torque min	Torque limits = Manual	Torque value for the lower limit	0
Torque max	Torque limits = Manual	Torque value for the upper limit	0
Angle limits	Target = Angle	Selected from a pull-down menu. The parameter options are: Auto or Manually. Angle values for max and min can be or selected	

Parameter name	Condition	Description	Default value
Angle limits	Target = Torque	Selected from a pull-down menu. The parameter options are: Off: No angle limit monitoring. From rundown complete: The monitoring window is set from when the Rundown complete torque is reached. From torque: The monitoring window is set from when the specific torque value is reached.	
Final angle monitoring torque		Torque value from when the angle limits are monitored	18.75 Nm
Angle min	Angle limits = on or manually	Angle value lower limit	324°
Angle max	Angle limits = on or manually	Angle value upper limit	396°
Angle search limit	Angle limits = manually		
Measure torque at		Selected from a pull-down menu. The parameter options are: Max torque value Value at peak angle	
NOK on final less than target		Selection made by a switch. On or Off position.	On
Change bolt limit			50 Nm

Table 25: Parameters in the STwrench tightening step

Parameter name	Condition	Description	Default value
Torque compensation point	Torque compensation = On		0°
PCT distance	Torque compensation = On		360°
PVT interval	Torque compensation = On		180°
Delay monitoring	Torque compensation = On		0°
Torque min	Torque compensation = On	Torque value for the lower limit	1 Nm
Torque max	Torque compensation = On	Torque value for the upper limit	20 Nm

Parameter name	Condition	Description	Default value
Compensation value	Torque compensation = On	Selected from a pull-down menu. The parameter options are: Average torque Peak torque	

Table 26: Parameters in the STwrench tightening step if the strategy is Wrench - Production, and PVT compensate with snug

STwrench loosening

The parameters shown in the tables are available if one of the STwrench strategies are used. There are several combinations of strategies. Some of the parameters are only available for certain strategies and may not be visible in other strategies.

Parameter rules are automatically checked. If a violation occurs, the error indicator  is displayed beside the incorrect parameters. Place the cursor on the error indicator to display more information about the error.

 Switching between strategies can result in the error indicator being shown. This indicates that the chosen combination is invalid, and needs to be corrected.

More details about the parameters are given in the STwrench user guide, document number 9836 4134.

Parameter name	Condition	Description	Default value
Loosening limit			0 Nm

Table 27: Parameters in the STwrench loosening step

STwrench stop step parameters

The parameters shown in the tables are available if one of the STwrench strategies are used. There are several combinations of strategies. Some of the parameters are only available for certain strategies and may not be visible in other strategies.

Parameter rules are automatically checked. If a violation occurs, the error indicator  is displayed beside the incorrect parameters. Place the cursor on the error indicator to display more information about the error.

 Switching between strategies can result in the error indicator being shown. This indicates that the chosen combination is invalid, and needs to be corrected.

More details about the parameters are given in the STwrench user guide, document number 9836 4134.

Parameter name	Condition	Description	Default value
End cycle time			100 ms

Table 28: Parameters in the STwrench loosening step

Batch configuration

Batch sequences

Batch sequences are used to perform a specified number of tightenings in a specific order. Each batch sequence is given a name.

Batch sequence settings

Batch sequence > <Selected sequence> > Settings

A batch sequence can consist of up to 99 batches, with a batch size of up to 99 tightenings. The batches in a batch sequence are carried out in the order listed, or by using a Socket selector to choose which batch to run.

Parameter name	Description	Default value
Lock tool on Batch sequence compl.	A batch sequence is completed when the batch sequence counter is equal to the batch sequence size. On: The tool is locked and a tightening program or batch sequence must be selected to continue performing tightenings. Off: After completion, the batch sequence is ready to be repeated.	On
Free order	No: The configured batches will be executed in the order listed, provided they have been configured to perform tightenings. If socket has been specified, the system will prompt for the socket when the batch is to be performed. Yes: The configured batches can be executed in any order. The operator must indicate to the system which batch is to be executed by using a Socket selector. A batch is regarded as complete when all joints have been completed.	No
Increment on NOK	Makes it possible to increment the batch counter value even though the tightening is reported as NOK. For Max consecutive NOK to work (the maximum number of times a single bolt can be tightened), Increment on NOK must be set to No . Setting this parameter to Yes, will allow the sequence to move on to the next tightening.	No

Parameter name	Description	Default value
Max consecutive NOK	Maximum consecutive not OK tightenings (NOK) are a defined maximum allowed number of NOK consecutive tightenings in a batch. If the Max consecutive NOK number is reached, the event Too many NOK tightenings (4020) is displayed.	0
Sequence abort timer	On: The selected batch sequence can be aborted within a specified time limit Off: The selected batch sequence cannot be aborted.	Off
Abort time (10-600)	The number of seconds during which the selected batch sequence can be aborted.	10

Table 29: Batch settings parameters

Batch configuration

Batch sequence > <Selected sequence> > Batch configuration

A batch is set up to perform a specified number of consecutive tightenings using the same tightening program. Batches must have tightening program and batch size specified in order to run.

Parameter	Description
Tightening program	The tightening program to use with the batch.
Batch size	Number of tightenings the batch will perform. Max. number of tightenings in one batch is 99. Batch size 0 will give the batch an infinite number of tightenings.
Identifier number	When using a Socket selector, this is the socket position used to activate the batch.

Table 30: Batch configuration parameters

Virtual station

Virtual stations are configured in the **Virtual Station** menu.

A virtual station is a software abstraction of a physical station and can be set up to use a specific tool and remotely execute different tasks using the tool.

In Power Focus 6000, it is possible to set up a number of virtual stations per controller. Each virtual station can be connected to one tool and one or more accessories.

By using virtual stations, the operator can operate multiple tools and run different tasks using the same controller. It is possible to connect one cable tool and multiple STB tools simultaneously to the controller.

When configuring different tools, make sure the selected start signal in Start source matches the selected tool and that the selected task can be run on the specific tool.

Before any tightening can begin a task must be selected in the virtual stations menu. A task is of one of three types:

- Tightening program
- Batch sequence
- Sources

The selection can be made manually by the operator or by external signals. For information about external signals, see Sources.

Virtual station - Creating a virtual station

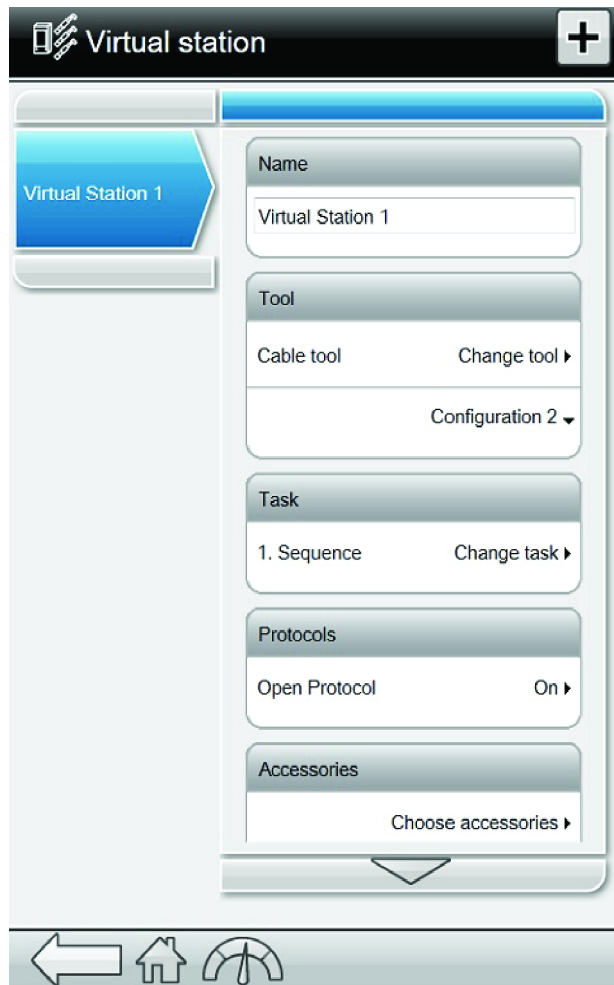


Illustration 16: Create a virtual station

To create a new virtual station:

1. Tap on the plus sign.
2. Edit the name and other parameters.

To remove a virtual station: Tap on delete at the bottom of the list of parameters.

The list of virtual stations created is presented in the order of creation.

- ❗ If no tool configuration is available when assigning a tool, a new tool configuration is automatically created and assigned to the virtual station.

This auto-created tools configuration will have Start source set to **Trigger only** and trace set to **Off**. For STB tools Start request will be set to **On**.

Virtual station - Tool settings

Tool connected to a virtual station

A virtual station can only have one tool connected. Just one of the tools connected to a controller can be a cable tool. Added virtual stations can connect wireless tools paired to the controller.

Each virtual station needs to have one tool configuration, in addition to the tool. The tool configurations are created in the **Configurations** menu, see Device configurations.

Connecting a tool to a virtual station

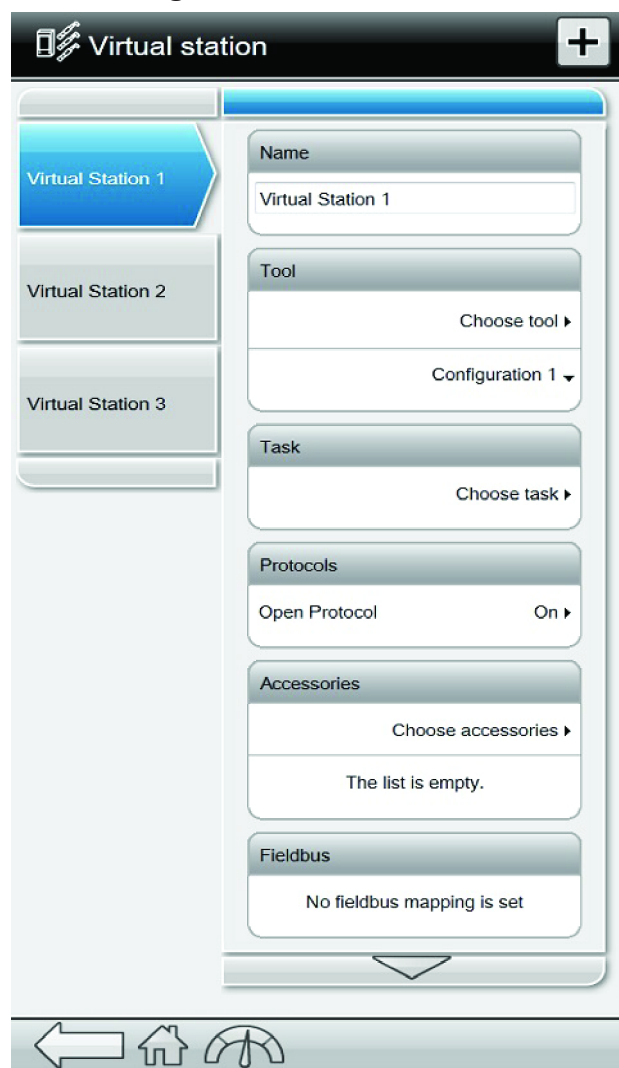


Illustration 17: Virtual station menu

1. Go to the **Virtual station** menu and tap the virtual station you want to connect the tool to.

2. In the Tool area, tap **Choose tool** to open the list of available tools.
Or, if a tool is already chosen, tap **Change tool** to open the list of tools available to change to.

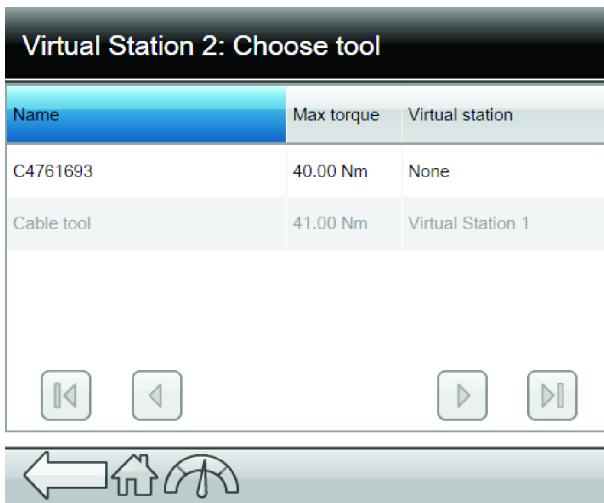


Illustration 18: List of tools

3. In the list of available tools, tap the desired tool to connect it to the virtual station.
 - ❗ Tools not available will be greyed out. To connect such a tool, it must first be disconnected from its virtual station.

4. When connecting a new tool a tool configuration is attached. If there are more than one configuration available a list of tool configurations is shown.

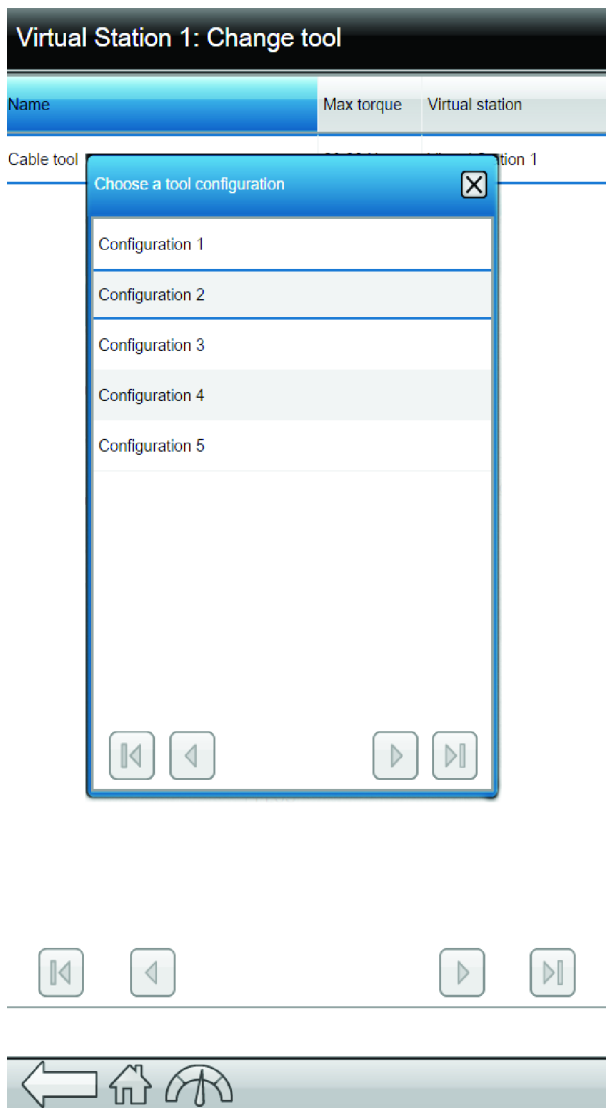


Illustration 19: List of configurations

It is possible to edit the configurations, see *Tool configuration* [Page 127].

5. To replace the tool configuration for the virtual station:
- Click on the arrow beside the name of the current configuration.
 - Choose another of the configurations in the list.

It is not possible to deselect a configuration, only to select another available configuration.

Virtual station - Task

The selected task can either be running a tightening program, running a batch sequence or enabling the task using a source configured in the **Sources** menu.

The task can be monitored from the controller and the result of the task can be presented together with any events that may have occurred during the operation.

Virtual station - manual mode

Manual mode for Virtual stations is used for performing tasks while the tool is in locked mode. In cases where the tool is locked for a certain reason (e.g. because the tool is outside its TLS footprint) there still may be a need to perform certain tasks with the tool, such as performing emergency work. By configuring manual mode for the virtual station, users can determine what signals are sent when entering manual mode (Entering signals), what task can be performed while in manual mode (Secondary task), and what signals are sent when leaving manual mode (Leaving signals).

Since desired scenarios can vary between different users (i.e. which signals to send upon entry and exit and what task to perform), manual mode is fully configurable for each virtual station.

Configuring manual mode

Configuration consists of three elements: entering signals, leaving signals and secondary task (note that by primary task is meant the (automatic) task that is assigned to the virtual station under *Task*).

1. Go to the **Virtual station** menu and click on the virtual station to configure, then under *Task*, click on **Set manual mode**
 2. In the Manual mode configuration screen, set the secondary task. This determines which task shall be run when in manual mode.
 - ❗ If no secondary task is set, the primary task will be used during manual mode.
 - ❗ The same tasks (tightening, batch sequence, source) can be set for the secondary task as for the primary task.
 3. Set the entering signals to be sent by clicking the **plus** icon at the bottom of the *Entering* section. See the parameters for entering signals below.
 4. Set the leaving signals to be sent by clicking the **plus** icon at the bottom of the *Leaving* section. See the parameters for leaving signals below.
- ❗ There is a limit of 99 signals that can be set for entering and leaving.

Entering/Leaving signals

The parameters for entering and leaving signals are the same.

There are two types of signals: Boolean and integer/string type. For Boolean type signals, an on/off (true/false) switch is used. For integer/string type signals, a text field is used where the (I/O) signal or string can be indicated.

Signal	Type	Default value
Generic IO [1-10]	Integer	0
Acknowledge events	Boolean	Off
Abort sequence	Boolean	Off
reset Too Many NOK	Boolean	Off
Set bistable relay	Boolean	Off
External monitored [1-8]	Boolean	Off
Disable Fieldbus	Boolean	Off
Unlock tool on disable	Boolean	Off

Table 31: Entering and leaving signals manual mode

Triggering manual mode

Manual mode can be activated by a switch or an external system. For example (indicated below), a button on an operator panel can be configured to activate manual mode.

1. Go to the **Configurations** menu and choose **Operator panel** in the left navigation.
 2. If no configuration for an operator panel exists, click the **plus** icon at the top right of the work space, otherwise continue to the next step.
 3. In the configuration you want to alter, click **Edit**.
 4. In the Operator panel configuration window, click on the position [A,B,C,D,E,F,G,I] to configure.
 5. In the Position configuration window, click on the Component list. In the list, click **One way key switch**.
 6. Click on the Turn signal list. In the list, choose Manual mode (use the arrow buttons to navigate within the list if necessary).
 7. Close the Position configuration window.
- i** If the user needs to be notified that Manual mode has been entered or left, then events 4070 and 4071 have to be configured, respectively. See *Configure events* [Page 159] for information on configuring events.

Virtual station - Protocols

Under the tab **Protocols** in the Virtual station menu you find a list of available communication protocols depending on the current license in use. The Open Protocol is available for all licenses.

To gain access to functionality through Open Protocol, a unique port for each Virtual Station needs to be defined.

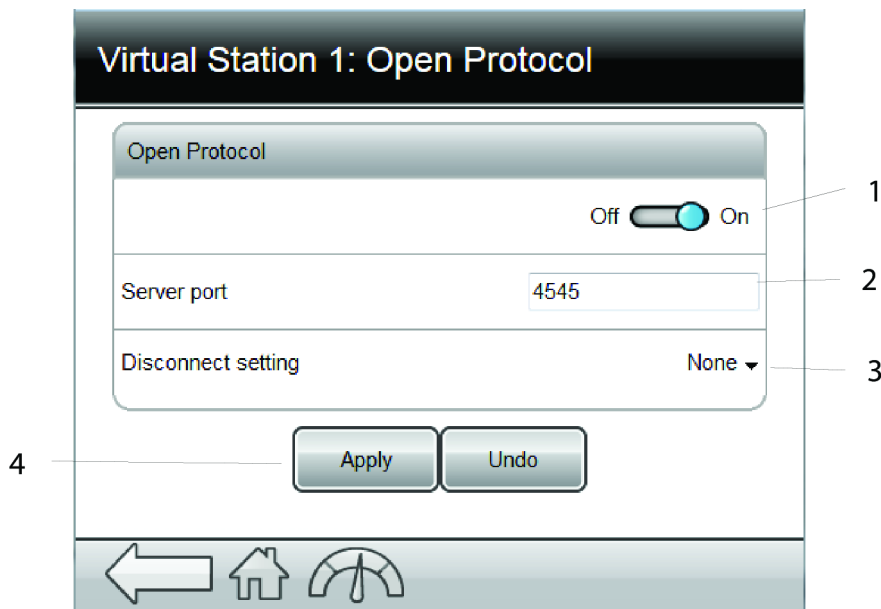


Illustration 20: Open protocol settings

1. Put the Open Protocol switch to **On**.
2. Enter the number of the port.
3. Choose the action to be applied when the connection to the client is lost.

4. Tap or click **Apply**.

The Disconnect setting controls the action applied when a connection error occurs:

- **None** - The tightening program continues normally.
- **Lock tool** - The tool is locked after finishing the current tightening normally.
- **Deselect task** - The tightening is aborted after finishing the ongoing task. Except for plain tightening programs or Batch sequences where the task will be removed after finishing.

Virtual station - Accessories

For connecting and disconnecting QIF accessories to and from a virtual station, see *Connecting QIF accessories to a virtual station [Page 138]* and *Disconnecting QIF accessories from a virtual station [Page 138]*.

For troubleshooting with the help of I/O diagnostics of an accessory, see *Digital signal diagnostics [Page 117]*.

See also

📖 Disconnecting QIF accessories from a virtual station [138]

Digital signal diagnostics

During deployment and during trouble shooting of a controller a diagnostic tool is very helpful. It is available for the analysis under the Info tag for a device configuration or a fieldbus mapping in the **Virtual station** menu.

The controller can operate in normal mode or in diagnostics mode. In normal mode the digital input and output signals operate normally and are routed between the internal controller logic and to an external accessory or a connector.

The diagnostics mode is divided into monitor mode and forced mode. In the monitor mode signals operate normally, but provides live monitoring of the signal behaviour. In forced mode the connection between the controller internal logic and the external accessory is opened and the input and output signals can be forced to a desired state.

It is possible to diagnose digital signals for one device or one fieldbus at a time.

Diagnostics configuration

Diagnostics for a specific accessory or fieldbus is accessible through the Info option in the Virtual Station view for the accessory or fieldbus.

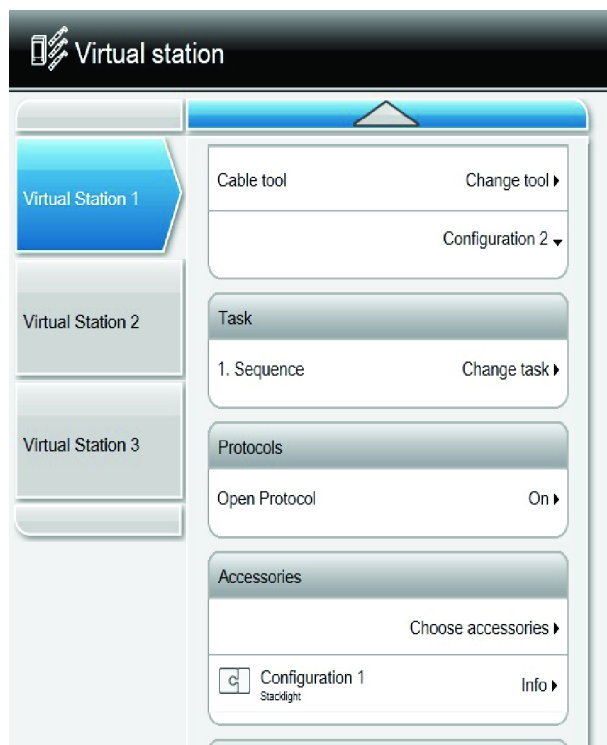


Illustration 21: Virtual station menu

1. Tap **Info** and on the next screen tap **Diagnostics**.
2. Activate **Monitor mode** or **Forced mode** with the switch.
3. The statuses of input signals and output signals are available under the respective tabs.

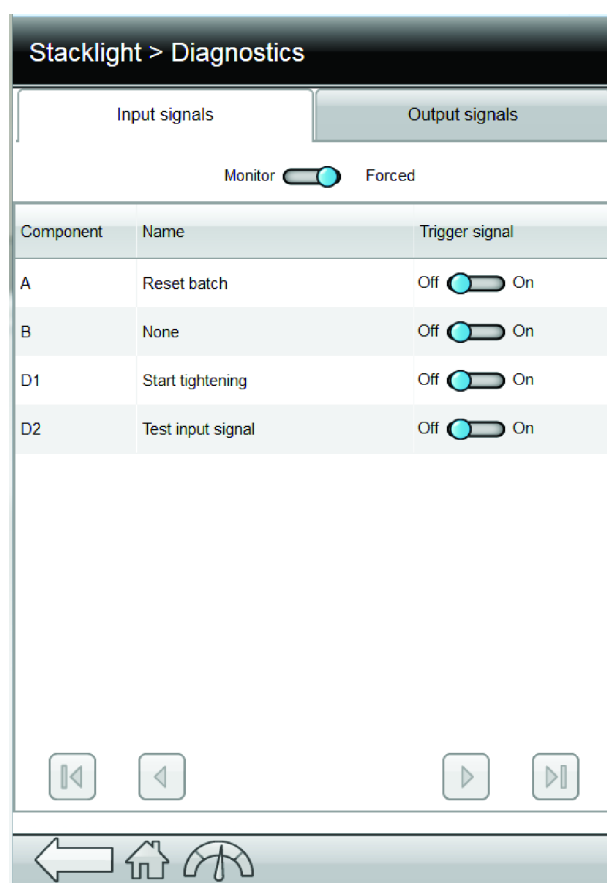


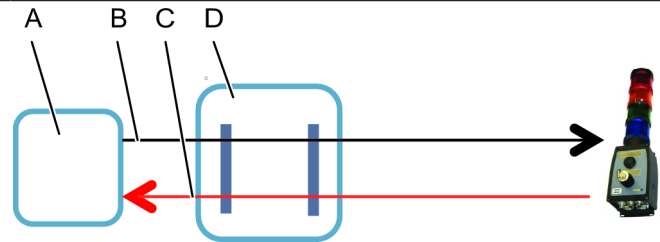
Illustration 22: Diagnostics view

It is only possible to access the diagnostics from one single user or function at a time. If the diagnostics is already in use an information message is shown on the screen.

Normal operations

In normal operations mode external input signals are passed to the internal controller logic and controller output signals are passed to an external target, without any intervention from the diagnostics module.

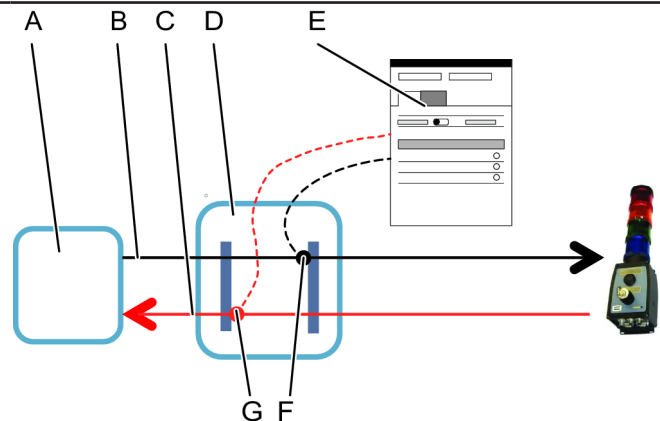
- A) Controller internal state machine and logic functions
- B) Digital output signal path
- C) Digital input signal path
- D) Diagnostics module



Monitor digital signals

In the diagnostics mode all signals passed to and from the controller internal logic can be monitored. A signal tap is connected in the diagnostics module and the signal states are displayed on the web GUI or the controller GUI.

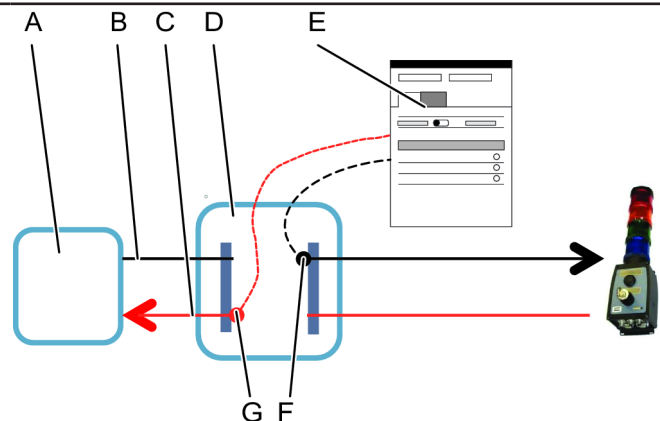
- A) Controller internal state machine and logic functions
- B) Digital output signal path
- C) Digital input signal path
- D) Diagnostics module
- E) User interface
- F) Output signal tap
- G) Input signal tap



Force digital signals

In the diagnostics mode all signals passed to and from the controller internal logic can be forced to a desired state. The signal lines are opened in the diagnostics module. From the user interface both input and output signals can be forced to steady states. The user interface is either the web GUI or the controller GUI.

- A) Controller internal state machine and logic functions
- B) Digital output signal path
- C) Digital input signal path
- D) Diagnostics module
- E) User interface
- F) Forced output signal insertion point
- G) Forced input signal insertion point



- ⓘ While signals are forced, the controller operates normally. When leaving the diagnostics mode and the forced mode all signals are set to the current operating state of the controller. This may lead to a change-of-state for digital outputs, which can create unwanted actions.

Virtual station - Fieldbus

The **Fieldbus** entry in the GUI shows the fieldbus mapping assigned to the controller.

To analyze the fieldbus configuration click on perform in the diagnostics field for the fieldbus mapping. Read more about the diagnostics tool in the Virtual station - Accessories section of this chapter.



Illustration 23: Virtual station - Fieldbus

Sources

Introduction to sources

External signals used as tasks for tightenings are configured in the **Sources** menu. Sources are accessories or similar connected to a virtual station. Two types of source tasks are available:

- Source **Tightening** task
- Source **Batch** task

Source Tightening is used to select a single tightening program.

Source Batch is used to select a batch sequence, a series of tightening programs.

For information about selection of tasks, see Virtual station - Assigning a task .

Tightening

The tightening menu shows a list of source tightening configurations. Separate lists can be linked to a Virtual Station by going to the Virtual Station in question, and choosing Task, Change task. There, a Source can be chosen as a task. Source tightenings link a specific tightening program to an identifier number. When the identifier number is sent to the controller (either by external digital signal, or, in case a socket selector is used, by lifting the corresponding socket in the selector) the linked program will run over and over until a different signal is sent (or socket is picked up). There is no batch counting.

Source Tightening lists can be set either in Control or Confirm mode.

Control

When set to Control, an external source selects a tightening program by requesting an identifier number. In case of a socket selector, the identifier number is linked to a corresponding socket in the socket selector, and by lifting the socket the tightening program is selected.

Confirm

In Confirm mode, the socket selector cannot be used as a controlling source. In this mode identifier numbers are linked to both a tightening program and a specific socket (indicated in an additional column in the list). When an identifier number is requested (by an external signal), the corresponding socket is prompted in the socket selector and the tightening program is activated when the operator lifts the socket (other sockets are disabled). If no socket is specified (i.e. set to 0 in the Socket column), the tightening program is activated directly and socket status is ignored.

Creating a Source Tightening

1. Go to the **Sources** menu, then select **Tightening** on the left navigation.
2. Click the **plus** icon in the top right of the workspace.
3. Give the Source Tightening a name and select the correct **Selector mode** (Control or Confirm, depending on what is required).
4. By default, only one editable Identifier number will be available when creating a new Source Tightening. At the bottom of the screen, click the **plus** icon to add more.

5. Give every item an identifier number

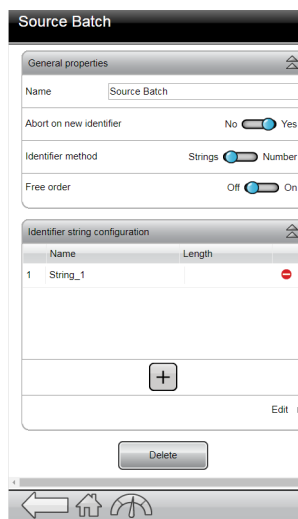
- ❗ If a socket selector is used, the identifier numbers will correspond to the positions in the socket selector, i.e. Identifier number 1 corresponds to socket number 1 in the socket selector.

6. Choose a tightening program to link to each identifier number by clicking on **Program** and choosing from the list of tightening programs.

Batch

The Source Batch configuration is found under the **Batch** option in the Sources menu.

The controller can be configured to select a batch sequence based on either an identifier number or an identifier string.



Input	Description
Identifier number	The number must be a positive integer number that can originate from an accessory or from an external control entity.
Identifier string	The string must consist of ASCII characters and can originate from a scanner or from an external control entity.
Socket selector	The use of one or several socket selectors.

Creating a Source Batch

- Go to the **Sources** menu, then select **Batch sequence** on the left navigation.
 - Click the **plus** icon in the top right of the workspace.
 - Give the Source Batch a name
 - Set the *Abort on new identifier* to **Yes** if scanning a new identifier string should abort the previous scan.
 - Select the **Identifier method** (String for text, or Number for numerical strings)
 - Set *Free order* to **On** if the strings should be able to be scanned in any order.
- ❗ Identifier strings can be made up of up to 4 different strings. When free order is set to No, the strings need to be scanned in a specific order for the system to recognize the string.

7. If required, add an identifier string by clicking on the **Plus** icon in the **Identifier string configuration** section.
8. Click on the **Name** label for the identifier string you want to change the properties of (pop-up window). The following properties can be indicated per string:
 - Name - the name of the string
 - Length - the length of the string. See *Combining identifier strings [Page 124]* for more information on concatenating strings.
 - Significant positions - the relevant positions in the string. See *Configuring Significant positions to read in barcode string [Page 123]* for more information on significant positions.
 - Saved positions - which positions are to be logged by the system. See *Saved positions [Page 124]* for more information about Saved positions.
-  The ID field in the string properties window cannot be altered, but can only be used to navigate between the different strings.
-  An error may occur when *Free order* is set to **On**, and the lengths of the different strings are duplicated. The scanned sequence will then not activate a tightening program. To remedy this error, set *Free order* to **Off**, or adjust the string lengths.
9. Click **Edit**.
10. In the **Edit** window, indicate which strings (in the **String contains** column) should be linked to which Batch sequence (in the **Activates** column). Click the **plus** icon at the bottom to add more strings.
 -  Wildcards can be used when typing the "string contains". The wildcard(s) can be used at any position in the string. No Batch sequence is activated in case of an ambiguous matching result.

The wildcard is a . (period)

Significant positions

Significant positions are used to specify which characters in the barcode string to read when putting together the string to match with your pre-defined string. The number of significant positions must match the number of characters in the pre-defined strings.

Configuring Significant positions to read in barcode string

The positions in the barcode string are associated with a number between 1 and 1024. The first position of the string is 1 and the last is 1024.

The significant positions must be specified following the rules described in the table below. Barcode strings:

Description	Significant positions	Valid configuration	Barcode string to match with pre-defined string
Significant positions in order	1,2,3,7,8 Will be changed automatically to 1-3,7-8	Ok	ABCGH

Description	Significant positions	Valid configuration	Barcode string to match with pre-defined string
Significant positions in optional order	7,1,2,3,8 Will be changed automatically to 1-3,7-8	Ok	GABCH
Range of numbers	1-3,7-8	Ok	ABCGH

Combining identifier strings

The *identifier string* that is used for matching is a combination of up to four strings from a factory management system or up to four scanner inputs that need to be combined into one string.

The **Add** and **Delete** command buttons manage how many strings are combined. The following parameters are available:

Parameter	Description
Check box	Select an entry if it is to be deleted.
Name	The string must be given a name.
Length	The length of the string must be known and must be entered. This is important to be able to combine the correct string identifier.
Start-End	The positions of the characters within the combined string.
Significant positions	The comma-separated positions or ranges (separated by hyphen) in the combined string that are used for matching.
Saved positions	The comma-separated positions or ranges in the strings that will be saved in the result.

Table 32: Parameters for combining identifier strings

If more than one *identifier string* is to be used, perform the following steps:

1. Press the **Add** command button to create a new entry in the table.
2. Give the string a name.
3. Enter the length of the string.
4. Repeat steps 1-3 for every string to be added. Up to four strings can be combined.

The Start-End parameters in each row define the individual string positions in the combined *string identifier* that is used in the next step of the matching process.

The first part in the task selection process using an *identifier string* as an input, is to define which positions in the string that are to be activated:

- Enter the significant positions, to define which positions in the *identifier string* will be used for matching. The positions must be comma separated or range.

Saved positions

Saved positions is a field where the user can indicate which parts of each string used in the Source Batch will be saved, and how they will be represented in the log. In this field, indicate the positions in the string that need to be saved. Posi-

tions can constitute only parts of the entire string. If the field is left empty, the entire (concatenated) string will be saved. The table below shows some examples of saved position combinations.

Saved position values are comma-separated (without spaces), and ranges are indicated using a hyphen.

Identifier string	Positions
String 1: 1234567	1-7
String 2: abcdef	8-13
String 3: GHIJKL	14-19
String 4: 890	20-22

Saved positions	Saved results
(empty)	1234567abcdefGHIJKL890
1-3,9,11,15,20-22	123bdH890
8-12,1-7,19,20-21 will be changed automatically to: 1-12,19-21	1234567abcdeL89

Table 33: Saved position examples

Configurations

The configuration of tool accessories and QIF accessories is available on the **Configurations** menu. The Scanner is configured on the Batch view on the **Sources** menu.

Digital signals

Input signals

Input signals are system commands that are carried out by using for example buttons or switches on an accessory, either a tool accessory or a QIF accessory, or by connecting the signal to an I/O input plug. For a complete list of available input signals, see the section *Input signals [Page 179]*.

 The input signal Lock tool must not be configured for more than one accessory for each virtual station.

Output signals

Output signals are states or events of the system. They can be linked to either a tool accessory or a QIF accessory. For a complete list of available output signals, see the section *Output signals [Page 181]*.

Tool configuration

Configuration of the available accessory functions on the tool is done from the Tool configuration menu in the **Configurations** menu.

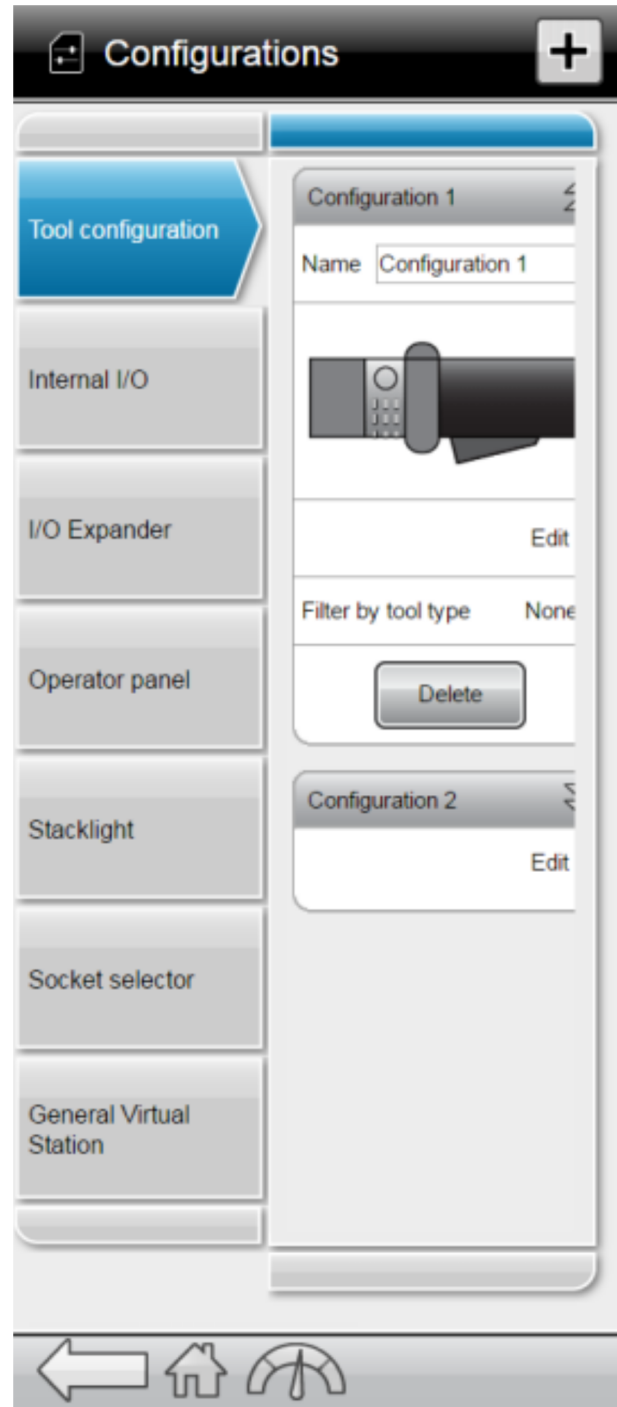
Different functions are available depending on the type of tool. To access the right functions choose tool under **Filter by tool type**. Available types are:

- Cable tool
- STB tool
- STwrench
- SRB tool
- TBP tool

Tap or click Edit to reach the configuration of the different functions.

The tool configurations are listed in alphabetic order.

- ❗ A configuration assigned to a virtual station cannot be deleted.



For STB tools and Cable tools: To configure the buzzer, the function button, or the direction switch, tap on the respective fields below the figure on the screen. Menus for the chosen function will appear.

The start conditions for a tool, such as start source, trace, and start request are configured here. The functions are described in the respective sections.



General settings

The general settings for the tool can be set in the General settings section.

Parameter	Description	Default value
Inactivity timeout	Determines whether the tool will get shut down after a set period of inactivity.	On

Parameter	Description	Default value
<Inactivity timeout>	Sets the number of minutes before shutdown if Inactivity timeout is set to On.	120 min
Front LED	Sets the behavior of the front LED (above tool trigger). Wireless tools only. When set to off, the front LED will not be lit when the trigger is pressed.	Off
Duration after trigger released	Sets the duration the front LED remains lit after the tool trigger is released (in seconds).	2 sec
	 For cable tools, the front LED is lit for 10 seconds after the tools trigger is pressed.	
Trace	Sets when the result trace (graph shown in result screen) is initiated: • Off: No trace is made • Trigger pressed: The trace is drawn from when the tool trigger is pressed. • Rundown complete: The trace is drawn from when Rundown complete is reached.  For multistep programs, trace is always on from Trigger pressed .  For wireless tools, the only option is Trigger only .	Trigger pressed
TAG check	Determines whether RFID TAG check on socket is performed (STWrench)	Off
TAG selection	Determines whether TAG selection will be used as a select input channel (STWrench)	Off

Tool LEDs

The different LED indicators on the tool are configured to be controlled by one of the available output signals.

Illustration 24: LED configurations

Blue LED

The blue LED is a single LED with a steady signal. The blue LED will be lit for a configurable duration of time, or configured to be lit until the following tightening. It is lit on the signal chosen by the configuration.

Result indicator

The result indicator decides how and for how long the LEDs are lit on tightening results. A pre-configured pattern is selected from a shortcut menu. This pattern can be a combination of tightening results.

Signal	Description
Off	No LEDs are activated after the tightening, regardless of the result
Green	If a result indicator is selected, a green light is the default signal if the tightening is terminated correctly (OK).
Red:high:yellow:low	If the tightening is terminated incorrectly (NOK); a red LED indicates that the final value is too high, or a yellow LED indicates that the value is too low. Red and yellow can be lit simultaneously (e.g. in case of too high torque, and too low angle).
Red:high(prio):yellow:low	If the tightening is terminated incorrectly (NOK); a red LED indicates that the final value is too high, or a yellow LED indicates that the value is too low. Red and yellow cannot be lit simultaneously. Only red is lit in case of simultaneous high and low values.
Red:NOK:yellow:low	A red LED indicates that the tightening is terminated incorrectly (NOK). An additional yellow LED can indicate if the value is too low.
Red:NOK	A red LED indicates that the tightening is terminated incorrectly (NOK). No additional LEDs are shown.

Table 34: Result indicator signals

LED ring

The LED ring decides how the LEDs behave between the tightenings. The LED ring consists of three circles of LED lamps. One circle of red LEDs, one circle of yellow LEDs and one circle of green LEDs. Each circle can have a steady signal or a flashing signal. This provides a total of six different signals that can be connected to the LED ring.

- A LED is turned on only when no tightening is ongoing and when the controlling output signal is activated.
- A LED is turned off when the maximum time is exceeded. Only applicable if the signal type is an **Event**.
- A LED is turned off when the next tightening is started.
- A LED is turned off when the controlling output signal is deactivated. Only applicable if the signal type is an **State**.

Function button

Use the function button on the tool to control up to six of the available input signals. The button's three possible condition states are combined with the two possible states of the direction switch.

Function button states	Direction switch states
Single push	CW
Single push	CCW
Double push	CW
Double push	CCW
Pressed	CW
Pressed	CCW

Two configurable parameters controls the push time.

Parameter	Description	Default value
Push detection interval	For single push: the maximum push time (in milliseconds) between the button being pressed and the button being released.	300 ms
Next push interval	For double push: the maximum time (in milliseconds) between the button being released after the first push, and the button being pressed again.	300 ms

Buzzer

The buzzer is configured by assigning a sound to a signal selected from a list of available signals.

The sound consists of a set of parameters described in the table. A signal with a sound can be prioritized between 1 and 10 where 1 is highest priority and 10 the lowest. By default a signal and sound has the priority 5. Up to 20 sounds can be assigned to signals.

Buzzer

+

None

None

Priority5

Frequency (0Hz, 400Hz - 4 000Hz)400 Hz

Time On200 ms

Time Off100 ms

Repeats1

Volume100 %

Clone

Delete

←

🏠

🔧

Parameter	Description
Frequency	Exact frequency in Hz.
Time on	Time (in ms) that the buzzer makes a sound.
Time off	Time (in ms) that the buzzer is quiet.
Repetition	Number of times the buzzer repeats the on/off sequence.
Volume	The buzzer volume, in percentage of max volume.

Direction switch

The direction switch on the tool can be configured to trigger one input signal when quickly switched from clockwise (CW) to counter clockwise (CCW) and back, or vice versa.

Start condition

The start conditions for a tool, such as start request, start source, trace, and TAG conditions for ST wrench are configured here. The functions are described in the respective sections.

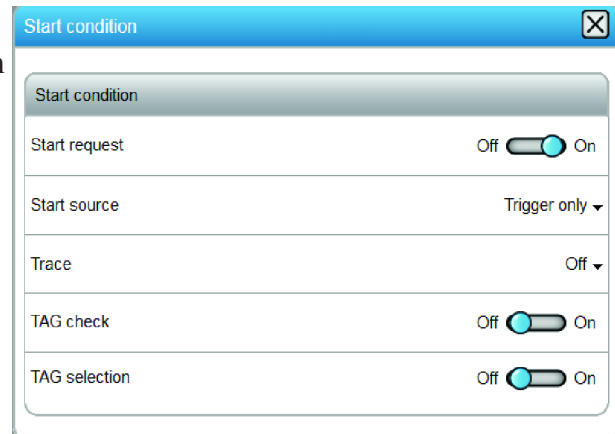


Illustration 25: Start condition

Start request

Start request enables the requirement of having a persistent connection between the tool and controller for an STB tool. This to make sure that the tool is always up to date with tightening program or batch settings, and with other settings on the controller, when performing tightening.

When Start request is set to On the tool gets locked if the tool loose connection with the controller. This means that if the tool loses connection in the middle of a tightening or a batch sequence, the tool will finish the ongoing tightening and then stop. The tool will be locked until it has reestablished the connection.

Parameter	Description	Default value
Start request	Lock the tool when the tool loose connection with the controller. On: The tool is locked from performing tightening if it loose connection with the controller.. Off: The tool can continue to perform tightening although it has lost connection with the controller.	On

Table 35: Parameters available for the start request

Start source

Use the tool start source to set how to start the tool. The default value is **Trigger only**.

Start source is not available for ST wrench

Start source	Description
Trigger only	Press the tool trigger to start the tightening.
Trigger OR Push	Press the tool trigger or push the tool against the joint to start the tightening.
Trigger AND Push	Press the tool trigger and push the tool against the joint to start the tightening.
Push only	Push the tool against the joint to start the tightening.

Start source	Description
Digital input	Have a signal using digital input to trigger the start of the tightening.
Safety trigger	Two triggers (as with trigger and push) activated within 500 ms from each other to start the tightening.

Table 36: Options for start source

Trace configuration

Traces provide users with a graphical representation of the tightening. Traces can begin either from when the trigger is pressed or from after rundown complete.

Parameter	Description	Default value
Trace	Enables the result to be viewed in graphic form. Off: No trace is made. Trigger pressed: The trace is drawn from when the tool trigger is pressed. Rundown complete: The trace is drawn from when Rundown complete is reached.	Off

 The maximum number of trace points is 2000 (200 for STB tools). If the maximum number of trace points is exceeded, every other result will be erased (effectively halving the sampling rate). Tracing will continue as long as the tightening is active, and every time the maximum number of trace points is reached, half of the trace points will be erased to allow the tracing to continue. Tracing will stop when the final stage of the tightening has finished.

TAG check

The TAG number is the RFID TAG which is used to identify the end-fitting tool in the STwrench.

TAG check	Description
Off	No TAG checking is done.
On	Check the TAG number of the End-fitting tool (socket). The TAG number must be identical to the number in the tightening program configuration

TAG selection

The TAG number is the RFID TAG which is used to identify the end-fitting tool in the STwrench.

Start request	Description
Off	The TAG value is not used to select a batch.

Start request	Description
On	Use the TAG number of the End-fitting tool (socket) to select a batch in a batch sequence. The TAG number must be written into the identifier number field in the Sequence edit menu under the batch sequence menu.

Accessory bus

Tool accessories are connected to the tool through the accessory bus. The tool accessories are configured separately for each tool configuration on the controller.

Type	Description
ST selector	A small display and buttons used to select tasks or programs according to the configuration.
TLS tag	Tool Location System tag used to provide output signaling to the operator.
EHMI	A small display and buttons used to select tasks or programs according to the configuration.

Table 37: Accessory bus configurations

ST Selector

The **ST selector** is a tool accessory. It is installed on the tool and connected to the tool accessory bus. It has a small display, two input buttons and output LEDs.

Display

The display shows one information at a time and has four different pages that can be configured to display different preset items on every page.

Parameter	Description
Page 1	Select the message to be displayed from the list..
Page 2	• Final torque
Page 3	• Final angle
page 4	• Batch count • Remaining batch • Generic IO 1 • Generic IO 2 • Generic IO 3 • Generic IO 4 • Generic IO 5 • Generic IO 6 • Generic IO 7 • Generic IO 8 • Generic IO 9 • Generic IO 10 • Selected tightening program id • Selected batch sequence id • Target torque • Target/Final torque

Table 38: ST selector display.

Switch time

Parameter	Description
Switch time	Select the time to display one message before the next message is displayed.

Buttons

The two buttons can be configured to act upon the displayed information and used to step through listed items.

Parameter	Description
Left button	Select one action from the shortcut menu.
Right button	Select one action from the shortcut menu.

Table 39: ST selector buttons.

Status LEDs

The status LEDs can be activated or deactivated.

Parameter	Description
Enable result LEDs	Select the desired On or Off radio button.

Parameter	Description
Enable extra LEDs	Select the desired On or Off radio button.

Table 40: ST selector status LEDs.

The result LEDs are red, green and yellow, and show the same information as the main tool LEDs.

The two extra LEDs can show *Batch OK* and *Batch sequence OK*. Both these LEDs are turned off at the next tightening.

TLS Tag

The **Tool Location System (TLS)** tag, is a tool accessory. The TLS tag is installed on the tool and connected to the tool accessory bus. The TLS tag is part of the Ubisense positioning system and is handled independently from the controller. In addition to the positioning, the TLS tag can be used to provide information to the operator. Selected output signals can generate different LED light combinations.

Up to 10 different output signals can be mapped to a light priority.

Parameter	Description
Signal	Select a signal to trigger the LED light from a shortcut menu. For a signal of the type Event , select the duration of the signal.
Color	Select a color for the LED.
Priority	10 priority levels are available for the sounds where one (1) is the highest priority level. Default priority level is five (5).

Table 41: TLS tag configuration parameters

For two simultaneous signals, the signal with the highest priority wins. When two signals with the same priority triggers the LED, the first arriving signal wins.

 An output signal can be of type **Event** or of type **State**.

A state signal is active as long as the state is active.

An event signal is active during a configurable time.

EHMI

The **EHMI** is a tool accessory. It is installed on the tool and connected to the tool accessory bus. It has a graphical display, three function buttons, and optionally a scanner. The display is a subset of the controller GUI with the possibility to select tightening programs, batch sequences, and to view results from tightenings. The interaction with the controller is through function buttons.

In the EHMI configuration it is possible to decide if the function buttons are On or Off.

Parameter	Description
Enable function buttons	On = The buttons have full functionality to configure settings within the visible menus. Off = The function buttons can only be used to acknowledge a necessary dialog on the EHMI.

Table 42: EHMI buttons.

Configure QIF accessories

A total of 15 QIF accessories can be connected to one controller. It is possible to add several scanners to each controller.

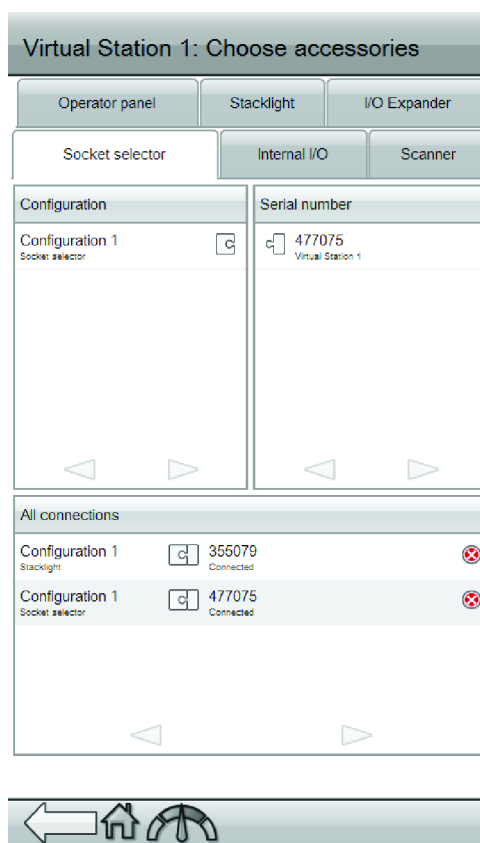
All QIF accessories connected to the controller can be connected to the same virtual station. One of each type of accessory and multiple socket selectors.

The functions of the QIF accessory can be connected to various input and output signals.

Connecting QIF accessories to a virtual station

To connect a QIF accessory to a virtual station:

1. Configure the accessory on the **Accessories** menu.
2. Connect the accessory to the controller I/O bus.
3. On the **Virtual station** menu, choose the virtual station and then tap **Choose accessories** under **Accessories**.
4. On the appropriate accessory tab, tap both the accessory and the configuration to connect them.
 - Connected accessories show up in **All connections**.



Disconnecting QIF accessories from a virtual station

To disconnect a QIF accessory or a scanner from a virtual station:

1. On the **Virtual station** menu, choose the virtual station and then tap **Choose accessories** under **Accessories**.
2. Under **All connections**, tap the disconnect icon on the right to disconnect.



Scanner configuration

Sources > Batch > Scanner configuration

 The scanner is configured in the **Sources** tab.

A scanner is used to read a barcode string or a QR code containing information to choose the appropriate batch sequence.

The scanner reads the characters you specify and puts them together to form a string of text. This text string is matched to the pre-defined strings you have specified in the controller, and if they match, the batch sequence linked to your pre-defined string is selected.

Barcode strings of a length of up to 1024 characters can be read and they can contain characters in the positions 32-126 in the ASCII table. If the barcode contains a string longer than 1024 characters, the remaining part of the string, from position 1025 and forward, is discarded.

Configuring the scanner

The scanner itself must be set up using a US keyboard, and the scanner will emit a carriage return character to terminate the barcode string.

Valid scanners

For a list of scanners verified for use with the Power Focus 6000 controller, contact the local Atlas Copco sales representative.

Selector configuration

Digital input information

Sources > Tightening > Digital inputs

Information about the connected digital inputs can be found by tapping **Tightening** and then **Digital inputs** on the **Sources** menu.

Socket selector configuration

Sources > Tightening > Socket selector

Socket selector is a socket tray with LEDs that can be used to guide the user through, for example, a Batch sequence. When using more than one tightening program, it is convenient to use a selector. When a socket is lifted, the corresponding tightening program is selected. Several socket selectors can be connected to each virtual station.

Information about the connected socket selectors can be found by tapping **Tightening** and then **Socket selector** on the **Sources** menu.

Configuring the socket selector

1. Go to **Configurations**, then **Socket selector** and click on the plus at the top right to create a new configuration
2. Give the configuration a name
3. Click on **Edit**
4. Click **Add** or **Remove** for the correct number of socket slots, then select all the slots that need to be active (indicated in blue)

Connecting a socket selector to a virtual station

1. On the **Virtual station** menu, go to the virtual station to use and then go to Accessories and tap **Choose accessories**.
2. Under Accessories, click Choose accessories, then navigate to the Socket selector tab.
3. In the *Configuration* column (left), select a configuration you want to use with the socket selector (see *Configuring the socket selector [Page 139]*)
4. In the *Connected accessories* column (right), select the socket selector you want to use.

Setting up a socket selector via I/O bus

1. Connect the socket selector to the controller's I/O bus.
2. Under **Virtual station > Accessories > Choose accessories > Socket selector**, check that the selector shows up in the *Connected accessories* column (right)

Setting up a Selector 6 via Ethernet cable/Wireless

Selector 6 main overview

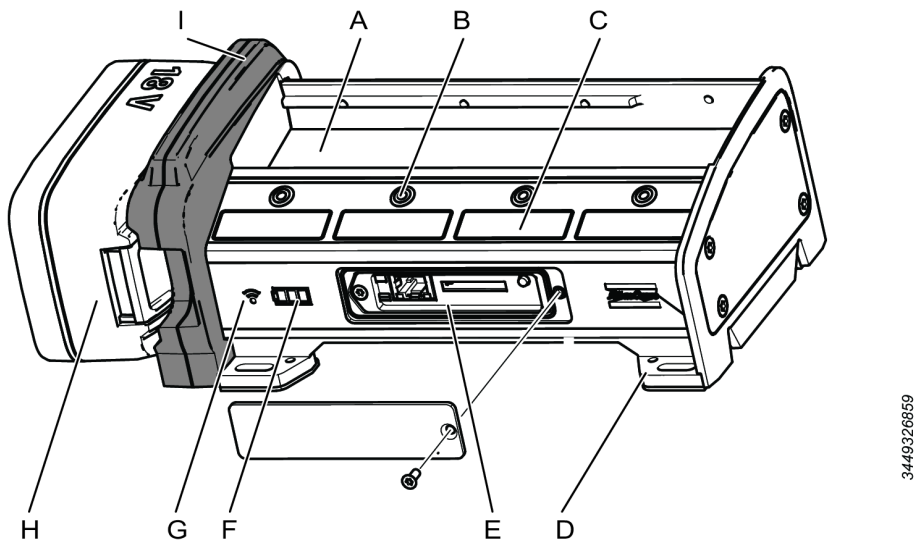


Illustration 26: Selector front view

A	Holder for socket or bit	F	Battery status LED (only available on wireless versions)
B	Indicator LEDs for the position	G	WLAN status LED (available on some selectors)
C	Sticker area	H	Battery (only available on wireless versions)
D	Mounting holes in each corner	I	Mobility module (only available on wireless versions)
E	Service port		

Selector 6 connection overview

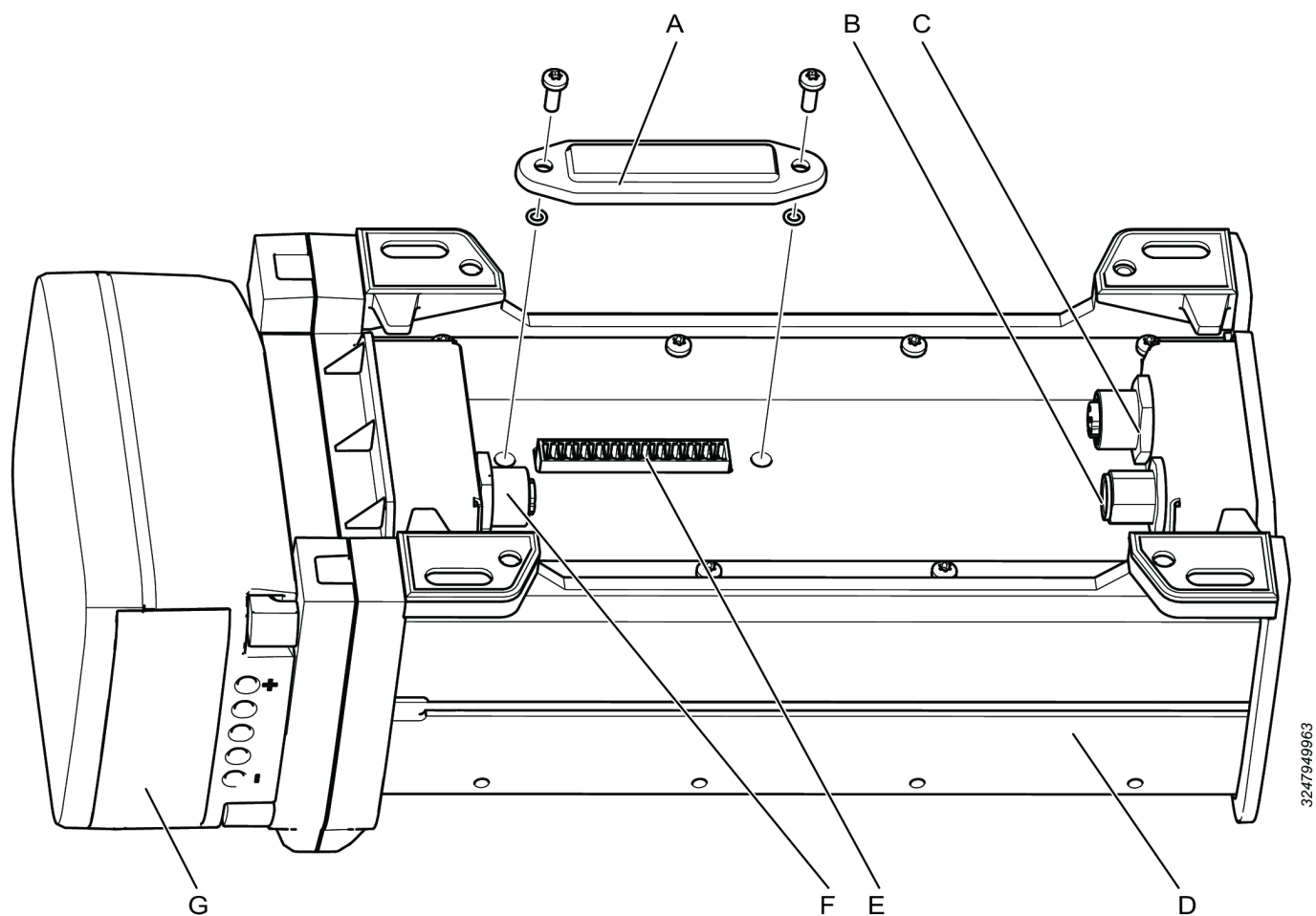


Illustration 27: Selector bottom view

A	Connector cover	E	Digital input and output connector
B	External DC power in; Kycon (DC DIN) connector	F	Ethernet out, downstream connection; M12 D-coded female connector
C	Ethernet in, upstream connection; M12 D-coded female connector	G	Battery
D	Selector back side		

Selector 6 service port overview

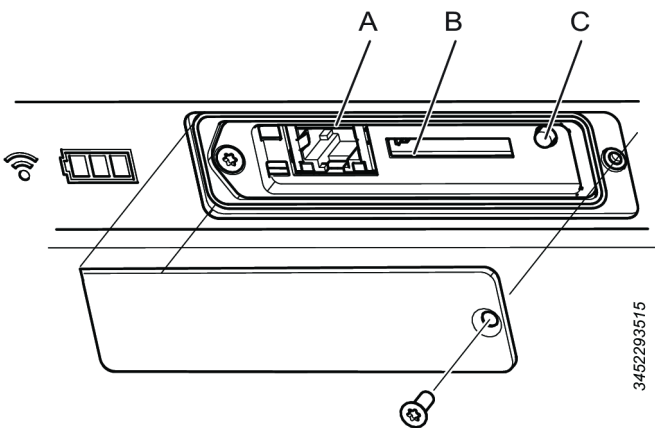


Illustration 28: Service interface

A	RJ45 Service port	C	Function button
---	-------------------	---	-----------------

B RBU slot

General set-up

1. On the controller, go to **Settings > Network** and under *Factory Ethernet* port, check the IP address (only required when setting up via wireless connection).
2. Open the service port cover on the selector. The cover is secured by a 2 mm allen screw.
3. Connect an ethernet cable between a PC and the RJ-45 connector in the service interface.
4. Make sure the selector powered, either by PoE, by external power supply or by battery.
5. Open a web browser window in the PC.
6. Type the web address 169.251.1.1 and press the **Enter** key. The web server in the selector will respond and show the selector web interface.
7. Select **Settings**  in the left navigation (this is selected by default). The **Settings** workspace shows the configuration menus and is divided into five different settings: Basic settings, Service port, Ethernet in, WLAN, and PF6000.
8. In the **Ethernet in** section, select **External mode** On or Off for the desired LED control source.
9. The next steps in the set-up depend on how the socket selector will be connected to the controller (Ethernet cable directly to the controller (default), Ethernet cable to factory network, or wireless to factory network). See the instructions below for your set-up.

Setting up socket selector - Ethernet wired to controller (default)

-  Ethernet ports (RJ45) for connecting devices and daisy-chaining controllers are only available in newer PF6000 models. In order to connect Selector 6 via Ethernet cable to older controller models, an adapter cable should be used to connect the Ethernet cable to the controllers COM PORT.

1. In the **Ethernet In** section, select *PF6000* (default) in the Connected to drop-down.
2. Click the **Save** button in top right of the workspace.
3. Remove the ethernet cable from the service port.
4. Close the service port with the lid and secure it with the allen screw.

The socket selector shows up in the Connected accessories list (**Virtual station > Accessories > Choose accessories > Socket selector**)

Setting up Selector 6 - wired to factory network

1. In the **Ethernet In** section, select *Factory net* from the Connected to drop-down
2. Select DHCP On or Off for dynamic or static IP address configuration. If a static IP address is required, in the IP address field, enter the IP address for the socket selector.
3. In the **PF6000** section, enter the controller IP address (see above) for the controller the selector will be connected to.
4. Click the **Save** button in top right of the workspace.
5. Remove the ethernet cable from the service port.

6. Close the service port with the lid and secure it with the allen screw.

The socket selector shows up in the Connected accessories list (**Virtual station > Accessories > Choose accessories > Socket selector**)

Setting up socket selector - wireless to factory network

1. In the **Ethernet In** section, select *Factory net* from the Connected to drop-down
2. In the WLAN section, fill out the following parameters:
 - Enable: set radio button to YES
 - SSID: fill out the SSID name for the socket selector
 - Password: fill out the password for the wireless network to be connected to
 - Encryption type: choose the correct encryption type for the wireless network (WPA-PSK, or WPA2-PSK, EAP-TLS)
3. In the **PF6000** section, enter the controller IP address (see above) for the controller the selector will be connected to.
4. Click the **Save** button in top right of the workspace.
5. Remove the ethernet cable from the service port.
6. Close the service port with the lid and secure it with the allen screw.

The socket selector shows up in the Connected accessories list (**Virtual station > Accessories > Choose accessories > Socket selector**)

General Virtual Station

In General Virtual Station different specific result reporting configurations can be saved. Different filters can be created filtering out specific results. These configurations can then be assigned to virtual stations.

Adding and editing a configuration

1. In the Configurations menu, click on the General Virtual Station tab, and click on the **plus sign** top right.
2. Give the new configuration a name and click on **Edit**.
3. In the Results filter for reporting window, set the switch to **On** for those parameters you want to include in the results. By default, all parameters are set to **On**.

The following parameters can be set:

- Loosening
- Batch increment
- Batch decrement
- Reset batch
- Bypass Tightening Program
- Abort sequence
- Reset batch sequence

Assigning a configuration to a virtual station

Each virtual station can have its own configuration associated with it, or multiple virtual stations can share the same configuration.

1. Go to the Virtual Station menu and select the Virtual Station you want to assign the configuration to.
2. Under General, the first General Virtual Station configuration will be chosen by default. Click on the configuration name.
3. In the pop-up window, select the desired configuration from the list. The pop-up window will be closed upon selection.

Tightening results

This section describes how to access tightening results on the Power Focus 6000 controller and how to read the information given in the different result views. It describes both the live results view available after each tightening and the historical results view available in **Results** on the **Reports** menu.

When a tightening is performed, the results are stored on the controller. Results can also be sent to an external system such as ToolsNet or exported for analysis using the *Export function* [Page 154].

Live results

The live result window shows results from the different virtual stations on the controller in the upper four as well as the lower four panes. The reason for this is that you can choose two different result views for the same virtual station to be shown at the same time.

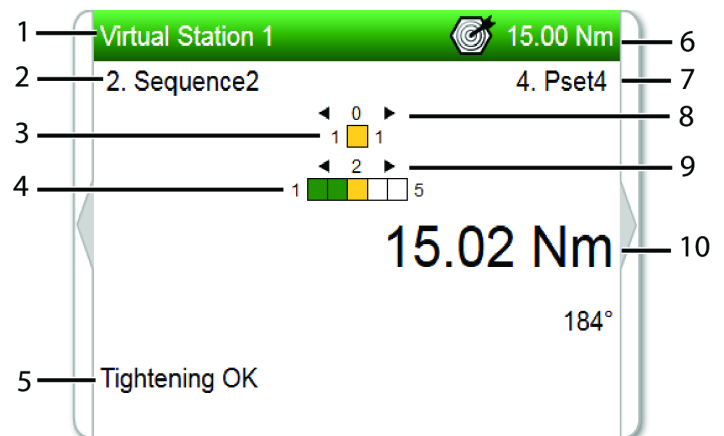
Tap a result pane to open a window where you can step through the different result views by clicking the arrows at the side of the result window.

Result view - Numbers

The first window will display the result in numbers.

1. Virtual station name
2. Batch sequence name
3. Batches in sequence
 - An OK batch is colored green.
 - An ongoing batch is colored yellow.
 - An NOK batch is colored red.
4. Tightenings in batch
 - An OK tightening is colored green.
 - An ongoing tightening is colored yellow.
 - An NOK tightening is colored red.
5. Result status

An NOK tightening will give a detailed status of the unsuccessful tightening.
6. Target torque/angle
7. Tightening program name
8. Number of completed batches in sequence
9. Number of completed tightenings in a batch
10. Tightening result

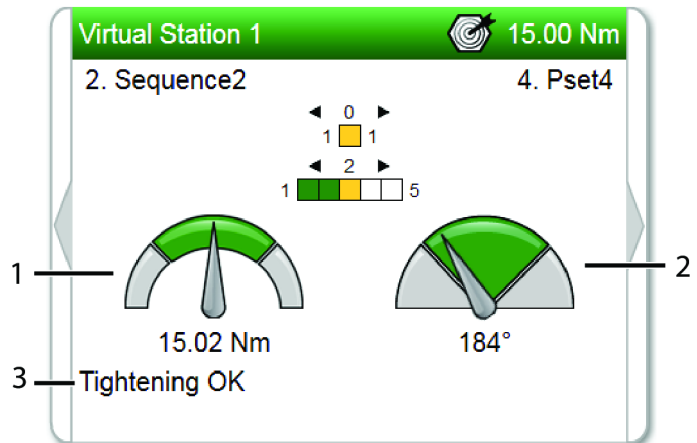


Result view - High-Low result

The graphic display shows whether the result is high, low or within the set limits.

- Graphic display showing if the tightening result is too high or too low with respect to the given limits for the tightening program. Torque value.
- Angle value
- Result status

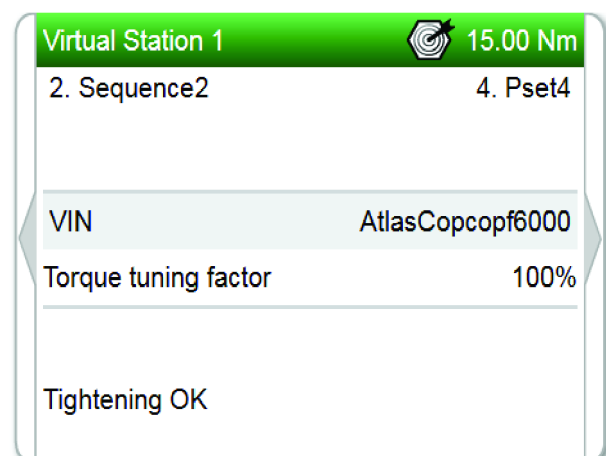
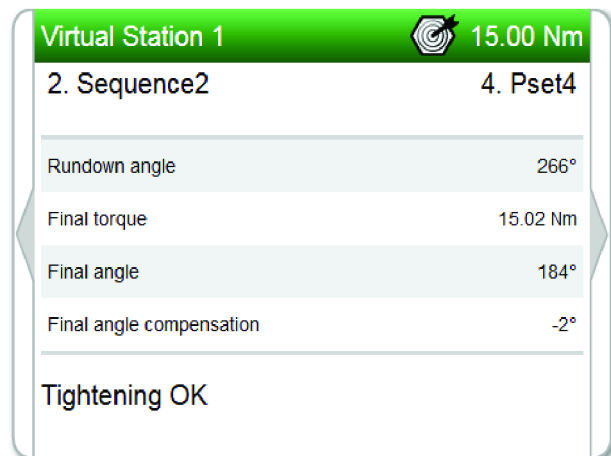
If the tightening is NOK, a detailed reason will be given. See section *Status for NOK results* [Page 148].



Result view - Extensive results

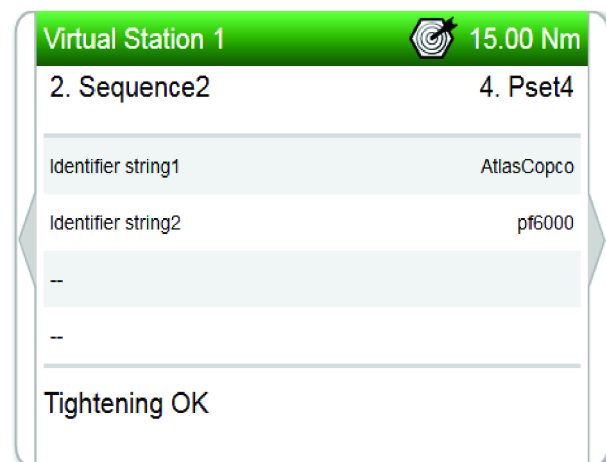
The extensive results views will display some additional tightening results.

The second view always shows the identifiers (VIN). If the first screen is already full with parameters, the rest of the parameters are shown on the second screen.



Result view - Identifier strings

This result view shows the identifier strings included in a multiple barcode scan.

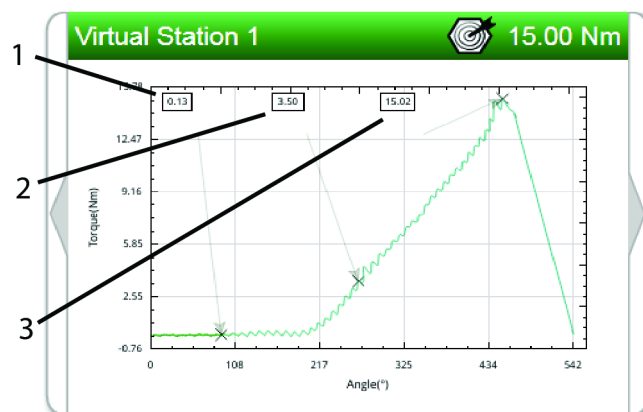
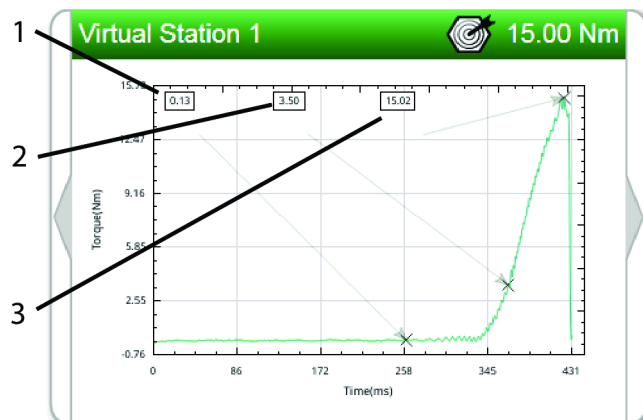


Result view - Trace

With the trace result view, one can learn better how the tightening behaves, in order to make adjustments to the tightening program. Depending on the tightening strategy, the trace will display different tightening parameters.

The trace result is available as two different graphs: torque/time and torque/angle.

1. Softstart
2. Rundown complete
3. Final torque



Stored results

The controller stores the result for every tightening or loosening performed. Tapping on a result causes the same result window to appear as was described in *Live results* [Page 145]. The result list will show information about:

- Date - The date and time of the tightening performed.
- Virtual station - The virtual station with which the tightening was performed.
- Tightening program - The tightening program or batch/tightening program.
- Result details - The torque or angle result, and the result status.

1. An NOK tightening
2. An OK tightening
3. An OK loosening

Results				
	Date	Virtual station	Pset	Result Details
1	 2014-08-29 18:13:33	Virtual Station 1	1. Batch seq. 1: 2. Quick step	37.06 Nm Final torque high
	 2014-08-29 18:13:29	Virtual Station 1	1. Batch seq. 1: 2. Quick step	31.85 Nm Loosening OK
2	 2014-08-29 18:13:20	Virtual Station 1	1. Batch seq. 1: 2. Quick step	8.31 Nm Tightening OK
	 2014-08-29 18:13:18	Virtual Station 1	1. Batch seq. 1: 2. Quick step	16.91 Nm Loosening OK
	 2014-08-29 18:13:10	Virtual Station 1	1. Batch seq. 1: 1. TurboTight	20.32 Nm Tightening OK
3	 2014-08-29 18:13:08	Virtual Station 1	1. Batch seq. 1: 1. TurboTight	16.27 Nm Loosening OK
	 2014-08-29 18:13:01	Virtual Station 1	1. Batch seq. 1: 1. TurboTight	20.76 Nm Tightening OK
	 2014-08-29 18:12:58	Virtual Station 1	1. Batch seq. 1: 1. TurboTight	6.16 Nm Loosening OK
	 2014-08-29 16:58:25	Virtual Station 1	1. Batch seq. 1: 2. Quick step	37.77 Nm Final torque high
	 2014-08-29 16:58:15	Virtual Station 1	1. Batch seq. 1: 2. Quick step	30.00 Nm Loosening OK

Tightening error reporting

Errors are reported if, for example, a tightening is not carried out correctly or the results do not match the set limits and targets etc. Error messages are displayed on the screen.

When errors are reported, it can be that one or several errors occurred at the same time. As the controller has a limited space for reporting the errors, only one error is presented at a time. The errors are sorted in a priority list, always causing the first error to abort to be shown.

Status for NOK results

For a complete list of NOK warnings and their descriptions, see *Events, NOK Results List* [Page 172]

System administration

The system administration tasks for the Power Focus 6000 controller are handled in the **Controller** menu. The menu is accessed through the controller GUI, the web GUI, or the Tools Talk 2 GUI.

IAM

Controller > IAM

The **Intelligent Application module (IAM)** is a non volatile storage that is located in the controller. The storage module contains all the controller programs, configurations and results. Certain modules may also include additional loaded *feature items*.

For a complete list of available IAMs and their capabilities, please consult an Atlas Copco sales representative.

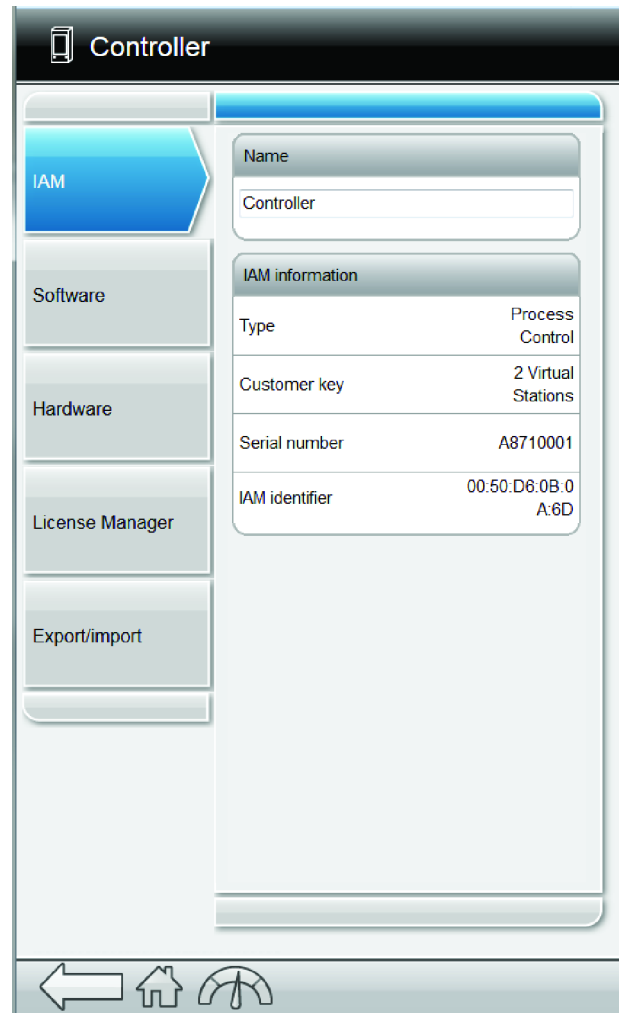


Illustration 29: IAM information

Hardware

Controller > Hardware

The Hardware tab contains Controller information, such as model designation and serial number, Health, Touch screen calibration, and information about the various electronics boards in the controller.

Health

The Health view contains information about battery status and controller temperature.

Controller battery

The PF6000 battery, located inside the controller's front panel serves as backup power for some system elements, such as the internal clock. The status of the battery is updated once a day, as well as at controller restart. When the battery is close to being completely depleted, a warning (3011) will be displayed. The battery shall be replaced as soon as possible when the warning pops up.

1. Click on Controller
2. Click on Hardware
3. The controller's battery status is listed under Health.

Controller temperature

Controller temperature is monitored continuously by the PF6000. Supported temperature units are degrees Celsius (°C) and degrees Fahrenheit (°F), with Celsius being the default unit. It is possible to switch between the two units without requiring a restart of the controller. When the controller temperature exceeds max temperature, the drive stage is disabled and an alert (3010) will be shown. The drive stage is once again enabled when the controller temperature drops below the temperature limit.

From the display or through the web GUI, users can access the latest controller temperature measured together with the timestamp when the measurement was taken.

1. Click on Controller
2. Click on Hardware
3. Controller temperature is listed under Health

Software

Controller > Software

The version number of two versions of software available in the Power Focus 6000 controller are found under the Software tab.

Installing a second version of the controller software is useful when performing upgrades on multiple controllers. When production is ready for switching to the upgraded software, activation of the new software version is done locally on the controller GUI, from a remote computer with the web GUI, or with Tools Talk.

A new software distribution can be installed either by connecting a USB flash drive containing the software to the controller's USB port, or by using the web GUI.

-  The software update option is visible only when accessing the controller GUI from a PC. When a mass storage device with a valid software version is inserted in the USB port a prompt to update the software will appear.

The software update file must not be unzipped and must be stored in a folder named **PFImages** in the root directory on the USB flash drive.

-  Changing software versions does not transfer the controller configurations or tightening programs.

Updating controller software through USB

To install the software from an USB flash drive:

1. The installation wizard will start automatically when the USB flash drive is connected to the controller. If several software versions are available on the USB flash drive, a list with the different software upgrade files is displayed.
 2. Select the software upgrade file to install and follow the instructions to finish the installation.
-  The USB flash drive needs to have a partition available and be formatted to work for Linux. Possible formats are for example FAT or NTFS.

Updating controller software through Web GUI

To install the software from the web GUI:

1. On the **Controller** menu, go to **Software**, and select **Software update** and click **Browse**.
2. Browse and choose the zip file with the software and follow the instructions to finish installation.

Software activation

The controller can store two installed software versions. By using the Software activation, it is possible to choose which software version to use. Software activation can be performed either locally from the controller GUI or remotely from the web GUI.

-  The activation process requires a restart of the controller.

To activate the installed software:

1. On the **Controller** menu, go to **Software**
2. Swipe the **Software activation** switch to stored and follow the instructions.

License manager

Controller > License manager

When using an IAM compatible with licensing, licensed features such as *TurboTight* and *TrueAngle compensation* are installed via a license server handled with the Tools Talk GUI. It is also possible to install licenses from a USB flash drive.

The licenses allocated to the Power Focus 6000 controller are visible in the list under the License manager tab.

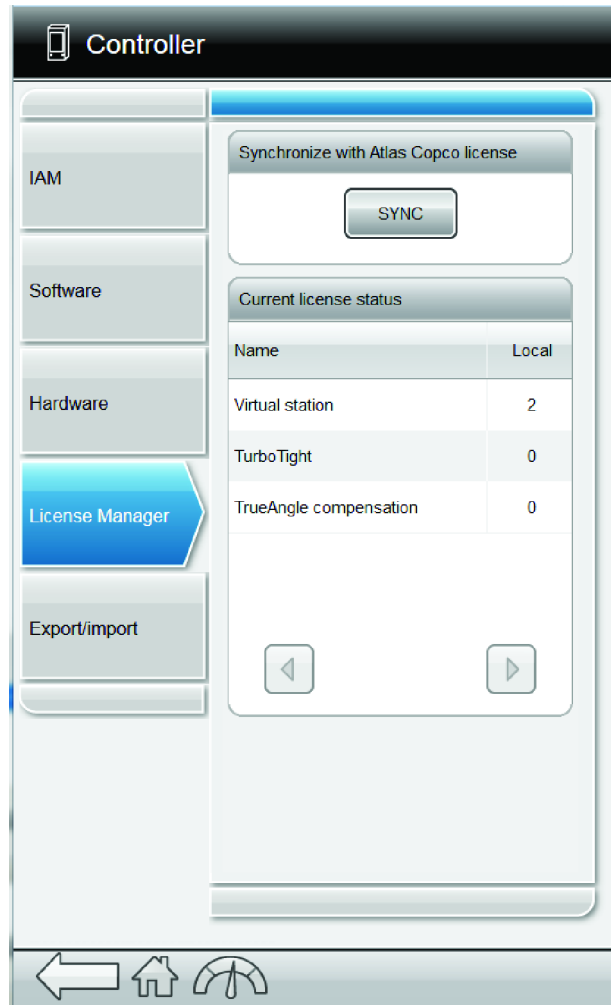


Illustration 30: License information

Functionality management system introduction

The **Functionality Management System (FMS)** allows Atlas Copco customers to use additional desired features, when they are needed, through a dynamic licensing scheme.

When the business deal is completed, the customer's account in **Atlas Copco License Portal (ACLP)** will automatically receive the purchased features within 24 hours and these features can be downloaded as a license file.

This capability file (included in the license agreement) is loaded in the **Local License Server (LLS)** where it is decoded and available for distribution.

A pool of *feature items* is created and may be used across a number of controllers. A desired feature item can be uploaded to the controller when needed, and be returned to the pool when it is not needed anymore.

In the Atlas Copco License Portal (ACLP) it is possible to manage an account with all feature items, entitle and return licenses to/from a license server.

i The creation and management of a customer account in the ACLP is not covered in this documentation.

Functionality management system - manual distribution of feature items

Each controller has a **License Manager (LM)**.

The license manager in the controller is responsible for handling the *feature items* and transfers them between the controller and the USB device.

The USB flash drive is the license distribution server. One part of its memory is a trusted storage area, that contains a pool of *feature items*. The license manager can load *feature items* from the server when it is needed and when the USB device is inserted into the controller. When they are not needed any more, they can be returned to the server pool.

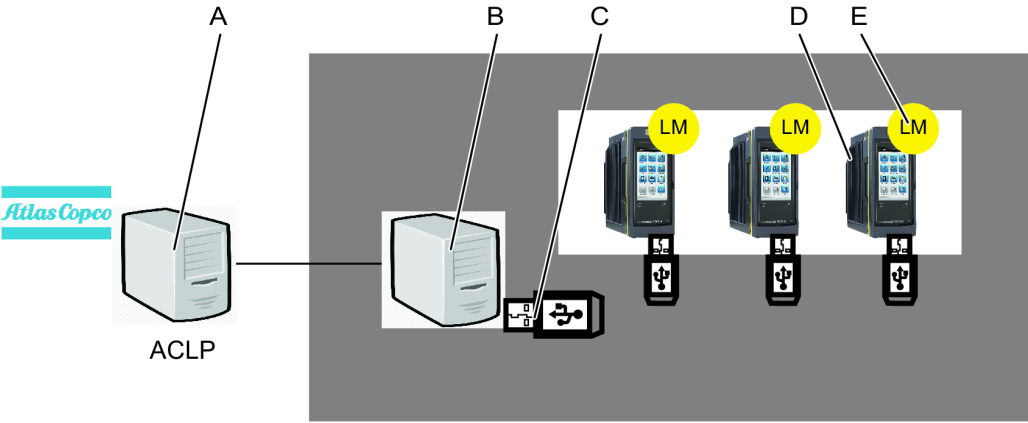


Illustration 31: Functional management system using a manual distribution architecture

A	Atlas Copco Licensing Portal	B	Computer at customer premises. Can communicate with external servers and the internet.
C	USB flash drive, the functionality distribution server.	D	Controller
E	License Manager in the controller		

 The figure only shows the FMS and the distribution of *feature items*. Controllers may be connected to a network for other reasons.

The process flow for the FMS using a license carrier is a follows:

1. The customer orders the desired *feature items* from Atlas Copco.
2. When the business deal is completed, the customer downloads the *feature items* from the **Atlas Copco License Portal** (ACLP) or receives a file in another way. This capability file is loaded into the **Local License Server** (LLS) where it is decoded. A pool of *feature item* is created that can be used across a number of controllers.
3. The license file is transferred from the computer to the general purpose memory area of the USB flash drive.
4. The USB flash drive is removed from the computer and inserted into a controller that supports FMS.
5. The license manager in the controller reads the entire file, decodes the file and deletes the file from the general purpose memory area and transfers its content to the trusted storage area in the USB flash drive. The trusted storage contains now a pool of *feature items* that can be used across a number of controllers.
6. The license manager can move *feature items* from the distribution server to the controller or move *feature items* from the controller to the distribution server when it is no longer needed.
7. Remove the USB device from the controller and move to the next controller that needs any changes in its functionality.

If additional *feature items* are needed, this is ordered from Atlas Copco, and a new file is downloaded.

USB flash drive

The **Functionality Management System** (FMS) uses a special USB device to transfer functionality to and from a controller.

The USB flash drive contains both a general purpose memory area and a trusted storage area that is only accessible by the **License manager** in a controller.

The purchased *feature items* are downloaded from Atlas Copco to the general purpose area. The first time the USB device is inserted into a controller with a **License manager**, the file is detected and decoded and the *feature items* are transferred to the trusted storage area that is only accessible from a **License manager**.

The USB device can act both as a general purpose memory drive but also as a distribution server by using its trusted storage.

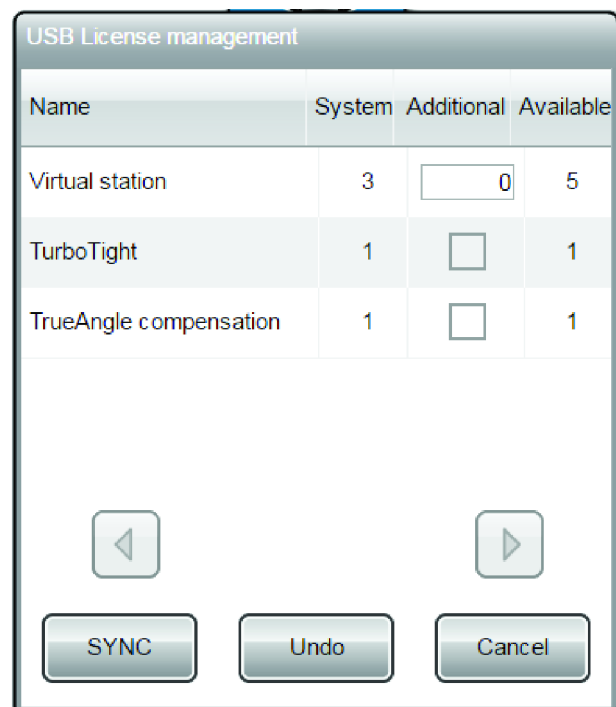


Illustration 32: Window opened on the controller when inserting the USB device.

- ❗ If the USB flash drive is used as a distribution server, a network distribution server cannot be used. Any attempt to use more than one distribution server may lead to permanently loss of *feature items*.

Export/Import configuration

Controller > Export/Import

The export and import function is used to export the events and tightening results accessible in the **Reports** menu for analysis in external programs, as well as allowing transfer of tightening program, batch, and controller configurations between controllers.

The export function is used to:

- Export tightening results and events for further processing, both from the cable tool, as well as connected wireless tools.
- Export log files for debug assistance from an Atlas Copco service engineer.
- Export controller configuration that can be used to copy settings to another controller

There are three options for what to export from the controller: **All controller information**, **Settings and configurations**, and **Logs from connected tools**.

The Settings and configurations option will export only the settings and it takes less time to perform. Neither All controller information, nor Settings and configurations will include information on connected tools.

 Currently, only tool logs for STB, SRB and TBP tools can be exported.

When using the import function, all settings for tightening program, batch, accessories, and controller are replaced by the settings from the import file. However, settings for network, PIN, and results and events are not imported.

When exporting files from the controller GUI, make sure a correctly formatted USB storage device is connected to the controller's USB port, since that is where the exported files will be stored. When files are exported from the web GUI, the files will be stored in the browser's download location. Note that when Logs from connected tools is chosen when no tools are connected to the controller, a file will still be exported. The file will contain no information.

Exported information and file format

Exported files

The exported file is a compressed file archive containing a binary file with the settings, as well as two character-separated values (csv) files with results and events.

When Settings and configurations is chosen no file with results or events will be exported into the archive.

File	Description
PfExport__<Controller name>_<Time stamp>_Events.csv	A semicolon-separated file containing the following information: • Severity: Type of event • Date and time: A time stamp of when the event occurred • Code: The event ID • Description: A short description of the event • Virtual station: Virtual station ID

File	Description
PFExport__<Controller name>_<Time stamp>_Results.csv	A semicolon-separated file containing the following information: • Type of tightening: Multi tool, single tool, single tool batch, or multi tool batch. • Virtual station name • VIN: Vehicle Identification Number • Date and time: A time stamp of when the result occurred • Batch sequence name: The batch sequence name • Batch sequence counter: The batch number in the batch sequence • Batch count: Actual tightening in the batch • Bolt name • Status: Tightening or loosening status OK or NOK • Status additional info: A short description of the result status • Tightening program name • Target torque: The target torque value • Final torque: The final torque value • Target angle: The target angle value • Final angle: The final angle value • Rundown angle: The rundown angle value • Torque tuning factor: Factor to compensate for the difference between residual torque and dynamic torque when using TurboTight. • Current at shutoff • TrueAngle compensation • Time to rundown complete • Time to final torque
ExportInfo.txt	Information about the controller set-up and controller software.
settings/settings.bin	A binary file containing all tightening programs and Batch settings, Accessory configurations, and controller settings such as: Language, Torque units, Fieldbus data, Date and time, and Result appearance.

Table 43: Exported information

Exported csv file format

The exported csv files uses different characters to separate the fields depending on the language setting in the controller. See the following table for details.

Language	Date/time	Field delimiter	Number format
English (en_US)	MM/dd/yyyy hh:mm:ss	,	123.456

Language	Date/time	Field delimiter	Number format
Czech (cs_CZ)	dd.MM.yyyy hh:mm:ss	;	123,456
German (de_DE)	dd.MM.yyyy hh:mm:ss	;	123,456
Spanish (es_ES)	dd/MM//yyyy hh:mm:ss	;	123,456
French (fr_FR)	dd/MM/yyyy hh:mm:ss	;	123,456
Korean (ko_KR)	yyyy-MM-dd hh:mm:ss	,	123.456
Italian (it_IT)	dd/MM/yyyy hh:mm:ss	;	123,456
Japanese (ja_JP)	yyyy/MM/dd hh:mm:ss	,	123.456
Portuguese (pt_BR)	dd/MM/yyyy hh:mm:ss	;	123,456
Russian (ru_RU)	dd.MM.yyyy hh:mm:ss	;	123,456
Swedish (sv_SE)	yyyy-MM-dd hh:mm:ss	;	123,456
Chinese (zh_CN)	yyyy/MM/dd hh:mm:ss	,	123.456

Table 44: Formats in different languages

Exporting or importing from web GUI

When using this function from a web GUI, a prompt to select where to save or retrieve the exported file is shown.

Exporting or importing from controller

When using this function from the controller GUI, a USB flash drive must be connected to be able to export and import data.

- ❗ The USB flash drive needs to be formatted and with a partition to work for Linux. Possible formats are for example FAT or NTFS.

Export and Import between controllers

Controllers may have different types of IAM modules that support a different numbers of tightening programs, batches or virtual stations.

A controller can export all the configurations that are applicable for the current type of IAM module.

- ❗ A controller cannot import a file exported from a different type of IAM module. This is applicable also when using ToolsTalk.

Events

Reading the information given in an event

An event contains information that describes the occurred event as well as some system information to help describe what has happened, where and when.

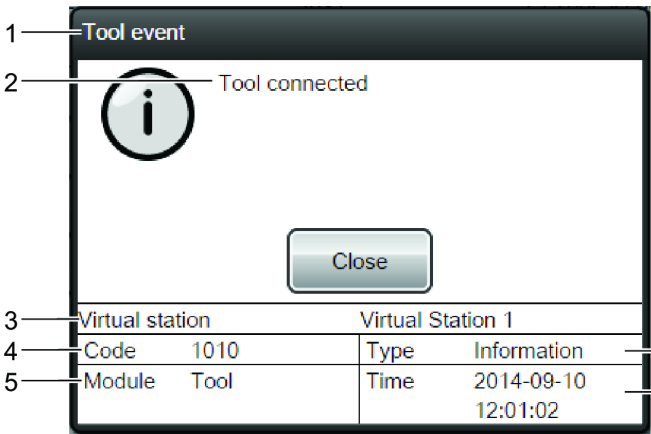


Illustration 33: Event information window

1. **Heading** - Describes what part of the system the event concerns.
2. **Event name** - A short descriptive text of the event.
3. **Virtual station** - If the event is related to a virtual station on the controller the virtual station name will be displayed.
4. **Code** - A unique four-digit number that identifies the event.
5. **Module** - Describes in what part of the system the event concerns.
6. **Type** - Information, Warning or Error.
7. **Time** - Date and time when the event occurred.

Event types

Events are divided into three categories; Information, Warning and Error.

Information event

Information events signal a noteworthy event that has occurred from actions performed by the user or the system. Information events do not require any specific user actions.

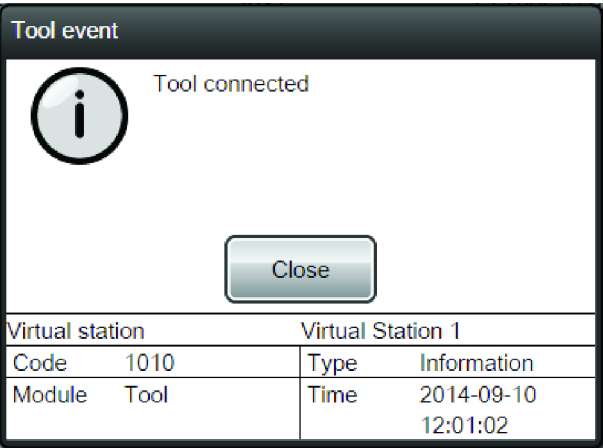


Illustration 34: Information event

Warning event

Warning events signal a potentially serious condition that could affect the system performance or result in injury.

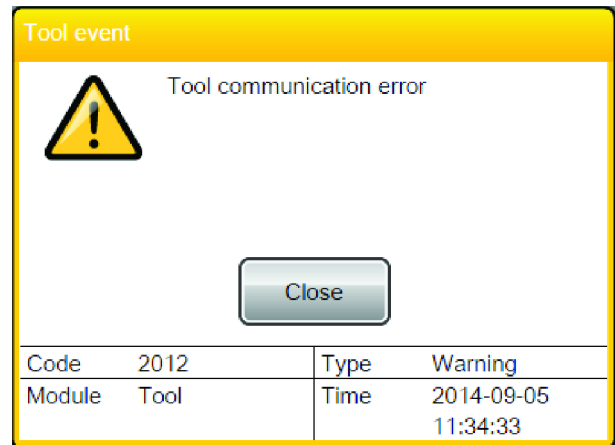


Illustration 35: Warning event

Error event

Warning events signal a serious condition, such as a failed service, that almost exclusively requires the user to make changes to the setup or the configuration in order to continue.

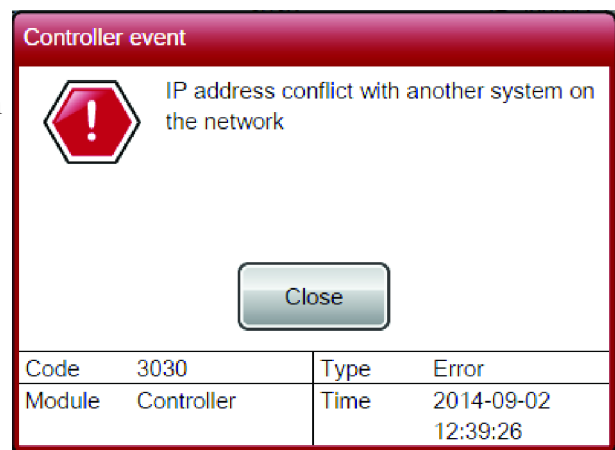


Illustration 36: Error event

Configure events

Settings -> Events

 Some options cannot be changed and they are greyed out.

Each event has a default setting for whether they should be acknowledged (Ack), logged (Log) or displayed (Disp). These settings can be configured in **Events** on the **Settings** menu.

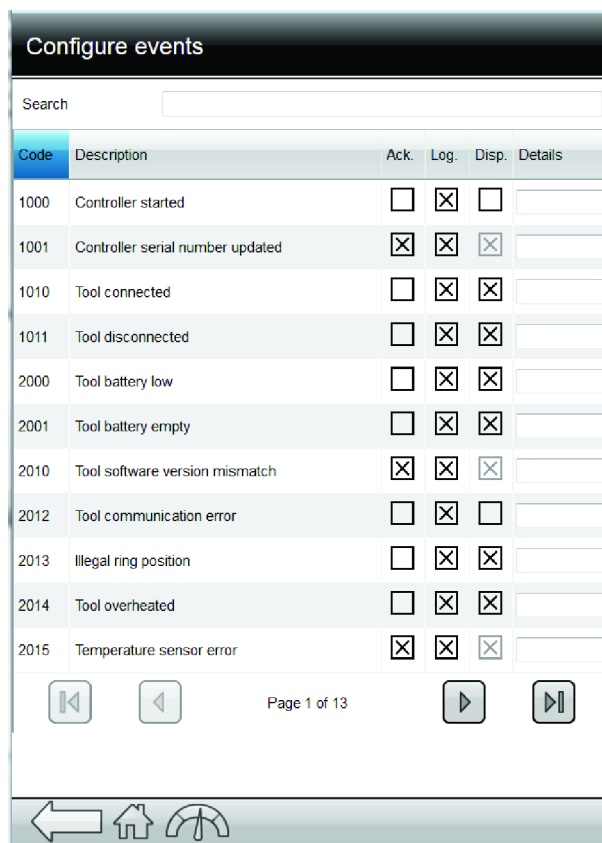


Illustration 37: Event list

Event codes in Power Focus 6000

Events are used to notify the user of certain state changes or occurrences in the system. They are of different types and require different kinds of actions.

- Some of the procedures described can only be performed by an Atlas Copco authorized service provider.

Event code	Group	Description
1000-1999	Controller, Tool	Controller and Tool events.
2000-2999	Tool	Tool events.
3000-3999	Controller, Drive, Channel, Configuration	Controller and Drive events, and Step sync events.
4000-4999	Process	Tightening process events.
5000-5999	Configuration	Program configuration events.
6000-6999	Accessory	Accessory events.
7000-7999	Message	Messages.

Table heading	Description
Event code	The unique event number.
Type	Type of event: • Info • Warning • Error

Table heading	Description
Name	A descriptive name of the event.
Description	A short description of the event and why it occurred.
Procedure	If applicable the procedure contains an instruction on how to clear the event.
A - Acknowledge	Tells the user whether the event has to be acknowledged or not before you can proceed. The value in this list is the default value.
L - Log	Tells the user whether the event is to be saved in the event log or not. The value in this list is the default value.
D - Display	Tells the user whether the event is to be displayed on the screen or not. The value in this list is the default value.

Event							
Code	Type	Name	Description	Procedure	L	D	A
1000	Info	Controller started	The controller is started.	N/A	X		
1001	Warning	Controller serial number updated	Generated at start-up if IT-board box serial number (controller serial number) differs from AUX-board box serial number. AUX-board is considered to be non-replaceable in field. The controller will reboot when the serial number is updated.	Replace IT-board or box.	X	X	X
1010	Info	Tool connected	A tool is connected.	N/A	X	X	
1011	Info	Tool disconnected	A tool is disconnected.	N/A	X	X	
2000	Warning	Battery low		Replace battery.	X	X	
2001	Warning	Battery empty		Replace battery.	X	X	
2002	Warning	Tool battery health low	SRB or TBP tool battery health problem is detected.	Replace battery	X	X	
2004	Warning	Tool is not of the preferred type	Tool has been replaced by a tool with a different Tool max torque.	Change tool	X	X	
2006	Warning	Tool backup battery health low	SRB or TBP tool backup battery health problem is detected.	Replace battery	X	X	X
2007	Warning	Tool backup battery missing	SRB or TBP tool backup battery is missing.	Insert battery	X	X	
2008	Warning	Tool backup battery error	SRB or TBP tool backup battery error detected.	Replace battery			
2009	Warning	Backup battery voltage low	The controller's backup battery is almost empty	Replace battery	X	X	
2010	Error	Tool software version mismatch	Tool and controller software versions not compatible.	Service tool - update tool software.	X	X	X

Event Code	Type	Name	Description	Procedure	L	D	A
2012	Warning	Tool communication error	Communication between tool and controller interrupted.	Relocate antenna placement.	X		
2013	Warning	Illegal ring position	Tool direction switch in faulty position.	If occurring frequently - service tool.	X	X	
2014	Warning	Tool overheated	Tool overheated.		X	X	
2015	Error	Tool temperature sensor error			X	X	
2016	Warning	Tool pulse unit overheated	SRB or TBP tool pulse unit overheated. Tool is not locked, but the warning is displayed whenever the tool is started as long as the pulse unit temperature is over threshold.	Allow tool to cool down	X	X	
2019	Warning	Tool could not start motor	For SRB and TBP tools. Tool motor failure.		X	X	
2020	Warning	Tool requires motor tuning	Tool requires motor tuning.	Perform a motor tuning.	X	X	
2021	Warning	Motor tuning failed	Motor tuning failed.	Complete motor tuning or service the tool.	X		
2022	Info	Motor tuning completed	Motor tuning completed.	N/A	X		
2023	Warning	The tool requires open end tuning	The tool requires open end tuning.	Perform open end tuning.	X	X	
2024	Warning	Open end tuning failed	Open end tuning failed.	Try to perform open end tuning one more time. If it fails again, service the tool.	X		
2025	Info	Open end tuning successful	Open end tuning successful.	N/A	X		
2026	Warning	Open end position failed	Open end position failed.	Press the trigger again and wait for the positioning to be completed. If it fails again, service the tool.	X	X	
2030	Error	Tool memory corrupt	Tool memory corrupt.	Service the tool.	X	X	X
2031	Error	Tool accessory memory corrupt	Tool accessory memory corrupt.	Service the tool accessory.	X	X	X
2040	Error	System check failure			X	X	X

Event							
Code	Type	Name	Description	Procedure	L	D	A
2041	Error	Torque transducer error	Will be generated either on calibration error or if tool reports transducer error.	Service the tool.	X	X	
2042	Error	Angle transducer error		Service the tool.	X	X	X
2043	Error	Tool ground fault error			X	X	X
2044	Info	Tool service interval expired	Indicates that servicing of the tool is needed. Triggered when the number of set tightenings has been exceeded.	Perform service of tool.	X	X	
2045	Warning	Tool calibration data invalid	If validation of calibration data fails.	Service the tool.	X	X	
2046	Info	Tool calibration indicator	Indicates that tool calibration is needed. Triggered when calibration alarm is enabled in settings and the current time is greater than next calibration date.	Service the tool.	X	X	
2047	Info	Auto update of servicedata checksum	Indicates that servicedata checksum has been updated automatically.	N/A	X	X	
2050	Error	Tool parameter file not supported	Required tool parameters are missing.	Update tool parameters.	X	X	
2060	Info	Unexpected trigger behaviour	Used to prevent start of tool if accessory is connected.	N/A	X	X	
2070	Info	Tool not supported	Tool is not licensed or supported.	N/A	X	X	
2071	Error	Tool memory is corrupt	Tool descriptor is corrupt.	Service the tool.	X	X	
2072	Info	Unknown device connected			X	X	
2073	Warning	Tool trigger supervision failure	HW channel failure. Mismatch between hardware and software of tool trigger.		X	X	
2074	Warning	Tool indicator board failure	Tool indicator board failure.	Service the tool.	X	X	
2075	Warning	Tool fan voltage failure	Tool fan voltage failure.	Service the tool.	X	X	
2076	Warning	Tool accessory bus voltage failure	Tool accessory bus voltage failure.	Service the tool.	X	X	
2077	Warning	Tool trigger sensor error	Tool trigger sensor error.	Service the tool.	X	X	

Event Code	Type	Name	Description	Procedure	L	D	A
2078	Info	Tool Tightening program updated			X	X	
2079	Error	Tool cable not supported	Tool cable is corrupt. The chip in the cable is not responding or is damaged.	Switch cable.	X	X	
2080	Error	Tool battery failure	DC voltage too high or too low. Battery failure.	Contact the Atlas Copco service representative and send back battery to Atlas Copco (do not reuse it!).	X	X	
2081	Error	Tool current limit reached	The current limit has been reached and the drive is disabled.	Service the tool.	X	X	
2082	Error	Tool current measurement error	Current measurement error. Current cannot be measured with a reliable result.	Service the tool.	X	X	
2083	Error	Tool internal error	Various internal hardware errors for STB.	Service the tool.	X	X	
2084	Error	Tool internal software error	Various internal software errors for STB.	Service the tool.	X	X	
2085	Error	Tool RBU error	An RBU error was detected by the tool software.	Check that the RBU is correctly installed. If error is still present then service the tool.	X	X	
2086	Error	Tool stall	Tool motor is stalling.	Service the tool.	X	X	
2087	Warning	Tool motor current high	SRB or TBP tool motor current limit is exceeded, and the tool is locked. Tool will enter failsafe mode.		X	X	
2088	Warning	Tool battery current high	SRB or TBP tool battery current is too high.		X	X	
2089	Warning	Tool drive voltage low	SRB or TBP tool drive voltage is below the monitored lower voltage limit.		X	X	
2090	Warning	Tool drive voltage high	SRB or TBP tool drive voltage is above monitored higher voltage limit.		X	X	
2091	Warning	Tool main board error	SRB or TBP tool main board internal error.		X	X	
2092	Warning	Tool power module error	SRB or TBP tool power module internal error		X	X	
2093	Warning	Pulse unit oil level low	The oil level of the connected pulse tool is low.	Service the tool	X	X	

Event								
Code	Type	Name	Description	Procedure	L	D	A	
2094	Warning	Pulse unit oil level empty	The oil level of the connected pulse tool is below required operational level	Service the tool	X	X	X	
2095	Warning	Tool battery communication lost	SRB or TBP tool lost communication with battery.	Make sure battery is seated correctly. Otherwise change battery	X	X		
2100	Info	smartHead removed	STwrench smartHead has been removed.	Reconnect smart-Head and restart the wrench.	X	X		
3000	Error	Controller internal software error	Software error in the controller.	Contact service.	X	X	X	
3001	Error	Controller clock battery empty	Internal battery is getting close to end of life.	Replace battery	X	X	X	
3010	Warning	System overheated	The controller is overheated.	Cool down.	X	X		
3020		Controller hardware failure						
3021	Warning	System voltage problem	DC voltage too high or too low.	N/A	X	X		
3030	Error	IP address conflicting with another node on the network	The set IP address is in use by another device on the same network.	Change IP address on one of the devices.	X	X		
3031	Info	Network cable unplugged	The carrier of the factory port is lost.	Check the cable connection.	X	X		
3032	Info	Radio pairing started	Tool pairing started.	N/A	X	X		
3033	Info	Radio pairing successful	Tool pairing successful.	N/A	X	X		
3034	Error	Radio pairing failed, no tool found	The controller found no tool to pair with when scanning for radio peers.	Set the tool in pairing mode and try again.	X	X		
3035	Error	Radio pairing failed, more than one tool found	The controller found more than one tool when scanning for radio peers.	Ensure that only one tool is in pairing mode when starting the pairing mode on the controller.	X	X		
3036	Error	Radio pairing failed while communicating with tool	The controller experienced a loss of connection, an unexpected answer or timeout during the pairing process.	Try to perform pairing one more time. If it fails again, service the tool.	X	X		
3040	Warning	Emergency stop	Drive disabled due to emergency stop.	Reset emergency stop.	X	X		

Event							
Code	Type	Name	Description	Procedure	L	D	A
3050	Info	System clock updated	System clock has been updated.	N/A	X		
3051	Error	System clock error	Wrong time read from hardware Real Time Clock (RTC).	Change RTC battery.	X	X	X
3052	Warning	Remote start configuration error	Mismatch between HW and SW remote start configuration.	Check and verify that HW dip switch matches the selected start source.	X	X	
3059		Failed to connect to Atlas Copco License Manager	Indicates that the controller failed to connect to the local license manager to get licenses.	Check local network. If it fails again, service the controller.	X	X	
3060		Number of Virtual Station licenses exceeded	Indicates that the number of virtual stations in use is bigger than the actual licensed number of virtual stations.	Delete the unlicensed virtual station or contact the local license server to get more licenses.	X	X	X
3084	error	Soft PLC runtime error	eCLR has terminated in an uncontrolled way.		X	X	
3500	Error	License Manager Generic Error			X	X	X
3501	Error	License Manager Synchronization Error			X	X	X
3502	Info	License Manager Synchronization Done			X		
3520	Warning	TurboTight not licensed	No license for TurboTight available.	Check licenses.	X	X	
3521	Warning	True Angle not licensed	No license for True Angle available.	Check licenses.	X	X	
3522	Warning	Soft PLC not Licensed	License missing for Soft PLC, or number of tools connected exceeds number of licenses installed.	Reinstall license or contact service	X	X	
3523	Warning	Yield not licensed	License missing for Yield, or number of tools connected exceeds number of licenses installed.	Reinstall license or contact service	X	X	
3524	Warning	Gradient not licensed	License missing for Gradient, or number of tools connected exceeds number of licenses installed.	Reinstall license or contact service	X	X	

Event								
Code	Type	Name	Description	Procedure	L	D	A	
3525	Warning	Multistep not licensed	License missing for Multistep, or number of tools connected exceeds number of licenses installed.	Reinstall license or contact service	X	X		
4010	Info	Tool locked by digital input	The tool is locked by a digital input signal.	N/A	X	X		
4011	Info	Tool locked by open protocol	The tool is locked by open protocol.	N/A	X	X		
4012	Info	Tool locked by field bus	The tool is locked by the field bus.	N/A	X	X		
4013	Info	Tool locked by socket selector	Tool is locked when the socket selector is disconnected from the Virtual Station.	Unlock by Master unlock	X	X		
4014	Info	Tool locked by Soft PLC	Soft PLC signal locked the tool.	Unlock by Master Unlock	X	X		
4015	Info	Loosening disabled	Loosening is disabled in the tightening program		X	X		
4016	Info	Tightening disabled			X	X		
4017	Info	Loosening not configured	Loosening is not configured in the selected tightening program	Select different tightening program	X	X		
4020	Info	Too many NOK tightenings	Maximum consecutive NOK tightenings in batch is exceeded		X	X		
4025	Info	No Tightening program selected	No tightening program selected.	Select tightening program or batch sequence.	X	X		
4030	Info	Batch sequence aborted			X	X		
4031	Info	Max time to complete batch sequence reached.			X	X		
4032	Info	Max time to complete first tightening reached.			X	X		
4035	Info	Locked by line control			X	X		
4040	Info	Locked by alternative identifier	Tool locked by alternative identifier.		X	X		
4050		Invalid socket configuration			X	X		

Event Code	Type	Name	Description	Procedure	L	D	A
4060	Info	Tool locked on batch complete	When running a batch with flag Tool lock on batch sequence complete this event is generated when the user press the trigger.	Unlock with signal Unlock Tool on complete.	X	X	
4070	Info	Manual mode	Indicates that manual mode has been activated for a virtual station				
4071	Info	Automatic mode	Indicates that automatic mode has been entered for a virtual station				
4500	Info	Result DriveError	Internal driver error or driver loss detected.				
4501	Info	Result Rehit	Attempt to tighten an already tightened bolt when Rehit detection is on.				
4502	Info	Result Soft Start Torque Low	Soft start torque below minimum level.				
4503	Info	Result Soft Start Torque High	Soft start torque exceeded maximum level.				
4504	Info	Result Self Tap Torque High	Selftap torque exceeded maximum level.				
4505	Info	Result Self Tap Torque Low	Selftap torque below minimum limit.				
4506	Info	Result Safety Torque Low	Automatically calculated torque value to ensure torque sensor is mounted correctly.				
4507	Info	Result Rundown Torque High	Rundown torque exceeded maximum level.				
4508	Info	Result Rundown Angle High	Rundown angle exceeded maximum level.				
4509	Info	Result Rundown Time High	Rundown time exceeded maximum limit.				
4510	Info	Result Rundown Time Low	Rundown time below minimum limit.				
4511	Info	Result Rundown Torque Low	Rundown torque below minimum level.				
4512	Info	Result Rundown Angle Low	Rundown angle below minimum level.				

Event						
Code	Type	Name	Description	Procedure	L	D A
4513	Info	Result Final Torque High	Final step torque exceeded maximum level.			
4514	Info	Result Final Angle High	Final step angle exceeded maximum level.			
4515	Info	Result Final Torque Low	Final step torque below minimum level.			
4516	Info	Result Final Angle Low	Final step angle below minimum level.			
4517	Info	Result Tightening Timeout	Tightening time limit exceeded. For CATLA max tightening time is 30 seconds. For multistep max tightening time depends on step restriction Maximum Time Limit. Error code is dependent on tightening stage.	Redo tightening.		
4518	Info	Result Trigger Lost	Tool trigger was released before target was reached. For CATLA it is not allowed to release the trigger before the tightening stage has finished. For multistep, the error is displayed when trigger is lost before the target in a specific step is reached.			
4519	Info	Result Slip Off	Socket has slipped off the nut.			
4520	Info	Result Target Reached Before Final Step	Target torque reached before final step in tightening program.			
4521	Info	Result Post View Torque Low	Post view torque below minimum level.			
4522	Info	Result Post View Torque High	Post view torque exceeded maximum level.			
4523	Info	Result Post View Torque Interval Not Reached	Post view torque interval not reached.			
4524	Info	Result Torque Compensation Interval Not Reached	Torque compensation interval angle before rundown end not reached.			
4525	Info	Result Comfort Stop Min				
4526	Info	Result Safety-CurrMon Sensor Mismatch	Current monitoring error.			

Event						
Code	Type	Name	Description	Procedure	L	D A
4527	Info	Result Comfort Stop Max				
4528	Info	Result Soft Start Angle High	Soft start angle exceeded maximum level (Four Step).			
4529	Info	Result Soft Start Angle Low	Soft start angle below minimum level (Four Step).			
4530	Info	Result First Angle High	First step angle exceeded maximum level (Four Step).			
4531	Info	Result First Angle Low	First step angle below minimum level (Four Step).			
4532	Info	Result First Torque High	First step torque exceeded maximum level (Four Step).			
4533	Info	Result First Torque Low	First step torque below minimum level (Four Step).			
4534	Info	Result First Time High	First step time exceeded maximum level (Four Step).			
4535	Info	Result First Time Low	First step time below minimum level (Four Step).			
4536	Info	Result Final Time High	Final step time exceeded maximum level (Four Step).			
4537	Info	Result Final Time Low	Final step time below minimum level (Four Step).			
4538	Info	Result Final Supervision Torque Low	Final Supervision Torque was not reached.			
4539	Info	Result Soft Start Time High	Soft start time exceeded maximum level (Four Step).			
4540	Info	Result Soft Start Time Low	Soft start time below minimum level (Four Step).			
4541	Info	Result PVT Compensate Overflow				
4542	Info	Result Snug Monitor Low				
4543	Info	Result Snug Monitor High	Wrench only. Monitor detected snug value exceeded.			
4544	Info	Result Snug Gradient High				
4545	Info	Result No Residual Torque	Wrench only. Residual torque was under threshold.			

Event								
Code	Type	Name	Description	Procedure	L	D	A	
4546	Info	Result Over-speed	Wrench only. Wrench gyro failed to measure angle due to high speed.					
4547	Info	Result Effective Loosening	Wrench only. Wrench detected unexpected loosening.					
4548	Info	Result Final Less Than Target	Final torque is below target torque set in tightening program.					
4549	Info	TurboTight time limit exceeded	TurboTight time limit exceeded.					
4550	Info	Result Run-down Pulses High	Maximum number of rundown pulses is exceeded.					
4551	Info	Result Run-down Pulses Low	Rundown is completed before the minimum number of rundown pulses is reached.					
4552	Info	Result Final Pulses High	maximum number of pulses is exceeded.					
4553	Info	Result Final Pulses Low	Tightening is completed before the minimum number of pulses is reached.					
4554	Info	Current at shut-off high	Current At Shutoff High is exceeded during the tightening stage.					
4555	Info	Current at shut-off low	Rundown torque low is not reached during the tightening.					
4556	Info	Uncategorized multistep error.	An error in the multistep configuration, often in conjunction with tool validation.					
5010	Warning	Invalid Tightening program parameter value	The parameter in the selected tightening program are invalid.	Check the configuration of the selected tightening program to find and change the value of the parameter.	X	X		
5020	Info	Main trigger not the start source	Generated when configured for push start only and user presses main trigger. Will be generated until user presses the push start.	Press push start to start the tool.	X	X		
5030	Error	Configuration complexity exceeded	The selected tightening program is too complex for the STB tool used. Tool will be locked.	Reduce complexity of the tightening program, or choose different program	X	X		
6010	Info	Accessory connected	Accessory is connected to the controller.			X	X	

Event								
Code	Type	Name	Description	Procedure	L	D	A	
6020	Info	Accessory disconnected	Accessory is disconnected from the controller.			X	X	
6021	Warning	Fieldbus off-line	No communication with fieldbus.		X	X	X	
6030	Warning	Accessory address collision	Two or more accessories with the same address are connected.	Change address on accessory.	X	X	X	
6040	Warning	Accessory communication error	Intermittent communication error with accessory.	Check cables and connectors.	X	X		
6041	Warning	Fieldbus error	Communication error with fieldbus.		X	X	X	
6050	Info	Wrong socket selected	Generated when no or incorrect socket is selected.		X	X		
6090	Warning	Barcode scanner could not be identified	When no unique serial number is found.	Configure the barcode reader device.	X	X	X	
7010	Info	Message text to display	General event for displaying of messages.	None				X

NOK Results List

Error message	Description	GUI location
Drive error	Internal driver error or driver loss detected.	N/A
Rehit	Attempt to tighten an already tightened bolt.	Tightening parameters (Edit) > Rehit detection
Soft start torque below min	Soft start torque below minimum level.	[Four Step] Tightening parameters (Edit) > (Step 1) Soft Start > Torque min
Soft start torque above max	Soft start torque exceeded maximum level.	Tightening parameters (Edit) > (Step 1) Soft Start > Torque max
Selftap torque above max	Selftap torque exceeded maximum level.	Tightening parameters (Edit) > (Step 2) Selftap > Torque max
Selftap torque below min	Selftap torque below minimum limit.	Tightening parameters (Edit) > (Step 2) Selftap > Torque min
Safety torque limit low	Automatically calculated torque value to ensure torque sensor is mounted correctly.	N/A
Rundown torque above max	Rundown torque exceeded maximum level.	Tightening parameters (Edit) > (Step 2) Rundown torque limits > Torque max
Rundown angle above max	Rundown angle exceeded maximum level.	Tightening parameters (Edit) > (Step 2) Rundown angle limits > Angle max

Error message	Description	GUI location
Rundown exceeded max time limit	Rundown time exceeded maximum limit.	Tightening parameters (Edit) > (Step 2) Rundown angle limits > Time max
Rundown below min time limit	Rundown time below minimum limit.	Tightening parameters (Edit) > (Step 2) Rundown angle limits > Time min
Rundown torque below min	Rundown torque below minimum level.	Tightening parameters (Edit) > (Step 2) Rundown torque limits > Torque min
Rundown angle below min	Rundown angle below minimum level.	Tightening parameters (Edit) > (Step 2) Rundown angle limits > Angle min
Final step torque above max	Final step torque exceeded maximum level.	Tightening parameters (Edit) > (Step 3) Final step > Torque limits Manual > Torque max
Final step angle above max	Final step angle exceeded maximum level.	Tightening parameters (Edit) > (Step 3) Final step > Angle max
Final step torque below min	Final step torque below minimum level.	Tightening parameters (Edit) > (Step 3) Final step > Torque limits Manual > Torque min
Final step angle below min	Final step angle below minimum level.	Tightening parameters (Edit) > (Step 3) Final step > Angle max
Tightening timeout	Tightening time limit exceeded.	[Multistep] Tightening parameters (Edit) > Step dependent [Other tightening programs]: fixed parameter set to 30 seconds
Trigger lost	Tool trigger was released before target was reached.	[Multistep]: trigger release before tightening step target has been reached [Other tightening programs]: trigger release before tightening stage has finished
Slip off	Socket has slipped off the nut.	Tightening parameters (Edit) > (Step 3) Tightening parameters > Slipoff detection time
Target reached before final step	Target torque reached before final step in tightening program.	Target torque
Post view torque below min	Post view torque below minimum level.	Tightening parameters (Edit) > (Step 2) Post view torque > Torque min
Post view torque above max	Post view torque exceeded maximum level.	Tightening parameters (Edit) > (Step 2) Post view torque > Torque max
Post view torque interval not reached	Post view torque interval not reached.	Tightening parameters (Edit) > (Step 2) Post view torque > Torque min length

Error message	Description	GUI location
Torque compensation interval not reached	Torque compensation interval angle before rundown end not reached.	Tightening parameters (Edit) > (Step 3) Torque compensation > Torque compensation point
Tool movement exceeded	Tool was moved beyond set angle limits.	Tightening parameters (Edit) > (Step 1) TrueAngle compensation (On); Tool movement limits > Positive/Negative
Current monitoring error	Current monitoring error.	Tightening parameters (Edit) > (Step 1) Current monitoring (On)
Soft start angle above max	Soft start angle exceeded maximum level.	[Four Step] Tightening parameters (Edit) > (Step 1) Soft start > Angle max
Soft start angle below min	Soft start angle below minimum level (Four Step).	[Four Step] Tightening parameters (Edit) > (Step 1) Soft start > Angle min
First step angle high	First step angle exceeded maximum level (Four Step).	[Four Step] Tightening parameters (Edit) > (Step 3) First step > First angle max
First step angle low	First step angle below minimum level (Four Step).	[Four Step] Tightening parameters (Edit) > (Step 3) First step > First angle min
First step torque high	First step torque exceeded maximum level (Four Step).	[Four Step] Tightening parameters (Edit) > (Step 3) First step > First torque max
First step torque below min	First step torque below minimum level (Four Step).	[Four Step] Tightening parameters (Edit) > (Step 3) First step > First torque min
First step exceeded max time limit	First step time exceeded maximum level (Four Step).	[Four Step] Tightening parameters (Edit) > (Step 3) First step > Time max
First step below min time limit	First step time below minimum level (Four Step).	[Four Step] Tightening parameters (Edit) > (Step 3) First step > Time min
Final step exceeded max time limit	Final step time exceeded maximum level (Four Step).	[TurboTight, Four Step] Tightening parameters (Edit) > (Step 3) Final step > Time max
Final step below min time limit	Final step time below minimum level (Four Step).	[TurboTight, Four Step] Tightening parameters (Edit) > (Step 3) Final step > Time min
Low torque at final supervision	Final Supervision Torque was not reached.	[Four Step] Tightening parameters (Edit) > (Step 3) Torque limits (manual) > Torque min
Soft start exceeded max time limit	Soft start time exceeded maximum level (Four Step).	[Four Step] Tightening parameters (Edit) > (Step 1) Soft start > Time max
TurboTight time limit exceeded	TurboTight time limit exceeded.	[TurboTight] Tightening parameters (Edit) > (Step 3) Final step > Time max

Error message	Description	GUI location
Snug monitor high	Wrench only. Monitor detected snug value exceeded.	Tightening parameters (Edit) > Rundown stage (Step 2) Rundown complete > Rundown complete torque
No residual torque	Wrench only. Residual torque was under threshold.	[TurboTight] + [TensorPulse] Tightening parameters (Edit) > (Step 3) > Tightening parameters > Residual torque correlation factor
Overspeed	Wrench only. Wrench gyro failed to measure angle due to high speed.	N/A

Table 45: Status for NOK tightenings

References

Terms and definitions

Term	Synonym	Definition	Note
batch		multiple tightening using the same tightening program and socket	
batch sequence	sequence	multiple tightening using a combination of different tightening programs and sockets	
controller GUI		user interface at controller buttons or touch screen	
event		controller and tool status signals	
final angle		actual measured angle value at the end of the tightening cycle	
final torque		actual measured torque value at the end of the tightening cycle	
GUI		user interface made up of interactive graphical elements such as windows, icons and symbols on a display	
HMI	Human Machine Interface	user interface to tool or controller	The HMI can be a computer web-based interface or controller touch screen.
IAM	Intelligent Application Module	removable module in controller containing program, configuration parameters and tightening results	
line structure		sorting and grouping controllers in structures, folders or sub-folders in Tool-sTalk	The line structure is a method for improving the visibility of a large group of controllers in a structured manner.
post view torque		function for monitoring and detecting torque maximum and minimum values before rundown is complete	One purpose of post view torque is the use of a self-locking nut.
Tightening program	Parameter set	configuration of parameters and values to control and monitor a single tightening action, and to store the tightening result	

Term	Synonym	Definition	Note
push		transfer of data saved in ToolsTalk to the controller memory	
QIF	Quality Integrated Fastening	fully integrated line of nutrunners, controllers, accessories and process monitoring tools to guarantee high quality and traceability of tightening in industrial assembly systems	QIF was developed at Atlas Copco and is preferably used in motor vehicle industry and other assembly situations where many joints are critical. The QIF concept also includes process monitoring and documentation.
QIF accessory		accessory for operator communication and guidance used in QIF	Accessory products used for communication between system and operator. For example: scanner, operator panel, stacklight and socket selector. The communication provides improved quality and traceability in the assembly process.
quick step		tightening strategy	A tightening strategy to reduce the joint's preload scatter by combining an initial step with a given speed and torque and then reducing the speed in the final step.
Re-hit detection		detection of re-tightening of an already tightened joint	
rotate		tightening strategy which rotates the tool head.	Rotate is mainly used for test or demonstration purposes.
rundown complete		end of the rundown step, when the screw head is in contact with the surface and the tightening step begins	
rundown step		step when a bolt enters the thread until the bolt head touches the surface	
snug		screw or bolt is approximately finger-tight to the surface	

Term	Synonym	Definition	Note
socket selector		QIF accessory, consisting of a socket tray with lamps, that can be used to guide an operator to the correct socket	
soft start		start tightening at slow speed during a specified rotation angle	The function helps the bolt to enter the thread in a well controlled way and may prevent unwanted ergonomic tool movement when the trigger is pressed.
stacklight		QIF accessory, which handles the communication between operator and controller through digital signals like lamps, buttons, switches and buzzer	
target		desired result of a tightening	The target is expressed in torque or angle.
target angle		desired angle value at the end of the tightening cycle, measured from a reference point	
target torque		desired torque value at the end of the tightening cycle	
three step		tightening strategy	A tightening strategy to reduce the joint's preload scatter and relaxation effects with an initial step with a given speed and torque followed by a short loosening step before the final tightening at reduced speed.
tightening step		step from when a bolt head has reached the surface until the tightening has reached the desired target torque or target angle	
tightening strategy		algorithm which continuously controls and monitors the tightening process	The user can select a strategy optimized for the joint and program certain parameters.

Term	Synonym	Definition	Note
TurboTight		tightening strategy	A tightening strategy based on the tool's maximum speed to perform fast and ergonomic tightening. The strategy requires only a target torque value to be set.
two step		tightening strategy	A tightening strategy to reduce the joint's preload scatter and relaxation effects with an initial step with a given speed and torque, followed by a short-term stop, before the final tightening at reduced speed.
web GUI		user interface to controller through web browser window from a remote computer	
virtual station	virtual controller	software abstraction of a physical controller to behave like multiple controllers	A controller can have only one cable tool connected to it, but several wireless tools. Each tool is connected to its own virtual station.

Input signals

Code	Input signal	Type	Description	PF	
				600 0	PF 600
10001	Batch increment	Event	Incrementally increases the batch counter by one.	X	X
10002	Batch decrement	Event	Incrementally decreases the batch counter by one.	X	X
10003	Reset batch	Event	Resets the batch counter to 0. No batch OK (nxOK). If batch OK is activated it will be deactivated.	X	X
10004	Acknowledge events	Event	Acknowledgement of an event.	X	X
10005	Master unlock	Event	Unlocks most locks defined in lock page.	X	X
10006	Barcode scanner input	Event	Generated for example when a USB barcode scanner has scanned a barcode.	X	X
10007	Stop drive	Event	Only controller internal use, used by locks to stop on-going tightenings, see Lock tab	X	X
10008	Bypass tightening program	Event	Skips the next tightening program in the running Batch sequence.	X	X
10010	Tightening start (continuous)	State	Active signal starts tightening. Once input goes inactive the tightening must be stopped.	X	X
10011	Loosening start (continuous)	State	Active signal starts loosening. Once digital input goes inactive the loosening must be stopped.	X	X

Code	Input signal	Type	Description	PF	PF
				600 0	600
10012	Abort batch sequence	Event	When a Batch sequence abort request is received, the Batch sequence functionality will wait for completion of the ongoing tightening result before aborting the Batch sequence.	X	X
10013	Reset Too many NOK	Event	Reset the batch after receiving lock Too Many NOK.	X	X
10014	Socket lifted	State	Is generated when a unique socket is lifted on socket selector (integer = socket ID), no socket is lifted (integer = 0) or when more than one is lifted (integer = 0).	X	X
10015	Protocol Message Ready	Event	Reported when a message is in queue from protocol.	X	X
10016	Select input bit 0	State	Input signal for select bit 0.	X	X
10017	Select input bit 1	State	Input signal for select bit 1.	X	X
10018	Select input bit 2	State	Input signal for select bit 2.	X	X
10019	Select input bit 3	State	Input signal for select bit 3.	X	X
10020	Select input	State	Input selected value.	X	X
10021	Set bistable relay	Event	Set the Bistable relay output.	X	X
10022	Reset bistable relay	Event	Reset the Bistable relay output.	X	X
10024	Tightening start (pulse)	Event	The tightening starts at signal. Runs until the tightening is finished, or until the 30 sec timeout in tightening program occurs.	X	X
10028	Start drive	State	Active signal starts the tool (default operation mode is X tightening). As soon as signal goes inactive the tool must be stopped. Used in combination with 10029 (Select loosening).	X	X
10029	Select loosening	State	Selects loosening as default operation mode and used in combination with 10028 (Start drive).	X	X
10030	Tightening stop (pulse)	Event	If this signal is generated any ongoing tightening will be stopped. Used in combination with 10024.	X	X
10046	Socket Selector External Green Light	State	Controls green lights when socket selector is in external mode (how multiple physical devices are mapped to logical sockets are defined by the socket selector resource configuration)Byte0 - logical sockets 1-4Byte1 - logical sockets 5-8Byte2 - logical sockets 9-12Byte3 - logical sockets 13-16(2 bits per socket, 00=off, 01=flash, 10=solid)	X	
10047	Socket Selector External Red Light	State	Controls red lights when socket selector is in external mode. See 10046 for details.	X	
10048	Soft select input value	State	Input soft select value	X	X
10049	Disable Fieldbus	State	Disables the fieldbus.	X	
10050	User ID	State	User ID	X	
10051	UnlockToolOnComplete	Event	Unlocks a tool that is locked by Tool Lock on Complete.	X	X
10052	HMI Select Value	State	Select Tightening program from HMI.	X	X

Code	Input signal	Type	Description	PF	PF
				600 0	600
10053	Reset batch sequence	Event	Resets the batch sequence. Unlocks a tool that is locked by Tool Lock on Complete.	X	X
10058	Flash Tool Green Led	Event		X	
10059	UnlockToolOnDisable	Event		X	
10060	Disable Open Protocol Commands	State		X	
30004	Read Result Handshake	State		X	

Input signals used by locking

Code	Input signal	Type	Description	PF	PF
				600 0	600
20002	DigIn lock tightening	State	Tool locked for tightening by digital input.	X	
20003	DigIn lock loosening	State	Incrementally decreases the batch counter by one.	X	
20004	DigIn lock tool	State	Resets the batch counter to 0.	X	
20020	Field bus lock tightening	State	Acknowledgement of an event.	X	
20021	Field bus lock loosening	State	Unlocks most locks defined in lock page.	X	

Output signals

Code	Output signal	Type	Description	PF	PF
				600 0	600
3	Tightening OK	Event	Tightening OK tells the user that the result of the tightening is within the specified limits.	X	X
4	Tightening NOK	Event	Tightening NOK tells the user that at least one result of the tightening is outside the specified limits, or that another not acceptable event occurred.	X	X
5	Final torque	Event		X	X
6	Low torque	Event	Torque result is lower than minimum torque limit.	X	X
7	High torque	Event	Torque result is higher than maximum torque limit.	X	X
8	Final Angle	Event		X	X
9	Low angle	Event	Angle result is lower than minimum angle limit.	X	X
10	High angle	Event	Angle result is higher than maximum angle limit.	X	X
11	Trigger pressed	State	Indicates that the tool trigger has been pressed.	X	X
12	Direction switch CW	State	The direction switch on the tool is turned in CW direction.	X	X

Code	Output signal	Type	Description	PF	PF
				600 0	600 600
13	Direction switch CCW	State	The direction switch on the tool is turned in CCW direction.	X	X
21	Tool tightening	State	The tool is running in the tightening direction.	X	X
22	Tool loosening	State	The tool is running in the loosening direction.	X	X
23	Tool running	State	Indicates that the tool is rotating (clockwise [CW] or counter-clockwise [CCW]).	X	X
24	Tool rotation CW	State	Tool rotation direction is CW for right-handed threaded screws.	X	X
25	Tool rotation CCW	State	Tool rotation direction is CCW for left-handed threaded screws.	X	X
26	Thread direction CCW	State	The chosen thread direction for the selected p-set is CCW.	X	X
27	Tightening is locked	State	The tightening is disabled.	X	X
28	Loosening is locked	State	The loosening is disabled.	X	X
29	Ready to start	State	Indicates if it is possible to start a tightening.	X	X
30	Batch completed	Event	The batch counter is equal to the batch size number. Result can be OK or NOK.	X	X
31	Batch count	State	Current number in the batch. Can only be viewed in a display.	X	X
32	Batch running	State	Indicates that a batch in a batch sequence is running.	X	X
33	Remaining batch	State	Remaining tightenings in a batch. Can only be viewed in a display.	X	X
34	Test	State	Reflecting test signal input.	X	X
35	Max coherent NOK reached	Event		X	X
36	Batch completed OK	Event	Batch finished with status OK.	X	X
37	Batch completed NOK	Event	Batch finished with status NOK.	X	X
38	Prompt socket	Event	Causes green leds on socket selector to be flashing or unlit. The integer is a mask where each bit represents a socket led. Ex. Bit 0 = socket 1, Bit X = socket x+1. A maximum of 32 leds can be controlled.	X	
39	Clear Results	Event		X	X
40	Bistable relay	State	Follow 2 inputs: Set/Reset Bistable relay.	X	X
42	IO on	State	Set to true at start up of IOExchange.	X	X
45	Batch sequence completed OK	Event	Batch sequence finished with status OK.	X	X
46	Batch sequence completed NOK	Event	Batch sequence finished with status NOK.	X	X
47	Batch sequence running	State	A batch sequence is selected and running.	X	X
48	Batch sequence completed	Event	The batch sequence counter is equal to the batch sequence size. Result can OK or NOK.	X	X

Code	Output signal	Type	Description	PF	PF
				600 0	600
69	Selected Tightening program Id	State	The actual id of a selected tightening program, 0 if no tightening program selected.	X	
70	Loosening OK	Event	OK loosening took place.	X	X
71	Station ready	State	Station is ready.	X	X
73	Tool Connected	State	This IO is active if a tool is connected and configured to a virtual station.	X	X
74	Loosening NOK	Event	NOK loosening took place.	X	X
84	Selected Batch Sequence Id	State		X	
89	Open End in open position	State	Open End tool in open position.	X	
90	Tool battery low	Event	Tool battery low.	X	
92	Tool in work	State		X	X
93	Tool in product space	State		X	X
94	ToolTag identifier	State		X	
95	Open Protocol Disconnected	State		X	
96	Fieldbus Disconnected	State		X	
97	Tool Led Mirror Red	Event		X	
98	Tool Led Mirror Green	Event		X	
99	Tool Led Mirror Yellow	Event		X	
30000	Disable tool	State		X	X
30001	Event Code	State		X	X
30003	Event Code	State		X	X
30100	Target torque	Event		X	x
30101	Target/Final torque	Event		X	X
31000	Tightening OK	State		X	X
31001	Tightening NOK	State		X	X
31002	Final torque	State		X	X
31003	Final Angle	State		X	X
31004	Tightening program Max Angle	State		X	X
31005	Tightening program Min Angle	State		X	X
31006	Final Angle Status	State		X	X
31007	Tightening program Max Torque	State		X	X
31008	Tightening program Min Torque	State		X	X

Code	Output signal	Type	Description	PF	
				600	600
31009	Final Torque Status	State		X	X
31010	Tightening Done	State		X	

Input/Output signals

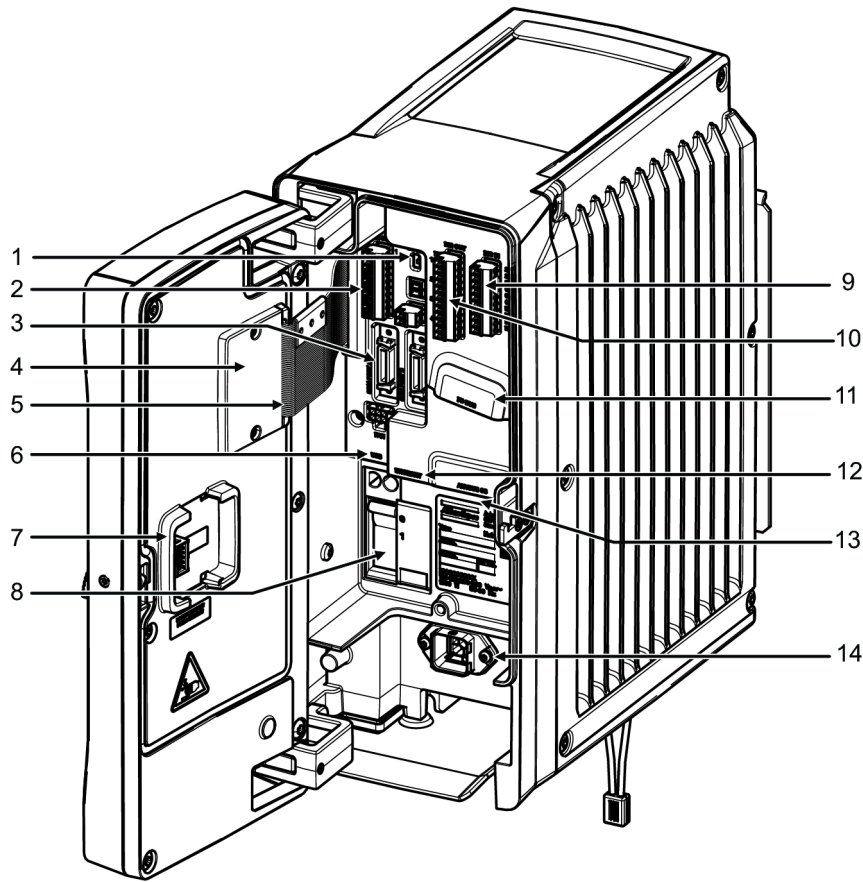
These signals are used for both input and output.

Code	Signal	Type	Description
50	Generic I/O 1	State	Input / Output 1.
51	Generic I/O 2	State	Input / Output 2.
52	Generic I/O 3	State	Input / Output 3.
53	Generic I/O 4	State	Input / Output 4.
54	Generic I/O 5	State	Input / Output 5.
55	Generic I/O 6	State	Input / Output 6.
56	Generic I/O 7	State	Input / Output 7.
57	Generic I/O 8	State	Input / Output 8.
58	Generic I/O 9	State	Input / Output 9.
59	Generic I/O 10	State	Input / Output 10.
10035	External monitored 1	State	Digital Input 1 - 8, monitored by open protocol, MID 210
10036	External monitored 2	State	
10037	External monitored 3	State	
10038	External monitored 4	State	
10039	External monitored 5	State	
10040	External monitored 6	State	Added to support backwards compatibility with PF4000 in certain protocols for socket lifted notifications (as opposed to Socket Lifted 10013). Integer is bit pattern for all lifted sockets (regardless of flashing or how many is lifted).
10041	External monitored 7	State	
10042	External monitored 8	State	
10043	Socket lifted raw	State	
10045	External identifier	State	
30002	Fieldbus Keep	State	Identifier sent from external system

Appendix A – Controller connections

Front connections

Connections and switches behind the front cover of the Power Focus 6000 controller:



PF6-000

Illustration 38: Controller connections behind the front cover

1. Remote start
2. Emergency stop
3. COM ports
4. Battery
5. Cable
6. USB port
7. IAM
8. Residual-current device (RCBO)
9. Digital input
10. Digital output
11. I/O bus
12. Factory Ethernet port
13. Anybus CC
14. Power connector

Appendix B – Remote start and EM Stop

Remote start configuration

A tightening can be started remotely from an accessory in both single and multiple controller configurations. The switch to activate remote start is found on the connector panel located behind the front access door of the controller. See Controller connections.

Whenever using remote start you must enable an emergency stop solution for safety reasons. For more information about emergency stop, see Emergency stop (EM Stop) in the product instructions for Power Focus 6000.

When using a tool with some type of safety handle (such as a trigger start button or a safety lever), remote start must be disabled by setting the switch to Off. This is done to ensure that it is not possible to override the safety function within the tool. See also Single controller without EM Stop button.

Emergency stop in Power Focus 6000

Power Focus 6000 is providing an infrastructure to build an emergency stop function with redundant breaking according to **EN ISO 13849-1 category 3 PL d**. The emergency stop function must be used when using remote start functionality.

The emergency stop functionality can be used with a supply-disconnecting device (such as an EM Stop button). When the EM Stop button is activated, it breaks the supply voltage to the controller.

A diagnose of the system is run automatically at the start of the controller. This is done both after an emergency stop and at a normal start.

The emergency stop function is used with either a single controller or up to 10 controllers in a single emergency stop chain. In a multiple controller configuration, the emergency stop signal is distributed from the first controller to all interconnected controllers using the I/O bus interface. The last controller in the chain returns a feedback signal to indicate that all controllers have received the emergency stop signal. The event **Emergency stop** is displayed.

For the emergency stop there is a 24V DC output through the EM Stop interface on the connector panel.

Cabling

EM Stop button cables

Single/Multiple controllers	Dimension	Maximum length
Single	0.7 mm ² cable	400 meters
Multiple	1.5 mm ² cable	50 meters

Table 46: Cable dimensions for the emergency stop button

I/O cables

For connecting multiple controllers with I/O cables distributing the emergency stop signal, observe the maximum length according to the following table:

AWG 22 cable	Maximum total length
4 controllers	200 meters
5 controllers	140 meters
6 controllers	100 meters
8 controllers	70 meters
10 controller	50 meters

Table 47: Cable dimensions for I/O cables

PIN configurations for emergency stop

The Power Focus has an external EM Stop interface and I/O bus on the connector panel located behind the *front access [Page 185]* door.

The PIN configuration differs depending on whether it is a single or multiple controller solution. Furthermore, for the single controller, the PIN configuration differs depending on whether the controller is equipped with an EM Stop button or not.

The following sections describe the available PINs on the connecting panel, and the use of the different PINs to connect an EM Stop button.

Single controller with EM Stop button

Connector: Phoenix, 6-pin Headers 3.5mm pitch

Use the following pins to attach an EM Stop button:

Pin	Use	
1	Do not use	
2	Do not use	
3	Attach an emergency button between pin 3 and pin 4	
4	See pin 3	
5	Attach an emergency button between pin 5 and pin 6	
6	See pin 5	
7	Connect a jumper between pin 7 and pin 8	
8	See pin 7	
9	Connect a jumper between pin 9 and pin 10	
10	See pin 9	

Illustration 39: Connections for a single controller

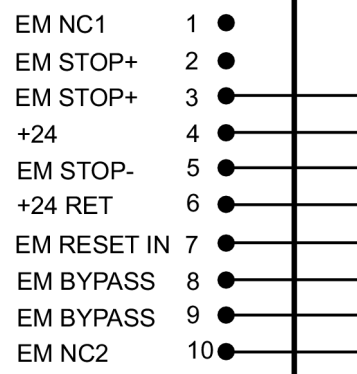
Single controller without EM Stop button

⚠ WARNING Remote start switch must be set to OFF for this configuration

Connector: Phoenix, 6-pin Headers 3.5mm pitch

Use the following PIN configuration:

Pin	Use
1	Do not use
2	Do not use
3	Connect a jumper between pin 3 and pin 4
4	See pin 3
5	Connect a jumper between pin 5 and pin 6
6	See pin 5
7	Connect a jumper between pin 7 and pin 8
8	See pin 7
9	Connect a jumper between pin 9 and pin 10
10	See pin 9

*Illustration 40: Connections with no EM stop***Multiple controllers with EM Stop button**

The PIN configuration differs depending on the location of the controller in the EM Stop chain.

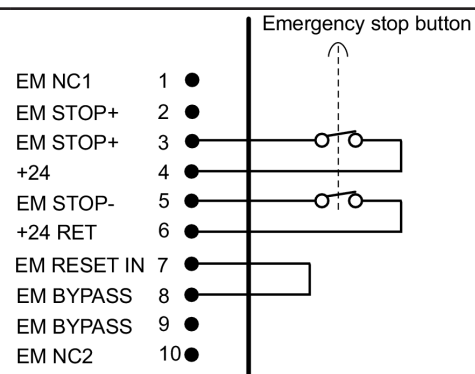
First controller with an EM stop button connected

EM Stop button connector: Phoenix, 6-pin Headers 3.5mm pitch

EM Stop I/O cable connector: Molex Micro-Fit, 5-pin

Use the following pin configuration:

Pin	Use
1	Do not use
2	Do not use
3	Attach an emergency button between pin 3 and pin 4
4	See pin 3
5	Attach an emergency button between pin 5 and pin 6
6	See pin 5
7	Connect a jumper between pin 7 and pin 8
8	See pin 7
9	Do not use
10	Do not use

*Illustration 41: Connections for the first controller*

Controllers between first and last

EM Stop I/O cable connector: Molex Micro-Fit, 5-pin

Remove plug or use the following pin configuration:

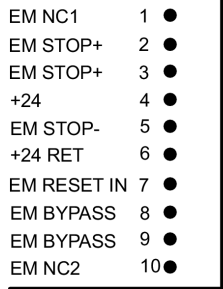
Pin	Use		
1	Do not use		No pins connected
2	Do not use		
3	Do not use		
4	Do not use		
5	Do not use		
6	Do not use		
7	Do not use		
8	Do not use		
9	Do not use		
10	Do not use		

Illustration 42: Connections for middle controllers

Last controller

EM Stop I/O cable connector: Molex Micro-Fit, 5-pin

Use the following pin configuration:

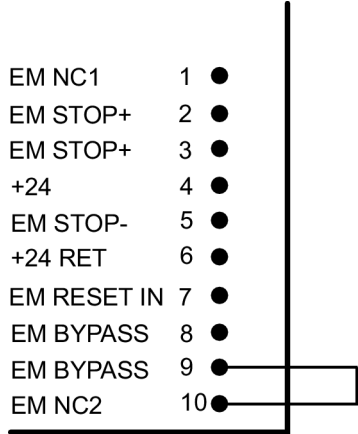
Pin	Use		
1	Do not use		
2	Do not use		
3	Do not use		
4	Do not use		
5	Do not use		
6	Do not use		
7	Do not use		
8	Do not use		
9	Connect a jumper between pin 9 and pin 10		
10	See pin 9		

Illustration 43: Connections for last controller

Appendix C - DIG IN/OUT connectors

The Power Focus 6000 uses the same hardware accessories (Stacklight, Operator panel etc.) as the Power Focus 4000 system. However, the digital input and output connectors are configured differently and use a different plug. In order to rewire the plug from Power Focus 4000 to Power Focus 6000 correctly, use the connector descriptions in the following sections.

Digital output connector

The Power Focus 6000 has a connector with four configurable internal digital outputs (DIG OUT) that are located behind the *front access [Page 185]* door.

Digital output connector for Power Focus 6000

Pin	Relay	Function	
1	Relay 1	Normally closed	RE 1
2		Common	
3		Normally open	
4	Relay 2	Normally closed	RE 2
5		Common	
6		Normally open	
7	Relay 3	Normally closed	RE 3
8		Common	
9		Normally open	
10	Relay 4	Normally closed	RE 4
11		Common	
12		Normally open	

0V +24V

NC 1

C 2

NO 3

NC 4

C 5

NO 6

NC 7

C 8

NO 9

NC 10

C 11

NO 12

RE 1

RE 2

RE 3

RE 4

●

●

●

●

●

●

●

●

●

●

●

●

○

○

○

○

○

○

○

○

○

○

○

○

○

○

○

○

○

○

○

○

○

○

PFE-006

Illustration 44: Connectors for out-put

Digital output connector for Power Focus 4000

Pin	Relay	Function	
12	Relay 4	Normally closed	RE 4 NC ● 12 C ● 11 NO ● 10
11		Common	
10		Normally open	
9	Relay 3	Normally closed	RE 3 NC ● 9 C ● 8 NO ● 7
8		Common	
7		Normally open	
6	Relay 2	Normally closed	RE 2 NC ● 6 C ● 5 NO ● 4
5		Common	
4		Normally open	
3	Relay 1	Normally closed	RE 1 NC ● 3 C ● 2 NO ● 1
2		Common	
1		Normally open	

Illustration 45: Connectors for output

Digital input connector

The Power Focus 6000 has a connector with four configurable internal digital inputs (DIG IN) that are located behind the *front access [Page 185]* door.

Digital input connector for Power Focus 6000

Pin	Function	
13	24V	24V ● 13 24V ● 14 0V ● 15 0V ● 16 0V ● 17
14	24V	
15	0V	
16	0V	
17	0V	
18	Digital input -	COM ● 18 DI 1 ● 19 DI 2 + ● 20 DI 3 + ● 21 DI 4 + ● 22
19	Digital input 1 +	
20	Digital input 2 +	
21	Digital input 3 +	
22	Digital input 4 +	

Digital input connector for Power Focus 4000

Pin	Function
22	GND (+24VDC isolated)
21	+24VDC isolated
20	Digital input 4 -
19	Digital input 4 +
18	Digital input 3 -
17	Digital input 3 +
16	Digital input 2 -
15	Digital input 2 +
14	Digital input 1 -
13	Digital input 1 +

0 22
+24VD 21
DI 4 20
19
DI 3 18
17
DI 2 16
15
DI 1 14
13

2.7k -
2.7k +

PF6-005

Third party licenses

List of Third Party Softwares

The following third party softwares are included in the software for the Power Focus controller. The license texts are available in alphabetic order following this table.

Software	Version	License
alsa-conf-base	1.0.27.2	LGPL V2.1
alsa-lib	1.0.27.2	LGPL V2.1
alsa-state	0.2.0	MIT
alsa-states	0.2.0	MIT
alsa-tools	1.0.27	GNU GPL V2
alsa-utils	1.0.27.2	GNU GPL V2
alsa-utils-aconnect	1.0.27.2	GNU GPL V2
alsa-utils-alsactl	1.0.27.2	GNU GPL V2
alsa-utils-alsaloop	1.0.27.2	GNU GPL V2
alsa-utils-alsamixer	1.0.27.2	GNU GPL V2
alsa-utils-alsaucm	1.0.27.2	GNU GPL V2
alsa-utils-amixer	1.0.27.2	GNU GPL V2
alsa-utils-aplay	1.0.27.2	GNU GPL V2
alsa-utils-aseqdump	1.0.27.2	GNU GPL V2
alsa-utils-aseqnet	1.0.27.2	GNU GPL V2
alsa-utils-iecset	1.0.27.2	GNU GPL V2
alsa-utils-midi	1.0.27.2	GNU GPL V2
alsa-utils-speakertest	1.0.27.2	GNU GPL V2
apm	3.3.2-14	GPLv2
apmd	3.2.2-14	GPLv2
atftpd	0.7.1+gitAUTOINC+be3291a18c	GNU GPL V2
base-files	3.0.14	GNU GPL V2
base-passwd	3.5.29	GNU GPL V2
bash	4.3	GNU GPL V3
bash-completion	2.1	GNU GPL V2
bluetooth-test	1.0	GNU GPL V1.0
boost	1.55.0	BSL-1.0 MIT Python-2.0
boost-serialization	1.55.0	BSL-1.0 MIT Python-2.0
boost-test	1.55.0	BSL-1.0 MIT Python-2.0
bt-aux	1.0	GNU GPL V1.0
busybox	1.22.1	GNU GPL V2
busybox-cron	1.22.1	GNU GPL V2
busybox-hwclock	1.22.1	GNU GPL V2
busybox-udhcp	1.22.1	GNU GPL V2
busybox-udhcpd	1.22.1	GNU GPL V2
ca-certificates	20130610	GNU GPL V2
cppunit	1.13.1	LGPL V2.1

Software	Version	License
curl	7.35.0	MIT
dbus-1	1.6.18	GNU GPL V2
dbus-c++	0.9.0+gitrAUTOINC+1f6f3e6e96	LGPL V2.1
directfb-config	1.0	GNU GPL V1.0
dropbear	2014.63	BSD V3
e2fsprogs	1.42.9	GNU GPL V2
e2fsprogs-badblocks	1.42.9	GNU GPL V2
e2fsprogs-e2fsck	1.42.9	GNU GPL V2
e2fsprogs-mke2fs	1.42.9	GNU GPL V2
e2fsprogs-tune2fs	1.42.9	GNU GPL V2
eclr	2.2.0.20725	MIT
ecryptfs-tools	1.0	GNU GPL V1.0
fbset	2.1	GNU GPL V2
fbset-modes	0.1.0	MIT
fb-test	1.1.0	GNU GPL V2
fieldbus-test	1.0	GNU GPL V1.0
firmware-imx	3.10.17-1.0.0	Proprietary
firmware-imx-sdma-imx51	3.10.17-1.0.0	Proprietary
firmware-imx-vpu-imx51	3.10.17-1.0.0	Proprietary
fsb	0.0.1	GNU GPL V1.0
gdbserver	7.6.2	GNU GPL V2
gnutls	3.2.13	LGPL V2.1
gpio	1.0	GNU GPL V1.0
grouper	0.0.1	GNU GPL V1.0
gststreamer	0.10.36	LGPL V2.1
gststreamer1.0	1.2.3	LGPL V2.1
gwt	2.6.1	Apache V2
gwt-ns	0.2.1	Apache V2
hwtest	1.1	GPL-1.0
Initscripts	1.0	GPLv2
initscripts-functions	1.0	GPLv2
ioaccess	1.0	GPL-1.0
ipwatchd	1.2	GPL-1.0
json-c	0.11	MIT
kernel-3.14.79-rt84-atlas	3.14	GNU GPL V2
kernel-base-generic	0.1+hg-8d6f9d23fb4a-r8-px2p4.12	GNU GPL V2
kernel-base-px2drv	2.6.22.6-r8-px2p4.12	GNU GPL V2
kernel-dev-generic	2.6.22.6-r8-px2p4.12	GNU GPL V2
kernel-devicetree	3.14	GNU GPL V2
kernel-dev-px2drv	2.6.22.6-r8-px2p4.12	GNU GPL V2
kernel-generic	2.6.22.6-r8-px2p4.12	GNU GPL V2
kernel-image-3.14.79-rt84-atlas	3.14	GNU GPL V2

Software	Version	License
kernel-module-configfs	3.14	GPLv2
kernel-module-emergencystop	0.0.1	MIT
kernel-module-evbug	3.14	GPLv2
kernel-module-ioaccess	1	GNU GPL V2
kernel-module-isofs	3.14	GPLv2
kernel-module-msdos	3.14	GPLv2
kernel-module-nls-iso8859-15	3.14	GPLv2
kernel-module-owl2xx	3.1.6	MIT
kernel-module-owl2xx-spi	3.1.6	MIT
kernel-px2drv	2.6.22.6-r8-px2pfm4.12	GNU GPL V2
kernel-module-serport	3.14	GPLv2
kernel-module-udf	3.14	GPLv2
kernel-modules	3.14	GPLv2
kernel-vmlinux-generic	2.6.22.6-r8-px2pfm4.12	GNU GPL V2
kernel-vmlinux-px2drv	2.6.22.6-r8-px2pfm4.12	GNU GPL V2
keytest	1	GNU GPL V1.0
keyutils	1.5.2	GNU GPL V2
kmsfbwrap	12.0	GNU GPL V2
libanybus1	1.1	LICENSE
libapm1	3.2.2-14	GPLv2
libasound2	1.0.27.2	LGPL V2.1
libblkid1	2.24.1	GNU GPL V2
libboost-date-time1.55.0	1.55.0	MIT
libboost-filesystem1.55.0	1.55.0	MIT
libboost-graph1.55.0	1.55.0	MIT
libboost-iostreams1.55.0	1.55.0	MIT
libboost-program-options1.55.0	1.55.0	MIT
libboost-regex1.55.0	1.55.0	MIT
libboost-signals1.55.0	1.55.0	MIT
libboost-system1.55.0	1.55.0	MIT
libboost-thread1.55.0	1.55.0	MIT
libbz2-0	1.0.6	bzip2
libc6	2.19	GNU GPL V2
libcap2	2.22	BSD V2
libcom-err2	1.42.9	GNU GPL V2
libcrypto1.0.0	1.0.1p	openssl
libcurl5	7.36.0	MIT
libdbus-1-3	1.6.18	GNU GPL V2
libdrm2	2.4.52	MIT
libe2p2	1.42.9	GNU GPL V2
libegl1	11.09.01	Proprietary
libestr0	0.1.6	LGPL V2.1
libevent	2.0.21	BSD V2

Software	Version	License
libexpat1	2.1.0	MIT
libext2fs2	1.42.9	GNU GPL V2
libffi6	3.0.13	MIT
libformw5	5.9	MIT
libfuse2	2.9.3	GNU GPL V2
libgcc1	4.8.4	GNU GPL V3
libgcrypt11	1.5.3	LGPL V2.1
libglesv2-2	11.09.01	Proprietary
libglib-2.0-0	2.38.2	LGPL V2.1
libgmp10	5.1.1	GNU GPL V3
libgnutls26	2.12.23	GPLv3 LGPLv2.1
libgpg-error0	1.12	LGPL V2.1
libgsl-fsl1	11.09.01	Proprietary
libgstapp-1.0-0	1.2.4	GNU GPL V2
libgstaudio-1.0-0	1.2.4	GNU GPL V2
libgstpbutils-1.0-0	1.2.4	GNU GPL V2
libgsttag-1.0-0	1.2.4	GNU GPL V2
libgstvideo-1.0-0	1.2.4	GNU GPL V2
libcudata53	53.1	ICU
libcui18n53	53.1	ICU
libicuuc53	53.1	ICU
libjpeg8	8d	BSD V3
libkmod2	17+	LGPL V2.1
libluabind0	git	MIT
liblzo2-2	2.06	LGPL V2.1
libmenuw5	5.9	MIT
libmount1	2.24.2	GNU GPL V2
libncursesw5	5.9	MIT
libnet1	1.1.6	BSD V2
libnfsidmap0	0.25	BSD V2
libopkg1	0.2.2	GNU GPL V2
liborc-0.4-0	0.4.18	BSD V2
libpanelw5	5.9	MIT
libpcap1	1.5.3	BSD V2
libpcrcl	8.34	BSD
libperl5	5.14.3	GNU GPL V1.0
libpng16-16	1.6.10	Libpng
libpopt0	1.16	MIT
libpx2dbus	1.0.0	GNU GPL V1.0
libqt5sensors5	5.3.1	LGPL V2.1
librcf	2.0	Proprietary
libreadline6	6.3	GNU GPL V3
libsamplerate0	0.1.8	GNU GPL V2

Software	Version	License
libsndfile1	1.0.25	LGPL V2.1
libsqlite3-0	3.8.4.3	PD
libss2	1.42.9	GNU GPL V2
libssl1.0.0	1.0.1p	openssl
libstdc++6	4.8.4	GNU GPL V3
libthread-db1	2.19	GNU GPL V2
libsysfs2	2.1.0	GPLv2 LGPLv2.1
libtasn1-6	3.4	GPLv3 LGPLv2.1
libtinfo5	5.9	MIT
libtinymce2.6.2	2.6.2	Zlib
libtirpc1	0.2.4	BSD V2
libts-1.0-0	1.1	LGPL V2.1
libudev0	182	LGPL V2.1
liburcu	0.8.1	LGPL V2.1
libusb-1.0-0	1.0.9	LGPL V2.1
libuuid1	2.24.2	GNU GPL V2
libwrap0	7.6	BSD V2
libxml2	2.9.1	MIT
libx1st	1.1.28	MIT
libz1	1.2.8	Zlib
logrotate	3.8.7	GNU GPL V2
log-server	1.0	GNU GPL V1.2
loopback	1.0	GNU GPL V1.2
lttng-tools	v2.4.0	GNU GPL V2
lttng-ust	2.4.0	LGPL V2.1
lua5.1	5.1.5	MIT
luabind	0.9.1	MIT
lzop	1.03	GNU GPL V2
memlogd	1.0	MIT
modutils-initscripts	1.0	PD
mtd-utils	1.5.1 + gitAUTOINC+9f107132a6	GNU GPL V2
nano	2.2.5	GNU GPL V2
ncurses	5.9	MIT
ncurses-terminfo	5.9	MIT
ncurses-terminfo-base	5.9	MIT
netbase	5.2	GNU GPL V2
nettle	2.7.1	LGPL V2.1
nfs-utils	1.2.9	GNU GPL V2
nfs-utils-client	1.2.9	GNU GPL V2
nginx	1.4.4	BSD-2-Clause
ntp	4.2.6p5	Ntp License
ntp-tickadj	4.2.6p5	Ntp License
ntp-utils	4.2.6p5	Ntp License

Software	Version	License
ntupdate	4.2.6p5	Ntp License
openssh	6.5p1	BSD
openssh-keygen	6.5p1	BSD
openssh-scp	6.5p1	BSD
openssh-sftp	6.5p1	BSD V2
openssh-sftp-server	6.5p1	BSD V2
openssh-ssh	6.5p1	BSD V2
openssh-sshd	6.5p1	BSD V2
openssl-conf	1.0.1p	openssl
opkg	0.2.2	GNU GPL V2
opkg-collateral	1.0	MIT
opkg-config-base	1.0	MIT
os-release	1.0	MIT
packagegroup-atlas-qt5	1	MIT
packagegroup-core-boot	1	MIT
packagegroup-core-eclipse-debug	1	MIT
packagegroup-core-nfs-server	1	MIT
packagegroup-core-ssh-dropbear	1	MIT
packagegroup-px2it	1	MIT
partitions	1.0	MIT
perl	5.14.3	GNU GPL V1.0
pfmfonts	0.0.1	Apache V2
pfmtool	1	MIT
pfmtool-bash-completion	1	MIT
pfmversion	5.14.0	MIT
pointercal	0.0	MIT
poky-feed-config-opkg	1.0	MIT
px2checksumv	1.0	MIT
px2hal	0.0.1	LGPL-3.0
px2initit	1.0	GPL-1.0
px2network	1.0	GPL-1.0
px2serviced	1.0	GPL-1.0
px2switch	0.0.1	GPL-1.0
px2w	0.0.1	GPL-1.0
px2watchdog	1.0	GPL-1.0
qcustomplot	1.2.1	Commercial
qt3d	5.3.0+	LGPL V2.1
qtbase	5.3.1	LGPL V2.1
qtbase-plugins	5.3.1	LGPL V2.1
qtbase-tools	5.3.1	LGPL V2.1
qtdeclarative	5.3.1	LGPL V2.1
qtlocation	5.3.1	LGPL V2.1
qtscript	5.3.1	LGPL V2.1

Software	Version	License
qtwebkit	5.3.1	LGPL V2.1
rhapsody-oxf	7521	GNU GPL V1.0
rpcbind	0.2.1	BSD V2
rsync	3.1.0	GNU GPL V3
rsyslog	7.4.4	GNU GPL V3
rtctest	1.0	GNU GPL V1.0
run-postinsts	1.0	MIT
shadow	4.1.4.3	BSD V2
shadow-securetty	4.1.4.3	MIT
sqlite3	3.8.4.3	PD
ssh-keys	1.0	GNU GPL V1.0
strace	4.8	BSD V2
sysfsutils	2.1.0	GPLv2 LGPLv2.1
sysvinit	2.88dsf	GNU GPL V2
sysvinit-inittab	2.88dsf	GNU GPL V2
sysvinit-pidof	2.88dsf	GNU GPL V2
tcf-agent	0.4.0+	EPL V1.0
tcpdump	4.3.0	BSD V2
tslib-calibrate	1.1	LGPL V2.1
tslib-conf	1.1	LGPL V2.1
tslib-tests	1.1	LGPL V2.1
tzdata	2013i	BSD V2
tzdata-africa	2013i	BSD V2
tzdata-america	2013i	BSD V2
tzdata-antarctica	2013i	BSD V2
tzdata-arctic	2013i	BSD V2
tzdata-asia	2013i	BSD V2
tzdata-atlantic	2013i	BSD V2
tzdata-australia	2013i	BSD V2
tzdata-europe	2013i	BSD V2
tzdata-misc	2013i	BSD V2
tzdata-pacific	2013i	BSD V2
tzdata-posix	2013i	BSD V2
tzdata-right	2013i	BSD V2
u-boot-image	2014.04	GNU GPL V2
u-boot-utils	2014.04	GNU GPL V2
udev	182	GNU GPL V2
udev-cache	182	GNU GPL V2
udev-extraconf	1.0	MIT
udev-utils	182	GNU GPL V2
update-alternatives-opkg	0.1.8+gitAUTOINC+c33b217016	GNU GPL V2
update-rc.d	0.7	GNU GPL V2
usbutils	7	GNU GPL V2

Software	Version	License
usbutils-ids	7	GNU GPL V2
wireless-tools	30.pre9	GNU GPL V2
wpa-supPLICant	2.3	BSD V2
wpa-supPLICant-cli	2.3	BSD V2
wpa-supPLICant-passphrase	2.3	BSD V2
xerces-c	2.7.0aes	Apache V2
zipfirmware-install-px2drv-tplcpx-4.	3.0	BSD V3

Apache Software License, Version 2.0

Apache License

Version 2.0, January 2004

<http://www.apache.org/licenses/>

TERMS AND CONDITIONS FOR USE, REPRODUCTION, AND DISTRIBUTION

1. Definitions.

"License" shall mean the terms and conditions for use, reproduction, and distribution as defined by Sections 1 through 9 of this document.

"Licensor" shall mean the copyright owner or entity authorized by the copyright owner that is granting the License.

"Legal Entity" shall mean the union of the acting entity and all other entities that control, are controlled by, or are under common control with that entity. For the purposes of this definition, "control" means (i) the power, direct or indirect, to cause the direction or management of such entity, whether by contract or otherwise, or (ii) ownership of fifty percent (50%) or more of the outstanding shares, or (iii) beneficial ownership of such entity.

"You" (or "Your") shall mean an individual or Legal Entity exercising permissions granted by this License.

"Source" form shall mean the preferred form for making modifications, including but not limited to software source code, documentation source, and configuration files.

"Object" form shall mean any form resulting from mechanical transformation or translation of a Source form, including but not limited to compiled object code, generated documentation, and conversions to other media types.

"Work" shall mean the work of authorship, whether in Source or Object form, made available under the License, as indicated by a copyright notice that is included in or attached to the work (an example is provided in the Appendix below).

"Derivative Works" shall mean any work, whether in Source or Object form, that is based on (or derived from) the Work and for which the editorial revisions, annotations, elaborations, or other modifications represent, as a whole, an original work of authorship. For the purposes of this License, Derivative Works shall not include works that remain separable from, or merely link (or bind by name) to the interfaces of, the Work and Derivative Works thereof.

"Contribution" shall mean any work of authorship, including the original version of the Work and any modifications or additions to that Work or Derivative Works thereof, that is intentionally submitted to Licensor for inclusion in the Work by the copyright owner or by an individual or Legal Entity authorized to submit on behalf of the copyright owner. For the purposes of this definition, "submitted" means any form of electronic, verbal, or written communication sent to the Licensor or its representatives, including but not limited to communication on electronic mailing lists, source code control systems, and issue tracking systems that are managed by, or on behalf of, the Licensor for the purpose of discussing and improving the Work, but excluding communication that is conspicuously marked or otherwise designated in writing by the copyright owner as "Not a Contribution."

"Contributor" shall mean Licensor and any individual or Legal Entity on behalf of whom a Contribution has been received by Licensor and subsequently incorporated within the Work.

2. Grant of Copyright License. Subject to the terms and conditions of this License, each Contributor hereby grants to You a perpetual, worldwide, non-exclusive, no-charge, royalty-free, irrevocable copyright license to reproduce, prepare Derivative Works of,

publicly display, publicly perform, sublicense, and distribute the Work and such Derivative Works in Source or Object form.

3. Grant of Patent License. Subject to the terms and conditions of this License, each Contributor hereby grants to You a perpetual, worldwide, non-exclusive, no-charge, royalty-free, irrevocable (except as stated in this section) patent license to make, have made, use, offer to sell, sell, import, and otherwise transfer the Work, where such license applies only to those patent claims licensable by such Contributor that are necessarily infringed by their Contribution(s) alone or by combination of their Contribution(s) with the Work to which such Contribution(s) was submitted. If You institute patent litigation against any entity (including a cross-claim or counterclaim in a lawsuit) alleging that the Work or a Contribution incorporated within the Work constitutes direct or contributory patent infringement, then any patent licenses granted to You under this License for that Work shall terminate as of the date such litigation is filed.

4. Redistribution. You may reproduce and distribute copies of the Work or Derivative Works thereof in any medium, with or without modifications, and in Source or Object form, provided that You meet the following conditions:

- (a) You must give any other recipients of the Work or Derivative Works a copy of this License; and
- (b) You must cause any modified files to carry prominent notices stating that You changed the files; and
- (c) You must retain, in the Source form of any Derivative Works that You distribute, all copyright, patent, trademark, and attribution notices from the Source form of the Work, excluding those notices that do not pertain to any part of the Derivative Works; and
- (d) If the Work includes a "NOTICE" text file as part of its distribution, then any Derivative Works that You distribute must include a readable copy of the attribution notices contained within such NOTICE file, excluding those notices that do not pertain to any part of the Derivative Works, in at least one

of the following places: within a NOTICE text file distributed as part of the Derivative Works; within the Source form or documentation, if provided along with the Derivative Works; or, within a display generated by the Derivative Works, if and wherever such third-party notices normally appear. The contents of the NOTICE file are for informational purposes only and do not modify the License. You may add Your own attribution notices within Derivative Works that You distribute, alongside or as an addendum to the NOTICE text from the Work, provided that such additional attribution notices cannot be construed as modifying the License.

You may add Your own copyright statement to Your modifications and may provide additional or different license terms and conditions for use, reproduction, or distribution of Your modifications, or for any such Derivative Works as a whole, provided Your use, reproduction, and distribution of the Work otherwise complies with the conditions stated in this License.

5. Submission of Contributions. Unless You explicitly state otherwise, any Contribution intentionally submitted for inclusion in the Work by You to the Licensor shall be under the terms and conditions of this License, without any additional terms or conditions.

Notwithstanding the above, nothing herein shall supersede or modify the terms of any separate license agreement you may have executed with Licensor regarding such Contributions.

6. Trademarks. This License does not grant permission to use the trade names, trademarks, service marks, or product names of the Licensor, except as required for reasonable and customary use in describing the origin of the Work and reproducing the content of the NOTICE file.

7. Disclaimer of Warranty. Unless required by applicable law or agreed to in writing, Licensor provides the Work (and each Contributor provides its Contributions) on an "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied, including, without limitation, any warranties or conditions of TITLE, NON-INFRINGEMENT, MERCHANTABILITY, or FITNESS FOR A PARTICULAR PURPOSE. You are solely responsible for determining the

appropriateness of using or redistributing the Work and assume any risks associated with Your exercise of permissions under this License.

8. Limitation of Liability. In no event and under no legal theory, whether in tort (including negligence), contract, or otherwise, unless required by applicable law (such as deliberate and grossly negligent acts) or agreed to in writing, shall any Contributor be liable to You for damages, including any direct, indirect, special, incidental, or consequential damages of any character arising as a result of this License or out of the use or inability to use the Work (including but not limited to damages for loss of goodwill, work stoppage, computer failure or malfunction, or any and all other commercial damages or losses), even if such Contributor has been advised of the possibility of such damages.

9. Accepting Warranty or Additional Liability. While redistributing the Work or Derivative Works thereof, You may choose to offer, and charge a fee for, acceptance of support, warranty, indemnity, or other liability obligations and/or rights consistent with this License. However, in accepting such obligations, You may act only on Your own behalf and on Your sole responsibility, not on behalf of any other Contributor, and only if You agree to indemnify, defend, and hold each Contributor harmless for any liability incurred by, or claims asserted against, such Contributor by reason of your accepting any such warranty or additional liability.

END OF TERMS AND CONDITIONS

APPENDIX: How to apply the Apache License to your work.

To apply the Apache License to your work, attach the following boilerplate notice, with the fields enclosed by brackets "[]" replaced with your own identifying information. (Don't include the brackets!) The text should be enclosed in the appropriate comment syntax for the file format. We also recommend that a file or class name and description of purpose be included on the same "printed page" as the copyright notice for easier identification within third-party archives.

Copyright [yyyy] [name of copyright owner]

Licensed under the Apache License, Version 2.0 (the "License");
you may not use this file except in compliance with the License.
You may obtain a copy of the License at

<http://www.apache.org/licenses/LICENSE-2.0>

Unless required by applicable law or agreed to in writing, software
distributed under the License is distributed on an "AS IS" BASIS,
WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either ex-
press or implied.

See the License for the specific language governing permissions and
limitations under the License.

BSD Software License, Version 2

License: BSD

Redistribution and use in source and binary forms, with or without
modification, are permitted provided that the following conditions
are met:

1. Redistributions of source code must retain the above copyright
notice, this list of conditions and the following disclaimer.
2. Redistributions in binary form must reproduce the above copyright
notice, this list of conditions and the following disclaimer in
the documentation and/or other materials provided with the
distribution.
3. The names of the authors may not be used to endorse or promote
products derived from this software without specific prior
written permission.

THIS SOFTWARE IS PROVIDED ``AS IS" AND WITHOUT ANY EX-
PRESS OR

IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, THE
IMPLIED

WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTIC-
ULAR PURPOSE.

BSD Software License, Version 3

Copyright (c) <YEAR>, <OWNER>

All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

1. Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
2. Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
3. Neither the name of the copyright holder nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT HOLDER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

bzip2 Software License

bzip2 and libbzip2 License v1.0.6

Full name:

bzip2 and libbzip2 License v1.0.6

Short identifier:

bzip2-1.0.6

Other web pages for this license:

<https://github.com/asimonov-im/bzip2/blob/master/LICENSE>

Notes:

The bzip2.org website only shows version 1.0.5 of the license.

Text:

This program, "bzip2", the associated library "libbzip2", and all documentation, are copyright (C) 1996-2010 Julian R Seward. All rights reserved. Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

1. Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
2. The origin of this software must not be misrepresented; you must not claim that you wrote the original software. If you use this software in a product, an acknowledgment in the product documentation would be appreciated but is not required.
3. Altered source versions must be plainly marked as such, and must not be misrepresented as being the original software.
4. The name of the author may not be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE AUTHOR ``AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE AUTHOR BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Julian Seward, jseward@bzip.org bzip2/libbzip2 version 1.0.6 of 6 September 2010

Standard License Header:

There is no standard license header for the license

Eclipse Public License, EPL V1.0

THE ACCOMPANYING PROGRAM IS PROVIDED UNDER THE TERMS OF THIS ECLIPSE PUBLIC LICENSE ("AGREEMENT"). ANY USE, REPRODUCTION OR DISTRIBUTION OF THE PROGRAM CONSTITUTES RECIPIENT'S ACCEPTANCE OF THIS AGREEMENT.

1. DEFINITIONS

"Contribution" means:

- a) in the case of the initial Contributor, the initial code and documentation distributed under this Agreement, and
- b) in the case of each subsequent Contributor:
 - i) changes to the Program, and
 - ii) additions to the Program;

where such changes and/or additions to the Program originate from and are distributed by that particular Contributor. A Contribution 'originates' from a Contributor if it was added to the Program by such Contributor itself or anyone acting on such Contributor's behalf. Contributions do not include additions to the Program which:

- (i) are separate modules of software distributed in conjunction with the Program under their own license agreement, and (ii) are not derivative works of the Program.

"Contributor" means any person or entity that distributes the Program.

"Licensed Patents" mean patent claims licensable by a Contributor which are necessarily infringed by the use or sale of its Contribution alone or when combined with the Program.

"Program" means the Contributions distributed in accordance with this Agreement.

"Recipient" means anyone who receives the Program under this Agreement, including all Contributors.

2. GRANT OF RIGHTS

a) Subject to the terms of this Agreement, each Contributor hereby grants Recipient a non-exclusive, worldwide, royalty-free copyright license to reproduce, prepare derivative works of, publicly display, publicly perform, distribute and sublicense the Contribution of such Contributor, if any, and such derivative works, in source code and object code form.

b) Subject to the terms of this Agreement, each Contributor hereby grants Recipient a non-exclusive, worldwide, royalty-free patent license under Licensed Patents to make, use, sell, offer to sell, import and otherwise transfer the Contribution of such Contributor, if any, in source code and object code form. This patent license shall apply to the combination of the Contribution and the Program if, at the time the Contribution is added by the Contributor, such addition of the Contribution causes such combination to be covered by the Licensed Patents. The patent license shall not apply to any other combinations which include the Contribution. No hardware per se is licensed hereunder.

c) Recipient understands that although each Contributor grants the licenses to its Contributions set forth herein, no assurances are provided by any Contributor that the Program does not infringe the patent or other intellectual property rights of any other entity. Each Contributor disclaims any liability to Recipient for claims brought by any other entity based on infringement of intellectual

property rights or otherwise. As a condition to exercising the rights and licenses granted hereunder, each Recipient hereby assumes sole responsibility to secure any other intellectual property rights needed, if any. For example, if a third party patent license is required to allow Recipient to distribute the Program, it is Recipient's responsibility to acquire that license before distributing the Program.

d) Each Contributor represents that to its knowledge it has sufficient copyright rights in its Contribution, if any, to grant the copyright license set forth in this Agreement.

3. REQUIREMENTS

A Contributor may choose to distribute the Program in object code form under its own license agreement, provided that:

- a) it complies with the terms and conditions of this Agreement; and
- b) its license agreement:
 - i) effectively disclaims on behalf of all Contributors all warranties and conditions, express and implied, including warranties or conditions of title and non-infringement, and implied warranties or conditions of merchantability and fitness for a particular purpose;
 - ii) effectively excludes on behalf of all Contributors all liability for damages, including direct, indirect, special, incidental and consequential damages, such as lost profits;
 - iii) states that any provisions which differ from this Agreement are offered by that Contributor alone and not by any other party; and
 - iv) states that source code for the Program is available from such Contributor, and informs licensees how to obtain it in a reasonable manner on or through a medium customarily used for software exchange.

When the Program is made available in source code form:

- a) it must be made available under this Agreement; and
- b) a copy of this Agreement must be included with each copy of the Program.

Contributors may not remove or alter any copyright notices contained within the Program.

Each Contributor must identify itself as the originator of its Contribution, if any, in a manner that reasonably allows subsequent Recipients to identify the originator of the Contribution.

4. COMMERCIAL DISTRIBUTION

Commercial distributors of software may accept certain responsibilities with respect to end users, business partners and the like. While this license is intended to facilitate the commercial use of the Program, the Contributor who includes the Program in a commercial product offering should do so in a manner which does not create potential liability for other Contributors. Therefore, if a Contributor includes the Program in a commercial product offering, such Contributor ("Commercial Contributor") hereby agrees to defend and indemnify every other Contributor ("Indemnified Contributor") against any losses, damages and costs (collectively "Losses") arising from claims, lawsuits and other legal actions brought by a third party against the Indemnified Contributor to the extent caused by the acts or omissions of such Commercial Contributor in connection with its distribution of the Program in a commercial product offering. The obligations in this section do not apply to any claims or Losses relating to any ac-

tual or alleged intellectual property infringement. In order to qualify, an Indemnified Contributor must: a) promptly notify the Commercial Contributor in writing of such claim, and b) allow the Commercial Contributor to control, and cooperate with the Commercial Contributor in, the defense and any related settlement negotiations. The Indemnified Contributor may participate in any such claim at its own expense.

For example, a Contributor might include the Program in a commercial product offering, Product X. That Contributor is then a Commercial Contributor. If that Commercial Contributor then makes performance claims, or offers warranties related to Product X, those performance claims and warranties are such Commercial Contributor's responsibility alone. Under this section, the Commercial Contributor would have to defend claims against the other Contributors related to those performance claims and warranties, and if a court requires any other Contributor to pay any damages as a result, the Commercial Contributor must pay those damages.

5. NO WARRANTY

EXCEPT AS EXPRESSLY SET FORTH IN THIS AGREEMENT, THE PROGRAM IS PROVIDED ON AN "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, EITHER EXPRESS OR IMPLIED INCLUDING, WITHOUT LIMITATION, ANY WARRANTIES OR CONDITIONS OF TITLE, NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Each Recipient is solely responsible for determining the appropriateness of using and distributing the Program and assumes all risks associated with its exercise of rights under this Agreement, including but not limited to the risks and costs of program errors, compliance with applicable laws, damage to or loss of data, programs or equipment, and unavailability or interruption of operations.

6. DISCLAIMER OF LIABILITY

EXCEPT AS EXPRESSLY SET FORTH IN THIS AGREEMENT, NEITHER RECIPIENT NOR ANY CONTRIBUTORS SHALL HAVE ANY LIABILITY FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING WITHOUT LIMITATION LOST PROFITS), HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OR DISTRIBUTION OF THE PROGRAM OR THE EXERCISE OF ANY RIGHTS GRANTED HEREUNDER, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

7. GENERAL

If any provision of this Agreement is invalid or unenforceable under applicable law, it shall not affect the validity or enforceability of the remainder of the terms of this Agreement, and without further action by the parties hereto, such provision shall be reformed to the minimum extent necessary to make such provision valid and enforceable.

If Recipient institutes patent litigation against any entity (including a cross-claim or counterclaim in a lawsuit) alleging that the Program itself (excluding combinations of the Program with other software or hardware) infringes such Recipient's patent(s), then such Recipient's rights granted under Section 2(b) shall terminate as of the date such litigation is filed.

All Recipient's rights under this Agreement shall terminate if it fails to comply with any of the material terms or conditions of this Agreement and does not cure such failure in a reasonable period of time after becoming aware of such noncompliance. If all Recipient's rights under this Agreement terminate, Recipient agrees to cease use and distribution of the Program as soon as reasonably practicable. However, Recipient's obligations under this Agreement and any licenses granted by Recipient relating to the Program shall continue and survive.

Everyone is permitted to copy and distribute copies of this Agreement, but in order to avoid inconsistency the Agreement is copyrighted and may only be modified in the following manner. The Agreement Steward reserves the right to publish new versions (including revisions) of this Agreement from time to time. No one other than the Agreement Steward has the right to modify this Agreement. The Eclipse Foundation is the initial Agreement Steward. The Eclipse Foundation may assign the responsibility to serve as the Agreement Steward to a suitable separate entity. Each new version of the Agreement will be given a distinguishing version number. The Program (including Contributions) may always be distributed subject to the version of the Agreement under which it was received. In addition, after a new version of the Agreement is published, Contributor may elect to distribute the Program (including its Contributions) under the new version. Except as expressly stated in Sections 2(a) and 2(b) above, Recipient receives no rights or licenses to the intellectual property of any Contributor under this Agreement, whether expressly, by implication, estoppel or otherwise. All rights in the Program not expressly granted under this Agreement are reserved.

This Agreement is governed by the laws of the State of New York and the intellectual property laws of the United States of America. No party to this Agreement will bring a legal action under this Agreement more than one year after the cause of action arose. Each party waives its rights to a jury trial in any resulting litigation.

GNU C License

This file contains the copying permission notices for various files in the GNU C Library distribution that have copyright owners other than the Free Software Foundation. These notices all require that a copy of the notice be included in the accompanying documentation and be distributed with binary distributions of the code, so be sure to include this file along with any binary distributions derived from the GNU C Library.

All code incorporated from 4.4 BSD is distributed under the following license:

Copyright (C) 1991 Regents of the University of California.
All rights reserved.

Redistribution and use in source and binary forms, with or without

modification, are permitted provided that the following conditions are met:

1. Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
2. Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
3. [This condition was removed.]
4. Neither the name of the University nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE REGENTS AND CONTRIBUTORS ``AS IS" AND

ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE

IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE

ARE DISCLAIMED. IN NO EVENT SHALL THE REGENTS OR CONTRIBUTORS BE LIABLE

FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL

DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS

OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION)

HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT

LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY

OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF

SUCH DAMAGE.

The DNS resolver code, taken from BIND 4.9.5, is copyrighted both by UC Berkeley and by Digital Equipment Corporation. The DEC portions are under the following license:

Portions Copyright (C) 1993 by Digital Equipment Corporation.

Permission to use, copy, modify, and distribute this software for any purpose with or without fee is hereby granted, provided that the above

copyright notice and this permission notice appear in all copies, and that the name of Digital Equipment Corporation not be used in advertising or publicity pertaining to distribution of the document or software without specific, written prior permission.

THE SOFTWARE IS PROVIDED ``AS IS" AND DIGITAL EQUIPMENT CORP.

DISCLAIMS ALL WARRANTIES WITH REGARD TO THIS SOFTWARE, INCLUDING ALL

IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS. IN NO EVENT SHALL

DIGITAL EQUIPMENT CORPORATION BE LIABLE FOR ANY SPECIAL, DIRECT,

INDIRECT, OR CONSEQUENTIAL DAMAGES OR ANY DAMAGES WHATSOEVER RESULTING

FROM LOSS OF USE, DATA OR PROFITS, WHETHER IN AN ACTION OF CONTRACT,

NEGLIGENCE OR OTHER TORTIOUS ACTION, ARISING OUT OF OR IN CONNECTION

WITH THE USE OR PERFORMANCE OF THIS SOFTWARE.

The Sun RPC support (from rpcsrc-4.0) is covered by the following license:

Copyright (C) 1984, Sun Microsystems, Inc.

Sun RPC is a product of Sun Microsystems, Inc. and is provided for unrestricted use provided that this legend is included on all tape media and as a part of the software program in whole or part. Users may copy or modify Sun RPC without charge, but are not authorized to license or distribute it to anyone else except as part of a product or program developed by the user.

SUN RPC IS PROVIDED AS IS WITH NO WARRANTIES OF ANY KIND INCLUDING THE

WARRANTIES OF DESIGN, MERCHANTABILITY AND FITNESS FOR A PARTICULAR

PURPOSE, OR ARISING FROM A COURSE OF DEALING, USAGE OR TRADE PRACTICE.

Sun RPC is provided with no support and without any obligation on the part of Sun Microsystems, Inc. to assist in its use, correction, modification or enhancement.

SUN MICROSYSTEMS, INC. SHALL HAVE NO LIABILITY WITH RESPECT TO THE INFRINGEMENT OF COPYRIGHTS, TRADE SECRETS OR ANY PATENTS BY SUN RPC OR ANY PART THEREOF.

In no event will Sun Microsystems, Inc. be liable for any lost revenue or profits or other special, indirect and consequential damages, even if Sun has been advised of the possibility of such damages.

The following CMU license covers some of the support code for Mach, derived from Mach 3.0:

Mach Operating System
Copyright (C) 1991,1990,1989 Carnegie Mellon University
All Rights Reserved.

Permission to use, copy, modify and distribute this software and its documentation is hereby granted, provided that both the copyright notice and this permission notice appear in all copies of the software, derivative works or modified versions, and any portions thereof, and that both notices appear in supporting documentation.

CARNEGIE MELLON ALLOWS FREE USE OF THIS SOFTWARE IN ITS ``AS IS"

CONDITION. CARNEGIE MELLON DISCLAIMS ANY LIABILITY OF ANY KIND FOR ANY DAMAGES WHATSOEVER RESULTING FROM THE USE OF THIS SOFTWARE.

Carnegie Mellon requests users of this software to return to

Software Distribution Coordinator
School of Computer Science
Carnegie Mellon University
Pittsburgh PA 15213-3890

or Software.Distribution@CS.CMU.EDU any improvements or extensions that they make and grant Carnegie Mellon the rights to redistribute these changes.

The file `if_ppp.h` is under the following CMU license:

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

1. Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
2. Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
3. Neither the name of the University nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY CARNEGIE MELLON UNIVERSITY AND

CONTRIBUTORS ``AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES,

INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED.

IN NO EVENT SHALL THE UNIVERSITY OR CONTRIBUTORS BE LIABLE FOR ANY

DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL

DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE

GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS

INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER

IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR

OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN

IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

The following license covers the files from Intel's "Highly Optimized Mathematical Functions for Itanium" collection:

Intel License Agreement

Copyright (c) 2000, Intel Corporation

All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

* Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.

* Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.

* The name of Intel Corporation may not be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS

"AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT

LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR

A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL INTEL OR

CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL,

EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO,

PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR

PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF

LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING

NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS

SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

The files inet/getnameinfo.c and sysdeps/posix/getaddrinfo.c are copyright

(C) by Craig Metz and are distributed under the following license:

/* The Inner Net License, Version 2.00

The author(s) grant permission for redistribution and use in source and binary forms, with or without modification, of the software and documentation provided that the following conditions are met:

0. If you receive a version of the software that is specifically labelled as not being for redistribution (check the version message and/or README), you are not permitted to redistribute that version of the software in any way or form.
1. All terms of the all other applicable copyrights and licenses must be followed.
2. Redistributions of source code must retain the authors' copyright notice(s), this list of conditions, and the following disclaimer.
3. Redistributions in binary form must reproduce the authors' copyright notice(s), this list of conditions, and the following disclaimer in the documentation and/or other materials provided with the distribution.
4. [The copyright holder has authorized the removal of this clause.]
5. Neither the name(s) of the author(s) nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY ITS AUTHORS AND CONTRIBUTORS ``AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE AUTHORS OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS

SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

If these license terms cause you a real problem, contact the author. */

GNU General Public License, GPL V1.0

GNU GENERAL PUBLIC LICENSE

Version 1, February 1989

Copyright (C) 1989 Free Software Foundation, Inc.

51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA

Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

Preamble

The license agreements of most software companies try to keep users at the mercy of those companies. By contrast, our General Public License is intended to guarantee your freedom to share and change free software--to make sure the software is free for all its users. The General Public License applies to the Free Software Foundation's software and to any other program whose authors commit to using it. You can use it for your programs, too.

When we speak of free software, we are referring to freedom, not price. Specifically, the General Public License is designed to make sure that you have the freedom to give away or sell copies of free software, that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs; and that you know you can do these things.

To protect your rights, we need to make restrictions that forbid anyone to deny you these rights or to ask you to surrender the rights. These restrictions translate to certain responsibilities for you if you distribute copies of the software, or if you modify it.

For example, if you distribute copies of a such a program, whether gratis or for a fee, you must give the recipients all the rights that you have. You must make sure that they, too, receive or can get the source code. And you must tell them their rights.

We protect your rights with two steps: (1) copyright the software, and (2) offer you this license which gives you legal permission to copy, distribute and/or modify the software.

Also, for each author's protection and ours, we want to make certain that everyone understands that there is no warranty for this free software. If the software is modified by someone else and passed on, we want its recipients to know that what they have is not the original, so that any problems introduced by others will not reflect on the original authors' reputations.

The precise terms and conditions for copying, distribution and modification follow.

GNU GENERAL PUBLIC LICENSE

TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0. This License Agreement applies to any program or other work which contains a notice placed by the copyright holder saying it may be distributed under the terms of this General Public License. The "Program", below, refers to any such program or work, and a "work based on the Program" means either the Program or any work containing the Program or a portion of it, either verbatim or with modifications. Each licensee is addressed as "you".

1. You may copy and distribute verbatim copies of the Program's source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this General Public License and to the absence of any warranty; and give any other recipients of the Program a copy of this General Public License along with the Program. You may charge a fee for the physical act of transferring a copy.

2. You may modify your copy or copies of the Program or any portion of it, and copy and distribute such modifications under the terms of Paragraph 1 above, provided that you also do the following:

a) cause the modified files to carry prominent notices stating that you changed the files and the date of any change; and

b) cause the whole of any work that you distribute or publish, that in whole or in part contains the Program or any part thereof, either with or without modifications, to be licensed at no charge to all third parties under the terms of this General Public License (except that you may choose to grant warranty protection to some or all third parties, at your option).

c) If the modified program normally reads commands interactively when run, you must cause it, when started running for such interactive use in the simplest and most usual way, to print or display an announcement including an appropriate copyright notice and a notice that there is no warranty (or else, saying that you provide a warranty) and that users may redistribute the program under these conditions, and telling the user how to view a copy of this General Public License.

d) You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

Mere aggregation of another independent work with the Program (or its derivative) on a volume of a storage or distribution medium does not bring the other work under the scope of these terms.

3. You may copy and distribute the Program (or a portion or derivative of it, under Paragraph 2) in object code or executable form under the terms of Paragraphs 1 and 2 above provided that you also do one of the following:

a) accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Paragraphs 1 and 2 above; or,

b) accompany it with a written offer, valid for at least three years, to give any third party free (except for a nominal charge for the cost of distribution) a complete machine-readable copy of the corresponding source code, to be distributed under the terms of Paragraphs 1 and 2 above; or,

c) accompany it with the information you received as to where the corresponding source code may be obtained. (This alternative is allowed only for noncommercial distribution and only if you received the program in object code or executable form alone.)

Source code for a work means the preferred form of the work for making modifications to it. For an executable file, complete source code means all the source code for all modules it contains; but, as a special exception, it need not include source code for modules which are standard libraries that accompany the operating system on which the executable file runs, or for standard header files or definitions files that accompany that operating system.

4. You may not copy, modify, sublicense, distribute or transfer the Program except as expressly provided under this General Public License. Any attempt otherwise to copy, modify, sublicense, distribute or transfer the Program is void, and will automatically terminate your rights to use the Program under this License. However, parties who have received copies, or rights to use copies, from you under this General Public License will not have their licenses terminated so long as such parties remain in full compliance.

5. By copying, distributing or modifying the Program (or any work based on the Program) you indicate your acceptance of this license to do so, and all its terms and conditions.

6. Each time you redistribute the Program (or any work based on the Program), the recipient automatically receives a license from the original licensor to copy, distribute or modify the Program subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein.

7. The Free Software Foundation may publish revised and/or new versions of the General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Program specifies a version number of the license which applies to it and "any later version", you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Program does not specify a version number of the license, you may choose any version ever published by the Free Software Foundation.

8. If you wish to incorporate parts of the Program into other free programs whose distribution conditions are different, write to the author to ask for permission. For software which is copyrighted by the Free Software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this. Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

NO WARRANTY

9. BECAUSE THE PROGRAM IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY FOR THE PROGRAM, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FIT-

NESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. SHOULD THE PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

10. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR REDISTRIBUTE THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER PROGRAMS), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

END OF TERMS AND CONDITIONS

Appendix: How to Apply These Terms to Your New Programs

If you develop a new program, and you want it to be of the greatest possible use to humanity, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms.

To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

<one line to give the program's name and a brief idea of what it does.> Copyright (C) 19yy <name of author>

This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 1, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

You should have received a copy of the GNU General Public License along with this program; if not, write to the Free Software Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston MA 02110-1301 USA.

Also add information on how to contact you by electronic and paper mail.

If the program is interactive, make it output a short notice like this when it starts in an interactive mode:

Gnomovision version 69, Copyright (C) 19xx name of author Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type `show w'. This is free software, and you are welcome to redistribute it under certain conditions; type `show c' for details.

The hypothetical commands `show w' and `show c' should show the appropriate parts of the General Public License. Of course, the commands you use may be called something other than `show w' and `show c'; they could even be mouse-clicks or menu items--whatever suits your program.

You should also get your employer (if you work as a programmer) or your school, if any, to sign a "copyright disclaimer" for the program, if necessary. Here a sample; alter the names:

Yoyodyne, Inc., hereby disclaims all copyright interest in the program 'Gnomovision' (a program to direct compilers to make passes at assemblers) written by James Hacker.

<signature of Ty Coon>, 1 April 1989 Ty Coon, President of Vice

That's all there is to it!

GNU Free Documentation License, Version 1.2

GNU Free Documentation License

Version 1.2, November 2002

Copyright (C) 2000,2001,2002 Free Software Foundation, Inc.

51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA

Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

0. PREAMBLE

The purpose of this License is to make a manual, textbook, or other functional and useful document "free" in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or noncommercially. Secondly, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others.

This License is a kind of "copyleft", which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft license designed for free software.

We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or

whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a world-wide, royalty-free license, unlimited in duration, to use that work under the conditions stated herein. The "Document", below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as "you". You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law.

A "Modified Version" of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language.

A "Secondary Section" is a named appendix or a front-matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document's overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (Thus, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The "Invariant Sections" are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections then there are none.

The "Cover Texts" are certain short passages of text that are listed, as Front-Cover Texts or Back-Cover Texts, in the notice that says that

the Document is released under this License. A Front-Cover Text may be at most 5 words, and a Back-Cover Text may be at most 25 words.

A "Transparent" copy of the Document means a machine-readable copy, represented in a format whose specification is available to the general public, that is suitable for revising the document straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup, or absence of markup, has been arranged to thwart or discourage subsequent modification by readers is not Transparent. An image format is not Transparent if used for any substantial amount of text. A copy that is not "Transparent" is called "Opaque".

Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML, PostScript or PDF produced by some word processors for output purposes only.

The "Title Page" means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, "Title Page" means the text near the most prominent appearance of the work's title, preceding the beginning of the body of the text.

A section "Entitled XYZ" means a named subunit of the Document whose title either is precisely XYZ or contains XYZ in parentheses following text that translates XYZ in another language. (Here XYZ stands for a specific section name mentioned below, such as "Acknowledgements", "Dedications", "Endorsements", or "History".) To "Preserve the Title" of such a section when you modify the Document means that it remains a section "Entitled XYZ" according to this definition.

The Document may include Warranty Disclaimers next to the notice which states that this License applies to the Document. These Warranty Disclaimers are considered to be included by reference in this License, but only as regards disclaiming warranties: any other implication that these Warranty Disclaimers may have is void and has no effect on the meaning of this License.

2. VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3.

You may also lend copies, under the same conditions stated above, and you may publicly display copies.

3. COPYING IN QUANTITY

If you publish printed copies (or copies in media that commonly have printed covers) of the Document, numbering more than 100, and the Document's license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts: Front-Cover Texts on the front cover, and Back-Cover Texts on the back cover. Both covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects.

If the required texts for either cover are too voluminous to fit

legibly, you should put the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages.

If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine-readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a computer-network location from which the general network-using public has access to download using public-standard network protocols a complete Transparent copy of the Document, free of added material. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public.

It is requested, but not required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the Document.

4. MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things in the Modified Version:

- A. Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any, be listed in the History section of the Document). You may use the same title as a previous version if the original publisher of that version gives permission.
- B. List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has fewer than five), unless they release you from this requirement.

- C. State on the Title page the name of the publisher of the Modified Version, as the publisher.
- D. Preserve all the copyright notices of the Document.
- E. Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.
- F. Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.
- G. Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document's license notice.
- H. Include an unaltered copy of this License.
- I. Preserve the section Entitled "History", Preserve its Title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section Entitled "History" in the Document, create one stating the title, year, authors, and publisher of the Document as given on its Title Page, then add an item describing the Modified Version as stated in the previous sentence.
- J. Preserve the network location, if any, given in the Document for public access to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the "History" section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.
- K. For any section Entitled "Acknowledgements" or "Dedications", Preserve the Title of the section, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or dedications given therein.
- L. Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles.
- M. Delete any section Entitled "Endorsements". Such a section may not be included in the Modified Version.
- N. Do not retitle any existing section to be Entitled "Endorsements" or to conflict in title with any Invariant Section.
- O. Preserve any Warranty Disclaimers.

If the Modified Version includes new front-matter sections or appendices that qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all

of these sections as invariant. To do this, add their titles to the list of Invariant Sections in the Modified Version's license notice. These titles must be distinct from any other section titles.

You may add a section Entitled "Endorsements", provided it contains nothing but endorsements of your Modified Version by various parties--for example, statements of peer review or that the text has been approved by an organization as the authoritative definition of a standard.

You may add a passage of up to five words as a Front-Cover Text, and a passage of up to 25 words as a Back-Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front-Cover Text and one of Back-Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one.

The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version.

5. COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice, and that you preserve all their Warranty Disclaimers.

The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that section if known, or else a unique number. Make the same adjustment to the section titles in the list of

Invariant Sections in the license notice of the combined work.

In the combination, you must combine any sections Entitled "History" in the various original documents, forming one section Entitled "History"; likewise combine any sections Entitled "Acknowledgements", and any sections Entitled "Dedications". You must delete all sections Entitled "Endorsements".

6. COLLECTIONS OF DOCUMENTS

You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided that you follow the rules of this License for verbatim copying of each of the documents in all other respects.

You may extract a single document from such a collection, and distribute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

7. AGGREGATION WITH INDEPENDENT WORKS

A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, is called an "aggregate" if the copyright resulting from the compilation is not used to limit the legal rights of the compilation's users beyond what the individual works permit. When the Document is included in an aggregate, this License does not apply to the other works in the aggregate which are not themselves derivative works of the Document.

If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one half of the entire aggregate, the Document's Cover Texts may be placed on covers that bracket the Document within the aggregate, or the electronic equivalent of covers if the Document is in electronic form. Otherwise they must appear on printed covers that bracket the whole aggregate.

8. TRANSLATION

Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with translations requires special permission from their copyright holders, but you may include translations of some or all Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License, and all the license notices in the Document, and any Warranty Disclaimers, provided that you also include the original English version of this License and the original versions of those notices and disclaimers. In case of a disagreement between the translation and the original version of this License or a notice or disclaimer, the original version will prevail.

If a section in the Document is Entitled "Acknowledgements", "Dedications", or "History", the requirement (section 4) to Preserve its Title (section 1) will typically require changing the actual title.

9. TERMINATION

You may not copy, modify, sublicense, or distribute the Document except as expressly provided for under this License. Any other attempt to copy, modify, sublicense or distribute the Document is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

10. FUTURE REVISIONS OF THIS LICENSE

The Free Software Foundation may publish new, revised versions of the GNU Free Documentation License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See <http://www.gnu.org/copyleft/>.

Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License "or any later version" applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation.

ADDENDUM: How to use this License for your documents

To use this License in a document you have written, include a copy of the License in the document and put the following copyright and license notices just after the title page:

Copyright (c) YEAR YOUR NAME.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.2 or any later version published by the Free Software Foundation; with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts. A copy of the license is included in the section entitled "GNU Free Documentation License".

If you have Invariant Sections, Front-Cover Texts and Back-Cover Texts, replace the "with...Texts." line with this:

with the Invariant Sections being LIST THEIR TITLES, with the Front-Cover Texts being LIST, and with the Back-Cover Texts being LIST.

If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation.

If your document contains nontrivial examples of program code, we recommend releasing these examples in parallel under your choice of free software license, such as the GNU General Public License, to permit their use in free software.

GNU General Public License, GPL V2

GNU GENERAL PUBLIC LICENSE

Version 2, June 1991

Copyright (C) 1989, 1991 Free Software Foundation, Inc.

51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA

Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public License is intended to guarantee your freedom to share and change free software--to make sure the software is free for all its users. This General Public License applies to most of the Free Software Foundation's software and to any other program whose authors commit to using it. (Some other Free Software Foundation software is covered by the GNU Library General Public License instead.) You can apply it to your programs, too.

When we speak of free software, we are referring to freedom, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish), that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs; and that you know you can do these things.

To protect your rights, we need to make restrictions that forbid anyone to deny you these rights or to ask you to surrender the rights. These restrictions translate to certain responsibilities for you if you distribute copies of the software, or if you modify it.

For example, if you distribute copies of such a program, whether gratis or for a fee, you must give the recipients all the rights that you have. You must make sure that they, too, receive or can get the source code. And you must show them these terms so they know their

rights.

We protect your rights with two steps: (1) copyright the software, and (2) offer you this license which gives you legal permission to copy, distribute and/or modify the software.

Also, for each author's protection and ours, we want to make certain that everyone understands that there is no warranty for this free software. If the software is modified by someone else and passed on, we want its recipients to know that what they have is not the original, so that any problems introduced by others will not reflect on the original authors' reputations.

Finally, any free program is threatened constantly by software patents. We wish to avoid the danger that redistributors of a free program will individually obtain patent licenses, in effect making the program proprietary. To prevent this, we have made it clear that any patent must be licensed for everyone's free use or not licensed at all.

The precise terms and conditions for copying, distribution and modification follow.

GNU GENERAL PUBLIC LICENSE

TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0. This License applies to any program or other work which contains a notice placed by the copyright holder saying it may be distributed under the terms of this General Public License. The "Program", below, refers to any such program or work, and a "work based on the Program" means either the Program or any derivative work under copyright law: that is to say, a work containing the Program or a portion of it, either verbatim or with modifications and/or translated into another language. (Hereinafter, translation is included without limitation in the term "modification".) Each licensee is addressed as "you".

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running the Program is not restricted, and the output from the Program is covered only if its contents constitute a work based on the Program (independent of having been made by running the Program).

Whether that is true depends on what the Program does.

1. You may copy and distribute verbatim copies of the Program's source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and give any other recipients of the Program a copy of this License along with the Program.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

2. You may modify your copy or copies of the Program or any portion of it, thus forming a work based on the Program, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:

a) You must cause the modified files to carry prominent notices stating that you changed the files and the date of any change.

b) You must cause any work that you distribute or publish, that in whole or in part contains or is derived from the Program or any part thereof, to be licensed as a whole at no charge to all third parties under the terms of this License.

c) If the modified program normally reads commands interactively when run, you must cause it, when started running for such interactive use in the most ordinary way, to print or display an announcement including an appropriate copyright notice and a notice that there is no warranty (or else, saying that you provide a warranty) and that users may redistribute the program under these conditions, and telling the user how to view a copy of this License. (Exception: if the Program itself is interactive but does not normally print such an announcement, your work based on the Program is not required to print an announcement.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Program, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those

sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Program, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Program.

In addition, mere aggregation of another work not based on the Program with the Program (or with a work based on the Program) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

3. You may copy and distribute the Program (or a work based on it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you also do one of the following:

- a) Accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,
- b) Accompany it with a written offer, valid for at least three years, to give any third party, for a charge no more than your cost of physically performing source distribution, a complete machine-readable copy of the corresponding source code, to be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,
- c) Accompany it with the information you received as to the offer to distribute corresponding source code. (This alternative is allowed only for noncommercial distribution and only if you received the program in object code or executable form with such an offer, in accord with Subsection b above.)

The source code for a work means the preferred form of the work for making modifications to it. For an executable work, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to

control compilation and installation of the executable. However, as a special exception, the source code distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

If distribution of executable or object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place counts as distribution of the source code, even though third parties are not compelled to copy the source along with the object code.

4. You may not copy, modify, sublicense, or distribute the Program except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense or distribute the Program is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

5. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Program or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Program (or any work based on the Program), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Program or works based on it.

6. Each time you redistribute the Program (or any work based on the Program), the recipient automatically receives a license from the original licensor to copy, distribute or modify the Program subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties to this License.

7. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or

otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Program at all. For example, if a patent license would not permit royalty-free redistribution of the Program by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Program.

If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply and the section as a whole is intended to apply in other circumstances.

It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system, which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

8. If the distribution and/or use of the Program is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Program under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.

9. The Free Software Foundation may publish revised and/or new versions of the General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Program specifies a version number of this License which applies to it and "any later version", you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Program does not specify a version number of this License, you may choose any version ever published by the Free Software Foundation.

10. If you wish to incorporate parts of the Program into other free programs whose distribution conditions are different, write to the author to ask for permission. For software which is copyrighted by the Free Software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this. Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

NO WARRANTY

11. BECAUSE THE PROGRAM IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY

FOR THE PROGRAM, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN

OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES

PROVIDE THE PROGRAM "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED

OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF

MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS

TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. SHOULD THE

PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING,

REPAIR OR CORRECTION.

12. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING

WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR

REDISTRIBUTE THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES,

INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING
OUT OF THE USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED
TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY
YOU OR THIRD PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER
PROGRAMS), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE
POSSIBILITY OF SUCH DAMAGES.

END OF TERMS AND CONDITIONS

How to Apply These Terms to Your New Programs

If you develop a new program, and you want it to be of the greatest possible use to the public, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms.

To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

<one line to give the program's name and a brief idea of what it does.>

Copyright (C) <year> <name of author>

This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

You should have received a copy of the GNU General Public License along with this program; if not, write to the Free Software Foundation, Inc., 51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA

Also add information on how to contact you by electronic and paper mail.

If the program is interactive, make it output a short notice like this when it starts in an interactive mode:

Gnomovision version 69, Copyright (C) year name of author

Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type `show w'.

This is free software, and you are welcome to redistribute it under certain conditions; type `show c' for details.

The hypothetical commands `show w' and `show c' should show the appropriate parts of the General Public License. Of course, the commands you use may be called something other than `show w' and `show c'; they could even be mouse-clicks or menu items--whatever suits your program.

You should also get your employer (if you work as a programmer) or your school, if any, to sign a "copyright disclaimer" for the program, if necessary. Here is a sample; alter the names:

Yoyodyne, Inc., hereby disclaims all copyright interest in the program
`Gnomovision' (which makes passes at compilers) written by James Hacker.

<signature of Ty Coon>, 1 April 1989

Ty Coon, President of Vice

This General Public License does not permit incorporating your program into proprietary programs. If your program is a subroutine library, you may consider it more useful to permit linking proprietary applications with the library. If this is what you want to do, use the GNU Library General Public License instead of this License.

GNU General Public License, GPL V3

GNU GENERAL PUBLIC LICENSE

Version 3, 29 June 2007

Copyright (C) 2007 Free Software Foundation, Inc. <<http://fsf.org/>>

Everyone is permitted to copy and distribute verbatim copies

of this license document, but changing it is not allowed.

Preamble

The GNU General Public License is a free, copyleft license for software and other kinds of works.

The licenses for most software and other practical works are designed to take away your freedom to share and change the works. By contrast, the GNU General Public License is intended to guarantee your freedom to share and change all versions of a program--to make sure it remains free software for all its users. We, the Free Software Foundation, use the GNU General Public License for most of our software; it applies also to any other work released this way by its authors. You can apply it to your programs, too.

When we speak of free software, we are referring to freedom, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for them if you wish), that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs, and that you know you can do these things.

To protect your rights, we need to prevent others from denying you these rights or asking you to surrender the rights. Therefore, you have certain responsibilities if you distribute copies of the software, or if you modify it: responsibilities to respect the freedom of others.

For example, if you distribute copies of such a program, whether gratis or for a fee, you must pass on to the recipients the same freedoms that you received. You must make sure that they, too, receive or can get the source code. And you must show them these terms so they know their rights.

Developers that use the GNU GPL protect your rights with two steps: (1) assert copyright on the software, and (2) offer you this License giving you legal permission to copy, distribute and/or modify it.

For the developers' and authors' protection, the GPL clearly explains that there is no warranty for this free software. For both users' and authors' sake, the GPL requires that modified versions be marked as

changed, so that their problems will not be attributed erroneously to authors of previous versions.

Some devices are designed to deny users access to install or run modified versions of the software inside them, although the manufacturer can do so. This is fundamentally incompatible with the aim of protecting users' freedom to change the software. The systematic pattern of such abuse occurs in the area of products for individuals to use, which is precisely where it is most unacceptable. Therefore, we have designed this version of the GPL to prohibit the practice for those products. If such problems arise substantially in other domains, we stand ready to extend this provision to those domains in future versions of the GPL, as needed to protect the freedom of users.

Finally, every program is threatened constantly by software patents. States should not allow patents to restrict development and use of software on general-purpose computers, but in those that do, we wish to avoid the special danger that patents applied to a free program could make it effectively proprietary. To prevent this, the GPL assures that patents cannot be used to render the program non-free.

The precise terms and conditions for copying, distribution and modification follow.

TERMS AND CONDITIONS

0. Definitions.

"This License" refers to version 3 of the GNU General Public License.

"Copyright" also means copyright-like laws that apply to other kinds of works, such as semiconductor masks.

"The Program" refers to any copyrightable work licensed under this License. Each licensee is addressed as "you". "Licensees" and "recipients" may be individuals or organizations.

To "modify" a work means to copy from or adapt all or part of the work in a fashion requiring copyright permission, other than the making of an exact copy. The resulting work is called a "modified version" of the earlier work or a work "based on" the earlier work.

A "covered work" means either the unmodified Program or a work based on the Program.

To "propagate" a work means to do anything with it that, without permission, would make you directly or secondarily liable for infringement under applicable copyright law, except executing it on a computer or modifying a private copy. Propagation includes copying, distribution (with or without modification), making available to the public, and in some countries other activities as well.

To "convey" a work means any kind of propagation that enables other parties to make or receive copies. Mere interaction with a user through a computer network, with no transfer of a copy, is not conveying.

An interactive user interface displays "Appropriate Legal Notices" to the extent that it includes a convenient and prominently visible feature that (1) displays an appropriate copyright notice, and (2) tells the user that there is no warranty for the work (except to the extent that warranties are provided), that licensees may convey the work under this License, and how to view a copy of this License. If the interface presents a list of user commands or options, such as a menu, a prominent item in the list meets this criterion.

1. Source Code.

The "source code" for a work means the preferred form of the work for making modifications to it. "Object code" means any non-source form of a work.

A "Standard Interface" means an interface that either is an official standard defined by a recognized standards body, or, in the case of interfaces specified for a particular programming language, one that is widely used among developers working in that language.

The "System Libraries" of an executable work include anything, other than the work as a whole, that (a) is included in the normal form of packaging a Major Component, but which is not part of that Major Component, and (b) serves only to enable use of the work with that Major Component, or to implement a Standard Interface for which an implementation is available to the public in source code form. A

"Major Component", in this context, means a major essential component (kernel, window system, and so on) of the specific operating system (if any) on which the executable work runs, or a compiler used to produce the work, or an object code interpreter used to run it.

The "Corresponding Source" for a work in object code form means all the source code needed to generate, install, and (for an executable work) run the object code and to modify the work, including scripts to control those activities. However, it does not include the work's System Libraries, or general-purpose tools or generally available free programs which are used unmodified in performing those activities but which are not part of the work. For example, Corresponding Source includes interface definition files associated with source files for the work, and the source code for shared libraries and dynamically linked subprograms that the work is specifically designed to require, such as by intimate data communication or control flow between those subprograms and other parts of the work.

The Corresponding Source need not include anything that users can regenerate automatically from other parts of the Corresponding Source.

The Corresponding Source for a work in source code form is that same work.

2. Basic Permissions.

All rights granted under this License are granted for the term of copyright on the Program, and are irrevocable provided the stated conditions are met. This License explicitly affirms your unlimited permission to run the unmodified Program. The output from running a covered work is covered by this License only if the output, given its content, constitutes a covered work. This License acknowledges your rights of fair use or other equivalent, as provided by copyright law.

You may make, run and propagate covered works that you do not convey, without conditions so long as your license otherwise remains in force. You may convey covered works to others for the sole purpose of having them make modifications exclusively for you, or provide you with facilities for running those works, provided that you comply with the terms of this License in conveying all material for which you do

not control copyright. Those thus making or running the covered works for you must do so exclusively on your behalf, under your direction and control, on terms that prohibit them from making any copies of your copyrighted material outside their relationship with you.

Conveying under any other circumstances is permitted solely under the conditions stated below. Sublicensing is not allowed; section 10 makes it unnecessary.

3. Protecting Users' Legal Rights From Anti-Circumvention Law.

No covered work shall be deemed part of an effective technological measure under any applicable law fulfilling obligations under article 11 of the WIPO copyright treaty adopted on 20 December 1996, or similar laws prohibiting or restricting circumvention of such measures.

When you convey a covered work, you waive any legal power to forbid circumvention of technological measures to the extent such circumvention is effected by exercising rights under this License with respect to the covered work, and you disclaim any intention to limit operation or modification of the work as a means of enforcing, against the work's users, your or third parties' legal rights to forbid circumvention of technological measures.

4. Conveying Verbatim Copies.

You may convey verbatim copies of the Program's source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice; keep intact all notices stating that this License and any non-permissive terms added in accord with section 7 apply to the code; keep intact all notices of the absence of any warranty; and give all recipients a copy of this License along with the Program.

You may charge any price or no price for each copy that you convey, and you may offer support or warranty protection for a fee.

5. Conveying Modified Source Versions.

You may convey a work based on the Program, or the modifications to

produce it from the Program, in the form of source code under the terms of section 4, provided that you also meet all of these conditions:

a) The work must carry prominent notices stating that you modified it, and giving a relevant date.

b) The work must carry prominent notices stating that it is released under this License and any conditions added under section 7. This requirement modifies the requirement in section 4 to "keep intact all notices".

c) You must license the entire work, as a whole, under this License to anyone who comes into possession of a copy. This License will therefore apply, along with any applicable section 7 additional terms, to the whole of the work, and all its parts, regardless of how they are packaged. This License gives no permission to license the work in any other way, but it does not invalidate such permission if you have separately received it.

d) If the work has interactive user interfaces, each must display Appropriate Legal Notices; however, if the Program has interactive interfaces that do not display Appropriate Legal Notices, your work need not make them do so.

A compilation of a covered work with other separate and independent works, which are not by their nature extensions of the covered work, and which are not combined with it such as to form a larger program, in or on a volume of a storage or distribution medium, is called an "aggregate" if the compilation and its resulting copyright are not used to limit the access or legal rights of the compilation's users beyond what the individual works permit. Inclusion of a covered work in an aggregate does not cause this License to apply to the other parts of the aggregate.

6. Conveying Non-Source Forms.

You may convey a covered work in object code form under the terms of sections 4 and 5, provided that you also convey the machine-readable Corresponding Source under the terms of this License, in one of these ways:

- a) Convey the object code in, or embodied in, a physical product (including a physical distribution medium), accompanied by the Corresponding Source fixed on a durable physical medium customarily used for software interchange.
- b) Convey the object code in, or embodied in, a physical product (including a physical distribution medium), accompanied by a written offer, valid for at least three years and valid for as long as you offer spare parts or customer support for that product model, to give anyone who possesses the object code either (1) a copy of the Corresponding Source for all the software in the product that is covered by this License, on a durable physical medium customarily used for software interchange, for a price no more than your reasonable cost of physically performing this conveying of source, or (2) access to copy the Corresponding Source from a network server at no charge.
- c) Convey individual copies of the object code with a copy of the written offer to provide the Corresponding Source. This alternative is allowed only occasionally and noncommercially, and only if you received the object code with such an offer, in accord with subsection 6b.
- d) Convey the object code by offering access from a designated place (gratis or for a charge), and offer equivalent access to the Corresponding Source in the same way through the same place at no further charge. You need not require recipients to copy the Corresponding Source along with the object code. If the place to copy the object code is a network server, the Corresponding Source may be on a different server (operated by you or a third party) that supports equivalent copying facilities, provided you maintain clear directions next to the object code saying where to find the Corresponding Source. Regardless of what server hosts the Corresponding Source, you remain obligated to ensure that it is available for as long as needed to satisfy these requirements.
- e) Convey the object code using peer-to-peer transmission, provided you inform other peers where the object code and Corresponding Source of the work are being offered to the general public at no charge under subsection 6d.

A separable portion of the object code, whose source code is excluded from the Corresponding Source as a System Library, need not be included in conveying the object code work.

A "User Product" is either (1) a "consumer product", which means any tangible personal property which is normally used for personal, family, or household purposes, or (2) anything designed or sold for incorporation into a dwelling. In determining whether a product is a consumer product, doubtful cases shall be resolved in favor of coverage. For a particular product received by a particular user, "normally used" refers to a typical or common use of that class of product, regardless of the status of the particular user or of the way in which the particular user actually uses, or expects or is expected to use, the product. A product is a consumer product regardless of whether the product has substantial commercial, industrial or non-consumer uses, unless such uses represent the only significant mode of use of the product.

"Installation Information" for a User Product means any methods, procedures, authorization keys, or other information required to install and execute modified versions of a covered work in that User Product from a modified version of its Corresponding Source. The information must suffice to ensure that the continued functioning of the modified object code is in no case prevented or interfered with solely because modification has been made.

If you convey an object code work under this section in, or with, or specifically for use in, a User Product, and the conveying occurs as part of a transaction in which the right of possession and use of the User Product is transferred to the recipient in perpetuity or for a fixed term (regardless of how the transaction is characterized), the Corresponding Source conveyed under this section must be accompanied by the Installation Information. But this requirement does not apply if neither you nor any third party retains the ability to install modified object code on the User Product (for example, the work has been installed in ROM).

The requirement to provide Installation Information does not include a requirement to continue to provide support service, warranty, or updates for a work that has been modified or installed by the recipient, or for the User Product in which it has been modified or installed. Access to a network may be denied when the modification itself materially and

adversely affects the operation of the network or violates the rules and protocols for communication across the network.

Corresponding Source conveyed, and Installation Information provided, in accord with this section must be in a format that is publicly documented (and with an implementation available to the public in source code form), and must require no special password or key for unpacking, reading or copying.

7. Additional Terms.

"Additional permissions" are terms that supplement the terms of this License by making exceptions from one or more of its conditions. Additional permissions that are applicable to the entire Program shall be treated as though they were included in this License, to the extent that they are valid under applicable law. If additional permissions apply only to part of the Program, that part may be used separately under those permissions, but the entire Program remains governed by this License without regard to the additional permissions.

When you convey a copy of a covered work, you may at your option remove any additional permissions from that copy, or from any part of it. (Additional permissions may be written to require their own removal in certain cases when you modify the work.) You may place additional permissions on material, added by you to a covered work, for which you have or can give appropriate copyright permission.

Notwithstanding any other provision of this License, for material you add to a covered work, you may (if authorized by the copyright holders of that material) supplement the terms of this License with terms:

- a) Disclaiming warranty or limiting liability differently from the terms of sections 15 and 16 of this License; or
- b) Requiring preservation of specified reasonable legal notices or author attributions in that material or in the Appropriate Legal Notices displayed by works containing it; or
- c) Prohibiting misrepresentation of the origin of that material, or requiring that modified versions of such material be marked in reasonable ways as different from the original version; or

- d) Limiting the use for publicity purposes of names of licensors or authors of the material; or
- e) Declining to grant rights under trademark law for use of some trade names, trademarks, or service marks; or
- f) Requiring indemnification of licensors and authors of that material by anyone who conveys the material (or modified versions of it) with contractual assumptions of liability to the recipient, for any liability that these contractual assumptions directly impose on those licensors and authors.

All other non-permissive additional terms are considered "further restrictions" within the meaning of section 10. If the Program as you received it, or any part of it, contains a notice stating that it is governed by this License along with a term that is a further restriction, you may remove that term. If a license document contains a further restriction but permits relicensing or conveying under this License, you may add to a covered work material governed by the terms of that license document, provided that the further restriction does not survive such relicensing or conveying.

If you add terms to a covered work in accord with this section, you must place, in the relevant source files, a statement of the additional terms that apply to those files, or a notice indicating where to find the applicable terms.

Additional terms, permissive or non-permissive, may be stated in the form of a separately written license, or stated as exceptions; the above requirements apply either way.

8. Termination.

You may not propagate or modify a covered work except as expressly provided under this License. Any attempt otherwise to propagate or modify it is void, and will automatically terminate your rights under this License (including any patent licenses granted under the third paragraph of section 11).

However, if you cease all violation of this License, then your

license from a particular copyright holder is reinstated (a) provisionally, unless and until the copyright holder explicitly and finally terminates your license, and (b) permanently, if the copyright holder fails to notify you of the violation by some reasonable means prior to 60 days after the cessation.

Moreover, your license from a particular copyright holder is reinstated permanently if the copyright holder notifies you of the violation by some reasonable means, this is the first time you have received notice of violation of this License (for any work) from that copyright holder, and you cure the violation prior to 30 days after your receipt of the notice.

Termination of your rights under this section does not terminate the licenses of parties who have received copies or rights from you under this License. If your rights have been terminated and not permanently reinstated, you do not qualify to receive new licenses for the same material under section 10.

9. Acceptance Not Required for Having Copies.

You are not required to accept this License in order to receive or run a copy of the Program. Ancillary propagation of a covered work occurring solely as a consequence of using peer-to-peer transmission to receive a copy likewise does not require acceptance. However, nothing other than this License grants you permission to propagate or modify any covered work. These actions infringe copyright if you do not accept this License. Therefore, by modifying or propagating a covered work, you indicate your acceptance of this License to do so.

10. Automatic Licensing of Downstream Recipients.

Each time you convey a covered work, the recipient automatically receives a license from the original licensors, to run, modify and propagate that work, subject to this License. You are not responsible for enforcing compliance by third parties with this License.

An "entity transaction" is a transaction transferring control of an organization, or substantially all assets of one, or subdividing an organization, or merging organizations. If propagation of a covered work results from an entity transaction, each party to that

transaction who receives a copy of the work also receives whatever licenses to the work the party's predecessor in interest had or could give under the previous paragraph, plus a right to possession of the Corresponding Source of the work from the predecessor in interest, if the predecessor has it or can get it with reasonable efforts.

You may not impose any further restrictions on the exercise of the rights granted or affirmed under this License. For example, you may not impose a license fee, royalty, or other charge for exercise of rights granted under this License, and you may not initiate litigation (including a cross-claim or counterclaim in a lawsuit) alleging that any patent claim is infringed by making, using, selling, offering for sale, or importing the Program or any portion of it.

11. Patents.

A "contributor" is a copyright holder who authorizes use under this License of the Program or a work on which the Program is based. The work thus licensed is called the contributor's "contributor version".

A contributor's "essential patent claims" are all patent claims owned or controlled by the contributor, whether already acquired or hereafter acquired, that would be infringed by some manner, permitted by this License, of making, using, or selling its contributor version, but do not include claims that would be infringed only as a consequence of further modification of the contributor version. For purposes of this definition, "control" includes the right to grant patent sublicenses in a manner consistent with the requirements of this License.

Each contributor grants you a non-exclusive, worldwide, royalty-free patent license under the contributor's essential patent claims, to make, use, sell, offer for sale, import and otherwise run, modify and propagate the contents of its contributor version.

In the following three paragraphs, a "patent license" is any express agreement or commitment, however denominated, not to enforce a patent (such as an express permission to practice a patent or covenant not to sue for patent infringement). To "grant" such a patent license to a party means to make such an agreement or commitment not to enforce a patent against the party.

If you convey a covered work, knowingly relying on a patent license, and the Corresponding Source of the work is not available for anyone to copy, free of charge and under the terms of this License, through a publicly available network server or other readily accessible means, then you must either (1) cause the Corresponding Source to be so available, or (2) arrange to deprive yourself of the benefit of the patent license for this particular work, or (3) arrange, in a manner consistent with the requirements of this License, to extend the patent license to downstream recipients. "Knowingly relying" means you have actual knowledge that, but for the patent license, your conveying the covered work in a country, or your recipient's use of the covered work in a country, would infringe one or more identifiable patents in that country that you have reason to believe are valid.

If, pursuant to or in connection with a single transaction or arrangement, you convey, or propagate by procuring conveyance of, a covered work, and grant a patent license to some of the parties receiving the covered work authorizing them to use, propagate, modify or convey a specific copy of the covered work, then the patent license you grant is automatically extended to all recipients of the covered work and works based on it.

A patent license is "discriminatory" if it does not include within the scope of its coverage, prohibits the exercise of, or is conditioned on the non-exercise of one or more of the rights that are specifically granted under this License. You may not convey a covered work if you are a party to an arrangement with a third party that is in the business of distributing software, under which you make payment to the third party based on the extent of your activity of conveying the work, and under which the third party grants, to any of the parties who would receive the covered work from you, a discriminatory patent license (a) in connection with copies of the covered work conveyed by you (or copies made from those copies), or (b) primarily for and in connection with specific products or compilations that contain the covered work, unless you entered into that arrangement, or that patent license was granted, prior to 28 March 2007.

Nothing in this License shall be construed as excluding or limiting any implied license or other defenses to infringement that may otherwise be available to you under applicable patent law.

12. No Surrender of Others' Freedom.

If conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot convey a covered work so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not convey it at all. For example, if you agree to terms that obligate you to collect a royalty for further conveying from those to whom you convey the Program, the only way you could satisfy both those terms and this License would be to refrain entirely from conveying the Program.

13. Use with the GNU Affero General Public License.

Notwithstanding any other provision of this License, you have permission to link or combine any covered work with a work licensed under version 3 of the GNU Affero General Public License into a single combined work, and to convey the resulting work. The terms of this License will continue to apply to the part which is the covered work, but the special requirements of the GNU Affero General Public License, section 13, concerning interaction through a network will apply to the combination as such.

14. Revised Versions of this License.

The Free Software Foundation may publish revised and/or new versions of the GNU General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Program specifies that a certain numbered version of the GNU General Public License "or any later version" applies to it, you have the option of following the terms and conditions either of that numbered version or of any later version published by the Free Software Foundation. If the Program does not specify a version number of the GNU General Public License, you may choose any version ever published by the Free Software Foundation.

If the Program specifies that a proxy can decide which future

versions of the GNU General Public License can be used, that proxy's public statement of acceptance of a version permanently authorizes you to choose that version for the Program.

Later license versions may give you additional or different permissions. However, no additional obligations are imposed on any author or copyright holder as a result of your choosing to follow a later version.

15. Disclaimer of Warranty.

THERE IS NO WARRANTY FOR THE PROGRAM, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. SHOULD THE PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

16. Limitation of Liability.

IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MODIFIES AND/OR CONVEYS THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER PROGRAMS),

EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

17. Interpretation of Sections 15 and 16.

If the disclaimer of warranty and limitation of liability provided above cannot be given local legal effect according to their terms, reviewing courts shall apply local law that most closely approximates an absolute waiver of all civil liability in connection with the Program, unless a warranty or assumption of liability accompanies a copy of the Program in return for a fee.

END OF TERMS AND CONDITIONS

How to Apply These Terms to Your New Programs

If you develop a new program, and you want it to be of the greatest possible use to the public, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms.

To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively state the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

<one line to give the program's name and a brief idea of what it does.>
Copyright (C) <year> <name of author>

This program is free software: you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation, either version 3 of the License, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

You should have received a copy of the GNU General Public License

along with this program. If not, see [<http://www.gnu.org/licenses/>](http://www.gnu.org/licenses/).

Also add information on how to contact you by electronic and paper mail.

If the program does terminal interaction, make it output a short notice like this when it starts in an interactive mode:

```
<program> Copyright (C) <year> <name of author>
```

```
This program comes with ABSOLUTELY NO WARRANTY; for details type  
'show w'.
```

```
This is free software, and you are welcome to redistribute it  
under certain conditions; type 'show c' for details.
```

The hypothetical commands `'show w'` and `'show c'` should show the appropriate parts of the General Public License. Of course, your program's commands might be different; for a GUI interface, you would use an "about box".

You should also get your employer (if you work as a programmer) or school, if any, to sign a "copyright disclaimer" for the program, if necessary. For more information on this, and how to apply and follow the GNU GPL, see [<http://www.gnu.org/licenses/>](http://www.gnu.org/licenses/).

The GNU General Public License does not permit incorporating your program into proprietary programs. If your program is a subroutine library, you may consider it more useful to permit linking proprietary applications with the library. If this is what you want to do, use the GNU Lesser General Public License instead of this License. But first, please read [<http://www.gnu.org/philosophy/why-not-lgpl.html>](http://www.gnu.org/philosophy/why-not-lgpl.html).

GNU Lesser General Public License, LGPL V2.1

GNU LESSER GENERAL PUBLIC LICENSE

Version 2.1, February 1999

Copyright (C) 1991, 1999 Free Software Foundation, Inc.
51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA
Everyone is permitted to copy and distribute verbatim copies
of this license document, but changing it is not allowed.

[This is the first released version of the Lesser GPL. It also counts
as the successor of the GNU Library Public License, version 2, hence

the version number 2.1.]

Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public Licenses are intended to guarantee your freedom to share and change free software--to make sure the software is free for all its users.

This license, the Lesser General Public License, applies to some specially designated software packages--typically libraries--of the Free Software Foundation and other authors who decide to use it. You can use it too, but we suggest you first think carefully about whether this license or the ordinary General Public License is the better strategy to use in any particular case, based on the explanations below.

When we speak of free software, we are referring to freedom of use, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish); that you receive source code or can get it if you want it; that you can change the software and use pieces of it in new free programs; and that you are informed that you can do these things.

To protect your rights, we need to make restrictions that forbid distributors to deny you these rights or to ask you to surrender these rights. These restrictions translate to certain responsibilities for you if you distribute copies of the library or if you modify it.

For example, if you distribute copies of the library, whether gratis or for a fee, you must give the recipients all the rights that we gave you. You must make sure that they, too, receive or can get the source code. If you link other code with the library, you must provide complete object files to the recipients, so that they can relink them with the library after making changes to the library and recompiling it. And you must show them these terms so they know their rights.

We protect your rights with a two-step method: (1) we copyright the library, and (2) we offer you this license, which gives you legal permission to copy, distribute and/or modify the library.

To protect each distributor, we want to make it very clear that there is no warranty for the free library. Also, if the library is modified by someone else and passed on, the recipients should know that what they have is not the original version, so that the original author's reputation will not be affected by problems that might be introduced by others.

Finally, software patents pose a constant threat to the existence of any free program. We wish to make sure that a company cannot effectively restrict the users of a free program by obtaining a restrictive license from a patent holder. Therefore, we insist that any patent license obtained for a version of the library must be consistent with the full freedom of use specified in this license.

Most GNU software, including some libraries, is covered by the ordinary GNU General Public License. This license, the GNU Lesser General Public License, applies to certain designated libraries, and is quite different from the ordinary General Public License. We use this license for certain libraries in order to permit linking those libraries into non-free programs.

When a program is linked with a library, whether statically or using a shared library, the combination of the two is legally speaking a combined work, a derivative of the original library. The ordinary General Public License therefore permits such linking only if the entire combination fits its criteria of freedom. The Lesser General Public License permits more lax criteria for linking other code with the library.

We call this license the "Lesser" General Public License because it does Less to protect the user's freedom than the ordinary General Public License. It also provides other free software developers Less of an advantage over competing non-free programs. These disadvantages are the reason we use the ordinary General Public License for many libraries. However, the Lesser license provides advantages in certain special circumstances.

For example, on rare occasions, there may be a special need to encourage the widest possible use of a certain library, so that it becomes a de-facto standard. To achieve this, non-free programs must be allowed to use the library. A more frequent case is that a free

library does the same job as widely used non-free libraries. In this case, there is little to gain by limiting the free library to free software only, so we use the Lesser General Public License.

In other cases, permission to use a particular library in non-free programs enables a greater number of people to use a large body of free software. For example, permission to use the GNU C Library in non-free programs enables many more people to use the whole GNU operating system, as well as its variant, the GNU/Linux operating system.

Although the Lesser General Public License is Less protective of the users' freedom, it does ensure that the user of a program that is linked with the Library has the freedom and the wherewithal to run that program using a modified version of the Library.

The precise terms and conditions for copying, distribution and modification follow. Pay close attention to the difference between a "work based on the library" and a "work that uses the library". The former contains code derived from the library, whereas the latter must be combined with the library in order to run.

GNU LESSER GENERAL PUBLIC LICENSE

TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0. This License Agreement applies to any software library or other program which contains a notice placed by the copyright holder or other authorized party saying it may be distributed under the terms of this Lesser General Public License (also called "this License"). Each licensee is addressed as "you".

A "library" means a collection of software functions and/or data prepared so as to be conveniently linked with application programs (which use some of those functions and data) to form executables.

The "Library", below, refers to any such software library or work which has been distributed under these terms. A "work based on the Library" means either the Library or any derivative work under copyright law: that is to say, a work containing the Library or a portion of it, either verbatim or with modifications and/or translated

straightforwardly into another language. (Hereinafter, translation is included without limitation in the term "modification".)

"Source code" for a work means the preferred form of the work for making modifications to it. For a library, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the library.

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running a program using the Library is not restricted, and output from such a program is covered only if its contents constitute a work based on the Library (independent of the use of the Library in a tool for writing it). Whether that is true depends on what the Library does and what the program that uses the Library does.

1. You may copy and distribute verbatim copies of the Library's complete source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and distribute a copy of this License along with the Library.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

2. You may modify your copy or copies of the Library or any portion of it, thus forming a work based on the Library, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:

- a) The modified work must itself be a software library.
- b) You must cause the files modified to carry prominent notices stating that you changed the files and the date of any change.
- c) You must cause the whole of the work to be licensed at no charge to all third parties under the terms of this License.

d) If a facility in the modified Library refers to a function or a table of data to be supplied by an application program that uses the facility, other than as an argument passed when the facility is invoked, then you must make a good faith effort to ensure that, in the event an application does not supply such function or table, the facility still operates, and performs whatever part of its purpose remains meaningful.

(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Library, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Library.

In addition, mere aggregation of another work not based on the Library with the Library (or with a work based on the Library) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

3. You may opt to apply the terms of the ordinary GNU General Public License instead of this License to a given copy of the Library. To do this, you must alter all the notices that refer to this License, so that they refer to the ordinary GNU General Public License, version 2,

instead of to this License. (If a newer version than version 2 of the ordinary GNU General Public License has appeared, then you can specify that version instead if you wish.) Do not make any other change in these notices.

Once this change is made in a given copy, it is irreversible for that copy, so the ordinary GNU General Public License applies to all subsequent copies and derivative works made from that copy.

This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

4. You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

5. A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a "work that uses the Library". Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

However, linking a "work that uses the Library" with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a "work that uses the library". The executable is therefore covered by this License. Section 6 states terms for distribution of such executables.

When a "work that uses the Library" uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be

linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

6. As an exception to the Sections above, you may also combine or link a "work that uses the Library" with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer's own use and reverse engineering for debugging such modifications.

You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

a) Accompany the work with the complete corresponding machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable "work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

b) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.

c) Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.

d) If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.

e) Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

For an executable, the required form of the "work that uses the Library" must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

It may happen that this requirement contradicts the license restrictions of other proprietary libraries that do not normally accompany the operating system. Such a contradiction means you cannot use both them and the Library together in an executable that you distribute.

7. You may place library facilities that are a work based on the Library side-by-side in a single library together with other library facilities not covered by this License, and distribute such a combined library, provided that the separate distribution of the work based on the Library and of the other library facilities is otherwise

permitted, and provided that you do these two things:

- a) Accompany the combined library with a copy of the same work based on the Library, uncombined with any other library facilities. This must be distributed under the terms of the Sections above.
- b) Give prominent notice with the combined library of the fact that part of it is a work based on the Library, and explaining where to find the accompanying uncombined form of the same work.

8. You may not copy, modify, sublicense, link with, or distribute the Library except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense, link with, or distribute the Library is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

9. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Library or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Library (or any work based on the Library), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Library or works based on it.

10. Each time you redistribute the Library (or any work based on the Library), the recipient automatically receives a license from the original licensor to copy, distribute, link with or modify the Library subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties with this License.

11. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot

distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Library at all. For example, if a patent license would not permit royalty-free redistribution of the Library by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Library.

If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply, and the section as a whole is intended to apply in other circumstances.

It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

12. If the distribution and/or use of the Library is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Library under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.

13. The Free Software Foundation may publish revised and/or new versions of the Lesser General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Library specifies a version number of this License which applies to it and

"any later version", you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Library does not specify a license version number, you may choose any version ever published by the Free Software Foundation.

14. If you wish to incorporate parts of the Library into other free programs whose distribution conditions are incompatible with these, write to the author to ask for permission. For software which is copyrighted by the Free Software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this. Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

NO WARRANTY

15. BECAUSE THE LIBRARY IS LICENSED FREE OF CHARGE, THERE IS NO

WARRANTY FOR THE LIBRARY, TO THE EXTENT PERMITTED BY APPLICABLE LAW.

EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR

OTHER PARTIES PROVIDE THE LIBRARY "AS IS" WITHOUT WARRANTY OF ANY

KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE

IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR

PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE

LIBRARY IS WITH YOU. SHOULD THE LIBRARY PROVE DEFECTIVE, YOU ASSUME

THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

16. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN

WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY

AND/OR REDISTRIBUTE THE LIBRARY AS PERMITTED ABOVE, BE LIABLE TO YOU

FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR

CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE
LIBRARY (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING
RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A
FAILURE OF THE LIBRARY TO OPERATE WITH ANY OTHER SOFTWARE), EVEN IF
SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH
DAMAGES.

END OF TERMS AND CONDITIONS

How to Apply These Terms to Your New Libraries

If you develop a new library, and you want it to be of the greatest possible use to the public, we recommend making it free software that everyone can redistribute and change. You can do so by permitting redistribution under these terms (or, alternatively, under the terms of the ordinary General Public License).

To apply these terms, attach the following notices to the library. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

<one line to give the library's name and a brief idea of what it does.>
Copyright (C) <year> <name of author>

This library is free software; you can redistribute it and/or modify it under the terms of the GNU Lesser General Public License as published by the Free Software Foundation; either version 2.1 of the License, or (at your option) any later version.

This library is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU Lesser General Public License for more details.

You should have received a copy of the GNU Lesser General Public

License along with this library; if not, write to the Free Software Foundation, Inc., 51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA

Also add information on how to contact you by electronic and paper mail.

You should also get your employer (if you work as a programmer) or your school, if any, to sign a "copyright disclaimer" for the library, if necessary. Here is a sample; alter the names:

Yoyodyne, Inc., hereby disclaims all copyright interest in the library 'Frob' (a library for tweaking knobs) written by James Random Hacker.

<signature of Ty Coon>, 1 April 1990
Ty Coon, President of Vice

That's all there is to it!

GNU LESSER GENERAL PUBLIC LICENSE

This product includes the library QCustomPlot under the terms of the GNU Lesser General Public License (LGPL). Also is it needed to have the GPL and the LGPL licenses included in the product. It is possible to download the licenses in different formats at <http://www.gnu.org/licenses/licenses.html>

GNU LESSER GENERAL PUBLIC LICENSE

Version 3, 29 June 2007

Copyright (C) 2007 Free Software Foundation, Inc. <<http://fsf.org/>>

Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

This version of the GNU Lesser General Public License incorporates the terms and conditions of version 3 of the GNU General Public License, supplemented by the additional permissions listed below.

0. Additional Definitions.

As used herein, "this License" refers to version 3 of the GNU Lesser General Public License, and the "GNU GPL" refers to version 3 of the GNU General Public License.

"The Library" refers to a covered work governed by this License, other than an Application or a Combined Work as defined below.

An "Application" is any work that makes use of an interface provided by the Library, but which is not otherwise based on the Library.

Defining a subclass of a class defined by the Library is deemed a mode of using an interface provided by the Library.

A "Combined Work" is a work produced by combining or linking an Application with the Library. The particular version of the Library with which the Combined Work was made is also called the "Linked Version".

The "Minimal Corresponding Source" for a Combined Work means the Corresponding Source for the Combined Work, excluding any source code for portions of the Combined Work that, considered in isolation, are based on the Application, and not on the Linked Version.

The "Corresponding Application Code" for a Combined Work means the object code and/or source code for the Application, including any data and utility programs needed for reproducing the Combined Work from the Application, but excluding the System Libraries of the Combined Work.

1. Exception to Section 3 of the GNU GPL.

You may convey a covered work under sections 3 and 4 of this License without being bound by section 3 of the GNU GPL.

2. Conveying Modified Versions.

If you modify a copy of the Library, and, in your modifications, a facility refers to a function or data to be supplied by an Application that uses the facility (other than as an argument passed when the facility is invoked), then you may convey a copy of the modified version:

- a) under this License, provided that you make a good faith effort to ensure that, in the event an Application does not supply the function or data, the facility still operates, and performs whatever part of its purpose remains meaningful, or
- b) under the GNU GPL, with none of the additional permissions of this License applicable to that copy.

3. Object Code Incorporating Material from Library Header Files.

The object code form of an Application may incorporate material from a header file that is part of the Library. You may convey such object code under terms of your choice, provided that, if the incorporated material is not limited to numerical parameters, data structure layouts and accessors, or small macros, inline functions and templates (ten or fewer lines in length), you do both of the following:

- a) Give prominent notice with each copy of the object code that the Library is used in it and that the Library and its use are covered by this License.
- b) Accompany the object code with a copy of the GNU GPL and this license document.

4. Combined Works.

You may convey a Combined Work under terms of your choice that, taken together, effectively do not restrict modification of the portions of the Library contained in the Combined Work and reverse engineering for debugging such modifications, if you also do each of the following:

- a) Give prominent notice with each copy of the Combined Work that the Library is used in it and that the Library and its use are covered by this License.
- b) Accompany the Combined Work with a copy of the GNU GPL and this license document.
- c) For a Combined Work that displays copyright notices during execution, include the copyright notice for the Library among these notices, as well as a reference directing the user to the copies of the GNU GPL and this license document.
- d) Do one of the following:

- 0) Convey the Minimal Corresponding Source under the terms of this License, and the Corresponding Application Code in a form suitable for, and under terms that permit, the user to recombine or relink the Application with a modified version of the Linked Version to produce a modified Combined Work, in the manner specified by section 6 of the GNU GPL for conveying Corresponding Source.
- 1) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (a) uses at run time a copy of the Library already present on the user's computer system, and (b) will operate properly with a modified version of the Library that is interface-compatible with the Linked Version.

e) Provide Installation Information, but only if you would otherwise be required to provide such information under section 6 of the GNU GPL, and only to the extent that such information is necessary to install and execute a modified version of the Combined Work produced by recombining or relinking the Application with a modified version of the Linked Version. (If you use option 4d0, the Installation Information must accompany the Minimal Corresponding Source and Corresponding Application Code. If you use option 4d1, you must provide the Installation Information in the manner specified by section 6 of the GNU GPL for conveying Corresponding Source.)

5. Combined Libraries.

You may place library facilities that are a work based on the Library side by side in a single library together with other library facilities that are not Applications and are not covered by this License, and convey such a combined library under terms of your choice, if you do both of the following:

- a) Accompany the combined library with a copy of the same work based on the Library, uncombined with any other library facilities, conveyed under the terms of this License.
- b) Give prominent notice with the combined library that part of it is a work based on the Library, and explaining where to find the accompanying uncombined form of the same work.

6. Revised Versions of the GNU Lesser General Public License.

The Free Software Foundation may publish revised and/or new versions of the GNU Lesser General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Library as you received it specifies that a certain numbered version of the GNU Lesser General Public License "or any later version" applies to it, you have the option of following the terms and conditions either of that published version or of any later version published by the Free Software Foundation. If the Library as you received it does not specify a version number of the GNU Lesser General Public License, you may choose any version of the GNU Lesser General Public License ever published by the Free Software Foundation.

If the Library as you received it specifies that a proxy can decide whether future versions of the GNU Lesser General Public License shall apply, that proxy's public statement of acceptance of any version is permanent authorization for you to choose that version for the Library.

ICU Software License

```
<html>
```

```
<head>
```

```
<meta http-equiv="Content-Type" content="text/html; charset=us-ascii"></meta>
```

```
<title>ICU License - ICU 1.8.1 and later</title>
```

```
</head>
```

```
<body>
```

```
<h1>ICU License - ICU 1.8.1 and later</h1>
```

```
<pre>
```

COPYRIGHT AND PERMISSION NOTICE

Copyright (c) 1995-2005 International Business Machines Corporation and others

All rights reserved.

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, provided that the above copyright notice(s) and this permission notice appear in all copies of the Software and that both the above copyright notice(s) and this permission notice appear in supporting documentation.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT OF THIRD PARTY RIGHTS. IN NO EVENT SHALL THE COPYRIGHT HOLDER OR HOLDERS INCLUDED IN THIS NOTICE BE LIABLE FOR ANY CLAIM, OR ANY SPECIAL INDIRECT OR CONSEQUENTIAL DAMAGES, OR ANY DAMAGES WHATSOEVER RESULTING FROM LOSS OF USE, DATA OR PROFITS, WHETHER IN AN ACTION OF CONTRACT,

NEGLIGENCE OR OTHER TORTIOUS ACTION, ARISING OUT OF OR IN CONNECTION

WITH THE USE OR PERFORMANCE OF THIS SOFTWARE.

Except as contained in this notice, the name of a copyright holder shall not be used in advertising or otherwise to promote the sale, use or other dealings in this Software without prior written authorization of the copyright holder.

All trademarks and registered trademarks mentioned herein are the property of their respective owners.

</pre>

</body>

</html>

Libpng License

This copy of the libpng notices is provided for your convenience. In case of any discrepancy between this copy and the notices in the file png.h that is included in the libpng distribution, the latter shall prevail.

COPYRIGHT NOTICE, DISCLAIMER, and LICENSE:

If you modify libpng you may insert additional notices immediately following this sentence.

libpng versions 1.2.6, August 15, 2004, through 1.2.35, February 14, 2009, are Copyright (c) 2004, 2006-2008 Glenn Randers-Pehrson, and are distributed according to the same disclaimer and license as libpng-1.2.5 with the following individual added to the list of Contributing Authors

Cosmin Truta

libpng versions 1.0.7, July 1, 2000, through 1.2.5 - October 3, 2002, are Copyright (c) 2000-2002 Glenn Randers-Pehrson, and are distributed according to the same disclaimer and license as libpng-1.0.6 with the following individuals added to the list of Contributing Authors

Simon-Pierre Cadieux
Eric S. Raymond
Gilles Vollant

and with the following additions to the disclaimer:

There is no warranty against interference with your enjoyment of the library or against infringement. There is no warranty that our efforts or the library will fulfill any of your particular purposes or needs. This library is provided with all faults, and the entire risk of satisfactory quality, performance, accuracy, and effort is with the user.

libpng versions 0.97, January 1998, through 1.0.6, March 20, 2000, are Copyright (c) 1998, 1999 Glenn Randers-Pehrson, and are distributed according to the same disclaimer and license as libpng-0.96, with the following individuals added to the list of Contributing Authors:

Tom Lane
Glenn Randers-Pehrson
Willem van Schaik

libpng versions 0.89, June 1996, through 0.96, May 1997, are Copyright (c) 1996, 1997 Andreas Dilger
Distributed according to the same disclaimer and license as libpng-0.88, with the following individuals added to the list of Contributing Authors:

John Bowler
Kevin Bracey
Sam Bushell
Magnus Holmgren
Greg Roelofs
Tom Tanner

libpng versions 0.5, May 1995, through 0.88, January 1996, are Copyright (c) 1995, 1996 Guy Eric Schalnat, Group 42, Inc.

For the purposes of this copyright and license, "Contributing Authors" is defined as the following set of individuals:

Andreas Dilger

Dave Martindale
Guy Eric Schalnat
Paul Schmidt
Tim Wegner

The PNG Reference Library is supplied "AS IS". The Contributing Authors and Group 42, Inc. disclaim all warranties, expressed or implied, including, without limitation, the warranties of merchantability and of fitness for any purpose. The Contributing Authors and Group 42, Inc. assume no liability for direct, indirect, incidental, special, exemplary, or consequential damages, which may result from the use of the PNG Reference Library, even if advised of the possibility of such damage.

Permission is hereby granted to use, copy, modify, and distribute this source code, or portions hereof, for any purpose, without fee, subject to the following restrictions:

1. The origin of this source code must not be misrepresented.
2. Altered versions must be plainly marked as such and must not be misrepresented as being the original source.
3. This Copyright notice may not be removed or altered from any source or altered source distribution.

The Contributing Authors and Group 42, Inc. specifically permit, without fee, and encourage the use of this source code as a component to supporting the PNG file format in commercial products. If you use this source code in a product, acknowledgment is not required but would be appreciated.

A "png_get_copyright" function is available, for convenient use in "about" boxes and the like:

```
printf("%s",png_get_copyright(NULL));
```

Also, the PNG logo (in PNG format, of course) is supplied in the files "pngbar.png" and "pngbar.jpg (88x31) and "pngnow.png" (98x31).

Libpng is OSI Certified Open Source Software. OSI Certified Open Source is a

certification mark of the Open Source Initiative.

Glenn Randers-Pehrson

glennrp at users.sourceforge.net

February 14, 2009

MIT Software License

The MIT License (MIT)

Copyright (c) <year> <copyright holders>

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

Ntp Software License

This file is automatically generated from html/copyright.html

Copyright Notice

jpg "Clone me," says Dolly sheepishly.

Last update: 1-Jan-2011 08:34 UTC

—

The following copyright notice applies to all files collectively called the Network Time Protocol Version 4 Distribution. Unless

specifically declared otherwise in an individual file, this notice applies as if the text was explicitly included in the file.

* *

* Copyright (c) University of Delaware 1992-2011 *

* *

* Permission to use, copy, modify, and distribute this software and *

* its documentation for any purpose with or without fee is hereby *

* granted, provided that the above copyright notice appears in all *

* copies and that both the copyright notice and this permission *

* notice appear in supporting documentation, and that the name *

* University of Delaware not be used in advertising or publicity *

* pertaining to distribution of the software without specific, *

* written prior permission. The University of Delaware makes no *

* representations about the suitability this software for any *

* purpose. It is provided "as is" without express or implied *

* warranty. *

* *

The following individuals contributed in part to the Network Time Protocol Distribution Version 4 and are acknowledged as authors of this work.

1. [1]Takao Abe <takao_abe@xurb.jp> Clock driver for JJY receivers

2. [2]Mark Andrews <mark_andrews@isc.org> Leitch atomic clock controller

3. [3]Bernd Altmeier <altmeier@atlsoft.de> hopf Elektronik serial line and PCI-bus devices

4. [4]Viraj Bais <vbais@mailman1.intel.com> and [5]Clayton Kirkwood <kirkwood@striderfm.intel.com> port to WindowsNT 3.5

5. [6]Michael Barone <michael_barone@lmco.com> GPSVME fixes

6. [7]Karl Berry <karl@owl.HQ.ileaf.com> syslog to file option

7. [8]Greg Brackley <greg.brackley@bigfoot.com> Major rework of WINNT port. Clean up recvbuf and iosignal code into separate modules.

8. [9]Marc Brett <Marc.Brett@westgeo.com> Magnavox GPS clock driver

9. [10]Piete Brooks <Piete.Brooks@cl.cam.ac.uk> MSF clock driver, Trimble PARSE support

10. [11]Nelson B Bolyard <nelson@bolyard.me> update and complete broadcast and crypto features in snTP

11. [12]Jean-Francois Boudreault
<Jean-Francois.Boudreault@viagenie.qc.ca> IPv6 support
12. [13]Reg Clemens <reg@dwf.com> Oncore driver (Current maintainer)
13. [14]Steve Clift <clift@ml.csiro.au> OMEGA clock driver
14. [15]Casey Crellin <casey@csc.co.za> vxWorks (Tornado) port and help with target configuration
15. [16]Sven Dietrich <sven_dietrich@trimble.com> Palisade reference clock driver, NT adj. residuals, integrated Greg's Winnt port.
16. [17]John A. Dundas III <dundas@salt.jpl.nasa.gov> Apple A/UX port
17. [18]Torsten Duwe <duwe@immd4.informatik.uni-erlangen.de> Linux port
18. [19]Dennis Ferguson <dennis@mrbill.canet.ca> foundation code for NTP Version 2 as specified in RFC-1119
19. [20]John Hay <jhay@icomtek.csiro.co.za> IPv6 support and testing
20. [21]Dave Hart <davehart@davehart.com> General maintenance, Windows port interpolation rewrite
21. [22]Claas Hilbrecht <neoclock4x@linum.com> NeoClock4X clock driver
22. [23]Glenn Hollinger <glenn@herald.usask.ca> GOES clock driver
23. [24]Mike Iglesias <iglesias@uci.edu> DEC Alpha port
24. [25]Jim Jagielski <jim@jagubox.gsfc.nasa.gov> A/UX port
25. [26]Jeff Johnson <jbj@chatham.usdesign.com> massive prototyping overhaul
26. [27]Hans Lambermont <Hans.Lambermont@nl.origin-it.com> or [28]<H.Lambermont@chello.nl> ntpswEEP
27. [29]Poul-Henning Kamp <phk@FreeBSD.ORG> Oncore driver (Original author)
28. [30]Frank Kardel [31]<kardel (at) ntp (dot) org> PARSE <GENERIC> driver (>14 reference clocks), STREAMS modules for PARSE, support scripts, syslog cleanup, dynamic interface handling
29. [32]William L. Jones <jones@hermes.chpc.utexas.edu> RS/6000 AIX modifications, HP-UX modifications
30. [33]Dave Katz <dkatz@cisco.com> RS/6000 AIX port
31. [34]Craig Leres <leres@ee.lbl.gov> 4.4BSD port, ppsclock, Magnavox GPS clock driver
32. [35]George Lindholm <lindholm@ucs.ubc.ca> SunOS 5.1 port
33. [36]Louis A. Mamakos <louie@ni.umd.edu> MD5-based authentication
34. [37]Lars H. Mathiesen <thorinn@diku.dk> adaptation of foundation code for Version 3 as specified in RFC-1305
35. [38]Danny Mayer <mayer@ntp.org> Network I/O, Windows Port, Code Maintenance
36. [39]David L. Mills <mills@udel.edu> Version 4 foundation: clock

discipline, authentication, precision kernel; clock drivers:

Spectracom, Austron, Arbiter, Heath, ATOM, ACTS, KSI/Odetics;

audio clock drivers: CHU, WWV/H, IRIG

37. [40]Wolfgang Moeller <moeller@gwdgv1.dnet.gwdg.de> VMS port

38. [41]Jeffrey Mogul <mogul@pa.dec.com> ntptrace utility

39. [42]Tom Moore <tmoore@fievel.daytonoh.ncr.com> i386 svr4 port

40. [43]Kamal A Mostafa <kamal@whence.com> SCO OpenServer port

41. [44]Derek Mulcahy <derek@toybox.demon.co.uk> and [45]Damon

Hart-Davis <d@hd.org> ARCRON MSF clock driver

42. [46]Rob Neal <neal@ntp.org> Bancomm refclock and config/parse code maintenance

43. [47]Rainer Pruy <Rainer.Pruy@informatik.uni-erlangen.de>

monitoring/trap scripts, statistics file handling

44. [48]Dirce Richards <dirce@zk3.dec.com> Digital UNIX V4.0 port

45. [49]Wilfredo Sánchez <wsanchez@apple.com> added support for NetInfo

46. [50]Nick Sayer <mrapple@quack.kfu.com> SunOS streams modules

47. [51]Jack Sasportas <jack@innovativeinternet.com> Saved a Lot of space on the stuff in the html/pic/ subdirectory

48. [52]Ray Schnitzler <schnitz@unipress.com> Unixware1 port

49. [53]Michael Shields <shields@tembel.org> USNO clock driver

50. [54]Jeff Steinman <jss@pebbles.jpl.nasa.gov> Datum PTS clock driver

51. [55]Harlan Stenn <harlan@pfcs.com> GNU automake/autoconfigure makeover, various other bits (see the ChangeLog)

52. [56]Kenneth Stone <ken@sdd.hp.com> HP-UX port

53. [57]Ajit Thyagarajan <ajit@ee.udel.edu> IP multicast/anycast support

54. [58]Tomoaki TSURUOKA <tsuruoka@nc.fukuoka-u.ac.jp> TRAK clock driver

55. [59]Paul A Vixie <vixie@vix.com> TrueTime GPS driver, generic TrueTime clock driver

56. [60]Ulrich Windl <Ulrich.Windl@rz.uni-regensburg.de> corrected and validated HTML documents according to the HTML DTD

References

1. mailto:%20takao_abe@xurb.jp

2. mailto:%20mark_andrews@isc.org
3. <mailto:%20altmeier@atlsoft.de>
4. <mailto:%20vbais@mailman1.intel.co>
5. <mailto:%20kirkwood@striderfm.intel.com>
6. <mailto:%20michael.barone@lmco.com>
7. <mailto:%20karl@owl.HQ.ileaf.com>
8. <mailto:%20greg.brackley@bigfoot.com>
9. <mailto:%20Marc.Brett@westgeo.com>
10. <mailto:%20Piete.Brooks@cl.cam.ac.uk>
11. <mailto:%20nelson@bolyard.me>
12. <mailto:%20Jean-Francois.Boudreault@viagenie.qc.ca>
13. <mailto:%20reg@dwf.com>
14. <mailto:%20clift@ml.csiro.au>
15. <mailto:casey@csc.co.za>
16. mailto:%20Sven_Dietrich@trimble.COM
17. <mailto:%20dundas@salt.jpl.nasa.gov>
18. <mailto:%20duwe@immd4.informatik.uni-erlangen.de>
19. <mailto:%20dennis@mrbill.canet.ca>
20. <mailto:%20jhay@icomtek.csir.co.za>
21. <mailto:%20davehart@davehart.com>
22. <mailto:%20neoclock4x@linum.com>
23. <mailto:%20glenn@herald.usask.ca>
24. <mailto:%20iglesias@uci.edu>
25. <mailto:%20jagubox.gsfc.nasa.gov>
26. <mailto:%20bjbj@chatham.usdesign.com>
27. <mailto:Hans.Lambermont@nl.origin-it.com>
28. <mailto:H.Lambermont@chello.nl>
29. <mailto:%20phk@FreeBSD.ORG>
30. <http://www4.informatik.uni-erlangen.de/%7ekardel>
31. [mailto:%20kardel\(at\)ntp\(dot\)org](mailto:%20kardel(at)ntp(dot)org)
32. <mailto:%20jones@hermes.chpc.utexas.edu>
33. <mailto:%20dkatz@cisco.com>
34. <mailto:%20leres@ee.lbl.gov>
35. <mailto:%20lindholm@ucs.ubc.ca>
36. <mailto:%20louie@ni.umd.edu>
37. <mailto:%20thorinn@diku.dk>
38. <mailto:%20mayer@ntp.org>
39. <mailto:%20mills@udel.edu>
40. <mailto:%20moeller@gwdgv1.dnet.gwdg.de>
41. <mailto:%20mogul@pa.dec.com>
42. <mailto:%20tmoore@fivel.daytonoh.ncr.com>

43. <mailto:%20kamal@whence.com>
44. <mailto:%20derek@toybox.demon.co.uk>
45. <mailto:%20d@hd.org>
46. <mailto:%20neal@ntp.org>
47. <mailto:%20Rainer.Pruy@informatik.uni-erlangen.de>
48. <mailto:%20dirce@zk3.dec.com>
49. <mailto:%20wsanchez@apple.com>
50. <mailto:%20mrapple@quack.kfu.com>
51. <mailto:%20jack@innovativeinternet.com>
52. <mailto:%20schnitz@unipress.com>
53. <mailto:%20shields@tembel.org>
54. <mailto:%20pebbles.jpl.nasa.gov>
55. <mailto:%20harlan@pfcs.com>
56. <mailto:%20ken@sdd.hp.com>
57. <mailto:%20ajit@ee.udel.edu>
58. <mailto:%20tsuruoka@nc.fukuoka-u.ac.jp>
59. <mailto:%20vixie@vix.com>
60. <mailto:%20Ulrich.Windl@rz.uni-regensburg.de>

PD Software License

This license was copied from PD-V0.35, it may have been changed so for precise license have a look at the distribution

This software is copyrighted by Miller Puckette and others. The following terms apply to all files associated with the software unless explicitly disclaimed in individual files.

The authors hereby grant permission to use, copy, modify, distribute, and license this software and its documentation for any purpose, provided that existing copyright notices are retained in all copies and that this notice is included verbatim in any distributions. No written agreement, license, or royalty fee is required for any of the authorized uses. Modifications to this software may be copyrighted by their authors and need not follow the licensing terms described here, provided that the new terms are clearly indicated on the first page of each file where they apply.

IN NO EVENT SHALL THE AUTHORS OR DISTRIBUTORS BE LIABLE TO ANY PARTY FOR DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF THIS SOFTWARE, ITS DOCUMENTATION, OR ANY DERIVATIVES THEREOF, EVEN IF THE AUTHORS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

THE AUTHORS AND DISTRIBUTORS SPECIFICALLY DISCLAIM ANY WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT. THIS SOFTWARE IS PROVIDED

ON AN "AS IS" BASIS, AND THE AUTHORS AND DISTRIBUTORS HAVE NO OBLIGATION TO PROVIDE MAINTENANCE, SUPPORT, UPDATES, ENHANCEMENTS, OR MODIFICATIONS.

RESTRICTED RIGHTS: Use, duplication or disclosure by the government is subject to the restrictions as set forth in subparagraph (c) (1) (ii) of the Rights in Technical Data and Computer Software Clause as DFARS 252.227-7013 and FAR 52.227-19.

zlib Software License

/* zlib.h -- interface of the 'zlib' general purpose compression library version 1.2.8, April 28th, 2013

Copyright (C) 1995-2013 Jean-loup Gailly and Mark Adler

This software is provided 'as-is', without any express or implied warranty. In no event will the authors be held liable for any damages arising from the use of this software.

Permission is granted to anyone to use this software for any purpose, including commercial applications, and to alter it and redistribute it freely, subject to the following restrictions:

1. The origin of this software must not be misrepresented; you must not claim that you wrote the original software. If you use this software in a product, an acknowledgment in the product documentation would be appreciated but is not required.
2. Altered source versions must be plainly marked as such, and must not be misrepresented as being the original software.
3. This notice may not be removed or altered from any source distribution.

Jean-loup Gailly Mark Adler

jloup@gzip.org madler@alumni.caltech.edu

*/

Original instructions



**Atlas Copco Industrial
Technique AB**
SE-10523 STOCKHOLM
Sweden
Telephone: +46 8 743 95 00
Telefax: +46 8 644 90 45
www.atlascopco.com

© Copyright 2018, Atlas Copco Industrial Technique AB. All rights reserved. Any unauthorized use or copying of the contents or part thereof is prohibited. This applies in particular to trademarks, model denominations, part numbers and drawings. Use only authorized parts. Any damage or malfunction caused by the use of unauthorized parts is not covered by Warranty or Product Liability.

Out of respect to wildlife and nature, our technical literature is printed on environmentally friendly paper.