Functional and Technical Description PowerMACS 4000

Contents

1 Document history

2007-05-07 First Edition
2007-05-09 Naming of Secondary TC and description of external 24V changed
2007-05-21 Description of external 24V changed
2007-07-30 Changed power connector type
2007-09-28 Removed incorrect TC dimensional drawings
2007-10-18 Changed info about Serial 2
2008-01-16 E-stop chapter moved to AHB System design and installation guide.
2008-05-22 Changed input power from 500W to 250W, added DigIN connector for rev D TCs 7.1 Fixed some errors.
2008-11-07 Added picture of connector labels, fixed some errors. Changed section External Power Supply Input.
2013-02-23 Changed technical data.

2 Introduction

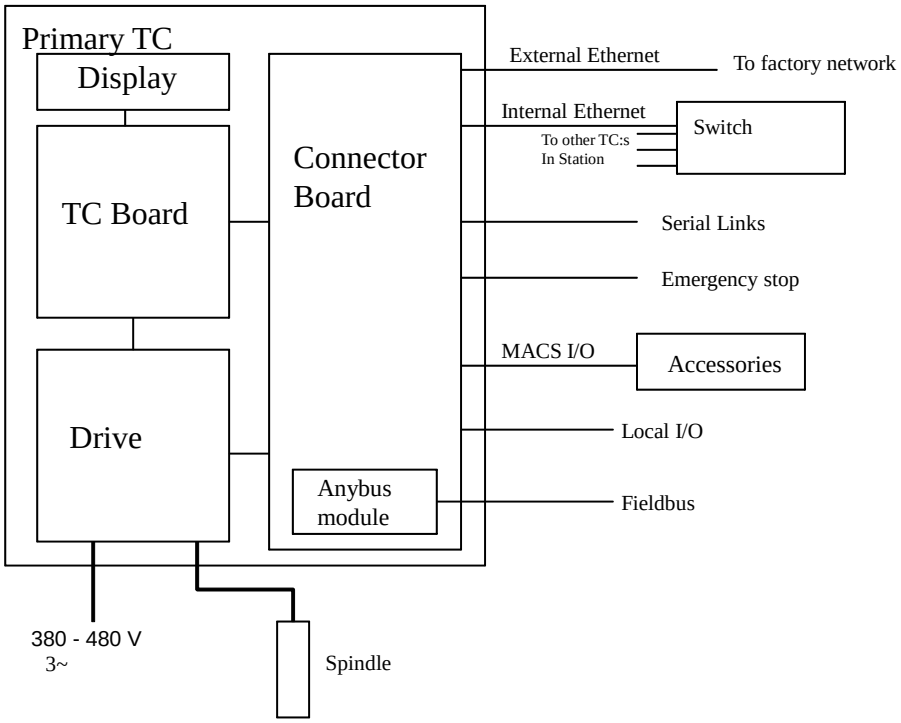
2.1 Overview

The PowerMACS 4000 Tightening Controller (TC) is designed for use with the Atlas Copco nutrunner spindles only.

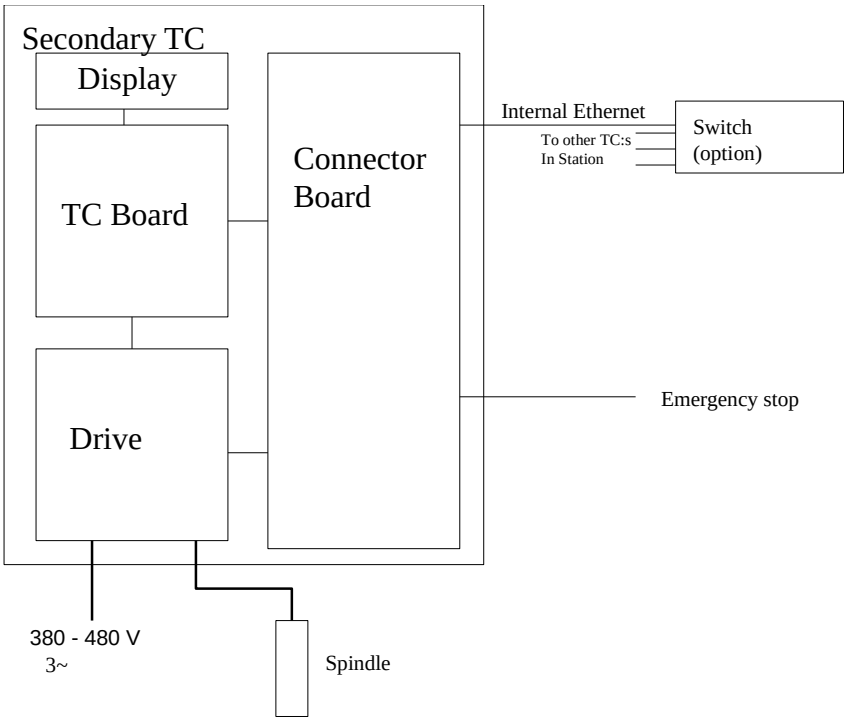
This document describes the features of the Tightening Controller (TC) unit. It focuses on the physical and logical parts of the TC unit.

2.2 General

A Tightening Controller takes care of various tasks around tightening: controlling spindles, taking care of data, running PLC etc. The TC exists in two different versions, the Primary TC (PTC) and the Secondary TC (STC). The Primary TC acts as the master controller for a station and apart from the control of the tightening the PTC does also contain functions for communication with external devices using Ethernet, fieldbus and serial links. The Secondary TC performs only the tightening function and communicates with the PTC only. There is one TC per spindle.



Primary TC Block Diagram



Secondary TC Block Diagram

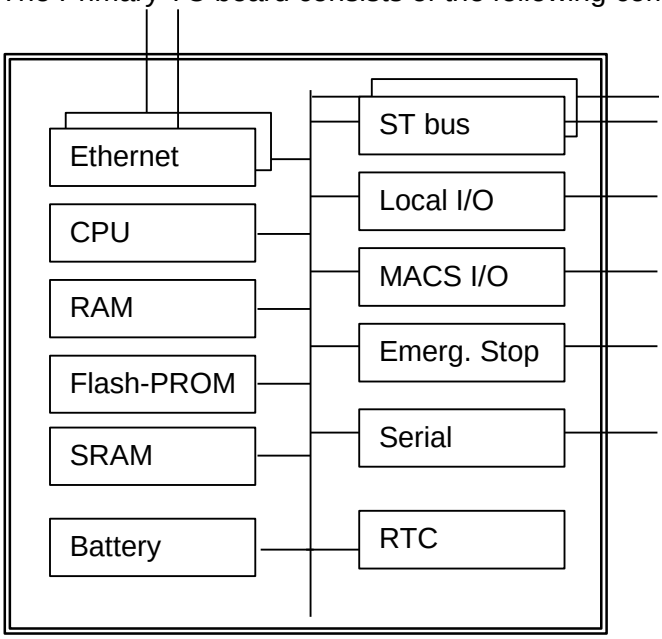
All connectors are positioned directly at the rear side of the TC, inside the wall mount.

2.3 General Description of the TC

In the following a generic description of the different parts in the TC is made. Later the difference between a Primary and Secondary Controller is described more in detail.

2.4 TC board

The Primary TC board consists of the following components:



Item	Function	Use
Ethernet	Ethernet interfaces	For communication with other TCs. In Primary TC:s the second Ethernet interface is used for communication with external interfaces, e.g the Console Computer (Tools Talk PowerMACS), 100 Mbit/s or a Tools Net Server
CPU	Central Processing Unit	PowerPC 880, 120 MHz
RAM	Random Access Memory	For storage of program and data when executing, 32 MB
Flash-PROM	Programmable Read Only Memory of Flash type	For storage of boot and application software. 8MB
SRAM	Static RAM with battery backup	For storage of set-ups, traces, cycle data etc. 2 MB
ST bus	St bus	The ST bus is for communication with the drive and the spindle, located in the tool connector.
Emerg. Stop	Emergency Stop	Class 3 Emergency Stop, breaks the gate drive voltage.
Local DI	Digital input	4 channels Opto Isolated Digital Input
Local DO	Digital Output	4 channel Relay Outputs
Serial	Serial interface	Interfaces to serial devices, 1 channels RS232/RS485, 1 channel RS232/RS422
MACS I/O	CAN bus interface	Opto Isolated interface to Atlas Copco standard accessories and Atlas Copco verified Device Net modules.
AnyBus CC	FieldBus interfaces	Interface to superior devices
Battery	RAM-backup	Expected life length >10 years
RTC	Real Time Clock	Battery backed up Real Time Clock

2.5 Servo

The servo drive has a ST bus interface towards the TC board. There are basically two main logical control signals with which the TC board controls the servo:

- The “current” value, defining the expected torque level (torque reference)
- The “voltage” value, defining the expected speed (target speed)

Normally the TC board will set the torque reference to the maximum value and then, while running at target speed, constantly measure the actual torque until it has reached the target torque. It will then stop the tightening by sending a stop command to the servo using the ST bus interface.

2.6 Servo and Spindle Communication

All measurement and processing of Torque and Angle measurements are made in the Spindle, and the processed values are sent to the TC board in digital form, using the ST bus. This bus is also used for sending commands to the drive and for reading and writing parameters in the spindle memory chip.

The TC can read maximum 2 torque channels and two angle channels. In addition the motor current can be read from the drive.

3 Primary TC Interfaces and features

The Primary TC is fitted with extensive connection possibilities to external equipment.
The Primary TC has the following interfaces:

3.1 Ethernet

There are two Ethernet interfaces. Ethernet 1 is for communication with other TC:s within a station. This interface must also be used when downloading system software into the PTC. Ethernet 2 is for communication with external Ethernet devices, such as the factory network. The Console Computer (Tools Talk PowerMACS) may be connected to any of the interfaces. The two interfaces are both of type 100 Base-T.

The PTC is fitted with a 6-port Ethernet switch, located in the wall mount. Normally, the Ethernet 1 port is connected to this switch with a short patch cable. The Ethernet switch has power supply from the TC using a separate cable. The cable is a standard product, 4222 1209 and is included in the Ethernet switch.

3.2 Serial Links

There are two connectors for serial links on the PTC. Using different cables can configure the electrical properties of these links. This means that only certain combination is available at the same time. The interfaces available are RS232, RS485 and RS422.
The following interface combinations are available:

- RS232, two channels
- RS232, RS485
- RS232, RS422
- RS422, RS485

3.3 MACS I/O

The MACS I/O bus is available in two connectors. The connectors contains the CAN bus and also isolated 24V supply for use as Power supply to external accessories.

3.4 Local I/O

The PTC contains four digital input channels and four switching relay outputs. The digital inputs are opto-isolated.
Relay Outputs:
Max Switching Voltage: 24V
Max Switching Current: 2A

3.5 Power Supply Output

The PTC is also able to supply external units with 24V, maximum 1A. The 24V supply from up to three TC:s may be connected in parallel and is then able to generate up to 2,6A. The power supply is available on several connectors, e.g. together with the MACS I/O and also at the local digital inputs.

3.6 External Power Supply Input

The TC is normally supplied with three-phase voltage that is also used to supply the internal electronics. In case an external emergency stop is used, the TC board may be supplied from an external source to prevent the TC board and communication to be shut off if the three-phase voltage is lost. When using the internal E-stop all external devices will run normally, see 3.8.

The external power supply only supply parts of the controller. The Ethernet (including the Ethernet switch), fieldbus and serial communication will run on the external power supply when the three-phase voltage is switched off. The MACS I/O bus, relay outputs and the internal E-stop will not work when the three-phase voltage is switched off.

3.7 Fieldbus Connection

The PTC contains support for connection of a fieldbus module of type Anybus CompactCom. This is a small module, fitted in a plastic enclosure that is plugged into the Compact Flash connector on the connector board. The Anybus module supports several fieldbuses such as Profibus, DeviceNet, CCLink, Ethernet-IP and Modbus TCP.

3.8 Emergency Stop

The TC is fitted with a class 3 compliant emergency stop. The emergency stop function breaks the supply to the gate drive of the drive; all other functionality will be unaffected. For connection and features of the emergency stop, refer to the AHB System design and Installation guide.

4 Secondary TC Interfaces and Features

The Secondary TC has a subset of the features of the Primary TC. The following interfaces are available:

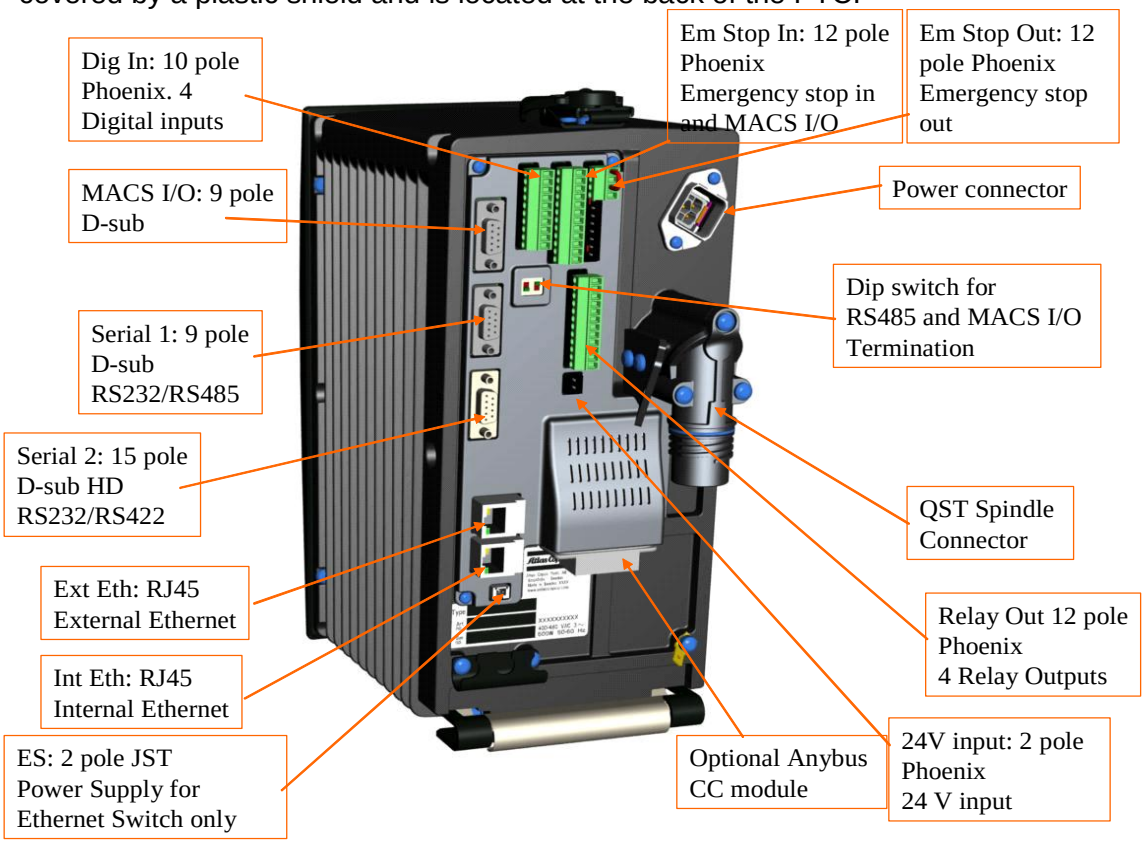
- Ethernet 1 for internal Ethernet connection.
- Ethernet switch (option).
- Power Supply for Ethernet switch.
- External Power Supply Input.
- Interface for connection of emergency stop chain.

5 Physical structure

The installation procedure for a PowerMACS system is described in dedicated System Design and Installation Guide.

6 PTC connector specification

The connector board is the basic connection point for cabling to external devices such as power supply, spindles (motor cables), ID devices, local printers etc. The connector board is covered by a plastic shield and is located at the back of the PTC.



6.1 Power Connector

Type: Harting
Use: Connects power from the Main Switch Box

6.2 QST Spindle Connector

Type: Atlas Copco Propriarity Design
Use: Connects the QST spindle cable

6.3 ES

Type: Phoenix Mini-Combicon MC1.5/2-ST.3,5 2-pole pin
Use: Power supply output for internal Power Supply of Ethernet switch.
Pin:
1 15V
2 0V

6.4 Int Eth

Type: RJ45 100 base-T
Use: Ethernet 1, for Inter TC communication.

6.5 Ext Eth

Type: RJ45 100 base-T
Use: Ethernet 2, for external communication.

6.6 Serial 2

Type: 15 pole D-sub HD (High Density) connector, socket
Use: RS232/RS422 and external ST bus connection
Socket:

1	RS232 Rx
2	RS232 Tx
3	Gnd
4	RS422 R+
5	RS422 R-
6	RS422 T+
7	RS422 T-
8	N/C
9	N/C
10	N/C
11	N/C
12	N/C
13	N/C
14	Gnd
15	Gnd

6.7 Serial 1

Type: D-sub 9-pole socket
Use: RS232/RS485 connection
Socket:

1. NC
2. RS232 Rx
3. RS232 Tx
4. NC
5. Gnd
6. RS485 D-
7. RS485 D+
8. NC
9. NC

6.8 Dig In

Type: Phoenix Mini-Combicon MC1.5/10-ST.3,5 10 poles
Use: Digital Input, opto isolated.
Pin:
Revision C TCs, with serial numbers starting with C:

24V	1
0V	2
DI1+	3
DI1-	4
DI2+	5
DI2-	6
DI3+	7
DI3-	8
DI4+	9
DI4-	10

Revision D TCs with serial numbers starting with D, produced after June 2008 and later:

24V	1
24V	2
0V	3
0V	4
0V	5
Common	6
DI1	7
DI2	8
DI3	9
DI4	10

For positive logic, connect 0V to Common and 24V inputs to DI1..Di4.

6.9 MACS I/O

Type: 9-pole D-sub pin
Use: MACS I/O bus
Keying: According to red markings in table
Pin:

1	+24V external
2	CAN_L
3	Gnd
4	Gnd
5	NC
6	Gnd
7	CAN_H
8	NC
9	+24V external

6.10 Em Stop In

Type: Phoenix Mini-Combicon MC1.5/12-ST.3,5 12 poles
Use: MACS I/O bus, Emergency Stop
Keying: According to red markings in table
Pin:

CAN_L	1
CAN_H	2
24V	3
24V	4
0V	5
0V	6
EM_STOP+	7
EM_STOP+	8
EM_STOP-	9
EM_RESET	10
EM_STOP	11
EM_NC1/EM_NC2	12

6.11 Em Stop Out

Type: Phoenix Mini-Combicon MC1.5/12-ST.3,5 12 poles
Use: MACS I/O bus, Emergency Stop interconnection
Keying: According to red markings in table
Pin:

CAN_L	1
CAN_H	2
24V	3
24V	4
0V	5
0V	6
EM_STOP+	7
EM_STOP+	8
EM_STOP-	9
EM_RESET	10
EM_STOP	11
EM_NC1/EM_NC2	12

6.12 Relay Out

Type: Phoenix Mini-Combicon MC1.5/12 ST.3,5 12 poles
Use: Relay Outputs
Keying: According to red markings in table
Pin:

RLY1_NC	1
RLY1_COM	2
RLY1_NO	3
RLY2_NC	4
RLY2_COM	5
RLY2_NO	6
RLY3_NC	7
RLY3_COM	8
RLY3_NO	9
RLY4_NC	10
RLY4_COM	11
RLY4_NO	12

6.13 24V Input

Type: Phoenix Mini-Combicon MC1.5/2-ST.3,5 2 poles
Use: Optional External 24V supply to TC board
Pin:

1	+24V
2	0V

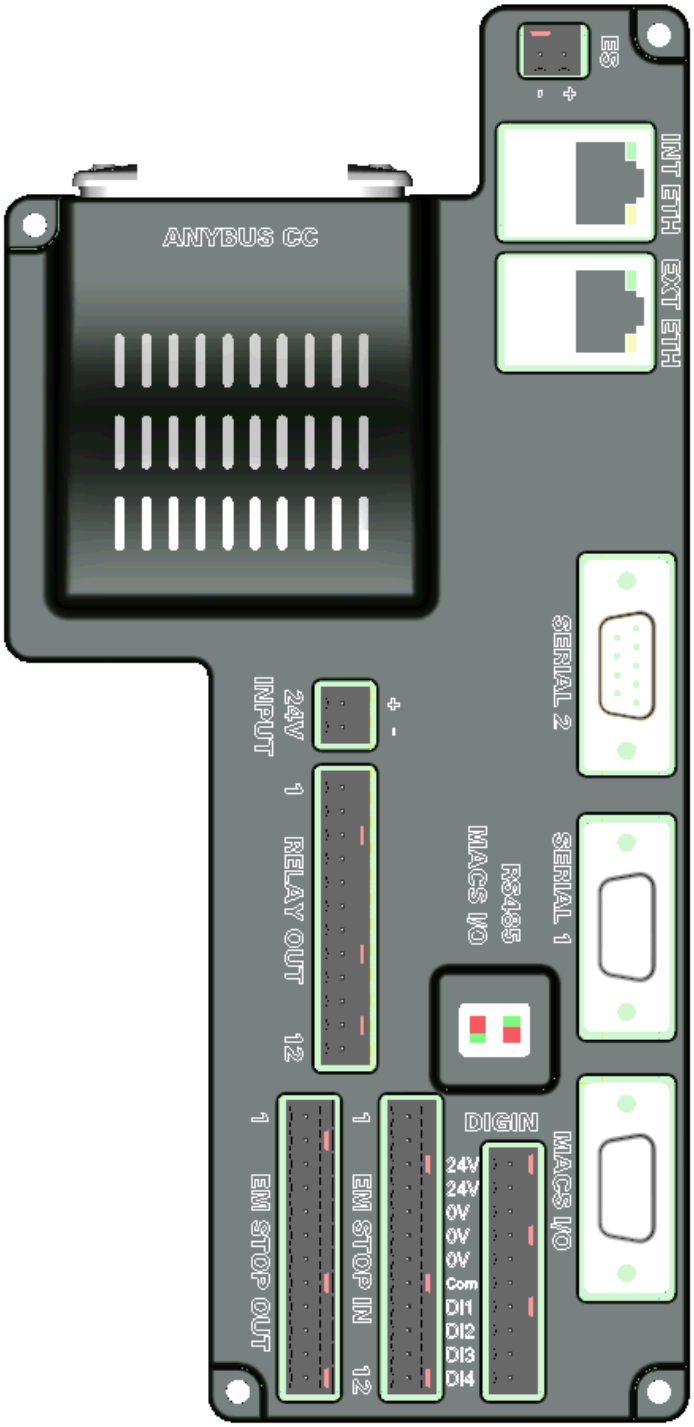
6.14 AnyBus CC

Type: Compact Flash Connector
Use: AnyBus Compact Com module connection

6.15 Dip Switch

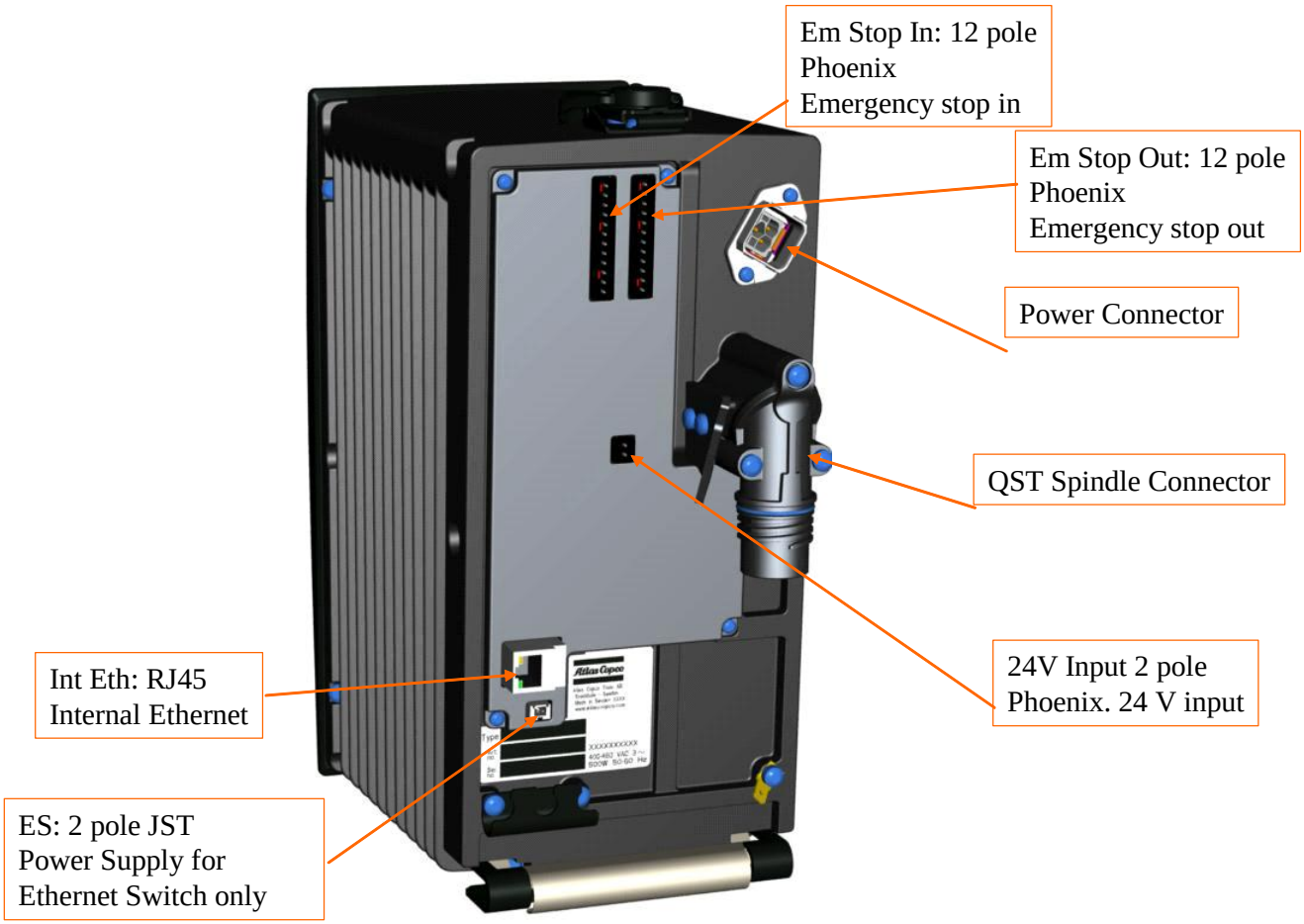
Type: Dip switch
Use: Connection of termination resistors for MACS I/O and RS485
Function:
Switch 1 On means that a 121 ohms termination resistor is connected to RS485.
Switch 2 On means that a 121 ohms termination resistor is connected to MACS I/O.

6.16 Connector labels PTC



6.17 Secondary TC connector specification

The Secondary TC units have a subset of the connectors available on the PTC. The connector board is covered by a plastic shield and is located at the back of the STC.



6.18 Power Connector

Type: Harting
Use: Connects power from the Main Switch Box

6.19 QST Spindle Connector

Type: Atlas Copco Propriarity Design
Use: Connects the QST spindle cable

6.20 ES

Type: Phoenix Mini-Combicon MC1.5/2-ST.3,5 2-pole pin
Use: Power supply output for internal Power Supply of Ethernet switch.
Pin:

1	15V
2	0V

6.21 Int Eth

Type: RJ45 100 base-T
Use: Ethernet, for Inter TC communication.

6.22 Em Stop In

Type: Phoenix Mini-Combicon MC1.5/12-ST.3,5 12 poles
Use: Emergency Stop
Keying: According to red markings in table
Pin:

N/C	1
N/C	2
24V	3
24V	4
0V	5
0V	6
EM_STOP+	7
EM_STOP+	8
EM_STOP-	9
EM_RESET	10
EM_STOP	11
EM_NC1/EM_NC2	12

6.23 Em Stop Out

Type: Phoenix Mini-Combicon MC1.5/12-ST.3,5 12 poles
Use: MACS I/O bus, Emergency Stop interconnection
Keying: According to red markings in table
Pin:

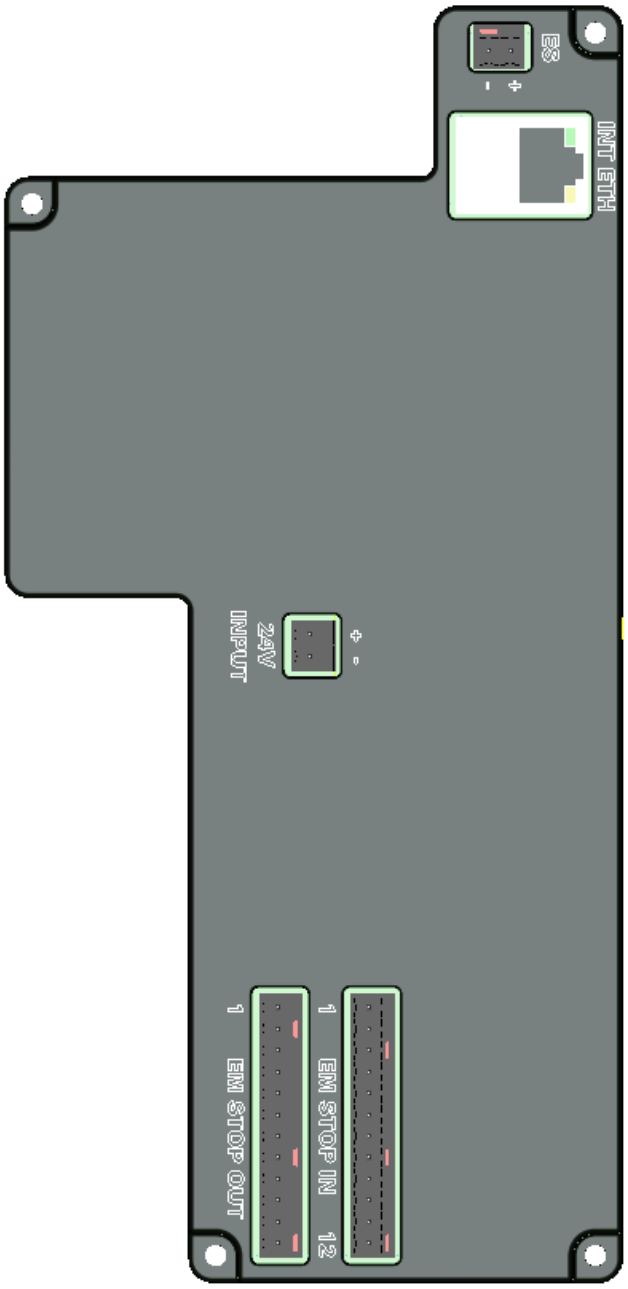
N/C	1
N/C	2
24V	3
24V	4
0V	5
0V	6
EM_STOP+	7
EM_STOP+	8
EM_STOP-	9
EM_RESET	10
EM_STOP	11
EM_NC1/EM_NC2	12

6.24 24V Input

Type: Phoenix Mini-Combicon MC1.5/2-ST.3,5 2 poles
Use: Optional External 24V supply to TC board
Pin:

1	+24V
2	0V

6.25 Connector labels Secondary TC



7 Indicator functionality

The indicators on PowerMACS 4000 consist of the following parts:

- LED indicators with 6 LED fields on the PTC and 3 LED fields on the TC.
- LCD Display with menu system.
- Four Membrane pushbuttons for navigation and settings.

The functionality of these is described below.

7.1 LED Indicators

The PTC has the following LED fields:

- OK, green field. Set to green color when the result of the last tightening operation for the spindle was OK.
- NOK, red field. Set to red color when the result of the last tightening operation for the spindle was NOK.
- ALL OK, green field. Set to green color when the result of the last tightening operation for the station was OK.
- ALARM, red field. Set to red color when an alarm has occurred, i.e. a severe hardware or software problem has been detected on the TC. The cause for the alarm can be viewed on the display.
- E-STOP, yellow field. Set to yellow color when the station has been emergency stopped, i.e. the emergency stop circuit needs to be reset.
- PRIM, white field. This field is lit when the PTC is configured as primary in the station.

The Secondary TC has the following LED fields:

- OK, green field. Set to green color when the result of the last tightening operation for the spindle was OK.
- NOK, red field. Set to red color when the result of the last tightening operation for the spindle was NOK.
- ALARM, red field. Set to red color when an alarm has occurred, i.e. a severe hardware or software problem has been detected on the TC. The cause for the alarm can be viewed on the display.

7.2 Display

Each TC has a display and button on the front. It can be used to get information about the TC and the system, and change setting for TC
The LCD display is a YMS12864-06AEBFDGL from Anshan Yes Optoelectronics Display Co Ltd with 128x64 dots. The display uses the driver S6B0724 from Samsung.

7.3 Menu

The menu has four buttons for navigation. The buttons on the TC do not have any labels, so button labels is written with a 8-dots font on the bottom row of the display. Above the bottom row, there is room for up to two rows of information with a 14-dots font, or one row of information with a 24-dots font.

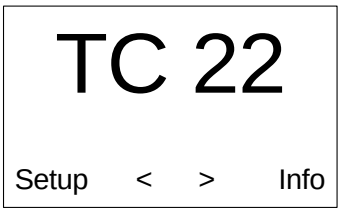
As default, the menu shows the TC number with the largest font. If a user traverses down in the menu without going back, the menu still returns to the top level after some idle time.

7.4 Menu levels

Below are examples from the different levels in the menu system.

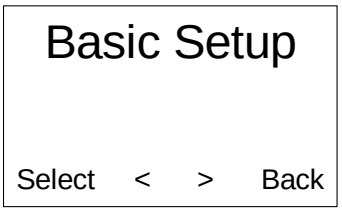
7.4.1 Top level

This image shows the default screen. “Menu” and “Info” at the bottom corresponds to the outer buttons. When following the “Info” link, events and information about the system (mostly version numbers) is displayed. When following the "Setup" link, the user is taken to the setup menu. By using the up and down arrows, the user can switch between TC number and Bolt Angle/Bolt Torque.



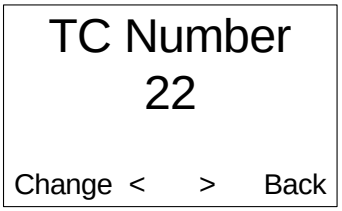
7.4.2 Setup menu

This image shows the first screen of the setup menu. By pressing “Select”, the user continues to the corresponding submenu. By using the up and down arrows, the user can choose between "Basic setup" and "IP setup".



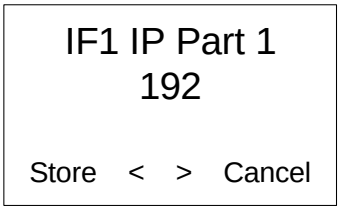
7.4.3 Setup submenu

On this level, the user can choose what settings to change.



7.4.4 Change item

This level is typically reached by choosing “Change” on the previous screen. The same data as in the previous screen stays, but the button texts changes. Here, on the last level in the menu system, the two middle buttons (the arrows) are no longer used to cycle between screens. They are used to alternate the value. The left button is used to store the value and the right button is as usual used to go back.



7.5 Buttons

7.5.1 Left button

The left button always progresses the user down in the menu, unless on the bottom level. When on the bottom level, the left button is used to confirm/store changes.

7.5.2 Right button

When on the top level, the right button takes the user to the info section. Otherwise, the right button always returns the user to the previous level in the menu.

7.5.3 Middle buttons

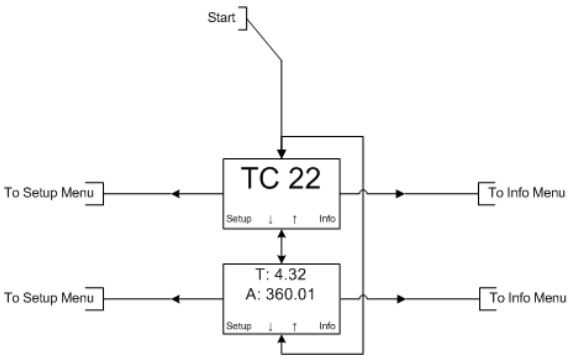
The left middle button always means “Down”, and the right middle button always means “Up”. When on the bottom level in the menu, these buttons are used to increase or decrease a value. Otherwise, they are used to cycle through all menu screens on the same level and in the same subtree.

7.6 Menu tree

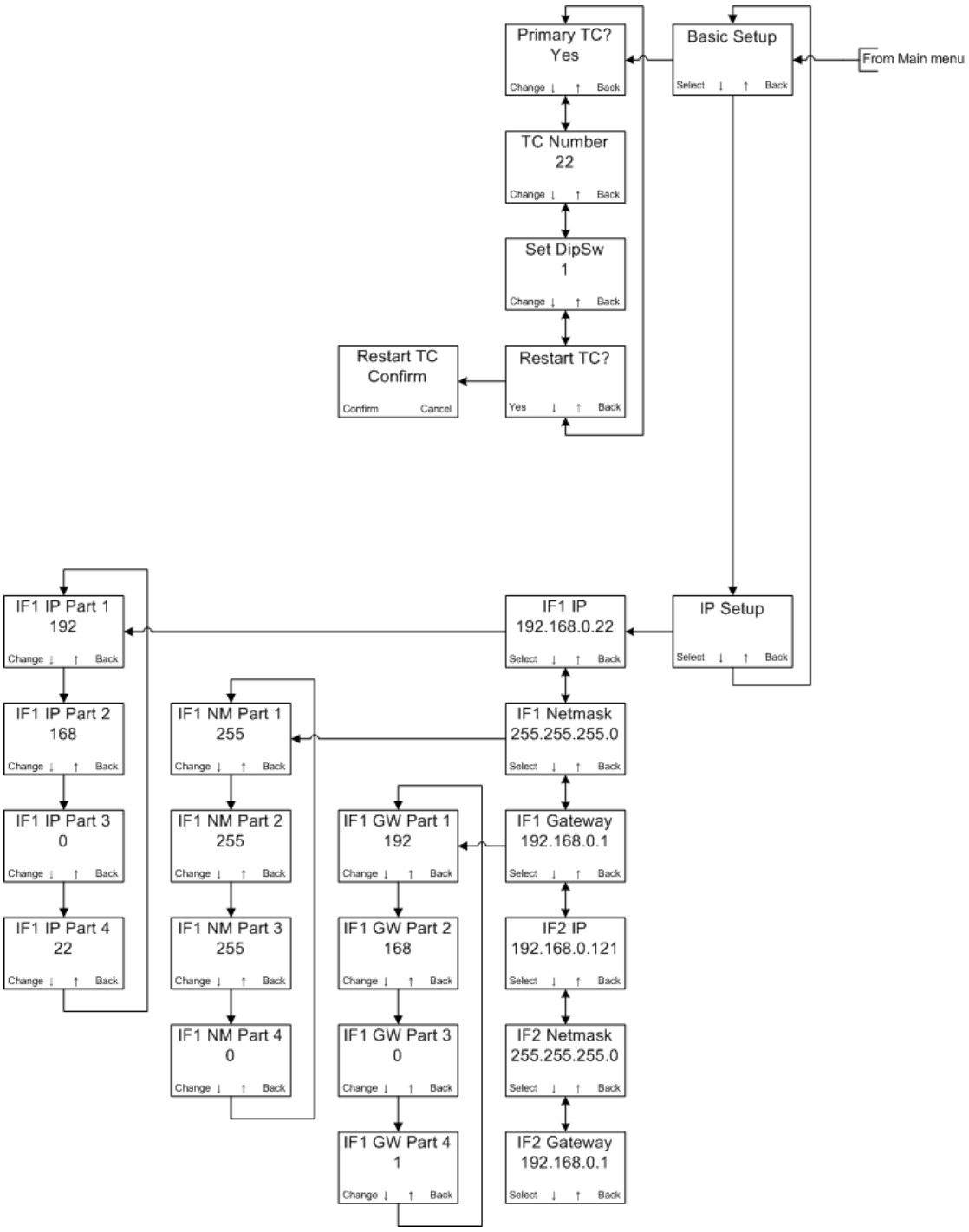
The whole menu tree is drawn below, but “Back”-arrows are left out everywhere since it is pretty obvious that they lead back to the previous menu level.

Arrows going out from the left of the boxes means that the left button has been pressed. Arrows going out from the top of the boxes means that the “Up” (middle left) button has been pressed, and arrows going out from the bottom of the boxes corresponds to a press on the “Down” (middle left) button.

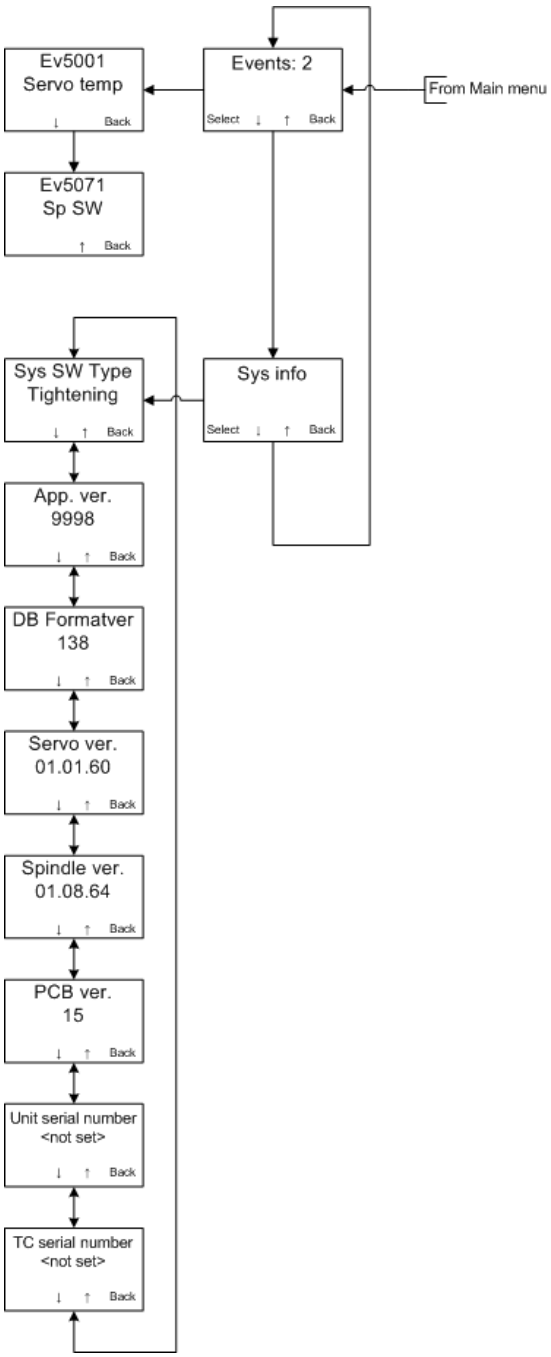
7.6.1 Main menu



7.6.2 Setup menu



7.6.3 Info menu



7.7 Events

When certain (fatal hardware errors) events occur in the TC, the events will be stored in the menu system until the next cycle start. Only the last 5 events are stored. The "ALARM" indicator above the display will be lit when there are events stored. Events can be viewed by going to the "Info" menu and then further to the "Events" menu. The first item displayed when entering the "Events" menu is the last item that occurred.

7.8 Downloading of new software

Just like with events, a special screen for downloading new software will override the menu.

When download is in process, the following screen will be displayed. None of the buttons will have any functions until download is done.

When download is done successfully, the following screen will be displayed. A click on the left button will restart the TC with the new application.

When download has failed, the following screen will be displayed. A click on the left button in this case will restart the TC bootloader. The new application can not be started since it is assumed to be corrupt.

7.9 Product data on display

On the “Info” menu on the top level of the menu system it is possible to view different product and system data. The following data is available:

Item	Comment
Unit Serial Number	
Unit Article Number	
TC board serial number	
Drive board serial number	Only showed when the TC has a valid setup.
Connected spindle serial number	Only showed when a spindle is connected.
Connected spindle type	Only showed when a spindle is connected.
Spindle chip serial number	Only showed when a spindle is connected.
TC Application Software version	
TC Bootloader version	Only shown during startup
Drive Software version	Only showed when the TC has a valid setup.
Drive Bootloader version	Only showed when the TC has a valid setup.
Spindle Software version	Only showed when a spindle is connected.
Spindle Bootloader version	Only showed when a spindle is connected.
TC Hardware version	
TC board MAC address	2 addresses on a PTC and one on a TC
Drive Hardware version	Only showed when the TC has a valid setup.
Spindle Chip Hardware version	Only showed when a spindle is connected.
Setup name	Only on PTC

You need to have a valid setup in the TC and a spindle connected to be able to access the Drive and Spindle data.

8 Technical data

Peak current out	60A
Max Power, continuous	500 W
Input voltage[1)]	380-480 V +/- 10%; 3 phase
Size (HxWxD)	292*146*298 mm
Weight	12kg
Temp. range[4)]	0-50°C

9 Design and manufacturing standards

EMC: Fulfills the standard EN 61800-3 in conformity with 89/336EEC

Electrical safety: Fulfills the standards IEC/EN 61010-1, IEC/EN 60204-1 in conformity with EN 60204-1
CE Marked under the Low Voltage Directive and the EMC Directive.