E1703C Modular 5-Axis CNC Controller

Users Manual

Table of Contents

1 Copyright

2 History

Date	Changes in document
05/2026	Hardware control commands added
05/2026	Configuration commands added
02/2026	Initial version

3 Safety

The hardware described within this document is designed to control a laser scanner system. Laser radiation may effect a person's health or may otherwise cause damage. Prior to installation and operation compliance with all relevant safety regulations including additional hardware-controlled safety measures has to be secured. The client shall solely be responsible to strictly comply with all applicable and relevant safety regulations regarding installation and operation of the system at any time.

Beside of that some laser equipment can be damaged in case it is controlled with wrong signals or signals outside a given specification. Thus it is highly recommended to check the output generated by this hardware using e.g. an oscilloscope to avoid problems caused by wrong configurations. This should be done prior to putting a system into operation for the first time, whenever some parameters have been changed or whenever any kind of software update was installed.

The hardware described here is shipped without any cover and without prefabricated equipment for electric installation. It is intended to be integrated in machines or other equipment. It is not a device for use "as is", but a component which is intended to be used as part of a larger device, e.g. for integration in a machine with own housing or within an electrical cabinet. Prior to operation compliance with all relevant electric / electromagnetic safety regulations including additional hardware-controlled safety measures has to be secured. The client shall solely be responsible to strictly comply with all applicable and relevant regulations regarding installation and operation of the system at any time.

The hardware described here is an electrostatic sensitive device. This means it can be damaged by common static charges which build up on people, tools and other non-conductors or semiconductors. To avoid such a damage, it has to be handled with care and including all relevant procedures (like proper grounding of people handling the hardware, shielding/covering to not to let a person touch the hardware unwanted, proper packaging in ESD-bags, ...). For more information please refer to related regulations and standards regarding handling of ESD devices. The EMC Directive (2014/30/EU) does not apply to this hardware as it is not intended for an end user (a person without knowledge of EMC) and as it is not otherwise made available on the market.

The Low Voltage Directive (2014/35/EU) does not apply to this hardware as the voltage supply is below the 50V AC / 75V DC limit.

This control board is considered partly completed machinery in accordance with the EU Machinery Directive (2006/42/EC). It cannot operate independently and is intended to be integrated into a larger machine or system. The final integrator is responsible for ensuring that the complete machine or system complies with all applicable safety and regulatory requirements in the intended market (such as CE- certification).

This document describes the E1703C-hardware but may contain errors and/or may be changed without further notice.

4 Overview

This document describes the E1703C modular CNC controller board family, their electrical characteristics and usage. It consist of E1703C 5-axis CNC controller baseboard plus optional extension board. Special variant E1701M is no CNC controller and therefore not covered by this document.

The E1703C CNC controller boards are designed for controlling motion-stage based stepper motor systems with two to five axes. Depending on the used extension boards (which are optional) they also supply extensive signals for laser or mechanical tools (like a mill) and external control. The communication between the host system and the controller boards is done via Ethernet or USB.

When using E1703C CNC controller boards, there is always one baseboard required for proper operation. This baseboard can be used together with different extension boards that provide additional signals for controlling the laser marking process. These extension boards are optional and have to be used only in environments where the additional signals processed by these boards are required. So depending on used type of laser and requirements, the minimal solution to control a laser marking system may consist of the baseboard only.
An E1703C baseboard can be combined with several extension boards of different types but never with more than one board of same type.

Different to the E1701 and E1702 series, the E1703 baseboards no longer consist of a stacked pair of boards but of one single PCB only.

4.1 Features

Following the features of available base- and extension boards are described

4.1.1 E1703C CNC Controller Baseboard

This baseboard can be used to control XY-tables, CNC-mills, XY/XYZ-stages or similar, stepper-motor driven devices. It can be combined with different extension boards without any restrictions as long as only one extension of same type is used at the same time. The E1703C baseboard offers following features:

- up to 5 stepper axes controllable via step and direction signals
- combined CNC motion of 2..5 axes
- can use lasers as well as many other mechanical tools for material processing/milling
- up to 370 kHz maximum step frequency (jitter-free)
- 100 Mbit Ethernet connection
- secondary buffer with a size of 1000 commands
- USB-C interface
- realtime processing of laser and motion signals
- can control nearly every laser type (this may require extension boards as described below)
- 500 MHz realtime CPU
- support for microSD, microSDHC and microSDXC cards
- can be operated without any SD card optionally
- continuous list concept, no need to swap between buffers
- BeamConstruct PRO license included

4.1.2 E1703C LP8 Extension Board

This board can be used to provide signals for controlling a wide range of laser types. It offers following features:

- LP8 8 bit CMOS level parallel digital output e.g. for controlling laser power
- LP8 latch CMOS level digital output for usage with IPG(tm) and compatible laser types
- Main Oscillator CMOS level digital output for usage with IPG(tm) and compatible laser types
- 8 bit 0..5V analogue output e.g. for controlling laser power (this output is directly connected to LP8 outputs)

- two laser CMOS level digital outputs for usage with YAG, CO2, IPG(tm), SPI(tm) and compatible laser types (outputs can provide PWM frequency, Q-Switch, FPK-pulse, CW/continuously running frequency, stand-by frequency) running with frequencies of up to 20 MHz

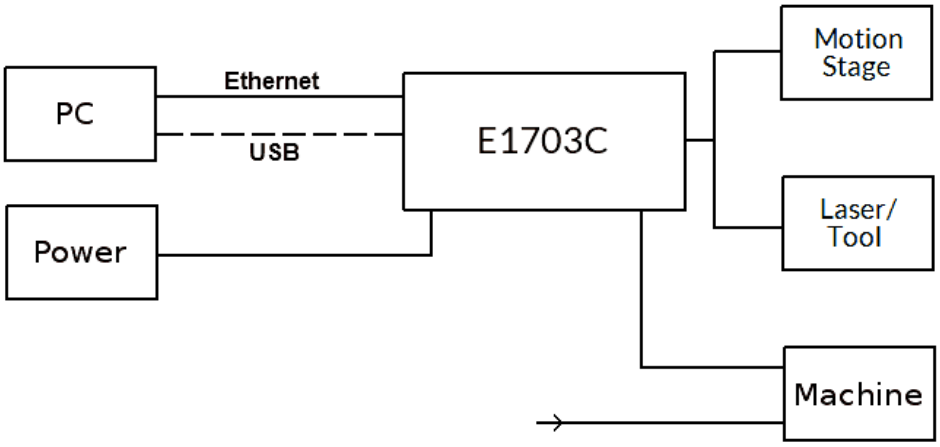
4.1.3 E1703C Digi I/O Extension Board

This board provides additional digital in- and outputs for synchronisation and communication with external equipment. It offers following features:

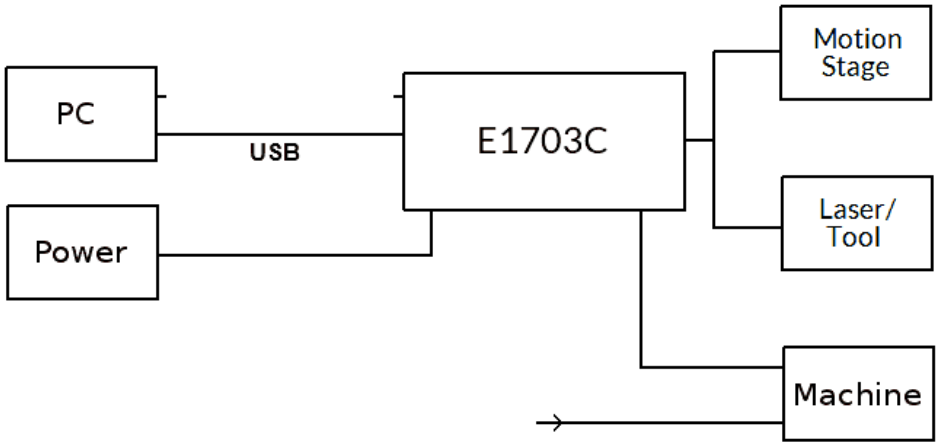
- 8 freely usable digital outputs providing either CMOS level or electrically insulated outputs via external power supply
- 8 freely usable digital inputs expecting either CMOS level or electrically insulated inputs via external power supply

5 Position Within The System

The E1703C CNC controller system can be connected to the host via Ethernet or USB to receive processing data from BeamConstruct laser marking application or from any other application which makes use of one of the provided programming possibilities (as described below). When using the Ethernet interface, it optionally can be connected via USB too. In this case USB connection is only used to retrieve BeamConstruct PRO license from the board:



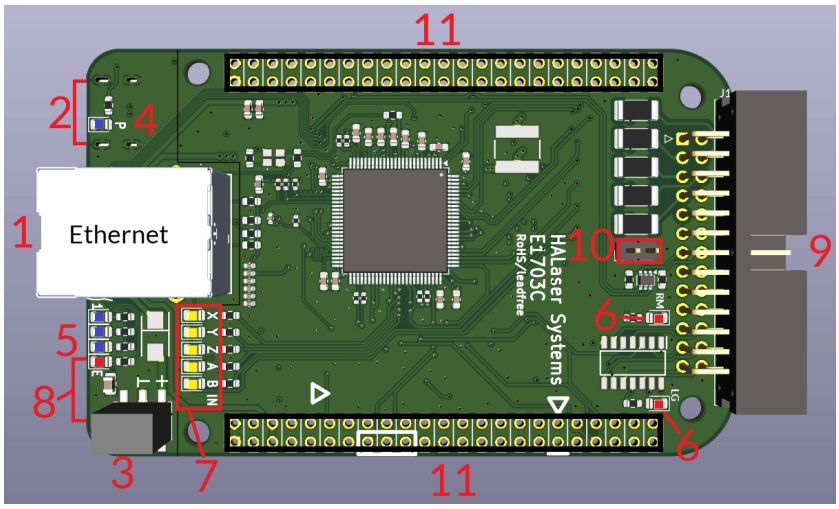
Since the 100 Mbit Ethernet typically provides a faster data transfer than USB, this connection type is preferred.
When using USB connection with such data, time from sending data to the card until marking operation can be started may be longer, caused by slower USB data transfer:



In both cases the board itself is connected with the stepper motors via separate power drivers to submit fully synchronous 2D, 3D or 4..5 axis movement information to it. Beside of that it is connected to a laser or any other tool to submit motion-synchronous data. Additional communication channels between the E1703C CNC controller board and a connected machine can be done via separate IOs of an extension board.

6 Boards And Connectors

6.1 E1703C CNC Controller Baseboard



The E1703C 5-axis CNC Controller Baseboard provides following connectors and interfaces:

1. Ethernet – for communication with the host system, motion and processing information are submitted via this path
2. USB – via USB-C connector for providing BeamConstruct PRO license to host system and optionally for submitting processing data from host to E1703C card (in case Ethernet is not used)
3. Power – for providing power in range 9..30V
4. Power LED – lights when power is available
5. User LEDs – show operational and error states of card
6. Operation LEDs – different LEDs that show the operational states
7. Input state LEDs – 5 LEDs showing current state of limit/reference inputs
8. optional microSD-card (on bottom side) – storage place for firmware and extended configuration file, can be used to upgrade firmware, to change the card's IP and other things more
9. Stepper motor and laser/tool signals – white 26 pin laser and motion signal output connector
10. Opto-Configuration - choose operation mode for limit-inputs
11. Extension connectors – extension boards can be placed here in order to add some more functionality and hardware interfaces to the board

6.1.1 Ethernet

This is a standard RJ45 Ethernet plug for connection of the board with the host system. When the controller board is accessed via this connection, all scanner and laser data are sent via Ethernet. Thus it is recommended for security reasons to have a separate machine network that contains the control-PC, the scanner controller card(s) and other Ethernet-devices for the machine, but has no physical connection to the “outer world”, means no access to the internet.
By default the E1803C board is using IP 192.168.2.254, thus the Ethernet network the card is connected with needs to belong to subnet 192.168.2.0/24.
PLEASE NOTE: For security reasons it is highly recommended to not to mix a standard communication network with an E1703C network or to connect the scanner controller card with a standard network. Here it may be possible someone else in that network (accidentally) connects to that scanner controller and causes laser emission.
The IP of the scanner controller can be changed. This is necessary e.g. in case an other subnet has to be used or in case the E1703C board has to be operated in multi-head environments where more than one card will be accessed at the same time. The IP can be configured using e1703.cfg configuration file that is placed on microSD-card. To change the IP, please perform the following steps:

1. disconnect E1703C board from power and USB

2. remove microSD-card
3. put microSD-card into a desktop computer, this may require a microSD- to SD-card-adapter
4. open the drive that is assigned to the card
5. open file e1703.cfg using a text editor like Notepad or kwrite
6. add a line or edit an existing line "`ip0=`", here the desired IP has to be appended (as example: when you want to configure IP 192.168.2.13 the line has to be "`ip0=192.168.2.13`" – without any quotation signs
7. save the file
8. eject the drive the card is assigned to
9. place the microSD-card in E1703C board (place without the use of force, notice correct orientation with connectors of SD-card to top!)
10. power up card

There is the possibility to operate the controller without any SD-card inserted. In this case, the confiuration is saved on-board. For such a scenario, to change the IP of the controller, following steps have to be done:

1. disconnect E1703C board from power and USB
2. remove microSD-card
3. put microSD-card into a desktop computer, this may require a microSD- to SD-card-adapter
4. open the drive that is assigned to the card
5. open file e1703.cfg using a text editor like Notepad or kwrite
6. add a line or edit an existing line "`ip0=`", here the desired IP has to be appended (as example: when you want to configure IP 192.168.2.13 the line has to be "`ip0=192.168.2.13`" – without any quotation signs
7. when not already available, add a line "`storeinflash=1`"
8. save the file
9. eject the drive the card is assigned to
10. place the microSD-card in E1703C board (place without the use of force, notice correct orientation with connectors of SD-card to top!)
11. power up card
12. wait until the Boot/Alive-LED (but not the Processing-LED!) starts blinking regularly
13. turn off power
14. remove microSD-card
15. now the new settings have been applied and the controller can be used without any SD card inserted

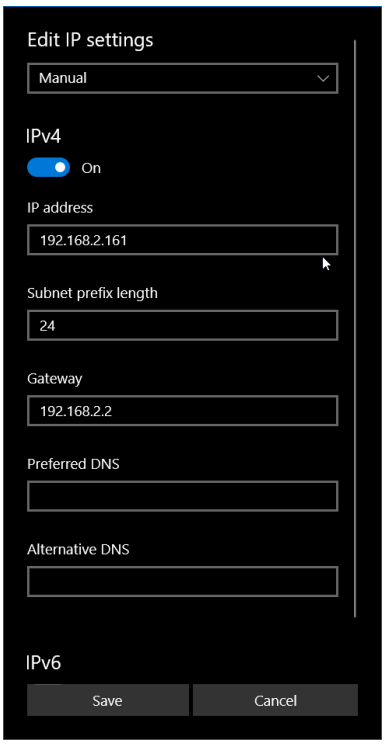
When User LEDs do not light up as described below, please check if microSD-card is placed in board correctly.

6.1.1.1 Ethernet Configuration With Windows 10

When E1703C scanner controller is accessed via Ethernet, it is recommended to use a separate network for security reasons. Since the controller is working with a static IP (default is 192.168.2.254) the Ethernet port on host PC has to be configured with an IP of same subnet in order to allow access to it. For Windows 10 (and similar) this configuration has to be done using following steps:

1. right-click the network-symbol in your taskbar
2. Select "Open network and internet settings"
3. Select "Ethernet" on the left
4. find the network interface E1703C has to be connected with and select it
5. Click the "Edit" button in section "IP settings"

6. now a window opens where “IPv4” has to be turned on and that has to be configured as follows:



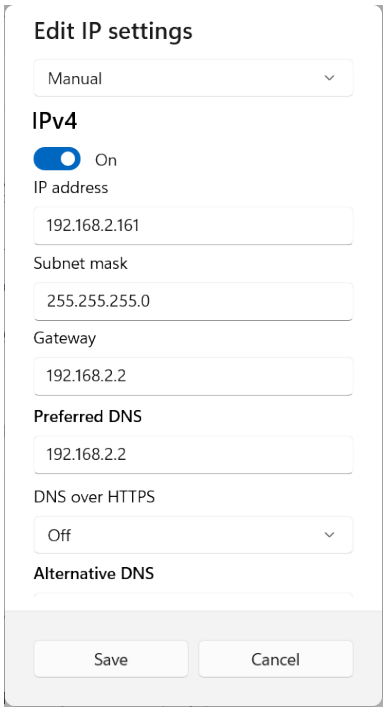
There you can specify an IP for your host PC. It has to belong to network 192.168.2.xxx and can be any number except than 192.168.2.254 (this is already the IP of the scanner card), 192.168.2.0 or 192.168.2.255.

6.1.1.2 Ethernet Configuration With Windows 11

When the E1703 controller is accessed via Ethernet, it is recommended to have a separate network for security reasons. Since the controller is working with a static IP (default is 192.168.2.254) the Ethernet port on host PC has to be configured with an IP of same subnet in order to allow access to it. For Windows 11 (and similar) this configuration has to be done using following steps:

1. right-click the network-symbol in your taskbar
2. Select “Network and internet settings”
3. Select “Ethernet” in the opened list
4. find the network interface E1703C has to be connected with and select it
5. Click the “Edit” button right beside “IP assignment”
6. now a window opens where “Edit IP Settings” has to be switched from “Automatic (DHCP)” to “Manual”

7. next “IPv4” has to be turned on and the remaining parameters in this window have to be configured as follows:



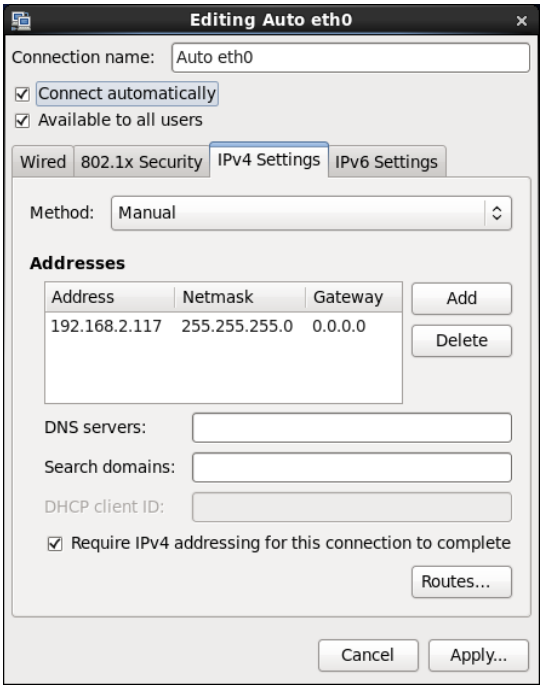
There you can specify an IP for your host PC. It has to belong to network 192.168.2.xxx and can be any number except than 192.168.2.254 (this is already the IP of the scanner card), 192.168.2.0 or 192.168.2.255.

6.1.1.3 Ethernet Configuration With Linux

When E1703C scanner controller is accessed via Ethernet, it is recommended to use a separate network for security reasons. Since the controller is working with a static IP (default is 192.168.2.254) the Ethernet port on host PC has to be configured with an IP of same subnet in order to allow access to it. For Linux (with NetworkManager) this configuration has to be done using following steps:

1. right-click the network-symbol in taskbar
2. click "Edit Connections..."
3. select the "Wired" network interface the scanner card is connected with and press button "Edit"

4. go to tab-pane "IPv4 Settings" and configure it as shown below:



There you can specify an IP for your host PC. It has to belong to network 192.168.2.xxx and can be any number except than 192.168.2.254 (this is already the IP of the scanner card), 192.168.2.0 or 192.168.2.255.

6.1.2 USB

This is a standard USB-C-connector for connection of the board with the host system. It is used to retrieve BeamConstruct PRO license and optionally – when Ethernet is not used – to send processing data to the card.
PLEASE NOTE: USB is typically slower than a standard 100 Mbit Ethernet connection, so expect less quick execution in case of complex processing data!
The required device driver is installed automatically during the installation of the HALsetup software package (Windows) or comes with operating system by default (Linux). E1703C card appears as COM-interface on Windows using any free number for the port. With Linux it appears as /dev/ttyACMx where "x" is any number. These numbers are provided by the operating system automatically.
By default USB provides 5V power supply too. So whenever card has to be stopped, both USB and power have to be disconnected in order to shut it down completely. It is not recommended to use USB as power supply, an additional, external power should be connected in order to operate E1703C controller correctly. Nevertheless it might be possible E1703C card can be operated on USB power only. Since this highly depends on the capabilities of used host system, it has to be evaluated for every particular case.
When the controller has NOT to be powered via USB, there is an option to turn of that power path permanently. For further details about this possibility, please contact HALaser Systems.

When the controller is connected via USB, a BeamConstruct PRO license is provided via this interface automatically. This is done without the need to configure anything, and as long as following conditions are true:

- physical USB connection from controller to host PC exists
- the COM-port (Windows) has a number smaller than COM20
- the controller is working and the Alive-LED in blinking

It is also possible to have the USB-connection for license retrieval only and to use the Ethernet-connection to transfer marking data to the controller, both can exist beside each other.

6.1.3 Power

Power supply for E1703C CNC controller board is done via 6 pin header right beside the Ethernet connector. Here pairs of pins belong to same power level. An appropriate fuse for circuit protection must be provided by the external equipment:

NC	GND	+9..+30V
NC	GND	+9..+30V

- +9..+30V input is marked by a "+" sign
- GND pins are marked with a "⊥" sign
- the pins not to be connected are not marked

Power has to be supplied via this connector by connecting to a unipolar power supply with a voltage in range from 9V to 30V DC, max +/- 0.15V tolerance and 1.5A (stabilised and smoothed). Do not apply voltages in excess of 30V or with inverted polarity to this input. The DC power supply must be grounded.
To avoid high frequency interferences from other electrical equipment or from within the power supply, it may be necessary to place a ferrite bead at the cable close to the board. Please also check for correct shielding in respect to the equipment the E1703C card is used within.

ATTENTION: due to the undefined behaviour of some power supplies with high peaks in some specific situations, the power to the controller never should be toggled just by pulling and reconnecting a cable which is on power (hot-swap). Always turn off the power the regular way via the power supplies input/a regular switch. Otherwise this can cause serious damage to the controller card or power supply.

6.1.4 Power LED

This led is lit as soon as the board is on some power. This means it may be functional and could emit any signals as soon as this LED is on, but it does not necessarily need to work properly since firmware may not be started at this point. Please refer section "6.1.5 User LEDs" below for LEDs that show functional state of the board.

6.1.5 User LEDs

The real operational state of the card is shown by four additional LEDs described here from inner to outer position:

Name	Colour	Label on PCB
Boot/Alive	blue	1
Processing	blue	
Referencing	blue	
Error	red	E

1. Boot- and Alive-LED – this LED is turned on permanently as soon as the firmware of the controller was loaded successfully. After the startup-process of the firmware has been completed, it starts blinking slowly. This is an alive-notification, as long as it blinks, the board is working and ready for operation. During operation the blink frequency may change. Only in case it does not blink for more than 10 seconds, the board has died for some reason and should be restarted.
2. Processing LED – during booting, this LED blinks when data are written from the SD-card to the internal flash of the controller. When a power-cycle happens during that phase, the written data may be damaged and it is not possible to operate the controller without an SD-card inserted. In this case it need to be rebooted again with the SD-card inserted.
   In such a situation the Boot/Alive LED is off.
   During regular operation of the firmware (means when the Boot/Alive LED is on), this LED is turned on as long as an operation is in progress and the controller is processing data. This may include motion operation with the axes or laser emmission. This LED does not correspond to the tool on-off/LaserGate signal. Comparing to it, it's also enabled during jumps or wait-cycles when laser is turned off but processing itself is active.
3. Referencing LED – this LED is lit as long as a the axes are referencing and seeking the reference switch.
4. Error-LED – this LED is turned on in case a fatal error occurs that normally should never happen.
   When the Error-LED is turned on during boot-phase (means when the Boot/Alive-LED is off), the firmware could not be started and the controller is not ready to work.
   When the Error-LED is turned on during regular operation (means when the Boot/Alive-LED is blinking), in most cases board can't continue with operation until the reason for error is removed and

the board is restarted. In case this LED is turned on please:
- check if you are using exactly one baseboard
- check if you are using E1703C extension boards only (and no other 3rd party hardware)
- check if you are using latest firmware and host software
- check all connections and cables
- undo your latest changes in hardware and configuration

If these steps do not help, please contact HALaser Systems for further assistance.

6.1.6 Operation LED

These LEDs shows the current marking/milling state of the controller. They consist of two LEDs which can act completely independent from each other and correspond to the related hardware signal (as described in section "6.1.9 Stepper motor and control signals"):

- LG LED – it shows the modulation state of the laser/the activation state of the connected tool and signal of laser gate output. It corresponds to the LaserGate output signal and is turned on as long as the laser/the tool is turned on and the laser gate output high. This LED does NOT signal the same like the Processing LED described above since it will be turned off during jumps.
- RM LED – it signalises any axis being active and moving. It corresponds to the RunningMotion output signal.

6.1.7 Input State LEDs

These 5 yellow LEDs show the state of corresponding 5 digital reference inputs. As long as a HIGH signal is detected on an input, the related LED is turned on. These LEDs can be used to check if a reference input "Ref" is at high.
On the PCB the LEDs are marked with X, Y, Z, U and V corresponding to the axis names.
For a description of these inputs, please refer to section "6.1.9 Stepper motor and control signals" below.

6.1.8 microSD-Card

The microSD card is the storage place for firmware and configuration files. Here SD, SDHC or SDXC cards are supported.

The E1703C can be operated with or without an SD-card. For **operation with SD-card**:

- when the firmware file e1703.fwi has a different version than the last firmware used, this new firmware is used; on first startup with this new firmware it is loaded onto the on-board flash of the controller, thus this first boot process may last somewhat longer
- when the configuration file e1703.cfg contains a parameter "`storeinflash=1`", ist contents are also stored controller-internal.
  ATTENTION: This parameter should be set only when it is intended to operate the controller without SD-card. Otherwise the parameters are written on every reset/power-cycle which will age the flash of the controller prematurely.

For operation **without SD-card**:

- the controller has to be started at least once with an SD-card inserted and until the Boot/Alive-LED blinks regularly
- to also write the configuration of the e1703.cfg file to the internal flash during that operation, this file needs to contain a line "`storeinflash=1`" during that operation
- once this is done, the controller can be turned off and the SD-card can be removed; now when it is re-powered and the Boot/Alive-LED blinks regularly, it is running with these internally stored data

To remove the microSD-card, first disconnect all power from the E1703C board completely (including USB, the Power LED has to go off). Next press microSD card gently into the board until you can hear a click-noise. Then you can pull it out of the board. To place a microSD card, the same has to be done in reverse order: place it into the E1703C board's card slot and press it gently until a click-noise signals locking of the card. Now the board can be powered.
E1703C baseboard is shipped with a card containing firmware and configuration files:

- e1703.fwi – firmware file that is used to operate the board, to be replaced when a firmware update is provided
- e1703.cfg – configuration text file, can be edited using a text editor in order to modify cards configuration
- version.txt – text-file containing information about the used firmware version

To use an other microSD card than the one shipped with the board, following conditions have to be met:

- FAT32 formatted
- using only one partition
- BOOT-flag is set
- e1703.fwi file available on card

An additional file e1703.cfg can be placed on the card too. It contains plain ASCII text, acts as configuration file and can contain several parameters and its values which are separated by an equal-sign. Every of the possible parameter/value pairs has to be located in an own line. Following configuration parameters are possible within this file:

Parameter	Description	Example
ip0	Configures IP of Ethernet port. Here only IPs in xxx.xxx.xxx.xxx notation are allowed but no host or domain names.	`ip0=192.168.2.100` specifies IP 192.168.2.100 to be used for Ethernet interface on next startup
rwip0	Configures an IP which has write permission for configuration parameters when the configuration commands (as described below) are used	`ip0=192.168.2.110` specifies IP 192.168.2.110 as incoming IP which is the only IP allowed to set configuration values
passwd	Specifies an access password that is checked when card is controlled via Ethernet connection. This password corresponds to password specified with function `E170XC_set_password()`, please refer below for a detailed description. When a client computer connects to the card without sending the correct password, Ethernet connection to this host is closed immediately. PLEASE NOTE: this password does not replace any network security mechanisms and does not give the possibility to operate E1703C controller via insecure networks or Internet! It is transferred unencrypted and therefore can be "hacked" easily. Intention of this password is to avoid collisions between several E1703C cards that operate in same network and are accessed by several software instances. Maximum allowed length of the password is 48 characters. It is recommended to not to use any language-specific letters.	`passwd=cArdPwd2026!` set a password "cArdPwd2026!"
mipout	Configure a Digi I/O output pin to be used as “mark in progress”-signal by default; here an output bit number in range 0..7 has to be configured which will be set to HIGH as long as an operation is in progress, the value given here can be overwritten by API-function `E170XC_digi_set_mip_output()`. A value 0f 0xFFFFFFFF uses the LaserB output (needs to be configured as GPO for this), any other value disables this function.	`mipout=1` use DOut1 for mark-in-progress signal

Parameter	Description	Example
wetout	Configure a Digi I/O output pin to be used as “wait for external trigger”-signal by default; here an output bit number in range 0..7 has to be configured which will be set to HIGH as long as an operation is in progress and the controller is waiting for an external trigger signal to arrive at ExtStart input, the value given here can be overwritten by API-function `E170XC_digi_set_wet_output()`. A value 0f 0xFFFFFFFF uses the LaserB output (needs to be configured as GPO for this), any other value disables this function.	`wetout=0` use DOut0 for mark-in-progress signal
digiinit	Initialises the digital outputs on firmware start-up with the given defaults. This overrides the hardware defaults. The default digital values set here are NOT available on power up but a few seconds later after firmware has been loaded and started.	`digiinit=2` set DOut1 to HIGH initially and all other outputs to LOW
digimask	Masks the digital inputs and specifies which inputs can be read. All input bits which are ignored by this command by setting the related value to 0, are no longer read.	`digimask=253` use only DIn2..DIn7 as input and ignore DIn0 and DIn1

tune	Enables special functions and features that are not activated by default. As parameter a number can be handed over that specifies the functions to be enabled. Starting with firmware version 41 the number can also be specified as hexadecimal value when it is prefixed with “0x”. Following numbers can be concatenated by adding them:
	
	8 (0x08) – invert LaserGate output to work as active HIGH signal; when this option is set, logic of LaserGate-LED changes too, it is on as long as laser is turned off and it is off as long as laser is on
	
	16 (0x10) – invert LaserA output of LP8 extension to work as active HIGH signal
	
	64 (0x40) – use LaserA output as GPO (general purpose output pin); when this flag is set, LaserA output is no longer able to emit a frequency but can be used as digital output pin; when this value is set, a tune-value of 0x10 (invert LaserA) is ignored.
	
	128 (0x80) – use LaserB output as GPO (general purpose output pin); when this flag is set, LaserB output is no longer able to emit a FPK pulse but can be used as digital output pin; when this value is set, a tune-value of 0x20 (invert LaserB) is ignored. This flag has to be set e.g. when LaserA has to be used together with `tunereadyout` or `tunemarkout` parameter.
	
	32768 (0x8000) – invert the mark-in-progress signal of Digi I/O extension
	
	65536 (0x10000) – invert the wait-external-trigger signal of Digi I/O extension
	
	16777216 (0x1000000) – inverts the logic of the ExtStart input. By default, the start-input reacts on a rising edge. When this flag is set, this is inverted and a falling edge is expected to release an external trigger.
		`tune=8`
		inverts the logic of the LaserGate output
		
		`tune=0x18`
		logically invert the logic of both, the LaserGate and the LaserA output signal

Parameter	Description	Example
usb	When this parameter is set to 0, USB interface is disabled completely. This means it is no longer possible to connect to E1703C USB serial interface via terminal software or via BeamConstruct and it is also no longer possible to retrieve BeamConstruct PRO license via USB. This option can be used to suppress unwanted access to USB and saves some power.	`usb=0` turn off USB interface
eth	This parameter specifies the behaviour of the Ethernet interface. When it is set to 0, the Ethernet network interface is disabled completely. This means it is no longer possible to connect to E1703C via Telnet or via BeamConstruct. This option can be used to suppress unwanted access to Ethernet, to save little startup-time and to save some power.	`eth=0` – turn off Ethernet interface completely

6.1.8.1 Firmware Update

As described above the firmware is located on microSD-Card and therefore can be updated easily. There are two possible usage scenarios where the update procedures are different:

Usage scenario A: The controller is operated **with SD-card inserted** and by using the data from that SD-card:

1. remove the microSD-Card as described above
2. download a new firmware from https://halaser.systems/download/Firmware/E1703 (the higher the number in the file name, the newer the firmware is)
3. copy the contents of this ZIP-file to microSD-Card (please take care about E1703.cfg in case it contains a changed configuration)
4. reinsert microSD-Card as described in previous section

Usage scenario B: The controller is operated with **no SD-card** inserted and by using its internal memory:

1. download a new firmware from https://halaser.systems/download/Firmware/E1703 (the higher the number in the file name, the newer the firmware is)
2. copy the contents of this ZIP-file to a microSD-Card
3. reinsert microSD-Card as described in previous section
4. turn on power and wait until the Boot/Alive-LED blinks
5. turn of power
6. remove the microSD-Card as described above

6.1.9 Stepper motor and control signals

The white 26 pin connector provides several signals to control up to five stepper motor axes and connected tools which can be a laser or any other tool that is able to deal with the related signal. The connector is a white one to avoid confusion when a LP8 Extension Board is used too. This connector provides following signals:

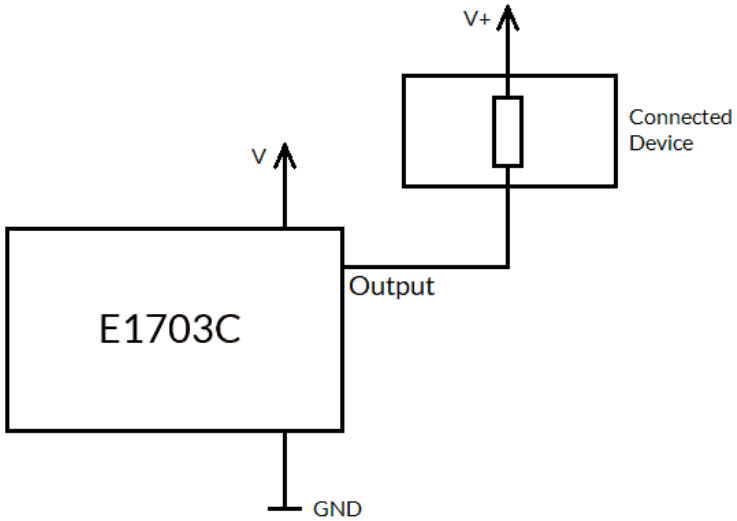
Upper Row Of Pins	Signal	Voltage	Remarks	Lower Row Of Pins	Signal	Voltage	Remarks
1	Unused, do not connect!			**2**	5V	5V	
3	RefX	CMOS, 0/5V or 0/V_{ext}	Reference inputs	**4**	RefY	CMOS, 0/5V or 0/V_{ext}	Reference inputs
5	RefZ	CMOS, 0/5V or 0/V_{ext}		**6**	RefA	CMOS, 0/5V or 0/V_{ext}	
7	RefB	CMOS, 0/5V or 0/V_{ext}		8	Do not connect!		
9	GND_{ext}	GND	External ground	**10**	GND	GND	Board-internal Ground
11	Running Motion	5V		12	Unused, do not connect!		
13	ExtStop	5V	Input control signal	**14**	ExtStart	5V	Input control signal
15	StepX	5V	Stepper pulse output signals	**16**	DirX	5V	Stepper motor direction output signals
17	StepY	5V		**18**	DirY	5V	
19	StepZ	5V		**20**	DirZ	5V	
21	StepU	5V		**22**	DirU	5V	
23	StepV	5V		**24**	DirV	5V	
25	LaserGate	5V		**26**	LaserA	5V PWM	

GND_{ext} depends on opto-configuration as described below. In opto-insulated mode (opto-configuration jumper not set) external ground has to be connected to this input. Then RefX..RefB work in respect to this external power add van be driven with an V_{ext} of up to 24 V. This is true for the reference inputs only, all other inputs remain with 0/5V logic levels and can't be driven with any external power.

WARNING: When no opto-insulated mode is selected (opto-configuration jumper is set), do NOT FEED ANY EXTERNAL POWER into Ref-inputs except the one from 5V output (pin 2), otherwise this would cause damage to the E1703C board!

The pins 15..24 provide the stepper motor control signals for axes 0..5 (step/direction signals to be used with a separate, external power driver).

Pins 15..26 all operate in open collector mode and have to be wired as follows:



Here V+ is either V (5V internal, non-insulated mode) or V_{ext} (up to 24V external, insulated mode). GND is either GND (non-insulated mode) or GND_{ext} (insulated mode). The internal resistor of the connected device is not allowed to have less than 530 Ohms (at 24V) or 110 Ohms (at 5V) in order to not exceed the given current limits as specified below.

The pins 3 to 7 are input pins for axes 0..5 to be used with the reference/homing position.

LaserGate provides laser modulation signal, turns on the laser during marks and off during jumps.

RunningMotion provides a HIGH-signal as long as a motion operation is active, means as long as any axis is moving. This signal can be used as additional safety switch to turn of/inhibit the laser when there is no motion.

LaserA usage depends on software configuration and control, it is able to output a pulse-width modulated frequency (e.g. for controlling CO_2 lasers), CW/continuously running frequency (e.g. for fiber lasers) or Q-Switch signal (e.g. for YAG lasers) in range 25 Hz..20 MHz.

Maximum current to be pulled out of each of the outputs is 20 mA.

ExtStart expects a CMOS-level input signal in respect to GND and can be used as external trigger signal to start operations when a HIGH-signal is detected at input pin.

ExtStop expects a CMOS-level input signal in respect to GND and can be used as external stop-signal in order to stop a running marking operation by using a HIGH-signal at input pin.

6.1.9.1 Referencing sequence

As the E1703C CNC controller makes use of external stepper motors which can't persist and provide the current position, prior to first use (after power-up) or when the motion position was changed manually and without the controller involved, all axes should be referenced in order to find a defined starting point. For this a referencing sequence has to be started either via the related API function call (please refer to section "9.1 E1703C Easy Interface Functions") or via suitable software. When started, a referencing sequence consists of the following steps:

1. move to the limit switch until it is hit (can be signalled either by LOW or HIGH input level, dependent on current configuration) using the first referencing speed
2. leave the limit switch until the leave distance has elapsed and using a lower speed; when the switch can't be left any more within a reasonable time, referencing fails and is cancelled at this point
3. move again to the limit switch until it is hit (can be signalled either by LOW or HIGH input level, dependent on current configuration) using the second referencing speed
4. leave the limit switch until the leave distance has elapsed and using a lower speed; when the switch can't be left any more within a reasonable time, referencing fails

When the referencing cycle has completed successfully, the controller sets the related axis position to value -2 (which can be changed to any other, suitable value by the controlling software). Now all movement operations can be done in relation to this fixed, defined position.
When the referencing cycle could not be completed successfully, the axis positions are undefined and should not be used for any motion operations!

6.1.10 Opto-Configuration

Using this jumper the operation mode for reference inputs RefX..RefB can be chosen. When is is set, the opto-couplers are powered internally. In this mode it is not working in opto-insulated mode and I/Os are using CMOS level signals.

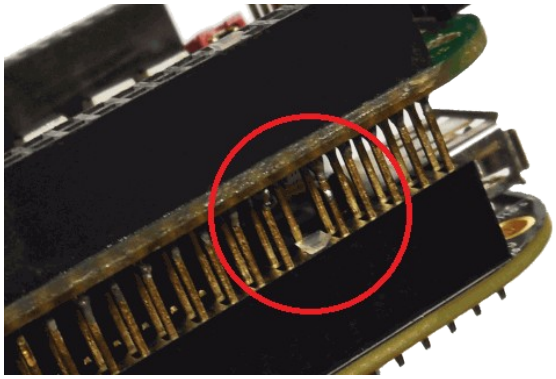
When it is not set, external ground has to be provided at GND_{ext} pin of the 26 pin connector (as described above) and the reference inputs are working in electrically insulated, opto-coupled mode with input signal levels in range 5V..24V.

This opto-insulated mode applies ONLY to the reference inputs, all other signals including step/direction signals to stepper motor driver are not separated and need to be operated with an external galvanic separation when this is required.

6.1.11 Extension Connectors

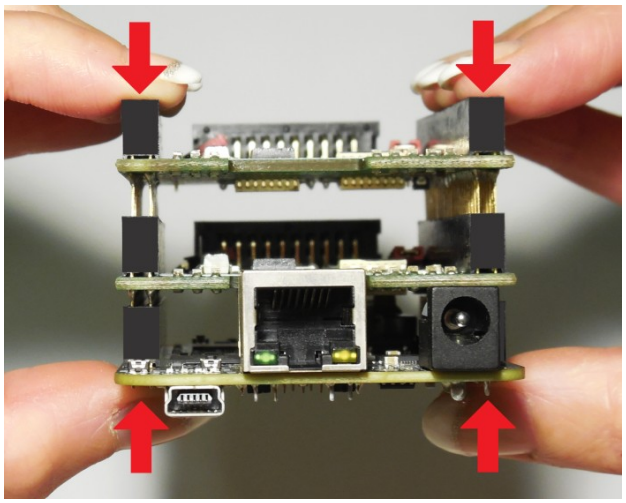
The two extension connectors on each side of the board can be used to place extension boards with additional peripheral interfaces. The extension connectors are designed to place/remove boards from time to time but

they are not intended for constant hardware changes. So changing extension boards repeatedly and often e.g. as permanent part of a production process is not recommended.

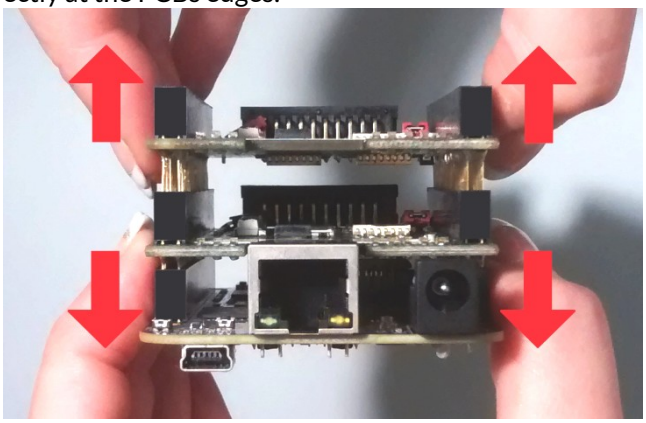


Key pin closed on lower connector and missing in upper board to ensure correct orientation

PLEASE NOTE: when placing a new extension board
1.check correct orientation and position of the key pin which is closed in connector
2.place the pins of the extension boards onto the extension connectors exactly
3.move down the extension board by pressing on its extension connectors gently; DO NOT PRESS THE BOARD ITSELF BUT ONLY THE CONNECTORS!



PLEASE NOTE: When removing an extension board DO NOT pull on the extension connectors but hold both boards on their long side directly at the PCBs edges:



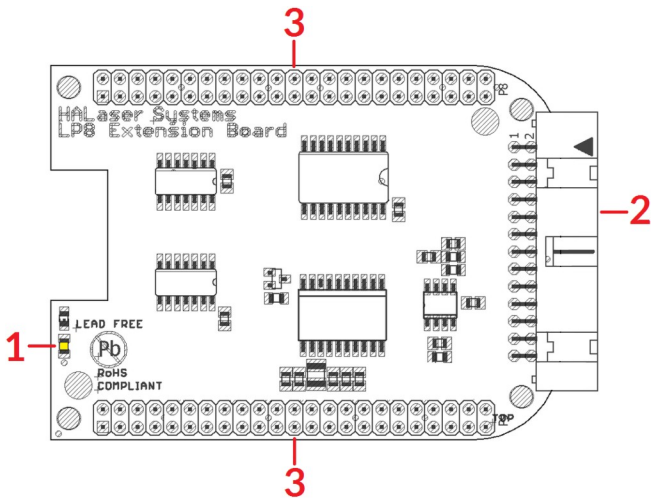
Due to of the large number of pins, it is easy to plug in an extension but more difficult to pull it out. So when removing an extension board, it is recommended to be very slow and to carefully pull each side up just a little bit to avoid bending of the pins as they exit.

6.1.12 Reset-Button

When this button is pressed for at least 20 milliseconds, it restarts the card completely, a current operation is cancelled, all signals are disabled and all remaining processing data are dropped. After releasing this button, the board is rebooted and firmware is started again.

6.2 E1703C LP8 Extension Board

The E1703C LP8 Extension Board provides following features:



1. MO LED – shows state of Main Oscillator output
2. Laser signals – black 26 pin laser output connector which provides signals for controlling a laser
3. Extension connectors – more extension boards can be placed here in order to add some more functionality and hardware interfaces to the board, please refer to related section in description of baseboard above

6.2.1 MO LED

This LED is specific to the Master Oscillator output signal described below. As long as the signal is on (HIGH-signal at output pin), the LED is turned on.

6.2.2 Laser Signals

The black 26 pin connector provides several signals for controlling a laser source. It can be used e.g. together with YAG, CO_2, IPG™, fiber and compatible lasers since it provides additional signals and frequencies these laser types may require for proper operation. To avoid confusion with similar connector used on E1703C Base board this connector is black.

This connector provides the following signals:

Upper Row Of Pins	Signal	Voltage	Remarks	Lower Row Of Pins	Signal	Voltage	Remarks
1	LP8_0	CMOS, 0/5V, max 8 mA		**2**	GND	GND	
3	LP8_1	CMOS, 0/5V, max 8 mA		4			
5	LP8_2	CMOS, 0/5V, max 8 mA		**6**	5V	5V	
7	LP8_3	CMOS, 0/5V, max 8 mA		**8**	MO	CMOS, 0/5V, max 8 mA	Master Oscillator
9	LP8_4	CMOS, 0/5V, max 8 mA		**10**	AOut0	0..5V, max 15 mA	Analogue output
11	LP8_5	CMOS, 0/5V, max 8 mA		12			
13	LP8_6	CMOS, 0/5V, max 8 mA		14			
15	LP8_7	CMOS, 0/5V, max 8 mA		16			
17	LP8 Latch	CMOS, 0/5V, max 8 mA		**18**	5V	5V	
19	LaserB	CMOS, 0/5V, max 14 mA	FPK	**20**			Connected to pin 21
21			Connected to pin 20	**22**	LaserA	CMOS, 0/5V, max 14 mA	PWM, frequency or Q-Switch
23	GND	GND		24			
25	5V	5V		**26**	Laser Gate[1]	CMOS, 0/5V, max 14 mA	

LP8_0...LP8_7 provide parallel 8 bit output signal (e.g. for power control with IPG(tm)/fiber lasers, waveform selection for SPI(tm) lasers and other).

LP8 Latch pin signals valid output at LP8_0..LP8_7 and AOut0 by submitting a latch pulse of software-controlled length.

MO can be used to enable master oscillator (e.g. for IPG(tm)/fiber lasers or compatible).

LaserA usage depends on software configuration and control, it is able to output a pulse-width modulated frequency (e.g. for controlling CO_2 lasers), CW/continuously running frequency (e.g. for fiber lasers) or Q-Switch signal (e.g. for YAG lasers) in range 25 Hz..20 MHz.

LaserB can be used for emitting a FPK pulse (e.g. for YAG lasers).

AOut0 pin provides unipolar analogue output for controlling e.g. laser power or additional equipment. This output depends on LP8_0..LP8_7 outputs, they are electrically connected and therefore can't have different values and can't be controlled by software independently. So when LP8 outputs are all LOW, AOut0 is on 0V. When LP8 outputs are all HIGH, AOut0 is 5V.

PLEASE NOTE: output of 5V at AOut0 depends on the used power supply. So in case board is powered via USB and USB power supply delivers less than 5V, maximum output on AOut0 will be less than 5V too. Here is would be recommended to use the base board with an external power supply that feeds exactly 5V into it.

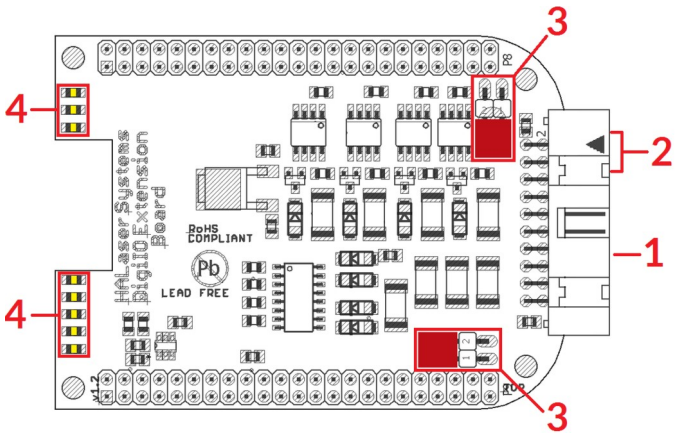
6.2.3 Extension Connectors

The two extension connectors on each side of the board can be used to place extension boards with additional peripheral interfaces. For a description of handling and usage of these connectors please refer above.

1 requires hardware-revision 1.1 or newer

6.3 E1703C Digi I/O Extension Board

The E1703CDigi I/O Extension Board provides following features:



1. Digi I/O – electrically insulated digital in- and outputs
2. optional inputs for 90 degree phase shifted encoders
3. Opto-Configuration – choose operation mode for Digi I/Os
4. Input state LEDs – displaying of HIGH/LOW state of used inputs

In case more extension boards are used on E1703D, Digi I/O extension always has to be placed on top.

6.3.1 Digi I/O

The 20 pin connector provides 8 lines for input and 8 lines for output of digital signals that can work on CMOS level (non-insulated mode) or via opto-couplers (electrically insulated mode with external power supply) optionally. The operation mode depends on jumper settings described below. The connector is used as follows:

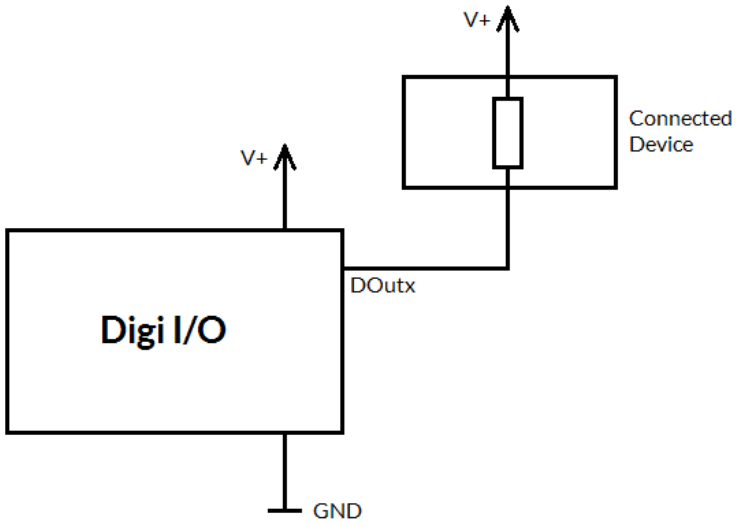
Upper Row Of Pins	Signal	Voltage	Remarks	Lower Row Of Pins	Signal	Voltage	Remarks
1	V_{ext}	5..24V	Input voltage to be used in opto-insulated mode only	**2**	GND_{ext}	GND	External ground
3	DOut0	CMOS, 0/5V or $0/V_{ext}$	Default level: LOW [1)]	**4**	DIn0	CMOS, 0/5V or $0/V_{ext}$	Encoder-input A1 for marking on-the-fly
5	DOut1	CMOS, 0/5V or $0/V_{ext}$	Default level: LOW [1)]	**6**	DIn1	CMOS, 0/5V or $0/V_{ext}$	Encoder-input B1 for marking on-the-fly
7	DOut2	CMOS, 0/5V or $0/V_{ext}$	Default level: LOW [1)]	**8**	DIn2	CMOS, 0/5V or $0/V_{ext}$	Second encoder-input A2 for marking on-the-fly
9	DOut3	CMOS, 0/5V or $0/V_{ext}$	Default level: LOW [1)]	**10**	DIn3	CMOS, 0/5V or $0/V_{ext}$	Second encoder-input B2 for marking on-the-fly
11	DOut4	CMOS, 0/5V or $0/V_{ext}$	Default level: HIGH [1)]	**12**	DIn4	CMOS, 0/5V or $0/V_{ext}$	
13	DOut5	CMOS, 0/5V or $0/V_{ext}$	Default level: HIGH [1)]	**14**	DIn5	CMOS, 0/5V or $0/V_{ext}$	
15	DOut6	CMOS, 0/5V or $0/V_{ext}$	Default level: HIGH [1)]	**16**	DIn6	CMOS, 0/5V or $0/V_{ext}$	
17	DOut7	CMOS, 0/5V or $0/V_{ext}$	Default level: HIGH [1)]	**18**	DIn7	CMOS, 0/5V or $0/V_{ext}$	
19	V	5V	Board voltage, to be used only when not operating in insulated mode	**20**	GND	GND	Board-internal ground

[1)] Please note the wiring scheme and the resulting, inverted logic below: a level of LOW means, the output is pulled to GND and a load that is connected from V to this pin is turned on. An level of HIGH means, the output is pulled to V and a properly wired load if turned off.

V_{ext} and GND_{ext} depend on opto-configuration as described below. In opto-insulated mode (opto-configuration jumpers not set) external power supply has to be connected to these inputs. Then DIn0..DIn7 and DOut0..DOut7 work in respect to this external power.

WARNING: When no opto-insulated mode is selected (opto-configuration jumpers are set), do NOT FEED ANY POWER into V_{ext}, this would cause damage to the E1703C board! In this case V_{ext} is equal to V (5V) of the board and GND_{ext} is connected to boards ground GND.

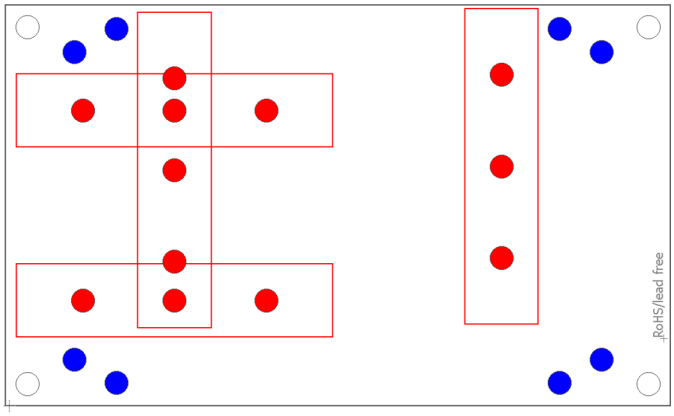
Maximum current for every output is 15 mA when internally powered (non-insulated mode), here it is recommended to use an external power supply.
Maximum current for outputs DOut0..DOut3 is 50 mA when externally powered (V_{ext} in insulated mode).
Signal output lines DOut0..DOut7 operate in open collector mode and have to be wired as follows:



Here “DOutx” symbolises one of the digital outputs DOut0..DOut7. V+ is either V (5V internal, non-insulated mode) or V_{ext} (up to 24V external, insulated mode). GND is either GND (non-insulated mode) or GND_{ext} (insulated mode). The internal resistor of the connected device is not allowed to have less than 490 Ohms in order to not exceed the given current limits.
DOut0..DOut3 provide LOW signal level by default, DOut4..DOut7 provide HIGH level by default. These levels are valid immediately on power-up of the card.

6.4 E170Xbase

The E1703base extension is a mounting help for easy installation on DIN rails/C45 rails and other possibilities of mechanical integration into machines:



RED – mounting positions for DIN/C45 rail locks/DIN/C45 rail adapters (bottom side). Pairs of locks can be mounted in one of 2 possible orientations. Here locks of type Phoenix Contact 1201578 or similar can be used. With these locks the board then can be clamped on a DIN/C45 rail.

BLUE – mounting holes for the E1703C CNC controller card on top of the E170Xbase in one of two possible orientations. These holes are symmetrically arranged so that the board can be mounted by 180 degrees rotated. Here Hex stands/distance bolts can be screwed in where the controller card is mounted on top.

Mounting procedure for E170Xbase:

1. Identify suitable positions (RED) for two DIN/C45 rail locks and mount them on bottom side (two or three screws from top side into the lock on bottom)
2. Mount hex-stands or distance bolts in at least four of the given mounting holes (BLUE).
3. Mount E1703C on top of these hex-stands/distance bolts
4. Clamp the board on your DIN/C45 rail

Without the DIN/C45 rail clamps the board also can be used as top-cover for boards of the E170X-series.

7 Quick Start into E1703C

Following a few steps are described that give users the possibility to quick start into usage of E1703C CNC controller. It makes use of BeamConstruct and the (slow) USB connection. For this quick start manual it is assumed correct wiring of the controller is already done according to the description above. For more detailed information about BeamConstruct usage please also refer to quick start manual from https://halaser.systems/download/manual_quickstart.pdf and to full user manual which is available at https://halaser.systems/download/manual.pdf.

To start with E1703C controller:

1. **SECURITY CHECK:** The following steps describe how to set up E1703C CNC controller card and how to control laser equipment and motors with it. Thus all laser safety rules and regulations need to be respected, all required technical security mechanisms need to be available and active prior to starting with it.
2. Install latest software version from https://halaser.systems/download.php – for Windows this package contains all required drivers, for Linux no separate drivers are needed.
3. Connect E1703C controller via USB. Power supply via power jack is recommended.
4. Now the Alive-LED should light up and then start blinking after some time. When this does not happen, please turn power off, check if the microSD-card is placed correctly and then try again.
5. Evaluate the serial interface the controller is connected with – for Windows the Device Manager (can be found in Control Panel) will list a new COM-port (e.g. “COM3”); for Linux type “dmesg” in console to find out to which interface it was connected with (typically “/dev/ttyACM0”).
6. Start BeamConstruct laser marking software.
7. Go to menu “Project” → “Project Settings...”, then tab-pane “Scanner”.
8. Now you can select “E1703C” as controller card.
9. Press the “Configure”-button to get into the settings dialogue for E1703C plug-in.
10. Enter the serial interface name in field “IP/Interface” (e.g. “COM3” or “/dev/ttyACM0”).
11. Leave everything with “OK”.
12. Draw some geometries as described in “BeamConstruct Quick Start Manual”.

13. **SECURITY CHECK:** Next the CNC controller card will be accessed for the first time. That means it is opened and initialised and all connected equipment may start working now. Thus it is very important to ensure all security regulations are met and nobody can be injured and no damage can be caused also in case laser output or other motion starts spontaneously and unexpectedly!
14. Press “F2” or go to menu “Process” → “Mark” to open the mark dialogue.
15. Start marking by pressing the yellow button with the laser-symbol

8 ASCII Command Interface

The E1703C can be accessed via different possibilities. One way to influence the device is via Telnet or USB serial port where ASCII-control-commands can be send to. This connection can also be used to configure the device properly in case no SD-card is used.
For this kind of control a Telnet-client has to connect to port 23 using the IP of the node or a terminal application has to connect to the serial port that is assigned to the USB interface. The Telnet client should work in passive mode. As soon as the connection is established, commands can be sent to the card. All commands come with following structure:

```
cxxxx <parameter(s)>
```

The commands always start with character “c”. Next four characters identify the command itself. Depending on the command itself, one or more optional or mandatory parameters may follow. The command always returns with an "OK" or with an error.

8.1 General Commands

The following commands can be used in all scenarios, they do not depend on a specific operation mode of the node.

`cvers`
"**vers**ion" – return version information of the controller card. This command returns a version string specifying version of hard- and firmware in style **`vMM.mm hh`** where “**`MM`**” is the major version of the firmware, “**`mm`**” the minor version and “**`hh`**” specifies the hardware revision of the controller.

8.2 Configuration Commands

Following commands can be used to view and to change the configuration of the E1703C:

`cgip0`
"**g**et **IP 0**" – get the static IP the node is currently using. The IP is returned as text in format xxx.yyy.zzz.aaa

`csip0 <xxx.yyy.zzz.aaa>`
"**s**et **IP 0**" – set a new IP for the node. Please note: this IP is neither stored automatically nor is it set immediately. To store the IP, the command `cwcfg` has to be used first, to make use of the new IP the node has to be rebooted.

Please also note: when changing the IP in a way where the subnet is affected, it may be necessary also the netmask and the gateway have to be reconfigured in order to reflect this new subnet and to let all three parameters fit to each other. When the node is rebooted without a proper network configuration, the E1703C **may become inaccessible**. In this case please use an SD-card together with a proper e1703.cfg configuration file to apply a valid configuration to the controller.
When an IP-adress 0.0.0.0 is specified here, the E1703C switches to DHCP-mode, means it tries to retrieve IP address, gateway and netmask from an DHCP-server in same network. In this case that DHCP-server is responsible for applying a proper IP address to the E1703C device.

`cggw0`
"**g**et **g**ate**w**ay **0**" – get the gateway address the node is currently using. The address is returned as text in format xxx.yyy.zzz.aaa

`csgw0 <xxx.yyy.zzz.111>`

"**s**et **g**ate**w**ay **0**" – set a new gateway address for the E1703C. Please note: this address is neither stored automatically nor is it set immediately. To store it, the command `cwcfg` has to be used first, to make use of the new gateway the node has to be rebooted.

Please also note: when changing the gateway in a way where the subnet is affected, it may be necessary also the netmask and the IP have to be reconfigured in order to reflect this new subnet and to let all three parameters fit to each other. When the node is rebooted without a proper network configuration, the E1703C **may become inaccessible**. In this case please use an SD-card together with a proper e1703.cfg configuration file to apply a valid configuration to the controller.

`cgnm0`

"**g**et **n**et**m**ask **0**" – get the netmask the node is currently using. The mask is returned as text in format xxx.yyy.zzz.aaa

`csnm0 <xxx.yyy.zzz.111>`

"**s**et **n**et**m**ask **0**" – set a new netmask for the node. Please note: this mask value is neither stored automatically nor is it set immediately. To store it, the command `cwcfg` has to be used first, to make use of the new netmask the node has to be rebooted.

Please also note: when changing the netmask in a way where the subnet is affected, it may be necessary also the gateway and the IP have to be reconfigured in order to reflect this new subnet and to let all three parameters fit to each other. When the node is rebooted without a proper network configuration, the E1703C **may become inaccessible**. In this case please use an SD-card together with a proper e1703.cfg configuration file to apply a valid configuration to the controller.

`cgipw`

"**g**et **w**rite-**IP**" – get the static IP which is allowed to have write-accesses to the hardware and from which it is possible to change configuration parameters via Telnet/serial USB. When no ip is set (0.0.0.0), all external clients are allowed to write to the hardware, elsewhere only the IP specified here has access.

`csipw <xxx.yyy.zzz.aaa>`

"**s**et **w**rite-**IP**" – set a new IP which is allowed to have write-accesses to the configuration parameters. Please note: this IP is neither stored automatically nor is it set immediately. To store the IP, the command `cwcfg` has to be used first, to make use of the new write-IP, the node has to be rebooted.
When an IP-adress 0.0.0.0 is specified here, the write-access limitation is disabled, all connected clients can change the configuration, no matter from what IP these connections come from. Otherwise only that client can perform write operations, that comes from the correct IP specified with this command.

`cwcfg`

"**w**rite **c**on**fig**uration to flash" – save changes in the current configuration in internal flash in order to persist them and to make them available after next restart. To apply changed configurations, it can be necessary to reboot the node. This should NOT be done by toggling the power but by calling command `crrrr`. Using this command ensures a previous save-operation was completed successfully and without any interruption.

`clcfg`

"list **c**on**fig**uration parameters" – lists all current configuration parameters together with the telnet command that can be used to set them. This command can be used to get and backup the full configuration of a E1703C for easy restore or for easy copying to an other node.

`crrrr`

"**r**eset" – performs a full reset with the node, this command interrupts all connections and running operations, reboots the E1703C and lets it come back with the default (stored) configuration

8.3 Hardware Commands

These commands can be used to access hardware signals directly. When these hardware outputs are set or unset while a marking operation is running, they may have no effect as they may be overridden immediately. Thus it is recommended to execute them only when the controller card is idle and no other operations are in progress. But also in this case, when a hardware output is set to a specific state, any operation (especially marking cycle) that is executed afterwards, may override that specific state-changes. Following hardware-specific commands are supported:

`cginp`

"**g**et **inp**ut" – get the current state of the digital inputs (in case a Digi I/O extension is available). The input state is returned as a decimal number representing the bitpattern at the inputs. So when e.g. a value "15" is returned, this means the lower four inputs are set to HIGH while the upper ones are at LOW level

`csout <value>`

"**s**et **out**put" – set the state of the digital outputs (in case a Digi I/O extension is available). The output to be set is specified as a decimal number representing the bitpattern. When no parameter is given, the behaviour is undefined.
Example: `csout 128` – set DOut7 at the Digi I/O extension board to HIGH while all others stay at LOW

`cslgt <value>`

"**s**et **L**aser**G**a**t**e" – set the state of the LaserGate output either to HIGH (value is set to 1) or to LOW (value is set to 0).

`cslmo <value>`

"**s**et **MO**" – set the state of the main oscillator output either to HIGH (value is set to 1) or to LOW (value is set to 0).

`cslp8 <value>`

"**s**et **LP8**" – set the state of the LP8 output port to the value given as parameter. Here value is allowed to be in range 0..255, the related bits of the LP8 output are set according to the bitpattern of the specified number.

`csao0 <value>`

"**s**et **AO**ut**0**" – set the state of the AOut0 analogue output port to the value given as parameter. Here value is allowed to be in range 0..255 resulting in a correcponendt output value in range 0..V_{max}.

9 Programming Interfaces

The libe170xc.dll / libe170xc.so shared library provides an own programming interface that gives the possibility to access and control the E1703C CNC controller card.

9.1 E1703C Easy Interface Functions

These functions belong to the native programming interface of E1703C CNC controller card and should be used preferential in order to get access to all features and full performance of the card. Functions of E1703C Easy Interface are either stream commands that are executed in the order they are called, or functions that are executed immediately.

The E1703C does NOT use the concept of two or more lists that have to be managed and switched by the calling application. Here all stream commands simply are sent to the card without the need to provide some additional management information. Output of data is started as soon as possible or when a card-internal threshold is exceeded. This card-internal triggered output of data can be held back only by calling function `E170XC_set_trigger_point()` as very first so that marking starts only after an external trigger signal was detected by the card. In this case it may happen that – in case of large amounts of data being sent – the commands and coordinates have to be stored on host-side and are not sent to the controller. Here it has t obe ensured enough resources are available on the host system in order to keep these data.

E1703C Easy Interface uses unit “mm” as base for all distance-units and -parameters.

E1703C Easy Interface provides following functions:

`unsigned char E170XC_set_connection(const char *address)`

This function has to be called as very first. It is used to specify the IP address where the card is accessible at (in case of Ethernet connection) or the serial interface (in case of USB connection, “COMx” for Windows and “/dev/ttyACMx” for Linux where “x” is the number of its interface).
It returns a board instance number that has to be used with all following functions.
Please note: this function does only set the connection information, it does not yet open the connection to the controller! This happens on first call to `E170XC_open_connection()`.
Parameters:
`address` – a char-array containing the IP in xxx.yyy.zzz.aaa notation or the name of the COM port to be used
Return: the board instance number or 0 in case of an error

`void E170XC_set_password(const unsigned char n,const char *ethPwd)`

Sets a password that is used for Ethernet connection of E1703C card. The same password has to be configured on E1703C configuration file E1703.cfg with parameter "`passwd`" to add an additional level of security to an Ethernet controlled card.

PLEASE NOTE: usage of this password does NOT provide enough security to control the card via networks that are accessible by a larger audience, publicly or via Internet! Also when this password is set, the card always should operate in secured, separated networks only!
Every card and every connection should use an own, unique password that can consist of up to 48 characters containing numbers, lower- and uppercase letters and punctuation marks. Due to compatibility reasons no language-specific special character should be used.
When connected via USB serial interface, this password is ignored. In this case no authentication is done.
Parameters:
`ethPwd` – the password to be used to authorise at an E1703C card. To reset a local password for connecting to a card that doesn't has a Ethernet password configured, hand over an empty string "" here

`int E170XC_set_debug_logfile(const unsigned char n,const char *path,const unsigned char flags)`

This function can be used during development to check an own application regarding called commands and their parameters. It lets libe1703c write all function calls into a logfile so that it is possible to evaluate the real order of commands.

Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
path – full path to the file which has to be used as debug log file
flags – a bunch of OR-concatenated flags which specify what function calls have to be written into or filtered from the log output; when 0x00 is specified here, the log file is kept quite small. When 0x01 is set, all motion-related function calls are added too, when 0x02 is set, all calls which check the state of the card are added to the log file.
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_write_debug_logfile(const unsigned char n,const char *format,…)

This function correpsonds to E170XC_set_debug_logfile(), it gives the user the possibility to write own log information into a logfile.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
format – format specifier as it is used e.g. by printf()
… - data according to the format specifier
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_open_connection(const unsigned char n)

Opens the connection to the CNC controller card.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

void E170XC_close(const unsigned char n)

Closes the connection to a card and releases all related resources. After this function was called, no more commands can be sent to the card until E170XC_set_connection() and E170XC_open_connection() is called again.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()

int E170XC_set_xy_correction(const unsigned char n,const unsigned int flags,const double gainX, const double gainY, const double rot,const double slantX, const double slantY)

Sets size correction factor and offset for X and Y direction of working area as well as a rotation and slant. With this command a matrix set with E170XC_set_matrix() will be overwritten.
This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands and changed values apply only to these vector data and coordinates, which are sent after calling this function.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
flags:

- E170XC_COMMAND_FLAG_XYCORR_MIRRORX – the output will be mirrored in X-direction
- E170XC_COMMAND_FLAG_XYCORR_MIRRORY – the output will be mirrored in Y-direction

gainX – scale factor in x-direction, 1.0 means no scaling
gainY – scale factor in y-direction, 1.0 means no scaling
rot – rotation of whole working area in unit degrees
offsetX – offset in x-direction in unit bits, 0 means no offset
offsetY – offset in y-direction in unit bits, 0 means no offset
slantX – trapezoidal correction along X-axis in range -45..45°
slantY – trapezoidal correction along Y-axis in range -45..45°
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_set_matrix(const unsigned char n,const unsigned int flags,const double m11,const double m12,const double m21,const double m22)

Specify a 2x2 matrix that contains scaling and rotation corrections for the output. When a given matrix element parameter has a value smaller or equal -10000000 it is ignored and the previous/default value is kept at this position in matrix. With this command any correction set with `E170XC_set_xy_correction()` will be overwritten.
This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.
Parameters:
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
`flags` – reserved for future use, set to 0 for compatibility
`m11` – first matrix element in first row
`m12` – second matrix element in first row
`m21` – first matrix element in second row
`m22` – second matrix element in second row
Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

int E170XC_set_speeds(const unsigned char n,double speed)

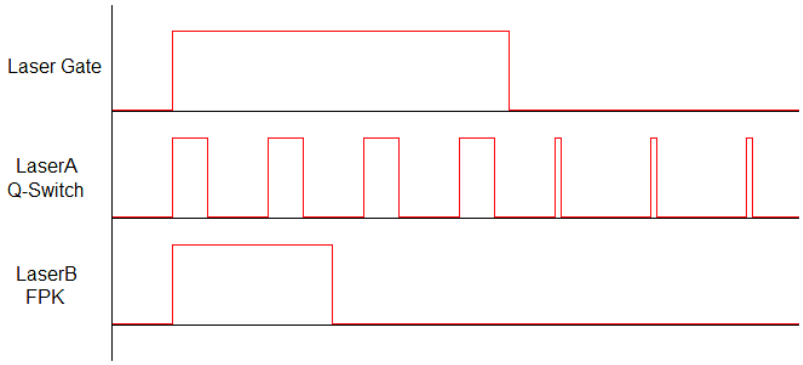
Set axis motion speed values to be used for all following vector data and until not replaced by other speed values. This command sets a path speed for the movement to be performed which – dependent on the movement direction – results in different absolute speeds of the single axes.
This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands and changed values apply only to these vector data and coordinates, which are sent after calling this function.

Parameters:
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
`speed` – movement speed resulting out of movement of all axes
Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

int E170XC_set_laser_mode(const unsigned char n,const unsigned int mode)

Sets the laser mode to be used for all following operations, this value influences the signals emitted at the connectors of the LP8 extension card. This function has to be called prior to setting any other laser parameters (like frequency, standby-frequency, power).
This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.
Parameters:
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
`mode` - the laser mode, here one of the following values is possible:

- `E170XC_LASERMODE_CO2` – for controlling CO2 lasers, this mode supports stand-by frequency at LaserA output (to be set with function `E170XC_set_standby()`) and PWM-modulated frequencies during marking and for power control (to be set with function `E170XC_set_laser_timing()`)
- `E170XC_LASERMODE_YAG1` – for controlling YAG lasers, this mode supports stand-by and Q-Switch frequency at LaserA output (to be set with function `E170XC_set_standby()`) and a first pulse killer signal at output LaserB that is issued on beginning of a mark together with the Q-Switch frequency (to be set with function `E170XC_set_fpk()`):



Here Q-Switch signal is started together with laser gate and FPK pulse. At end of mark when laser gate is turned off stand-by frequency is emitted at LaserA.

- `E170XC_LASERMODE_CRF` – for controlling lasers that require a continuously running frequency (like fiber-lasers), this frequency is emitted at LaserA output and can be set and changed by calling function `E170XC_set_standby()`.
- `E170XC_LASERMODE_MOPA` – for fiber lasers which are driven by a main oscillator and power amplifier and that are power-controlled via LP8 digital port and latch bit

Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

`int E170XC_set_laser(const unsigned char n,const char on)`

Switches the laser on or off independent from any mark or jump commands.

Parameters:
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
`on` – set to 1 to turn the laser on or to 0 to turn it off
Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

`int E170XC_jump_abs(const unsigned char n,const uint32_t flags,const double x,const double y,const double z,const double u,const double v)`

Perform a jump (movement with laser/tool turned off) to the given position. This causes a motion from current position to the one specified by this functions parameters using the jump speed.
This function does not guarantee a movement which describes a straight line from current coordinate position to the jump-target-coordinates. Instead of this always the fastest way to the new target position is used.
This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.
Parameters:
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
`flags` – a set of OR-concatenated flags which specify which of the handed over coordinate values have to be used. Here at least one of the flags `E170XC_COMMAND_FLAG_AXIS_X`, `E170XC_COMMAND_FLAG_AXIS_Y`, `E170XC_COMMAND_FLAG_AXIS_Z`, `E170XC_COMMAND_FLAG_AXIS_U` and `E170XC_COMMAND_FLAG_AXIS_V` has to be set. When a flag fr a coordinate is not set, the related value is ignored.
`x` – the x-coordinate in unit mm the tool has to jump to
`y` – the y-coordinate in unit mm the tool has to jump to
`z` – the z-coordinate in unit mm the tool has to jump to
`a` – the a-coordinate in unit mm the tool has to jump to
`b` – the b-coordinate in unit mm the tool has to jump to
Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

`int E170XC_mark_abs(const unsigned char n,const uint32_t flags,const double x,const double y,const double z,const double u,const double v)`

Perform a mark (movement with laser/tool turned on) to the given position. This causes a movement from current position to the one specified by this functions parameters using the mark speed. Different to any call to `E170XC_jump_abs()` this function also guarantees a straight line movement is

performed from current axis coordinate position to the one specified by this function call. When laser was turned off before this function is called, laser is turned on at the beginning.

This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.
Parameters:
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
`flags` – a set of OR-concatenated flags which specify which of the handed over coordinate values have to be used. Here at least one of the flags `E170XC_COMMAND_FLAG_AXIS_X`, `E170XC_COMMAND_FLAG_AXIS_Y`, `E170XC_COMMAND_FLAG_AXIS_Z`, `E170XC_COMMAND_FLAG_AXIS_U` and `E170XC_COMMAND_FLAG_AXIS_V` has to be set. When a flag fr a coordinate is not set, the related value is ignored.
`x` – the x-coordinate in unit mm the tool has to move to
`y` – the y-coordinate in unit mm the tool has to move to
`z` – the z-coordinate in unit mm the tool has to move to
a – the a-coordinate in unit mm the tool has to move to
`b` – the b-coordinate in unit mm the tool has to move to
Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

`int E170XC_set_trigger_point(const unsigned char n)`

Specifies a point in data stream where execution has to stop until an external trigger signal (mark start) or a manual release of this trigger point is detected. This expects a rising edge on ExtStart input or calling of function `E170XC_release_trigger_point()`.
This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.
Parameters:
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

`int E170XC_release_trigger_point(const unsigned char n)`

This function should be called only when a call to `E170XC_set_trigger_point()` was done before. It acts like an external trigger signal, releases the waiting condition and lets the controller start processing. So this function provides some kind of software-simulated external start-signal.
This is not a stream-command, it is applied to controller immediately.
Parameters:
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

`int E170XC_set_sync(const unsigned char n,const unsigned int value)`

This function sends a synchronisation value "value" to the controller. As soon as marking reaches the related position in stream, the value returned by `E170XC_get_sync()` changes to the value given here. When the given value is ensured to be unique, this command can be used to watch the exact execution position of the current marking operation.
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
`value` – a unique value which can be used to identify the current progress
Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

`unsigned int E170XC_get_sync(const unsigned char n)`

This function returns the current sync-value as set by function `E170XC_set_sync()` as soon as a markign operation has reached the related position. When no sync-markers have been set with `E170XC_set_sync()` or when the firs sync-position has not been reached yet, the returned value is 0xFFFFFFFF.
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
Return: the current sync-position

int E170XC_stop_execution(unsigned char n)

Stops the currently running execution as fast as possible and drops all marking data that still may be queued. A running motion operation is not cancelled but stopped with the defined deceleration rate so that no motion steps are lost on the connected motor and no referencing is necessary after such a stop.
This is not a stream command since it controls the current stream of commands.
Parameters:
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

int E170XC_halt_execution(unsigned char n,unsigned char halt)

Halts or continues the processing and output of marking data. On `halt=1` marking is tried to be stopped next time the laser/tool would be turned off. This stop is not guaranteed to take place immediately, so also when this function was called, current process may still continue for some time. Different to a full stop no vector data are flushed. On continue (`halt=0`) controller continues processing at the point where halt occurred. When marking is stopped with `E170XC_stop_execution()` the halt-condition is cleared too, means on next transmission of new marking data they are processed without the need to explicitly continue last operation.
Parameters:
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
`halt` – 1 to halt operation next time the laser is off, 0 to continue a previously halted operation

Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

unsigned int E170XC_get_startstop_state(const unsigned char n)

This function returns a bit pattern that informs about state of the start and stop input pins.
This is not a stream command since it returns the current state immediately. Here "current state" means the last known state. When the state changes during this call, it may be possible the previous, no longer actual state is given back since transmission of data from controller to host is done asynchronously and independent from a call to this function.
Parameters:
`n` – the 1-based board instance number as returned by `E170XC_set_connection()`
Return: a bit pattern specifying the current state:

- bit 0 and 1 (0x00000003) specify if the start input was set after last call of this function, when these bits are set, a rising edge has been detected at this input; calling this function resets the internal state of these bits, means when it is called again and when no new rising edge has been detected meanwhile, these bits will be 0
- bit 2 and 3 (0x0000000C) specify if the stop input was set after last call of this function, when they are set, a rising edge has been detected at this input; calling this function resets the internal state of these bits, means when it is called again and when no new rising edge has been detected at top input meanwhile, these bits will be low
- bit 12 (0x00001000) this bit signals the start input is low, as long as this bit is set no start input signal is detected

int E170XC_get_card_state(const unsigned char n, unsigned int *state)

This function returns a bit pattern that informs about cards current operational state. Here "current state" means the last known state-change which was not fetched by a call to this commandxc. When the state changes during this call, it may be possible the previous, no longer actual state is given back since transmission of data from controller to host is done asynchronously and independent from a call to this function.
The card-states are enqueued internally in order to not to lose any state which may be available for a very short time only in case of very small and fast marking cycles. So every state change on the controller (which itself always is caused by the calling application) results in one state change returned by this function. This means for every marking cycle the application has to wait for two state changes: first wait until this function signals "busy" (`E170XC_CSTATE_MARKING|E170XC_CSTATE_PROCESSING`), next wait until this function signals "ready" (0).

Same for a referencing operation: first wait until this function signals busy with the E170XC_CSTATE_IS_REFERENCING flag set, next wait until this flag is cleared.
During transfer of vector data and motion/laser parameters this function should be called as rarely as possible: every call of E170XC_get_card_state() performs a full cycle of transmission and receiving of data to and from the controller. Dependent on the current transmission state this may result in submission of a small block of data which does not uses the full available bandwidth. On excessive use of this function this can slow down the whole transfer of data.
This is not a stream command since it returns the current state immediately.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
state – pointer to a variable where the card state has to be written to: a bit pattern of or-concatenated constants specifying the current state:

- E170XC_CSTATE_MARKING - card is currently marking
- E170XC_CSTATE_PROCESSING - card has received some data that are enqueued for marking
- E170XC_CSTATE_HALTED – the marking process is currently halted and waits for being stopped completely or being released in order to continue operation
- E170XC_CSTATE_WAIT_EXTTRIGGER – the marking process is running but does not do anything right now as the controller is waiting for a signal at the ExtStart input (or for a call to E170XC_release_trigger_point())
- E170XC_CSTATE_WAIT_INPUT – the marking process is running but does not do anything right now as the controller is waiting for a signal at a digital input
- E170XC_CSTATE_ERROR – a fatal operational error happened, such as a failed reference run
- E170XC_CSTATE_IS_REFERENCING – the controller is still in referencing mode which may include movement of axes that are signalled by flag E170XC_CSTATE_MARKING additionally.

When the function returns an error code instead of E170XC_OK, this value is undefined and can't be used.
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_delay(unsigned char n,const double delay)

Pause marking for the given time.
This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
delay - time to wait until marking continues in unit usec, smallest possible value is 0,5 usecs
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_set_laser_timing(const unsigned char n,const double frequency,const double pulse)

Set the frequency and pulse-width to be used during marking at LaserA output of LP8 Extension Board.
This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
frequency – emitted frequency in unit Hz and in range 25..20000000 Hz
pulse – pulse width in usec, this value has to be smaller than period length that results out of frequency
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_set_standby(const unsigned char n,const double frequency,const double pulse,const bool force)

Set the frequency and pulse-width to be used during jumps, as stand-by frequency or as continuously running frequency at LaserA output of LP8 Extension Board.
This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()

frequency – emitted frequency in unit Hz and in range 25..20000000 Hz. When a value of 0 is given, the frequency at LaserA output is turned off at end of mark.
pulse – pulse width in usec, this value has to be smaller than period length that results out of frequency
force – when set to true, the new stand-by frequency is not applied the next time the laser is turned off, but immediately
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_set_fpk(const unsigned char n,const double fpk,const double yag3QTime)

Set the parameters for first pulse killer signal that is emitted via LaserB output of the baseboard or the LP8 extension board whenever the laser is turned on; this applies to YAG-modes only and is emitted as one single pulse at LaserB output.
This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
fpk – the length of the first pulse killer signal in usec
yag3QTime – the length of the first pulse killer signal in usec, this value is used only when laser mode E1703_LASERMODE_YAG3 is set, elsewhere it is ignored
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

void E170XC_get_version(const unsigned char n,unsigned short *hwVersion,unsigned short *fwMajorVersion,unsigned short *fwMinorVersion)

Get the hardware and software version of the used board. It is recommended to call this function after successful connect always and check if used hardware and firmware version is at least a version that is known to work with own software.
This is not a stream command, it is executed immediately and independent from all other commands.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
hwVersion – pointer to a variable where the hardware revision/version number is written into
fwVersion – pointer to a variable where the revision/version number of the firmware running on the board is written into

int E170XC_get_library_version()

Returns an integer value which is an identifier specifying the version of this shared library. In decimal notation this identifier uses format "Mmmrrr" where "M" is the major version, "m" the minor version number and "r" the release count. The bigger the whole returned number is, the newer the library is.

int E170XC_motion_set_steps(const unsigned char n, const unsigned int flags,const double steps)

Set the factor which defines the relation between steps (increments) of the used stepper motor and the distance that it travels. This value needs to be specified prior to all other operations in order to allow correct calculation of all distances and speeds as expected by the other functions as described below. For the E1703C CNC controller no default value exists, so if no factor is set, motion operations are done with an undefined, random value which may lead to unexpected results.
The E1703C API always makes use of real distances (in unit mm) and does not expect the calling application to do the conversion from increments to mm.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
flags – command flags specifying for which axes the given values have to be applied
(E170XC_COMMAND_FLAG_AXIS_X, E170XC_COMMAND_FLAG_AXIS_Y, E170XC_COMMAND_FLAG_AXIS_Z, E170XC_COMMAND_FLAG_AXIS_U, E170XC_COMMAND_FLAG_AXIS_V)

steps – factor which defines relation between stepper motor steps and travel distance (in unit increments/mm)
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_motion_set_limits(const unsigned char n,const unsigned int flags,const double llimit,const double hlimit)

Set motion limits for axis operations. When any follow-up command tries to set values beyond these limits, these values are clipped to the allowed range set with this function.

Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
flags – command flags specifying for which axes the given values have to be applied (E170XC_COMMAND_FLAG_AXIS_X, E170XC_COMMAND_FLAG_AXIS_Y, E170XC_COMMAND_FLAG_AXIS_Z, E170XC_COMMAND_FLAG_AXIS_U, E170XC_COMMAND_FLAG_AXIS_V)
llimit – lower motion limit (in unit mm)
hlimit – upper motion limit (in unit mm)
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_motion_set_accel(const unsigned char n,const unsigned int flags,const double accel)

Set the acceleration to be used for start and stop for all motion operations and for the specified axes.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
flags – command flags specifying for which axes the given values have to be applied (E170XC_COMMAND_FLAG_AXIS_X, E170XC_COMMAND_FLAG_AXIS_Y, E170XC_COMMAND_FLAG_AXIS_Z, E170XC_COMMAND_FLAG_AXIS_U, E170XC_COMMAND_FLAG_AXIS_V)
accel – acceleration (in unit mm/sec^2)
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_motion_reference(const unsigned char n,const unsigned int axis,const unsigned int mode,const double leaveDist,double speedStep0,double speedStep1)

Starts a referencing operation (=homing sequence) to have a defined position for the axis. The referencing sequence consists of following steps:

- move to reference switch (connected to reference-input) with first referencing speed speedStep0
- leave the reference switch by the given distance leaveDist – when the switch has not been released after the distance specified by leaveDist or after a reasonable time, referencing operation is set as "failed"
- move to reference switch (connected to reference-input) with second referencing speed speedStep1
- leave the reference switch by the given distance leaveDist – when the switch has not been released after the distance specified by leaveDist or after a reasonable time, referencing operation is set as "failed"
- set the position of the referenced axis to -1 – when referencing fails for some reason (because it was interrupted or because the limit switch could not be left within a reasonable time), the position of the axis will be undefined and E170XC_get_card_state() will return an error E170XC_CSTATE_ERROR.

This function returns only in case referencing was finished or cancelled due to an error. It can be interrupted by calling E170XC_stop_execution().
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
axis – specifies which axis has to be referenced, here a value in range 0..4 is expected
mode – specifies how referencing has to be done exactly, here a bunch of OR-concatenated flags can be handed over: one of the flags E170XC_MOTION_REFSTEP_N (to search for the reference input in negative

direction) or E170XC_MOTION_REFSTEP_P (to search for the reference input in positive direction) which optionally can be combined with flag E170XC_MOTION_REFSTEP_INV_SWITCH to have inverted logic on the reference input

leaveDist – distance (in unit mm or degrees) to move off the reference switch after the switch was found for the first time

speedStep0 – referencing speed (in unit mm/sec or degrees/sec) to find the reference switch for the first time (this value can be larger than speedStep1 but should be small enough to not to overrun the switch)

speedStep1 – referencing speed (in unit mm/sec or degrees/sec) to find the reference switch for the second time (this value should be smaller than speedStep0 and is responsible for the accuracy of the referenced position)

Return: E170XC_OK when operation could be completed successfully, E170XC_ERROR_REFERENCING when referencing has failed for some reason or E170XC_ERROR_-return code in case of an other error

int E170XC_motion_set_pos(const unsigned char n,const unsigned int flags,const double pos)

This function does not cause any movement but resets the current axis position(s) to a new value. It can be used e.g. after successful referencing to set the initial positions to some own values. All following movement operations then are done in respect to the position values given here.

n – the 1-based board instance number as returned by E170XC_set_connection()

flags – command flags specifying for which axes the given values have to be applied (E170XC_COMMAND_FLAG_AXIS_X, E170XC_COMMAND_FLAG_AXIS_Y, E170XC_COMMAND_FLAG_AXIS_Z, E170XC_COMMAND_FLAG_AXIS_U, E170XC_COMMAND_FLAG_AXIS_V)

pos – the new position value to be set for the specified axis/axes (in unit mm or degrees)

Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_lp8_write(const unsigned char n,const unsigned char value)

Sets the LP8_0..LP8_7 outputs of 8 bit laser port of LP8 Extension Board without touching the related latch output. Total execution time of this command during processing on controller is 1 usec.

This function does not change the value at the analogue AOut0 output of LP8 Extension Board.

Depending on the value of parameter flags this is either a stream-command (means it is executed at a point in stream that is relative to the other stream commands) or a direct command (means it is executed immediately on calling).

Parameters:

n – the 1-based board instance number as returned by E170XC_set_connection()

value – the 8 bit value to be set at LP8 port

Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_lp8_write_latch(const unsigned char n,const unsigned char on,const unsigned char value)

Sets the LP8 8 bit laser port of LP8 Extension Board with freely definable delays and toggles the related latch output automatically; calling this function causes the following sequence of commands:

- set LP8
- wait until the LP8 signal has settled
- toggle the latch bit to apply the LP8 value
- wait until the latch toggle has been applied

Depending on the value of parameter "on" this function may or may not set the analogue AOut0 output successfully.

This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.

Parameters:

n – the 1-based board instance number as returned by E170XC_set_connection()

on – specifies if the latch bit has to be set to HIGH (on=1) or LOW (on=0) on first step, on second step it will toggle to value !=on

value – the 8 bit value to be set at LP8 port

Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_lp8_a0(const unsigned char n,const unsigned char value)

Sets the analogue output AOut0 of LP8 Extension Board. This also changes the state of LP8_0..LP8_7 outputs and toggles the LP8 latch.
This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
flags – handling flags specifying the behaviour of this command, E170XC_COMMAND_FLAG_STREAM to use it as stream command, E170XC_COMMAND_FLAG_DIRECT to execute it immediately and independent on current stream and execution state
value – the 8 bit value to be set at analogue output port
Return: E170XC_OK or an E170XC_ERROR_ return code in case of an error

int E170XC_lp8_write_mo(const unsigned char n,const unsigned char on)

Sets the main oscillator output MO of LP8 Extension Board to be used with e.g. fiber lasers.
This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.

Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
on – the state the MO output has to be switched to; PLEASE NOTE: the main oscillator depends on the current internal state of the laser. Thus turning it on is always possible but turning off the MO is possible only when the controller is not yet handling the laser-off delay, means it is not possible as long as the laser is turned on. In such a case this command is ignored.
Return: E170XC_OK or an E170XC_ERROR_-return code in case of an error

int E170XC_digi_write(const unsigned char n,unsigned int value,const unsigned int mask)

Sets the 8 bit digital output port of Digi I/O Extension Board.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
mask – specifies which of the bits in "value" have to be used for setting and clearing output data, only these bits that are set to 1 in mask are changed according to the given value
value – the 8 bit value to be set at digital out port

Return: E170XC_OK or an E170XC_ERROR_ return code in case of an error

int E170XC_digi_pulse(const unsigned char n,const unsigned int in_value,const unsigned int mask,const unsigned int pulses,const double delayOn,const double delayOff)

Send a sequence of pulses to the 8 bit digital output port of Digi I/O Extension Board.
Parameters:
n – the 1-based board instance number as returned by E170XC_set_connection()
mask – specifies which of the bits in "value" have to be used for setting and clearing output data, only these bits that are set to 1 in mask are changed according to the given value
value – the 8 bit value to be set at digital out port
pulses – specifies how often the output has to be set/cleared
delayOn – the delay (in unit usec) which has to be issued every time after setting the output, the minimal resolution of this value is 1 msec
delayOff – the delay (in unit usec) which has to be issued every time after clearing the output, the minimal resolution of this value is 1 msec
Return: E170XC_OK or an E170XC_ERROR_ return code in case of an error

int E170XC_digi_read(const unsigned char n,unsigned int *value)

Reads the 8 bit digital input port of Digi IO Extension Board.

This is not a stream-command, means it is executed immediately and returns the current state of the digital inputs.

Parameters:

`n` - the 1-based board instance number as returned by `E170XC_set_connection()`

`value` – pointer to a variable where the current digital input state has to be written into.

When the function returns an error code instead of E170XC_OK, this value is undefined and can't be used.

Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

int E170XC_digi_wait(const unsigned char n,const unsigned long value,const unsigned long mask)

Stop execution and output of data until the given bitpattern was detected at digital inputs of Digit I/O Extension board. Here parameter `mask` specifies which of the bits at the input have to be checked, they have to be set to 1. These bits within `mask` that need to be ignored have to be set to 0. Parameter `value` itself defines the states of the bits that has to be detected at the input to continue processing of data. All bits of `value` that correspond to bits of `mask`, that are 0, are ignored.

Parameters:

`n` - the 1-based board instance number as returned by `E170XC_set_connection()`

`value` – the expected bitpattern at digital input

`mask` – specifies which of the input bits and value bits have to be used for comparison

Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

int E170XC_digi_set_mip_output(const unsigned char n,const unsigned int value)

This function can be used to specify which of the digital outputs has to be used for signalling "marking in progress". When `value` is set to 0xFFFFFFFF, this function is disabled and CNC controller card does not provide this signal automatically. When the number of the digital output (in range 0..7) is given as `value`, the related digital output pin is used for "mark in progress" signal.

PLEASE NOTE: here the number (means the count) of one specific output pin has to be given, not a bitpattern specifying one or more pins!

During operation the selected "mark in progress" pin is HIGH as long as the axes are moving and/or the laser is on and/or a delay is processed and when marking parameter are processed between these operations. It becomes LOW as soon as no more marking data are available and current operation is stopped or when controller is waiting for an external trigger signal (ExtStart).

This is not a stream-commando, when it is called it is applied to current configuration immediately.

Parameters:

`n` – the 1-based board instance number as returned by `E170XC_set_connection()`

`value` – the number of the digital output to be used for this signal

Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

int E170XC_digi_set_wet_output(const unsigned char n,const unsigned int value)

This function can be used to specify which of the digital outputs has to be used for signalling "waiting for external trigger". When `value` is set to 0xFFFFFFFF, this function is disabled and CNC controller card does not provide this signal automatically. When the number of the digital output (in range 0..7) is given as `value`, the related digital output pin is used for "waiting for external trigger" signal.

PLEASE NOTE: here the number (means the count) of one specific output pin has to be given, not a bitpattern specifying one or more pins!

During operation the selected "waiting for external trigger" pin is HIGH as long as the controller is waiting for an external trigger to be applied at ExtStart input. It becomes LOW as soon as this signal has been detected or when current operation is stopped.

This is not a stream-command, when it is called, it is applied to current configuration immediately.

Parameters:

`n` – the 1-based board instance number as returned by `E170XC_set_connection()`

`value` – the number of the digital output to be used for this signal

Return: `E170XC_OK` or an `E170XC_ERROR_`-return code in case of an error

9.1.1 Error Codes

Most of the functions described above can return an error code in case an operation could not be completed successfully for any reason. So when it does not return with `E170XC_OK` the error code informs about the reason for failure:

- `E170XC_ERROR_INVALID_CARD` – a wrong or illegal card number was specified with function parameter `n`
- `E170XC_ERROR_NO_CONNECTION` – a connection to card could not be established
- `E170XC_ERROR_NO_MEMORY` – there is not enough memory available on the host to perform the requested operation
- `E170XC_ERROR_UNKNOWN_FW` – card is running an unknown and/or incompatible firmware version
- `E170XC_ERROR_TRANSMISSION` – data transmission to card failed
- `E170XC_ERROR_FILEOPEN` – opening of a file failed
- `E170XC_ERROR_FILEWRITE` – writing of data into a file failed
- `E170XC_ERROR_BORD_NA` - a base- or extension board that would be required for a function is not available
- `E170XC_ERROR_INVALID_DATA` – data or parameters handed over to a function are invalid, out of range or illegal in current context
- `E170XC_ERROR_UNKNOWN_BOARD` – trying to access a controller board that is not a suitable controller
- `E170XC_ERROR_FILENAME` – a file name handed over to a function was illegal, it is either too long, has an illegal or too long file extension, comes with too much sub-directories or contains illegal characters
- `E170XC_ERROR` – an other, unspecified error occurred
- `E170XC_ERROR_NOT_SUPPORTED` – the requested feature or function is not supported by the current firmware version
- `E170XC_ERROR_NO_DATA_AVAILABLE` – within a function it was tried to receive some data but there are none available yet
- `E170XC_ERROR_OUT_OF_RANGE` – a function was called with input data that are out of range
- `E170XC_ERROR_REFERENCING` – referencing an axis has failed (e.g. limit switch not found or not left)

10 Supported CNC G-Code Commands

Beside the possibility to use the programming interface of the library mentioned in section “9.1 E1703C Easy Interface Functions”, it is also possible to control the E1703C via G-Code commands, without the need to use any platform-dependent library. These commands can be sent:

- by using the USB serial port
- by using a Telnet-style TCP/IP connection to the contriollers port 20026

In such a scenario, a calling application can watch the execution state either via a digital output which is configured by using the configuration parameter `wetout`, or via a specific G-Code control protocol that is described in section 10.5 Control Protocol below.

To allow fast and efficient processing of a CNC file within E1703C, some points have to be noticed. So in order to improve loading performance it is recommended to:

- not to have lots of leading or trailing spaces
- not to make use of large comments
- have exactly one space between code and related parameter

Beside of that it is mandatory to

- have a CR/LF between two different codes (so e.g. “`G21 G90`” or “`G21G90`” will result in an error)
- have no space within a code or within a parameter of a code (so e.g. “`G0 X-0.5 Y.75 Z10`” is valid but “`G 0 X-0 .5 Y. 75 Z 10`” is not and will result in an error)
- use a dot as separator in floating point variables (so e.g. “`T1 F6000.0`” is valid but “`T1 F6000,0`” is not and will result in an error)

Following the G-Code commands are described which are supported.

10.1 General G-Code Characters

Following codes and identifiers are supported by E1702 G-Code interpreter:

Code	Description	Example
G	G-commands, please refer below for a description	`G1 X25.75 Y31 Z0.25`
M	M-commands, please refer below for a description	`M3`
T	T-commands, please refer below for a description	`T1 F3000`

10.2 Supported “G”-codes

Following “G” codes and identifiers are supported by E1702 G-Code interpreter:

Code	Description	Example
G0	Jump to a specified position using unit mm and with a speed which is at max the value set by command “T1F”. The position to jump to is specified by up to five parameters X, Y, Z, U and/or V. This command not necessarily causes an exact linear movement from the current to the target coordinate, it may perform any different movement when a faster path is possible.	`G0 X0 Y0 Z0 U0 V0`

Code	Description	Example
G1	Move to a specified position using unit mm and with the speed that was defined before by using command “T1F”. The position to move to is specified by up to five parameters X, Y, Z, U and/or V. Different to G0 this command generates an exact linear mocement from the current to the target position.	`G1 X10 Y10.5 Z11.75`
G4	When followed by a parameter „P“ execution is delayed by the given time (in unit seconds)	`G4 P0.002`
G21	Set measurement unit to mm, means all positions handed over e.g. with G0 or G1 will be followed by coordinates in mm. This is the default setting, the E1703C supports only mm unitsy	`G21`
G28	Start the referencing process for a single axis. Here the parameter P specifies with a value in range 0..4 which of the axes X, Y, Z, A or B have to be referenced. The referencing process itself is done with the parameters specified via commands M766, M767, M768, M769, M770	`G28 P2`
G90	Enable absolute positioning, means all positions handed over e.g. with G0 or G1 will be followed by absolute coordinates according to the used coordinate system.	`G90`
G91	Enable relative positioning, means all positions handed over e.g. with G0 or G1 will be followed by coordinates that are relative to the previously used position in used coordinate system.	`G91`

10.3 Supported “M”-codes

Following “M” codes and identifiers are supported by E1702 G-Code interpreter, here all codes in range 700..799 are specific to the E1702 and contain all laser-related parameters and values:

Code	Description	Example
M3	Set laser on. This command should be sent prior to a marking operation done with a G1 command.	`M3`
M5	Set laser off. This command should be sent after a marking movement with command G1 has been done and when the marking has to be ended or a jump with G0 has to be performed next	`M5`
M700	Set the used laser type. This command is mandatory and has to be called prior to every laser-related command. As parameter it expects a decimal number which corresponds to the lasermode-types `E170X_LASERMODE_xxx` as described in section „9.1 E1703C Easy Interface Functions“	`M700 A1073741831`
M713	Set first pulse killer value (FPK) for YAG laser types using unit usec	`M713 A10000`
M715	Set standby-frequency (at parameter A) in unit Hz and standby-pulsewidth (at parameter B) in unit nsec.	`M715 A50000 B1000`
M718	Set laser frequency (at parameter A) in unit Hz and pulsewidth (at parameter B) in unit usec.	`M718 A50000 B10`
M719	Switch main oscillator on (1) or off (0). This command can be used together with SPI or IPG laser types prior to starting a mark operation to turn MO on or afterwards to turn it off.	`M719 A1`

Code	Description	Example
M750	Change the digital outputs at the digital interface, the bitpattern that corresponds to the given A-parameter defines the new HIGH and LOW states of the different pins and the B-pattern specifies the mask, means it defines which of the output pins have to be changed.	`M750 A3 B15`
M751	Change the digital outputs at the LP8 interface, the bitpattern that corresponds to the given A-parameter defines the new HIGH and LOW states of the different pins and the B-pattern specifies the mask, means it defines which of the output pins have to be changed.	`M751 A8 B12`
M752	Turn the LP8 latch pin on (1) or off (0). This command can be used together with MOPA laser types in order to latch-in a specified 8 bit LP8 port value as set with command M751.	`M719 A1`
M753	Enable an output to be used to emit a hardware „wait for externel trigger“ signal that is high as long as the controller is waiting for an external trigger signal: When the A-value is set to -1, this function is disabled and the controller card does not provide this signal automatically. When the number of the digital output (in range 0..7) is given, the related digital output pin is used for the "waiting for external trigger" signal.	`M753 A4`
M754	Enable an output to be used to emit a hardware „marking in progress“ signal that is HIGH as long as a markign operatin is running: When the A-value is set to -1, this function is disabled and the controller card does not provide this signal automatically. When the number of the digital output (in range 0..7) is given, the related digital output pin is used for the "markign in progress" signal.	`M754 A4`
M755	Dynamically set/change tuning-flags according to the description in section „6.1.8 microSD-Card“, here as A-value the same value can be specified as described above	`M755 A8`
M756	Set standby-frequency (at parameter A) in unit Hz and standby-pulsewidth (at parameter B) in unit nsec. Different to command M715, which enables the stand-by frequency the next time the laser is turned off by M5, this command applies and emits this frequency immediately. So it should be used on initialisation of the controller.	`M756 A50000 B1000`
M757	Wait for an external trigger. This can be a signal at the ExtStart input as well as a “^” control command provided via serial USB/Telnet connection. When a “wait external trigger” output is specified by the “wetout” configuration parameter or via command M753, the related output is at HIGH as long the controller is waiting.	
M758	Wait for a specific bitpattern at the digital inputs of the DigiIOs extension card’s digital interface, the bitpattern that corresponds to the given A-parameter defines the HIGH and LOW states of the different pins and the B-pattern specifies the mask, means it defines which of the output pins have to be watched.	`M758 A1 B3`
M759	This function sends a synchronisation value to the controller. As soon as marking reaches the related position in stream, the sync-value returned by the current state feedback (as described below) is set to this value. Using this command it is possible to watch at what position the marking operation currently is.	`M759 A13900`

Code	Description	Example
M763	Specify the length of a step-pulse (in unit usec) that has to be emitted at the step-outputs of the controller during a motion operation. This command is handled a stream-command, means a change of the step-pulsewidth is not applied immediately but at the time this command is executed regularly in current stream of commands.	`M763 A3.5`
M764	Specify the resolution of a stepper axis (in steps/mm) that has to be used for a specific axis during a motion operation. The A-parameter specifies the axis in range 0..4 the value has to be set for, the B-parameter specifies the resolution to be used for that axis. This command is handled a stream-command, means a change of the step-pulsewidth is not applied immediately but at the time this command is executed regularly in current stream of commands.	`M763 A0 B300`
M765	Specify the acceleration and deceleration value to be used for motion operations of a specific stepper axis (in unit mm/sec²) that has to be used during a motion operation. The A-parameter specifies the axis in range 0..4 the value has to be set for, the B-parameter specifies the acceleration to be used for that axis. This command is handled a stream-command, means a change of the step-pulsewidth is not applied immediately but at the time this command is executed regularly in current stream of commands.	`M763 A0 B300`
M766	Specifies if the motion direction of an axis during referencing has to be inverted (`A1`) or not (`A0`).	
M767	Specifies if the input logic of a limit switch has to be inverted (`A1`) or not (`A0`).	
M768	Specifies the first referencing speed (speedStep0) that is used to initially find the reference switch (in unit mm/min). This speed is used for the first referencing movement which is intended to find the reference switch as fast as possible. Nevertheless here a value should be chosen that allows the axis to be stopped without leaving the reference swithc on the other side.	
M769	Specifies the second referencing speed (speedStep1) that is used to exactly detect the reference switch (in unit mm/min). This speed is used for the referencing movements which leave and re-enter the switch in order to get its exactl position. So here a low speed should be set which allows accurate positioning of the axes.	
M770	Specifies the leave-distance during and after referencing (in unit mm). This leave-distance is used after the reference switch has been hit.	`M770 A2.5`

10.4 Supported “T”-codes

Following “T” codes and identifiers are supported by E1702 G-Code interpreter:

Code	Description	Example
T1	Set motion speed to be used with commands G0 and G1 in unit mm/min.	`T1 F6000.0`

10.5 Control Protocol

While the G-Codes, its syntax and meaning are standardised, the communication protocol that is used to evaluate the current state of the CNC-like operation, is not defined. Here several different control standards and protocols exist that are not compatible to each other. So this controller makes use of a very common, slim and easy to interpret control protocol: the one which is known from the GRBL free software. Due to the different type of controller, there are some changes which are described here.

Following commands can be sent in between a stream of G-code data (different to GRBL they all have to be completed with a CR/LF in order to let the client software transmit the command to the controller properly):

- `?` - check the current state of processing. Here a string is returned which makes use of following syntax:

  `<STATE|WPos:x,y,z,u,v|Bf:SEC,PRI|Pn:0x0000|CSt:0x0000>`

  Here STATE can be “Idle” (when no marking operation is in progress), “Hold” when a marking process is active but the execution was held by the “!” control command or when it is waiting for a signal at the ExtStart input. or “Run” when a marking operation is in progress;

  WPos is an optional value which returns the current/last position of the axes X, Y, Z, U and V (using format 0.00);

  Bf shows the buffer fill state, here SEC is the secondary buffer, its number specifies how much space is left in execution buffer for G-Code commands (so this buffer counts the number of commands). PRI is the primary buffer which specifes the overall freee space in receiving buffer (in unit bytes). So as an example: a command „G0X100.0Y25.5\r\n“ would consume 15 bytes in primary buffer and – as soon as it has been processed and forwarded into the secondary buffer – 1 element in buffer „SEC“.

  Pn is an optional value which returns the state of the digital inputs at the digital interface(s); this format is slightly different to the GRBL variant, here a hexadecimal number is given which represents the input pattern while GRBL lets one single character appear for each known input

  Cst returns the state flags that provide much more detailled information about the internal state of the controller. The bits/flags of this value correspond to the E170XC_STATE_flags as mentioned in section „9.1 E1703C Easy Interface Functions“

- `!` - halt the current marking operation at the next suitable position, means the next time when the laser is turned off regularly; when this control command is used, the marking state changes from “Run” to “Hold”

- `~` - continue a marking operation which was held with the “!” control command

APPENDIX A – Wiring between E1703C and IPG YLP Series Type B, B1 and B2 fiber laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant using LP8 Extension Board and optional Digi I/O Extension Board for laser alarms.

Signal Name	Board	Connector / Pin	IPG Pin
LP0	LP8 Extension Board	Pin 1	Pin 1
LP1		Pin 3	Pin 2
LP2		Pin 5	Pin 3
LP3		Pin 7	Pin 4
LP4		Pin 9	Pin 5
LP5		Pin 11	Pin 6
LP6		Pin 13	Pin 7
LP7		Pin 15	Pin 8
MO / Main Oscillator		Pin 8	Pin 18
LP8 Latch		Pin 17	Pin 9
LaserA / Frequency		Pin 22	Pin 20
Laser Gate / Modulation		Pin 26	Pin 19
LaserB		Pin 19	Pin 22 *)
Alarm, one of DIn0…DIn7	Digi I/O Extension Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 16
Alarm, one of DIn0..DIn7		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 21

*) may require additional power driver since some laser variants consume a current at this input which is higher than the maximum output allowed

In this wiring-scheme no GND-connections are listed, they have to be added in order to get valid and working connections.

APPENDIX B – Wiring between E1703C and JPT YDFLP series fiber laser (“MOPA”) or IPG YLP Series Type D fiber laser or Raycus RFL Series fiber laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant using LP8 Extension Board and optional Digi I/O Extension Board for laser alarms.

Signal Name	Board	Connector / Pin	JPT D-SUB25 Pin
LP0	LP8 Extension Board	Pin 1	Pin 1
LP1 / serial data		Pin 3	Pin 2
LP2 / serial clock		Pin 5	Pin 3
LP3		Pin 7	Pin 4
LP4		Pin 9	Pin 5
LP5		Pin 11	Pin 6
LP6		Pin 13	Pin 7
LP7		Pin 15	Pin 8
MO / Main Oscillator		Pin 8	Pin 18
LaserA / Frequency		Pin 22	Pin 20
Laser Gate / Modulation		Pin 26	Pin 19
LaserB / serial enable		Pin 19	Pin 22 [1])
Alarm, one of DIn0…DIn7	Digi I/O Extension Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 16
Alarm, one of DIn0…DIn7		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 21

[1]) for details regarding double-usage of this pin, please refer to the manual of the laser

In this wiring-scheme no GND-connections are listed, they have to be added in order to get valid and working connections.

APPENDIX C – Wiring between E1703C and IPG YLP Series Type E fiber laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant using LP8 Extension Board and Digi I/O Extension Board for laser alarms with support for APD index setting via DB-25 serial data interface

Signal Name	Board	Connector / Pin	IPG Pin
LP0	LP8 Extension Board	Pin 1	Pin 1
LP1		Pin 3	Pin 2
LP2		Pin 5	Pin 3
LP3		Pin 7	Pin 4
LP4		Pin 9	Pin 5
LP5		Pin 11	Pin 6
LP6		Pin 13	Pin 7
LP7		Pin 15	Pin 8
MO / Main Oscillator		Pin 8	Pin 18
LP8 Latch		Pin 17	Pin 9
LaserA / Frequency		Pin 22	Pin 20
Laser Gate / Modulation		Pin 26	Pin 19
LaserB		Pin 19	Pin 22 [1])
Alarm, one of DIn0..DIn7	Digi I/O Extension Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 16
Alarm, one of DIn0..DIn7		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 21
Serial Enable	LP8 Extension Board	Pin 7	Pin 24 [2])
Serial Clock		Pin 9	Pin 13 [2])
Serial Data		Pin 11	Pin 10 [2])

[1]) may require additional power driver since some laser variants consume a current at this input which is higher than the maximum output allowed

In this wiring-scheme no GND-connections are listed, they have to be added in order to get valid and working connections.

APPENDIX D – Wiring between E1703C and IPG YLP Series Type G fiber laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Signal Name	Board	E1703C Connector / Pin	D-SUB25
LP0	LP8 Extension Board	Pin 1	Pin 1
LP1		Pin 3	Pin 2
LP2		Pin 5	Pin 3
LP3		Pin 7	Pin 4
LP4		Pin 9	Pin 5
LP5		Pin 11	Pin 6
LP6		Pin 13	Pin 7
LP7		Pin 15	Pin 8
MO / Main Oscillator		Pin 8	Pin 18
LP8 Latch		Pin 17	Pin 9
LaserA / Frequency		Pin 22	Pin 20
Laser Gate / Modulation		26 pin connector, pin 26	Pin 19
LaserB		Pin 19	Pin 22
GND		Pin 2 or 23	Pin 14
Alarm, one of DIn0…DIn7	Digi IO Extension Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 11
Alarm, one of DIn0…DIn7		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 16
Alarm, one of DIn0…DIn7		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 21

APPENDIX E – Wiring between E1703C and IPG YLR Series laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Signal Name	Board	Connector / Pin	IPG Pin
AOut0	LP8 Extension Board	Pin 10	Pin 12 [1])
MO / Main Oscillator		Pin 8	Pin 18
Laser Gate / Modulation		Pin 26	Pin 15

[1]) maximum analogue output voltage of LP8 extension is limited to 5V while this laser type expects 0..10V range. So this voltage needs to be doubled by some external equipment, elsewhere the laser can be driven with a maximum of 50% power only

In this wiring-scheme no GND-connections are listed, they have to be added in order to get valid and working connections.

APPENDIX F – Wiring between E1703C and SPI G4 Pulsed Fibre Laser / TRUMPF TruPulse nano series

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant 1: waveform selected via LP8 outputs of LP8 Extension Board, simmer, power and extended parameter control via laser controller plug in/serial interface:

Signal Name	Board	Connector / Pin	SPI Laser Connector Pin
LP0	LP8 Extension Board	Pin 1	Pin 17
LP1		Pin 3	Pin 18
LP2		Pin 5	Pin 19
LP3		Pin 7	Pin 20
LP4		Pin 9	Pin 51
LP5		Pin 11	Pin 52
LP6		Pin 13	Pin 53
LP7		Pin 15	Pin 54
MO / Laser Enable		Pin 8	Pin 7
LP8 Latch		Pin 17	Pin 23
LaserA / Pulse Trigger		Pin 22	Pin 47
Laser Gate / Modulation		Pin 26	Pin 5
Alarm, one of DIn0…DIn7	Digi I/O Extension Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 9

Variant 2: waveform selected via digital outputs of Digi I/O Extension Board, simmer, power and extended parameter control via laser controller plug in/serial interface:

Signal Name	Board	Connector / Pin	SPI Laser Connector Pin
DOut0	Digi I/O Extension Board	Pin 3	Pin 17
DOut1		Pin 5	Pin 18
DOut2		Pin 7	Pin 19
DOut3		Pin 9	Pin 20
DOut4		Pin 11	Pin 51
DOut5		Pin 13	Pin 52
DOut6		Pin 15	Pin 53
DOut7		Pin 17	Pin 23
Alarm, one of DIn0…DIn7		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 9
MO / Laser Enable	LP8 Extension Board	Pin 8	Pin 7
LaserA / Pulse Trigger		Pin 22	Pin 47
Laser Gate / Modulation		Pin 26	Pin 5

Variant 3: waveform selection, simmer, power and extended parameter control via laser controller plug in/serial interface:

Signal Name	Board	Connector / Pin	SPI Laser Connector Pin
MO / Laser Enable	LP8 Extension Board	Pin 8	Pin 7
LaserA / Pulse Trigger		Pin 22	Pin 47
Laser Gate / Modulation		Pin 26	Pin 5
Alarm, one of DIn0…DIn7	Digi I/O Extension Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 9

In these wiring-schemes no GND-connections are listed, they have to be added in order to get valid and working connections.

APPENDIX G – Wiring between E1703C and Raycus fiber laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant using LP8 Extension Board and optional Digi I/O Extension Board for laser alarms.

Signal Name	Board	Connector / Pin	Raycus DB25 Pin
LP0	LP8 Extension Board	Pin 1	Pin 1
LP1		Pin 3	Pin 2
LP2		Pin 5	Pin 3
LP3		Pin 7	Pin 4
LP4		Pin 9	Pin 5
LP5		Pin 11	Pin 6
LP6		Pin 13	Pin 7
LP7		Pin 15	Pin 8
MO / Main Oscillator		Pin 8	Pin 18
LaserA / Frequency		Pin 22	Pin 20
Laser Gate / Modulation		Pin 26	Pin 19
Alarm, one of DIn0…DIn7	Digi I/O Extension Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 16
Alarm, one of DIn0…DIn7		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 21

In this wiring-scheme no GND-connections are listed, they have to be added in order to get valid and working connections.

APPENDIX H – Wiring between E1703C and MaxPhotonics MFP fiber laser

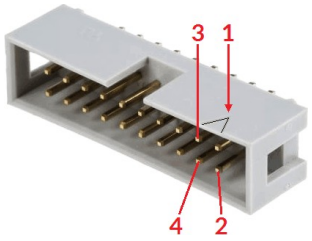
PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant using E1703D Baseboard, LP8 Extension Board and optional Digi I/O Extension Board for laser alarms.

Signal Name	Board	Connector / Pin	MaxPhotonics DB25 Pin
LP0	LP8 Extension Board	Pin 1	Pin 1
LP1		Pin 3	Pin 2
LP2		Pin 5	Pin 3
LP3		Pin 7	Pin 4
LP4		Pin 9	Pin 5
LP5		Pin 11	Pin 6
LP6		Pin 13	Pin 7
LP7		Pin 15	Pin 8
LP8 Latch		Pin 17	Pin 9
MO / Main Oscillator		Pin 8	Pin 18
LaserA / Frequency		Pin 22	Pin 20
Laser Gate / Modulation		Pin 26	Pin 19
GND		Pin 2 or 23	Pin 10-15
Alarm, one of DIn0…DIn7	Digi I/O Extension Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 16
Alarm, one of DIn0…DIn7		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 21

APPENDIX I – IDC connector pin numbering

Pin numbering of the IDC connectors (according to pinout-tables shown in hardware description sections above) can be seen in below image:

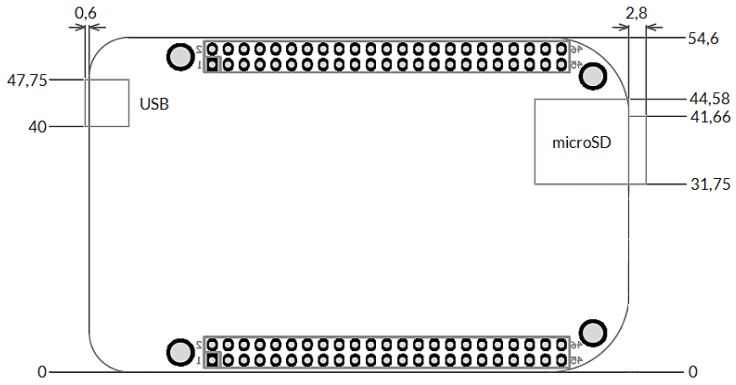


The first pin is marked by a small arrow in connector. Second pin is below of it, counting continues column-wise.

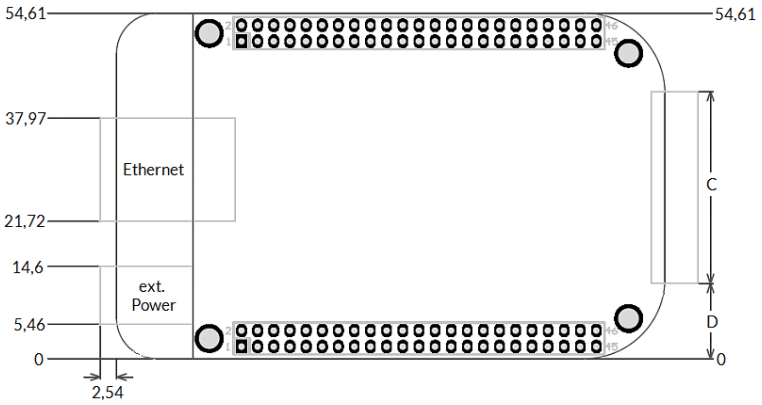
APPENDIX J – Board dimensions

Board dimension drawings (baseboard plus optional extension boards), all values are given in unit mm.

Connectors, bottom view:

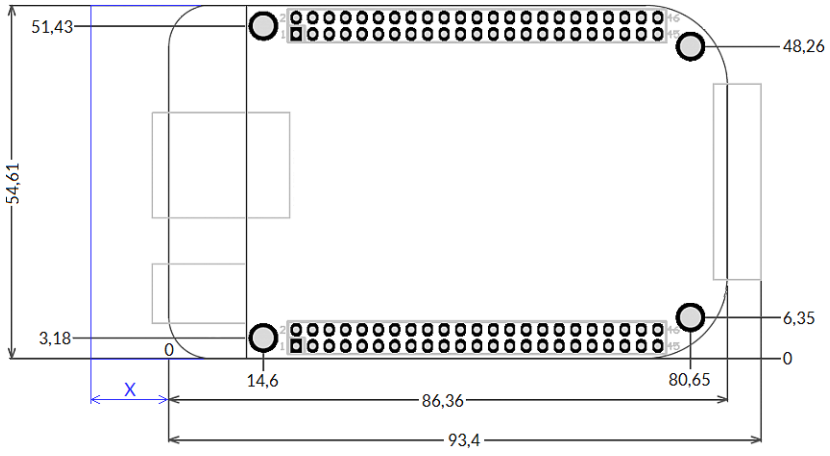


Connectors, top view:



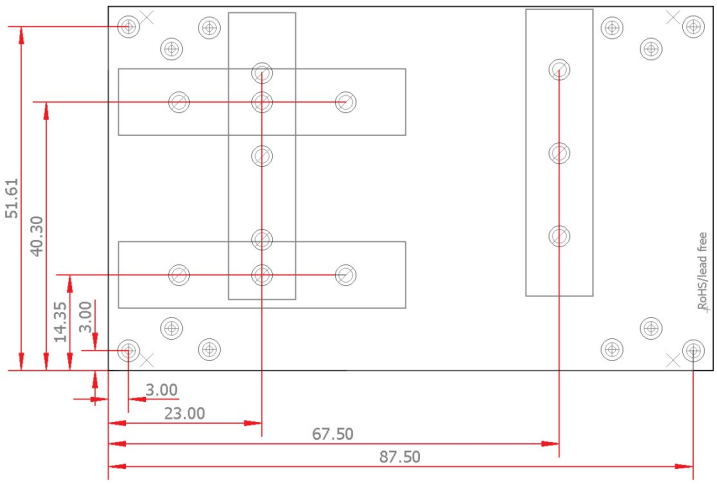
Board type	C	D
E1703C Baseboard	40 mm	7,3 mm
LP8 Extension Board	40 mm	7,3 mm
Digi I/O Extension Board	34 mm	10,3 mm

Dimensions, top view:



X – for future compatibility leave additional space of 10 mm at Ethernet connector side of the controller

E170Xbase dimension drawing, all values are given in unit mm.



Index