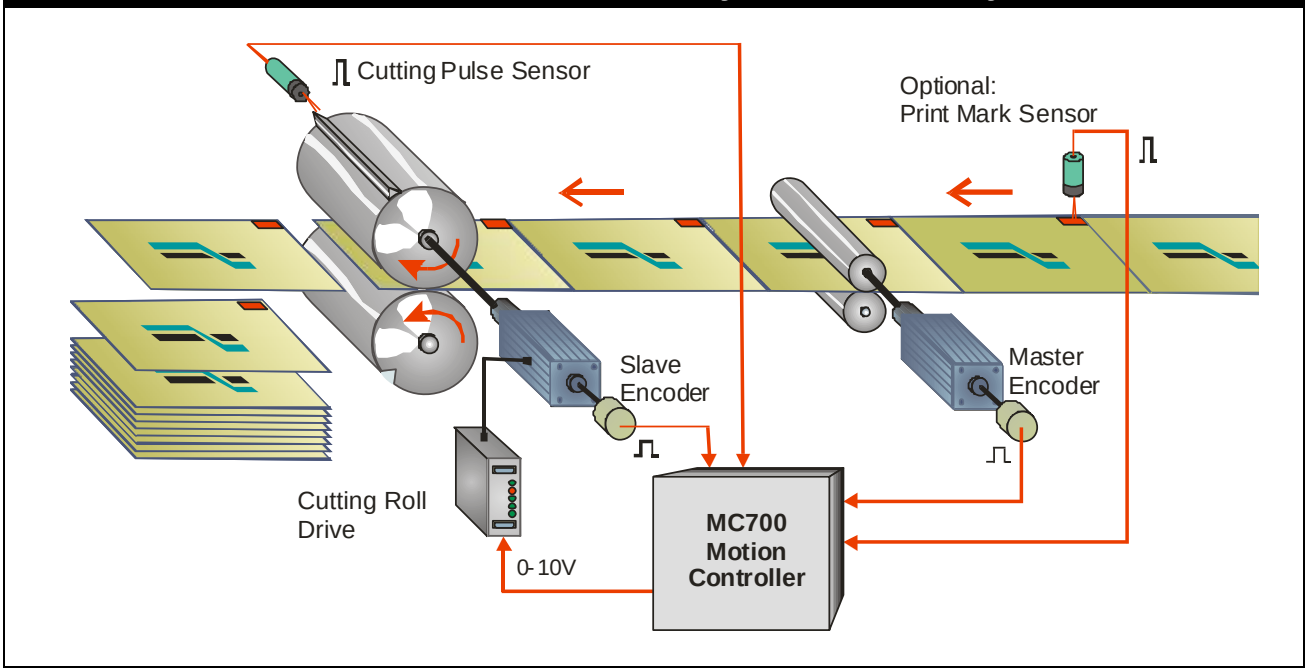
CT 703.03 Firmware

safety - control - motion - interface

MC700 / MC720 Motion Control Firmware for Rotating Cutters and Printing Rolls



Software Manual

Product features:

- Easy parameter setting instead of sophisticated programming
- Immediately ready to work, with minimum commissioning time
- High dynamic response by means of short cycle time, therefore accurate cutting results also during change of line speed
- High cutting precision due to 400 kHz of feed-back frequency
- Suitable for “stand-alone” operation as well as for connection to field bus systems (CANBUS, PROFIBUS etc.)
- Extremely smooth motion by optimized S-shape profiles

Version:	Changes:
CT70301A / TJ/ May 2010	Original Version (function like version CT702 10)
CT70302A / TJ / March 2012	Improved print mark operation
CT70303A / TJ / May 2013	Protection of parameter blocks with access code
Ct70303b / AG / May 2015	- Correction of a misspelling - 4.2.3 Index Mode (2 x Encoder3 changed to Encoder2) - Cross references linked and blue colored - Disclaimer included

Disclaimer:

Table of Contents

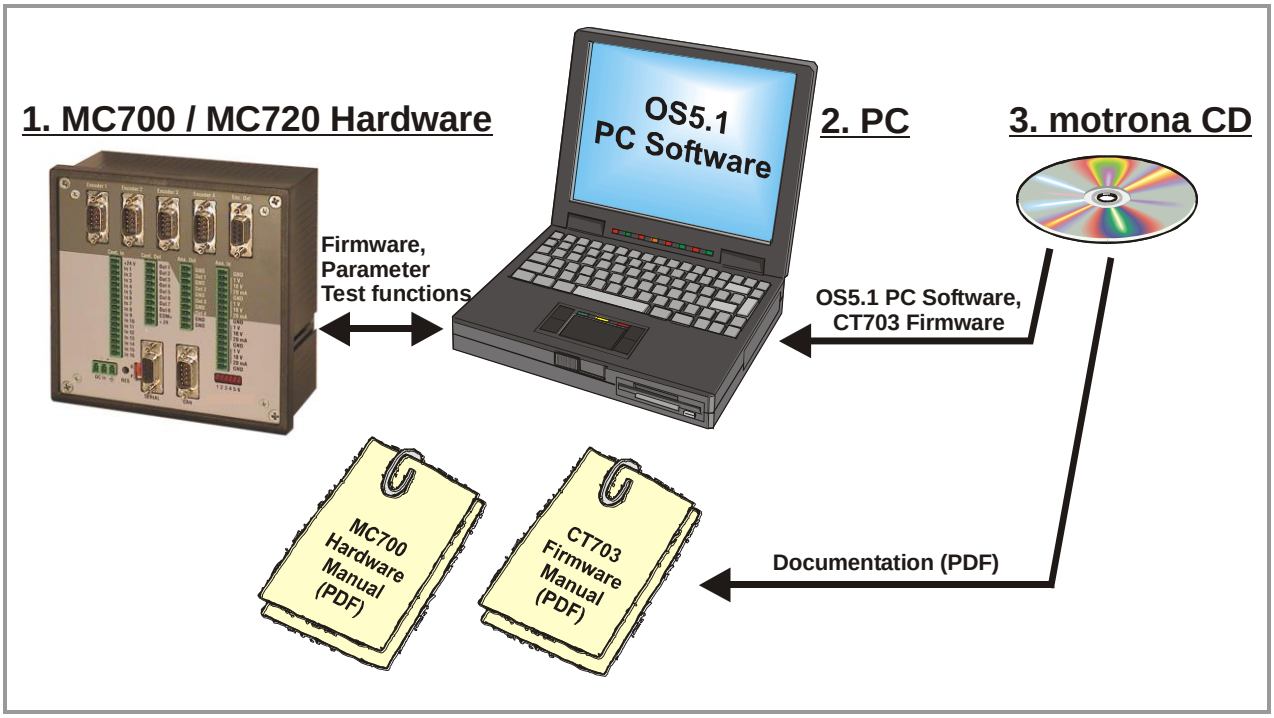
1. Preamble

This document provides all information about the CT703 firmware, including parameters, variables and hints for commissioning.

To implement this application, you will need:

1. A motion controller hardware of type MC700 or MC720
2. A PC with operating system
   Windows 95, 98, NT, 2000 or XP
3. The motrona CD containing the PC operator software OS5.x, the firmware file CT703xxx.ecr and the pdf files for the manuals MC700_de.pdf (hardware description, connections, and specifications) and CT703xxx.pdf (description of the firmware as actually at hand)

All of above files are also available for free download from our homepage: www.motrona.com



Moreover, at the "Applications" site of above homepage you can watch a short demo movie showing a typical application of the firmware described here.

The CT703 firmware is liable to payment of a license fee and can only be used with the corresponding license key!

2. General Remarks about the Firmware functions

2.1. Introduction

The CT 703 firmware is suitable for control of rotating cutter systems, partial printing screens and rotating punching or sealing applications.

This firmware has been designed for the special requirements of these rotating systems, under consideration of maximum efficiency and accuracy, with minimum stress for all mechanical parts. Very short control cycles together with intelligent motion profiles provide excellent performance under all operating conditions.

This unit is very easy to set up. All settings are made by PC, with use of the motrona operator software OS5.0.

All relevant operational parameters and variables are accessible by RS232/RS485 communication and via CANopen interface. For PROFIBUS applications, our PB251 gateway is available. Therefore the user has multiple possibilities for remote control of all batch and cutting parameters via operator terminals, PC or PLC systems

The firmware is suitable for control of cutting applications as well as for partial printing screens. This manual always says „cutting" or „cut" and the reader may replace this by „printing" when applicable.

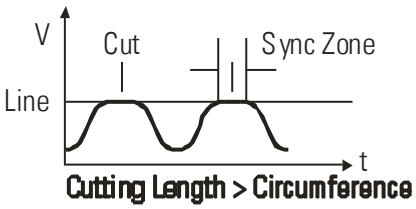
2.2. Principle of operation

When a cutting process needs synchronous circumferential speed of the cutting tool with the line, the only length that can be cut is the one corresponding to the circumference of the cutting roll (at constant rotational speed). Change of the cutting length needs exchange of the cutting roll against another one with appropriate diameter.

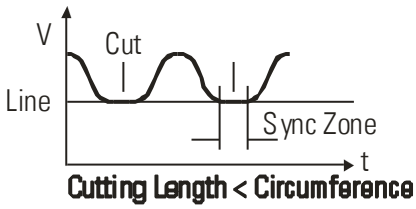
The CT 703 controller uses a two-speed principle featuring full synchronism while the cut is in progress, but taking a different roll speed when the tool is outside the cutting zone (where synchronism is not necessary). So, in terms of one revolution of the roll, we are talking about two speed zones: The „synchronous cutting zone" (which is register settable) and the „asynchronous zone" where the roll follows a speed profile calculated in order to get the desired cutting length. The speed profile of the „asynchronous zone" is calculated in a way that the physically possible minimum of acceleration and deceleration torque is applied to the drive with respect to actual line speed and preset cutting length.

All speed transitions use self-optimizing S-shape profiles for minimum wear and tear of all mechanical parts, unless a linear ramp form has specifically been selected by corresponding parameter setting.

With length settings smaller than the roll circumference, the „asynchronous zone" will take higher speeds than the „synchronous zone". With length settings longer than the circumference, the asynchronous speed will be lower and the drive can even go to a temporary standstill if necessary. The figure below shows two typical speed profiles:



Cutting Length > Circumference



Cutting Length < Circumference

Continuous closed loop control of the relative roll position with respect to the length progress of the line, combined with a short update time provide best cutting accuracy and exceptional smooth motion of the cutting roll at any time.

It is a must to use a 4-quadrant drive or a servo drive for the cutting roll, because the CT 703 must be able to accelerate and decelerate the roll under real closed loop conditions. However, no special requirements are necessary for the line drive for full performance.

2.3. System Configuration

As a master drive, mostly the motor of a feed roll is used. The "master" can also be a measuring wheel equipped with an incremental encoder. For testing and commissioning the shear without material, a "Virtual Master Axis" can be selected, providing simulation of the line encoder at the selected line speed.

The encoder resolutions should be at least 5 times higher than the maximum acceptable cutting error.

Quadrature encoders must be used. Where you find you must use 24V encoders with A/B output, please apply our level converter type PU202 to generate the proper RS422 signals required.

At maximum line speed, the master encoder frequency should be at least about 1 kHz, for best resolution of the analogue output. Moreover, the input frequency must not exceed the maximum level of 400 kHz.

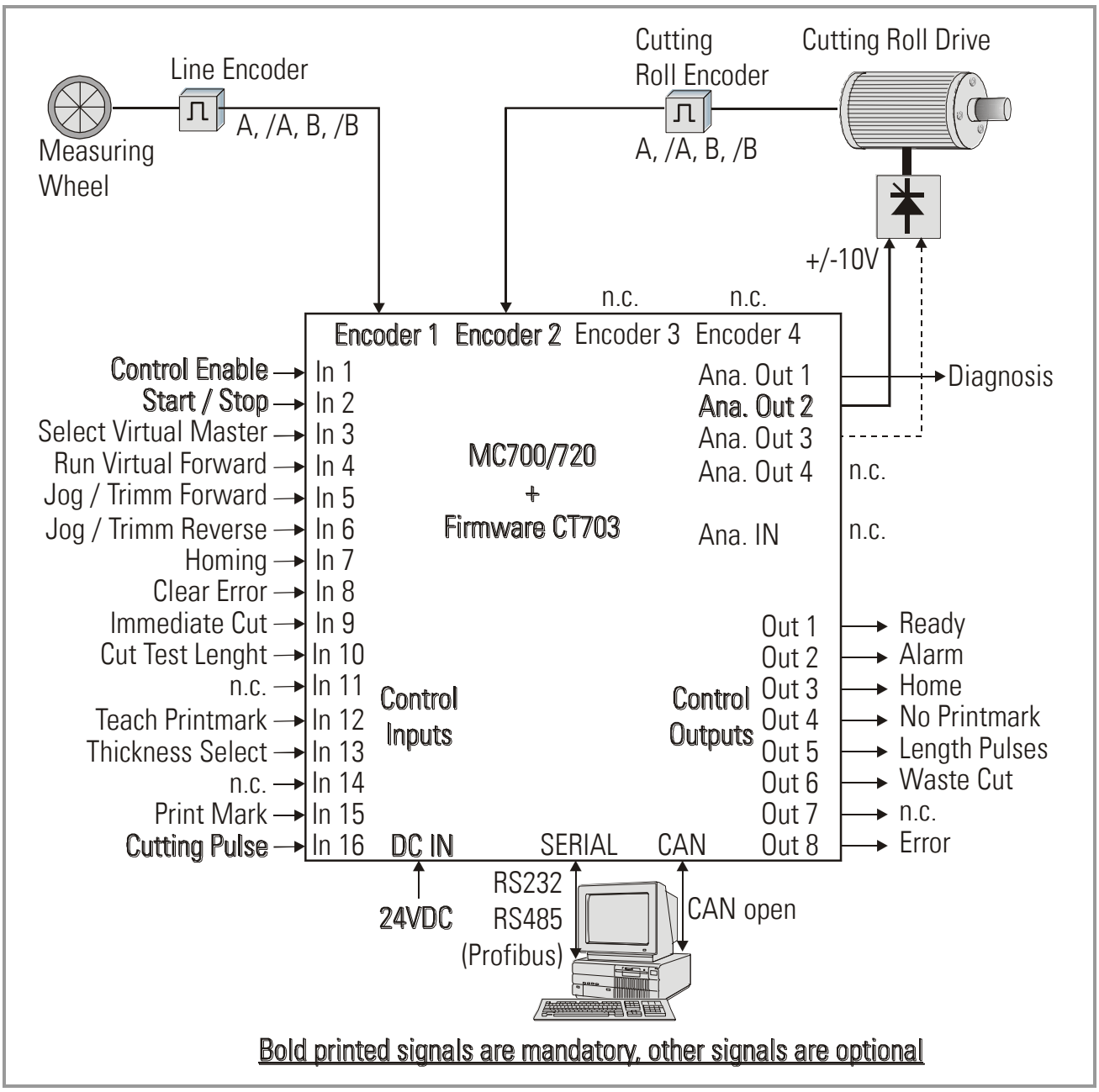
It is best to choose the ppr numbers of line and cutting roll encoders in a way to produce frequencies in the same range. Acceptable ratios are in the range of

5:1 ... 1:1 ...1:5

Mismatching beyond 1:16 and 16:1 are not allowed, especially with maximum speed of the cutting roll (see register “v max / v line”).

Where applicable, the (x1), (x2) or (x4) hardware multiplication of the Master channel or the Slave channel may be used to adapt the frequencies.

The block diagram below shows the principle of wiring of a rotating cutter system:



The line encoder must be connected to input “Encoder 1” and the cutting roll encoder to input “Encoder 2”.

For speed reference of the cutting roll drive, the analogue output “Ana. Out 2” is used.

The unit must receive a „cutting pulse“ with each revolution of the cutting roll. You can use an external sensor (proximity switch, light barrier) or the zero pulse of the cutting roll encoder, if the encoder is fitted directly to the cutting roll with no gear ratio between.

The rising edge of this cutting pulse must be physically located somewhere in the synchronous zone, i.e. around the position where the tool performs the cut. With respect to this rising edge, the user can set a „before cut“ zone and an „after cut“ zone where the tool must be synchronous to the line.

It is necessary to adjust the cutting roll drive to its maximum dynamic response (no internal ramps, no integral control loop, high proportional gain), because the CT 703 will generate the ramps which the drive has to follow with no additional delay.

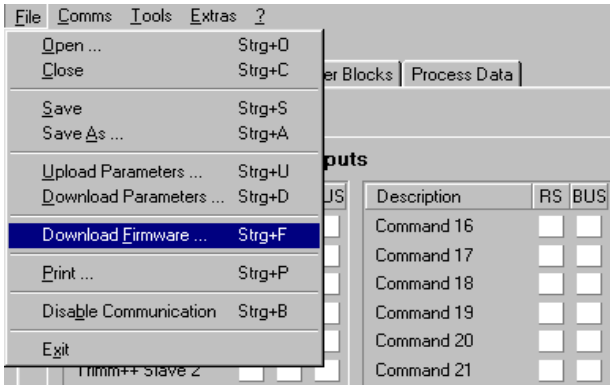
Two inputs “Trim / Jog” provide manual displacement of the cutting point on the material and also allow jogging the cutting roll with in standstill.

After power-on or after manually moving of the cutting roll, e. g. by Jog function, you can perform a homing sequence to move the cutting roll to its home position. When you start the homing sequence, the cutting roll moves with a register settable speed till the cutting pulse appears. Then it moves on to the home position, which is located opposite to the center point of the synchronous zone.

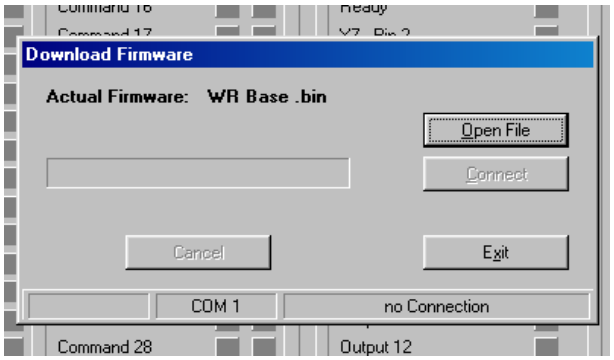
3. Download Procedure

Ex-factory, all MC 700- and MC 720 controllers have loaded the MC-Base firmware, which was used for factory testing purposes.

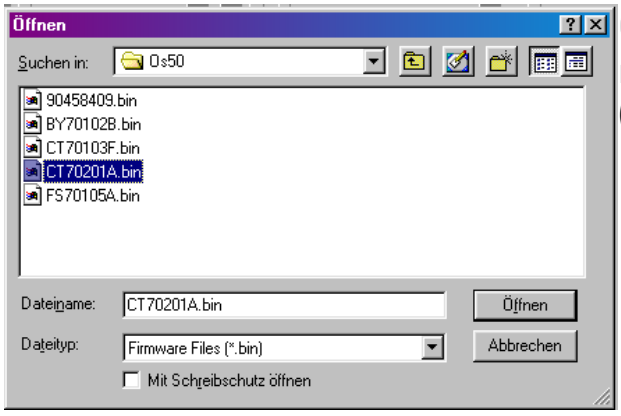
To download an application firmware, please take the following steps:



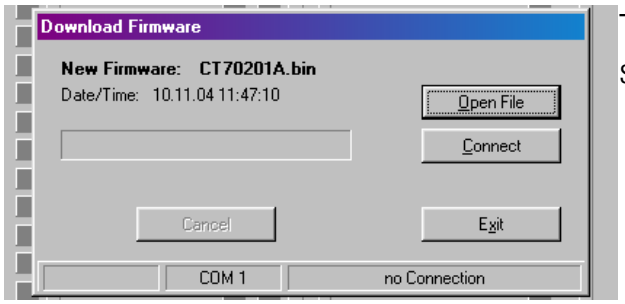
Connect the PC to the controller, using a RS232 cable (see 3.8 of the hardware manual). Apply power to the controller and start the OS5.0 PC software. Select "Download Firmware" from the "File" menu.



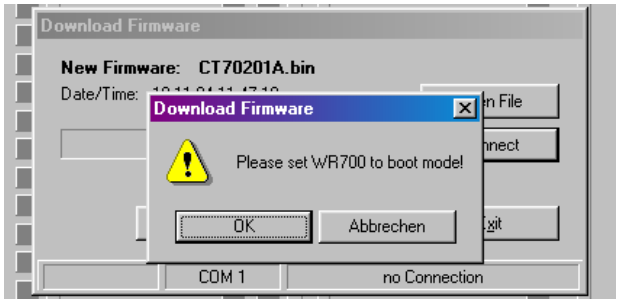
The screen now indicates the firmware which is actually loaded to the unit, in general "MCBasexx.bin"



Click to "Open File" and select drive and file name of the download firmware (CT703xxx.ecr).

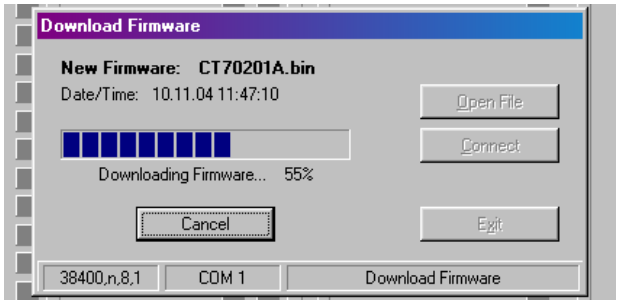


Then click to "Connect" to download the selected firmware.

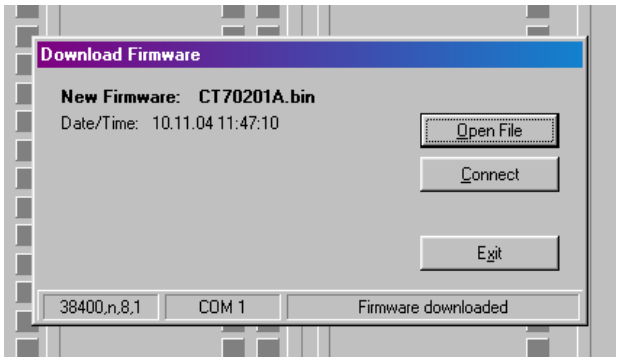


The PC now requests you to set the controller to the "boot mode". To do this, slide the front switch from the "Run" position to the "Program" position and push the Reset button located behind the front plate, by means of a pin

Click "OK" to start the download

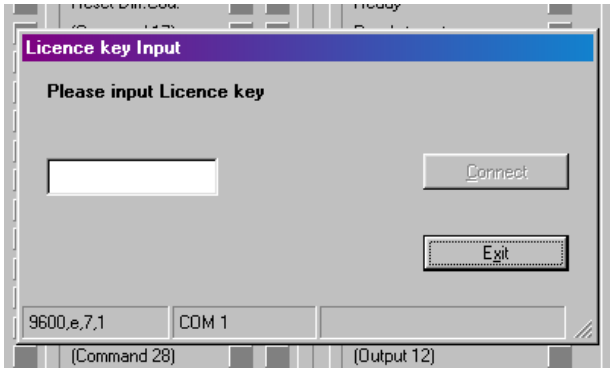


The download uses several loading steps and the progress is displayed on the screen



<u>After successful conclusion of the procedure</u>

a. Click to "Exit"
b. Slide the switch back to the "<u>R</u>un" position
c. Activate the Reset button for new initialization of the controller

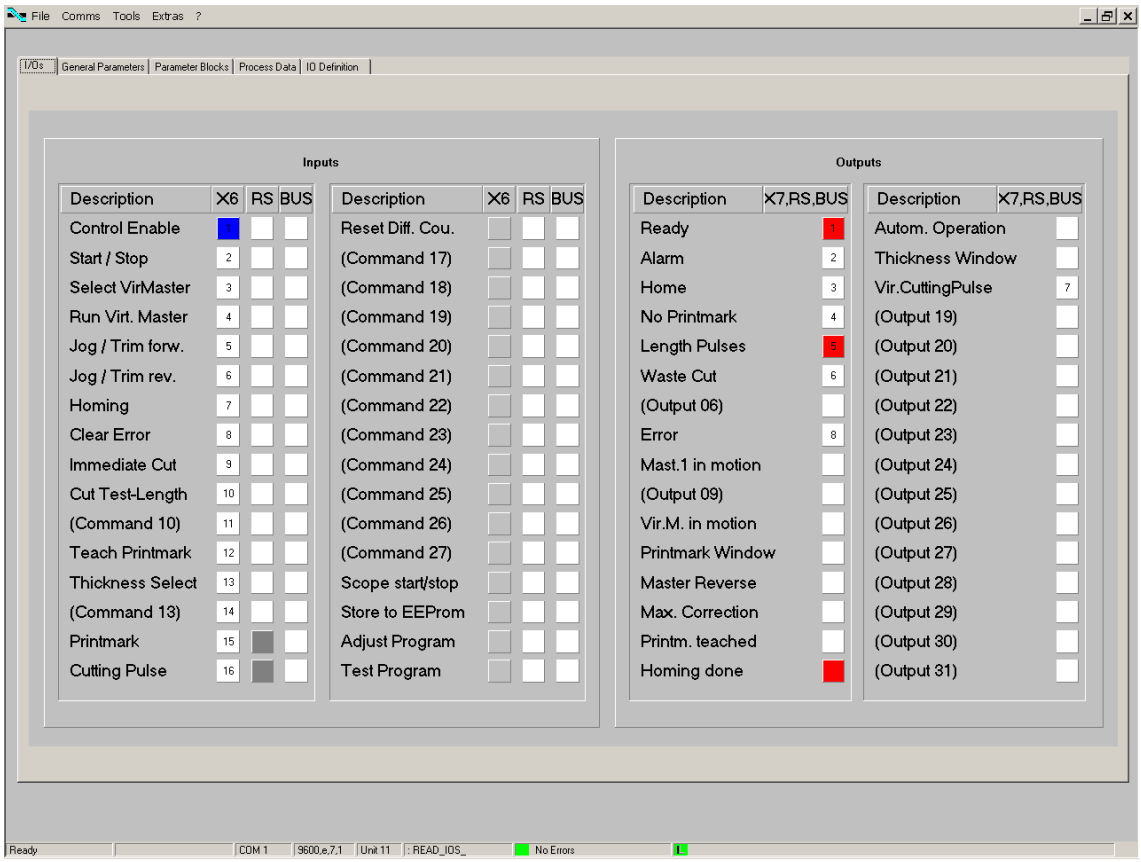


Finally you must input the <u>license key</u>:

a. Select "Input license key"" from the "File" menu
b. Input the license key and click to "connect"

4. How to Use the Operator Software

The OS5 software uses a clear structure of register cards and the contents automatically adapt to the firmware of the controller.



4.1. I/Os (Inputs and Outputs)

This register card shows the logical state of all digital inputs and outputs.

4.1.1. Inputs

Input signals that are in use for the current application are marked with its designation, whereas unused inputs are marked with “Command …” only.

It is possible to assign each input signal to any of the 16 hardware inputs that are accessible via screw terminal X6 (marked “Cont.In”), please see chapter 4.1.3 for details. The number of the hardware input “In…” assigned to the input signal is displayed in column “X6”.

(Please note: “In …” input numbering is not equal to X6 connector pin numbering!)

Indicator boxes in the column marked “X6” shine blue, when the associated hardware input signal terminal X6 is HIGH, LOW state is white. Where the input signal has not been assigned to any hardware input, the box remains grey.

Indicator boxes in the columns marked "RS" shine blue, when the associated input signal has been switched on via serial link. White box means "signal off". You can switch on and off every input from your PC by clicking to the corresponding indicator box in the "RS" column.
Indicator boxes in the column "BUS" shine blue, when the associated input signal has been switched on via CAN-Bus. White box means again "signal off".

All input signals can be controlled via serial interface or CAN-Bus, independent of they are assigned to a hardware input or not.

All input signals follow a logical "OR" conjunction and the input signal is in "ON" state when at least one of the associated boxes shines blue.

Meaning and function of the input signals:

⌐¬ = static operation
⌐↑ = dynamic operation, rising edge
Ser/Bus = Activation by serial command or by field bus only.

Control Enable ⌐¬	OFF:	The whole controller and all functions are disabled. All analogue outputs are zero. All counters are hold in a Reset state.
	ON:	The controller is enabled
Start / Stop ⌐¬	OFF:	The cutting roll is held in its actual position (closed loop position control). The cutting roll can be moved into forward and reverse direction by use of the inputs "Jog forw" and "Jog rev". Input "Immediate Cut" allows actuating a cutting cycle.
	ON:	The automatic cutting procedure is in progress. Depending on the selected mode of operation, the unit cuts automatically according to length preset or to print marks. It is recommended to move the cutting roll to its home position before activating Start command (see also input "Homing" and register "Home Window")
Select Virt. Master ⌐¬	OFF:	The line encoder connected to "Encoder1" acts as "Master"
	ON:	An internal frequency generator acts as "Master" (Virtual Master Axis) and signals generated by Encoder 1 are not evaluated. This input will work only with the "Start / Stop" input in OFF state, i.e. it is only possible to change between real and virtual master axis while the cutting roll is in standstill.

Run Virt. Master ⌐¯	OFF:	The virtual master frequency generator is switched off (0 Hz). A transition from ON to OFF will ramp down the frequency from its actual value to zero (standstill), according to the ramp time setting.
	ON:	The virtual master frequency generator is switched on. A transition from OFF to ON will ramp the frequency up from zero (standstill) to the selected speed, according to the ramp time setting.
Jog / Trim forward ⌐¯ Jog / Trim reverse ⌐¯	ON:	With Start/Stop = OFF: In stop state the inputs Jog / Trim forward and Jog / Trim reverse move the cutting roll in one or the other direction (Jog speed register settable). After termination of a Jog command, the cutting roll will be held again in its new position in closed-loop control. With Start/Stop = ON: At automatic cutting cycles the inputs Jog / Trim forward and Jog / Trim reverse shift the cutting position forward or reverse (Trim speed register settable), i. e. the unit temporarily cuts longer or shorter pieces while one of the Trim inputs is ON.
Homing	⌐¯	Starts a homing cycle and moves the knife to a defined home position. Within a homing cycle the cutting roll moves forward till the cutting pulse appears. Then it moves on to the home position. When the input "Control Enable" is set to ON and the cutting roll is not yet in its home position, we recommend performing a homing cycle.
Clear Error	⌐¯	Resets error states and clears the corresponding error messages
Immediate Cut ⌐¯		When the cutting roll is at standstill, a positive edge at this input will immediately start a cutting cycle, independent on what the actual length is. The subsequent cut will correspond to the preset length again, unless another Flying Cut will be triggered again.
Cut Test Length ⌐¯	OFF:	The controller cuts the normal length as set to the "Cutting Length" register.
	ON:	The controller cuts the test length as set to the "Test Cut. Length" register.
	⌐¯	When this input receives a short ON pulse only, there will be just one single cut of the test length between the regular cuts, with the subsequent cycle.

(Command 10)		Not in use
Teach Printmark ⌐		This input defines the printmark position set point and locates the printmark window: When a printmark is detected while the input is ON, this printmark is selected as valid and the printmark window is located at this printmarks position. When "Teach Printmark" is reset to OFF without a printmark having been detected while it was ON, the falling edge of the input (i.e. the position where it has been reset to OFF) will be taken as printmark position set point. This can be used to teach printmark position when the material line is at standstill. (for more details see also parameter "Printmark Window")
Thickness Select ⌐	OFF:	Control characteristics adapted to thin or soft material
	ON:	Control characteristics adapted to thick or hard material
(Command 13)		Not in use
Print Mark	⌐	Sensor input for HTL print mark
Cutting Pulse	⌐	Sensor input for HTL cutting pulse. For definition of the knife position, the controller needs one index pulse with every cut, which can be generated either by a remote sensor or from the marker pulse of the encoder. (See register "Index Mode")
Reset Differential Counter ⌐	OFF:	The PI closed loop control is on, position error count and position control are active
	ON:	The position error counter is kept to zero; the PI control loop is switched off. The cutting roll drive operates "open-loop" with no correction of position errors.
(Command 17 … 28)		Not in use
Store to EEProm	⌐	Stores all actual registers and parameters to the EEPROM (safe for power-down)
Adjust Program ⌐		Switches the controller over from normal operation to the "Adjust" program (Condition: Control Enable = OFF / OFF)
Test Program ⌐		Switches the controller over from normal operation to the "Test" program (Condition: Control Enable = OFF / OFF)

4.1.2. Outputs

Output signals that are in use for the current application are marked with a text, unused outputs are marked with "Output …" only.

It is possible to assign each output signal to any of the 8 hardware outputs that are accessible via screw terminal X7 (marked "Cont.Out"), please see chapter 4.1.3 for details. The number of the hardware output "Out…" assigned to the output signal is displayed in the corresponding lateral indicator box.

The indicator box shines red when the corresponding output signal is on (the assigned hardware output then is HIGH), otherwise the box remains white (the assigned hardware output then is LOW).

All output signals appear on the PC screen and are accessible via serial link or CAN-Bus, independent of they are assigned to a hardware input or not.

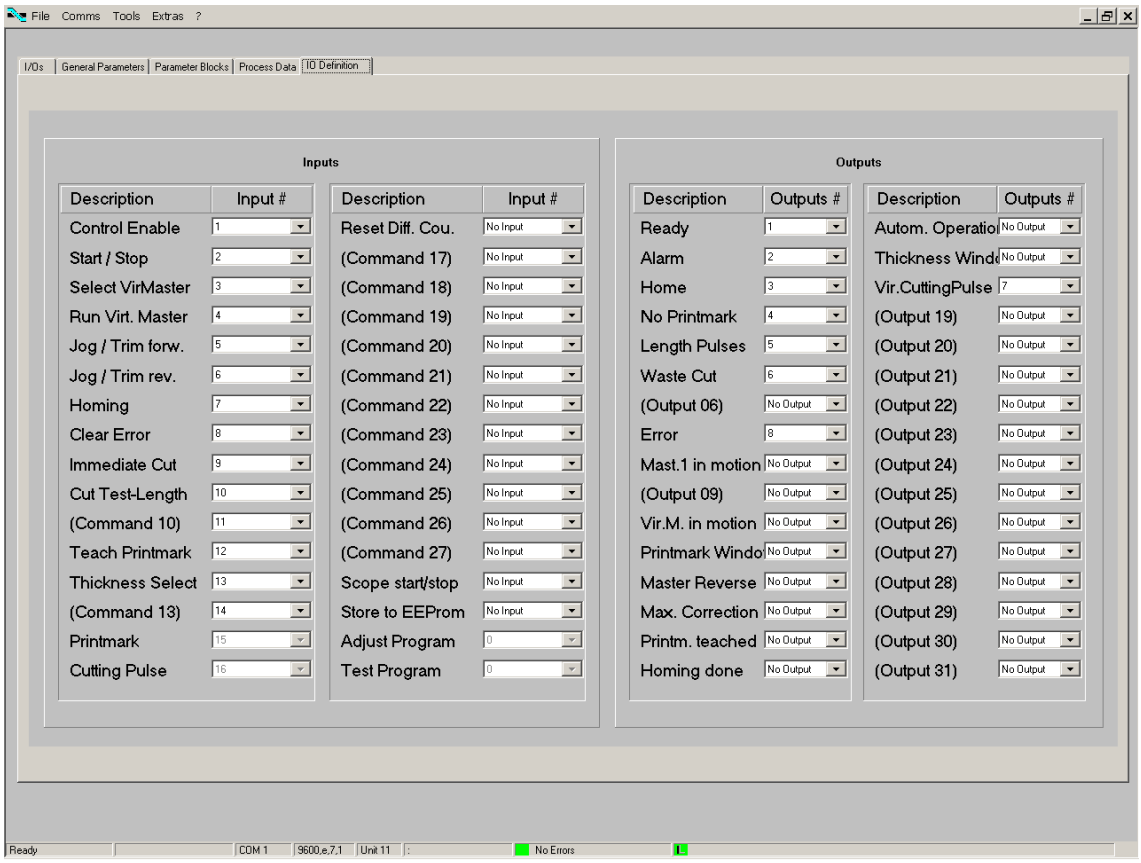
Meaning and function of the output signals:

Ready	Indicates that the unit is ready to operate after power-up, initialization and successful self-test. The signal however is not a guarantee that all functions really work trouble-free.
Alarm	Indicates that the cutting roll, with respect to its profile position set point, actually runs with a positive or negative position error higher than the limit set under parameter „Alarm".
Home	A HIGH state of this output indicates that the cutting roll is in its home position like defined by register "Home Window". The output is LOW whenever the cutting roll is outside the home window.
No Printmark	Indicates that for an adjustable number of sheets no printmark has been detected within the printmark window (see parameter „Missing Printmark")
Length Pulses	This output generates impulses proportional to the motion of the material line, with scalable engineering units. It is designed for use with remote counters or PLCs to totalize or record the total material length during a certain period. The output duty cycle is always 1:1.
Waste Cut	Indicates a waste cut, i. e. a cut is out of the tolerance window set by register "Cut Tolerance" or a test length cut.
(Output 06)	Not in use
Error	This output goes HIGH when an error is detected during operation (see chapter 6 "Error messages"). The error is also indicated in the bottom line of the PC operator software.

Master 1 in motion	This output is HIGH when the line speed of "Encoder 1" input is higher than the standstill definition set in register "Zero Speed. Master"
(Output 09)	Not in use
Vir. M. in motion	This output is HIGH when the frequency generated by the virtual master axis is higher than the standstill definition set in register "Zero Freq. Master"
Printmark window	This output is HIGH while the printmark window is open and detected printmarks are valid. When the printmark window function is disabled, this output is set all the time (every printmark is valid)
Master Reverse	Master reverse movement monitor This output goes HIGH when the material line moves in reverse direction for a distance greater than set in register "Master Rev. Limit". The output is reset to LOW when the master moves forward again the same distance or when input "Clear Error" is activated.
Max. Correction	This output indicates that the proportional correction value has reached the maximum as set to the "Max.Correction" register, and that possibly the cutting roll is out of control.
Printmark teached	Indicates that the printmark position set point has successfully been set by input „Teach Printmark".
Homing Done	Set to on when the homing cycle is finished. Reset to off when the home position is no more valid and a new homing cycle should be executed (after Jog, Control Enable = low or power down).
Automatic Operation	Set to on during automatic cutting operation when input "Start/Stop" is on. When input "Start/Stop" is reset to off, this output is set to off not before the actual cut is finished and the cutting roll has come to standstill.
Thickness Window	Indicates that the knife is inside the thickness control window (See parameters "Thickness Mode", "Startpos. Thickn." and "Endpos. Thickn.")
Vir. Cutting Pulse	The rising edge of this output indicates the virtual cutting pulse at the cutting position of the knife (see parameter "Cutting Pulse Offset"). The output is reset to low at the end of the synchronous zone after the cut (see parameter "Sync. After Cut")
(Output 19 … 31)	Not in use

4.1.3. Assignment of Hardware Inputs and Outputs

By using register card „IO Definition“ nearly all input and output signals can be assigned to the hardware inputs and outputs, respectively:



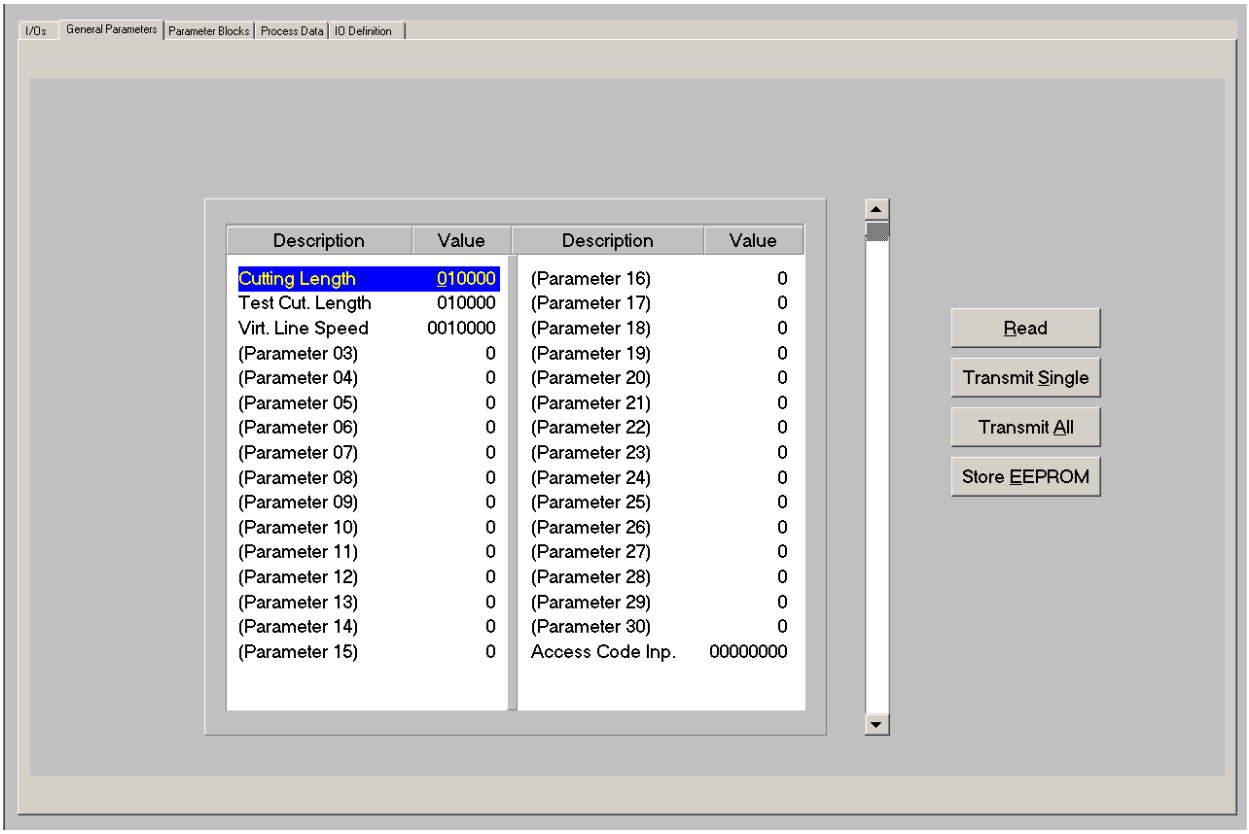
Any hardware input can be assigned to several input signals at the same time if necessary. The hardware input then switches all input functions associated in parallel.

Also any hardware output can be assigned to several output signals at the same time if necessary. Then the output signals are logical OR'd, i.e. the hardware output is set to high if any of the associated output signals is set to on.

Fixed assignments that cannot be changed (e. g. Index signals) are marked in grey color.
The input/output assignment is stored to EEPROM when leaving this register card.

4.2. General Parameters

This register card holds the essential variable settings of general nature



Prior to register setting you must decide which dimensions or length units (LU) you like to use for preset of the cutting length. This could be 0.1mm or 1mm or 0.001 inch or any other resolution you desire. All further settings refer to the Length Units you decided to use. E.g. when you chose to set the length with a 0.1 mm resolution, 1000 LUs will represent a length of 100.0 millimeters with all further entries.

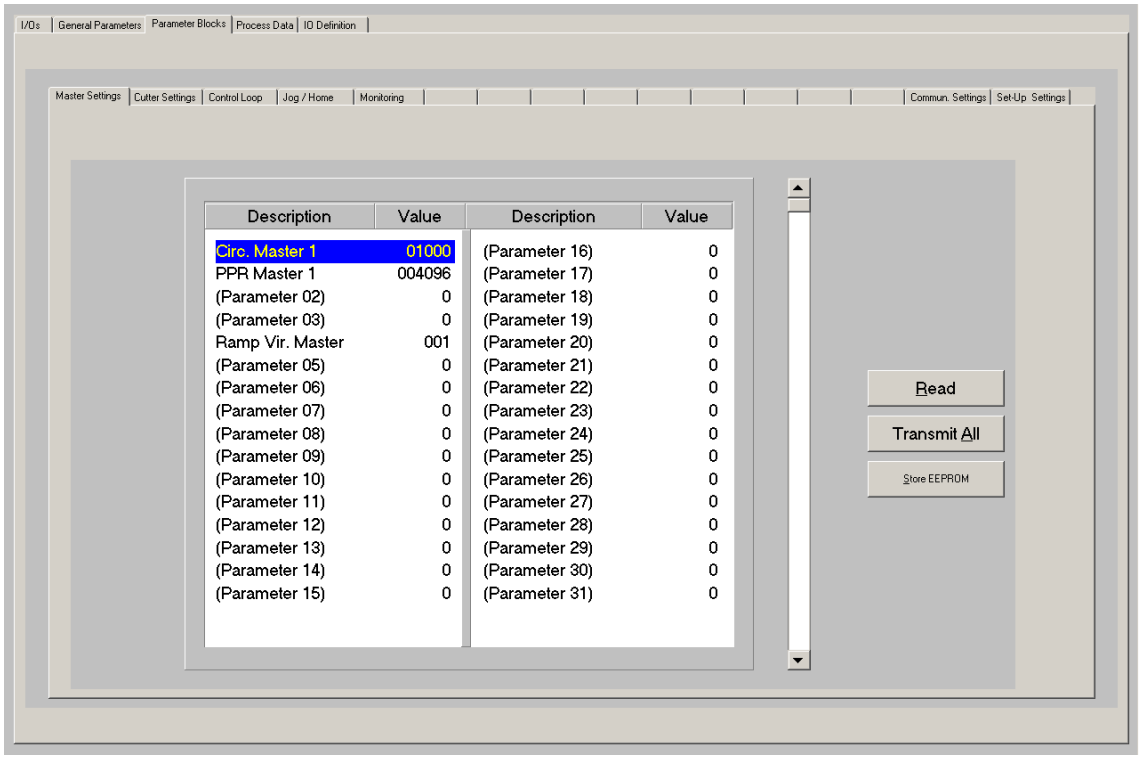
When you transmit new register values during a cutting cycle the new values will not become active before the cutting pulse appears, because the precalculations for the new cutting profile take place in the synchronous zone after the cutting pulse.

Cutting Length	Preset of the desired cutting length, setting in “Length Units”. This length will be cut when input “Cut Test Length” is LOW. Setting range 1 - 999 999 length units.
Test Cut. Length	Preset of the desired test length, setting in “Length Units”. This length will be cut when input “Cut Test Length” is HIGH or was shortly HIGH during the previous cutting cycle. Test length can be used to cut test samples or waste pieces etc.. Setting range 1 - 999 999 length units.

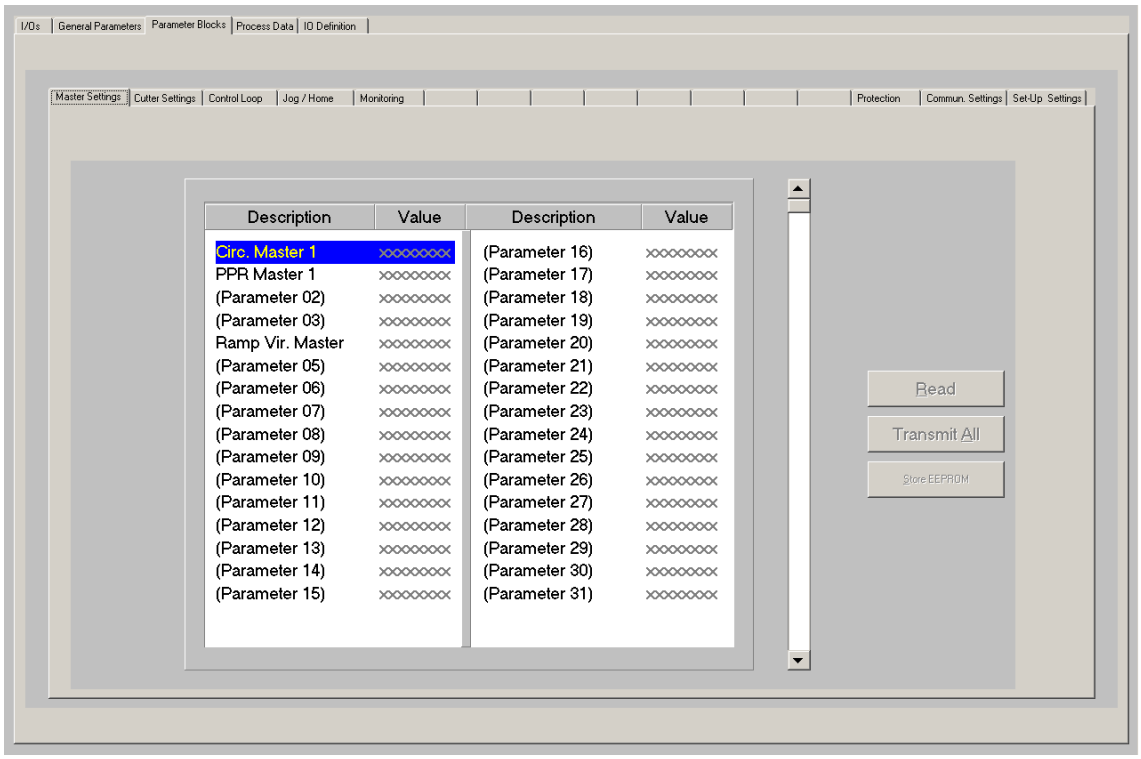
Virt. Line Speed	Speed set value of the virtual master axis, to be set as Length Units (LU) per minute Range 0 – 9 999 999 LU/min, the setting is limited to the value of register "Max. Line Speed". Internal resolution = 1/2048 of Max Line Speed.
(Parameter 03…31)	Not in use
Access Code Input	Input of access code for the parameter blocks. At parameter "Access Code Def." in parameter block "Protection" you can define an access code for all parameter blocks (see chapter 4.3.6) To read or write the subsequently described parameters you need to enter the correct access code here. If you enter a wrong code, the parameter blocks are protected from any access and the parameter values are shown as "xxxxxxxx". For security reasons, register "Access Code Input" will not be stored to EEPROM. When you close the PC operator software or disconnect the serial connection between PC and MC700 the entered code is automatically reset to 0.

4.3. Parameter Blocks

This field contains more parameters and machine specifications, separated to clearly arranged blocks.



If the parameter protection is active it shows “xxxxxxxx” instead of the parameter values:

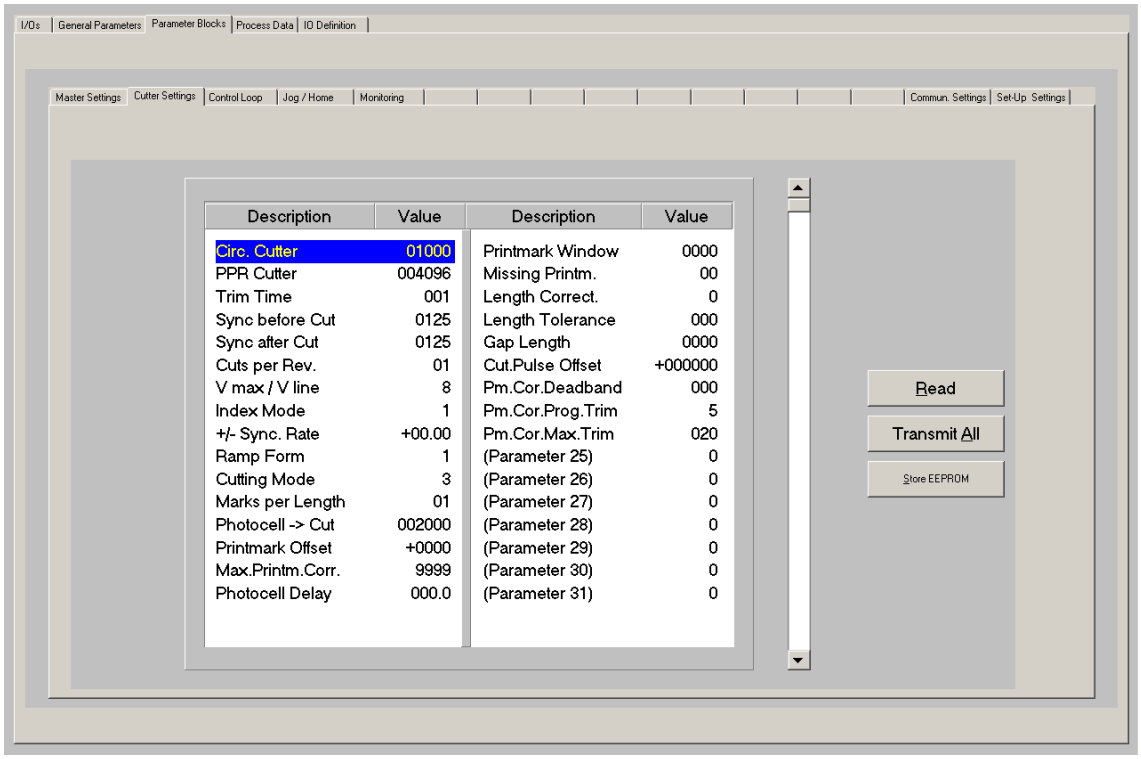


For details of the parameter protection please see parameter “Access Code Input” (chapter 4.2) and parameter “Access Code Definition” in block “Protection” (chapter 4.3.6).

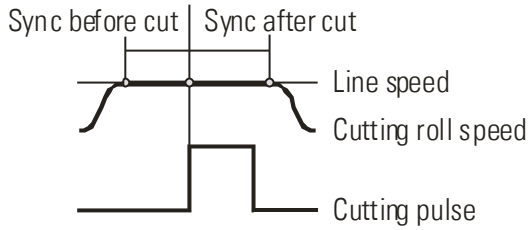
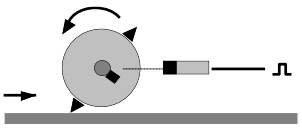
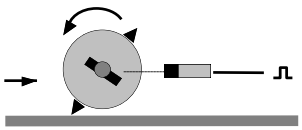
4.3.1. Master Settings

Circ. Master 1	This register must be set to the circumference of the line feed roll or the measuring wheel of the line encoder connected to input „Encoder1“. Setting in length units you decided to use. Range 1 – 99999 length units.
PPR Master 1	Pulses per revolution of the line encoder connected to input “Encoder1”. Enter the number of pulses from the encoder for one revolution of the feeding roll or measuring wheel with regard to the multiple edge count setting (x1, x2, x4) Range 1 - 999 999.
(Parameter 02)	-Not in use-
(Parameter 02)	-Not in use-
Ramp Vir. Master	Sets the ramp time of the virtual master axis between standstill and maximum speed (acceleration and deceleration) Range 0 – 999 s.
(Parameter 05…31)	-Not in use-

4.3.2. Cutter Settings



Circ. Cutter	Circumference of the cutting roll. Range 1 – 99999 length units.
PPR Cutter	Pulses per revolution of the cutting roll. Enter the number of pulses from the encoder for one revolution of the cutting roll with regard to the multiple edge count setting (x1, x2, x4). Range 1 - 999 999.
Trim Time	Adjustment time for one length unit of cut position displacement with use of the Trim function or for correction of cutting position in cutting mode 3 001 = 1 ms for each length unit (fast) 999 = 999 ms for each length unit (slow)
Sync before Cut	This register defines, how long before the cut (rising edge of the virtual cutting pulse) the cutting roll must be synchronous to the line. Range 1 – 9999 length units.

Sync after Cut	This register defines, how long after the cut (rising edge of the virtual cutting pulse) the cutting roll must remain synchronous before the speed profile starts to change speed. Range 1 – 9999 length units. 
Cuts per Rev.	Number of cuts per revolution of the cutting roll. Setting range 1-99. Set this register to 1 when your cutting roll has only one tool at its circumference to perform one single cut per revolution. There are two different ways of setting this register when you have mounted two or more tools around the cutting roll to perform two or more cuts by every revolution of the cutting roll: a. If you have more than one tool but only one single cutting pulse per revolution of the cutting roll, then set register "Cuts per Rev." to the number of cuts performed by one revolution of the cutting roll. The controller will generate the missing cutting pulses internally. **Example:** Two cuts per revolution but only one cutting pulse → Set "Cuts per Rev." = 2  b. If you perform several cuts per revolution of the cutting roll and each cut generates its own separate cutting pulse, then proceed as follows: ▪ Set register "Cuts per Rev." to 1. ▪ Do not set register "Circ. Cutter" to the real circumference of the cutting roll but set it to the partial circumference between two tools. ▪ Also set register "PPR Cutter" to the number of pulses between two tools at the cutting roll. **Example:** Two cuts per revolution and also two cutting pulses → Set "Cuts per Rev." = 1, "Circ. Cutter" = half the cutting roll circumference and "PPR Cutter" = half the number of pulses per revolution. 

<table>
<tr><td>V max / V line</td><td>This setting is important only when the range of cutting lengths includes lengths shorter than the roll circumference, so the roll must accelerate between two cuts. The register sets the maximum speed ratio between the circumferential roll speed and the line speed that the drive will take when required.
This means, whenever you cut shorter length, it is necessary the slave drive can at least run double line speed. The higher the ratio, the shorter the minimum length you can cut. It is important to know that this ratio setting does not refer to the maximum line speed, but to the real line speed you use when cutting short length. You are free to reduce your line speed with shorter length preset and i. e. set this register to 8. But then you must be sure that the cutter drive can really run 8 times the line speed you actually use for your shortest length. In general, setting „8“ can be recommended. Range 2 – 8.</td></tr>
<tr><td>Index Mode</td><td>This register selects the source of the cutting pulse and the print mark pulse. You are free to use either the RS422/TTL inputs on the encoder connectors, or the 24V/HTL inputs at the Cont. In screw terminal:
<table>
<tr><th>Index Mode</th><th>Cutting pulse source:</th><th>Print mark source:</th></tr>
<tr><td>0</td><td>HTL (Cont.In16 terminal 17)</td><td>HTL (Cont.In15 terminal 16)</td></tr>
<tr><td>1</td><td>TTL (Encoder2 input, Pin 6/7)</td><td>HTL (Cont.In15 terminal 16)</td></tr>
<tr><td>2</td><td>HTL (Cont.In16 terminal 17)</td><td>TTL (Encoder1 input, Pin 6/7)</td></tr>
<tr><td>3</td><td>TTL (Encoder2 input, Pin 6/7)</td><td>TTL (Encoder1 input, Pin 6/7)</td></tr>
</table></td></tr>
<tr><td>+/- Sync Rate</td><td>This register allows a percental adaption of the synchronous speed in a range of +/- 99.9%. In general, this register will be set to 00.0 and the cutting roll will synchronize with the line exactly according to the encoder information.
Some applications may require slightly higher or lower speed during the synchronous zone, e. g. due to the cutting tool design.
This setting affects the synchronous speed only, but not the cutting length.</td></tr>
<tr><td>Ramp Form</td><td>Selects the shape of the ramps of the cutting roll speed profile:
0: Parabolic S-ramps
(recommended in general with standard servo drives)
1: Linear ramps
(recommended with less dynamic systems, e.g. DC drives)
2: Sin² shaped ramps
(recommended with extremely dynamic servo systems)</td></tr>
<tr><td>Cutting Mode</td><td>Operation mode.
1: Cut to length according to length preset (without print mark)
2: Cut according to the print marks on the material, correction of the cutting position is provided by continuous adaption of the cutting length set point
3: Cut according to the print marks on the material, correction of the cutting position is provided by additional speed. The additional speed can be adjusted by register “Trim Time”.(This cutting mode is recommended when the distance of the printmark sensor is less than one sheet length)</td></tr>
</table>

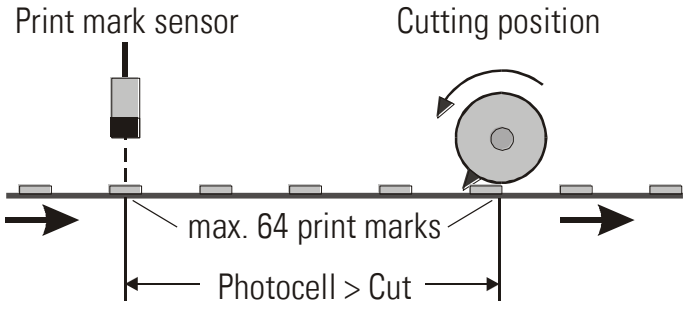
Hints for printmark operation:

Even with printmark operation, parameter "Cutting Length" must be set to the correct cutting length, i.e. it must be set to the printmark distance value. With missing printmarks or those that were not detected correctly by the sensor, the controller automatically places the cut to the position where the printmark should have been. However, a sudden wide change of print mark distance which is not in multiples of the normal distance, or wrong or additional printmark pulses, may result in waste cuts.

Where you run mixed production with length and printmark operation (sometimes with, sometimes without printmark), set parameter "Cutting Mode" to 2 or 3 and install a selector switch to apply to or remove the printmark pulse from input "Printmark", according to actual need.

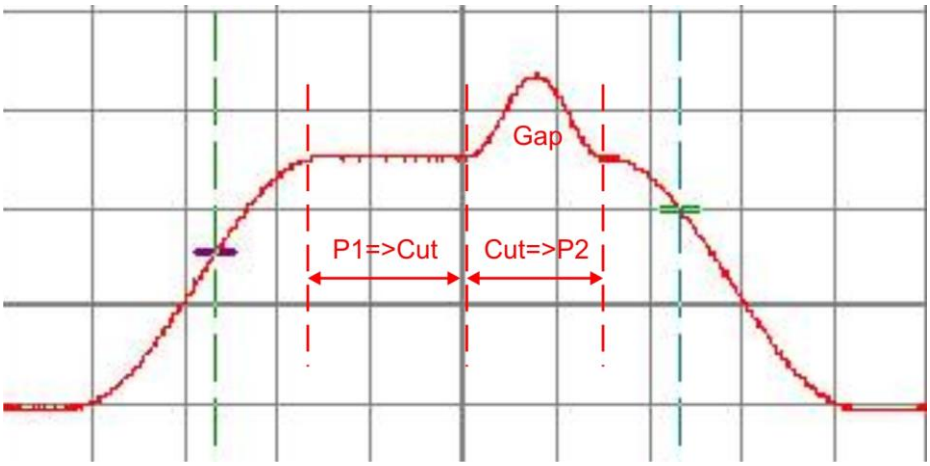
When your application provides print marks with randomly varying distance, please take care of correct location of the print mark sensor.
In this case the minimum distance between sensor and cutting position should be at least two times of the cutting length when using Cutting Mode 2, however it should be less than one cutting length when you use Cutting Mode 3

All subsequent parameters marked with an asterisk (*) are only relevant for printmark operation. These parameters need not to be set with cut to length operation (Cutting Mode 1).

Marks per Length *	Set this register to 1 when you have only one print mark with each cut. Set it to the number of print marks between two cuts, when you find several marks, but the cut should only be executed with one specific mark. Range: 1 – 99.
Photocell -> Cut *	Distance between the print mark sensor and the cutting position. Range 0 - 999999 length units. The controller stores up to 64 print marks between sensor and cutting position in a FIFO shift register, and controls the cutting length according to the momentary actual mark. The unit will switch to Error state when more than 64 marks have been detected between the sensor and the carriage home position.
	

Printmark Offset *	Fine adjustment of the desired cutting position with respect to the print mark. Setting to 0 results in placement of the cut to the edge of the print mark (rising edge of the photocell). A positive value moves the cut forward (leading the printmark), a negative value moves the cut backwards (lagging behind the printmark). Range +/- 9999 length units. With use of the Trim function for of cut position displacement Printmark Offset value is limited to one cutting length
Max. Printmark Correction *	The response to registered cutting position errors with printmark operation is limited to the value set here. Corrections of the cutting position greater than this value will be executed over several sheets. Range 9999 length units.
Photocell Delay*	Compensation of delay time of printmark sensor: Here you can set the latency time (dead-time) of the printmark sensor (e.g. photocell) scaled in milliseconds. The detected position of the printmark will be automatically corrected according to the delay time set here. Range 0.0 – 500.0 ms.
Printmark Window*	Defines a symmetric window around the rising edge of the print mark sensor. The print mark is supposed to appear inside this window and signals outside the window will not trigger the print mark registration. The position of the window is determined by input "Teach Printmark" Range 0-9999 length units. Setting 0 disables printmark window function, then every printmark will be detected. Clarification: When using print mark operation, many times you can find several marks on one size of the sheet to be cut, and only one of these marks is valid for registration to define the cutting position. The unit can automatically blank out the other marks by defining a printmark window around the position of the valid printmark. To set the correct position of the printmark window, set input "Teach Printmark" to high when the valid print mark is close to the print mark sensor, but is not yet sensed. Move the line slowly until the sensor detects the mark and switches from low to high (rising edge required!). The "Teach Printmark" counter input must go back to low state before the sensor generates the next rising edge from the following mark. This stores the position of the valid print mark and the unit will not trigger to the other marks between.
Missing Printmark*	Monitoring of printmarks within the printmark window: This register sets the number of sheets without printmark until output "No printmark" is set. Range 0 – 99. Setting 0 disables the printmark monitoring.

*) For printmark operation only

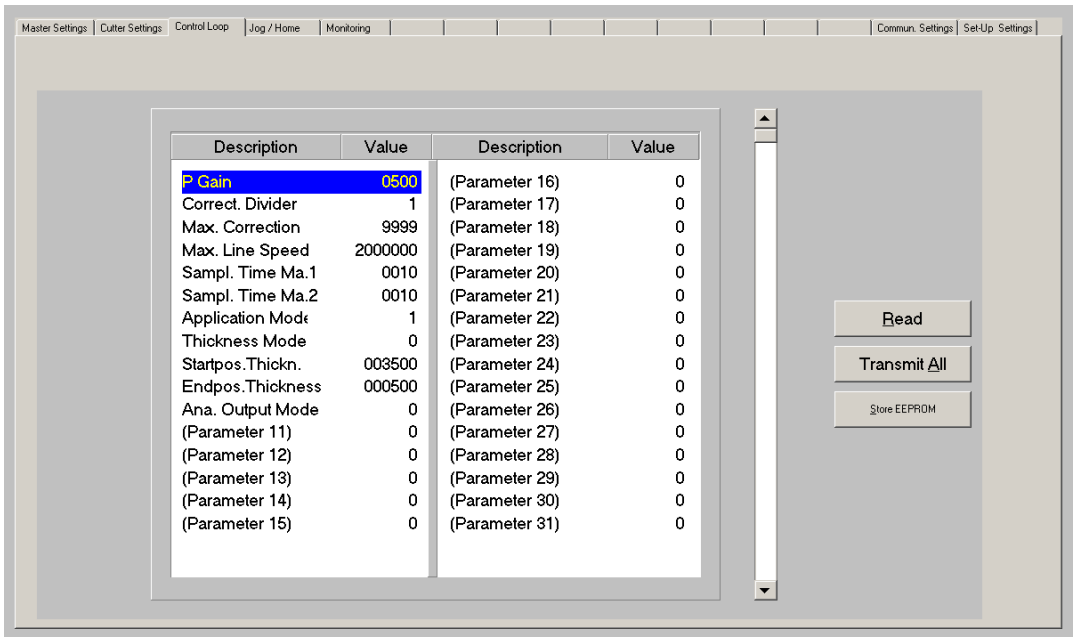
Length Correction*	Automatic overwrite of the length setting by the print mark distance found by measurement. Setting range 0 – 5 0 = Automatic length overwrite switched off 1 = Automatic length overwrite after 1 cycle 2 = Automatic length overwrite after 2 cycles 3 = Automatic length overwrite after 4 cycles etc. **Clarification:** When cutting or printing paper or foils with print marks, the material can shrink or stretch for reasons of tension, ambient temperature, humidity etc.. As a result, the distance between two print marks (i. e. the cutting length) will change and no more exactly match the preset length. Due to the proportional control feature of the firmware, this would also cause a slight displacement of the real cutting position with respect to the print mark. The „Length Correction" register sets a number of cutting cycles where the cut must be out of tolerance (see register "Length Tolerance") in always the same direction and consecutively. When reached, the length preset is automatically overwritten by the mean value of the real length measured between the print marks and proportional position errors are eliminated.
Length Tolerance*	Defines the discrimination threshold for the automatic length overwrite as described before. Scaled in length units, setting range 0 – 999 length units.
Gap Length	With some applications it is desirable, after the cut, to produce a gap between following material and the piece actually cut, by short acceleration of the cutting roll The gap width can be set directly in length units. Range 0-9999 LU. The entire gap is worked out during the after-cut-phase "Cut=>P2". This means the superimposed gap profile is more flat with higher Cut=>P2 values and steeper with shorter Cut=>P2 values in order to always reach the desired gap distance.  **With most applications, this function remains unused (Gap Length = 0).**

*) For printmark operation only

Cutting Pulse Offset	Offset register for virtual displacement of the physical cutting pulse (generated from encoder index or by proximity). Setting in +/- encoder increments. This register makes superfluous a precise mechanical adjustment of the location of the pulse (the virtual cutting pulse must be located exactly in the peak position of tool penetration). Setting range: +/-999999 increments.
Pm. Cor. Deadband *	Printmark Correction Deadband: Window to limit the response to registered cutting position errors with printmark operation. When the registered cutting position error is less than the deadband setting, no correction will be executed. Setting range 0 – 999 length units.
Pm. Cor. Prog. Trim *	Printmark correction progressive trimm function: Sets the characteristic of the response to cutting position errors in Cutting Mode 3. 0: Compensation of the cutting position error is linear, i. e. with a constant additional speed as set by register Trimm Time ≥1: Compensation of the cutting position error is progressive, i. e. with higher speed as the actual print mark error is high, and with continuously decreasing speed as the actual error declines. With setting 1, the progressive compensation is very sharp, with higher setting the progressive compensation gets softer. Setting Range 0 – 9. Recommended Setting: 3…5
Pm. Cor. Max. Trim *	Printmark correction maximum trimm: Limitation of the additional speed for with Cutting Mode = 3 and Pm. Cor. Prog. Trim ≠ 0 Setting Range 0 – 999. Recommended Setting: 20
(Parameter 25...31)	-Not in use-

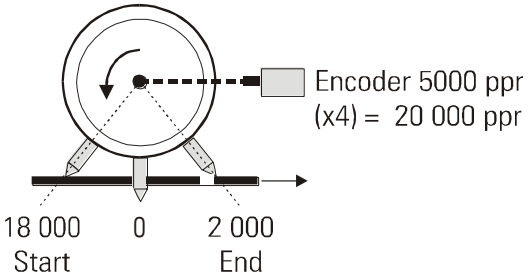
*) For printmark operation only

4.3.3. Control Loop Settings

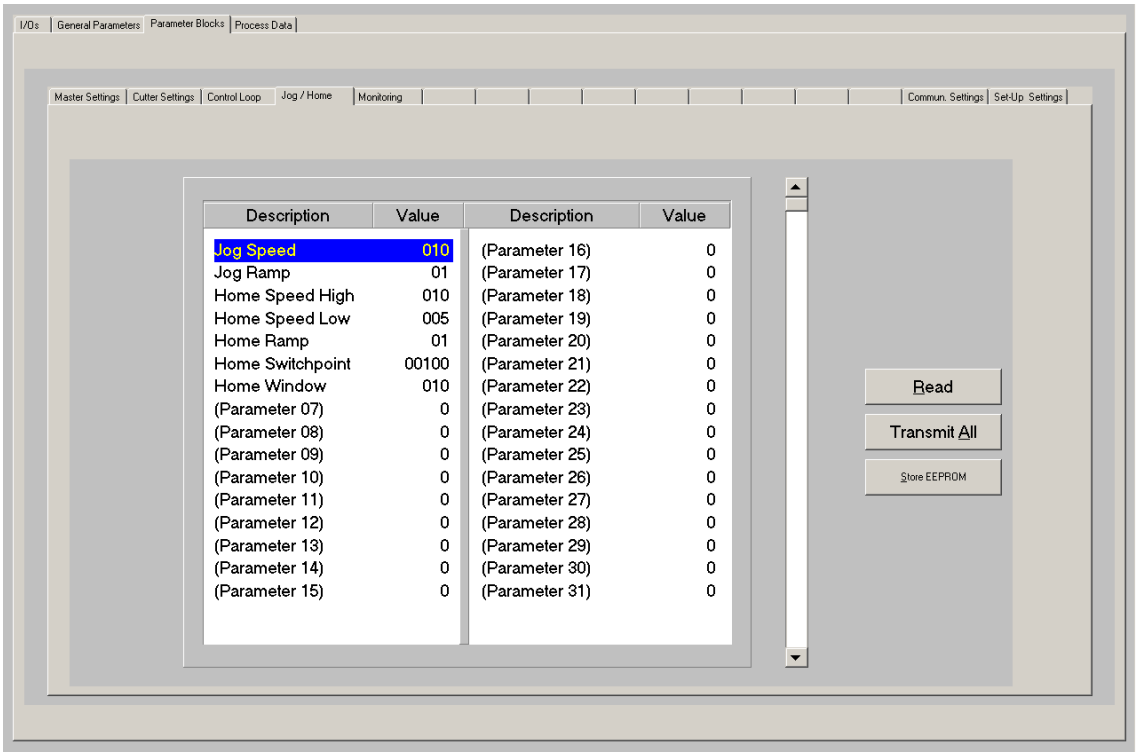


P Gain	Proportional gain for compensation of relative errors of the cutting roll position with respect to the scheduled position. Setting range: 0 – 9999 Recommended settings: 500 – 2500.
Correction Divider	This register provides a digital attenuation of the position correction signal that is produced, when the drive on mechanical grounds (dead band or backlash) cannot respond. In such a case, it is not desirable to make corrections immediately. The Correction Divider provides a window for the drive "backlash", within which the controller produces no correction, and a division of the incremental position error count. **1:** No window, Reaction to every error increment, no division of the position error counter. **2:** Window +/- 1 increment, division by 2 **3:** Window +/- 3 increments, division by 4 **4:** Window +/- 7 increments, division by 8 **5:** Window +/- 15 increments, division by 16 etc. **9:** Window +/- 255 increments, division by 256
Max. Correction	Limitation of the active correction signal resulting from the proportional position control loop. When the correction has reached this limit, the analogue output will no more follow to further increase of the error, but the error record itself will be continued in the background. Setting range: 0 – 9999 mV. Recommended settings: ≥ 1000 mV

Max. Line Speed	Setting of the maximum applicable line speed. Setting range 1 – 9 999 999 LU/min. This setting is used for internal scaling and resolution of the line speed. For best resolution, this value should not be set higher than really necessary for the application. Upper limit to the value of register "Virt. Line Speed".
Sampling Time Master 1	Provides digital filtering of the feed forward signal generated from the line encoder connected to input "Encoder1". Range 0001 - 9999 ms; normal setting: 1 ms. For applications with unsteady line speed or bumpy motion of the measuring wheel, settings like 10 ms or even 100 ms can be advantageous for smoother motion of the cutting roll and increased accuracy. Please note that higher settings result in lower response to actual changes of the line speed, i.e. you should consider increasing the ramp times of your line drive to ensure that your cutting accuracy remains good also during changes of the line speed.
Sampling Time Master 2	-Not in use-
Application Mode	Application-specific fine tuning of control loop 0: Recommended setting for printing, embossing, stamping and similar applications where the processed material remains unsplit. 1: Setting for cutting applications
Thickness Mode	Parameter to adapt the control loop characteristics to different thickness and hardness grades of the material. Setting range is 0, 1 or 2. Normal setting is 0, a different setting is only necessary for very thick or very hard material when normal cut performance is not sufficient. Best setting depends on many details like tool shape, drive dynamics, material properties etc. and must therefore be found out. The parameter is active in a small "Thickness Window" only, which opens shortly prior to the cut and closes shortly after the cut.
Startpos. Thickn.	Opening position of the "Thickness Window" with regard to the cutting pulse (which represents zero). Setting in "Encoder Increments". Must be set to a position shortly before the tool touches the material (see example on next page).
Endpos. Thickness	Closing position of the "Thickness Window" with regard to the cutting pulse (which represents zero). Setting in "Encoder Increments". Must be set to a position where the tool has moved out of the touching range of the material (see example on next page).

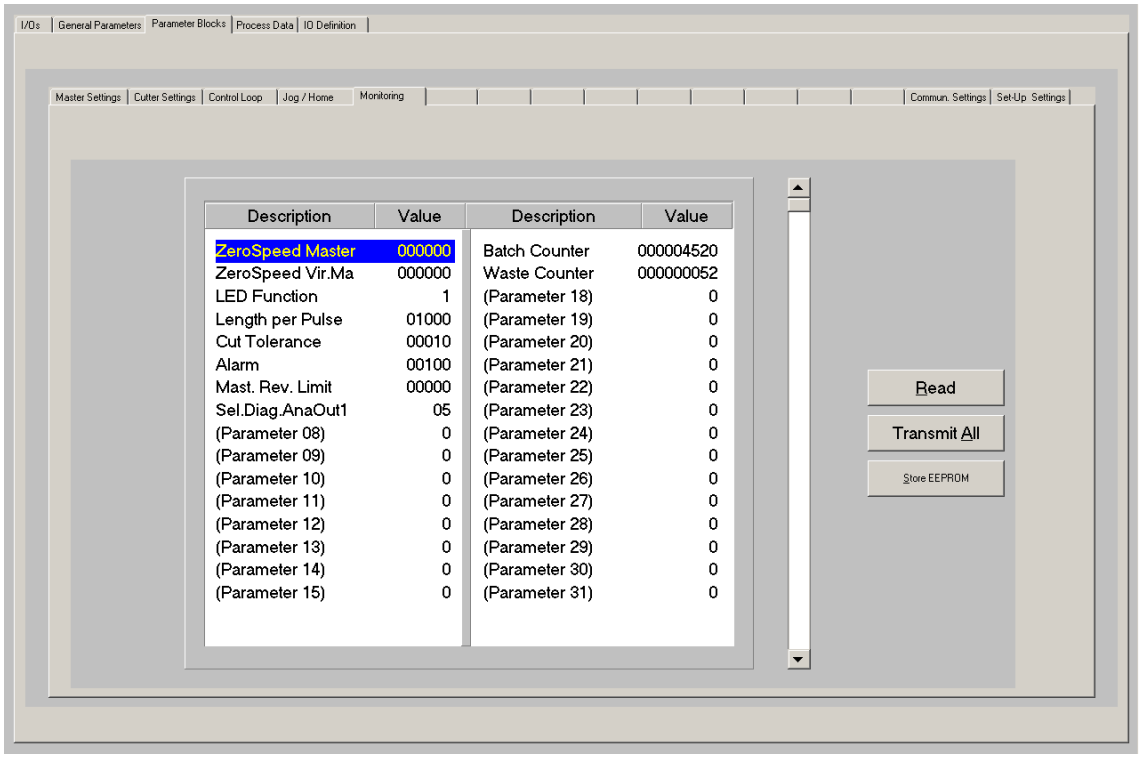
	Example for settings of Start and End of the "Thickness Window" with a 5000 ppr encoder at edge evaluation (x4) Startpos. Thickn. = 18 000 Endpos. Thickness = 2 000 
Ana. Output Mode	This parameter allows to separate feed forward signal and correction signal: 0: Feed forward signal and correction signal are added to a speed set point signal that is available at analogue output 2 (standard) 1: Feed forward signal only is available at analogue output 2 and correction signal is separately available at analogue output 3 2: Feed forward signal only is available at analogue output 2 and *inverted* correction signal is separately available at analogue output 3 With setting 1 or 2, feed forward signal and correction signal must be connected to two different analogue inputs of the drive. The two signals then must be added in the drive to obtain the speed set point value.
(Parameter 11…31)	-Not in use-

4.3.4. Jog / Home



Jog Speed	Preset of the desired cutting roll speed for Jog operations with use of the inputs "Jog / Trim forward" and "Jog / Trim reverse" in stop state. Setting range 000 – 100%, where 100% corresponds to the "Maximum Line Speed" setting.
Jog Ramp	Ramp time for Jog operations. Setting range 01 – 99 s with respect to speed changes between standstill and full Jog speed.
Home Speed High	Fast Homing speed. Every homing cycle will start with this speed. Setting range 000 – 100%, where 100% corresponds to the "Maximum Line Speed" setting.
Home Speed Low	Slow Homing speed. A Homing cycle will end with this speed Setting range 000 – 100%, where 100% corresponds to the "Maximum Line Speed" setting
Home Ramp	Ramp time for acceleration and deceleration with Homing cycles. Range: 0 – 99 s.
Home Switchpoint	Distance from the final home position where the speed changes over from High speed to Low speed within a homing cycle. Range: 1 – 99999 length units.
Home Window	Sets a window around the home position of the cutting roll, which is located opposite to the center point of the synchronous zone. Setting range 1-999 length units. The output "Home" indicates by High state that the cutting roll position is inside this window. If a cut is started with the cutting roll not being in this window the controller will display "No Home Position" error.
(Parameter 07…31)	-Not in use-

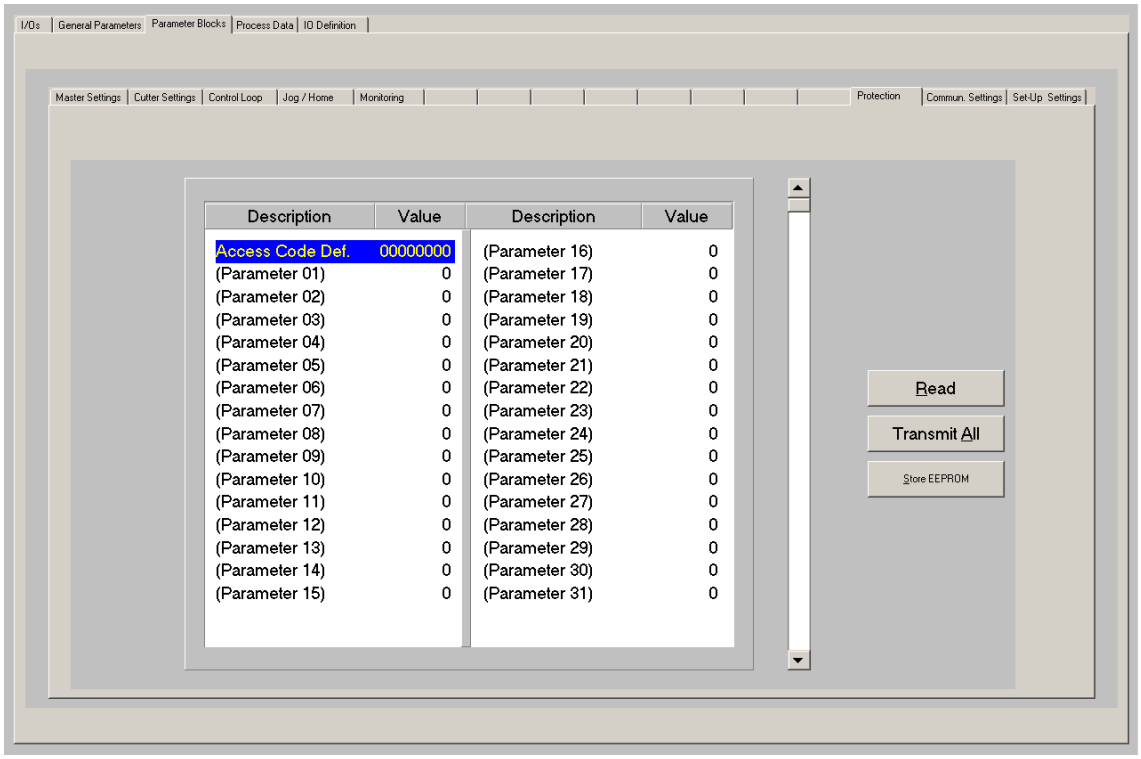
4.3.5. Monitoring



Zero Speed Master	Standstill definition for the line encoder. When the speed of the line encoder is higher than the setting of this register the referring output “Master X in Motion” is switched ON. Setting range: 0 – 999 999 LU/min.
Zero Speed Vir. Master	Standstill definition for the virtual master. Output “Vir. M. in Motion” is switched ON when the speed generated by the virtual master is higher than the setting of this register. Setting range: 0 – 999 999 LU/min.
LED Function	Selects the function of the 6 LEDs located on the connector plate of the controller. **0:** LEDs display the switching state of the hardware outputs Out1 - Out6 **1:** LEDs indicate the actual position error of the cutting roll. See chapter 5 “Function of LED indicators”
Length per Pulse	Scaling factor for the auxiliary “Length Pulses” output. Setting range 1 - 99999 length units per pulse. When e.g. the whole system is calibrated in “Millimeters“ and you have set this register to 1000, the output will generate one pulse every 1000 millimeters of forward motion of the line.

Cut Tolerance	Defines the threshold of the output „Waste Cut“ and the waste counter. If the actual cutting length of a piece is more than the value of “Cut Tolerance” lower or higher than the preset cutting length the piece is counted as waste and the output “Waste Cut” is set to high. Range: 0 – 99999 length units.
Alarm	Defines the switching level of the output “Alarm” when the system is forced out of synchronization due to external events (drive fault or mechanical problem). Setting occurs in cutting roll encoder increments and the alarm output switches on when the positional error of the roll in respect to the scheduled position overpasses the number of encoder pulses set. Range 1 – 9999 increments.
Mast. Rev. Limit	Master reverse movement limit (see also output “Master Reverse”). Setting range 0 – 99 999 LU. When the material line moves in reverse direction for a distance greater than the value set in this register, the master encoder pulses in reverse direction are blocked and no more counted. This prevents the cutting roll from moving backwards. Setting 0 disables the Master reverse movement monitoring.
Sel.Diag.AnaOut1	Selects the actual value from the menu “Process Data”, which should appear at analogue output “Ana Out 1” for diagnosis purpose. Setting range 0 - 31 (number of actual value) See chapter 4.4 and table in chapter 10 for selection.
	Parameter Ana Out1 Gain from the Set-up register card (see chapter 4.3.7) allows the scaling of the analogue diagnosis signal: Output voltage [V] = (Ana Out 1 Gain x actual value) / 2048 Setting Ana Out1 Gain to 10.00, for example, means that a digital value of 2048 will cause a full scale analogue output of 10 volts.
(Parameter 08…15)	-Not in use-
Batch Counter	Counts the number of cuts made with the normal cutting length during automatic operation.
Waste Counter	Counts the number of waste pieces. Increments with every waste cut, immediate cut and test length cut.
	Hint: Batch counter and waste counter will not be saved automatically to the EEPROM upon power-down!
(Parameter 18…31)	-Not in use-

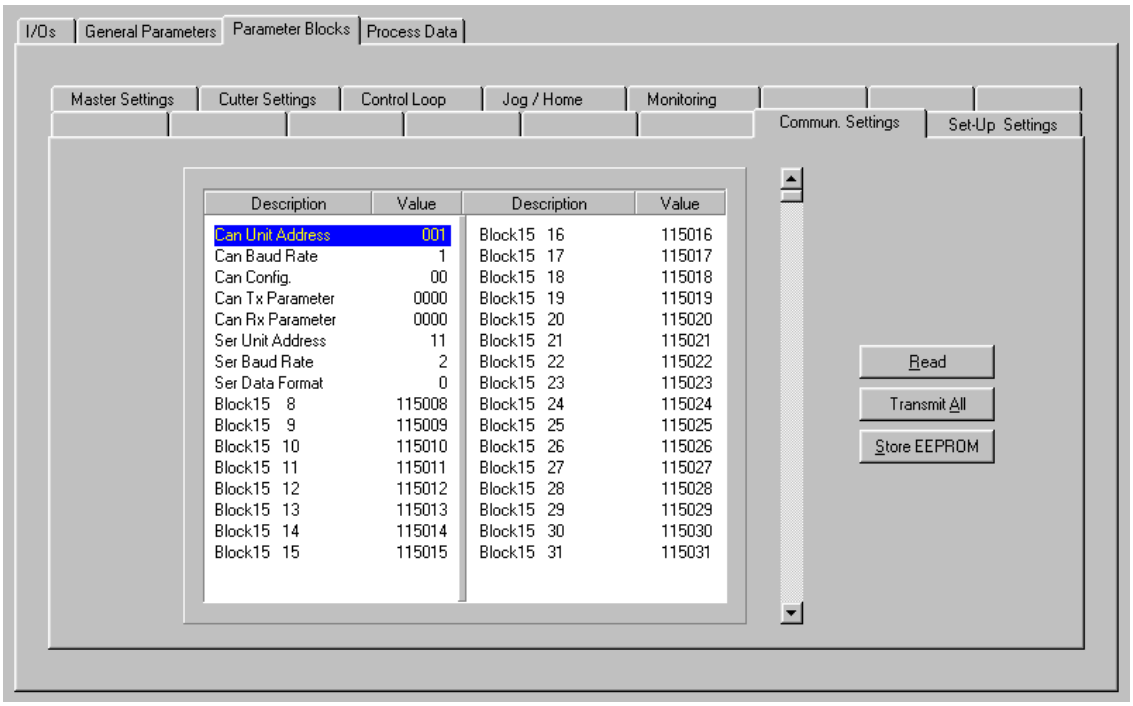
4.3.6. Protection Settings



Access Code Definition	Definition of an access code for the parameter blocks protection. Setting = 0: The parameter block protection is disabled. All parameter values in the parameter blocks can be read and written without restriction. Setting > 0: The parameter block protection is enabled. The access code as defined here must be entered at parameter "Access Code Input" to get read and write access to the parameter blocks. Setting range 0 – 99999999.
(Parameter 01…31)	-Not in use-

4.3.7. Communication settings

This register card sets the communication parameters for the CAN interface and the serial link.



Settings and operation of the CANopen interface are explained separately in the manual **CI700**, which is available on our homepage or on our CD-ROM.

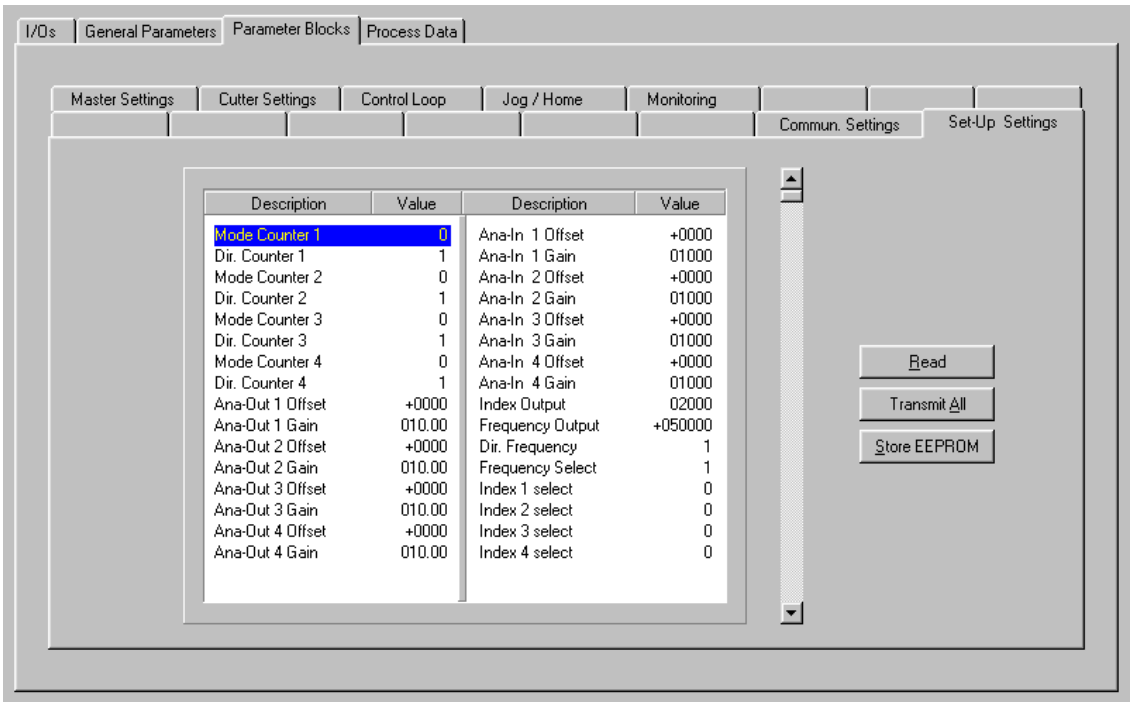
The serial link uses the following parameters:

Ser. Unit Address	Serial unit address. Range 11 ... 99. Address numbers containing zeros like 01, 02, 03, ..., 10, 20, etc. are not permitted because these are reserved for broadcast messages (collective addressing of several units) Factory default address is always 11.
Ser. Baud Rate	0: 38400 Bit/s 1: 19200 Bit/s 2: 9600 Bit/s 3: 4800 Bit/s 4: 2400 Bit/s **Factory default setting: 2**

Serial Data Format:	Setting:	Data bits	Parity	Stop bits
	0	7	even	1
	1	7	even	2
	2	7	odd	1
	3	7	odd	2
	4	7	none	1
	5	7	none	2
	6	8	even	1
	7	8	odd	1
	8	8	none	1
	9	8	none	2
	Factory default setting: 0			

4.3.8. Setup Settings

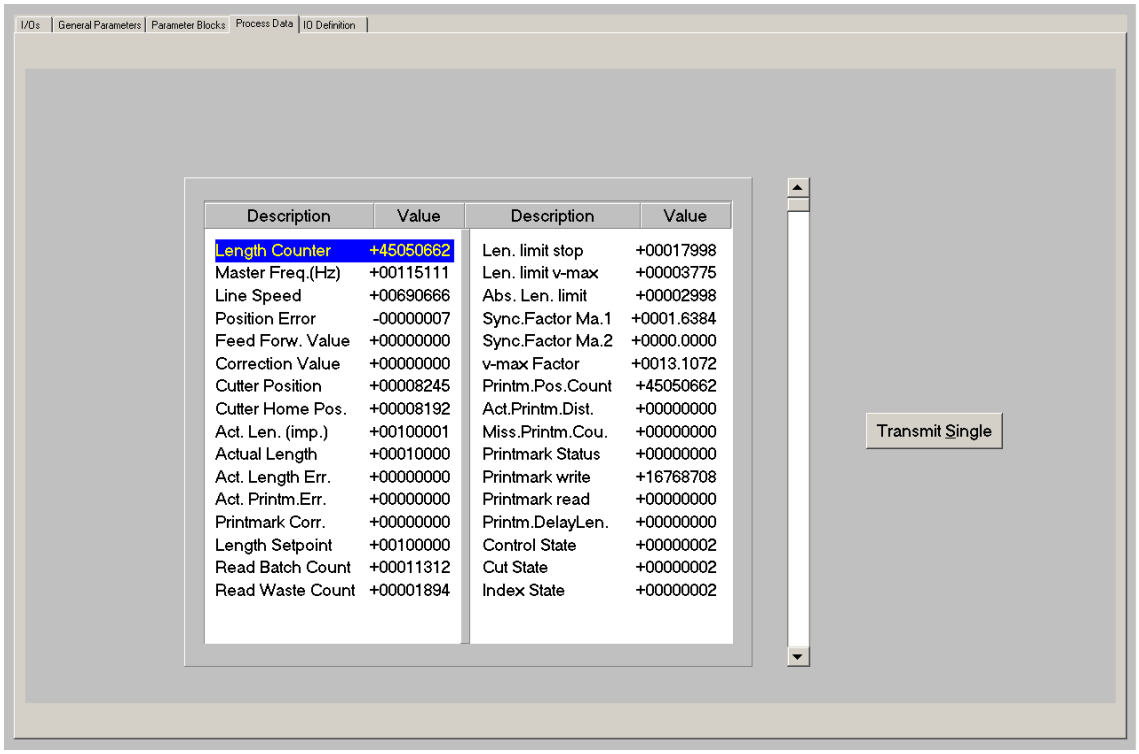
These settings define all important hardware properties of inputs and outputs of the MC700 controller. You must only make settings for those functions that are really used and wired with this application.



Mode Counter (1–4)	Determines the number of edges counted from the four incremental encoder inputs: 0 = x1, 1 = x2 2 = x4
Dir. Counter (1–4)	Assigns a counting direction (up / down) to the corresponding encoder input, depending on the quadrature A/B phase displacement. These parameters are found out and set best in the Test menu or the Adjust menu
Ana-Out Offset (1–4)	Sets the zero position of the corresponding analogue output. This parameter uses a numeric range from –2047 ... 0000 ... +2047 corresponding to --100% ... 0000 ... +100% of full-scale output. The normal setting is "0"
Ana-Out Gain (1-4)	Sets the full-scale output of the corresponding analogue output, directly in volts. 0 – 10.00 means 0 – 10 volts
Ana-In 1-4 Offset	Not used with this application
Ana-In 1-4 Gain	Not used with this application
Index Output	Not used with this application
Frequency Output	-For factory testing purpose only-
Dir. Frequency	Sets the counting direction of the virtual master frequency: 1 = forward, 0 = reverse
Frequency Select	Selects the source of the output frequency appearing at connector "Encoder Output", used for cascading and other purpose: 0: The output frequency is the same signal as applied to input "Encoder1" 1: The output frequency is the signal generated by the virtual master axis
Index 1-4 select	Not used with this application

4.4. Process data (actual values)

You can follow all real process data assigned to this firmware, when you open the register card “Process data”. These actual values are updated continuously.



You find a description of the actual process data values in the corresponding table of chapter 10.

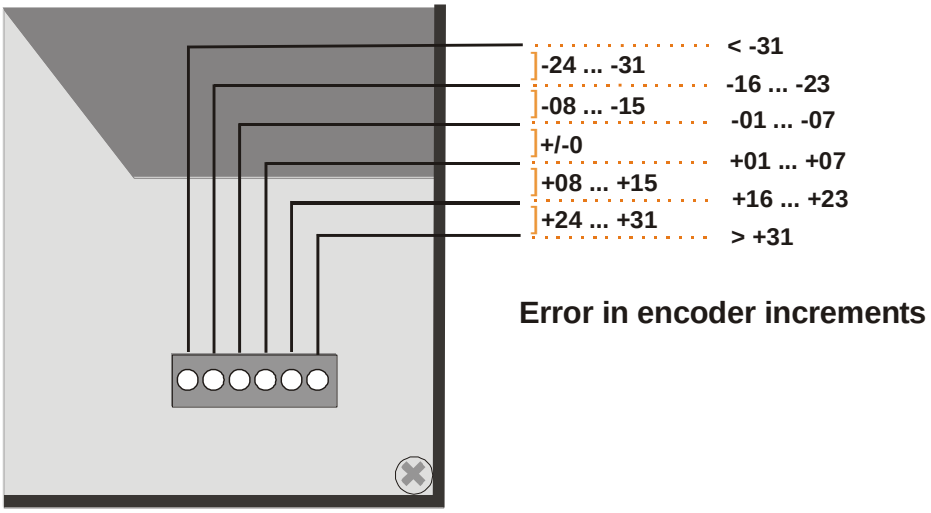
5. Function of the LED indicators

The function of the 6 red LEDs on the connector plate of the unit can be set by register “LED Function” on the register card “Monitoring”.

LED Function = 0 indicates the state of the digital outputs Out1 to Out6 (from left to right)
LED Function = 1 indicates the momentary proportional error (position error) of the cutting roll with respect to the scheduled position.

The error display operates with a special scaling of encoder increments, as shown by the figure below. Because the LEDs are updated within microseconds, they provide a simple, but also very useful means for observation of the dynamic performance of the control loop.

With MC720 hardware, the front LEDs operate in a similar way. As soon as a functional error comes up, (see next section), all LEDs start to blink at a frequency of approx. 1 Hz, independent of the LED function setting, until the error has been cleared.



Positive errors (LEDs on right site of center position) indicate that the cutting roll lags the line. Negative errors (LEDs on left site of center position) indicate that the cutting roll leads the line. Under regular production conditions and with good adjustment of the control loop, you should find between 2 and 4 of the center LEDs on or blinking, which indicates at the same time that the cutting accuracy is fine.

Where you find one of the extreme left or right LEDs on, this indicates that the controller is not adjusted well, or that the dynamic response of the drive is not sufficient. This however does not really mean that your cutting accuracy must be bad, because errors repeating continuously may eliminate themselves.

6. Error messages

Upon detection of an error, the cutting roll remains in a closed-loop standstill position after termination of the current cut. Output "Error" switches to HIGH and all LEDs on the connector plate blink (exceptions see in the table below). Where your PC with OS50 software is online, you can read the error message at the bottom of the screen. To clear an error state (for exceptions see below):

- Activate input "Clear Error" or
- switch off the "Control Enable" input or
- Press the Reset button located behind the hole in the connector plate or
- cycle the power supply of the unit

Please note that the unit will immediately return to the error state if the cause for the error has not been eliminated.

Error 00: DPRAM Error	An error was detected when checking the internal Dual Port RAM. The DPRAM is used for data exchange with the CAN network, therefore no CAN communication will be possible while this error exists. This error appears in the display only but will not stop the cutting roll. It can only be reset by cycling the power supply.
Error 01: Power Low	The power supply voltage is too low. This error is reset automatically when the power supply voltage recovers and exceeds the minimum power supply voltage level.
Error 02: No Cutting Pulse	The cutting pulse is missing. This error will be set if no cutting pulse appears within one revolution of the cutting roll during the homing sequence or if no cutting pulse appears within the synchronous zone of the cutting cycle in normal operation.
Error 03: No Home Pos.	The cutting roll is not in the home position when a cutting cycle is started. This error appears in the display only but will not stop the cutting roll.
Error 04 Printmark Buffer	Overflow of the print mark buffer register. This means too many print marks have been detected between the print mark sensor and the cutting roll position.
Error 05: Val. Range exceed	Internal overflow error during pre-calculation of the cutting profile. This error can occur by the following reasons: ▪ The ratio between the number of line encoder pulses and the number of cutting roll encoder pulses has exceeded the permitted range (see section 2.3 "system configuration" for details). The ratio can be checked by the actual values "Sync. Factor" and "v-max Factor" (see chapter 4.4 and 10 "Process data" for details). ▪ The value of "Home switchpoint" is too high. ▪ The synchronous zone is greater than the cutting roll circumference
Error 06: Cut not possible	The cut is not possible because the preset cutting length is too low.

7. Steps for Commissioning

For set-up and commissioning of all drives, the "Adjust" menu is available under "Tools" in the main menu of the screen. To start the Adjust menu, input "Control Enable" must first be LOW.

At this time, all drives must be adjusted to a proper and stable operation over the full speed range. The cutting roll drive needs a maximum of dynamics and response (set ramps to zero, switch of any integral or differential component of the internal speed control loop, operate the drive with proportional speed control only, with the proportional Gain as high as possible).

For the set-up procedure the cutting roll must be able to move in both directions without any mechanical limitations.

Before you start the Adjust menu, make sure that all parameters on the required register cards are set correctly.

The Adjust Program is used to set the directions of rotation of the encoders and to adjust the analogue output levels and the Proportional Gain. Also, the screen displays the actual encoder frequency.

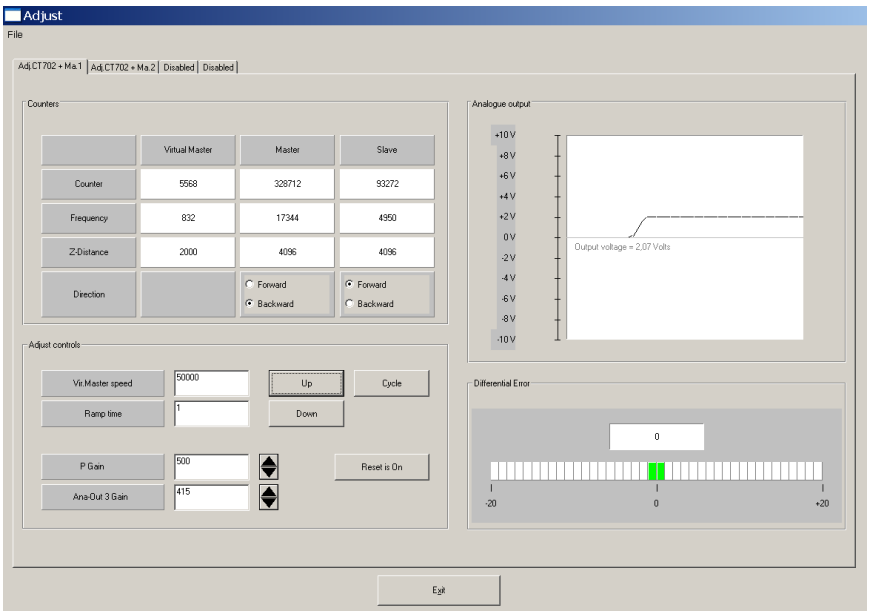
Please note: For the adjustment procedure, the cutting roll drive does always use the virtual master axis as reference, independent of the inputs "Select Virtual Master" and "Select Master 1/2".

7.1. Preparations

Use register card "Adjust CT703" to set up the cutting roll drive (all other register cards in the Adjust-menu are disabled).

The controller will generate the speed reference voltage to move the drive. For this, the following settings must be made:

- Vir. Master Speed: Set the virtual speed that you would like to use for adjusting the Slaves. This setting is in LU/min. and the default value is 10% of the maximum line speed you have set before (= Recommended speed for adjustments).
- Ramp Time: This ramp time is used for all acceleration and deceleration during the adjust procedure.
- P-Gain: An initial setting of 500 is recommended.
- Ana-Out-Gain: Start with the default value of 1000, which corresponds to a maximum analogue output of 10.00 volts.



7.2. Direction of Rotation

This definition must be met for the master(s) (line encoder(s)) and the slave (cutting roll drive encoder).

Master:

- Move your line encoder into forward direction (manually or by means of a remote speed signal to the line drive)
- Observe the counter in the "Master" column. It must count up (increment)! Where you find it counts down, please click to the unchecked direction box of the "Master" column (Forward or Reverse) to change the direction.

Slave:

- Click to the "Up" key to start the slave drive. The Slave will ramp up to the speed according to your previous ramp and frequency settings.
- Please observe the cutting roll: Does it move into forward direction? If it does not, the polarity of the analogue speed reference is
  not correct or the direction setting of the drive is wrong.
- It is a must that the Counter in the "Slave" column counts up (increments). Where you find it counts down, please click to the other direction box (Forward or Reverse) to force it to upwards count.
- Once we count up, click to the "Down" key to stop the drive again. The definition of direction of rotation is finished now.

Only when both counters count up while the encoders are moving forward, the definition of the encoder directions is correct!

When you have also wired the marker pulses of your encoders and the register "Index Mode" is set to 3, the window "Z-Distance" shows the ppr number of your encoders. This provides at the same time a useful test for correct wiring of the encoder channels.

7.3. Tuning the Analogue Output

- Start the drive again by clicking "Up". Now switch the Reset to OFF by clicking to the Reset key showing actually "Reset On". This activates the closed loop control.
- Observe the color bar and the differential counter in the field "Differential Error". There are two possibilities:
  - The bar graph moves to the right and the counter counts up (+):
    This indicates that the analogue signal is too low. Please increase the setting of "Ana-Out Gain" by overtyping the figures or by scrolling up with the arrow key.
  - The bar graph moves to the left and the counter counts down (-):
    This indicates that the analogue signal is too high. Please decrease the setting of "Ana-Out Gain" by overtyping the figures or by scrolling down with the arrow key.
    "Ana-Out Gain" is set correctly when the bar graph remains in its center position and the differential counter swings around zero (e.g. +/-8)
    Hint: You can reset the differential counter to zero at any time between, by cycling the "Reset" command.

7.4. Setting of the proportional Gain

The setting of register "P-Gain" determines how strong the controller responds to position and speed errors of the drive. In principle, this setting therefore should be as high as possible. However, depending on dynamics and inertia of the whole system, too high gain values will produce stability problems.

Please try to increase the setting of P-Gain from 500 to 1000, 1500, 2000 etc. However, as soon as you find unsteady operation, noise or oscillation, you must reduce the setting again correspondingly.

We also recommend using the "Cycle" function for observations of the stability. When clicking to this key, the drive will continuously ramp up and down while you can check the differential counter for stable operation.

Once you have done these steps, you can leave the Adjust menu by pressing the "Exit" button.

7.5. Tuning the controller

Now your machine is ready for operation and you can run initial test cuts.

- Set the "Control Enable" input "HIGH" to enable the controller
- Start a homing sequence by activating input "Homing". The cutting roll performs a homing sequence and moves to the home position, which is located opposite to the center of the synchronous zone.
- For the very first trials you should use a long length setting ("Cutting Length") and a slow line speed.
- If you want to perform the initial test cuts without material you can use the virtual master to simulate the material line. To this end, switch input "Select Virtual Master" ON while input "Start/Stop" is still LOW (Stop) and set the line speed to simulate at register "Virt. Line Speed". Then set input "Run Virtual Master" to HIGH to start the virtual master. The line simulation will work now and on your PC screen you can see the indicator box "Length Pulses" blinking.
- Activate input "Immediate Cut" and see how the controller executes a first cutting cycle.
- Switch the Start/Stop input to HIGH. The cutting roll will wait for expiration of the length and then execute a cutting cycle
- Change over to register card "Process Data" to see actual values like the progress of the length, the virtual line speed and the position error of the cutting roll.

Observe the display of the "Position Error" and the LEDs on the connector plate (provided that LED Function is set to 1). During the whole cutting cycle the position error should not exceed values like 30 and the LEDs should remain in the center area all the time. Increase the line speed step by step and continue the observations.

When you have achieved settings to keep the LEDs at the center position of the LED bar at all line speeds and with all cutting length presets, there is nothing to improve.

If, despite of this, your cutting results should not satisfy you in terms of accuracy or synchronism, there are definitely mechanical problems or other external reasons outside of the control loop.

The following hints refer to improvements you can make when LED and "Position Error" indicate unusual characteristics:

If many of the front LEDs are lit at the same time and the "Position Error" register shows very unstable values: The encoder resolution (pulses per length unit) could be much higher than the mechanical clearance of your gear tooth wheels etc.

- Reduce edge count setting from (x4) to (x2) or (x1)
- Increase the value of "Correction Divider"
  (see description of register "Correction Divider" for details)
- Reduce "P-Gain" setting if this eliminates the problem.

Remark: Even though your LEDs can indicate a very unstable characteristic, your cutting accuracy and performance may be good. Then just accept this visual flaw.

If The LEDs and the "Position Error" value move up and down with the speed cycle of the cutter:

- Try to increase the setting of register "P-Gain".
- Check for avoidable ramps and delays in your drive
- Possibly the cutter drive is not strong and dynamic enough to follow the speed profile and / or to generate enough torque at the time the tool penetrates the material
- Reduce the line speed for all length settings where you observe this problem.

Remark: This must not really affect your cutting performance. When the cutting accuracy is good, you can accept this visual flaw. Position errors will not affect the cutting accuracy, unless they occur directly during the cut and differ from cut to cut, because position errors repeating continuously from cut to cut may eliminate themselves.

This concludes the procedure of commissioning of your rotary cutter system. We recommend saving all parameter settings on hard disc or disc. In case of repeat applications (machine with similar specifications), or after exchange of the controller, you just need to download the settings and are immediately ready to go.

8. Hints for Controller Type MC720 with Integrated Operator Terminal

Controllers type MC720 are equipped with a keypad and a LCD display, providing all entries and operations of the controller

8.1. Setting of parameters and registers

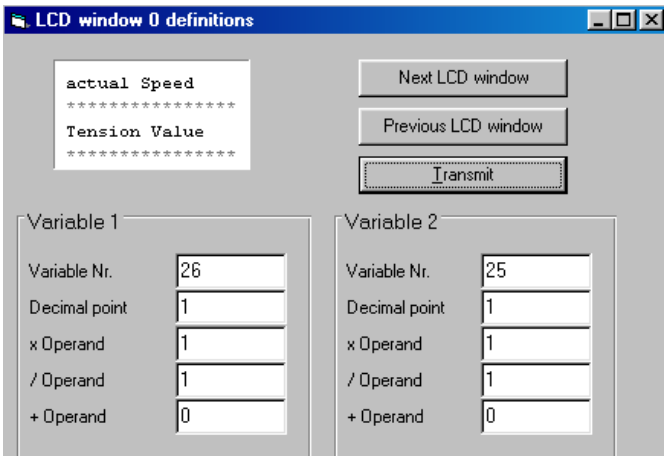
All the menu structure of the LCD display is fully similar to the structure of the register cards with the PC software. To start the menu, press **F1**. Select the menus and sub-menus by using the arrow keys and confirm your choice by Enter. With all further actions, **Enter** will go **forward** and **PRG** go **back** in the menu structure.

For all operations, just follow the hints given on the LCD menu. Once you have studied section 4 of this manual, all keypad and LCD operations will be self-explaining.
Actually, the keyboard of MC720 allows parameter changes only in the Stop state with the cutting roll in standstill (Start/Stop input LOW, no immediate cut, no Jog)!
(Subject to change soon).

You can however change all settings "on the fly" when using serial or field bus communication.

8.2. Display of actual process values

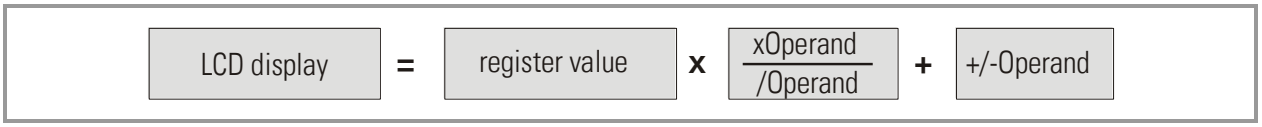
During normal production, you can use the LCD for display of interesting actual values and process data. The PC operator software allows you to define and to scale these values and to add text comments according to your choice. The menu "LCD Definitions" can be found under "Extras" of the headline menu.



- There are totally four LCD windows accessible (0 – 3) and the actual window number appears in the blue headline. To change from one window to another, use the keys "Next LCD window" or "Previous LCD window".

- Each window allows displaying two actual values with two text comments. The line with asterisks ******* serves as space holder for the values displayed later on the LCD. When you click to the text line, you can edit the text comments according to your need (max. 16 characters for each text comment)
- **Variable Nr:** Defines which of all available values should appear in the display. Please choose one of the 32 available actual values (00 – 31) as shown on the screenshot "Process Data" in chapter 4.4 and in the corresponding table in chapter 10.
- **Decimal point:** Defines the position where a decimal point should appear on the LCD display (0=no decimal point).
- **xOperand, /Operand, +Operand:**

  These 5-decade operands can be used to change the scaling of your display value to the desired engineering units.



When you have entered your specifications to a window, click to "Transmit" to store your definitions to the controller.

In production state, you can use the key F2 to switch from one of the four windows to the next and to read the actual values you have assigned.

Key **F1:**	Enter into the menu setting or modifying parameter
Key **F2:**	Cycle from one window to next to read actual process values

9. Physical Requirements and Limitations of the Cutting System

The possible range of cutting lengths depends on several mechanical and electrical parameters like roll diameter, maximum line speed, synchronous zone length, maximum speed and dynamics of the drive. There is no limitation of the cutting length from the CT703 controller within the physical range of the cutting system. This unit calculates at any time the longest ramps possible to achieve the desired cutting result.

As soon as these ramps become so short that the drive is unable to follow the ramps due to deficiency of dynamics, the cutting system runs to its physical limit.

The subsequent formulae should help you to design and to optimize the layout of your cutting system or to calculate what cutting lengths are possible or impossible with an existing machine. The following abbreviations are used:

U_{sync}	Circumference of the cutting roll (in mm)
v_0	Maximum line speed (in mm per sec.)
l_{sync}	Length of the synchronous zone (in mm)
t_L	Shortest time the drive needs to accelerate the cutting roll from standstill to line speed or to decelerate the cutting roll from line speed to standstill (in sec.)
t_H	Shortest time the drive needs to accelerate the cutting roll from line speed to eight times line speed or to decelerate the cutting roll from eight times line speed to standstill (in sec.)
L	Preset cutting length (in mm)
L_{min}	Shortest cutting length possible (in mm)
L_{max}	Longest cutting length possible (in mm)
t_1, t_2, L_1,L_2	Reference values for calculation

For the calculations it is assumed that the cutter drive could run eight times faster than line speed (Vmax / Vline = 8). In situations where the cutting roll can only run lower maximum speeds, the required acceleration and deceleration times are lower, and the shortest possible cutting length is greater than given by the formulae.

9.1. Dynamic Requirements of the Cutting Roll Drive

The subsequent formulae show what the drive must be able to execute in terms of acceleration and deceleration time, when the cutting parameters are specified.
On principle, the drive must fulfill the following requirement, regardless of the cutting length:

$$t_L = \frac{U - l_{sync}}{v_0}$$

To differ between the different types of the cutting profile, it is necessary to calculate two reference length values:

$$L_1 = \frac{2U + 7l_{sync}}{9}$$

$$L_2 = 2U - l_{sync}$$

The reference lengths L1 and L2 calculated by the controller and scaled in master encoder increments are available as actual values “Len Limit v-max” and “Len. Limit Stop” at the Process Data window (see chapter 4.4 and 10)

For all cutting lengths $L \geq U$ only tL as calculated above is required, there are no more additional requirements.

If $L \geq L_2$the cutting roll comes to a standstill during the cutting profile.
The cutting length has no upper limit.

If $L \leq L_1$ he cutting roll reaches its maximum speed during the cutting profile and you get:

$$t_H = \frac{8L - 7l_{sync} - U}{7v_0}$$

For all other cutting lengths $L_1 < L < U$ you get:

$$t_H = \frac{7(L - l_{sync})^2}{4v_0\ (U - L)}$$

9.2. The Shortest Length Possible

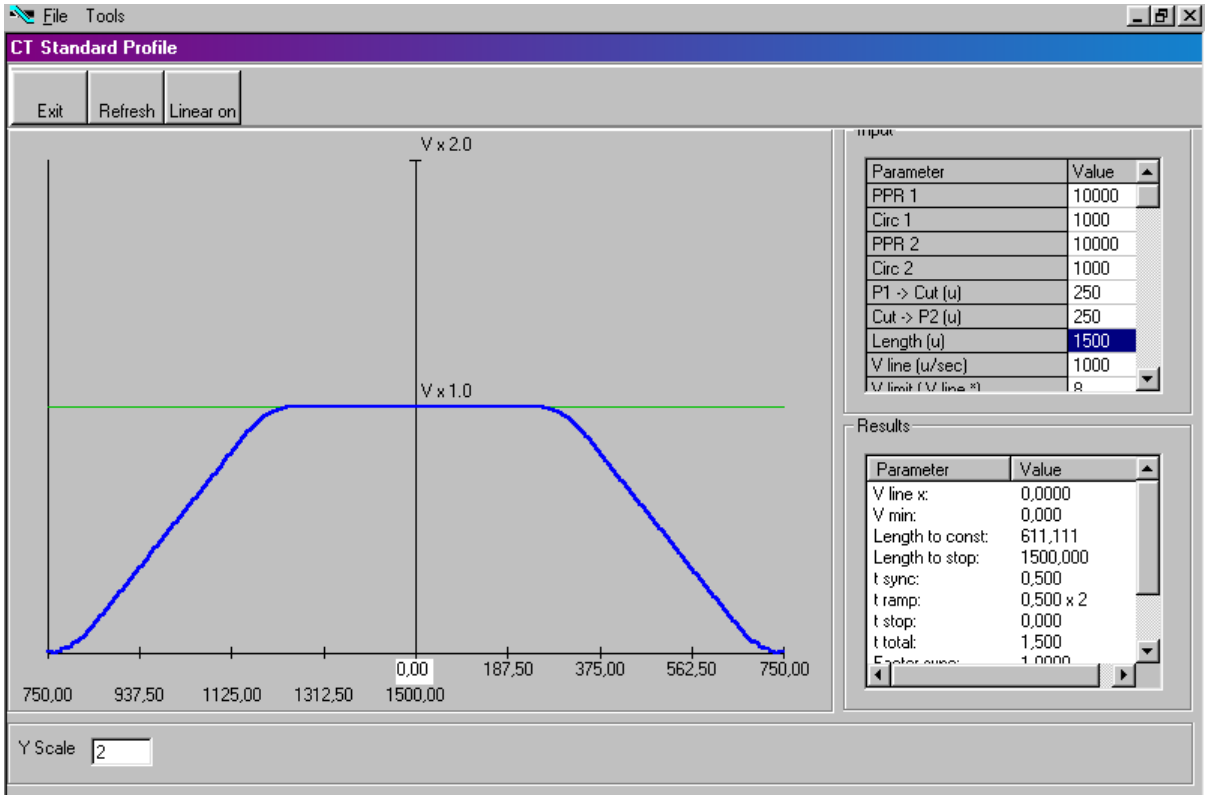
The shortest length possible to cut depends, among other things, on the maximum speed of the cutting roll in comparison to the line speed. Again it is assumed that the cutter drive can run eight times faster than line speed (Vmax / Vline = 8). In situations where the cutter can only run lower maximum speeds, the shortest possible cutting length is greater than given by the formulae.

First you must calculate the reference time t_1 : $$t_1 = \frac{U - l_{sync}}{9\, v_0}$$

If $t_H \le t_1$: $$L_{\min} = \frac{7(l_{sync} + v_0 t_H) + U}{8}$$

If $t_H > t_1$: $$L_{\min} = l_{sync} - \frac{2}{7} v_0 t_H + \frac{2}{7}\sqrt{v_0^2 t_H^2 + 7(U - l_{sync}) v_0 t_H}$$

For calculation and display of speed profiles of the cutting roll, based on customer-programmable cutting parameters, motrona offers the users special PC software, suitable for easy judgment of demands and limits of rotating cutter systems.



10. Parameter Tables

General Parameters						
Name	Unit	Serial Code		Minimum	Maximum	Default
		(Hex)	(Dec)			
Cutting Length	Length units	0000	0	1	999999	10000
Test Cut. Length	Length units	0001	1	1	999999	10000
Virtual Line Speed	Len. Units/min.	0002	2	0	9999999	10000
(Parameter 03)		0003	3	0	0	0
…		…	…			
(Parameter 30)		001E	30	0	0	0
Access Code Input		001F	31	0	99999999	0

Parameter Blocks						
Master Settings						
Name	Unit	Serial Code		Minimum	Maximum	Default
		(Hex)	(Dec)			
Circ. Master 1	Length units	0100	256	1	99999	1000
PPR Master 1	Incr.	0101	257	1	999999	1000
(Parameter 02)		0102	258	0	0	0
(Parameter 03)		0103	259	0	0	0
Ramp Vir. Master	S	0104	260	0	999	1
…		…	…			
(Parameter 31)		011F	287	0	0	0

Sub codes are always 0.

Cutter Settings						
Name	Unit	Serial Code		Minimum	Maximum	Default
		(Hex)	(Dec)			
Circ Cutter	Length units	0120	288	1	99999	1000
PPR Cutter	Incr.	0121	289	1	999999	1000
Trim Time	Ms	0122	290	1	999	100
Sync Before Cut	Length units	0123	291	0	9999	10
Sync After Cut	Length units	0124	292	0	9999	10
Cuts per Rev.		0125	293	1	99	1
V max / V linie		0126	294	2	8	8
Index Mode		0127	295	0	3	0
+ / - Sync. Rate	%	0128	296	-99.99	+99.99	00.00
Ramp Form		0129	297	0	1	0
Cutting Mode		012A	298	1	2	1
Marks per Length		012B	299	1	99	1
Photocell -> Cut	Length units	012C	300	1	999999	1000
Printmark Offset	Length units	012D	301	-9999	+9999	0
Max. Printm. Corr.	Length units	012E	302	1	9999	9999
Photocell Delay	ms	012F	303	0.0	500.0	0
Printmark Window	Length units	0130	304	0	9999	0
Missing Printmarks		0131	305	0	99	0
Length Correction		0132	306	0	5	0
Length Tolerance	Length units	0133	307	0	999	0
Gap Length	Length units	0134	308	0	9999	0
Cut. Pulse Offset	Incr.	0135	309	-999999	999999	0
Pm.Cor.Deadband	Incr.	0136	310	0	999	0
Pm.Cor.Prog.Trim		0137	311	0	9	0
Pm.Cor.Max.Trim	Incr.	0138	312	1	999	100
(Parameter 25)		0139	313	0	0	0
…		…	…			
(Parameter 31)		013F	319	0	0	0

Control Loop Settings						
Name	Unit	Serial Code		Minimum	Maximum	Default
		(Hex)	(Dec)			
P-Gain		0140	320	0	9999	1000
Corr. Divider		0141	321	1	9	1
Max. Correction	mV	0142	322	1	9999	9999
Max. Line Speed	Len. Units/min.	0143	323	1	9999999	100000
Sampl. Time Mast. 1	ms	0144	324	1	1000	1
Sampl. Time Mast. 2		0145	325	0	1000	1
Application Mode		0146	326	0	1	1
Thickness Mode		0147	327	0	2	0
Startpos.Thickn.	Incr.	0148	328	0	999999	100
Endpos.Thickness	Incr.	0149	329	0	999999	900
(Parameter 10)		014A	330	0	0	0
…		…	…			
(Parameter 31)		015F	351	0	0	0

Jog / Home Settings						
Name	Unit	Serial Code		Minimum	Maximum	Default
		(Hex)	(Dec)			
Jog Speed	%	0160	352	1	100	10
Jog Ramp	s	0161	353	0	99	1
Home Speed High	%	0162	354	1	100	10
Home Speed Low	%	0163	355	1	100	5
Home Ramp	s	0164	356	0	99	1
Home Switchpoint	Length units	0165	357	1	99999	100
Home Window	Length units	0166	358	1	999	10
(Parameter 07)		0167	359	0	0	0
…		…	…			
(Parameter 31)		017F	383	0	0	0

Monitoring Settings						
Name	Unit	Serial Code		Minimum	Maximum	Default
		(Hex)	(Dec)			
Zero Speed Master	Len. Units/min.	0180	384	0	999999	0
Zero Speed Vir. Ma.	Len. Units/min.	0181	385	0	999999	0
LED Function		0182	386	0	1	0
Length per Pulse	Length units	0183	387	1	50000	1000
Cut Tolerance	Length units	0184	388	0	99999	10
Alarm	Incr.	0185	389	0	32000	100
Mast.Rev:Limit	Length units	0186	390	0	999999	0
Sel.Diag.AnaOut1		0187	391	0	31	0
(Parameter 08)		0188	392	0	0	0
…		…	…			
(Parameter 15)		018F	399	0	0	0
Batch Counter		0190	400	0	999999999	0
Waste Counter		0191	401	0	999999999	0
(Parameter 18)		0192	402	0	0	0
…		…	…			
(Parameter 31)		019F	415	0	0	0

Protection Settings						
Name	Unit	Serial Code		Minimum	Maximum	Default
		(Hex)	(Dec)			
Access Code Def.		02A0	672	0	99999999	0
(Parameter 01)		02A1	673	0	0	0
…		…	…			
(Parameter 31)		02BF	703	0	0	0

Communication Settings						
Name	Unit	Serial Code		Minimum	Maximum	Default
		(Hex)	(Dec)			
Can Unit Address		02C0	704	001	127	001
Can Baud Rate		02C1	705	0	7	1
Can Config.		02C2	706	000	255	000
Can Tx Par		02C3	707	000	255	000
Can Rx Par		02C4	708	000	255	000
Ser Unit Address		02C5	709	11	99	11
Ser Baud Rate		02C6	710	0	4	2
Ser Data Format		02C7	711	0	9	0
(Block 15 8)		02C8	712	0	0	0
…		…	…			
(Block 15 31)		02DF	735	0	0	0

Setup-Up Settings						
Name	Unit	Serial Code		Minimum	Maximum	Default
		(Hex)	(Dec)			
Mode Counter 1		02E0	736	0	2	0
Dir. Counter 1		02E1	737	0	1	1
Mode Counter 2		02E2	738	0	2	0
Dir. Counter 2		02E3	739	0	1	1
Mode Counter 3		02E4	740	0	2	0
Dir. Counter 3		02E5	741	0	1	1
Mode Counter 4		02E6	742	0	2	0
Dir. Counter 4		02E7	743	0	1	1
Ana-Out Offset 1		02E8	744	-2047	+2047	0
Ana-Out Gain 1		02E9	745	000.00	320.00	1000
Ana-Out Offset 2		02EA	746	-2047	+2047	0
Ana-Out Gain 2		02EB	747	000.00	320.00	1000
Ana-Out Offset 3		02EC	748	-2047	+2047	0
Ana-Out Gain 3		02ED	749	000.00	320.00	1000
Ana-Out Offset 4		02EE	750	-2047	+2047	0
Ana-Out Gain 4		02EF	751	000.00	320.00	1000
Ana-In 1 Offset		02F0	752	-9999	+9999	0
Ana-In 1 Gain		02F1	753	0	99999	010.00
Ana-In 2 Offset		02F2	754	-9999	+9999	0
Ana-In 2 Gain		02F3	755	0	99999	010.00
Ana-In 3 Offset		02F4	756	-9999	+9999	0
Ana-In 3 Gain		02F5	757	0	99999	010.00
Ana-In 4 Offset		02F6	758	-9999	+9999	0
Ana-In 4 Gain		02F7	759	0	99999	010.00
Index Output		02F8	760	2	65500	2000
Frequency Output		02F9	761	-500000	+500000	50000
Dir. Frequency		02FA	762	0	1	1
Frequency Select		02FB	763	0	1	1
Index 1 select		02FC	764	0	2	0
Index 2 select		02FD	765	0	2	0
Index 3 select		02FE	766	0	2	0
Index 4 select		02FF	767	0	2	0

Process Data (Actual values)					
No.	Name	Unit	Serial Code		Explanation
			(Hex)	(Dec)	
0	Length Counter	Incr.	0800	2048	Material length counter (line encoder)
1	Master Frequency	Hz	0801	2049	Frequency of line encoder
2	Line Speed	Length Units/min	0802	2050	Line speed
3	Position Error	Incr.	0803	2051	Actual cutting roll position error
4	Feed Forw. Value		0804	2052	Internal value for feed forward set point
5	Correction Value		0805	2053	Correction set point
6	Cutter Position	Incr.	0806	2054	Actual position of cutting roll
7	Cutter Home Position	Incr.	0807	2055	Cutting roll home position
8	Act. Len (Imp)	Incr.	0808	2056	Calculated actual cutting length
9	Actual Length	Length units	0809	2057	Calculated actual cutting length
10	Act. Length Error	Length units	080A	2058	Calculated actual cutting length error
11	Act. Printm. Error	Incr.	080B	2059	Actual cutting error with respect to printmark
12	Printmark corr.	Incr.	080C	2060	Actual correction with respect to printmark
13	Length setpoint	Incr.	080D	2061	Cutting length setpoint
14	Read Batch Count	pieces	080E	2062	Batch counter value (read only)
15	Read Waste Count	pieces	080F	2063	Waste counter value (read only)
16	Len. Limit stop	Incr.	0810	2064	With cutting lengths greater than this value the cutting roll comes to standstill during cutting cycle
17	Len. Limit v-max	Incr.	0811	2065	With cutting lengths below this value the cutting roll reaches max. speed during cutting cycle
18	Abs. Len. Limit	Incr.	0812	2066	Absolutely shortest length possible to cut
19	Synchron Factor		0813	2067	Encoder pulse ratio of line encoder and cutting roll in synchronous zone (during cut)
20			0814	2068	(not in use)
21	v-max Factor	Incr.	0815	2069	Encoder pulse ratio of line and cutting roll at max. speed of cutting roll
22	Printm.Pos.Count.	Incr.	0816	2070	Position counter for printmark window
23	Act.Printm.Dist.		0817	2071	Actual measured printmark distance

Process Data (Actual values), continued					
No.	Name	Unit	Serial Code		Explanation
			(Hex)	(Dec)	
24	Miss.Printm.Cou.		0818	2072	Counter for missing printmarks
25	Printmark Status		0819	2073	Status flags for printmark operation
26	Printmark write		081A	2074	Position of last detected printmark (last printmark in buffer)
27	Printmark read		081B	2075	Position of printmark to be cut next (printmark to be read next from buffer)
28	Length Cou.at Cut		081C	2076	Length counter value at cut
29	Control State		081D	2077	Actual state of controller
30	Cut State		081E	2078	Actual state of cutting cycle
31	Printm.Delay Len.		081F	2079	Printmark shift length corresponding to photocell delay time

Status of Commands, Outputs and Errors			
Description	Serial Code		Bit No. see tables below
	(Hex)	(Dec)	
Hardware Commands ("Cont.In" X6)	0B00	2816	
Serial Commands	0B01	2817	
CAN Commands	0B02	2818	
All Commands	0B03	2819	
Output Status	0B04	2820	
Error Status	0B05	2821	

Input signals (Commands)					
Name of Command	Serial Code for single Command		Bit # of "Serial Commands" (Code 0B01 Hex) / "CAN Commands" (Code 0B02 Hex)	Possible assignment to hardware input X6 "Cont.In"	Explanation → Chapter 4.1
	(Hex)	(Dec)			
Control Enable	0900	2304	0	In 1 … 16	
Start / Stop	0901	2305	1	In 1 … 16	
Select VirMaster	0902	2306	2	In 1 … 16	
Run Virt. Master	0903	2307	3	In 1 … 16	
Jog forward	0904	2308	4	In 1 … 16	
Jog reverse	0905	2309	5	In 1 … 16	
Homing	0906	2310	6	In 1 … 16	
Clear Error	0907	2311	7	In 1 … 16	
Immediate Cut	0908	2312	8	In 1 … 16	
Cut Test-Length	0909	2313	9	In 1 … 16	
(Command 10)	090A	2314	10	In 1 … 16	
Teach Printmark	090B	2315	11	In 1 … 16	
Thickness Select	090C	2316	12	In 1 … 16	
(Command 13)	090D	2317	13	In 1 … 16	
Printmark	–	–	–	In 15 (fix)	
Cutting Pulse	–	–	–	In 16 (fix)	
Reset Diff.Cou.	0910	2320	16	In 1 … 16	
(Command 17)	0911	2321	17	In 1 … 16	
(Command 18)	0912	2322	18	In 1 … 16	
(Command 19)	0913	2323	19	In 1 … 16	
(Command 20)	0914	2324	20	In 1 … 16	
(Command 21)	0915	2325	21	In 1 … 16	
(Command 22)	0916	2326	22	In 1 … 16	
(Command 23)	0917	2327	23	In 1 … 16	
(Command 24)	0918	2328	24	In 1 … 16	
(Command 25)	0919	2329	25	In 1 … 16	
(Command 26)	091A	2330	26	In 1 … 16	
(Command 27)	091B	2331	27	In 1 … 16	
(Command 28)	091C	2332	28	In 1 … 16	
Store to EEProm	091D	2333	29	In 1 … 16	
Adjust Program	091E	2334	30	–	
Test Program	091F	2335	31	–	

Output signals					
Name	Serial Code for single output		Bit No. of "Output Status" (Code 0B04 Hex)	Possible assignment to hardware output X7 "Cont.Out"	Explanation → Chapter 4.1
	(Hex)	(Dec)			
Ready	0A00	2560	0	Out 1 … 8	
Alarm	0A01	2561	1	Out 1 … 8	
Home	0A02	2562	2	Out 1 … 8	
No Printmark	0A03	2563	3	Out 1 … 8	
Length Pulses	0A04	2564	4	Out 1 … 8	
Waste Cut	0A05	2565	5	Out 1 … 8	
(Output 06)	0A06	2566	6	Out 1 … 8	
Error	0A07	2567	7	Out 1 … 8	
Master 1 in motion	0A08	2568	8	Out 1 … 8	
(Output 09)	0A09	2569	9	Out 1 … 8	
Vir.M. in motion	0A0A	2570	10	Out 1 … 8	
Printmark Window	0A0B	2571	11	Out 1 … 8	
Master Reverse	0A0C	2572	12	Out 1 … 8	
Max. Correction	0A0D	2573	13	Out 1 … 8	
Printmark teached	0A0E	2574	14	Out 1 … 8	
Homing Done	0A0F	2575	15	Out 1 … 8	
Autom. Operation	0A10	2576	16	Out 1 … 8	
Thickness Window	0A11	2577	17	Out 1 … 8	
(Output 18)	0A12	2578	18	Out 1 … 8	
(Output 19)	0A13	2579	19	Out 1 … 8	
(Output 20)	0A14	2580	20	Out 1 … 8	
(Output 21)	0A15	2581	21	Out 1 … 8	
(Output 22)	0A16	2582	22	Out 1 … 8	
(Output 23)	0A17	2583	23	Out 1 … 8	
(Output 24)	0A18	2584	24	Out 1 … 8	
(Output 25)	0A19	2585	25	Out 1 … 8	
(Output 26)	0A1A	2586	26	Out 1 … 8	
(Output 27)	0A1B	2587	27	Out 1 … 8	
(Output 28)	0A1C	2588	28	Out 1 … 8	
(Output 29)	0A1D	2589	29	Out 1 … 8	
(Output 30)	0A1E	2590	30	Out 1 … 8	
(Output 31)	0A1F	2591	31	Out 1 … 8	

Errors			
Error No.	Description	Bit No. of "Error Status" (Code 0B05 Hex)	Explanation → Chapter 6
00	DPRAM Error	0	
01	Power Low	1	
02	No Cutting Pulse	2	
03	No Home Position	3	
04	Printmark Buffer Overflow	4	
05	Value Range Exceed	5	
06	Cut not possible	6	
07	—	7	
08	—	8	
09	—	9	
10	—	10	
11	—	11	
12	—	12	
13	—	13	
14	—	14	
15	—	15	