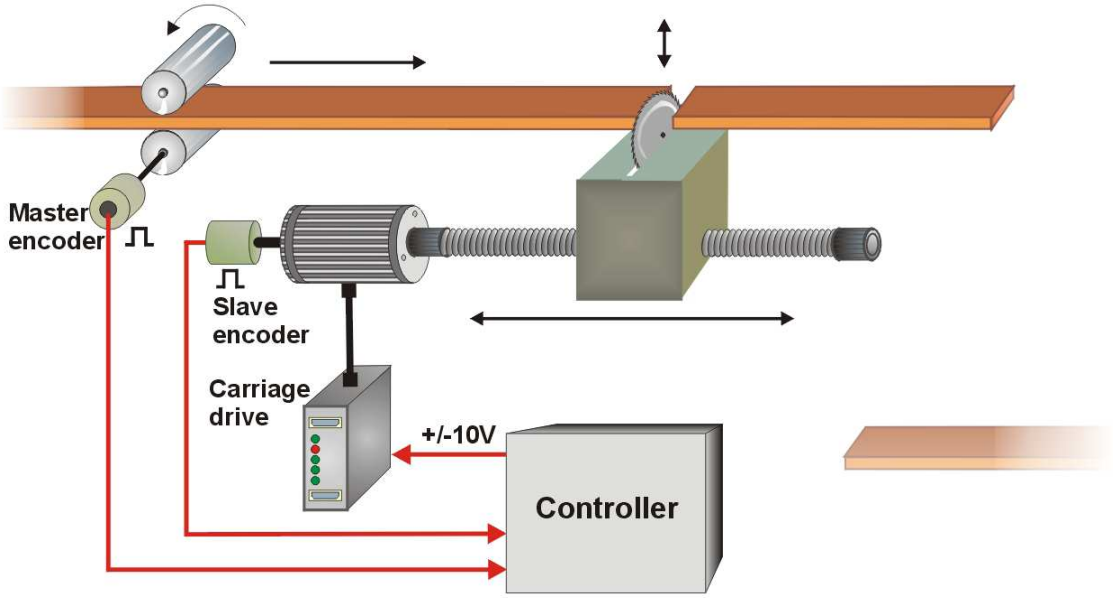
motrona GmbH
Zeppelinstraße 16
78244 Gottmadingen
Tel. +49 (0)7731-9332-0
Fax +49 (0)7731-9332-30
info@motrona.com
www.motrona.com

safety - control - motion - interface

Software Manual

FS 801.06

MC800 Motion Control Firmware
Motion Control for Flying Shears and Saws



- 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 2 MHz of feed-back frequency
- Suitable for "stand-alone" operation as well as for connection to field bus systems
- Extremely smooth motion by optimized S-shape profiles
- Useful supplementary functions like print mark control, multiple cutting sequence, gap function etc.
- Additional axis for saw blade movement

Version:	Changes:
FS80101a / TJ / Dec 2016	Original Version
FS80101b / CN / Jan 2017	Diagram in chapter 4.3.6 added
Fs80102a / TJ / Jun 2017	New feature implemented: Optional fieldbus interface modules
Fs80103a / TJ / Jul 2018	New feature implemented: Serial communication with Modbus RTU on board
Fs80104a / TJ / May 2019	New features implemented: - Function of each control input and control output selectable by parameter - Additional operation mode of saw axis for clamping - Homing sequence for carriage and saw axis
Fs80105a / TJ / Oct 2019	New features implemented: - "Pendulum" function (optimized return movement of carriage) - Minimum synchronous movement of carriage selectable - Ramp length of acceleration and deceleration ramp of carriage selectable - Input command "Inhibit Return" - Value range of registers "+/- Sync rate", "Acceleration 1 / 2" and "Deceleration 1 / 2" extended
Fs80106a / TJ / Sep 2020	Interface module PN800 for Profinet implemented

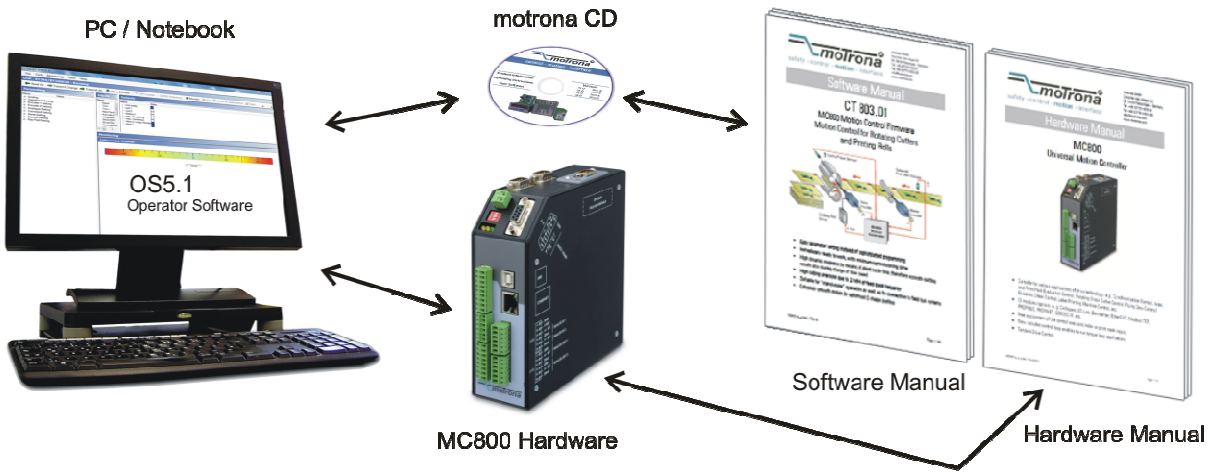
Table of Contents

1. Preamble

This document provides all information about the CT803 firmware, including parameters, variables and hints for commissioning.

To implement this application, you will need:

1. A motion controller hardware of type MC800
2. A PC with operating system
   Windows XP or Windows 7
3. The motrona CD or motrona website containing the PC operator software OS5.1, the FS801 firmware file and the pdf files for the manuals MC800xxx.pdf (hardware description, connections, and specifications) and FS801xxx.pdf (description of the firmware as actually at hand)



All of above files are also available for free download on 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 FS801 firmware is liable to payment of a license fee and can only be used with the corresponding license key!

2. General Remarks about this Firmware Functions

2.1. Introduction

The FS801 firmware is suitable for control of “Flying Shears” and “Flying Saws”, frequently used for cut-to-length applications with endless material, where the material is in continuous motion and cannot be stopped during the cutting process.
The mechanical construction provides a carriage with a cutting tool, following synchronously the material while the cut is in progress, and then returning to a home position, to wait for the next cut.

This firmware has been designed for the special requirements of these flying shear 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 OS5.1. All relevant operational parameters and variables are accessible by RS232/RS485 communication, USB (in preparation) and fieldbus interface (in preparation). Therefore the user has multiple possibilities for remote control of all batch and cutting parameters via operator terminals, PC or PLC systems

2.2. Principle of operation

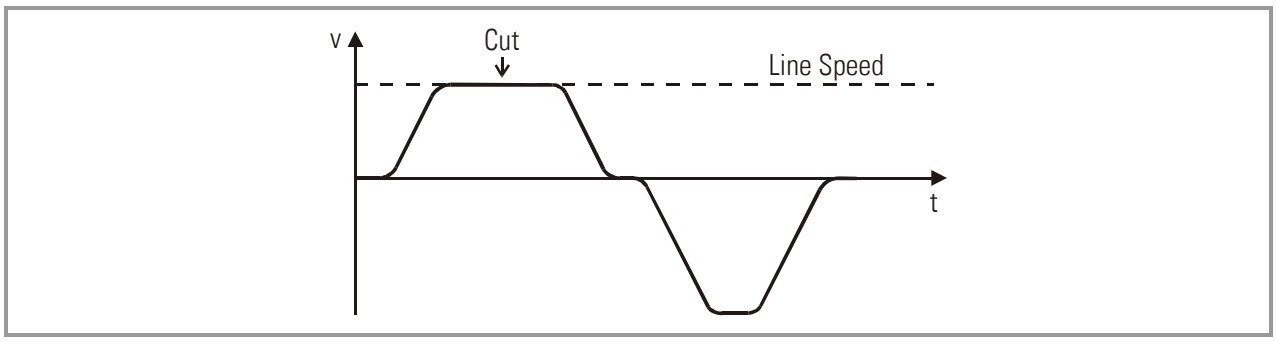
The shear or saw blade is fixed on a carriage that can move in forward and reverse direction, under control of a +/- 10 volts speed reference signal, with a 4-quadrant DC or Servo or Vector drive.

Initially, the carriage keeps waiting in its rear home position, while the controller counts the current length of the passing material by means of encoder signals from a line roll or a measuring wheel.

As soon as the cutting point approaches an anticipated position, the carriage will accelerate and reach the line speed exactly where the cutting position matches the tool position. A “Ready-to-Cut” output will start the cutting procedure, while the carriage will exactly follow the material. When the cut is done, a remote “Cut completed” signal must tell the controller to decelerate and then return the carriage back to the home position again.

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.

The figure below shows the typical speed profile:



The FS801 control continuously measures the line speed and calculates an anticipation value to start the carriage before the cutting length is reached. Thus the shear will exactly match the cutting position of the material upon completion of the acceleration ramp and no overshoot or oscillation will take place prior to the cut. This saves time and increases the cutting efficiency of the shear system considerably.

2.3. System Configuration

As master mostly a measuring wheel equipped with an incremental encoder is used. Also the motor of a feed roll that is controlled by an other device can be the master. 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 FS801 controller provides two slave axes: One for the saw carriage (movement parallel to the material line), and an additional axis for the saw blade movement (across material or vertical).

All axes, the master and the two slaves, must be equipped with incremental encoders.
The encoder resolutions should be at least 5 times higher than the maximum acceptable cutting error.

Quadrature encoders with A/B output channels must be used.

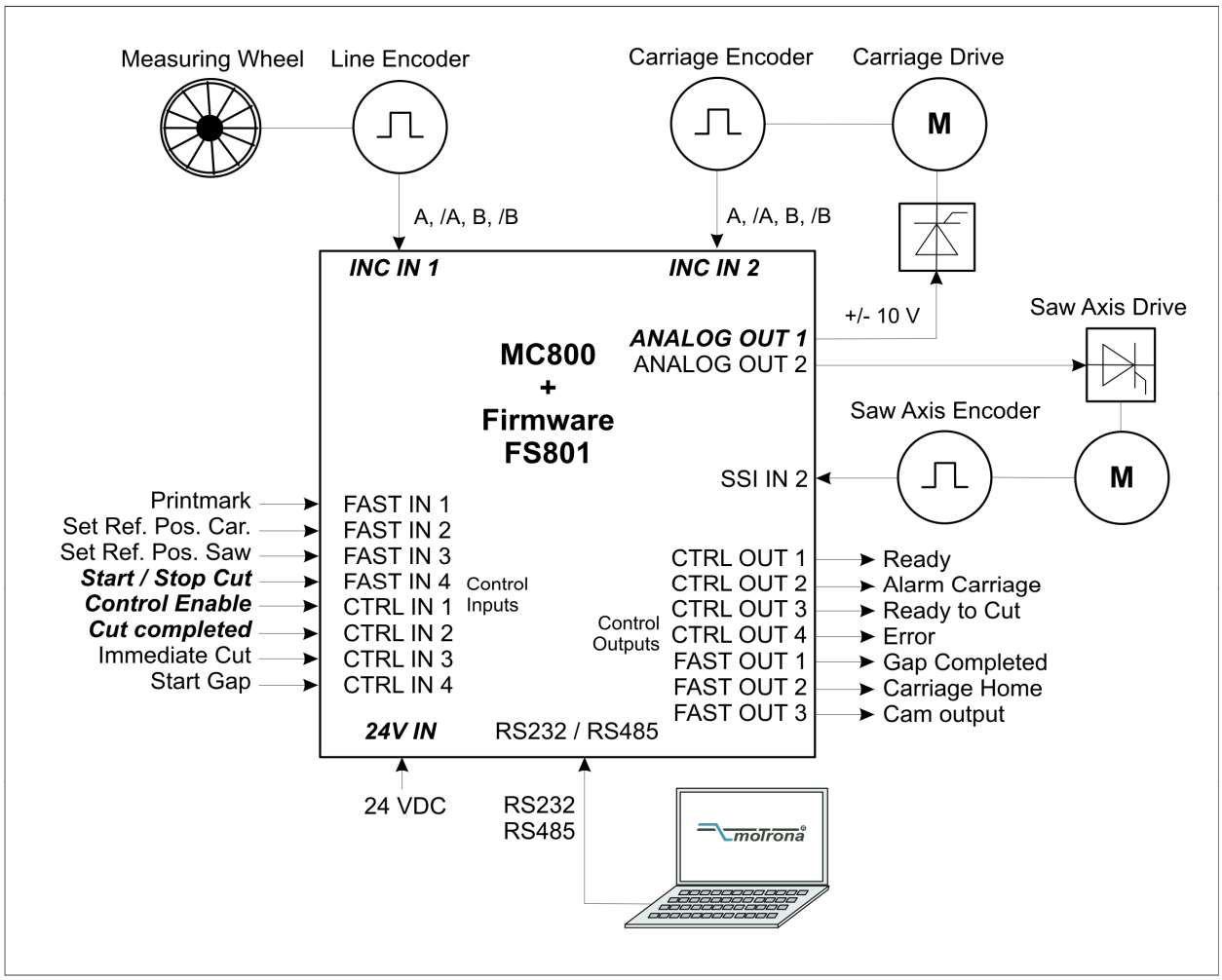
At maximum line speed, the master encoder frequency should be at least about 1 kHz, for best resolution of the analog output. Moreover, the input frequency must not exceed the maximum level of 2 MHz.

It is best to choose the ppr numbers of line and carriage 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. Where applicable, the (x1), (x2) or (x4) hardware multiplication of the Master channel or the Slave channels may be used to adapt the frequencies.

The block diagram below shows the principle of wiring of a flying shear system:



Please note: Signals printed ***bold italic*** are mandatory, all other signals optional.

The line encoder must be connected to input "INC IN 1" (X9), the carriage encoder to input "INC IN 2" (X7) and the saw axis encoder to input "SSI IN 2" (X8). Please note, in the present version this input works as an RS422 incremental input!
(Terminal "CLK" = A, "/CLK" = /A, "DATA" = B and "/DATA" = /B).

For speed reference of the carriage drive, the analog output "ANALOG OUT 1" is used and for speed reference of the saw blade positioning axis, the analog output "ANALOG OUT 2" is used.

If you do not need the additional saw blade positioning axis, please leave all corresponding input and output signals unconnected and all corresponding parameters to their default settings.

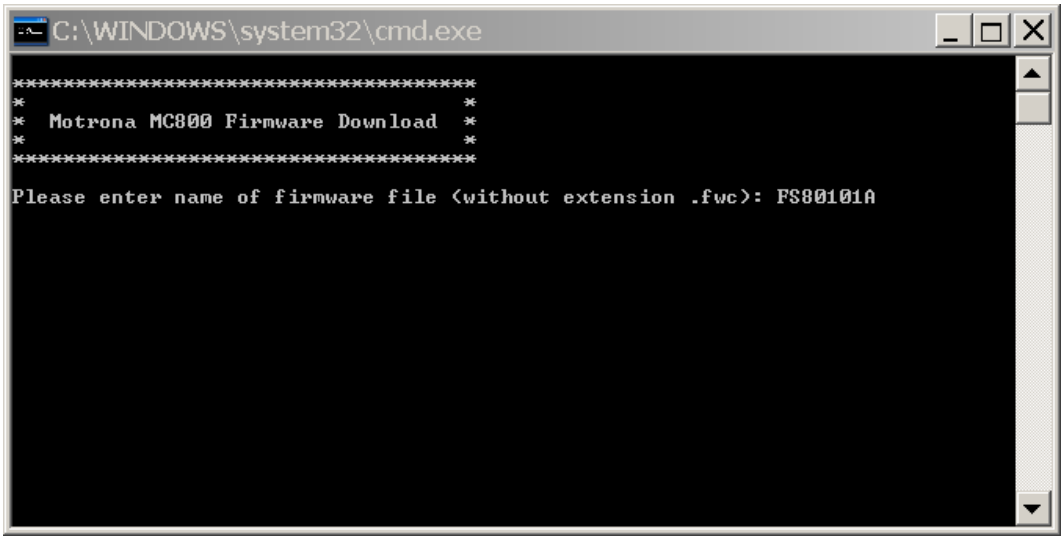
It is necessary to adjust the carriage drive to its maximum dynamic response (no internal ramps, no integral control loop, high proportional gain), because the FS801 will generate the ramps which the drive has to follow with no additional delay.

For safety reasons it is mandatory to limit the travelling range of the carriage by independent limit switches at both ends, in order to avoid damage with carriage overshoot upon failure of the electronic control system!

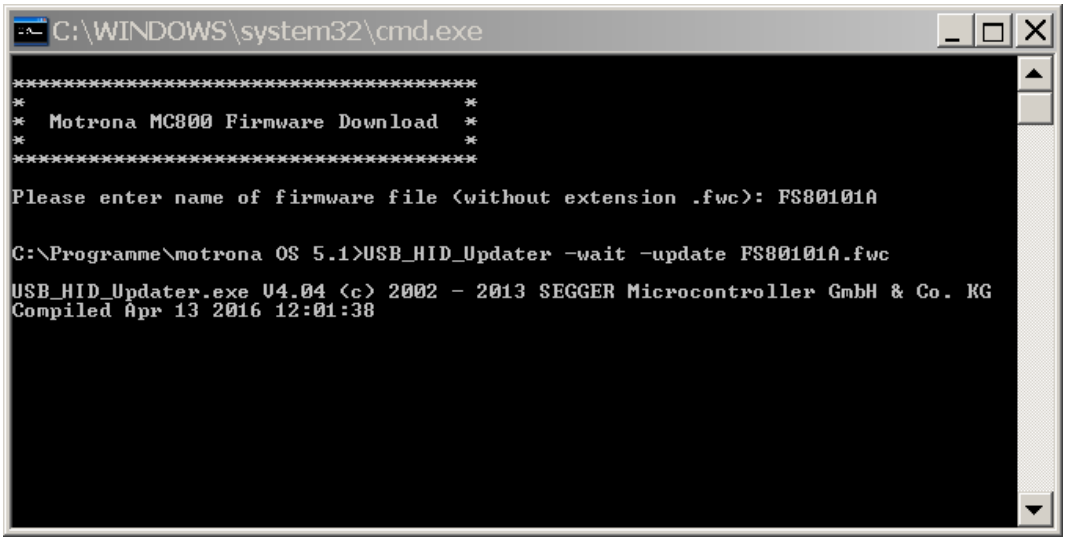
3. Download Procedure

Ex factory, all MC800 controllers have loaded the MC800xxx base firmware, which was used for factory testing purposes.
To download an application firmware, please take the following steps:

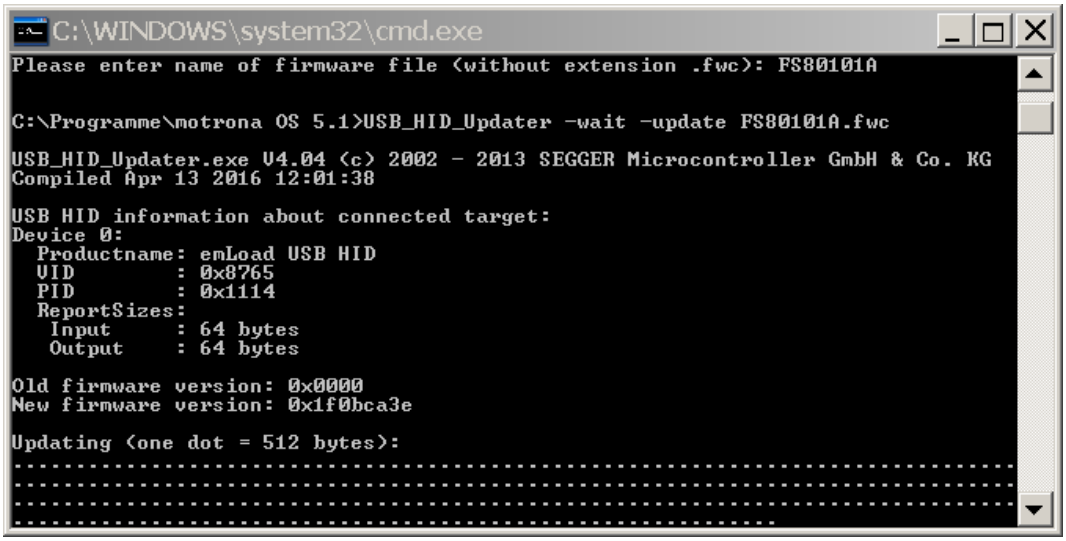
- Switch off the MC800
- Copy the firmware-file “FS801xxx.fwc” to the motrona OS5.1 folder
- Go to OS5.1 folder and double-click to “Download_MC800_Firmware.bat”.
  The following window appears:



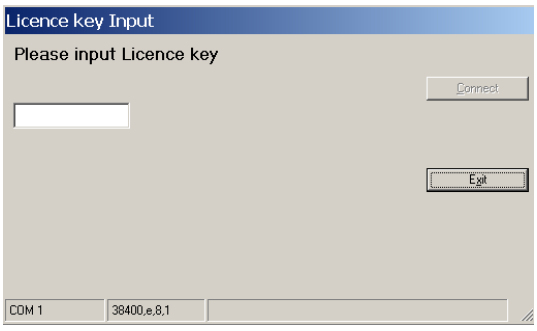
- Input name of firmware file “FS801xxx” without extension “.fwc” and press Enter key
  The window now reads:



- Connect the USB interface of the MC800 with your PC
- Power on the MC800.
  The download starts, and download progress is shown in the window:



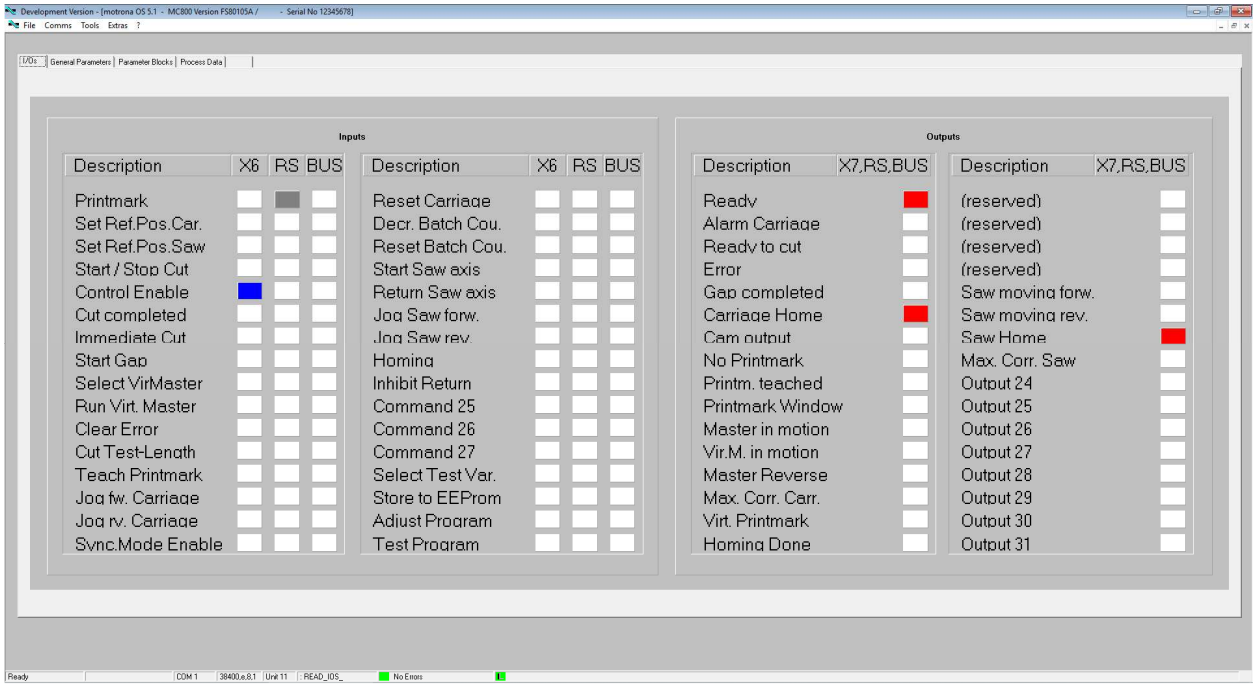
- When download is finished, please press any key to close download window
- Disconnect USB connection between MC800 and PC
- The new firmware in the MC800 starts automatically, there is no additional reset or power cycling required.
- Connect serial interface of the MC800 to your PC and start motrona OS5.1 operator software. The actual firmware of the MC800 is shown in the header of the main window.
- Finally you must input the <u>license key:</u>
  - Select “Input license key” from the “File” menu:



  - Input the license key and click to “connect”
- Now the FS801 firmware is ready for operation.

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. Input commands

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

Each input command can be assigned to a hardware control input by the settings in parameter block “Ctrl. I/O Setting”.
Indicator boxes in the column marked “X6” shine blue, when the associated hardware input signal is HIGH, while LOW state is white.

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 Fieldbus. White box means again “signal off”.
All input signals can be controlled via serial interface, 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.

01	Print Mark	FAST IN 1	↑	Sensor input for print mark
02	Set Ref. Pos. Car. ⌐	* (default: FAST IN 2)	ON:	This input allows defining the reference position of the carriage. It is only active with the "Start/Stop" input in LOW state. The internal carriage position counter is reset and held to zero while this input is High. All limitation settings and alarms refer to this zero position. Please note that upon power up the carriage position counter will be cleared also and the unit would take any actual position as a zero position. Where you power the controller down while the carriage is not at zero position, or where you move the carriage with the controller in powerless state, it is always necessary to redefine position after power up by a homing sequence.
03	Set Ref. Pos. Saw	* (default: FAST IN 3)	ON:	This input allows defining the reference position of the saw axis. The internal saw axis position counter is reset and held to the negative value of parameter "Home Dist. Saw" while this input is High. All position settings refer to this position. Please note that upon power up the saw axis position counter will be cleared also and the unit would take any actual position as zero or home position. Where you power down the controller while the saw axis is not at home position, it is always necessary to redefine the position after power up by a homing sequence.
04	Start / Stop Cut ⌐	* (default: FAST IN 4)	OFF:	The carriage and the saw axis are held in their actual position (closed loop position control). The carriage and the saw axis 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.

*) Function can be assigned to FAST IN 2…4 or CTRL IN 1…4 (see chapter 4.3.7)

05	Control Enable ┘‾	* (default: CTRL IN 1)	OFF:	The whole controller and all functions are disabled. All analog outputs are zero. All counters are hold in a Reset state.
			ON:	The controller is enabled
	It is not mandatory to assign the input command "Control Enable" to a hardware input. If this input command is not assigned to any of the hardware control inputs it will be set automatically during initialization after power on.			
06	Cut Completed	* (default: CTRL IN 2)	↓	This input must receive a signal when mechanically a cut has been fully completed. The direction of the signal (rising or falling edge) is register selectable. With the selected edge, the controller will start deceleration and reversal in order to put the carriage back to its rear home position. With this signal missing, the carriage will continue to follow the material synchronously. When the carriage reaches the "Alarm position", the "Alarm" output will be set, but the carriage will not automatically stop! When the additional saw axis is used with Operation Mode Saw = 1 this signal will be generated automatically and needs not to be connected.
07	Immediate Cut ┘‾	* (default: CTRL IN 3)	ON:	A positive edge at this input will immediately start the shear for 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.
08	Start Gap ┘‾	* (default: CTRL IN 4)	ON:	With use of the "Gap" function (see section 4.3.1) this input will start the gap action after the cut has been made. The input must remain unconnected when the Gap function is not in use or when the saw axis is used.
09	Select Virt. Master	*	OFF:	The line encoder connected to "INC IN 1" acts as Master
			ON:	An internal frequency generator acts as Master (Virtual Master Axis). This input will switch 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 carriage is in standstill.

*) Function can be assigned to FAST IN 2…4 or CTRL IN 1…4 (see chapter 4.3.7)

10	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.
11	Clear Error	*	↓	Resets error states and clears the corresponding error messages
12	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.
13	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")
14	Jog fw. Carriage ⌐¬	*	ON:	Moves the carriage in one or the other direction (Jog speed register settable). The carriage automatically stops when it reaches one of the software limit switches (Minimum or Maximum position). After termination of a Jog command, the carriage will be held again in its new position under closed-loop control.
15	Jog rv. Carriage ⌐¬	*	ON:	From this new home position the carriage will also start to execute the next cut, no matter where it is. The Jog inputs are only active when the Start/Stop input is in stop state. The limitation of the travelling range by the software limit switches will be disabled while you keep the "Set Ref. Pos. Car." input HIGH.

*) Function can be assigned to FAST IN 2…4 or CTRL IN 1…4 (see chapter 4.3.7)

16	Sync. Mode Enable ⌐	*	ON:	Selects a different control mode during the synchronous cutting period. Must be used exceptionally only and after consulting motrona. Input remains unconnected with most common applications.
17	Reset Carriage ⌐	*	OFF:	The PI closed loop control of the carriage is on, position error count and position control are active
			ON:	The position error counter of the carriage is kept to zero; the PI control loop is switched off. The carriage operates "open-loop" with no correction of position errors
18	Decr. Batch Cou.	*	↓	This input will decrement the batch counter by one, and at the same time increment the waste counter by one. It can be used to make batch corrections, if for example one piece is unusable due to fault in the material etc.
19	Reset Batch Cou. ⌐	*		Resets the batch counter and waste counter to zero.
20	Start Saw axis	*	↓	Starts a cutting cycle of the saw axis. Can be used for test purpose or cutting while the material is at standstill. (In this case the command is only active while input Start/Stop is in stop state and carriage at home position.) Also necessary with Operation Mode Saw = 2 to start the cutting cycle of the saw after synchronization of the carriage. When the additional saw axis is used with Operation Mode Saw = 1 this signal will be generated automatically and needs not to be set.
21	Return Saw axis	*	↓	Interrupts the cutting cycle of the saw axis. When this commend is set during movement of the saw axis, it will stop and return to its home position immediately.
22	Jog Saw forw. ⌐	*	ON:	Moves the saw in one or the other direction (Jog speed register settable). After termination of a Jog command, the saw axis will be held again in its new position under closed-loop control. From this new home position the saw axis will also start to execute the next cutting cycle, no matter where it is. The Jog inputs are only active when the Start/Stop input is in stop state.
23	Jog Saw rev. ⌐	*	ON:	

*) Function can be assigned to FAST IN 2…4 or CTRL IN 1…4 (see chapter 4.3.7)

24	Homing	*	↓	Starts a homing sequence for saw axis (if active) and carriage. The command is only active while input Start/Stop is in stop state and the carriage is at home position. If the saw axis is used ("Operation Mode Saw" = 1 or 2), then first the homing of the saw axis starts while the carriage remains stopped: The saw is moving reverse until it reaches the reference position (input "Set Ref.Pos.Saw."). Then the saw axis is moving forward to the home position and stops. Now the homing of the carriage starts: The carriage is moving reverse until it reaches the reference position (input "Set Ref.Pos.Car."). Then the carriage is moving forward to its home position and stops. Finally output "Homing Done" is set. For details of the homing sequence please see also chapter 4.3.3 "Jog / Home / Ref".
25	Inhibit Return	*	ON	When this command is set, the carriage stops after the cut at the end of forward deceleration ramp. It then waits and does not start the reverse movement before this command is reset.
26	Command 25	*		Not in use
27	Command 26	Ser/Bus		For factory test only, don't use!
28	Command 27	Ser/Bus		For factory test only, don't use!
29	Select Test Var.	Ser/Bus		For factory test only, don't use!
30	Store to EEProm	*	↓	Stores all actual registers and parameters to the EEPROM (safe for power-down)
31	Adjust Program ⌐¬	Ser/Bus		Switches the controller over from normal operation to the "Adjust" program (Condition: Control Enable = OFF) Is set automatically by OS5.1 when "Adjust" program is selected.
32	Test Program ⌐¬	Ser/Bus		For factory test only, don't use!

*) Function can be assigned to FAST IN 2…4 or CTRL IN 1…4 (see chapter 4.3.7)

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.

Each output signal can be assigned to a hardware control output (CTRL OUT 1…4 or FAST OUT 1…3) by the settings in parameter block "Ctrl. I/O Setting" (see chapter 4.3.7).

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, independent of they are assigned to a hardware input or not.

Meaning and function of the output signals:

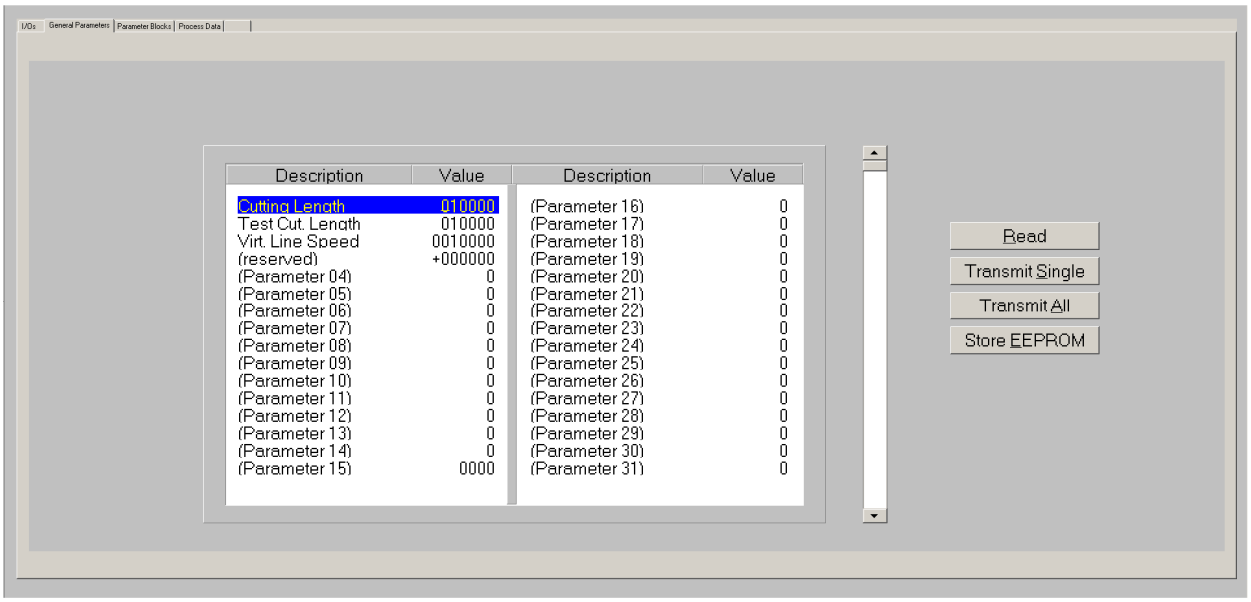
01	Ready	Indicates that the unit is ready to operate after power-up, initialization and successful self-test. The signal however is not a guarantee that all functions really work trouble-free.
02	Alarm Carriage	This output goes to HIGH when during forward motion the carriage reaches the "Alarm Position". It can be used to limit the travelling range of the carriage into forward direction during production. If, e.g. for mechanical or other reasons, the carriage could not synchronize with the line, the controller would never generate the "Ready to cut" signal and the carriage would run to the front stop. The output switches High to indicate that the carriage will run out of range if not broken down immediately. If the saw axis is used, a high signal at this output Interrupts the cutting cycle of the saw axis; i. e. the saw axis will stop its forward movement and return to its home position immediately.
03	Ready to Cut	This output goes High when the shear has reached its cutting position with respect to the material and moves fully synchronous with the line. It goes only Low again after the controller has received a remote "Cut completed" signal.
04	Error	This output goes HIGH when an error is detected during operation (see section "Error messages"). The error is also indicated in the bottom line of the PC operator software.
05	Gap completed	With use of the "Gap" function, this output signals that the gap has been completed, and that the controller waits for the "Cut completed" signal to initialize the return cycle of the carriage. If the saw axis is used, a high signal at this output automatically starts the return movement of the saw axis.

06	Carriage Home	A HIGH state of this output indicates that the carriage is in its home position like defined by register "Home Window Carr." The output is LOW whenever the carriage is outside the home window.
07	Cam output	Switching output before cut: This output is set to high when the scheduled cutting position on the material reaches an adjustable position in front of the home position of the saw carriage. See parameters "Cam 1 Distance", "Cam1 Pulse Width" and "Cam1 Delay Time".
08	No Printmark	Indicates that for an adjustable number of sheets no printmark has been detected within the printmark window (see parameter „Missing Printmark").
09	Printmark teached	Indicates that the printmark position set point has successfully been set by input „Teach Printmark".
10	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)
11	Master 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"
12	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"
13	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.
14	Max. Corr. Carr.	This output indicates that the proportional correction value of the carriage has reached the maximum as set to the "Max.Corr. Carr." register, and that possibly the carriage is out of control.
15	Virt. Printmark	This Outputs indicates a virtual printmark to be cut (see register "Virt. Printmarks" for details)
16	Homing Done	This output indicates that a homing sequence has been performed.

17	(reserved)	Not in use
18	(reserved)	Not in use
19	(reserved)	Not in use
20	(reserved)	Not in use
21	Saw moving forw.	A HIGH state of this output indicates that the saw axis is moving in forward direction.
22	Saw moving rev.	A HIGH state of this output indicates that the saw axis is moving in reverse direction.
23	Saw Home	A HIGH state of this output indicates that the saw axis is in its home position like defined by register "Home Window Saw". The output is LOW whenever the saw axis is outside the home window.
24	Max. Corr. Saw	This output indicates that the proportional correction value of the saw axis has reached the maximum as set to the "Max.Corr. Saw" register, and that possibly the saw axis is out of control.
	Output 24 … 31	Not in use

4.2. General Parameters

This register card holds the essential variable settings of general nature



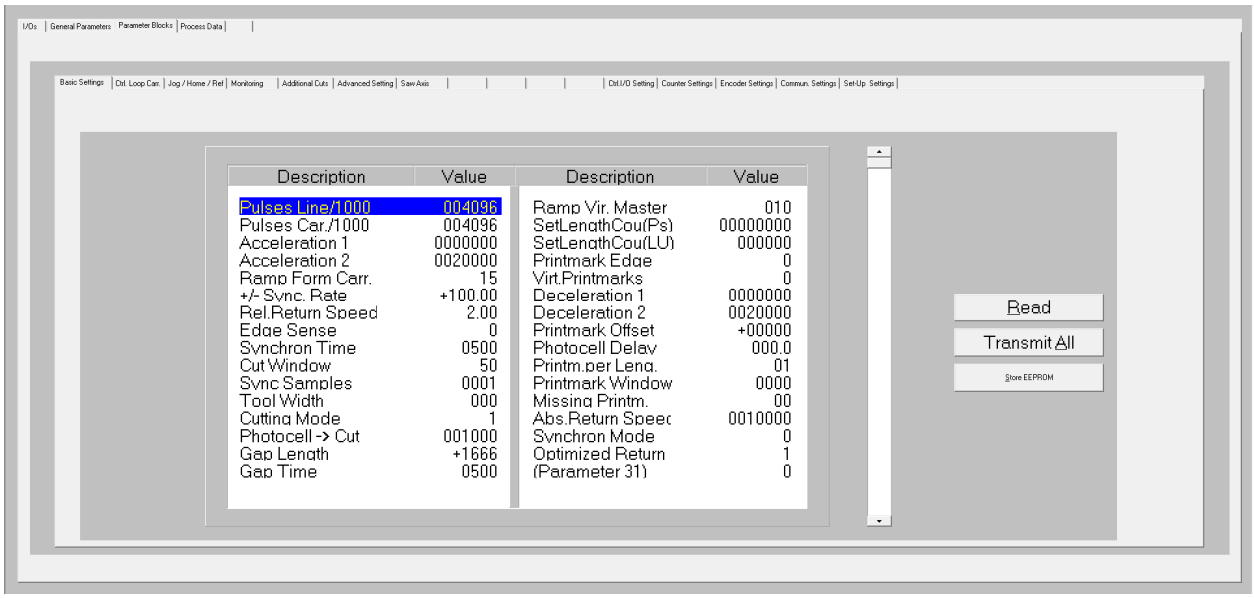
Prior to register setting you must decide which dimensions or length units (LU) you like to use for preset of the cutting length. This could be 0.1mm or 1mm or 0.001 inch or any other resolution you desire. All further settings refer to the Length Units you decided to use. E.g. when you chose to set 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 = 1/10000 of Max Line Speed.
(reserved)	Not in use with this application firmware
(Parameter 04…31)	Not in use

4.3. Parameter Blocks

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

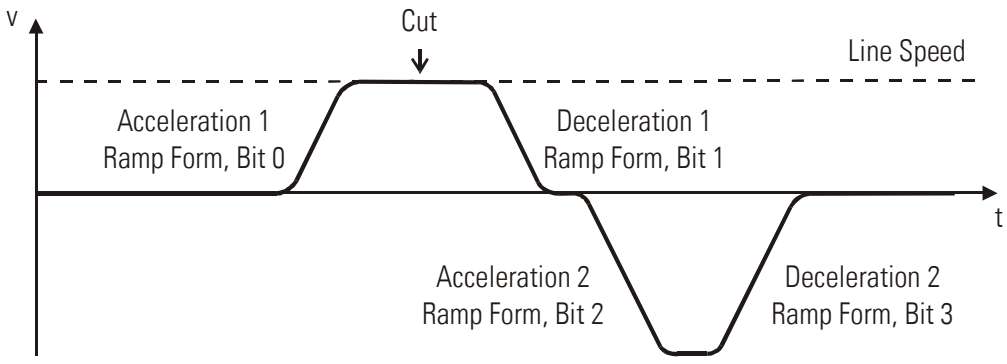


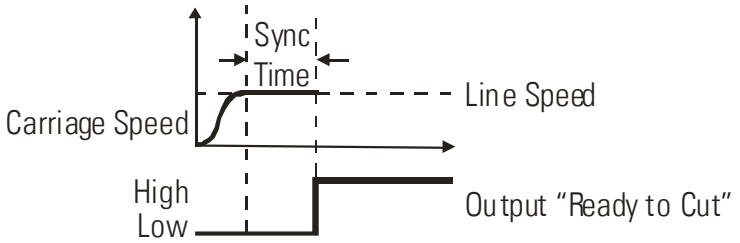
4.3.1. Basic Settings

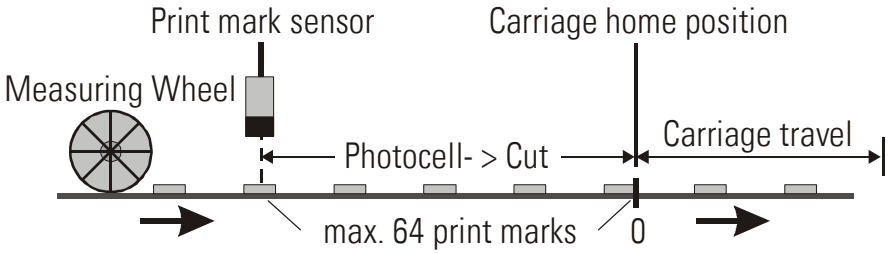
Pulses Line / 1000	This register is for scaling of the line encoder. Find out how many pulses you receive when the line moves 1000 length units (LU) forward. Set the proper number of pulses here. Range 0-999 999
Pulses Cut / 1000	This register is for scaling of the carriage. Find out how many pulses you receive when the carriage moves 1000 length units (LU) forward. Set the proper number of pulses here. Range 0-999 999
Acceleration 1 *)	Acceleration rate of the carriage during forward motion. Scaled in Length units per second squared. Range 0 – 9999999 LU/s^2 If set to 0, parameter "Acc. 1 Ramp Dist" in parameter block "Advanced Setting" is valid (fixed ramp length and thus varying acceleration rate)
Acceleration 2 *)	Acceleration rate of the carriage during reverse motion. Scaled in Length units per second squared. Range 1 – 9999999 LU/s^2 **Only valid if register "Optimized Return" = 0**

*) Deceleration rates to be set separately by parameters "Deceleration1" and "Deceleration2"!

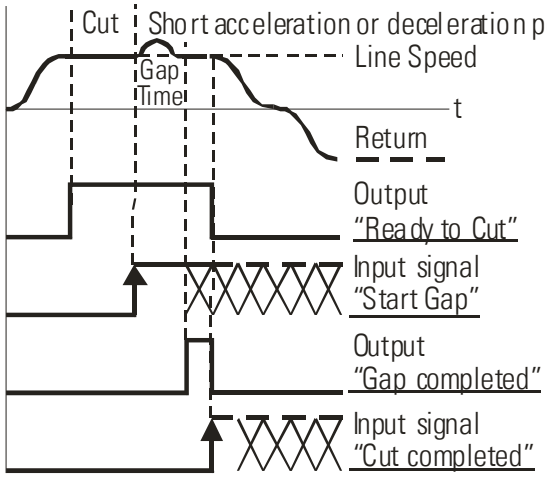
- The controller generates ramps of a constant gradient. Therefore, the ramp times depend on the acceleration settings and the actual line speed. When, for example, the unit is scaled to entire millimeters, an acceleration setting of 5000 mm/s² would mean that the carriage accelerates from zero to a speed of 5 m/s (= 300 m/min) within 1 second. Therefore it would need 100 ms when the real speed is 30 m/min only etc.
- You must only use acceleration settings that the drive is really able to follow. Settings outside of the physical capability of the drive will result in malfunction or even failure of the whole system.
- The acceleration settings refer to linear ramp forms. When you use S-ramps (see next parameter), the maximum acceleration at the steepest position of the S-profile will be by factor 1.25 higher.

Ramp Form	Selects the shape of the ramps of the carriage speed profile. Two types of ramps are available: linear and S-shaped ramps. The selection can be made independently for each of the four ramps of the speed profile by setting the corresponding bit of the parameter "Ramp Form" either to 0 or to 1: Bit 0: forward acceleration ramp Bit 1: forward deceleration ramp Bit 2: backward acceleration ramp Bit 3: backward deceleration ramp A ramp is S-shaped when the corresponding bit is 0 and it is linear when the corresponding bit is 1. Example: Ramp Form = 00 means that all ramps are S-shaped, Ramp Form = 01 means that only the forward acceleration ramp is S-shaped, and Ramp Form = 15 means that all ramps are linear. S-shaped ramps are recommended when using drives with high response (e.g. servo drives) whereas linear ramps are recommended for drives with lower response (e.g. big DC drives). 

+/- Sync Rate	This register allows a percental adaption of the synchronous speed in a range of -99.00% to +300.00%. In general, this register will be set to 00.0 and the carriage will synchronize with the line exactly according to the encoder information. Some special applications may require higher or lower speed during the synchronous zone. This setting affects the synchronous speed only, but not the cutting length.
Rel. Return Speed	Sets the ratio between the actual line speed and the maximum return speed. Setting Range 0.00 - 9.99. **Only valid when register "Optimized Return" = 0!** Setting 2.00 says that, if necessary, the return speed is permitted to be the double of the actual line speed. The controller will however use this maximum return speed only if really required from the cutting process. **Setting 0 means that the return speed is defined by parameter "Abs Return Speed".**
Edge Sense	Sets the active edge of the remote "Cut Completed" signal. 0: A rising edge at the "Cut Completed" input will conclude the synchronous cutting phase and initialize the return cycle of the carriage. 1: A falling edge at the "Cut Completed" input will conclude the synchronous cutting phase and initialize the return cycle of the carriage.
Synchron Time	This is an adjustable delay time between reaching the synchronous speed and switching on the "Ready to cut" output. Setting range 1-9999 milliseconds. Under regular conditions the carriage will be in the correct cutting position immediately after completion of the acceleration ramp, and the Sync Time register can be set to its minimum value of 1 ms. With mechanically unstable carriage constructions it may however be applicable to leave a short stabilization time before activating the cut. 
Cut Window	Sets a tolerance window around the cutting position where the carriage must be before the "Ready to cut" signal is switched on. Setting is directly in number of increments of the carriage encoder. Range 1-99 increments. We recommend setting this window not too small, because no cut will be activated when for any reasons we do not reach this window (carriage will then run to the front stop).

Sync. Samples	Filter for the cut window. The purpose of this parameter is to ensure that the carriage has reached a stable position within the cut window and does not leave the window again right after the "ready to cut"-output has been switched on. Sync Samples = n means that during n consecutive control cycles the carriage must be inside the window, before the "ready to cut"-signal is switched on. This function should only be used for systems with poor dynamic performance. Please note that too high settings of this parameter may cause the controller to never set the "ready to cut"-signal. Setting range: 1 – 9999, recommended setting: 1
Tool Width	Provides compensation of the width of the saw blade or cutting tool. Setting 0-999 length units
Cutting Mode	Operation mode. 1: Cut to length according to length preset (without print mark) 2: Cut according to the print marks on the material 3. Cut according to print marks, with several sub-cuts between marks (see section 4.3.5)
Photocell -> Cut*	Distance between the print mark sensor and the home position of the carriage. Setting range 0 – 999 999 LU. This setting is only relevant with print mark operation (cutting mode 2 or 3). The controller will store in a FIFO shift register up to 64 print marks between sensor and carriage, and control the cut 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. 
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 tool prior to removing it from its cutting position. The gap width can be set directly in length units, range +/-9999 LU. Negative values can be used for double processing in one movement cycle: The carriage then decelerates after the cut and moves (relative to the material line) backwards behind the cutting position. **With most applications, this function remains unused (Gap Length = 0).** To use the gap function, the following timing of signals must be observed:

*) For printmark operation only

	
Gap Time	Preset time to make the gap. Setting range 1 – 9999 ms. Please leave the drive an appropriate time to accelerate and decelerate for making the gap, according to the desired gap width and the dynamic performance and maximum speed of the carriage system.
Ramp Vir. Master	Sets the ramp time of the virtual master axis between standstill and maximum speed (acceleration and deceleration) Range 0 – 999 s.
Set Length Cou (Pulses)	Set value for material length counter at start of automatic length operation, scaled in master encoder pulses. When input "Start" is set to high the material length counter is set to this value. Afterwards, the register "Set length Counter" is cleared to zero (set value only used one time). Range 0 – 99999999 Increments.
Set Length Cou (LU)	As above, but scaled in Length units. Range 0 – 999999 LU Parameters "Set length Counter" can be used to include a material remainder of the discontinued last cut to the first cut when starting the machine
Printmark Edge*	Sets the active edge of the printmark sensor signal: 0: Rising edge (input "Print Mark" is HIGH while a print mark is detected) 1: Falling edge (input "Print Mark" is LOW while a print mark is detected)
Virt. Printmarks*	With print mark operation only: Generation of virtual print marks at start. 0: Virtual printmark function disabled 1: When input "Start" is set to high, the printmark buffer will be filled with virtual printmarks located between printmark sensor position and cutting position. This will lead the saw to cut as soon as possible without waiting until the first printmark has reached cutting position and avoids waste pieces
Deceleration 1	Deceleration rate of the carriage during forward motion. Scaled in Length units per second squared. Range 0 – 9999999 LU/s^2 If set to 0, parameter "Dec. 1 Ramp Dist" in parameter block "Advanced Setting" is valid (fixed ramp length and thus varying deceleration rate)

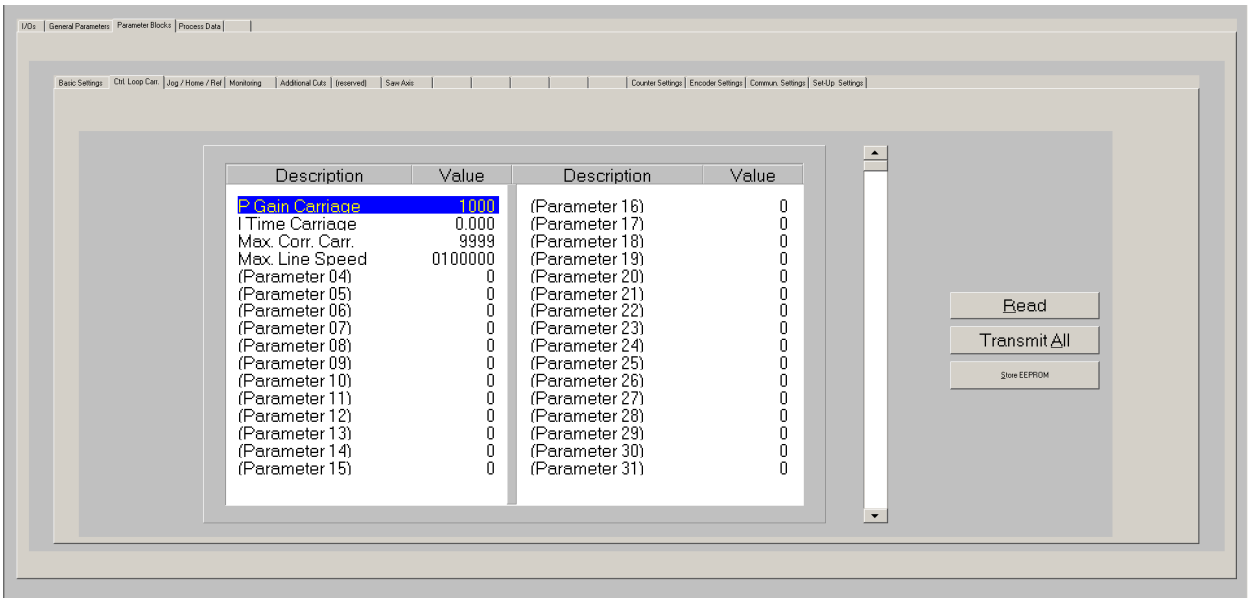
*) For printmark operation only

Deceleration 2	Deceleration rate of the carriage during reverse motion. Scaled in Length units per second squared. Range 1 – 9999999 LU/s^2 Only valid if register "Optimized Return" = 0
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 or falling edge according to register "Printmark Edge"). A positive value moves the cut forward (leading the printmark), a negative value moves the cut backwards (lagging behind the printmark). Range +/- 99999 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.
Printmarks 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.
Printmark Window*	Defines a symmetric window around the 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, and 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. For the correct operation of the print mark window it is important to set parameter "Cutting Length" to the correct distance of the valid print marks (i. e. the sheet length)!

*) For printmark operation only

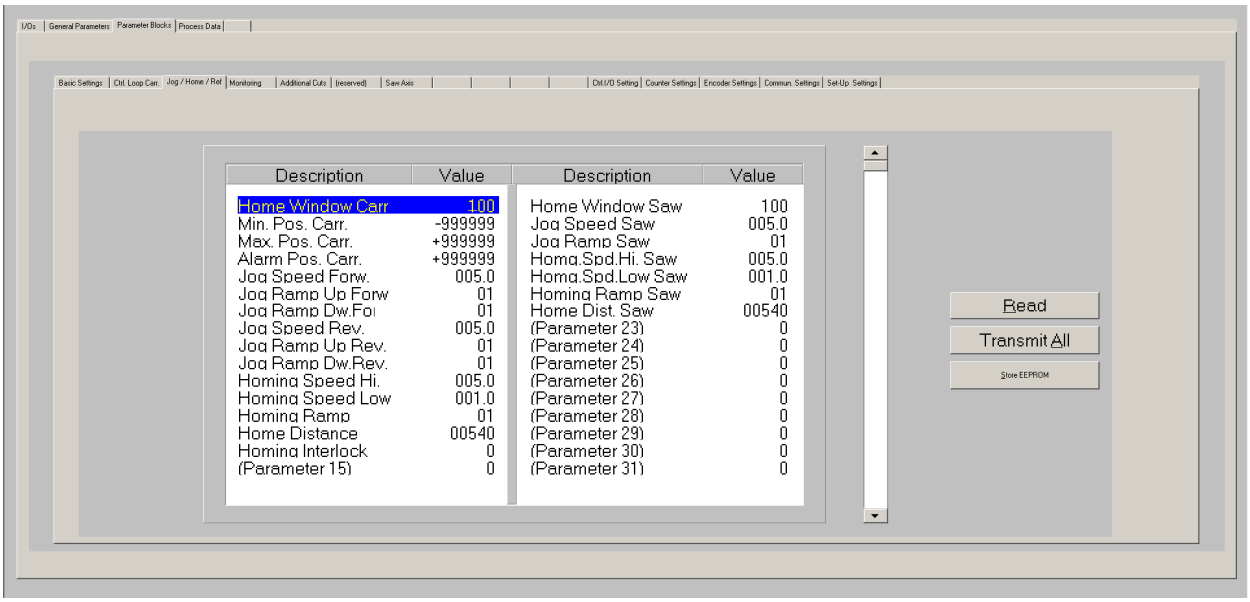
Missing Printmark*	Monitoring of printmarks within the printmark window: This register sets the number of sheets without printmark until output "No printmark" is set. Range 0 – 99. Setting 0 disables the printmark monitoring.
Abs. Return Speed	If register "Optimized Return" = 0 and "Rel. Return Speed" = 0: Sets the return speed to an absolute value independent of the line speed. If register "Optimized Return" = 1 or "Rel. Return Speed" = X: Selects the minimum return speed. That means that the optimized return speed or the relative return speed cannot be lower than the value set here. Scaled in length units per minute, setting range 1 … 9999999 LU/min.
Sync Mode	Provides the possibility to change the control characteristics of the carriage during the synchronous cutting phase. Input "Sync.Mode Enable" switches over from normal mode to the selected Sync Mode. **This parameter must always be set to 0,** except for very special applications with external clamping mechanism during the cut. Please ask motrona before using settings different from zero.
Optimized Return	"Pendulum" function for optimized return movement of carriage 0: Function disabled Return movement of carriage with preset speed as selected by registers "Rel. Return Speed" or "Abs. Return Speed" 1: Optimized return movement of carriage enabled Carriage does not use preset speed and acceleration for return movement. After each cut the firmware calculates an optimized return movement so that the carriage returns to the home position only a short time before the next cut. So the return movement of the carriage then takes the full time* available until next cut and the carriage is moving nearly continously like a pendulum. By this speed and acceleration of the return movement are minimized and thus mecanical stress and energy consumption are reduced. *) For advanced users: Selectable by register "Return Duty Cycle" in parameter block "Advanced Setting"
(Parameter 31)	-Not in use-

4.3.2. Control Loop Carriage

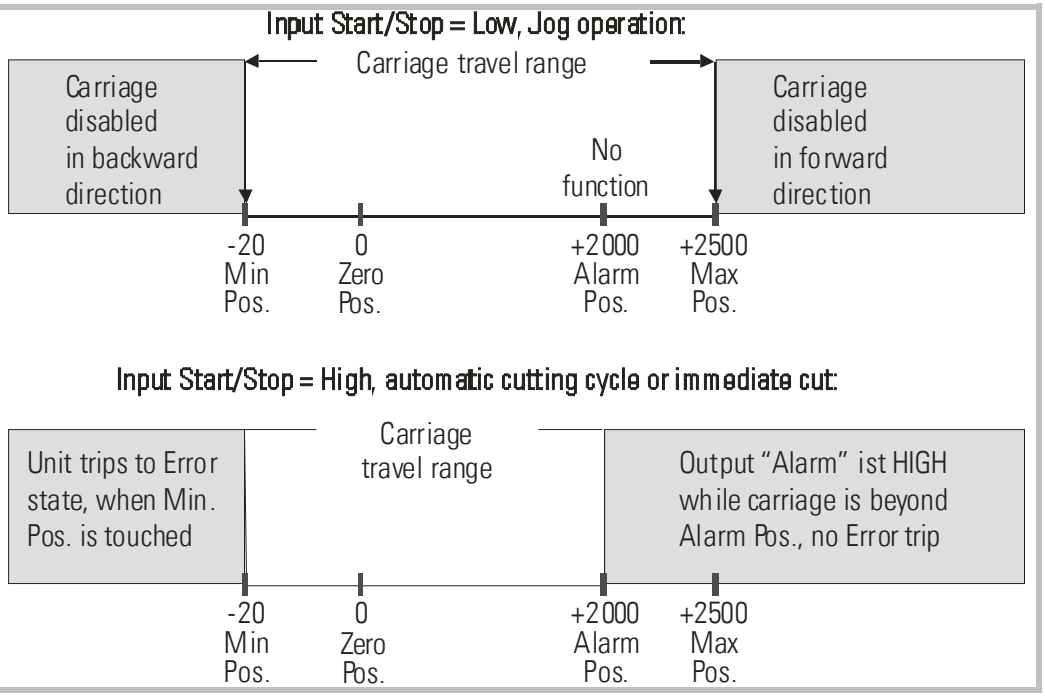


P Gain Carriage	Proportional gain for compensation of relative errors of the carriage position with respect to the scheduled position. Setting range: 0 – 9999 Recommended settings: 500 – 2500.
I Time Carriage	Sets the integration time (seconds) to compensate for position and cutting errors caused by non-linearity of the carriage drive. 0.000 = Integration off, proportional control only 0.001 = very fast integration at 1 ms time base 1.000 = slow integration at 1 s time base etc..
Max. Corr. Carriage	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”.
Parameter 04 … 31	-Not in use-

4.3.3. Jog / Home / Ref



Home Window Carr.	Sets a window around the home position of the carriage. Setting range 1-999 LU. The output "Carriage Home" indicates by High state that the carriage position is inside this window. The unit will go to Error state when a new cutting cycle would need to start before the carriage has returned to the home window from the previous cut.
Min. Pos. Carr., **Max. Pos. Carr.**	Programmable software limit switches for the carriage position. Setting range -999 999 to + 999 999 LU. The settings refer to the reference position, which is set by the "Set Ref. Pos. Car." input. Min Pos must always be set to a negative value and Max Pos must always be set to a positive value. When the "Start/Stop Cut" input is in Stop state (Low), these two software limit switches will limit the travelling range with Jog operations. With automatic operation ("Start/Stop Cut" = HIGH) or during an immediate cut, only the rear "Min. Pos. Carr." switch remains active and sets the unit to an Error state when touched during operation. The front "Max. Pos. Carr." switch however is out of operation. Instead, the "Alarm Pos. Carr." switch is monitoring the forward carriage motion and sets an alarm output when touched during a cutting cycle. The following drawings explain the function of the software limit switches, based on the following settings (example): "Min. Pos. Carr." = -20 LU, "Max. Pos. Carr." = +2500 LU, "Alarm Pos. Carr." = 2000 LU:

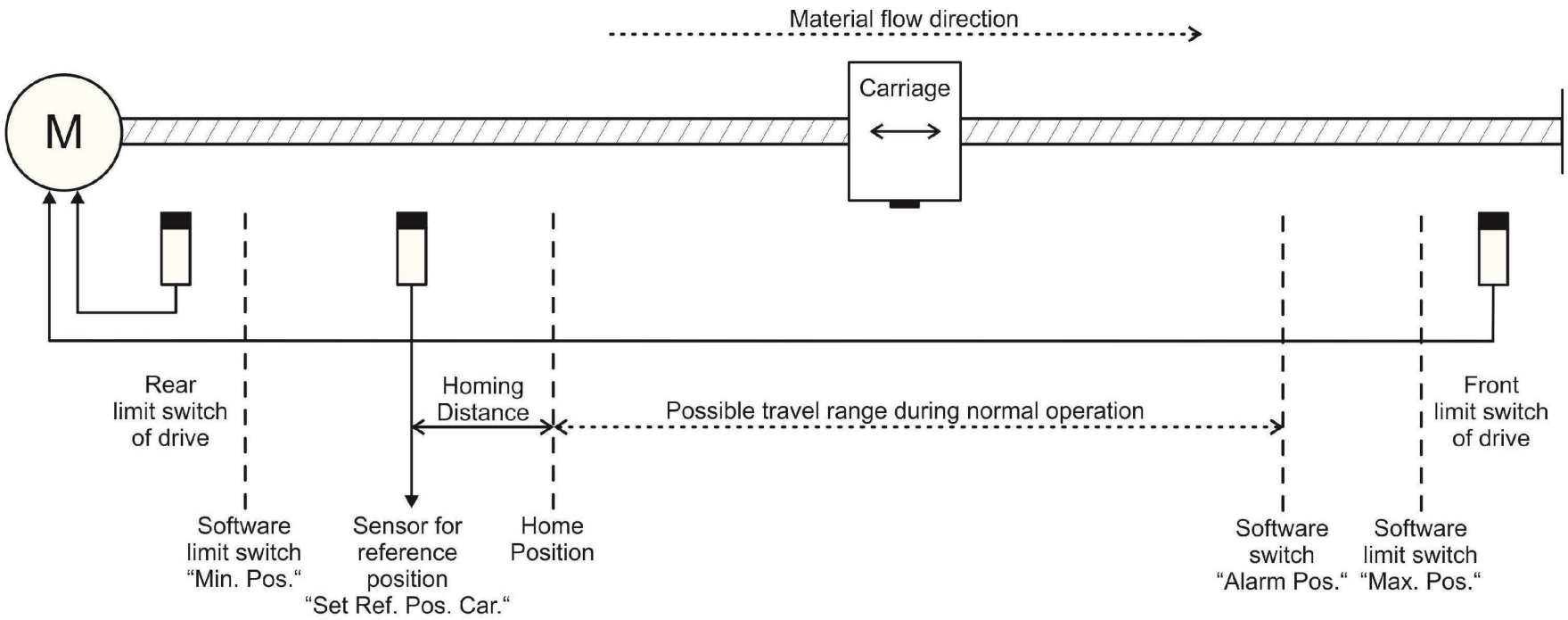


- The home position of the carriage for executing a cut is always the position where the carriage is located at the moment where the "Start/Stop Cut" input changes from LOW to HIGH.
- The reference (or zero) position however is the position where the carriage is located while the controller is powered up, or where it is located during the falling edge of the "Set Ref. Pos. Carr." input signal.
- Therefore home position of carriage can be different from reference position! (for more details please also refer to description of homing sequence below)

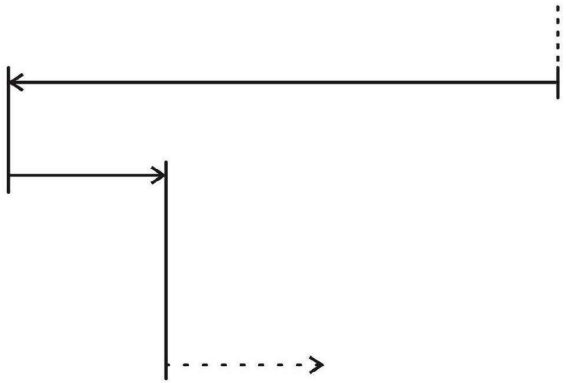
Alarm Pos. Carr.	Sets an alarm position for the forward motion of the carriage during automatic cutting operation. Setting range 0 – 999 999 LU. The "Alarm carriage" output indicates by HIGH state that the actual carriage position is beyond the "Alarm Pos. Carr." setting. See also diagram at parameters "Min. Pos. Carr.", "Max. Pos. Carr" and output "Alarm Carriage".
Jog Speed Forw.	Preset of the desired carriage speed for Jog operations in forward direction with use of input "Jog fw. Carriage". Setting range 0 – 100.0%, where 100% corresponds to the "Maximum Line Speed" setting.
Jog Ramp Up Forw.	Acceleration ramp time for Jog operation in forward direction Setting range 01 – 99 s with respect to speed changes between standstill and maximum line speed.
Jog Ramp Dw. Forw.	Deceleration ramp time for Jog operation in forward direction Setting range 01 – 99 s with respect to speed changes between maximum line speed and standstill.

Jog Speed Rev.	Preset of the desired carriage speed for Jog operations in backward direction with use of input "Jog rv. Carriage". Setting range 0 – 100.0%, where 100% corresponds to the "Maximum Line Speed" setting.
Jog Ramp Up Rev.	Acceleration ramp time for Jog operation in backward direction Setting range 01 – 99 s with respect to speed changes between standstill and maximum line speed.
Jog Ramp Dw. Rev.	Deceleration ramp time for Jog operation in backward direction Setting range 01 – 99 s with respect to speed changes between maximum line speed and standstill.
Homing Speed Hi.	Speed for the homing of the carriage when the carriage is moving in reverse direction towards reference position sensor (connected to input "Set Ref.Pos.Car."). Setting range 0 – 100.0%, where 100% corresponds to the "Maximum Line Speed" setting. For detailed description of the homing sequence please see drawing below.
Homing Speed Low	Speed for the homing of the carriage when the carriage is moving in forward direction from reference position sensor (connected to input "Set Ref.Pos.Car.") to home position. Setting range 0 – 100.0%, where 100% corresponds to the "Maximum Line Speed" setting. For detailed description of the homing sequence please see drawing below.
Homing Ramp	Ramp time for acceleration / deceleration of homing speed of the carriage. Setting range 01 – 99 s with respect to speed changes between standstill and maximum line speed.
Homing Distance	Distance between reference position (position of "Set Ref.Pos.Car." sensor) and home position of the carriage. During homing, the carriage moves forward for this distance after it has found the reference position. Scaled in length units, setting range 0 – 99 999 LU For detailed description of the homing sequence please see drawing below.
Homing Interlock	Determines whether a homing sequence is mandatory or not 0: Homing sequence is not mandatory. You can start cutting operation without having done a homing sequence before. 1: Homing sequence is mandatory. Before you can start cutting operation you must have performed a homing sequence, i. e. output "Homing Done" must be high when you set input "Start/Stop Cut" or "Immediate Cut" (otherwise error "No Homing" will appear).
(Parameter 15)	-Not in use-

Home Window Saw	Sets a window around the home position of the saw axis. Setting range 1-999 LU. The output "Saw Home" indicates by High state that the saw axis position is inside this window.
Jog Speed Saw	Preset of the desired saw axis speed for Jog operations with use of input "Jog Saw forw." or "Jog Saw rev.". Setting range 0 – 100.0%, where 100% corresponds to maximum speed (10 V speed setpoint).
Jog Ramp Saw	Acceleration and deceleration ramp time for Jog operation of the saw axis. Setting range 01 – 99 s with respect to speed changes between standstill and maximum speed (10 V speed setpoint).
Homg.Spd.Hi. Saw	Speed for the homing of the saw axis when the saw axis is moving in reverse direction towards reference position sensor (connected to input "Set Ref.Pos.Saw"). Setting range 0 – 100.0%, where 100% corresponds to maximum speed (10 V speed setpoint). For detailed description of the homing sequence please see drawing below.
Homg.Spd.Low Saw	Speed for the homing of the saw axis when the carriage is moving in forward direction from reference position sensor (connected to input "Set Ref.Pos.Saw") to home position. Setting range 0 – 100.0%, where 100% corresponds to maximum speed (10 V speed setpoint). For detailed description of the homing sequence please see drawing below.
Homing Ramp Saw	Ramp time for acceleration / deceleration of homing speed of the saw axis. Setting range 01 – 99 s with respect to speed changes between standstill and maximum speed (10 V speed setpoint).
Home Dist. Saw	Distance between reference position ("Set Ref.Pos.Saw" sensor) and home position of the saw axis. During homing, the carriage moves forward for this distance after it has found the reference position. Scaled in length units, setting range 0 – 99 999 LU For detailed description of the homing sequence please see drawing below.
(Parameter 23 … 31	-Not in use-

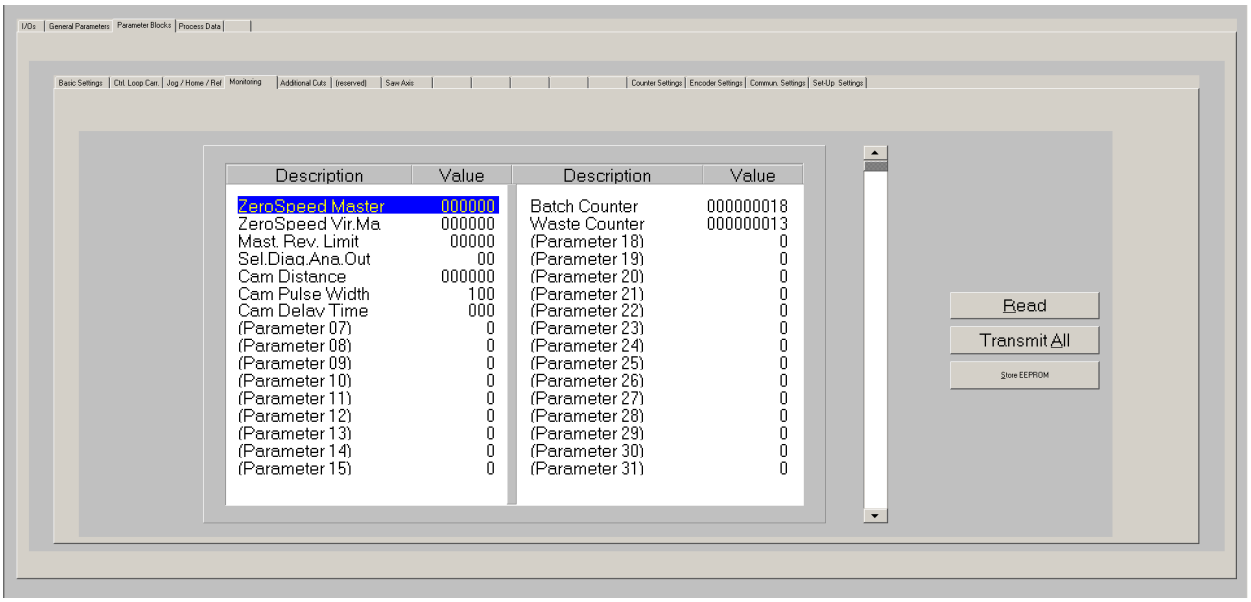


Homing Sequence:



1. Set Input “Homing“
2. Carriage moves backwards to Reference Position with “Homing Speed High“
3. Carriage moves forward to Home Position with “Homing Speed Low“ (Distance adjustable by parameter “Homing Distance“)
4. Carriage stops at Home Position
5. Output “Homing Done“ is set, carriage is ready for cutting operation

4.3.4. Monitoring



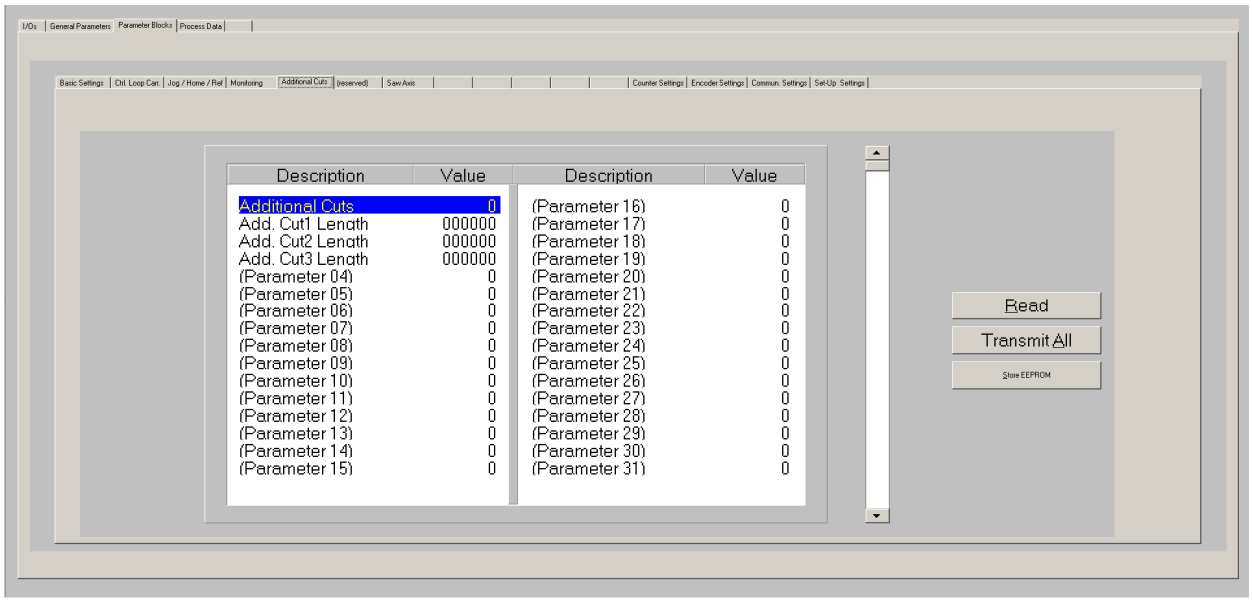
Zero Speed Master	Standstill definition for the line encoder. When the speed of the line encoder is higher than the setting of this register the referring output "Master in Motion" is switched ON. Setting range: 0 – 999 999 LU/min.
Zero Speed Vir. Master	Standstill definition for the virtual master. 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.
Mast. Rev. Limit	Master reverse movement monitoring: The output "Master Reverse" goes HIGH when the material line moves in reverse direction for a distance greater than set in this register. Setting range 0 – 99 999 LU. Setting 0 disables the Master reverse movement monitoring.
Sel.Diag.Ana.Out	<u>Only if additional saw axis is not used:</u> Selects the actual value from the menu "Process Data", which should appear at analogue output "ANALOG OUT 2" for diagnosis purpose. Setting range 0 - 31 (number of actual value) See chapter 4.4 and table in chapter 8 for selection. Parameter "Sel.Diag.Ana.Out" is only valid if parameter "Operation Mode Saw" = 0!
	Parameter **Ana Out 2 Gain** from the Set-up register card (see chapter 4.3.9) allows the scaling of the analogue diagnosis signal: Output voltage [V] = (Ana Out 2 Gain x actual value) / 10000 Example: Setting Ana Out2 Gain to 10.000 means that a digital value of 1000 will cause an analogue output of 1 Volt.

Cam Distance	Switching position of "Cam Output": "Cam Output" is set to high when the scheduled cutting position on the material is at the distance set here in front of the carriage home position. Setting range 0 – 999 999 length units.
Cam Pulse Width	Pulse width of "Cam output" in ms. Setting range 1 – 999 ms.
Cam Delay Time	Compensation of reaction time of actor connected to "Cam output": When this parameter is set to 100 for example, "Cam output" is set to high 100 ms before it reaches its real switching position as defined by parameter "Cam Distance". Setting range 0 – 999 ms. Setting 0 disables the delay time compensation.
(Parameter 07…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-

4.3.5. Printmark Operation with Multiple Cuts

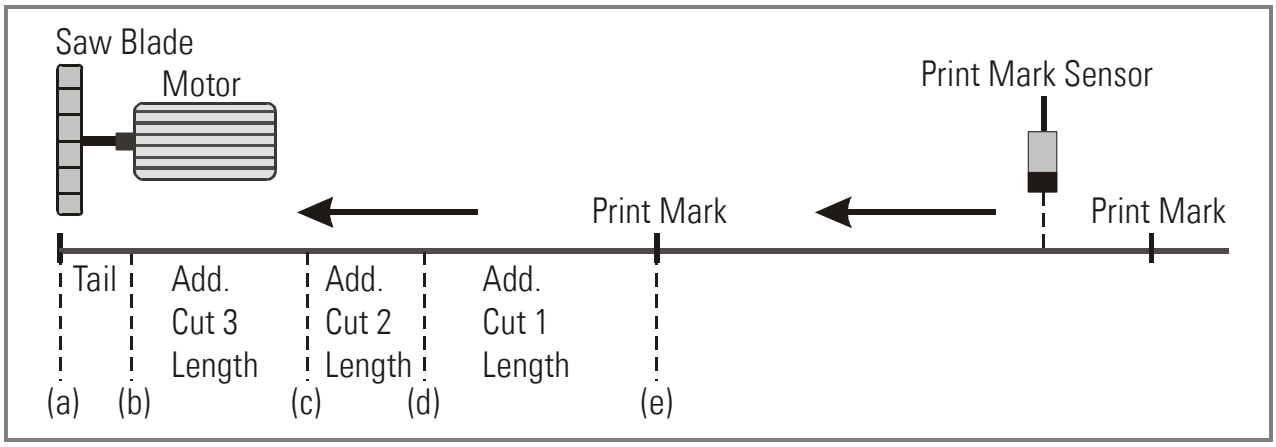
The unit is able to execute several cuts in sequence, triggered by one print mark, when parameter "Cutting Mode" is set to 3 (see "Basic Settings").
Besides the cut to the mark itself, 3 additional cuts can be set, i.e. the piece between two print marks can be divided into totally 4 pieces at maximum (3 pieces with adjustable length and the remaining tail).

All settings for the use of the multiple cut function can be found under "Additional Cuts":



Additional Cuts	Number of supplementary cuts per print mark. Setting range: 0 – 3 **0:** No supplementary cut, only one cut to the print mark **1:** Cut to print mark and one supplement cut ("Add. Cut 1 Length") **2:** Cut to print mark and two supplement cuts ("Add. Cut 1 Length", "Add. Cut 2 Length") **3:** Cut to print mark and three supplement cuts (all 3 "Add. Cut Length")
Add. Cut 1 Length	Length of the first additional cut. Setting range 0 – 999 999 LU
Add. Cut 2 Length	Length of the second additional cut. Setting range 0 – 999 999 LU
Add. Cut 3 Length	Length of the third additional cut. Setting range 0 – 999 999 LU
(Parameter 04 ... 31)	-Not in use-

Additional cuts are executed with the following sequence:
(a): Cut to the previous print mark
(b): Tail
(c): Add. Cut 3 Length
(d): Add. Cut 2 Length
(e): Add. Cut 1 Length = Cut to trigger print mark



Parameter "Tool Width" will be considered with all additional cuts, too.

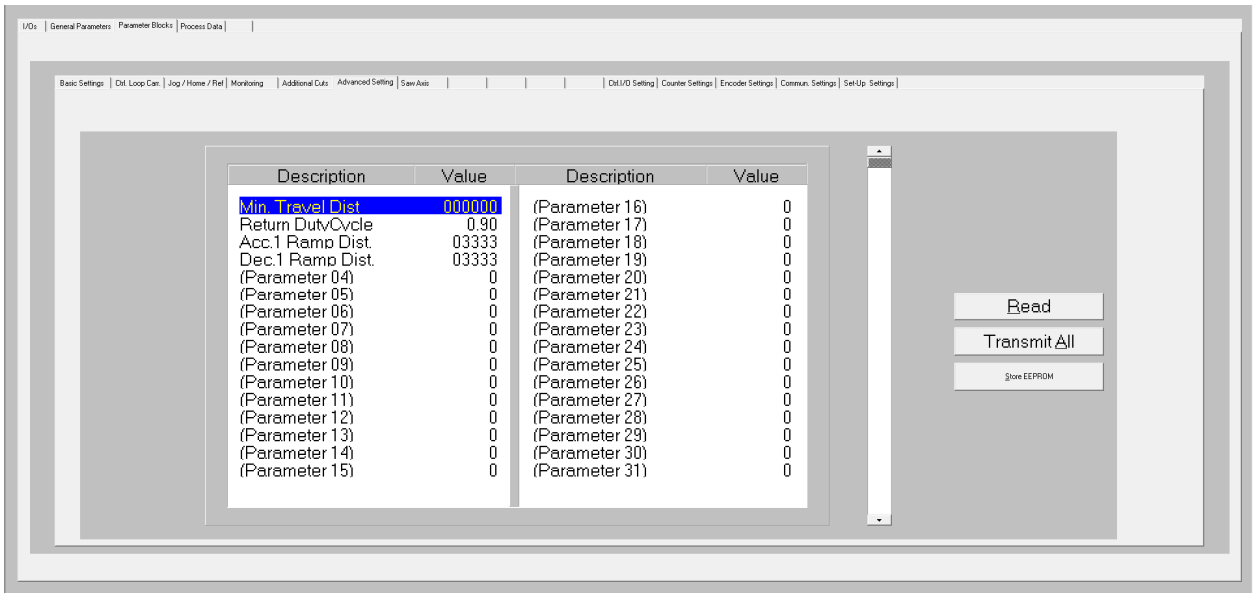
Therefore, when your setting provides a tool width ≠ 0, the remaining tail piece will always be shorter than calculated from the total print mark distance and the total sum of all cuts.

Additional cutting positions are calculated and stored to the cutting sequence register upon detection of the print mark. Therefore, changes of "Multiple Cut" parameters become active not before all the cuts of already registered print marks and their associated additional cuts have been fully completed.

The print mark position register can totally store up to 64 cutting positions. So when using the "multiple Cut" option, the total number of print marks allowed between sensor and carriage reduces correspondingly:

Additional cuts:	Max. number of printmarks between print mark sensor and carriage:
0	64
1	32
2	21
3	16

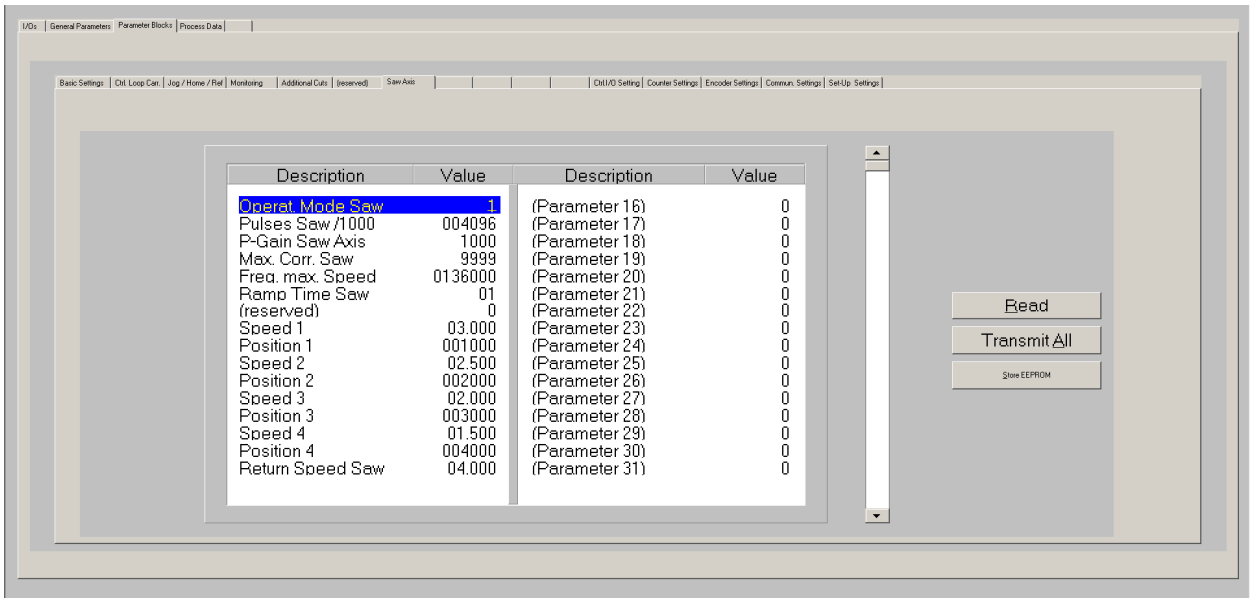
4.3.6. Advanced Settings



Min. Travel Dist.	Minimum travel distance of carriage during cutting cycle. After a cut has been finished (signal "Cut completed" received) the carriage goes on moving synchronous with the material until it has reached the distance from zero position that is set here. Setting range 0 – 999 999 LU. For example useful for applications where the carriage must support the cut material until it has completely reached a feed out conveyor.
Return Duty Cycle	Adaption of optimized return movement (Only valid if register "Optimized Return" = 1) Sets the ratio of the remaining time until next cut that is really used for return movement. Example: A setting of 0.80 means that 80% of the time until next cut is used for return travel and 20% for waiting in home position. Setting Range 0.01 … 0.99 Recommended setting and default setting: 0.90
Acc. 1 Ramp Dist.	Acceleration ramp length of the carriage during forward motion scaled in length units (fixed ramp length with varying acceleration rate) Only valid when register "Acceleration 1" = 0 Setting range 0 – 999 999 LU
Dec. 1 Ramp Dist	Deceleration ramp length of the carriage during forward motion scaled in length units (fixed ramp length with varying deceleration rate) Only valid when register "Deceleration 1" = 0 Setting range 0 – 999 999 LU
(Parameter 04 ... 31)	-Not in use-

4.3.7. Saw axis

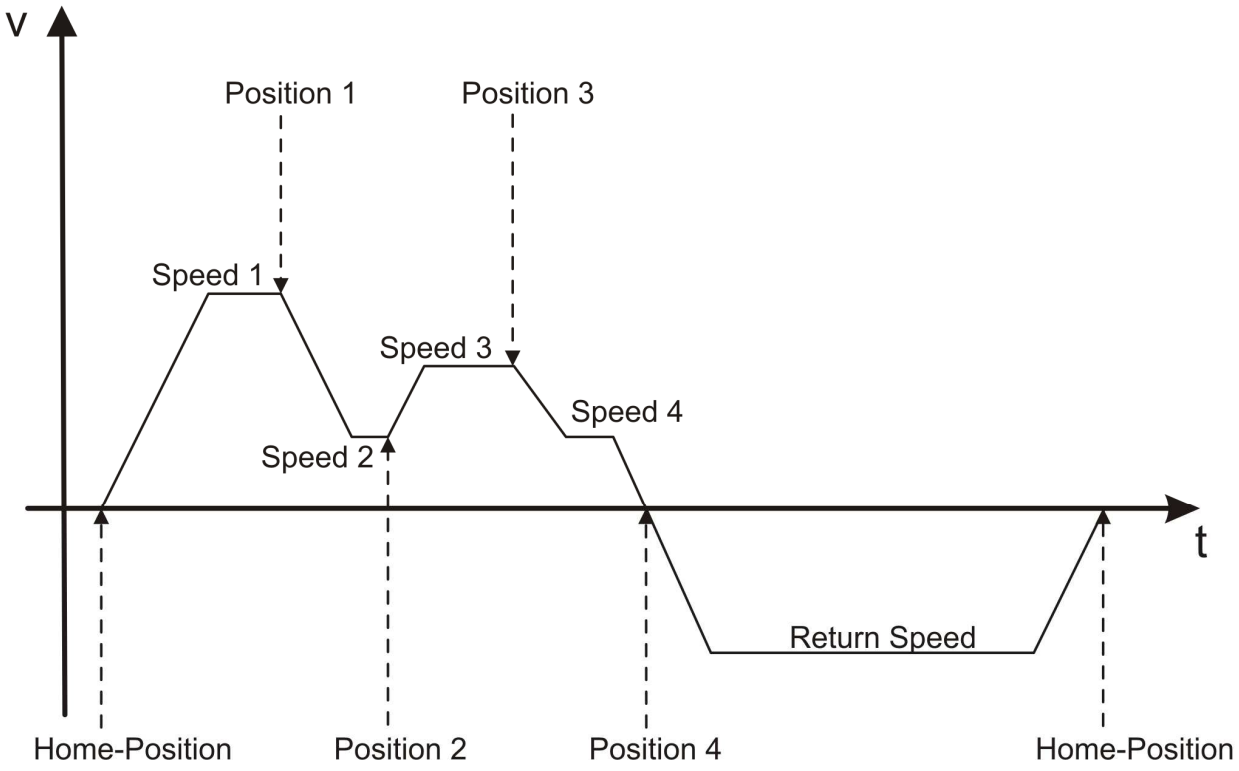
The additional saw axis is designed to control the movement of the saw blade while it cuts the material. For Example, it can be used to move the circular saw across the material line for cutting plates or sheets, or to move the saw blade (mounted to a vertical axis or a lever) up and down for cutting endless tubes or profiles.
The saw axis provides speed control (open loop) during the movement of the saw blade and closed-loop position control during standstill at home position or reversal position.



Operat. Mode Saw	Operation mode of additional saw axis: 0: Saw axis disabled (Analogue output "ANALOG OUT 2" can be used for diagnosis purpose, see parameter "Sel.Diag.Ana.Out") 1: Saw axis enabled, automatic start of saw axis: Saw axis movement starts automatically when the carriage has reached its cutting position and moves synchronous with the material line and the carriage automatically returns when the cut is finished (Input commands "Start Saw Axis" and "Cut Completed" are not required) 2: Saw axis enabled, manual start of saw axis: When the carriage has reached its cutting position with respect to the material and moves fully synchronous with the line, then output "Ready to Cut" is set to high. Then you must set input command "Start Saw Axis" to start the saw axis movement. When the saw axis has performed the cut and returned to its home position then output "Ready to Cut" is reset to low. Now you must set input command "Cut Completed" to return the carriage to its home position.(You can use this mode, for example, when clamping of carriage to the material during the cut is necessary)

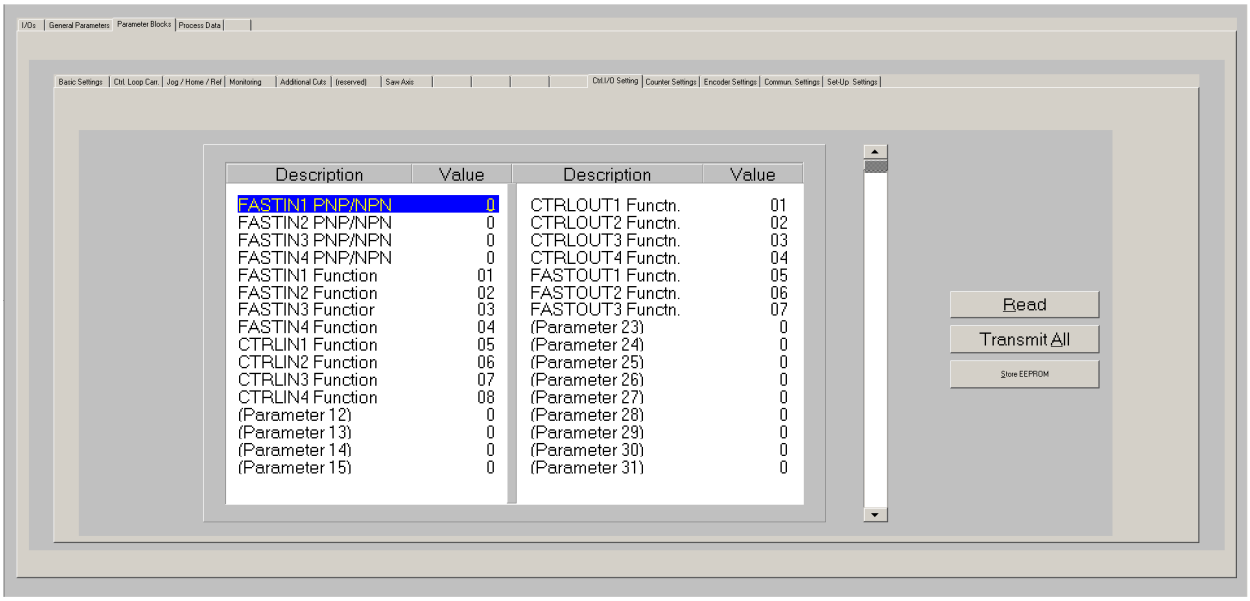
Pulses Saw / 1000	This register is for the encoder scaling of the saw axis. Set here the number of encoder pulses you receive when the saw axis moves 1000 length units (LU). Range 0-999 999 Please note, the length units selected for the saw axis can be different to the length units selected for the cutting length and carriage parameter settings. For example, if the circular saw is mounted to a lever instead of a linear axis, it is also possible to use 1° or 0.1° degree as length unit *for the saw axis*.
P-Gain Saw Axis	Proportional gain for the closed loop position control of the saw axis during standstill. Setting range: 0 – 9999, recommended settings: 500 – 2500.
Max. Corr. Saw	Limitation of the active correction signal resulting from the proportional position control loop. When the position 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
Freq. max. Speed	Feedback frequency of the saw axis encoder at full speed. Please enter here the pulse frequency you receive from the saw axis encoder when the saw axis runs with an analogue speed setpoint of 10 V. Setting range: 1 … 1000000 Hz
Ramp Time Saw	Acceleration and deceleration ramp time of the saw axis. Setting range 01 – 99 s with respect to speed changes between standstill and maximum speed.
(reserved)	-Not in use-
Speed 1	Speed setpoint of the saw axis between home position and Position 1 scaled in volts. Setting range 0.001 … 10.000 V
Position 1	Position of the saw scaled in length units (LU) where the speed setpoint of the saw changes from Speed 1 to Speed 2. Setting range: 1 … 999999 LU
Speed 2	Speed setpoint of the saw axis between Position 1 and Position 2 scaled in volts. Setting range 0.001 … 10.000 V
Position 2	Position of the saw scaled in length units (LU) where the speed setpoint of the saw changes from Speed 2 to Speed 3. Setting range: 1 … 999999 LU

Speed 3	Speed setpoint of the saw axis between Position 3 and Position 4 scaled in volts. Setting range 0.001 … 10.000 V
Position 3	Position of the saw scaled in length units (LU) where the speed setpoint of the saw changes from Speed 3 to Speed 4. Setting range: 1 … 999999 LU
Speed 4	Speed setpoint of the saw axis between Position 3 and Position 4 scaled in volts. Setting range 0.001 … 10.000 V
Position 4	Reversal position of the saw scaled in length units (LU). At this position the saw stops its forward movement and starts the return movement back to home position. Setting range: 1 … 999999 LU
Return Speed Saw	Speed setpoint of the saw axis for the return movement from Position 4 back to home position scaled in volts. Setting range 0.001 … 10.000 V
(Parameter 16 … 31)	-Not in use-



Speed profile of saw axis movement

4.3.8. Control I/O Settings

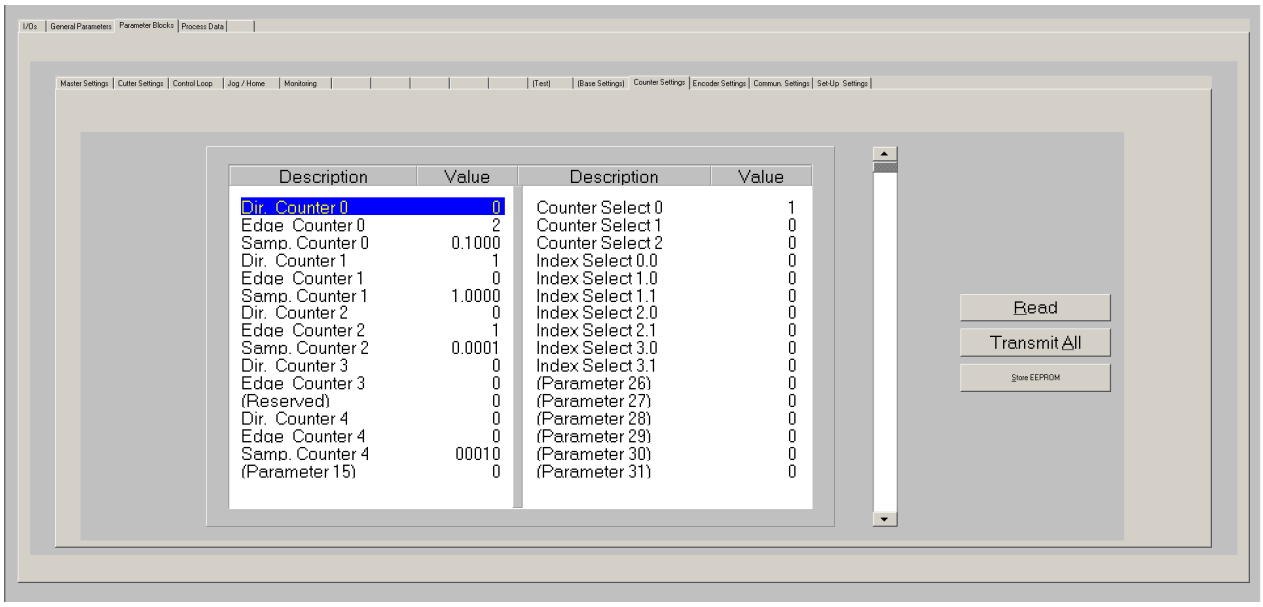


FASTIN1 PNP/NPN	Switching characteristics of control input FAST IN 1: **0:** PNP (switch to +10 … 30 V to set input, unconnected input is low) **1:** NPN (switch to GND to reset input; unconnected input is high)
FASTIN2 PNP/NPN	Switching characteristics of control input FAST IN 2: **0:** PNP (switch to +10 … 30 V to set input, unconnected input is low) **1:** NPN (switch to GND to reset input; unconnected input is high)
FASTIN3 PNP/NPN	Switching characteristics of control input FAST IN 3: **0:** PNP (switch to +10 … 30 V to set input, unconnected input is low) **1:** NPN (switch to GND to reset input; unconnected input is high)
FASTIN4 PNP/NPN	Switching characteristics of control input FAST IN 4: **0:** PNP (switch to +10 … 30 V to set input, unconnected input is low) **1:** NPN (switch to GND to reset input; unconnected input is high)
FASTIN1 Function	Fixed to 1 (FASTIN1 is used for printmark input. Function cannot be changed)
FASTIN2 Function	Function assignment for input FAST IN 2 Set here the number of the input command you want to assign to input FAST IN 2 (see table in chapter 4.1.1). Setting 0 assigns no function, i.e. input FAST IN 2 is disabled. Example: With FASTIN2 Function = 11 you can set the “Clear Error” command by input FASTIN2. Range: 0 … 30, factory default setting: 2
FASTIN3 Function	Function assignment for input FAST IN 3 (see explanation above) Range: 0 … 30, factory default setting: 3

FASTIN4 Function	Function assignment for input FAST IN 4 (see explanation above) Range: 0 … 30, factory default setting: 4
CTRLIN1 Function	Function assignment for input CTRL IN 1 (see explanation above) Range: 0 … 30, factory default setting: 5
CTRLIN2 Function	Function assignment for input CTRL IN 2 (see explanation above) Range: 0 … 30, factory default setting: 6
CTRLIN3 Function	Function assignment for input CTRL IN 3 (see explanation above) Range: 0 … 30, factory default setting: 7
CTRLIN4 Function	Function assignment for input CTRL IN 4 (see explanation above) Range: 0 … 30, factory default setting: 8
(Parameter 12…15)	-Not in use-
CTRLOUT1 Functn.	Function assignment for output CTRL OUT 1 Set here the number of the output signal you want to assign to output CTRL OUT 1 (see table in chapter 4.1.2) Setting 0 assigns no function, i.e. output CTRL OUT 1 is disabled. Example: When you set CTRLOUT1 Function = 08 then output CTRL OUT 1 provides the output signal "No Printmark". Range: 0 … 32, factory default setting: 1
CTRLOUT2 Functn.	Function assignment for output CTRL OUT 2 (see explanation above) Range: 0 … 32, factory default setting: 2
CTRLOUT3 Functn.	Function assignment for output CTRL OUT 3 (see explanation above) Range: 0 … 32, factory default setting: 3
CTRLOUT4 Functn.	Function assignment for output CTRL OUT 4 (see explanation above) Range: 0 … 32, factory default setting: 4
FASTOUT1 Functn.*	Function assignment for output FAST OUT 1 (see explanation above) Range: 0 … 32, factory default setting: 5
FASTOUT2 Functn.*	Function assignment for output FAST OUT 2 (see explanation above) Range: 0 … 32, factory default setting: 6
FASTOUT3 Functn.*	Function assignment for output FAST OUT 3 (see explanation above) Range: 0 … 32, factory default setting: 7
(Parameter 23…31)	-Not in use-

*) Only valid if parameter Fast Output Sel. = 7 (see chapter 4.3.121)!

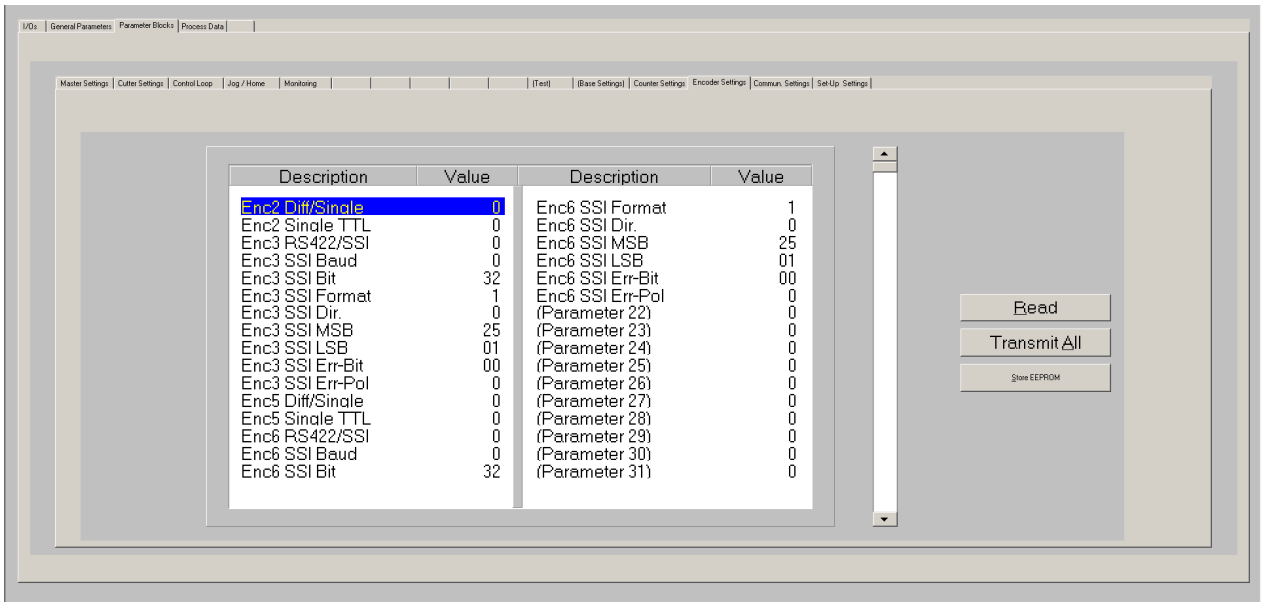
4.3.9. Counter Settings



Dir. Counter 0	Not in use with this application firmware
Edge Counter 0	
Samp. Counter 0	
Dir. Counter 1	Assigns the counting direction (up / down) of the line encoder input, depending on the quadrature A/B phase displacement. This parameter is found out and set best in the Adjust menu
Edge Counter 1	Determines the number of edges counted from the line encoder input: 0 = x 1, 1 = x 2, 2 = x 4
Samp. Counter 1	Provides digital filtering of the feed forward signal generated from the line encoder. Range 0.0001 – 9.9999 s; normal setting: 0.0010 (= 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 carriage 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.
Dir. Counter 2	Assigns the counting direction (up / down) of the carriage encoder input, depending on the quadrature A/B phase displacement. This parameter is found out and set best in the Adjust menu
Edge Counter 2	Determines the number of edges counted from the carriage encoder input: 0 = x1, 1 = x2 2 = x4

Samp. Counter 2	Not in use with this application firmware
Dir. Counter 3	Assigns the counting direction (up / down) of the virtual master. Should be set to 0.
Edge Counter 3	Determines the number of edges counted from the virtual master. Should be set to 0.
(reserved)	Not in use
Dir. Counter 4	Assigns the counting direction (up / down) of the saw axis encoder input, depending on the quadrature A/B phase displacement. This parameter is found out and set best in the Adjust menu
Edge Counter 4	Determines the number of edges counted from the saw axis encoder input: 0 = x1, 1 = x2 2 = x4
Samp. Counter 4	Not in use with this application firmware
(Parameter 15)	Not in use
Counter Select 0	Not in use with this application firmware
Counter Select 1	Must be set to 0
Counter Select 2	Must be set to 1
Index Select 0.0	Not in use with this application firmware
Index Select 1.0	This register selects the source of the print mark pulse. You are free to use either the RS422/TTL inputs on the encoder connectors or the 24V/HTL digital control input at terminal X4: 0: Print mark source is line encoder input X9, Pin 8 (Z) and 9 (/Z) 1: Print mark source is FAST IN 1 at terminal X4 pin 2
Index Select 1.1	Not in use with this application firmware
Index Select 2.0	Not in use with this application firmware
Index Select 2.1	Not in use with this application firmware
Index Select 3.0	Not in use with this application firmware
Index Select 3.1	Not in use with this application firmware
(Parameter 15…31)	Not in use

4.3.10. Encoder Settings

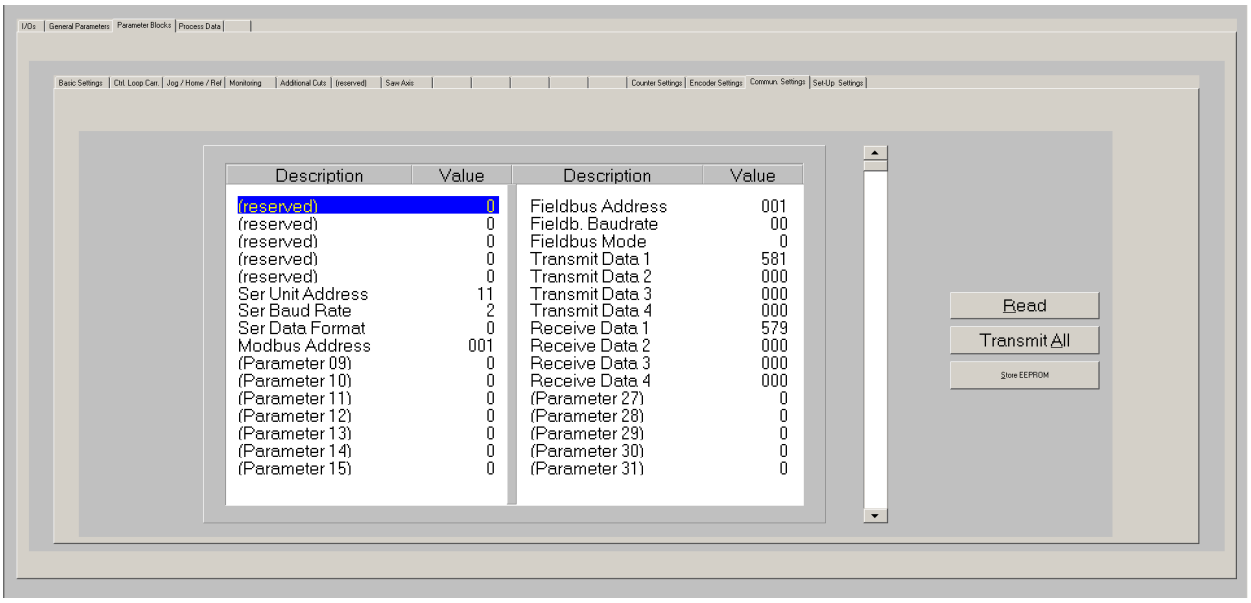


Enc2 Diff/Single	Line encoder pulse type: **0:** Differential pulses (2x90° with inverted signals: A, /A, B, /B) **1:** Single-ended pulses (2x90° without inverted signals: A, B)
Enc2 Single TTL	Line encoder pulse level: **0:** RS422/TTL pulses (5V) **1:** HTL (10…30V)
Enc3 RS422/SSI	Not in use with this application firmware
Enc3 SSI Baud	
Enc3 SSI Bit	
Enc3 SSI Format	
Enc3 SSI Dir.	
Enc3 SSI MSB	
Enc3 SSI LSB	
Enc3 SSI Err-Bit	
Enc3 SSI Err-Pol	
Enc5 Diff/Single	Carriage encoder pulse type: **0:** Differential pulses (2x90° with inverted signals: A, /A, B, /B) **1:** Single-ended pulses (2x90° without inverted signals: A, B)
Enc5 Single TTL	Carriage encoder pulse level: **0:** RS422/TTL pulses (5V) **1:** HTL (10…30V)

Enc6 RS422/SSI	Not in use with this application firmware
Enc6 SSI Baud	
Enc6 SSI Bit	
Enc6 SSI Format	
Enc6 SSI Dir.	
Enc6 SSI MSB	
Enc6 SSI LSB	
Enc6 SSI Err-Bit	
Enc6 SSI Err-Pol	
(Parameter 15…31)	-Not in use-

4.3.11. Communication settings

This register card sets the parameters for the communication interfaces

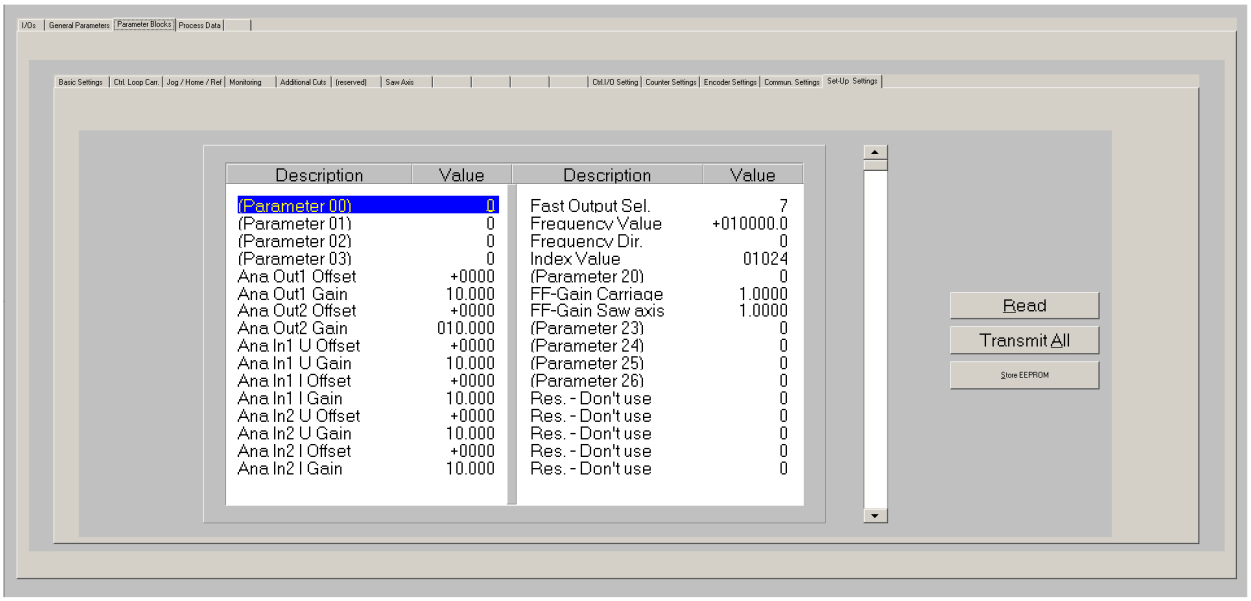


(reserved)	Parameters reserved for further use
Ser. Unit Address	Unit address for serial communication with standard Lecom protocol (used when DIL-switch 1 is set to off). Range 11 ... 99. Address numbers containing zeros like 01, 02, 03, ..., 10, 20, etc. are not permitted because these are reserved for broadcast messages (collective addressing of several units). Factory default address is always 11.
Ser. Baud Rate	Transmission rate of the serial interface 0: 38400 Bit/s 1: 19200 Bit/s 2: 9600 Bit/s (factory default setting) 3: 4800 Bit/s 4: 2400 Bit/s

Serial Data Format:	Data format of the serial interface			
	Setting:	**Data bits**	**Stop bits**	**Parity**
	0	**7**	**1**	**even**
	1	7	2	even
	2	7	1	odd
	3	7	2	odd
	4	7	1	none
	5	7	2	none
	6	8	1	even
	7	8	1	odd
	8	8	1	none
	9	8	2	none
	Factory default setting: 0			
Modbus Address	Node address for serial communication with Modbus RTU protocol (used when DIL-switch 1 is set to on). Range 1 ... 247.			
(Parameter 09…15)	-Not in use-			
Fieldbus Address **Fieldb. Baudrate** **Fieldbus Mode** **Transmit Data 1…4** **Receive Data 1…4**	Parameters for the optional fieldbus interface module. If you are using a fieldbus interface module, please refer to the corresponding manual for the setting of these parameters.			
(Parameter 27…31)	-Not in use-			

4.3.12. Setup Settings

These settings define hardware properties of inputs and outputs of the MC800 controller. You must only make settings for those functions that are really used and wired with this application.

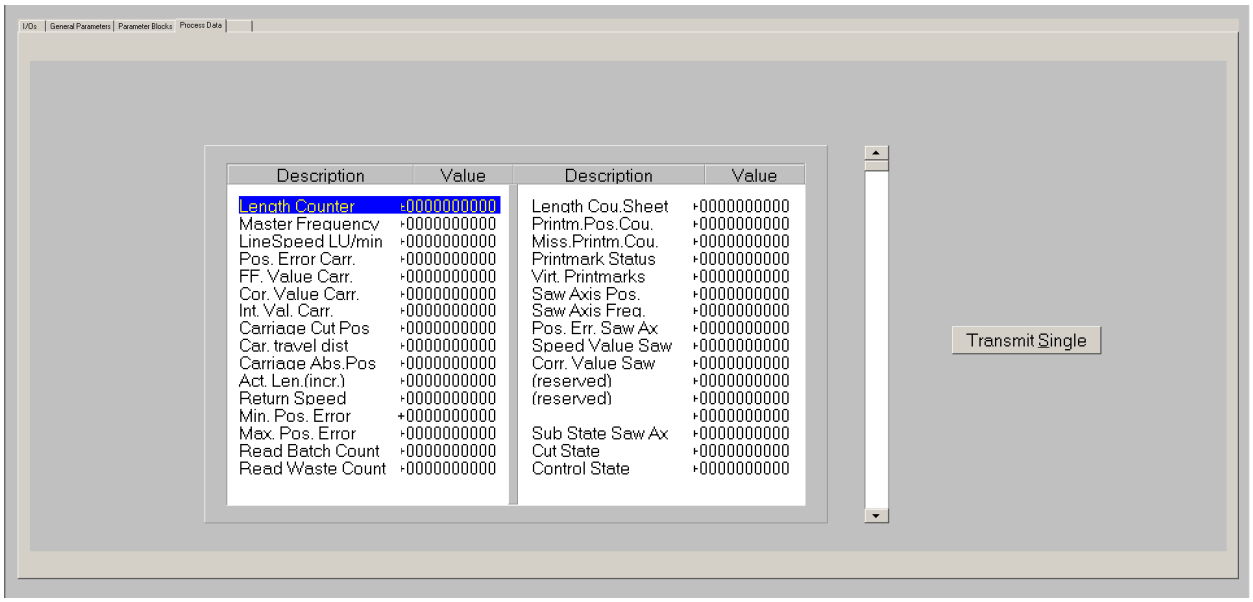


(Parameter 00)	-Not in use-	Parameters "FastIn…PNP/NPN" have been shifted to parameter block "Control I/O Settings" (see chapter 4.3.7)
(Parameter 01)	-Not in use-	
(Parameter 02)	-Not in use-	
(Parameter 03)	-Not in use-	
Ana Out1 Offset	Sets the zero position of the analog output ANALOG OUT 1 (carriage speed setpoint output) directly in Volts. Setting range -9999 mV … + 9999 mV The default setting is 0.	
Ana Out1 Gain	Sets the full-scale output of the analog output ANALOG OUT 1 (carriage speed setpoint output) directly in Volts. Setting range 0 … 99.999V, normal setting 10.000 V. (However, physically the max. output voltage is about 12 V)	
Ana Out2 Offset	Sets the zero position of the analog output ANALOG OUT 2 (saw axis speed setpoint output or diagnosis output) directly in mV. Setting range -9999 mV … + 9999 mV The default setting is 0.	
Ana Out2 Gain	Sets the full-scale output of the analog output ANALOG OUT 2 (saw axis speed setpoint output or diagnosis output) directly in Volts. Setting range 0 … 99.999V, normal setting 10.000 V. (However, physically the max. output voltage is about 12 V)	
Ana In1 U Offset	Not in use with this application firmware	
Ana In1 U Gain		
Ana In1 I Offset		
Ana In1 I Gain		
Ana In2 U Offset	Not in use with this application firmware	
Ana In2 U Gain		
Ana In2 I Offset		
Ana In2 I Gain		

Fast Output Sel.	Selects the source of the output signal appearing at FAST OUT 1…3 at connector X6, used for cascading and other purpose: 0: The output signal is the virtual master frequency 1: The output signal is the signal applied to encoder input SINCOS IN 1 at connector X1 (not in use with this application firmware) 2: The output signal is the signal applied to line encoder input INC IN 1 at connector X9 3: The output signal is the signal applied to encoder input SSI IN 1 at connector X10 (not in use with this application firmware) 4: The output signal is the signal applied to encoder input SINCOS IN 2 at connector X2 (not in use with this application firmware) 5: The output signal is the signal applied to carriage encoder input INC IN 2 at connector X7 6: The output signal is the signal applied to saw axis encoder input SSI IN 2 at connector X8 7: Control output signals as assigned by parameter "FASTOUT1 Functn.", "FASTOUT2 Functn." and "FASTOUT3 Functn." (see chapter 4.1.23.7)
Frequency Value	-For factory testing purpose only-
Frequency Dir.	Not in use
Index Value	Index distance of the virtual master: Generates a virtual marker pulse every xxxxx virtual encoder pulses. Range 10 – 65535
(Parameter 20)	Not in use
FF-Gain Carriage	Gain for the feed forward speed signal of the carriage, calculated from the master encoder frequency. Range 0.0001…9.9999 This parameter is found out and set in the Adjust menu.
FF-Gain Saw axis	Must be set to 1.0000
(Parameter 23…26)	Not in use
Res. – Don't use	Reserved, please don't use!

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 8.

5. Error messages

Upon detection of an error, carriage and saw axis remains in a closed-loop standstill position after termination of the current cut. Output “Error” switches to HIGH. Where your PC with OS5.1 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 command “Clear Error” or
- switch off the “Control Enable” input 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: Hardware Error	An error was detected when checking the internal Hardware. This error appears in the display only but will not stop the carriage or saw axis. 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: Cut not possible	A cut is declared as "not possible" when the carriage already should start into forward direction before it has fully returned to Home position from the previous cut. This, in general, will happen with too short cutting lengths at too high line speed.
Error 03: Limit Switch	This error indicates that during automatic cutting operation the rear software limit switch has been touched. See drawing and explanation at parameter "Min. Pos. Carr."
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 carriage home position.
Error 05: Val. Range exceed	The ratio between the number of line encoder pulses and the number of carriage encoder pulses is outside the permitted range (see section 2.3 "system configuration")
Error 06: No Homing	Homing sequence has not been performed Only applicable when homing sequence is mandatory before start of cutting operation (Parameter "Homing Interlock" = 1)
Error 07: Software Error	Malfunction of firmware (Unexpected state of the firmware during operation)
Error 08	(reserved)
Error 09: Watchdog Error	Malfunction of firmware (Cycle time too long during operation, software probably stuck)
Error 10…14: Supply Error	Internal power supply voltage out of range
Error 15: Over temperature	Internal temperature too high
Error 16 … 30	(reserved)
Error 31: Anybus Error	Error of optional fieldbus interface module

6. 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 carriage drive and the saw axis drive need 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 it is recommended to mechanically disconnect the motor shaft from the carriage, so you can run the motor continuously and need not to observe the mechanical limitations of the carriage.
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 feed forward signal and the Proportional Gain. Also, the screen displays the actual encoder frequency.

Please note: **For the adjustment procedure, the carriage drive will always use the virtual master axis as reference, independent of the input "Select Virtual Master".**

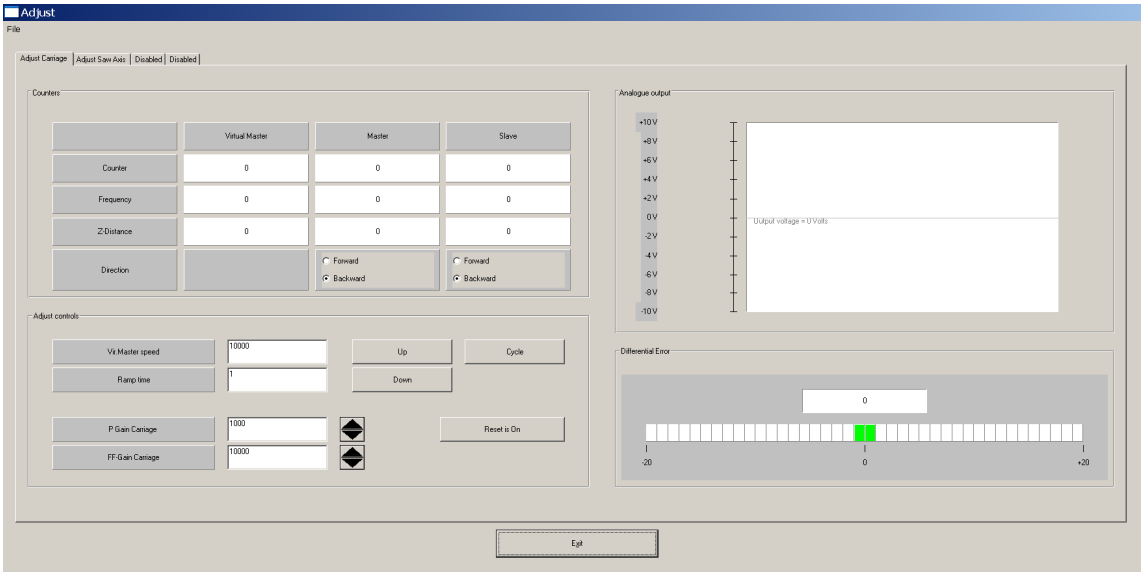
6.1. Preparations

Use register card "Adjust Carriage" to set up the carriage drive and register card "Adjust Saw Axis" to set up the saw axis drive (all other register cards in the Adjust-menu are disabled). First do the direction set-up for the master, then the complete set-up procedure for the carriage and then for the saw axis (if used).

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

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. We recommend using 50% of the maximum line speed for the 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.
- FF-Gain: Start with the default value of 10000.



6.2. Direction of Rotation

This definition must be met for the master (line encoder) and for both slave axis (carriage encoder and saw axis encoder).

Master:

- Disable the carriage drive and saw axis drive.
- 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:

- Enable your slave drive, i. e carriage drive when using "Adjust Carriage" or saw axis drive when using "Adjust Saw Axis".
- 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 carriage or saw axis, respectively: Does it move into forward direction? If it does not, the polarity of the analog speed reference is not correct or the direction setting of the drive is wrong and needs to be changed. The carriage or saw axis, respectively, must run forward with a positive analogue speed setpoint.
- Now observe the counter in the "Slave" column. It also must count up (increment). Where you find it counts down, please click to the other direction box (Forward or Reverse) to force it to upwards count.
- Once it counts up, click to the "Down" key to stop the drive again. The definition of direction of rotation is finished now.

Only when all counters count up while the encoders are moving forward, the definition of the encoder directions is correct! This is essential for the correct function of the device.

In “Adjust Carriage” the window “Z-Distance” shows the number of encoder pulses between two marker pulses of the correspondent encoder:

- “Z-Distance” in the Master column shows the distance between two printmark pulses or between two Z-pulses of the line encoder (depends on parameter “Index Select 1.0”)
- “Z-Distance” in the Slave column shows the distance between two Z pulses of the carriage encoder (provided that the Z pulse is wired and connected)

This provides a useful test for correct wiring of the encoder channels.
(Unfortunately this feature is not possible for the saw axis encoder)

6.3. Tuning the feed forward signal

This step is only necessary for the carriage:

- 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 colour bar and the differential counter in the field “Differential Error”. There are two possibilities:
  a. The bar graph moves to the right and the counter counts up (+):
     This indicates that the feed forward signal is too low. Please increase the setting of “FF-Gain” by overtyping the figures or by scrolling up with the arrow key.
  b. The bar graph moves to the left and the counter counts down (-):
     This indicates that the feed forward signal is too high. Please decrease the setting of “FF-Gain” by overtyping the figures or by scrolling down with the arrow key.
     “Feed Forward Gain” is set correctly when the bar graph remains in its centre 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.

6.4. Setting of the proportional Gain

This step is only necessary for the carriage:
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 P 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 for all axes, you can leave the Adjust menu by pressing the “Exit” button.

6.5. Tuning the controller

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

If you do not use the saw axis and you cannot get the "Cut completed" signal during commissioning (e. g. because the carriage drive is mechanically disconnected to the machine), it is legal to link the "Ready to cut" output directly to the "Cut completed" input.
This however is allowed for testing purpose without material only!
To do this, set parameter "Edge Sense" to 0 and "Sync Time" to the desired synchronous time. The carriage will then start the return cycle after lapse of this synchronous time, regardless of the tool position.

- Set the "Control Enable" input to HIGH to enable the controller
- Use the Jog function to put the carriage to the desired Home position. Where your software limit switches should bar you from reaching the position, keep input "Set Ref. Pos. Car." HIGH. This will prevent limitation by the software switches because the counter for the carriage position is kept to zero.
- Make sure that – with respect to your definition of the zero position – your software limit switches are set correctly, so that the carriage can move inside the designated travelling range, but cannot leave it.
- 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: Switch input "Select Virtual Master" ON while input "Start/Stop" is still LOW (Stop) and set the line speed to be simulated at register "Virt. Line Speed". Then set input "Run Virtual Master" to HIGH to start the virtual master. The line simulation will work now.
- Activate input "Immediate Cut" and see how the controller executes a first cutting cycle.
- Switch the Start/Stop input to HIGH. The carriage 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 carriage.
- Observe the display of the "Pos. Err. Carr." (position error of the carriage). During the whole cutting cycle the position error should not exceed values like 30 and should oscillate around zero all the time. Increase the line speed step by step and continue the observations
- If during forward acceleration position error takes high positive values, this indicates that the carriage drive cannot follow the acceleration ramp and you should decrease the "Acceleration 1" setting. The same is valid for "Acceleration 2", when during reverse acceleration you observe high negative errors.

- Where you find your position error remains small enough all the time, you are free to increase the Acceleration settings. This will cause steeper ramps and increase your total cutting output.

When you have achieved settings to keep the position error around zero 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 the position error indicates 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: Position errors will not affect the cutting accuracy, unless they occur directly during the cut.

At this time you can try to optimize also other settings:

- Reduce "Cut Window" to e.g. 20 and change "I-Time" to e.g.30. This would be a very typical practical setting.
- Increase the setting of "Return Speed" to save time with the fly back of the carriage. If necessary, the carriage then will take higher return speed, which increases again the total cutting output.
- Increase the "Acceleration" settings as far as more dynamic motion is desirable and the drive can follow.
- Keep the cutting time (penetration time of the tool or saw blade) as short as possible to achieve maximum efficiency

This concludes the procedure of commissioning of your flying shear system. We recommend saving all parameter settings in a file. 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.

7. Accuracy and Limitations of the Cutting System

7.1. Accuracy considerations

It is easy to understand that the controller functions are based on correct information from the encoders. When you observe the position error of the carriage at the moment when a cut takes place, you can easily see what the theoretical cutting error can be. In practical applications, with the drive and the unit properly adjusted, the cutting error should be limited to approximately 5 encoder increments and the resolution of the encoders will provide the real error expressed in length units.

Where you find the real cutting errors are higher than indicated by the position error, it is absolutely sure that there are external reasons, and you should check for the following items:

- Do feed roll or the measuring wheel slip?
- Is the measuring wheel not exactly orthogonal to the material surface or to the direction of the line, or is it not exactly round, or is there tolerance in diameter?
- Is there any length change of the material between the measuring wheel and the position where the cut takes place (i.e. shrinking of hot material that cools down or stretching due to mechanical deformation prior to cut)?
- Is the line speed stable and does not oscillate?
- Is there clearance or backlash of the carriage drive or the cutting tool etc.?
- EMC: Is there noise on the line encoder signal or the carriage encoder signal? Noise on the encoder signals can cause cutting errors as well. Noise on the carriage encoder signal can easily be detected because it causes the home position of the carriage to shift. Noise on the line encoder signal can be detected by reading the "Z-Distance" field in the Adjust menu. This window must always contain the number of pulses of the line encoder (including multiple edge count). If the content of this register varies by more than +/- 1 encoder increment there is noise on the line encoder signal that involves cutting errors.

  Using this function requires the Z and Z' outputs of the line encoder to be connected
- Is the synchronous ratio correct?

  An incorrect synchronous ratio (values of parameters "Pulses Line/1000" or "Pulses Cut/1000" incorrect) can cause considerable cutting errors that are particularly big with changes of the line speed.

If all of the above points have been checked and eliminated the remaining cutting errors can basically consist of two components: The electronic cutting error caused by the controller and the error caused by the length measurement (slip of the measuring wheel etc.). There is a fundamental difference between these two errors: The electronic error is independent of the cutting length, and the length measurement error is proportional to the cutting length.

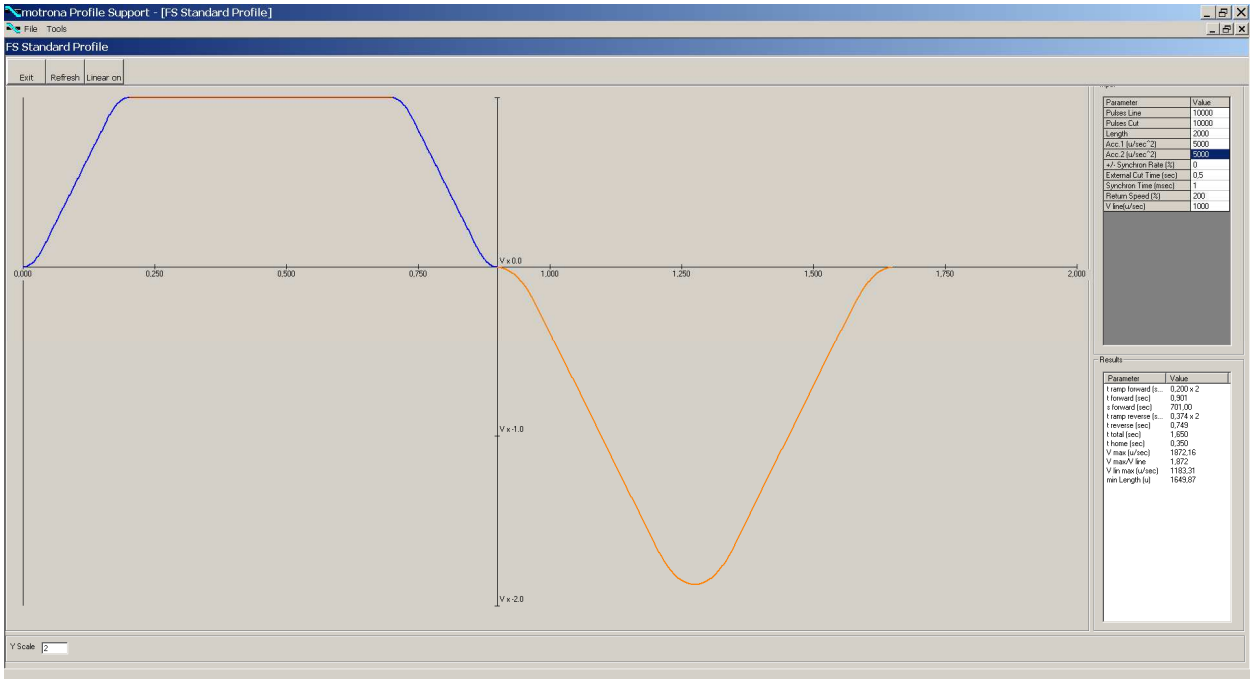
For a rough estimation of the electronic accuracy, also the actual values “Min. Pos. Error” and “Max. Pos. Error” can be used. They record the maximum position error of the carriage between the signals “Ready to Cut” and “Cut completed” (the units are “encoder increments” of the carriage encoder which must be converted to length units correspondingly).

7.2. Limitations of cutting length and line speed

Flying shears have physical limitations with respect to short cutting length at high line speeds, i.e. not every length can be cut at any line speed. This should be shown by the following example:

When you would need to cut pieces of 1 meter length at a line speed of 60 meters/minute, this means the machine must execute one cut every second. If our saw blade would take one full second to perform the cut, it is easy to understand that this cannot work (There is no time left to accelerate, decelerate and return to home position).

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



8. Parameter Tables

General Parameters							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
1	Cutting Length	Length units	0000	0	1	999999	10000
2	Test Cut. Length	Length units	0001	1	1	999999	10000
3	Virt. Line Speed	Length units/min.	0002	2	0	9999999	10000
4	(reserved)		0003	3	-999999	+999999	0
5	(Parameter 04)		0004	4	0	0	
…	…		…	…			
32	(Parameter 31)		001F	31	0	0	0

= Consecutive register number for access via optional fieldbus interface

Subcodes for serial communication are always 0.

Parameter Blocks							
Basic Settings							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
33	Pulses Line / 1000	Incr.	0100	256	1	999999	1000
34	Pulses Car. / 1000	Incr.	0101	257	1	999999	1000
35	Acceleration 1	Len. units / s²	0102	258	0	9999999	1000
36	Acceleration 2	Len. units / s²	0103	259	1	9999999	1000
37	Ramp Form Carr.		0104	260	0	15	0
38	+/- Sync Rate	%	0105	261	-99.00	+300.00	0.00
39	Rel. Return Speed		0106	262	0	9.99	1.00
40	Edge Sense		0107	263	0	1	0
41	Synchron Time	ms	0108	264	1	9999	1
42	Cut Window	Length units	0109	265	1	99	50
43	Sync Samples		010A	266	1	9999	1
44	Tool Width	Length units	010B	267	0	999	0
45	Cutting Mode		010C	268	1	3	1
46	Photocell -> Cut	Length units	010D	269	1	999999	1000
47	Gap Length	Length units	010E	270	-9999	9999	0
48	Gap Time	ms	010F	271	10	9999	10

Continued on next page

Basic Settings (continued)							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
49	Ramp Vir. Master	s	0110	272	0	999	1
50	Set Length Cou (Ps)	Increments	0111	273	0	0	0
51	Set Length Cou (LU)	Length units	0112	274	0	99999999	0
52	Printmark Edge		0113	275	0	999999	0
53	Virt. Printmarks		0114	276	0	1	0
54	Deceleration 1	Len. units / s²	0115	277	0	9999999	1000
55	Deceleration 2	Len. units / s²	0116	278	1	9999999	1000
56	Printmark Offset	Length units	0117	279	-99999	+99999	0
57	Photocell Delay	ms	0118	280	000.0	500.0	0
58	Printm. per Length		0119	281	0	99	0
59	Printmark Window	Length units	011A	282	0	9999	0
60	Missing Printmarks		011B	283	0	99	0
61	Abs. Return Speed	Len. units/min	011C	284	1	9999999	1000
62	Synchron Mode		011D	285	0	2	0
63	Optimized Return		011E	286	0	1	0
64	(Parameter 31)		011F	287	0	0	0

Ctrl. Loop Carr.							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
65	P-Gain Carriage		0120	288	0	9999	1000
66	I Time Carriage	s	0121	289	0.000	9.999	0.000
67	Max. Corr. Carr.	mV	0122	290	1	9999	9999
68	Max. Line Speed	Len. units/min.	0123	291	1	9999999	100000
69	(Parameter 04)		0124	324	0	0	0
…	…		…	…			
96	(Parameter 31)		013F	351	0	0	0

Jog / Home / Ref.							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
97	Home Window Carr.	Length units	0140	320	1	999	100
98	Min. Pos. Carr.	Length units	0141	321	-999999	0	-999999
99	Max. Pos. Carr.	Length units	0142	322	0	999999	999999
100	Alarm Pos. Carr.	Length units	0143	323	0	999999	999999
101	Jog Speed Forw.	%	0144	324	000.1	100.0	10.0
102	Jog Ramp Up Forw.	s	0145	325	0	99	1
103	Jog Ramp Dw. Forw.	s	0146	326	0	99	1
104	Jog Speed Rev.	%	0147	327	000.1	100.0	10.0
105	Jog Ramp Up Rev.	s	0148	328	0	99	1
106	Jog Ramp Dw. Rev.	s	0149	329	0	99	1
107	Homing Speed Hi.	%	014A	330	000.1	100.0	005.0
108	Homing Speed Low	%	014B	331	000.1	100.0	010.0
109	Homing Ramp	s	014C	332	0	99	1
110	Home Distance	Length units	014D	333	0	99999	100
111	Homing Interlock		014E	334	0	1	0
112	(Parameter 15)		014F	335	0	0	0
113	Home Window Saw	Length units	0150	336	1	999	100
114	Jog Speed Saw	%	0151	337	000.1	100.0	10.0
115	Jog Ramp Saw	s	0152	338	0	99	1
116	Homg.Spd.Hi. Saw	%	0153	339	000.1	100.0	005.0
117	Homg.Spd.Low Saw	%	0154	340	000.1	100.0	010.0
118	Homing Ramp Saw	s	0155	341	0	99	1
119	Home Dist. Saw	Length units	0156	342	0	99999	100
120	(Parameter 23)		0157	343	0	0	0
	...		...	...			
128	(Parameter 31)		015F	351	0	0	0

Monitoring							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
129	Zero Speed Master	Len. units/min.	0160	352	0	999999	0
130	Zero Speed Vir. Ma.	Len. units/min.	0161	353	0	999999	0
131	Master Rev. Limit	Length units	0162	354	0	99999	0
132	Sel.Diag.Ana.Out		0163	355	0	31	0
133	Cam Distance	Length units	0164	356	0	999999	0
134	Cam Pulse Width	ms	0165	357	1	999	100
135	Cam Delay Time	ms	0166	358	0	999	0
136	(Parameter 07)		0167	359			
	…		…	…	0	0	0
144	(Parameter 15)		016F	367	0	0	0
145	Batch Counter		0170	368	0	999999999	0
146	Waste Counter		0171	369	0	999999999	0
147	(Parameter 18)		0172	370	0	0	0
	…		…	…			
160	(Parameter 31)		017F	383	0	0	0

Additional Cuts							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
161	Additional Cuts		0180	384	0	3	0
162	Add. Cut 1 Length	Length units	0181	385	0	999999	0
163	Add. Cut 2 Length	Length units	0182	386	0	999999	0
164	Add. Cut 3 Length	Length units	0183	387	0	999999	0
165	(Parameter 04)		0184	388	0	0	0
	…		…	…			
192	(Parameter 31)		019F	415	0	0	0

Advanced Setting							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
193	Min. Travel Dist.	Length units	01A0	416	0	999999	0
194	Return Duty Cycle		01A1	417	0.01	0.99	0.90
195	Acc. 1 Ramp Dist.	Length units	01A2	418	0	99999	0
196	Dec. 1 Ramp Dist	Length units	01A3	419	0	99999	0
197	(Parameter 04)		01A4	420	0	0	0
	…		…	…			
224	(Parameter 31)		01BF	447	0	0	0

Saw Axis							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
225	Operat. Mode Saw		01C0	448	0	2	0
226	Pulses Saw / 1000	Incr.	01C1	449	1	999999	10000
227	P-Gain Saw Axis		01C2	450	0	9999	1000
228	Max. Corr. Saw	mV	01C3	451	0	9999	9999
229	Freq. Max. Speed	Hz	01C4	452	1	1000000	100000
230	Ramp Time Saw	s	01C5	453	0	99	1
231	(reserved)		01C6	454	0	0	0
232	Speed 1	V	01C7	455	0.001	10.000	1.000
233	Position 1	Length units	01C8	456	1	999999	1000
234	Speed 2	V	01C9	457	0.001	10.000	2.000
235	Position 2	Length units	01CA	458	1	999999	2000
236	Speed 3	V	01CB	459	0.001	10.000	3.000
237	Position 3	Length units	01CC	460	1	999999	3000
238	Speed 4	V	01CD	461	0.001	10.000	4.000
239	Position 4	Length units	01CE	462	1	999999	4000
240	Return Speed Saw	mV	01CF	463	0.001	10.000	5.000
241	(Parameter 16)		01D0	464	0	0	0
	…		…	…			
256	(Parameter 31)		01DF	479	0	0	0

Control I/O Settings							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
385	FASTIN1 PNP/NPN		0260	608	0	1	0
386	FASTIN2 PNP/NPN		0261	609	0	1	0
387	FASTIN3 PNP/NPN		0262	610	0	1	0
388	FASTIN4 PNP/NPN		0263	611	0	1	0
389	FASTIN1 Function		0264	612	1	1	1
390	FASTIN2 Function		0265	613	0	30	2
391	FASTIN3 Function		0266	614	0	30	3
392	FASTIN4 Function		0267	615	0	30	4
393	CTRLIN1 Function		0268	616	0	30	5
394	CTRLIN2 Function		0269	617	0	30	6
395	CTRLIN3 Function		026A	618	0	30	7
396	CTRLIN4 Function		026B	619	0	30	8
397	(Parameter 12)		026C	620	0	0	0
398	(Parameter 13)		026D	621	0	0	0
399	(Parameter 14)		026E	622	0	0	0
400	(Parameter 15)		026F	623	0	0	0
401	CTRLOUT1 Functn.		0270	624	0	32	1
402	CTRLOUT2 Functn.		0271	625	0	32	2
403	CTRLOUT3 Functn.		0272	626	0	32	3
404	CTRLOUT4 Functn.		0273	627	0	32	4
405	FASTOUT1 Functn.		0274	628	0	32	5
406	FASTOUT2 Functn.		0275	629	0	32	6
407	FASTOUT3 Functn.		0276	630	0	32	7
408	(Parameter 23)		0277	631	0	0	0
...	...		...	...			
416	(Parameter 31)		027F	639	0	0	0

Counter Settings							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
417	Dir. Counter 0		0280	640	0	1	0
418	Edge Counter 0		0281	641	0	2	0
419	Samp. Counter 0	s	0282	642	0.0001	9.9999	0.0010
420	Dir. Counter 1		0283	643	0	1	0
421	Edge Counter 1		0284	644	0	2	0
422	Samp. Counter 1	s	0285	645	0.0001	9.9999	0.0010
423	Dir. Counter 2		0286	646	0	1	0
424	Edge Counter 2		0287	647	0	2	0
425	Samp. Counter 2	s	0288	648	0.0001	9.9999	0.0010
426	Dir. Counter 3		0289	649	0	1	0
427	Edge Counter 3		028A	650	0	2	0
428	(Reserved)		028B	651	0	0	0
429	Dir. Counter 4		028C	652	0	1	0
430	Edge Counter 4		028D	653	0	2	0
431	Samp. Counter 4	s	028E	654	0.0001	9.9999	0.0010
432	(Parameter 15)		028F	655	0	0	0
433	Counter Select 0		0290	656	0	1	0
434	Counter Select 1		0291	657	0	1	0
435	Counter Select 2		0292	658	0	1	0
436	Index Select 0.0		0293	659	0	3	0
437	Index Select 1.0		0294	660	0	1	0
438	Index Select 1.1		0295	661	0	3	0
439	Index Select 2.0		0296	662	0	1	0
440	Index Select 2.1		0297	663	0	3	0
441	Index Select 3.0		0298	664	0	3	0
442	Index Select 3.1		0299	665	0	1	0
443	(Parameter 26)		029A	666	0	0	0
...	...		...	...			
448	(Parameter 31)		029F	671	0	0	0

Encoder Settings							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
449	Enc2 Diff/Single		02A0	672	0	1	0
450	Enc2 Single TTL		02A1	673	0	1	0
451	Enc3 RS422/SSI		02A2	674	0	1	0
452	Enc3 SSI Baud		02A3	675	0	3	0
453	Enc3 SSI Bit		02A4	676	8	32	32
454	Enc3 SSI Format		02A5	677	0	1	1
455	Enc3 SSI Dir.		02A6	678	0	1	0
456	Enc3 SSI MSB		02A7	679	2	32	25
457	Enc3 SSI LSB		02A8	680	1	31	01
458	Enc3 SSI Err-Bit		02A9	681	0	32	0
459	Enc3 SSI Err-Pol		02AA	682	0	1	0
460	Enc5 Diff/Single		02AB	683	0	1	0
461	Enc5 Single TTL		02AC	684	0	1	0
462	Enc6 RS422/SSI		02AD	685	0	1	0
463	Enc6 SSI Baud		02AE	686	0	3	0
464	Enc6 SSI Bit		02AF	687	8	32	32
465	Enc6 SSI Format		02B0	688	0	1	1
466	Enc6 SSI Dir.		02B1	689	0	1	0
467	Enc6 SSI MSB		02B2	690	2	32	25
468	Enc6 SSI LSB		02B3	691	1	31	01
469	Enc6 SSI Err-Bit		02B4	692	0	32	0
470	Enc6 SSI Err-Pol		02B5	693	0	1	0
471	(Parameter 22)		02B6	694	0	0	0
...	...		...	...			
480	(Parameter 31)		02BF	703	0	0	0

Communication Settings							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
481	(reserved)		02C0	704	001	127	001
	…						
485	(reserved)		02C4	708	000	255	000
486	Ser Unit Address		02C5	709	11	99	11
487	Ser Baud Rate		02C6	710	0	4	2
488	Ser Data Format		02C7	711	0	9	0
489	Modbus Address		02C8	712	1	247	1
490	(Parameter 09)		02C9	713	0	0	0
…	…		…	…			
496	(Parameter 15)		02CF	719	0	0	0
497	Fieldbus Address		02D0	720	1	127	1
498	Fieldb. Baudrate		02D1	721	0	63	6
499	Fieldbus Mode		02D2	722	0	1	0
500	Transmit Data 1		02D3	723	0	594	581
501	Transmit Data 2		02D4	724	0	594	0
502	Transmit Data 3		02D5	725	0	594	0
503	Transmit Data 4		02D6	726	0	594	0
504	Receive Data 1		02D7	727	0	594	579
505	Receive Data 2		02D8	728	0	594	0
506	Receive Data 3		02D9	729	0	594	0
507	Receive Data 4		02DA	730	0	594	0
508	(Parameter 27)		02DB	731	0	0	0
…	…		…	…			
512	(Parameter 31)		02DF	735	0	0	0

Setup-Up Settings							
#	Name	Unit	Serial Code		Minimum	Maximum	Default
			(Hex)	(Dec)			
513	(Parameter 00)		02E0	736	0	0	0
514	(Parameter 01)		02E1	737	0	0	0
515	(Parameter 02)		02E2	738	0	0	0
516	(Parameter 03)		02E3	739	0	0	0
517	Ana Out1 Offset	mV	02E4	740	-9999	+9999	0
518	Ana Out1 Gain		02E5	741	0	99.999	10.000
519	Ana Out2 Offset	mV	02E6	742	-9999	+9999	0
520	Ana Out2 Gain		02E7	743	0	99.999	10.000
521	Ana In1 U Offset	mV	02E8	744	-9999	+9999	0
522	Ana In1 U Gain		02E9	745	0	99.999	10.000
523	Ana In1 I Offset	µA	02EA	746	-9999	+9999	0
524	Ana In1 I Gain		02EB	747	0	99.999	10.000
525	Ana In2 U Offset	mV	02EC	748	-9999	+9999	0
526	Ana In2 U Gain		02ED	749	0	99.999	10.000
527	Ana In2 I Offset	µA	02EE	750	-9999	+9999	0
528	Ana In2 I Gain		02EF	751	0	99.999	10.000
529	Fast Output Sel.		02F0	752	0	7	7
530	Frequency Value	Hz	02F1	753	1	500000	100000
531	Frequency Dir.		02F2	754	0	1	0
532	Index Value		02F3	755	10	65535	1024
533	(Parameter 20)		02F4	756	0	0	0
534	FF-Gain Cutter		02F5	757	0.0001	1.0000	9.9999
535	FF-Gain Feeder		02F6	758	0.0001	1.0000	9.9999
536	(Parameter 23)		02F7	759	0	0	0
	…		…	…			
539	(Parameter 26)		02FA	762	0	0	0

Process Data (Actual values)						
#	Name	No.*	Unit	Serial Code		Explanation
				(Hex)	(Dec)	
545	Length Counter	0	Incr.	0800	2048	Material Length Counter (Line Encoder)
546	Master Frequency	1	Hz	0801	2049	Frequency of Line Encoder
547	Line Speed	2	LU / min.	0802	2050	Line Speed
548	Pos. Error Carr.	3	Incr.	0803	2051	Actual carriage position error
549	FF. Value Carr.	4		0804	2052	Internal value for feed forward set point of carriage
550	Corr. Value Carr.	5		0805	2053	Proportional correction set point of carriage
551	Int. Val. Carr.	6		0806	2054	Integral correction set point of carriage
552	Carriage Cut Pos	7	Incr.	0807	2055	Carriage position counter during cut cycle (related to home position)
553	Car. travel dist.	8	Incr.	0808	2056	Carriage travel distance during cut cycle
554	Carriage Abs.Pos	9	Incr.	0809	2057	Carriage absolute position counter (related to zero position)
555	Act. Len. (incr.)	10	Incr.	080A	2058	Actual cutting length
556	Return Speed	11	Incr. / s	080B	2059	Speed of carriage return movement
557	Min. Pos. Error	12	Incr.	080C	2060	Minimum and maximum position error of the carriage during cut
558	Max. Pos. Error	13	Incr.	080D	2061	
559	Read Batch Count	14		080E	2062	Batch counter value (read only)
560	Read Waste Count	15		080F	2063	Waste counter value (read only)
561	Length Cou. Sheet	16	Incr.	0810	2064	Length Counter within one sheet
562	Printm. Pos. Cou.	17	Incr.	0811	2065	Counter for printmark position
563	Miss. Printm. Cou.	18		0812	2066	Counter for missing printmarks
564	Printmark Status	19		0813	2067	State of printmark operation
565	Virt. Printmarks	20		0814	2068	Number of virtual printmarks
566	Saw Axis Position	21	Incr.	0815	2069	Counter for saw axis position
567	Saw Axis Freq.	22	Hz	0816	2070	Actual frequency of saw axis encoder
568	Pos. Error Saw	23	Incr.	0817	2071	Actual saw axis position error at standstill (closed loop position control)
569	Speed Value Saw	24	mV	0818	2072	Speed signal of saw axis
570	Corr. Value Saw	25	mV	0819	2073	Correction signal of saw axis
571	(reserved)	26				(reserved for further use)
572	(reserved)	27				(reserved for further use)
573	Homing state	28		081C	2076	Actual state of the homing sequence
574	Sub State Saw	29		081D	2077	Actual state of saw axis movement.
575	Cut State	30		081E	2078	Actual state of carriage movement.
576	Control State	31		081F	2079	Actual main state of controller

*) Used for setting of parameter “Sel.Diag.Ana.Out” in parameter block “Monitoring”

Status of Commands, Outputs and Errors				
#	Description	Serial Code		Bit No. see tables below
		(Hex)	(Dec)	
577	Hardware Inputs	0B00	2816	
578	Serial Commands	0B01	2817	
579	Fieldbus Commands	0B02	2818	
580	All Commands	0B03	2819	
581	Output Status	0B04	2820	
582	Error Status	0B05	2821	
583	(reserved)	0B06	2822	
...				
592	(reserved)	0B0F	2831	

Errors			
Error No.	Description	Bit No. of "Error Status" (Code 0B05 Hex / Register # 582)	Explanation → Chapter 5
00	Hardware Error	0	
01	Power Low	1	
02	Cut not possible	2	
03	Limit Switch	3	
04	Printmark Buffer Overflow	4	
05	Value Range Exceed	5	
06	No Homing	6	
07	Software Error	7	
08	(reserved)	8	
09	Watchdog Error	9	
10	Supply 3V3 Error	10	
11	Supply 5V0 Error	11	
12	Supply 5V2 Error	12	
13	Supply+12V Error	13	
14	Supply-12V Error	14	
15	Over temperature	15	
16	(reserved)	16	
...		...	
30	(reserved)	30	
31	Fieldbus interface module Error	31	

Input signals (Commands)					
Name of Command	Serial Code for single Command		Bit # of "Serial Commands" (Code 0B01 Hex) and "Fieldbus Commands" (Register # 579)	Hardware input (X4)	Explanation → Chapter 4.1.1
	(Hex)	(Dec)			
Printmark	–	–	–	FAST IN 1	
Set Ref. Pos. Car.	0901	2305	1	*	
Set Ref. Pos. Saw	0902	2306	2	*	
Start / Stop Cut	0903	2307	3	*	
Control Enable	0904	2308	4	*	
Cut completed	0905	2309	5	*	
Immediate Cut	0906	2310	6	*	
Start Gap	0907	2311	7	*	
Select Vir. Master	0908	2312	8	*	
Run Virt. Master	0909	2313	9	*	
Clear Error	090A	2314	10	*	
Cut Test-Length	090B	2315	11	*	
Teach Printmark	090C	2316	12	*	
Jog fw. Carriage	090D	2317	13	*	
Jog rv. Carriage	090E	2318	14	*	
Sync. Mode Enable	090F	2319	15	*	
Reset Carriage	0910	2320	16	*	
Decr. Batch Cou.	0911	2321	17	*	
Reset Batch Cou.	0912	2322	18	*	
Start Saw axis	0913	2323	19	*	
Return Saw axis	0914	2324	20	*	
Jog saw forw.	0915	2325	21	*	
Jog Saw rev.	0916	2326	22	*	
Homing	0917	2327	23	*	
Inhibit Return	0918	2328	24	*	
(Command 25)	0919	2329	25	*	
(Command 26)	091A	2330	26	*	
(Command 27)	091B	2331	27	–	Don't use!
Select Test Var.	091C	2332	28	–	Don't use!
Store to EEProm	091D	2333	29	*	
Adjust Program	091E	2334	30	–	Don't use!
Test Program	091F	2335	31	–	Don't use!

*) Function can be assigned to FAST IN 3…4 or CTRL IN 1…4

Output signals					
Name	Serial Code for single output		Bit No. of "Output Status" (Code 0B04 Hex / Register # 581)	Hardware output (X5, X6)	Explanation → Chapter 4.1.2
	(Hex)	(Dec)			
Ready	0A00	2560	0	*	
Alarm Carriage	0A01	2561	1	*	
Ready to cut	0A02	2562	2	*	
Error	0A03	2563	3	*	
Gap completed	0A04	2564	4	*	
Carriage Home	0A05	2565	5	*	
Cam output	0A06	2566	6	*	
No Printmark	0A07	2567	7	*	
Printmark teached	0A08	2568	8	*	
Printmark Window	0A09	2569	9	*	
Master in motion	0A0A	2570	10	*	
Vir. M. in motion	0A0B	2571	11	*	
Master Reverse	0A0C	2572	12	*	
Max. Corr. Carr.	0A0D	2573	13	*	
Virt. Printmark	0A0E	2574	14	*	
Homing Done	0A0F	2575	15	*	
(reserved)	0A10	2576	16	*	
(reserved)	0A11	2577	17	*	
(reserved)	0A12	2578	18	*	
(reserved)	0A13	2579	19	*	
Saw moving forw.	0A14	2580	20	*	
Saw moving rev.	0A15	2581	21	*	
Saw Home	0A16	2582	22	*	
Max. Corr. Saw.	0A17	2583	23	*	
(Output 24)	0A18	2584	24	*	
(Output 25)	0A19	2585	25	*	
(Output 26)	0A1A	2586	26	*	
(Output 27)	0A1B	2587	27	*	
(Output 28)	0A1C	2588	28	*	
(Output 29)	0A1D	2589	29	*	
(Output 30)	0A1E	2590	30	*	
(Output 31)	0A1F	2591	31	*	

*) Function can be assigned to CTRL OUT 1…4 or FAST OUT 1…3