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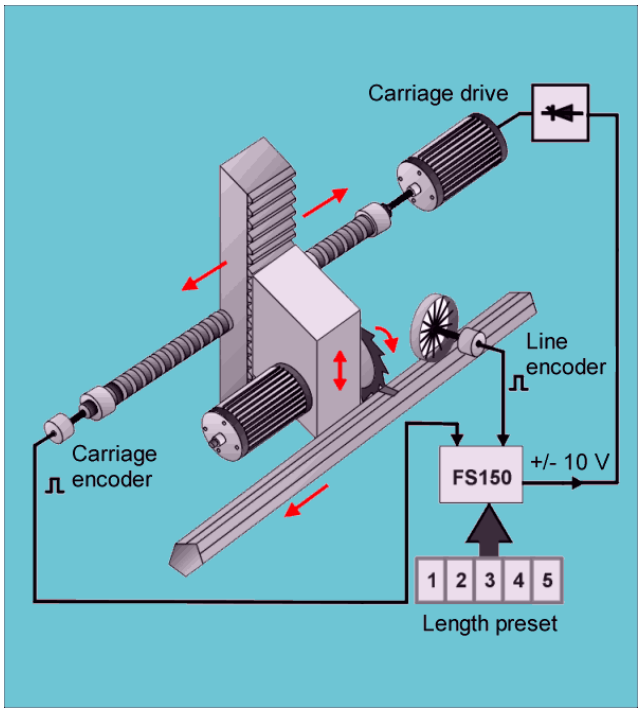
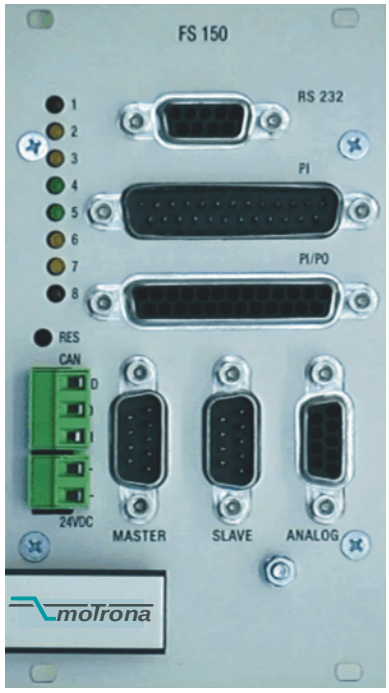
control – motion – interface

FS150

High Performance Flying Shear Control





- Stand alone controller for "Cut on the fly" applications
- Can operate with Servo- or DC- or AC- inverter drives
- High accuracy, 300 kHz input frequency
- Highly dynamic, 150 µsec response time
- Easy remote length preset by thumbwheel switches or PLC or host computer
- Easy LCD display setting or PC setting via serial link
- RS232/RS485 and CANopen interface
- Speed transitions by sin² profile. Speed variable anticipation for carriage start.
- Print mark registration and batch counters included.

Operating Instructions

Safety Instructions

- This manual is an essential part of the unit and contains important hints about function, correct handling and commissioning. Non-observance can result in damage to the unit or the machine or even in injury to persons using the equipment!
- The unit must only be installed, connected and activated by a qualified electrician
- It is a must to observe all general and also all country-specific and application-specific safety standards
- When this unit is used with applications where failure or maloperation could cause damage to a machine or hazard to the operating staff, it is indispensable to meet effective precautions in order to avoid such consequences
- Regarding installation, wiring, environmental conditions, screening of cables and earthing, you must follow the general standards of industrial automation industry
- - Errors and omissions excepted –

Version:	Description:
FS15016N/ TJ/ Oct. 03/ Page/21/26/42	Max. 8 print marks between sensor and home position Control word and status word Encoder inputs levels and max. frequency
FS15016C_d/Bo/Jul-08	Modification to motrona format

Table of Contents

Compatibility Hint

Versions FS15014A and higher use some different control inputs and control outputs and therefore are not fully hardware compatible to former versions!

You must modify a few connections at the PI/PO connector when replacing older version against FS15014A or a higher version! See section 5.

The software has been upgraded and now includes

- Batch counters for total quantity, waste quantity, total length
- Registers for actual line speed, carriage speed, synchronizing error etc.
- 3 software limit switches to protect against carriage overshoot. No more proximity for extreme carriage positions necessary.
- Real acceleration settings instead of ramp times
- Virtual master axis with adjustable simulation speed
- Impulse output with scaling facility for material line
- Correction register for easy compensation of slip of the measuring wheel
- Enhanced setup tools in the OS30 operator software, including scope functions, providing still easier commissioning procedures.
- Improved S- shape profile for still higher cutting efficiency.

1. Introduction

Flying shears are used for cutting applications, where endless material to be cut to length cannot be stopped during the cutting process and the cut must be effected "on the fly". The mechanical construction provides a saw or shear system mounted on a carriage, that follows the material with synchronous speed while cutting is in progress, and then returns to a home position to wait for the next cut. See schematics on title page.

The FS flying shear control is based on a BY150 synchronizer system. The software has been designed for the special requirements of flying shears under consideration of maximum efficiency and accuracy at minimum stress for all mechanical parts.

Only a few registers must be set in order to adapt the controller to the mechanical and electrical specifications of the shear system.
A small keypad with LCD provides easy setup, but also a disc with operator software OS3.2 is included for easy PC setup of the controller.

All essential registers like cutting length, tool width etc. are also accessible by parallel interface, providing easy setting by remote BCD thumbwheel switch or PLC parallel output.

The unit uses a closed 19" steel cassette for maximum EMC protection. With option SM150, the housing can also be mounted on DIN rails.

2. Principle of Operation

The shear (or saw blade) is fixed on a carriage that can move forward and reverse under control of a +/- 10V speed reference voltage of the carriage drive. Normally, a 4 quadrant DC or servo drive is used. For lower requirements in performance, the FS150 unit can also control 1-quadrant AC drives using a positive speed reference signal and two outputs for forward/reverse select.

The FS150 controller counts the length from the line encoder (feed roll or measuring wheel) while the carriage is held in its rear home position.

Once the cutting position approaches, the carriage accelerates and synchronizes with the line. A "Ready to cut" signal is generated in order to start the cutting process, while the shear moves fully synchronous with the cutting position on the material. When the cut is completed, the FS150 must receive a "cut complete" signal. This will cause a deceleration and a reversal of the carriage until it has reached its home position again. All speed transitions occur with a smooth $\sin^2$ speed profile for absolutely careful treatment of screws and other mechanicals parts.

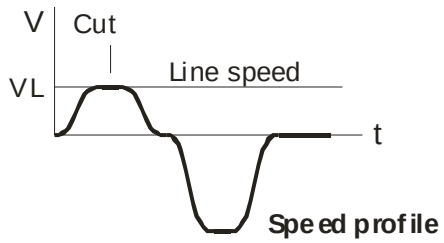


Fig 1

The FS150 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 over swing or oscillation will take place prior to the cut. This saves time and increases the cutting efficiency of the shear system considerably.

3. Hardware Configuration

As a master drive, mostly the motor of a feed roll is used. The "master" can also be a measuring wheel equipped with an incremental encoder.
The encoder resolution should be at least 5 times higher than the maximum acceptable cutting error.

Quadrature encoders (TTL-types A, /A, B, /B) must be used. Where you find you must use HTL encoders (10 – 30 V, A and B output), please apply our level converter type PU210 to generate the proper RS422 signals required.

Digital feed forward technology needs a certain minimum frequency: At maximum line speed, the master encoder frequency should be at least a few hundred Hertz. It is best to choose the ppr numbers of line and carriage encoders in a way to produce frequencies in the same range.

It is necessary to adjust the slave to its maximum dynamic response (no internal ramps, no integral control loop, high proportional gain etc.) because the FS150 will generate ramps to which the drive must follow with no additional delay.

A signal must be available to indicate completion of a cut to the FS150 controller. All control signals must be PNP (switching to positive) with a level of 18....30 volts DC. Fig. 2 shows the block diagram of the unit.

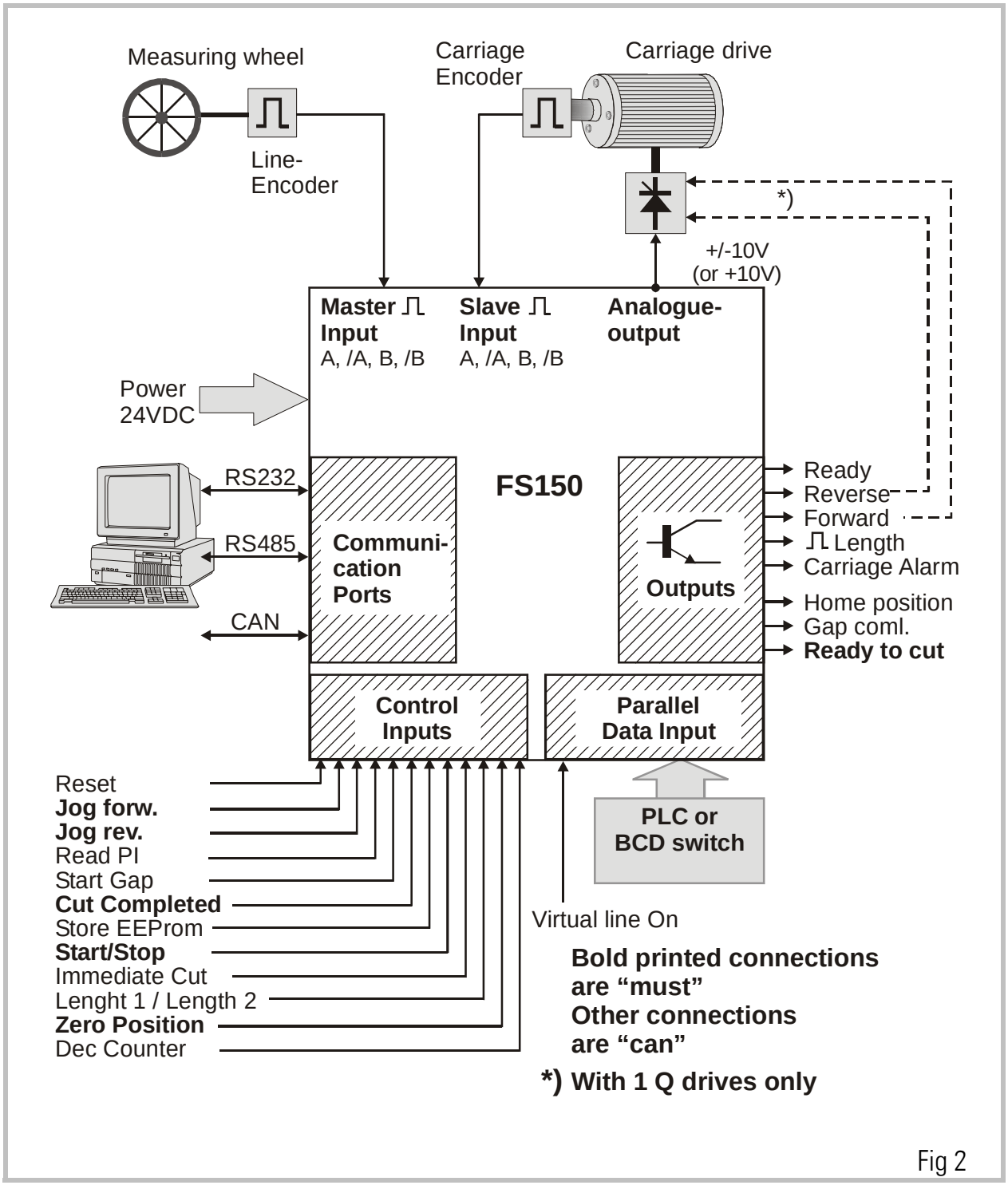


Fig 2

For safety reasons, we strictly recommend to limit the travelling range by mechanical limit switches at both ends in order to avoid damage with carriage overshoot upon failure of the electronic control system!

4. Wiring and Screening

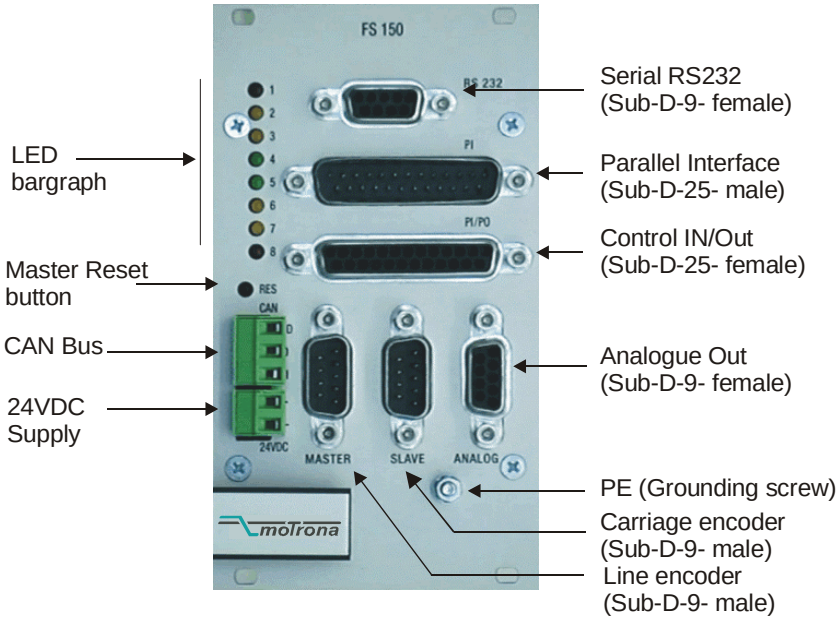


Fig.3

For reasons of proper screening, it is a must to follow the subsequent instructions.
Where you don't exactly observe these grounding and screening rules, it is almost for sure that you will have problems later!

a. The minus wire of the power supply must be connected to the grounding screw on the front plate of the FS150 controller with a short wire of at least 0.75 mm².
On site of the power supply, the minus output must be earthed.
Where the wires between power unit and FS150 controllers are longer than e.g. 1 meter, it is advisable to ground the front plate of the controller again by a separate wire, on the shortest way possible.

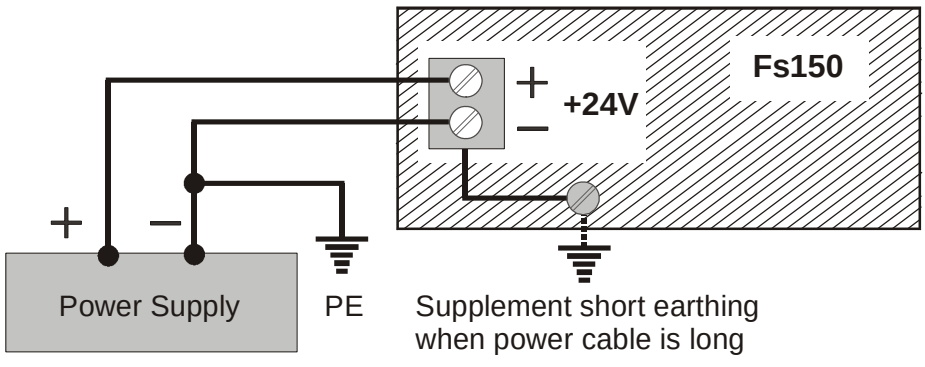


Fig 4

b. All screens on the controller side must be connected to the housing of the corresponding Sub-D-connector. This is valid for encoder cables, analogue output and PI or PO lines. Where you use Sub-D-connectors with a plastic housing, you must solder the screen to the metallic frame of the connector.
At any time you must be sure the screen gets a proper contact to the front fascia of the unit when connected to the controller.

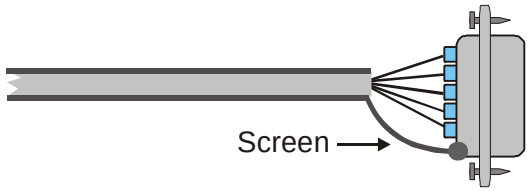
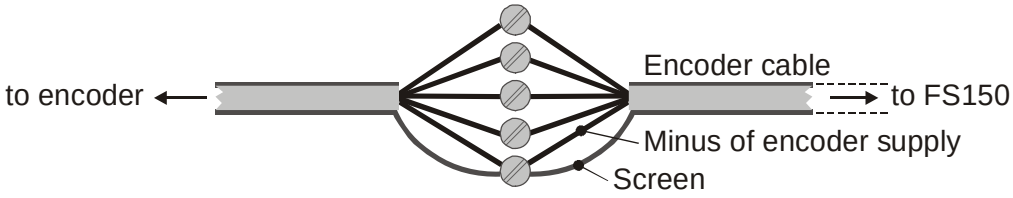


Fig 5

c. When **encoder cables** are interrupted by terminal boxes or intermediate connectors on their way from the controller to the encoder, you must connect the screen to the Minus wire of the encoder supply there, but never to earth potential again!



Tie Minus of encoder supply and screen together whereever you interrupt the encoder cable by terminal or connectors.
Make sure the screen can never get any earth potential here!

Fig 6

d. When the cable arrives at the encoder site, the screen must again be connected to the Minus wire of the encoder supply, but not at all grounded to earth. In general, there are two types of encoder connections:

Encoder with plug connector

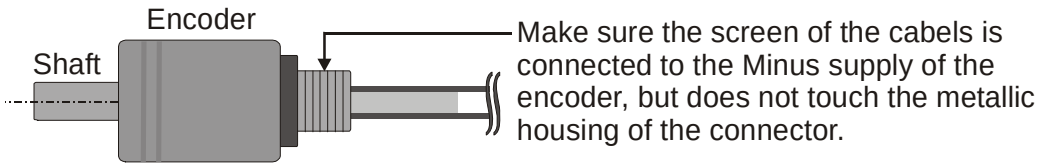
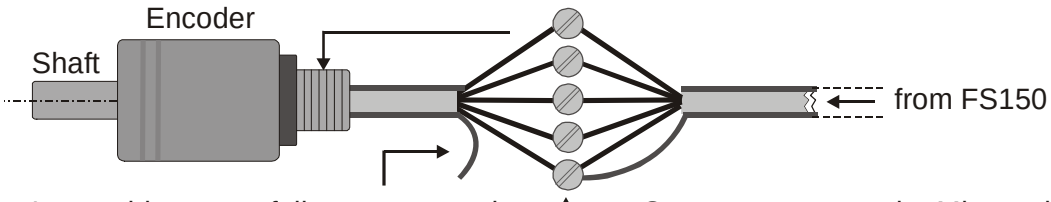


Fig 7

Encoder with cable end



Leave this screen fully unconnected here to avoid illegal double-earthing! (Screen is internally earthed to the encoder housing).

Connect screen to the Minus wire of the encoder supply here. Avoid any earth connection via contact to housings ect.

Fig8

e. With **all other cables** like analogue output, control or parallel output, put the screen to the metal connector housing on the FS150 side and leave it **unconnected on its peripheral side**. Again avoid double earthing. The only place where the screen is earthed must be the front plate of the unit!

Example: Analogue speed reference signal

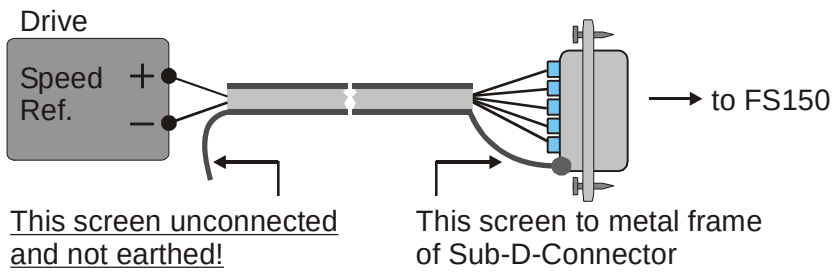


Fig 9

All cables connected to the FS150 should be separated from motor cables and other power lines. It is indispensable to use screened motor cables.

4.1. Encoders

The unit only accepts TTL impulse signals (5V, RS 422) or similar from an encoder simulation (resolver). It is essential to connect the channels A, /A, B, /B: The index inputs Z, /Z are not used with this application.
Where you find you are working with existing 10 - 30 Volt encoder signals which feature only A, B, Z signals, the PU 210 converter should be used to gain full complementary signals in line with RS 422 standards.

An auxiliary voltage of **5,2 V (max. 400 mA)** is available on the connector plugs **"Master"** and "Slave", for easy supply of the encoders. Both connectors on the unit are Sub - D - 9 pin, male. Fig. 10 and Fig. 11 show the encoder connections and the principle of the input circuit. All impulse inputs are isolated by high speed optocouplers.

When connecting the encoders it is not too important to wire the A and B signals to produce the correct counting direction. The direction can be determined in the setup menu.

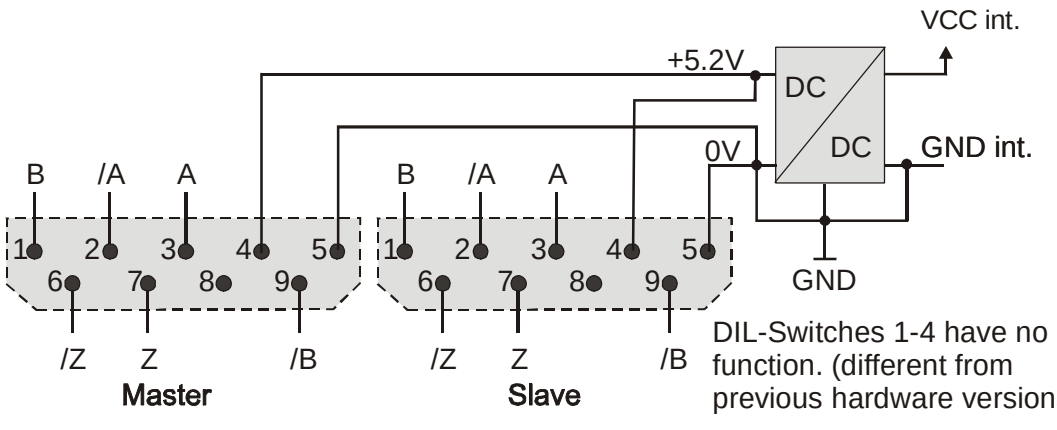


Fig 10

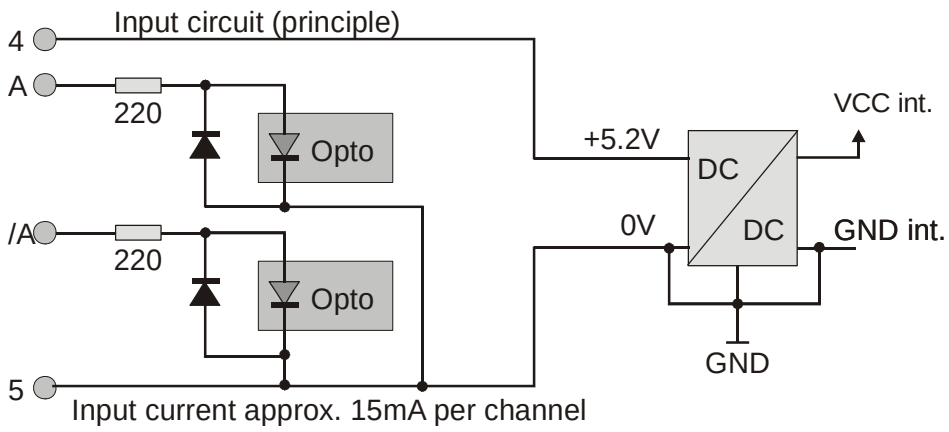


Fig 11

Important

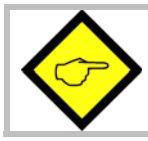
- With encoders, supplied by the FS150:

  Connector pins 4 and 5 provide the encoder supply.
- With encoders, supplied by an external source, or when an encoder simulation from the drive is used (Common GND operation)

  Use connector pin 5 as common zero Volt potential.
- For fully potential-free operation:

  Connect only A, /A and B, /B and leave terminal 5 (Common) unconnected.

For reason of best noise immunity, we recommend to use potential- free operation wherever you have line driver signals with remote supply.



You must ensure that no external voltage is applied to pins 4 and 5 as this can cause serious damage to the unit!

- Where you use one common encoder for feedback of the drive and feedback for the FS150 at the same time, there may come up interference problems. You can use a GV150 impulse splitter to eliminate any kind of problems. In most applications, the common encoder would also work fine when it is supplied by the drive and the FS150 operates in fully differential mode like shown.

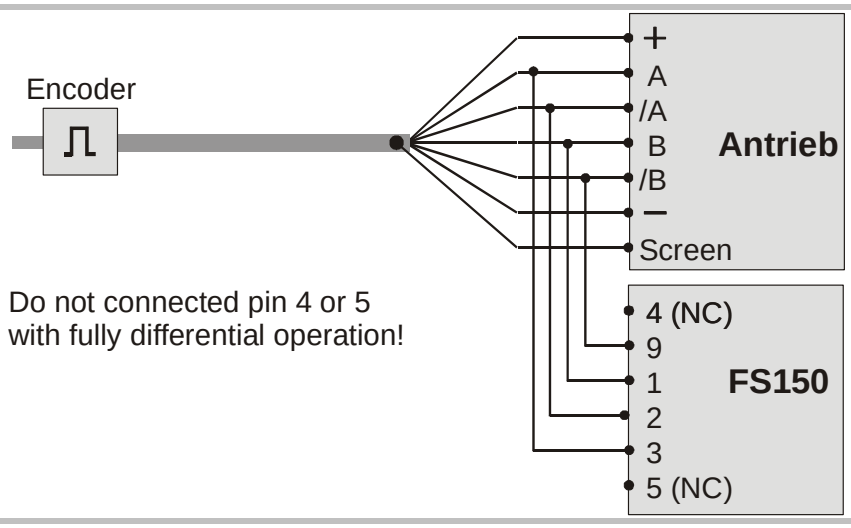


Fig 12

DIL switches S1 / 5 - 8 provide the selection of the **encoder edge counting**. It is possible with complementary signals to count with times 1, 2, or 4 without any fear of miscounting. The selection always applies separately to the master and the slave input signals.

Master:		
DIL-Pos. 5	DIL-Pos. 6	Edge count
ON	ON	X1
OFF	ON	X2
ON	OFF	X4
OFF	OFF	Counter disabled
Slave:		
DIL-Pos. 7	DIL-Pos. 8	Edge count
ON	ON	X1
OFF	ON	X2
ON	OFF	X4
OFF	OFF	Counter disabled

Fig. 13

Please note, that

- The maximum frequency of the FS150 refers to the total **number of edges** counted, i.e. 300 kHz (x1) or 150 kHz (x2) or 75 kHz (x4).
- Impulse numbers, to be entered upon setup, also refer to the total **number of edges** counted, i. e. the entry data must be doubled with (x2) etc.
- When possible, you should set the switches in a way to produce approximately similar impulse numbers on Master and Slave side to achieve best operation. i.e. 4096 impulses x 1 on the Master side and 1000 impulses x 4 on the Slave side. The cross section of encoder cables must be chosen with consideration of voltage drop on the line. The FS150 provides a 5.2 V encoder supply and at the other end the encoder must at least receive its minimum supply voltage! (See encoder specifications).

4.2. Analogue Output

The analogue connector (Sub-D-9 female) provides several auxiliary lines that are not applicable with FS150 functions. The only pins that must be connected are pin 2 (GND) and pin 7 (output). The cable must be screened and the screen must be connected to the connector housing on the FS150 side. **The screen must be unconnected on the drive side!**

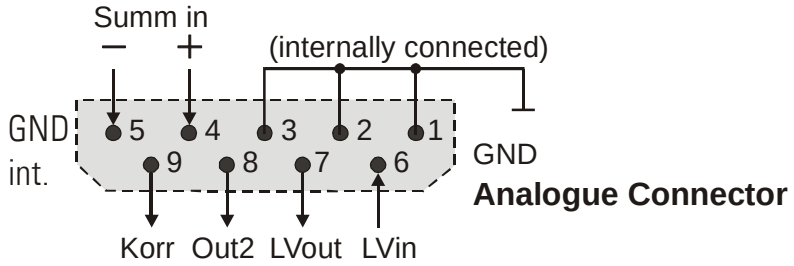


Fig. 14

4.3. Power Supply

The FS150 operates from an unstabilized 24 VDC supply (+/- 25%), however, the voltage including ripple should not exceed the following limits (18 V...30 V). The supply of the FS150 is both electrically and mechanically protected against wrong polarity misconnection by protection diodes and a special plug.

At pin 1 of the "PI" connector and pin 1 of the "PI/PO" connector, a +24V output is available for easier wiring of input and output supplies. This voltage is taken from behind of a current limiting resistor. Short circuiting these outputs to GND can burn the resistor or internal printed lines.

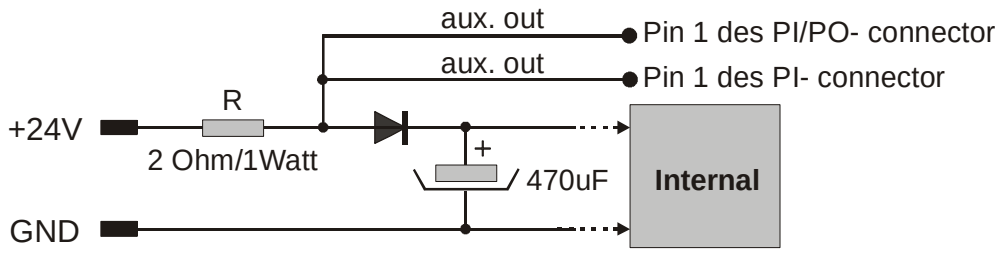


Fig. 15

4.4. Parallel Interface (PI)

The interface provides remote setting of operational and configuration registers. It receives BCD or binary data (selectable) from a remote thumbwheel switch or PLC control. There are three binary coded select lines which provide 8 addresses being accessible, via 20 data lines. The register parameters are stored in the following manner:

a. Read and activate parallel data upon a strobe pulse. The data is then transmitted to the internal RAM and activated immediately.
b. Store the data to the EEprom by a Store pulse, when you like the unit to use same data again after power down.

It is easy to see how 8 external registers may be loaded into the FS150. For operation of Read and Store inputs see section 4.5.
The connection of the parallel interface is a 25 pin Sub-D connector (male) which is marked as "PI" on the front fascia.

All inputs are PNP switching and fully PLC compatible. All signals refer to GND and the minus potential of the supply.

Log. 0	(low)	=	0.....5 Volt
Log. 1	(high)	=	18...30 Volt

Important Advice

Upon power up, the unit loads the full register set stored in its EEProm. Data transmitted from the parallel and/or serial interface will overwrite the operational RAM data, but not the corresponding EEProm registers. As a result, when powering up, any parallel or serial data will be replaced by EEProm data, until it is overwritten again.
The RAM data however can be restored to the EEProm at any time by parallel or serial command.

Parallel interface operations must keep the following timing conditions:

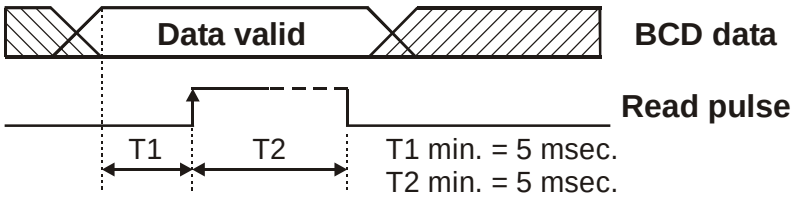


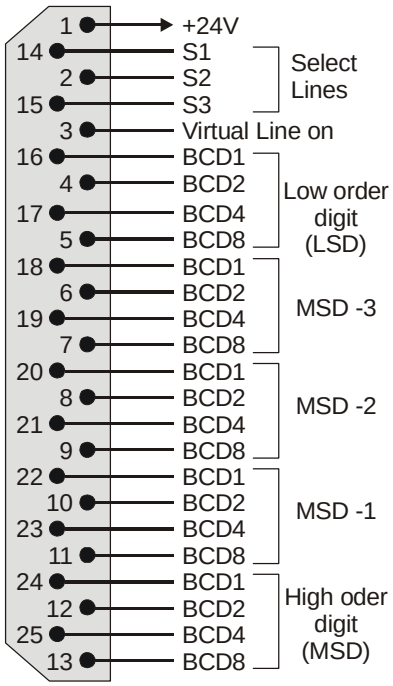
Fig 16

Data latch occurs with the positive transition of the strobe pulse. Data lines must be in a valid state at least 5 msec. prior to the strobe, and remain present for an additional 5 msec. while the data is read. There is no upper limit for T1 and T2.

Mostly the parallel interface is used to preset the cutting length by a simple remote BCD thumbwheel switch or by a PLC parallel output. The select lines S1-S3 allow to preset also other registers like shown in table above. Registers are described later in this manual.

Pin 3 of the PI parallel interface provides a special control function:

A “virtual line axis“ can be switched on by this pin, allowing to fully operate all carriage functions without material and with the measuring wheel in standstill. This is useful for testing and commissioning. More details are to be found in the section “Virt. Line“.



S4	S3	S2	S1		
0	0	0	0	Length 1	(C 02)
0	0	0	1	Length 2	(C 03)
0	0	1	0	+/- Sync	(C 06)
0	0	1	1	Accel 1	(C 04)
0	1	0	0	Accel 2	(C 05)
0	1	0	1	Sync Time	(C 07)
0	1	1	0	Virt. Line	(C 19)
See register description					

With signed parameters the most significant bit (pin 13) is used as sign bit (low = +).

When using binary format pin 16 is the LBS and pin 13 is the MSB.

Fig 17

5. Control IN / OUT Port (PI/PO)

There are 12 input lines and 8 output lines for remote control purpose.

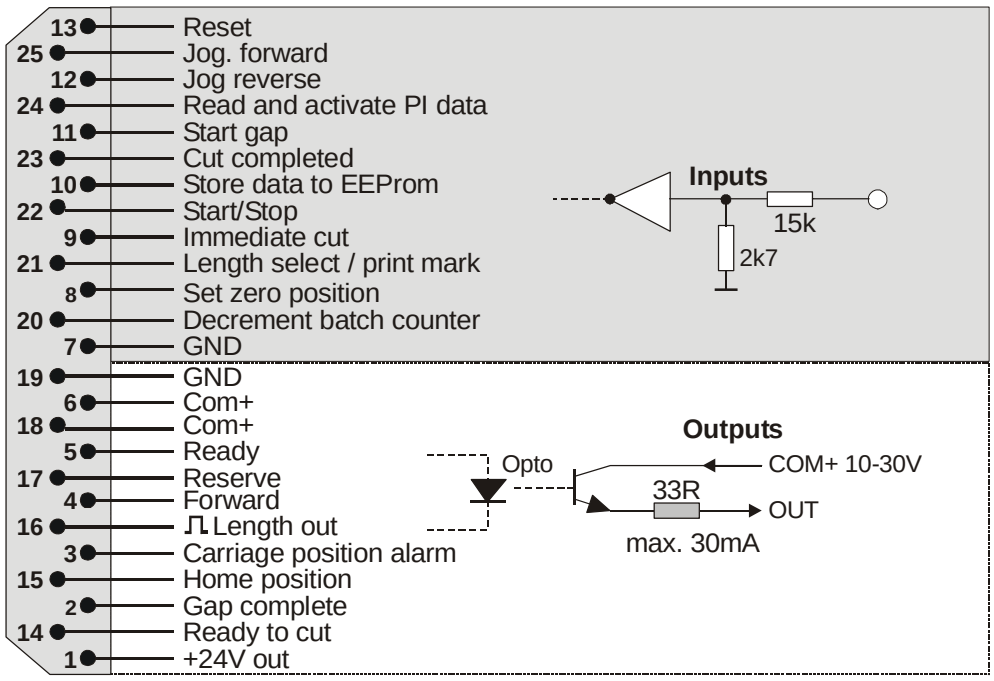
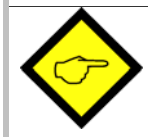


Fig 18

Inputs	Description
Reset (13):	When set High, a new initializing cycle is started and error messages will be cleared. Reset does not affect any carriage position counters or batch counters.
Jog forward (25) Jog reverse (12):	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). Jog inputs are only active when the Start/Stop input is in stop state. The software limit switches do not operate while you keep the "Teach Zero" input high. Whenever the Jog command is released, the shear will be electrically hold in its new actual position and start from there to execute the next cut.
Read and activate data (24):	Reads data from the parallel interface and activates new data in the cutting process.
Start gap (11):	Upon completion of the cut it is possible to shortly accelerate the carriage, so the tool will shift forward the material and make a gap between. The size of the gap is register settable and an output will signal when the gap is completed. Leave input unconnected when gap function not used.

Inputs	Description
Cut completed (23):	This input must receive a signal when a cut has been completed. The direction of the signal (High/Low) is register selectable. With the selected edge the FS 150 will start deceleration and reversal in order to put the carriage back to its rear home position. Each cut completed signal will increment the batch counter.
Store EEprom (10):	A High signal on this input will store all register data to the EEprom. Data which have been transmitted by the parallel interface will be lost after power down, unless this input has been activated prior to power down. The EEprom has a limited number of 100.000 store cycles during its life time.
Start/$\overline{\text{Stop}}$ (22):	When low, the automatic cutting cycle will be interrupted, but the Jog functions and the Immediate cut input will remain active. When high, the carriage will continuously execute cutting cycles according to the preset length.
Immediate cut (9):	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 a Flying Cut has been triggered again. This function i.e. allows the operator to cut out bad parts of the material. Immediate cut commands will increment the waste counter.
Length select / print mark:	This input provides a double function: • With Mode 1 (normal operation without print mark), this is a length selection. Since the unit stores two cutting lengths (Length 1 and Length 2), a low at this input selects Length 1 to be cut while a High at this input selects Length 2. • With Mode 2 (operation with print marks), this is the input for the sensor or photocell detecting the print mark.
Set Zero position (8):	This input allows to define the "Zero" position of the carriage. The internal carriage position counter is Reset 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 in at Zero, or where you move the carriage with the controller in powerless state, it is always necessary to redefine "Zero" after power up by a positive signal to this input.
Decrement batch counter (20):	The unit provides an internal batch counter incrementing by one with each cut. If for any reason one cutted piece cannot be used (waste), the counter can be decremented by a positive edge to this input, to match the real number of usable products.

Outputs	Description
Ready (5):	A high signal indicates the unit is ready to operate and a low signal indicates the unit is out of order or an error has been detected and the unit has switched off the control loop (see “Errors“). When high, the unit could not detect a fault by itself, but this is not a guarantee that the whole system is ready to work.
Reverse (17) / Forward (4):	Where you use a carriage drive with only positive speed reference and digital forward/reverse select, these two outputs will control the direction of rotation. The output goes High when the corresponding direction is required.
⎍⎍ Length out (16):	This output generates impulses proportional to the line motion with scalable length units. As an example, it might be used to totalize full meters of material passing through, by a separate counter or PLC.
Carriage position alarm (3):	This can be used to limit the travelling way of the carriage into forward direction during production. If, i.e., for mechanical or other reason, 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 detent. The alarm position is register settable and this output switches High to indicate the carriage will run out of range if not braked down immediately.
Carriage home (15):	A high state of this output indicates the carriage is in its home position like defined by register “home window“.
Gap complete (2) :	When the gap function is used, a high signal indicates that the gap has been executed and the controller now waits for the “cut completed“ input.
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. See parameter "Cut window". It goes Low again when the shear signals "Cut completed".
	Important remarks: 1. When for any electrical or mechanical reasons the carriage cannot reach the proper cutting position or cannot synchronize with the line speed, the "Ready to Cut" signal will never switch on and the carriage could run to its front detent without executing a cut! Use the Carriage alarm output and mechanical safety switches to avoid damage. 2. Each cut must be followed by a "Cut completed" signal, otherwise no reversal of the carriage will take place and it will run to its front detent! For tests (with saw blade or shear removed) it is legal to connect the “Ready to cut“ output to the “Cut completed“ input.

6. The Serial Port

The RS 232 serial link can be used for two purposes:

The unit includes a serial RS232 and a RS485 interface, both accessible by the Sub-D-9 connector marked „RS232".

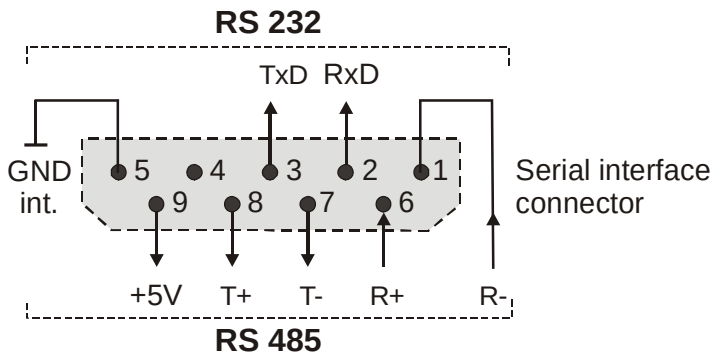
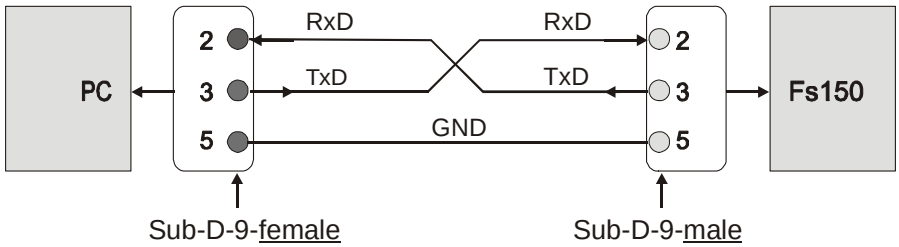


Fig 19

To run the OS 3.2 operator software with your PC by RS232, your PC must be connected to the FS150 unit like shown:



Only pins 2,3 and 5 must be wired and pins 2 and 3 must be crossed over

Fig 20

Please make sure your PC serial cable uses only the three pins shown. When also other pins are connected, this will cause interference with the RS485 pins and the PC communication will not work.

When using the RS485 interface, you can serve up to 32 different bus participants in either 2-wire or 4-wire transmissions mode. The subsequent figures show, as an example, how to run a TX720 operator terminal with a FS150 unit and other controllers.

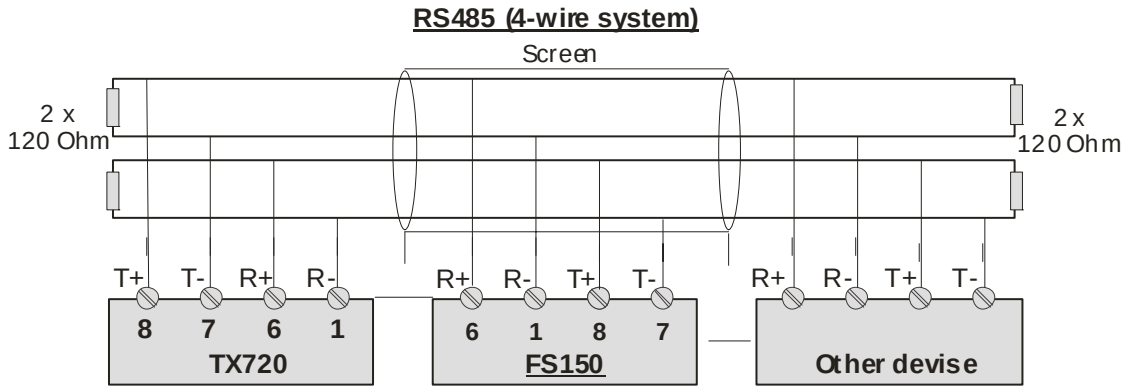


Fig 21

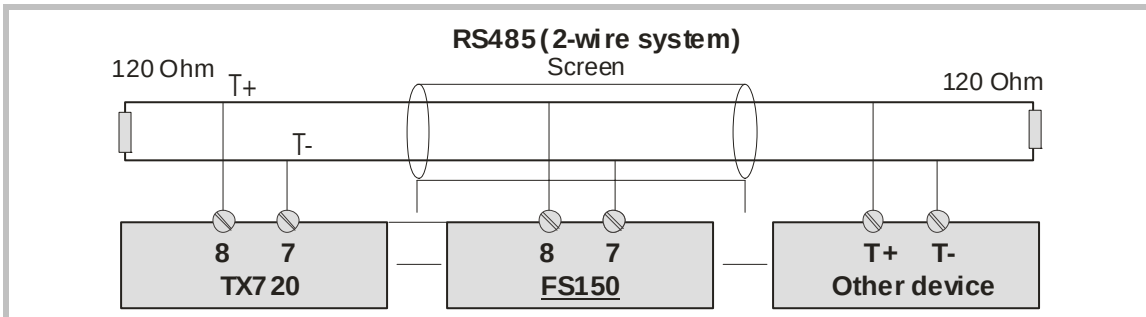


Fig 22

A detailed description of the serial protocol is available upon request or can be downloaded from the Download site of the motrona homepage www.motrona.com
document name: „Serpro"

7. Register settings

Registers can be set by keypad under LCD control or by PC, using the OS3.2 operator software. This section describes the registers and their meanings and the next section shows how to program the registers.

The unit provides 4 Sub-Menus.

Data In Contains operational registers.

Setup Contains registers that need to be set only once upon commissioning.

Adjust provides easy setting of the analogue gains upon commissioning.

Testprog executes various testing functions for internal and external signals.

Expressions like C00 indicate the serial register access codes.

8. How to operate the Keypad

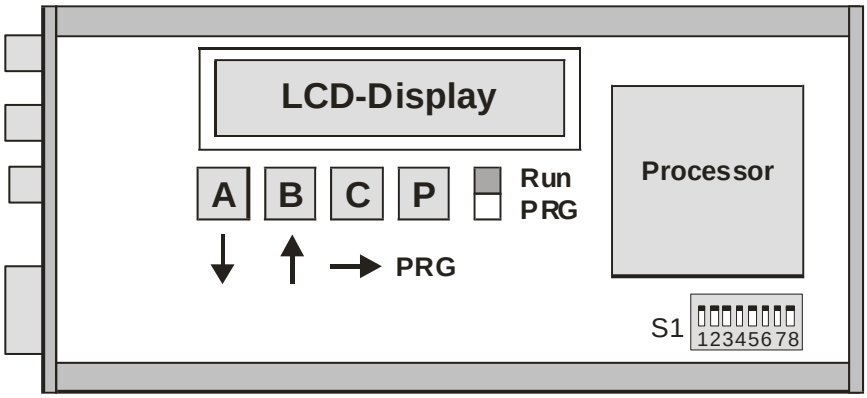


Fig 23

To access the operator PCB, remove right hand side plate.

The on board setting controls comprise an LCD display, 4 small buttons and a sliding switch. When the switch is selected to "Run", the LCD permanently displays the software version of the program and the buttons A, B, C and P have no function.
Programming by the on board setting controls requires the sliding switch to be slid to "PRG". For external PC setting it must however be in the „Run“ position.

The buttons have the following control functions (Cursor highlights the register):

Button A: Scrolls register down; scrolls menu forward and also increments the highlighted digit.

Button B: Scrolls registers up; scrolls menu backward and also decrements the highlighted digit.

Button C.: Returns from register to menu titles; increments highlighted digits to the right, (or from full right to full left).

Button P: Enters from menu to registers; changes register from text to value and back to text again. Stores actual data to the EEprom.

The following example shows how to set the “Acceleration 1“ register of the Data In menu (see register table).

Action	LCD
• Slide the switch to "PRG	DATA IN
• Select the Data IN Menu by pressing "P"	Imp Line
• Press "A" several times until the LCD shows "Accel 1"	Accel 1
• Select the Accel 1 register by P and read the actual setting (i.e.1000)	1000
Change setting to i.e. 500 msec. like shown:	
• Key B decrements digit highlighted by cursor	0000
• Key C shifts cursor right	0000
• Key A increments highlighted digit. Press A 5 times.	0500
• Press P to store the new value	Accel 2

When you slide the switch back to "RUN", you read again "FS15013" and the unit is ready to operate.
When you press "C" instead, you come back to "DATA IN" etc.

Please note:
The unit is unable to operate or to make serial communication while the slide switch is in the "PRG" position!

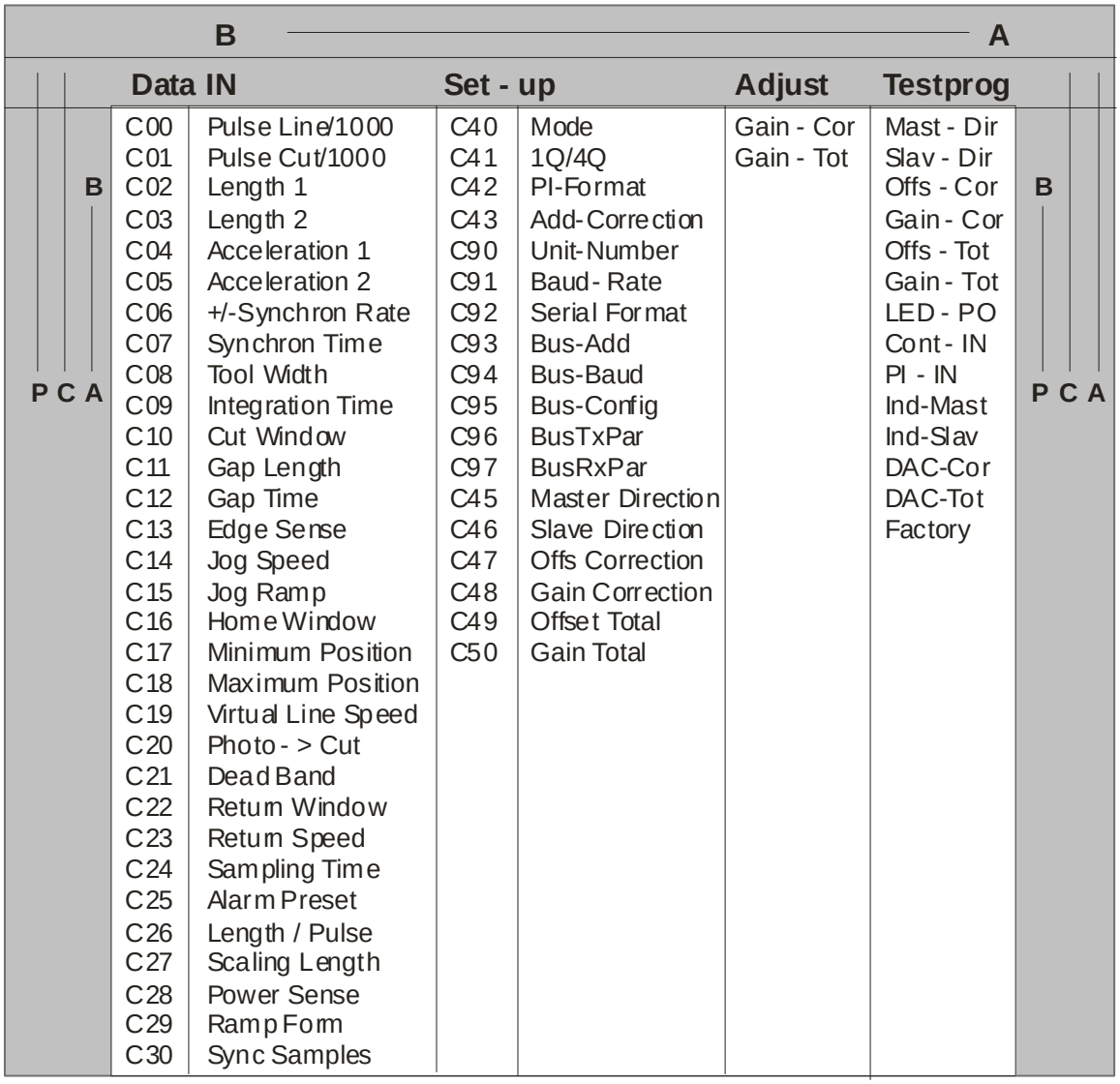
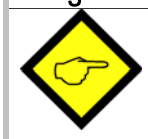
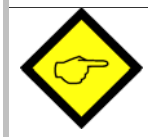
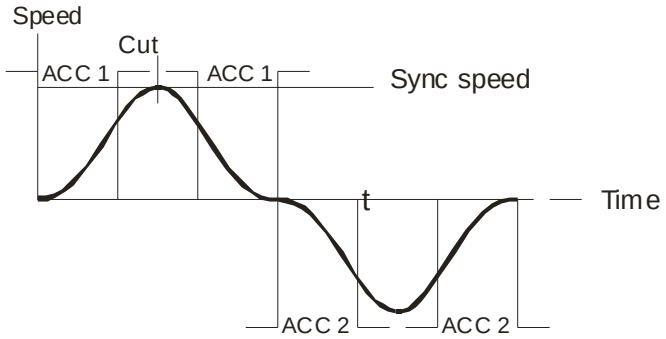
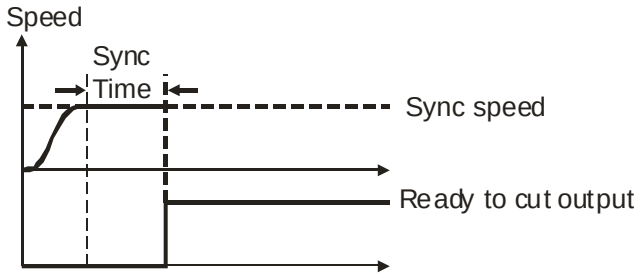


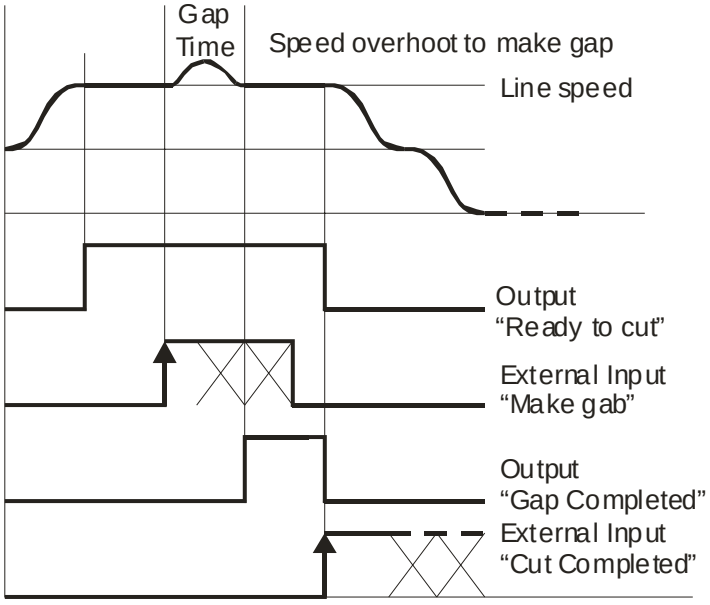
Fig. 24

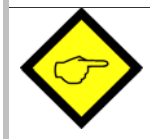
Prior to register setting you must decide with which dimensions or units you like to preset the cutting length. This could be 0.1mm or 1mm or 0.001 inch or any other resolution you desire. All further settings refer to the length units you decided to use. When i. e. you choose to set the length with a resolution of 0.1mm, 1000 length units will be 100 millimeters and you must preset the length in a format like 100.0mm.

9. The Data IN – Menu

Register	Description
Pulses Line:	This register calibrates the encoder ppr of the **line encoder**. You must find out how many impulses we receive when the line moves **1000 length units** forward. Set the number of impulses to this register. Range 0-999 999
Pulses Cut:	This register calibrates the encoder ppr of the carriage encoder. Setting is similar to the Pulse lines register.
Length 1 Length 2:	These registers contain your cutting lengths. Enter a default length here.
	<u>Clarification:</u> You can preset two length and the remote signal "Length select" will decide whether we cut length 1 or length 2. Upon power up, the unit will load the length set to these registers. Data transmitted by parallel or serial interface will overwrite the registers. Parallel or serial data will be valid until to the next power down only, unless they have been stored by a "Store to EEprom" command.
Acceleration1:	Acc/Dec rate for forward motion of the carriage, scaled in **length units/sec².**
Acceleration2:	Acc/Dec rate for reverse motion of the carriage, scaled in **length units/sec².**
	**Remarks to acceleration settings** • The ramp times for acceleration and deceleration result from the setting and from the speed. Where you use length units of entire millimeters and you set Acceleration to 10 000 mm/sec², the unit would accelerate the carriage within one second from standstill to 10 m/sec which is 600 m/min. This means it would take 100 msec. to go from standstill to 60 m/min etc. • Acceleration values must be set in a way that motor and drive can follow the ramps generated by the controller. Setting values outside the physical range of the drive system result in malfunction or failure of the whole system.

Register	Description
	 Fig.25
+/- Synchron Rate:	This register allows to slightly vary the synchronous speed in a range of +/-9.99%. In general, this register will be **set to 0.00** and the carriage will synchronize with the line exactly according to the encoder information. Some applications with extrusion lines need to adapt the sync speed, because the material is hot and cools down on the way between the measuring wheel and the cutting position. This will cause shrink which can be compensated by the +/- Synchron Rate register. It affects the synchronous speed but not the length.
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 completing of the acceleration ramp and the Sync Time register can be set to its minimum value of 1 msec. With mechanically unstable carriage constructions it may however be applicable to leave a short stabilization time before activating the cut.  Fig.26
Tool width:	Provides compensation of the width of the saw blade or cutting tool. Setting 0-999 length units.

Register	Description
Integration Time:	Sets the integration in order to avoid cutting errors caused by non-linearity of the carriage drive. 00 = Integrator off 01 = Fast integration 99 = Slow integration For setting see section "Steps for commissioning".
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 to set this window not too small, because no cut will be activated when for any reasons we do not reach this window (carriage will run to the front limit).
Gap Length:	In some applications it is desirable, after the cut, to shortly accelerate the saw blade in order to shift the cut piece forward and produce a gap prior to removing the tool from the line. The gap can be set directly in length units, range 0-9999. In most applications, this function will not be used. To use the gap function, the following timing of signals must be observed:  Fig.27 When the gap function is not used, the input "Make gap" remains unconnected, but at any time the signal "Cut completed" must be applied to start the return process of the shear.
Gap Time:	Time in milliseconds to make the gap. Range 1 - 9999 msec.

Register	Description
Edge sense:	Sets the active edge for the external "Cut completed" signal **0: LOW**  **HIGH** Rising edge at input "Cut completed" terminates the synchronous phase and starts the return cycle **1: HIGH**  **LOW** Falling edge at input "Cut completed" terminates the synchronous phase and starts the return cycle Fig.28
Jog speed:	Sets the carriage speed when one of the "Jog forward" or "Jog reverse" inputs is active. The setting range is 0.00 to 9.99 Volts of speed reference for the slave drive.
Jog Ramp:	Ramp time for Jog operation, dependant on selected jog voltage: **0000 :**  **(jump)** **0030 :**  **(approx. 100 msec/Volt)** **0060 :**  **(approx. 200 msec/Volt)** **usw.** Fig.29
Home Window:	Sets a window around the home position of the carriage. Setting in length units 1-9999 units. The output "Carriage home" is high when the carriage position is inside this window. The unit will go to Alarm state when a new cutting cycle will be started before the carriage has returned to the home window from the previous cut.
Min Position Max Position:	Programmable software limit switches for the extreme forward and rear carriage position. Setting is in length units and the range is from -999999 to + 999999. The setting refer to the "Zero" Position which is set by the "Zero Position" input. In general (but this is not a "must"), the Zero position is also used as the "Home" Position. In this case, the Min Pos must always be set to negative and the Max Pos must always be set to positive values. When the Start/Stop input is in Stop state, these two software limit switches will limit the travelling range with Jog operations.
	When we are in Start state (automatic cutting), only the rear limit switch will stay active and cause the unit to go Alarm state when touched. The maximum position switch will not work, but instead the "Carriage Alarm Preset" will control the maximum forward position of the drive. The following drawings assume we have set our Minimum position to -20mm, our Maximum position to 2500mm and our Carriage Alarm to 2000mm.

1. STOP state, Jog operation

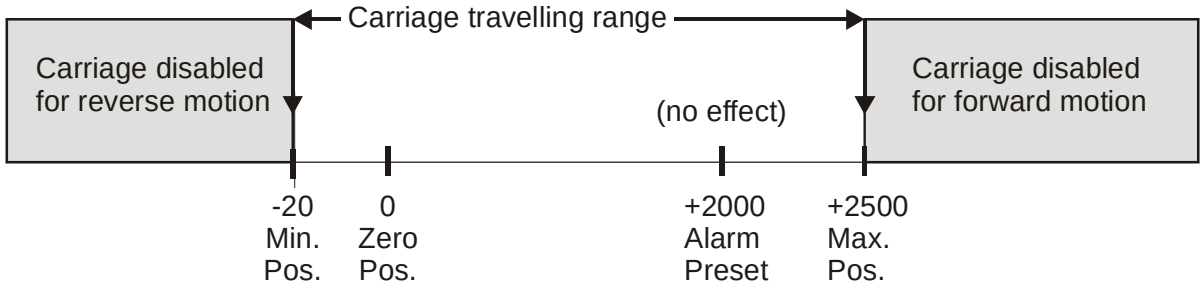


Fig 30

2. START state, automatic cutting operation

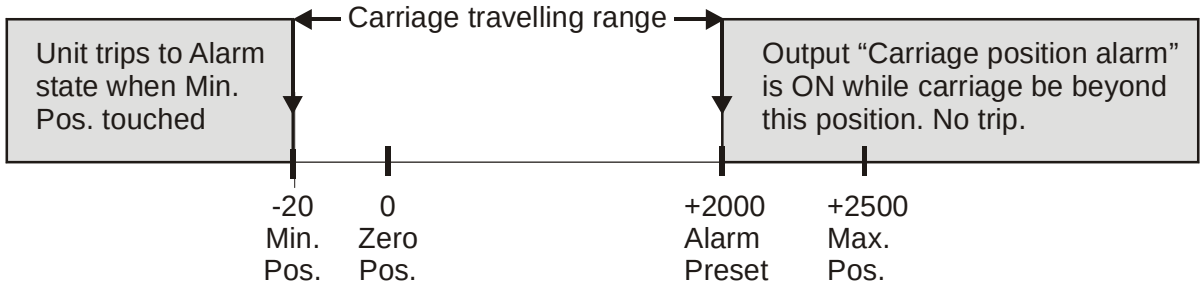
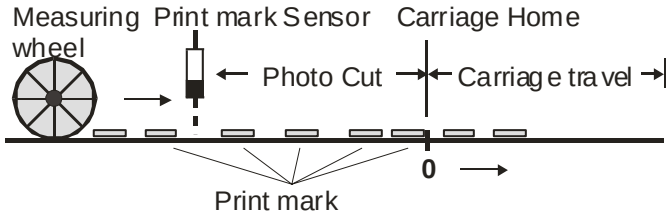
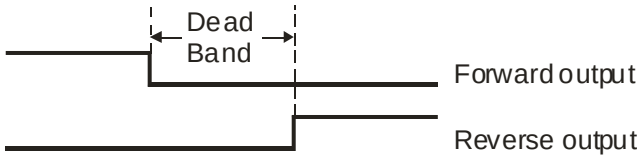


Fig 31

Please note that for "Home" the unit uses the position where the carriage is while we switch the Start/Stop command to Start, i.e. "Home" and "Zero" can be different positions!

Register	Description
Virt Line Speed:	Virtual speed to simulate the motion of the line. Setting as "Length units per minute". With a scaling of full millimeters, setting of e.g. 20.000 means 20m/min. When the virtual line is switched on, the controller simulates the motion of the measuring wheel. To switch the simulation on: • Have the carriage in it's home position • Have the Start/Stop input Low (Stop) • Now apply a positive transition to pin 3 of the parallel interface and keep it High. • Set the Start/Stop input to High (Start) to run the machine with the virtual speed.
Photo →Cut*):	Distance between photocell and home position with print mark tracking. Setting 0-999 999 length units. This register is only operative in Mode 2 (print mark registration). Please note the print mark sensor must be mounted in a way that never more than 8 print marks appear between the sensor and the carriage home position. The FS150 controller can store up to 8 print mark positions in a FIFO shift register and cut accordingly. The unit trips to Alarm state when more than 8 print marks are detected between the position of the photocell and the carriage home.

Register	Description
	 Fig. 32
Dead Band:	For use with 1-quadrant inverter drives only: Provides a delay bet-ween the forward output signal and the reverse output signal to avoid overlapping of the for/rev select. Adjustable in milliseconds. Range 0 - 9999msec.  Fig.33
Return Window:	Applicable when 1-Q inverter drives are used as carriage drive. Since these drives do not have any torque in standstill, they tend to slightly overshoot when moving back into the Home position. I.e. the carriage comes to a stop a few millimeters beyond the scheduled position. Return window is scaled in length units and compensates for overshoot by starting the deceleration ramp earlier.
Return Speed:	Sets the ratio between the actual line speed and the maximum return speed. Range 0.01 - 9.99. Setting 2.00 says that, if necessary, the return speed can take the double amount of the actual line speed.
Sampling Time:	Provides digital filtering of the feed forward signal generated from the line encoder. Range 0001 - 9999 msec. Normal setting 1 msec. recommended. In applications where the line speed is very unsteady, settings like 10 or even 100 msec. can be advantageous for smoother motion of the carriage. Please note that higher setting results in lower response with changes of the line speed.
Alarm Preset:	Sets an alarm position for the forward motion of the carriage and switches on the alarm output when exceeded. See also “Min/Max Position“. If for any reasons the unit cannot switch on the “Ready to cut“ signal, the alarm output can be used to prevent the carriage to run to the mechanical front end. You should set the preset position in a way that there is still space to break the carriage down to standstill before we reach the detent. Setting range 0 - 999 999 length units.
Length/Pulse:	Scaling factor for the auxiliary impulse output. Setting range 1 - 99 999 length units per impulse. If the whole system is calibrated in “Millimeters“ and the output should be used to count and totalize the line with full meters, set this register to 1000 to receive one impulse every meter.

Register	Description
Scaling Length:	In some applications the real cutting length may be different from the cutting length set to the unit, due to some slip of the measuring wheel etc. As an example, the length setting could be 6000 millimeters and you find out the real cutting length is 6010 millimeters. Where you find your real cutting length is different from your setting, enter the real cutting result here (i.e. 6010 mm) and the unit will automatically change the scaling to receive 6000 mm when you set 6000mm.
	A new internal impulse scaling factor is calculated every time you take serial access to this register, and repeated access will raise this factor to higher power, which results in wrong scaling. Please write the value of the active cutting length into the register "Scaling Length" before starting the scaling procedure explained above. This ensures that the initial value of the internal scaling factor is 1.0000. The internal impulse scaling factor is **stored to EEPROM automatically.**
Power Sense:	0 = batch counters not stored in the EEprom upon power down 1 = batch counters stored in the EEprom
Ramp Form	Selects the shapes of the ramps of the carriage speed profile. Two types of ramps are available: linear and S-shaped (sine square) ramps. The selection can be made independently for each of the four ramps of the speed profile by setting the corresponding bit of this parameter to either 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 an S-shaped ramp if the corresponding bit is 0 and it is linear if the corresponding bit is 1. Example: RampForm = 0 means that all ramps are S-shaped, RampForm = 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 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 stays in this window after the "ready to cut"-output has been switched on. After reaching the synchronic phase the FS150 controller continuously checks whether the carriage is in the cut window or not. SyncSamples = n means that the result of n consecutive checks must be positive (i.e. carriage in the cut 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 will probably cause the FS150 controller to give no "ready to cut"-signal at all! Setting range: 1 – 9999

10. Setup Menu

<table>
<tr><th>Register</th><th>Description</th></tr>
<tr><td>Mode:</td><td>Operation mode.
1 = Cut to length without print mark
2 = Cut with print marks</td></tr>
<tr><td>1Q/4Q:</td><td>Selects the type of the carriage
1: The carriage drive is a 4-quadrant drive moving forward with positive and moving reverse with negative speed reference voltage.
2: The carriage drive is a 1-quadrant drive using only positive speed reference voltage and selecting the direction of motion by digital inputs forward/reverse.</td></tr>
<tr><td>PI Format:</td><td>Selects the entry code of the PI parallel interface:
0 = Data entry in BCD-code
1 = Data entry in binary code.</td></tr>
<tr><td>Add-Cor:</td><td>Must normally be set to “1“ at any time. Setting to “0“ switches off the digital control loop for testing purpose.</td></tr>
<tr><td>Unit NR:</td><td>Attaches a device number to the FS150 controller for serial communication. Setting from 11 to 99. It is not allowed to use device numbers containing a “0“ (i.e. 09 or 20) since those are reserved for collective addressing of several units.
Ex factory, motrona units use always Unit NR.11.</td></tr>
<tr><td>Baud Rate</td><td>For serial operation only.
The following transmission rates can be selected:
<table>
<tr><th>Baud Rate</th><th>Setting</th></tr>
<tr><td>0</td><td>9600 Baud</td></tr>
<tr><td>1</td><td>4800 Baud</td></tr>
<tr><td>2</td><td>2400 Baud</td></tr>
<tr><td>3</td><td>1200 Baud</td></tr>
<tr><td>4</td><td>600 Baud</td></tr>
<tr><td>5</td><td>19200 Baud</td></tr>
<tr><td>6</td><td>38400 Baud</td></tr>
<tr><td colspan="2">Factory setting: = 0 Fig 34</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Register</th><th>Description</th></tr>
<tr><td>Ser- Form</td><td>For serial operation only.
The following formats of serial data can be selected:
<table>
<tr><th>Ser-Form</th><th>Data bits</th><th>Parity</th><th>Stop bits</th></tr>
<tr><td>0</td><td>7</td><td>Even</td><td>1</td></tr>
<tr><td>1</td><td>7</td><td>Even</td><td>2</td></tr>
<tr><td>2</td><td>7</td><td>Odd</td><td>1</td></tr>
<tr><td>3</td><td>7</td><td>Odd</td><td>2</td></tr>
<tr><td>4</td><td>7</td><td>None</td><td>1</td></tr>
<tr><td>5</td><td>7</td><td>None</td><td>2</td></tr>
<tr><td>6</td><td>8</td><td>Even</td><td>1</td></tr>
<tr><td>7</td><td>8</td><td>Odd</td><td>2</td></tr>
<tr><td>8</td><td>8</td><td>None</td><td>1</td></tr>
<tr><td>9</td><td>8</td><td>None</td><td>2</td></tr>
<tr><td colspan="4">Factory setting: 0 Fig. 35</td></tr>
</table></td></tr>
<tr><td>Bus-Add,
Bus-Baud,
Bus-Config,
BusTxPar,
BusRxPar:</td><td>Only relevant for units with option „field bus interface“ (CAN-Bus or PROFI-Bus DP). See supplementary instructions for further information.</td></tr>
<tr><td>Mast Dir:</td><td>Selects clockwise or anticlockwise rotation of the line encoder. For setting see section “Steps for commissioning“.</td></tr>
<tr><td>Slave Dir:</td><td>Selects clockwise or anticlockwise rotation of the carriage encoder. For setting see section “Steps for commissioning“.</td></tr>
<tr><td>Offs. Cor:</td><td>Sets the offset of the analogue correction signal. Range -99...+99mV. Must be set to 00 under regular conditions. See remark.</td></tr>
<tr><td>Gain Cor:</td><td>Adjusts the proportional Gain of the digital control loop. Practical settings are from 200 to 1000.
See section „“Steps for commissioning“.</td></tr>
<tr><td>Offset Tot:</td><td>Sets the offset of the total analogue output signal. Range -99.... +99mV. Must be set to 00 under regular conditions. See remark.</td></tr>
<tr><td>Gain-Tot:</td><td>Sets the Gain of the analogue feed forward signal to drive the carriage at correct speed. Range 0 - 999 999. For setting see “Steps for Commissioning“.</td></tr>
<tr><td>  </td><td><u>Remark for offset settings:</u>
FS150 uses precision operational amplifiers with a zero offset error of less than 1mV and the offset register can be set to zero normally. With extended installations however, an offset voltage can build up in the cables, caused by small balance currents between the different devices. Where you find the speed reference voltage of your carriage drive is not really zero at standstill, you can use the offset registers for compensation.</td></tr>
</table>

11. Adjust Menu

There are only the parameters Gain-Cor and Gain-Tot accessible (the same as described above), but in this menu they can be changed continuously with the motors running. This allows easy adjustment of the analogue synchronization and the intensity of correction while observing the LED bar graph and the drives. Keeping down key A continuously increments the values and key B decrements, while the LCD displays the current state. The PRG key stores the setting to the EEProm and key C resets the LED bar graph to its green centre position.

For the setup procedure it is best to mechanically disconnect the motor shaft from the carriage, so we can run the motor continuously and need not to observe the mechanical limitations of the carriage.

12. Testprog – Menu

This menu contains a couple of useful tests for the controller itself and its peripheral devices (encoders, remote lines etc.)

Register	Description
Mast-Dir:	This is the same register as in the setup menu, but the LCD display operates as an up/down counter for the master encoder pulses, permitting full check of the encoder functions. When the encoder is rotated "forward", the counter counts up. If incorrect, press "A" to change the counting direction. Key "B" operates as a counter reset button. Key "PRG" automatically stores the direction in the “Mast-Dir” register.
Slave-Dir:	Similar to Mast-Dir, but for slave encoder. Counter must also count up with forward rotation.
Off-Cor:	Similar to the setup menu, but continuous scroll up/down by keys "A" and "B" and 100x increased resolution (100 mV output correspond to 1 mV in reality) for better measuring.
Gain-Cor:	Similar to the setup menu, but continuous scroll up/down by "A" and "B" and full scale correction output (1024 error bits are simulated).
Offs-Tot:	Similar to setup menu, but scroll function with "A" and "B"
Gain-Tot:	Similar to setup menu, but scroll function with "A" and "B"
LED + PO:	Test for front Led’s and Control outputs PI/PO. Switches on and off all Led’s and outputs, one after the other.
Cont-IN:	Checks and displays the state of the PI/PO control inputs. The LCD display shows the inputs in hexadecimal code (0...9, A, B, C, D, E, F). Touching key "A" changes the code to "1 of 12" and the high state pin numbers of the connector appear in the display. In this code, only one pin can be displayed.
PI-IN:	Displays the state of all data and select lines in a BCD or hexadecimal code. Suited best to check data transmission from a remote switch or a PLC.
Factory:	Hidden registers, factory accessible only.

13. The LED Display

The 8 Led's mounted on front of the module indicate the instantaneous positional error between the real carriage position and the position where it should be in respect to the line. The display provides information for commissioning and fault monitoring, in a very simple form.

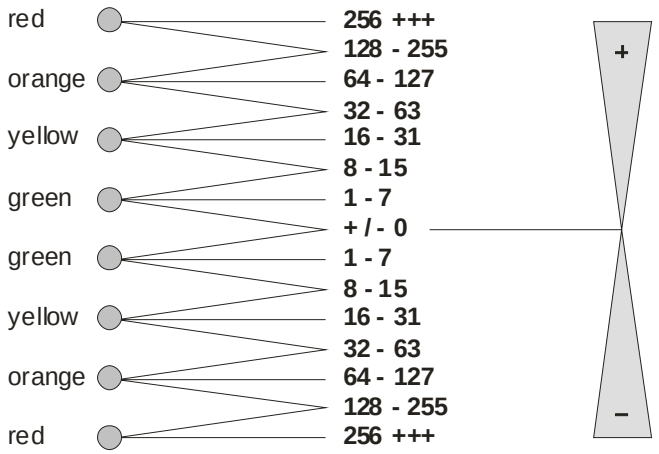


Fig. 36

When both green Led's in the center are lit, the positional error is absolutely zero, this means the carriage is exactly where is should be at that time.

When either of the green Led's is lit alone, the error lies between 1 to 7 encoder bits. When one green and one yellow LED is lit, the position error lies between 8 to 15 bits, etc.

When the lights are up, this indicates positive correction (Line leads carriage)
When the lights are down, this indicates negative correction (Line lags carriage)

The above notes hold for positive reference and forward motion. Everything is reversed for negative reference and reverse motion.

Under regular production conditions, with the unit properly set up, you should find the LED's in their center range at any time with the green and perhaps one yellow LED blinking.

14. Remarks about Drives, Encoders, Cables, Installation

14.1.

The drives in use must be dimensioned correctly in respect to power and dynamics required. The FS150 can never provide good operation outside the physical limits of the drives. Prior to connecting the master and the slave to the controller, both drives must be adjusted for a proper stand-alone operation with no oscillation, by means of a remote speed reference voltage. The reference inputs must be potential free.

14.2.

The resolution of the TTL-encoders, in principle, should be as high as possible, in order to keep the mechanical phase error as small as possible when the controller "plays" a few encoder increments around the zero error position. However it would be nonsense to choose the number of ppr much higher than needed or reasonable. If, for example, a gear box with several 0.1 mm of clearance is installed, a 0.01 mm resolution of the encoder could cause slight stability problems.

The FS150 loads each encoder channel with a current of 15 mA. For this reason, one encoder is unable to supply the impulse input of several target units at a time, as needed with some multi drive systems. In such applications, our impulse distributor type GV150 must be used to feed several controllers from one encoder.

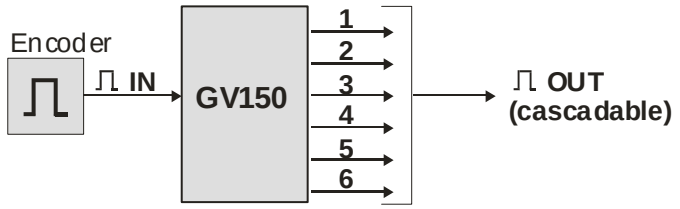


Fig. 37

14.3.

Please note, that not all types of cables are suited to transmit frequencies as high as 300 kHz! However, with proper installation and screening, the RS 422 lines provide perfect transmission even over long distances.

The cross section of encoder cables must be chosen with consideration of voltage drop on the line. The FS150 provides a 5.2 V encoder supply and at the other end the encoder must at least receive it's minimum supply voltage! (See encoder specifications).
Please observe the unit accepts at maximum 300 kHz of encoder frequency.

14.4.

You must strictly observe all rules and specifications given in the drive manual and all **general safety and installation standards**. Use shielded power cables for the motors. Keep distance between power cables and electronic cables. Put filters to all inductive equipment installed in the same cabinet (i.e. RC filters in parallel to coils of AC contactors, diodes in parallel to electromagnetic DC values etc.) Make sure your cabinet and your machine have a solid earthing/grounding system. FS150 possesses excellent features with EMC immunity, but it can fail under poor electrical environment conditions.
Keep strictly to the instructions for screening given in section 4)!

14.5.

If you need to switch electronic signals by relay contacts, it is **necessary** to use relays with **gold contacts**. For impulse or analogue switching, we recommend the use of our electronic matrix switch type **GV155**.

15. Steps for commissioning

In principle, all commissioning could happen without a PC, just by use of LCD and keypad. Since, however, things go much easier and faster, we recommend you to use the OS3.2 operator software and follow the subsequent steps.

15.1.

At this time you must be sure your carriage drive is adjusted for proper operation and maximum dynamics. Remove any ramps and delays from the drive because the FS150 controller will produce the ramps. Make sure the drive can run the maximum speed with a speed reference of 9 Volts already (We must leave 1 Volt of output swing for the FS150 to make corrections). For the setup procedure it is best to mechanically disconnect the motor shaft from the carriage, so we can run the motor continuously and need not to observe the mechanical limitations of the carriage.

15.2.

Make sure all connections are correct and DIL switch S1 is set according to need.

You must be sure your carriage drive runs forward (direction of the line) when is receives a positive voltage. If not, you must change this on your drive now.

15.3.

Power the unit up, connect the serial cable to the PC and start the OS3.2 software.

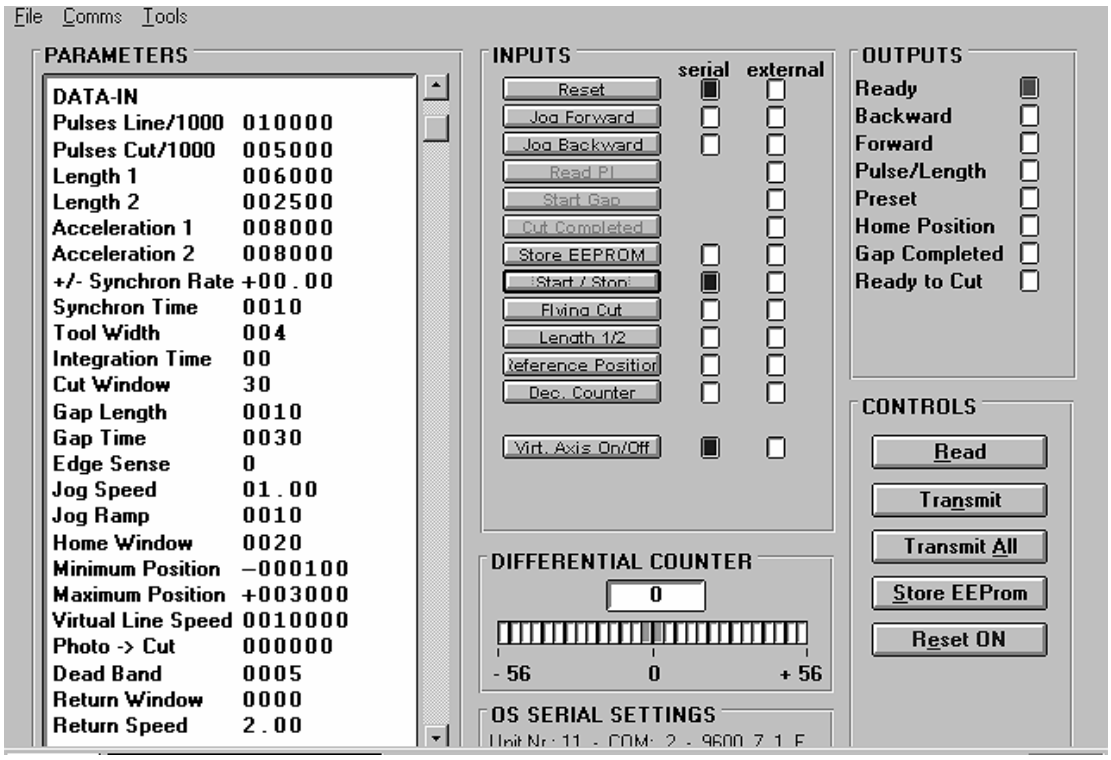


Fig 38

15.4.

Set all registers according to need.
For Virtual line speed select a small value (e.g. 10m/min) for the first steps. Also it is better to start with lower acceleration values and to optimize them later.

The following registers must be set to initial values like shown:

+/- Sync. Rate	:	00.00	Mode	:	1
Integration Time	:	00	Add Correction	:	1
Cut Window	:	99	Gain Correction	:	200
Return Speed	:	1.00	Gain Total	:	see table
			Unit NR.	:	11
			Baud Rate	:	0
			Ser Form	:	0

Fig 39

The initial Gain Tot setting depends on the expected maximum frequency of the line encoder (frequency in KHz at maximum line speed)

fmax	Gain Total
1 kHz	170 000
3 kHz	57 000
10 kHz	17 000
30 kHz	5 700
100 kHz	1 700
For frequencies between use interpolated values. Initial setting can be approximately.	

Fig 42

Setting of registers "Mast-Dir" and "Slave-Dir" is not important at this time.

Click "Transmit All" and then to "Store EEprom" to store your settings to the FS150 controller.

15.5.

We must first set the counting direction of the encoders. Select the **"Test"** function in the **"Tools"** menu.

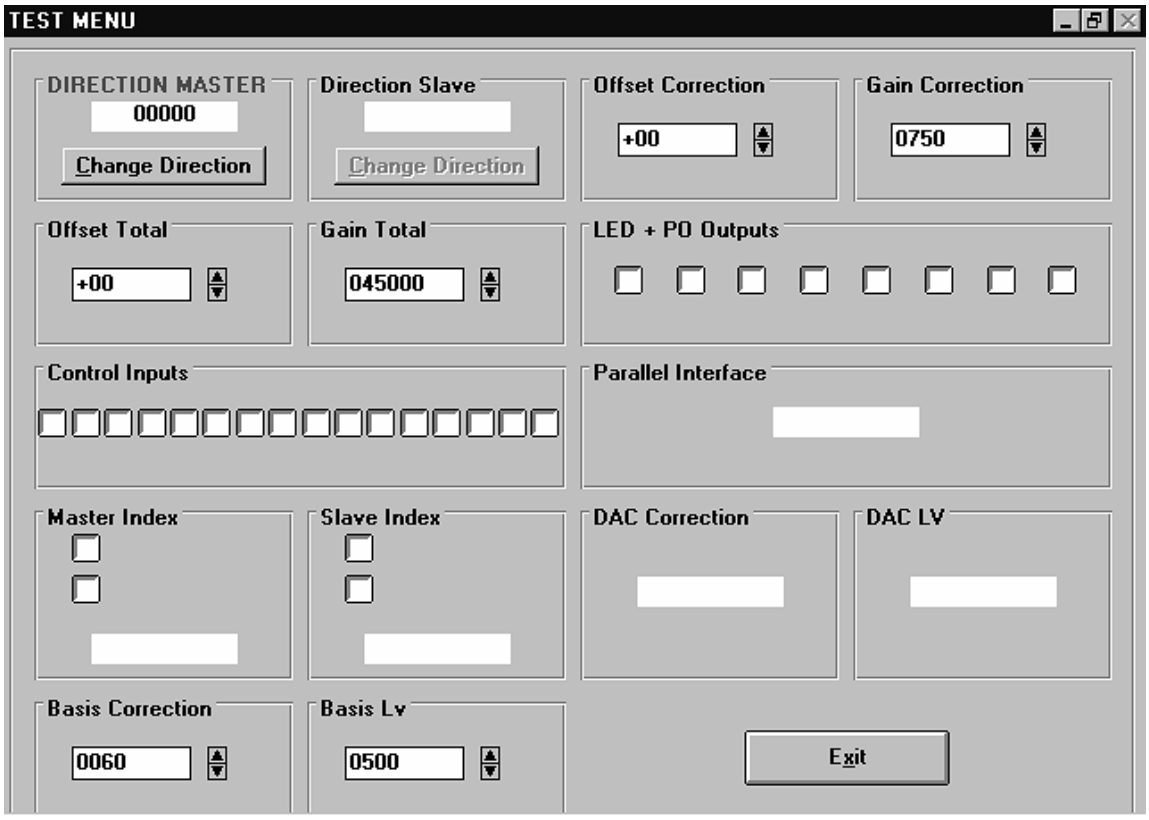


Fig 41

Click to the “Master Direction“ field. Rotate the Master encoder in forward direction, e.g. the direction it will rotate later with the material. The counter in the Master Direction field must count up. Where you find we count down, click “Change direction“.

When we count up, click to the **“Direction Slave“** field. Enable the carriage drive now. It will rotate with the speed set to the “virtual line“ register. Also this counter must count up. Where you find we count down, click “change direction“. When we count up, click to any other field to stop the carriage drive again.

15.6.

Where you use the parallel interface for length preset (e.g. with a remote BCD switch or a PLC data output), please click to the **“Parallel Interface“** field and verify the parallel data arrive correctly.

15.7.

Click “Exit“ now to return to the normal screen. This will save the settings in the controller. At this time you should check if the **control inputs** you use operate correctly. Apply all signals like “Reset“ or “Start/Stop“ and see if the signal change is visible in the “external“ column of the Inputs field of your screen.

15.8.

As a next step, we must set the **Gain Total** value for the analogue feed forward signal. Make sure the carriage drive is enabled to run, then select the **“Adjust“** function in the **“Tools“** menu. The carriage drive will immediately start to run with the speed set to the virtual line register.

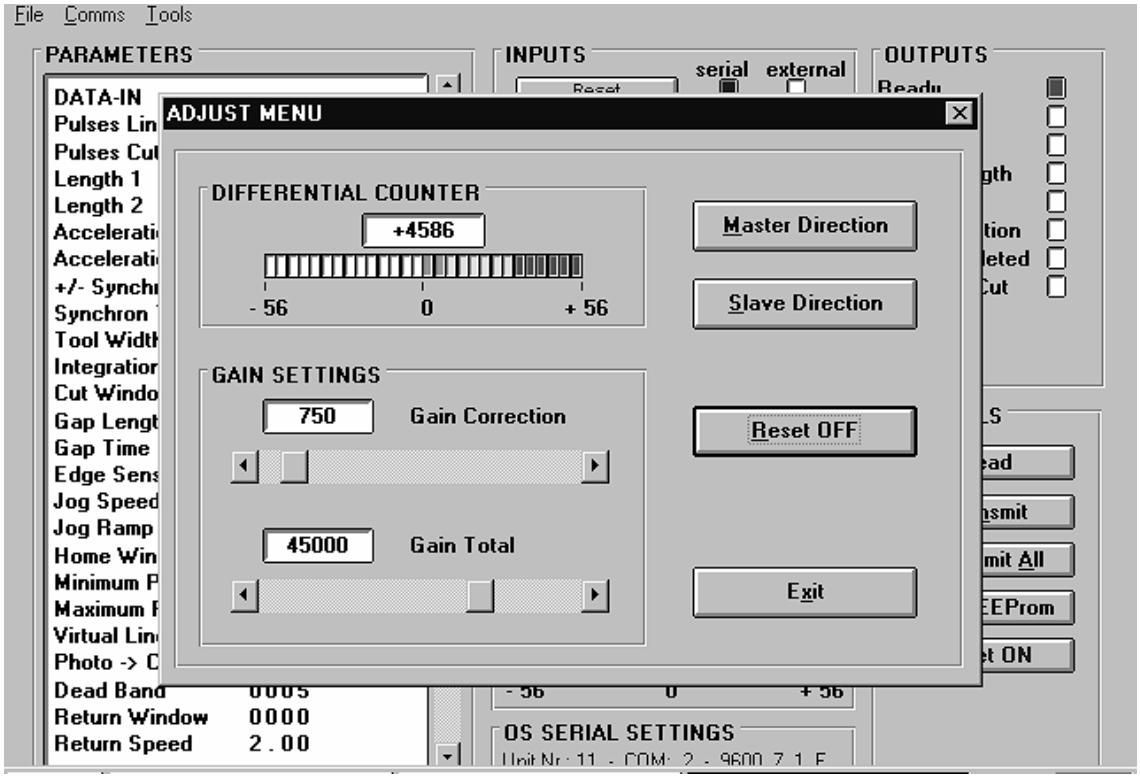


Fig42

We must observe the color bar graph and the differential counter now while we adjust the "Gain Total". Gain Correction should always be set to 200 during this procedure.
When we click the Reset to "ON", our differential counter will show zero and the bar graph will be in its green center position.
When we click the Reset to "OFF", our differential counter will run away and the bar graph will move to one or the other direction.

We must find now a setting for Gain Total that keeps our counter close around zero
(i. e. -5....0....+5) and the bar graph in its green/yellow center position.

- When the counter counts to positive (bar graph moves to right):
  Gain Total is too low and must be increased.
- When the counter counts to negative (bar graph moves to left):
  Gain Total is too high and must be reduced.
- For important changes of Gain Total use the slide button in the Gain Total field.
  For fine tuning, use the ▶ and ◀ buttons.and

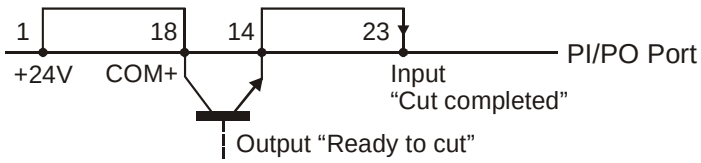
15.9.

When Gain-Total has been set correctly, we must now adjust **Gain-Correction**.
The rule is to have Gain Correction **as high as possible**. Typical values are from 300 to 1000, sometimes even 2000. Where you find your drive starts oscillating or running roughly, reduce Gain Correction again until we have stable operation. To change Gain-Correction, use the slide button or the ◀ and ▶ keys.

15.10.

We now can exit the Adjust Menu and return to the main menu. The machine is ready to cut and we can simulate automatic cutting cycles.

Hint:
When you cannot get the "Cut completed" signal because the carriage drive is mechanically disconnected to the machine, it is legal to link directly the "Ready to cut" output to "Cut complete input". This is valid for testing purpose only!



When you use this circuit for test:
a. Set register "Edge Sense" to "0"
b. Set the desired synchronous time to register "Sync Time"
c. Be aware the carriage will return with no regard to the tool!

Fig.43

- Put the carriage to the desired Home position by using the Jog function.

  Where your software limit switches would not allow you to reach the desired position, keep the "Set zero position" input High while you jog.
- Make sure your software limit switches (Min-Position, Max-Position, Alarm Preset) are correctly set so the carriage can move over the desired range. The software limit switches will not work while the „"Position Reset" is High, because this keeps the carriage position counter to zero.
- Set a long length and a low virtual line speed for the first tests.
- Have the Start/Stop input at stop while you switch the virtual line input to high.
- Set the start signal to "High".

  The virtual line is running now and the carriage is waiting for the first cut. On the screen you can see the Pulse/Length output blinking. This indicates the virtual line is running
- Watch the color bar on the screen (or even better the LCD's on the front of the unit) while we cut. We should stay in the green/yellow center field all the time. Increase the virtual line speed step by step while you continue watching the front LED's. Please do not use big steps. Increase like 10....20....30....40....50m/min, but never from 10 to 50 directly because this can cause problems.
- Where, during forward acceleration, the LED's move up, our "acceleration1" setting is too high and must be reduced (drive cannot follow the ramp).

  Where, during reverse acceleration, the LED's move down, our "acceleration2" setting is too high and must be reduced (drive cannot follow the ramp).
  Where during accelerations the LED's remain stable, you can increase the acceleration settings in order to get steeper ramps and faster cutting cycles.
  You can also use the oscilloscope function of the operator software. Set channel one to serial code **:1** to show the synchronizing error.
  Set channel two to serial code **:2** to show the carriage speed profile (The speeds appear positive in both directions)

The subsequent picture shows a typical example where the “acceleration2“ setting is too high and the drive cannot follow the ramps. This is indicated by synchronizing errors while the carriage accelerates or decelerates in reverse direction.

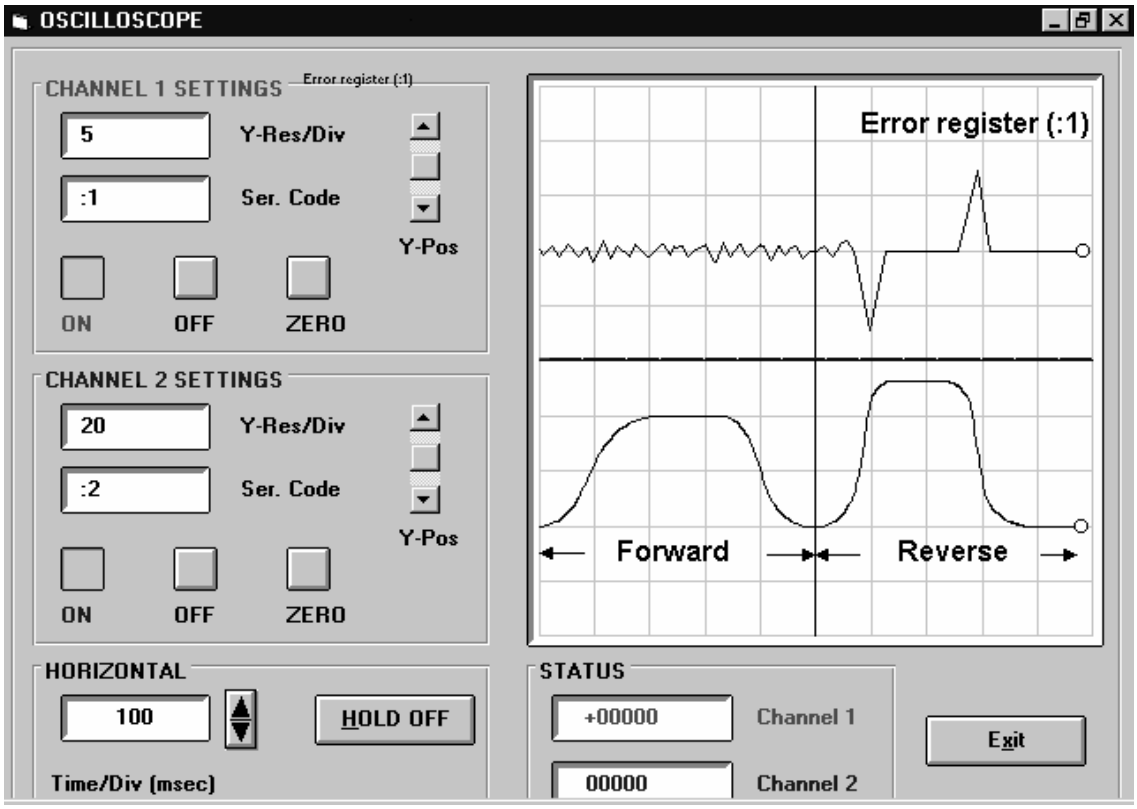


Fig 44

15.11.

We can try now to optimize some other settings:

- Reduce the “Cut Window“ setting to e.g. 20 and set „Integration Time“ to e.g. 30 at the same time. These are typical setting for most applications.
- Increase the “Return Speed“ ratio in order save time. The carriage will than return with higher speed.
- Increase acceleration settings to the limit where the drive still follows, whenever you need highest production efficiency.
- Keep the cutting time of the saw blade or shear as short as possible to reduce cycle time.

This concludes the setup procedure of the FS150 Flying Shear Control. We recommend you to store your settings on a disc or the hard disc of your PC. In case of exchange of the unit you just need to load down the parameter file to the controller to be ready for production again.

16. Alarm States and Conditions

We recommend to use the "Ready" output for alarm and trip control. When the unit trips to Alarm state,

- the Ready signal will go low
- the analogue output will go zero
- no further control will be maintained
- the two green center LED's on the front will blink
- serial communication will be possible and the reason for the trip can be read out from register **;0** .

To **exit** the Alarm State:

- Apply a High signal to the Reset input or
- Push the small Reset button located behind the front plate or
- Power down and up the unit again.

Please be aware the unit will immediately trip again unless the reason for the alarm has been removed.

These are possible reason for the unit to trip:

- During automatic production, the carriage touches the rear software limit switch (Min. Position)
- A cut cannot be executed because the carriage has not returned Home before it should restart again (cutting length too short or line speed too high)
- In mode 2 (Print Mark Operation), more than 10 marks have been detected between the photocell and the Carriage Home Position (stack overflow).

There is one alarm situation that needs to be controlled by remote customer circuit individually according to demand:
In automatic operation, the FS150 provides a High signal at the **carriage alarm output** when, during forward motion, the carriage position exceeds the preset level. The unit however will not stop the drive nor trip, but just signal that the preset position has been exceeded.

17. Accuracy considerations

It is easy to understand that the FS150 controller functions are based on correct information from the encoders. When you observe the LED 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 4-7 encoder increments and the resolution of the encoders will give the real error expressed in length units.
Where you find the real errors are more than indicated by the LED, you must check for the following items:

17.1.

Slip of the feed roll or the measuring wheel.

17.2.

Measuring wheel not exactly orthogonal to the material line or not exactly round, or tolerance in diameter.

17.3.

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).

17.4.

Clearance or backlash of the carriage drive or the cutting tool etc.

17.5.

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 register "<5" (see "8. Auxiliary register and command codes").This register must always contain the number of pulses of the line encoder (including multiple edge count). If the contents 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 to the FS150 controller.

17.6.

An incorrect synchronous ratio (values of parameters “Pulses Line/1000” or “Pulses Cut/1000” incorrect) can cause considerable cutting errors that are particularly big when the line speed changes. To check your synchronous ratio proceed as follows: First check the parameter “Pulses Cut/1000” (either by calculating it from your theoretical machine data or – if you are not 100% sure that the theoretical data are correct - by measuring it).

To measure this parameter you can use the carriage position counter “:4” that counts the carriage encoder pulses. Next move the line forward until there is material under the shear, stop the line and perform a flying cut. Then switch the Start/Stop-Input to high and start the line. Measure the first piece of material that has been cut after the line has been started and compare its length with the length preset of the FS150 controller. If the measured length is shorter than the length preset the value of parameter “Pulses Line/1000” is too low and must be increased. If the measured length is longer than the length preset the value of parameter “Pulses Line/1000” is too high and must be decreased. Repeat this procedure until you have found the correct setting of “Pulses Line/1000” (measured length and length preset are equal). 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 FS150 (which can be seen on the LED display) 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 whereas the length measurement error generally is proportional to the cutting length. Hence the two errors can be separated by a linear correlation function.

Example: Measuring 100 pieces of L = 0.5m, 1m and 2m at the same line speed has shown the following cutting errors:

$L = 0.5m \rightarrow \Delta L = \pm 0.4mm$ $L = 1.0m \rightarrow \Delta L = \pm 0.5mm$ $L = 2.0m \rightarrow \Delta L = \pm 0.7mm$

Hence, we have the following equation for ΔL : $|\Delta L| = 0.3mm + 0.2 \frac{mm}{m} \times L.$

Consequently the electronic cutting error (that is independent of the length) is ± 0.3mm and the length measurement error (that is proportional to the length) is ± 0.2mm/m.

It must be pointed out that the front LED’s are a reliable means to judge the cutting error. A rough estimation of the electronic cutting error can be obtained by reading the registers “;5” and “;6” that store the minimum and the maximum of the carriage position error from the “ready to cut”- to the “cut complete”-signal (unit: carriage encoder pulses; must be converted to length units by using parameter “Pulses Cut/1000”).

When the line and/or the carriage do not move smoothly, you could find 4 or even more LED’s ON at the time where we cut takes place. This however, in general, does not mean higher cutting errors. The LED’s are updated with a 100 µsec scan and display any kind of vibration, whilst the drive operates in a millisecond range and performs the average of what the LED’s say.

18. Which shortest length can we cut at a certain line speed?

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

When we would need to cut pieces of 1 meter length at a line speed of 60 meters/minute, this means we 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).
The following formulae allow calculation of the shortest cutting length possible at a certain line speed:

L_{min} :	Shortest possible length	(meter)	
R_1 :	Ramp 1 time for forward motion	(seconds)	
R_2 :	Ramp 2 time for reverse motion	(seconds)	
T :	Duration of the cut itself	(seconds)	
	(Time between termination of the acceleration ramp and the external „Cut completed" signal		
V_L :	Actual line speed (meters per second)		
V_R :	Maximum carriage return speed (meters per second)		Fig 45

Please note formulae use **ramp times** and not acceleration values, because otherwise we would get equations of third order which you would be certainly unable to solve.

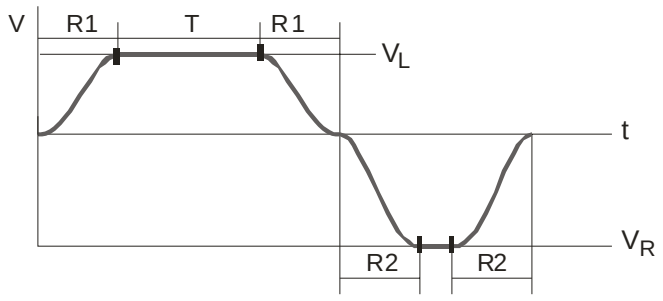


Fig 46

We need to separate two cases:

a. When $(R_1 + T) \cdot V_L \geq R_2 \cdot V_R$:

$$L_{min} = V_L \cdot \left[R_1 \cdot \left(2 + \frac{V_L}{V_R} \right) + R_2 + T \cdot \left(1 + \frac{V_L}{V_R} \right) \right]$$

b. When $(R_1 + T) \cdot V_L < R_2 \; V_R$:

$$L_{min} = V_L \cdot \left[2 \cdot (R_1 + R_2) + T \right]$$

Where you must cut shorter length, you must reduce line speed.

19. Which maximum line speed can we use with a certain cutting length

We need to separate two length ranges to calculate the maximum line speed.

a. When $L \le V_R \cdot \frac{R_2}{R_1+T} \cdot (2R_1+R_2+T)$

our maximum line speed must not exceed

$$V_{L\,max} = \frac{L}{2R_1+2R_2+T}$$

b. When $L > V_R \cdot \frac{R_2}{R_1+T} \cdot (2R_1+R_2+T)$

our maximum line speed can be

$$V_{L\,max} = V_R \left(\frac{-2R_1-R_2-T+\sqrt{(2R_1+R_2+T)^2+\frac{4}{V_R}\cdot L\cdot(R_1+T)}}{2R+2T} \right)$$

20. Which travelling distance does our carriage need?

This question may be important for the mechanical construction of our carriage system.

$$d = V_{L\,max}\left(R_1+T\right)$$

21. Auxiliary Register and Command Codes

The following auxiliary registers are accessible by serial link, with the access codes shown (R = Read only, R/W = Read/write)

Code	Name		Function
:1	Error Count	(R)	Shows the differential number of encoder increments between the scheduled carriage position and the real carriage position at any time
:2	LV value	(R)	Represents the actual feed forward signal (speed profile) of the carriage drive. 0 = Standstill 4095 = maximum speed.
:3	Length counter	(R)	32 bit counter counting continuously the length of the material passing the measuring wheel. Reset to zero by external Reset command.
:4	Carriage position	(R)	Position counter showing the actual carriage position with respect to "HOME".
:5	Integrator (R)		Current value of the integral part of the correction signal during synchronous phase.
:7	Batch counter	(R/W)	Increments with every cut executed. Decrements by input "Dec counter". Can be preset to zero or datum.
:8	Waste counter	(R/W)	Increments with every "Immediate Cut" signal. Can be preset to zero or datum.
:9	Line Speed	(R)	Represents the encoder frequency of the measuring wheel. 1 bit = 5Hz.
;0	Error Status	(R)	Shows internal error state. 3 = Overflow print mark buffer (trip) 2 = Min. Position touched (trip) 1 = Cut not executable. Carriage to restart before back home (trip).
;2	Absolute Pos.	(R)	Indicates the absolute position of the carriage, with respect to the "ZERO" position set by the Teach input.
;5	Min. Position Error	(R)	Minimum position error of the carriage between the "ready to cut"- and the "cut complete"-signal.
;6	Max. Position Error	(R)	Maximum position error of the carriage between the "ready to cut"- and the "cut complete"-signal.
<4	Actual Cutting Length	R)	Actual cutting length.
<5	Master Z-Distance	(R)	Distance between two index pulses of the line encoder (in encoder increments, including multiple edge count).

Beside the serial access codes shown in this manual, the subsequent codes are available to execute the same commands that can be activated by the hardware inputs also:

Code	Bit of control word (86)	Function	Type
55	14	Length select	S
56	4	Read PI data	D
57	2	Cut completed	S
58	0	Start/Stop	S
59	15	Immediate cut	D
60	7	Reset	S
61	13	Set zero position	S
62	12	Dec. Batch counter	S
65	6	Jog forward	S
66	5	Jog backwards	S
67	3	Activate data	D
68	1	Store EEProm	D

S = Static command, must be set to 1 to activate command and must be reset to 0 to deactivate command.

D = Dynamic command, must be set to 1 to activate command.
Is automatically reset to 0 after execution.

Fig. 47

All commands can be activated either by its serial access code or by setting the corresponding bit of the control word **(Ser. Access code 86).**

Please note that all serial commands are “logical OR” to hardware commands (control inputs) and hence a command is ON whenever set by serial command or hardware input or both at a time.
The state of the control outputs can be read out by the status word (Ser. Access code 85) via serial interface. Bit 7, 6, 5, …, 1, 0 of the status word correspond to control outputs PI/PO pin 5, 17, 4, 16, 3, 15, 2, 14.

22. General Master Reset and Erase of EEProm

The unit carefully checks all entry data for validity and correctness within their permitted numeric range. If, as an extreme exception, invalid data should intrude into the register range, bad function or even a full hang-up could be the result. If this should ever happen

- push the Reset button on the unit's front (accessible by a small screw driver only)

  or
- power down the unit and power up again after a few seconds.

  Both measures result in a complete reconfiguration of all ports and registers. **RAM and buffer data** will be **lost** and the unit restores all data from the EEProm.

  If, however, invalid data should have penetrated to the EEProm, even the previous steps will not help. In this case we must erase the EEprom:

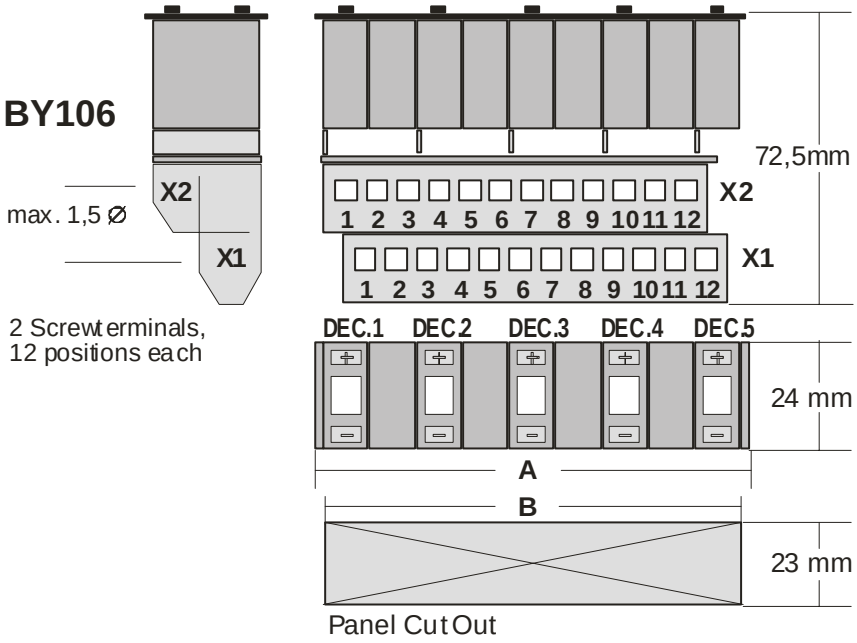
- switch off the unit
- set the slide switch PRG/RUN to the PRG position
- keep key A down while powering up the unit and keep it down for at least another 5 sec.

  This will clear up all the EEProm to its factory default values, and all registers need to be setup once more.

Above steps represent an emergency procedure that you will never have to apply under regular conditions.
In an extreme case however (i. e. lightening-strike in the factory etc.) they could help to get the unit working again.

It is mandatory erase the EEprom when the processor has been changed for reasons of software upgrade.

23. The BY 106-X Remote Thumbwheel Switch



Switch Type	No.Decades	A (mm)	B (mm)
BY 106-3	3	59,5	57
BY 106-4	4	59,5	57
BY 106-5	5	74,5	72

Fig. 48

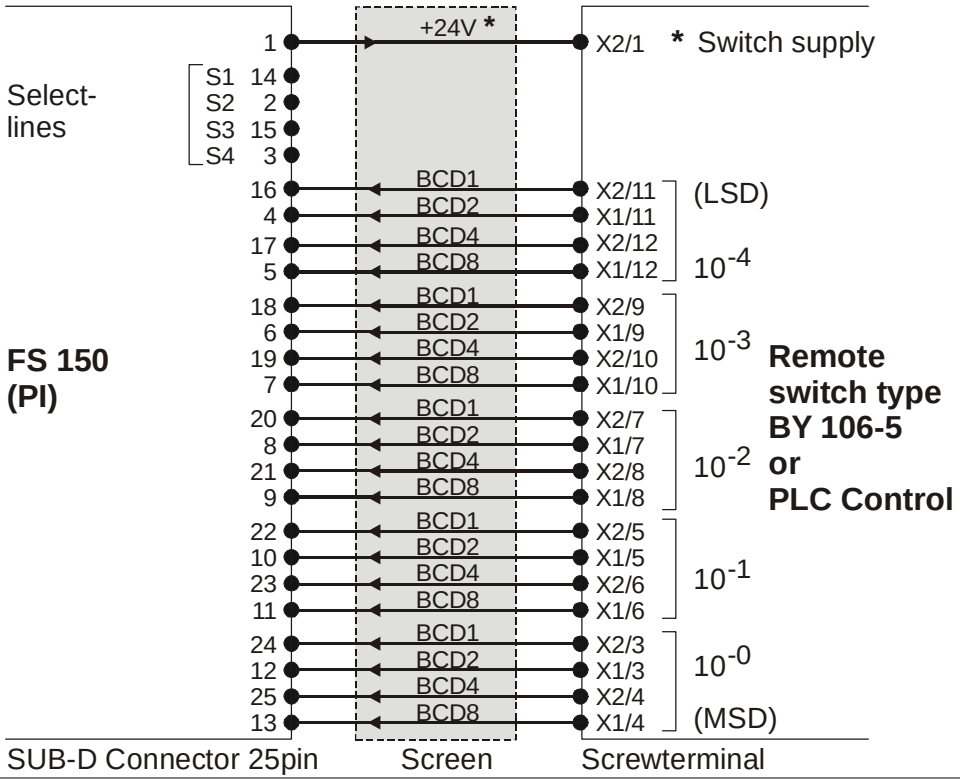


Fig. 49

24. Dimensions and Specifications

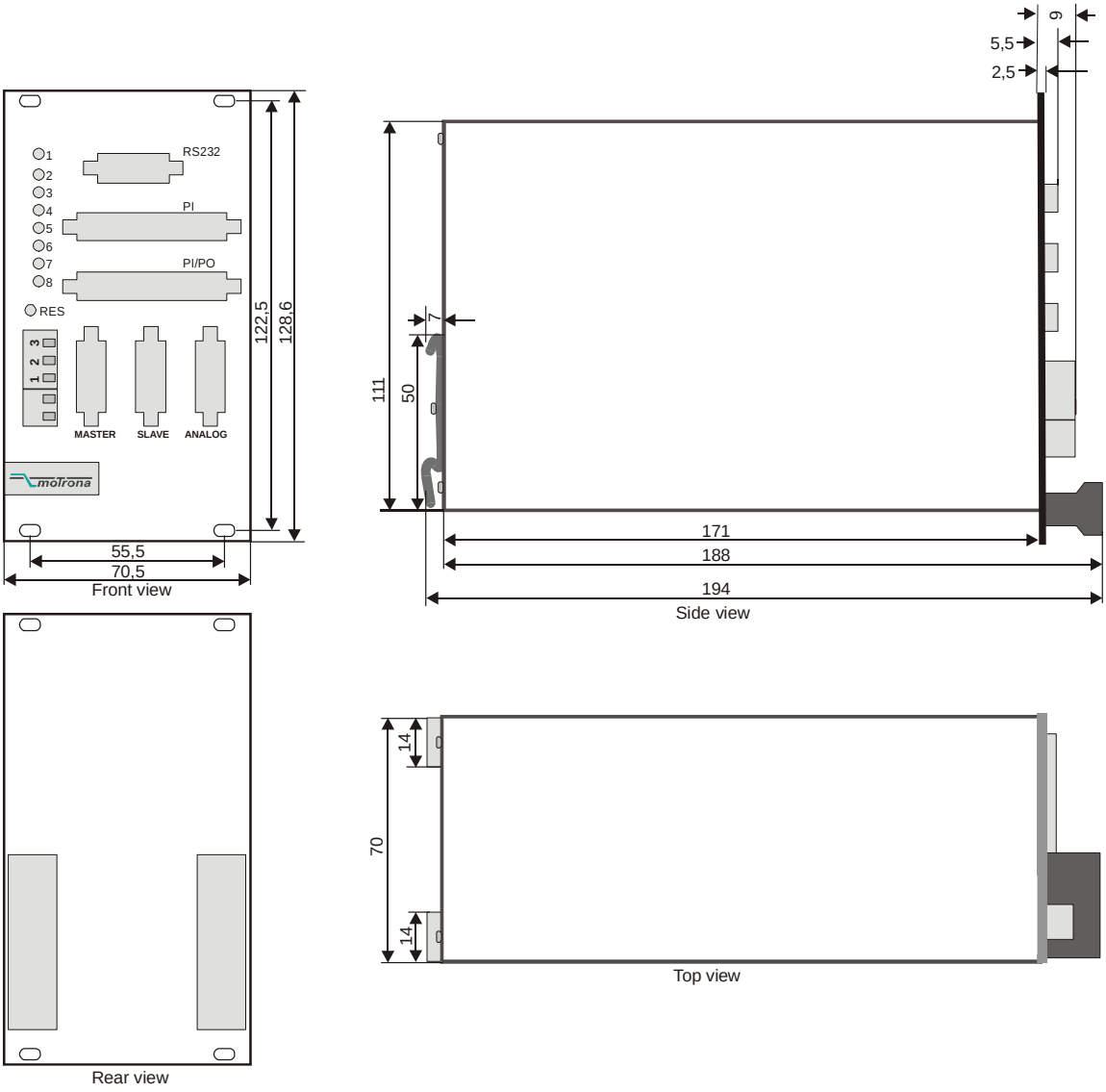


Fig 50

Power supply	:	18...30 V unstabilized
Consumption	:	approx. 300 mA (plus 25% of the encoder supply currents, if internal encoder supply used)
Encoder Supply	:	Aux. voltage 5.2 V, max. 400 mA installed
Processor	:	H8/532 with 20 MHz clock frequency
PCB and Technology	:	SMD, Multiplayer PCB`s, High speed logic 74 HCT
Encoder Inputs	:	Two A, /A, B, /B, Z, /Z (5 V TTL opto-isolated) Low < 0.8 V, High >3.0 V (4.0 V differential input signals)
Other Inputs	:	1 parallel port PI (24 lines) 1 control port (12 lines) all PNP with 10 - 30 V level.
Serial link	:	RS 232 and RS485, CAN optional, Profibus u. d.
Absolute max. frequency	:	310 kHz
Response time	:	approx. 150 µsec
Analogue In/Out	:	3 inputs +/- 10 V (Ri = 100 kOhms) 3 outputs +/- 10 V (Imax = 5 mA) Resolution: 12 Bit (= 4096 steps)
Analogue Correction	:	10 Bit = 1024 error increments
Error memory	:	32 000 error increments
Control Outputs	:	8 transistor outputs (opto-coupler 30 V / 30 mA max.)
Cutting accuracy	:	ca. +/- 5 encoder increments
Ambient temperature	:	Operation: 0 - 45°C (32 – 113°F) Storage: -25 - +70°C (-13 – 158°F)
Dimensions	:	see drawing
Weight	:	Approx. 850 g
Conformity and standards	:	EMC 89/336/EEC: EN 61000-6-2 EN 61000-6-3 NS73/23/EEC: EN 61010-1

25. Serial Code List

25.1. Parameter

#	Menu	Name	Code	Min	Max	Default
0	DATA-IN	Pulses Line/1000	00	1	999999	10000
1	DATA-IN	Pulses Cut/1000	01	1	999999	10000
2	DATA-IN	Length 1	02	1	999999	1000
3	DATA-IN	Length 2	03	1	999999	1000
4	DATA-IN	Acceleration 1	04	1	999999	5000
5	DATA-IN	Acceleration 2	05	1	999999	5000
6	DATA-IN	+/- Synchron Rate	06	-9999	9999	0
7	DATA-IN	Synchron Time	07	1	9999	100
8	DATA-IN	Tool Width	08	0	999	0
9	DATA-IN	Integration Time	09	0	99	50
10	DATA-IN	Cut Window	10	2	99	99
11	DATA-IN	Gap Length	11	0	9999	0
12	DATA-IN	Gap Time	12	10	9999	10
13	DATA-IN	Edge Sense	13	0	1	0
14	DATA-IN	Jog Speed	14	0	1000	100
15	DATA-IN	Jog Ramp	15	1	9999	10
16	DATA-IN	Home Window	16	1	9999	100
17	DATA-IN	Minimum Position	17	-999999	999999	-999999
18	DATA-IN	Maximum Position	18	-999999	999999	999999
19	DATA-IN	Virtual Line Speed	19	1	9999999	50000
20	DATA-IN	Photo -> Cut	20	0	999999	0
21	DATA-IN	Dead Band	21	0	9999	0
22	DATA-IN	Return Window	22	0	9999	0
23	DATA-IN	Return Speed	23	1	999	999
24	DATA-IN	Sampling Time	24	1	9999	10
25	DATA-IN	Preset	25	0	999999	1000
26	DATA-IN	Length / Pulse	26	1	65535	100
27	DATA-IN	Scaling Length	27	1	999999	1000
28	DATA-IN	Power Sense	28	0	1	0
29	DATA-IN	Ramp Form	29	0	15	0
30	DATA-IN	Sync Samples	30	1	9999	1

#	Menu	Name	Code	Min	Max	Default
31	SET-UP	Mode	40	1	2	1
32	SET-UP	1Q/4Q	41	1	2	1
33	SET-UP	PI-Format	42	0	1	0
34	SET-UP	Add-Correction	43	0	1	1
35	SET-UP	Ser. Unit Number	90	11	99	11
36	SET-UP	Ser. Baud Rate	91	0	6	0
37	SET-UP	Ser. Data Format	92	0	9	0
38	SET-UP	Bus Address	93	1	127	1
39	SET-UP	Bus Baud Rate	94	0	7	1
40	SET-UP	Bus Config.	95	0	255	1
41	SET-UP	Bus Tx Parameter	96	0	255	0
42	SET-UP	Bus Rx Parameter	97	0	255	0
43	SET-UP	Master Direction	45	0	1	0
44	SET-UP	Slave Direction	46	0	1	0
45	SET-UP	Offset Correction	47	-99	99	0
46	SET-UP	Gain Correction	48	0	9999	100
47	SET-UP	Offset Total	49	-99	99	0
48	SET-UP	Gain Total	50	1	999999	1000

25.2. Inputs

#	Name	Code	Cmd Bit	SerStatus	BusStatus	ExtStatus
0	Reset	60	0080	Yes	No	Yes
1	Jog Forward	65	0040	Yes	No	Yes
2	Jog Backward	66	0020	Yes	No	Yes
3	Read PI		0010	No	No	Yes
4	Start Gap		0008	No	No	Yes
5	Cut Completed		0004	No	No	Yes
6	Store EEPROM	68	0002	Yes	No	Yes
7	Start / Stop	58	0001	Yes	No	Yes
8	Flying Cut	59	8000	Yes	No	Yes
9	Length 1/2	55	4000	Yes	No	Yes
10	Reference Position	61	2000	Yes	No	Yes
11	Dec. Counter	62	1000	Yes	No	Yes
12			0800	No	No	No
13	Virt. Axis On/Off	63	0400	Yes	No	Yes
14			0200	No	No	No
15			0100	No	No	No

25.3. Variables

#	Name	Code	Notes
0	tstcou	":0"	Internal Using
1	diff1	":1"	R(*)
2	lvwert	":2"	R
3	lengcoh	":3"	Internal Using
4	cutcouh	":4"	
5	integ	":5"	
6	len_p1h	":6"	R
7	prdcouh	":7"	R/W(**)
8	wstcouh	":8"	R/W
9	v_leit	":9"	R
10	errsta	";0"	Internal Using
11	cystah	";1"	
12	poscouh	";2"	
13	lenim1h	";3"	
14	lenim2h	";4"	
15	mindiff	";5"	
16	maxdiff	";6"	
17	poserr	";7"	
18	cutminh	";8"	
19	cutmaxh	";9"	
20	rmptim1	"<0"	
21	rmptim2	"<1"	
22	scalfach	"<2"	
23	dprsta	"<3"	
24	actlenh	"<4"	R
25	zmasdis	"<5"	Internal Using
26	h'0000	"<6"	
27	h'0000	"<7"	R
28	h'0000	"<8"	R
29	h'0000	"<9"	Internal Using
30	varaddh	"=0"	
31	h'0000	"=1"	

(*) Read only
(**) readable and writable