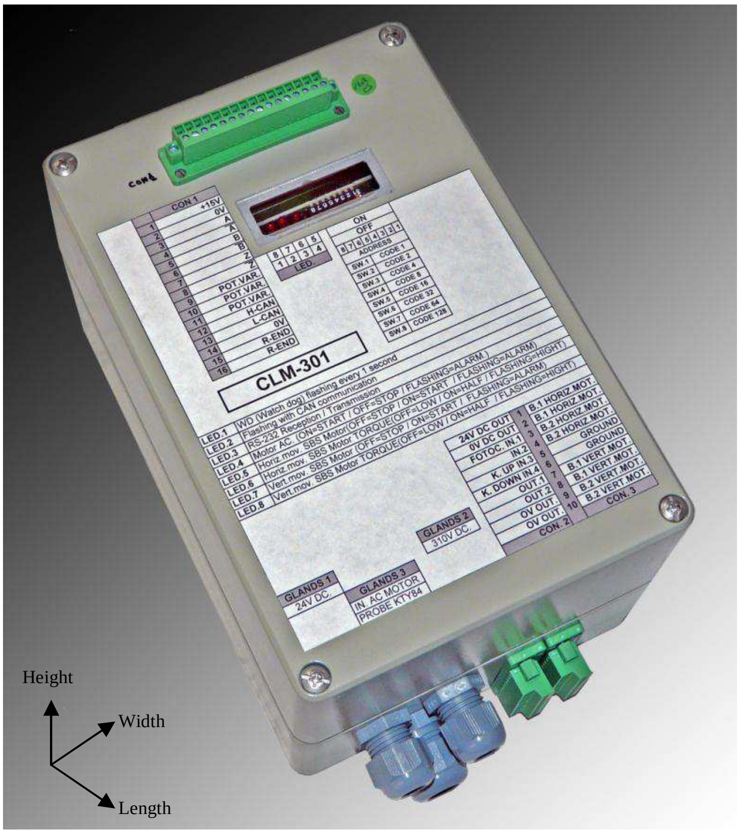
MULTIPLE MOTORS CONTROL THROUGH CAN CLM-301

Description

Module used to control two SBS motors (step by step, for the horizontal and vertical movement of the knife) and a brushless (torque, for the turn of the knife) through CAN communication, being able the use of different working ways (asynchronous, synchronous, pulse counting) as well as the control of acceleration and deceleration ramps.

- Allows horizontal synchronized movement of several equipments.
- Allows knife vertical position measurement to control the penetration of it.
- Has inputs and outputs for general purpose



Application

Its principal application is found in the longitudinal cut of heavy machinery in the paper industry: CLM = Motorized, Longitudinal, Cut

	Dimensions(mm)			*Weight (Kg)*
	Height	Width	Length	
Total necessary area	155	155	270	
Case	135	155	238	

Additional Data

- ✓ Synchronism horizontal movement between top and low knife.
- ✓ Knifes turning speed control through PMSM motor (permanent magnet synchronous motor).
- ✓ Modules addressing through micro-switch.
- ✓ SW adapted for graphical visualization of records and change of version through RS232.
- ✓ Inputs with supply for extern detectors and differentials encoders.
- ✓ Outputs for devices control
- ✓ Knife penetration auto-adjustment through potentiometer reference.
- ✓ Alarms and devices state signals with led diodes.

Common data

To govern a longitudinal arm, the CLM-301 module has to control:

- ✓ PMSM motor for knife turn.
- ✓ SBS motors for horizontal and vertical movement of the knife.
- ✓ Potentiometer for knife penetration reference.
- ✓ Four stages
  1: photoelectric cell for knife diameter calculation.
  2: general purpose.
- ✓ Two outputs:
  1: Acts on the electro-valve that presses the top knife against the low one.
  2: general purpose.

The CLM-301 control is done through the OPENCAN, hanging from a CANMASTER as many modules as necessary. Each CLM-301 uses 4 gates of the CAN controller, must not overload the line. Each module addressing is done with a micro-switch according to selected code, beginning with the switch of less weight (CODE1).

ON	
OFF	
8 7 6 5 4 3 2 1	
ADDRESSING	
SW.1	CODE 1
SW.2	CODE 2
SW.3	CODE 4
SW.4	CODE 8
SW.5	CODE 16
SW.6	CODE 32
SW.7	CODE 64
SW.8	CODE 128

According to standard OPENCAN, the gate definition comes given by…

ID									CRC
OPENCAN Standard + switch	8 bytes								

…being switch the addressing to each CLM-301 module.

The gates addresses and the frames composition of the CLM-301 module seen from the CODESYS programming language is the following:

frame

Gate 1	180h+switch	RXPDO_1 PMSM control	RXPDO_2 PSM speed level	RXPDO_3 Horizontal SBS control	RXPDO_4 Vertical SBS control
Gate 2	200h+switch	TXPDO_1 PMSM states / alarms	TXPDO_2 PMSM real speed	TXPDO_3 horizontal SBS state	TXPDO_4 horizontal SBS state
Gate 3	280h+switch	RXPDO_1 y RXPDO_2 outputs / pulses to move for horizontal SBS		RXPDO_3	RXPDO_4 Pulses to move for vertical SBS
Gate 4	300h+switch	TXPDO_1 y TXPDO_2 inputs / present pulses horizontal SBS		TXPDO_3 Potentiometer	TXPDO_4 Present pulses for vertical SBS

gates 1 and 3 -> transmission for codesys (reception for CLM-301)
gates 2 and 4 -> reception for codesys (transmission for CLM-301)

Each CLM-301 module has a glazed window on the upper side of its case for leds visualization. These leds show all devices state, according to following table code.

VISUALIZ. ORDER			
8	7	6	5
1	2	3	4
LED.			

LED.1	**WD (Watch dog) flashing every 1 second**	
LED.2	**CAN Communication**	FLASHING
LED.3	**RS-232 Reception/Transmission**	
LED.4	**PMSM motor.**	OFF=STOP ON=START FLASHING=ALARM ***(*)***
LED.5	**Horizontal mov. SBS motor**	OFF=STOP ON=START FLASHING=ALARM
LED.6		TORQUE OFF=LOW ON=MIDDLE FLASHING=HIGH
LED.7	**Vertical mov. SBS motor**	OFF=STOP ON=START FLASHING=ALARM
LED.8		TORQUE OFF=LOW ON=MIDDLE FLASHING=HIGH

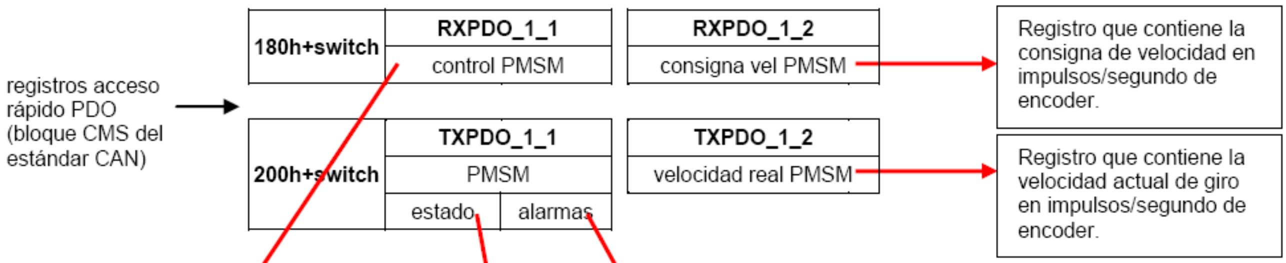
(*) *The alarm indicated by the LED4 can have different meanings for a PMSM or a SBS motor. See them detailed in the part of this document that refers to the above mentioned motor.*

MOTOR PMSM (brushless / torque)

The control of this motor is done in closed speed loop. Just the first time that the motor starts (after a reset of the CPU), the motor turns in open loop until it founds the position of the "0" angle of the stator poles. Once the motor is positioned it will turn taking as a reference the "0" position of the calculated angle. The configuration values of the PID loops, alarms… are customized by default, being able to modify them from the CODESYS programming language. The control records and the motor visualization are located on the "processmap" and depend on the ID (Switch number).

Switch	Processmap del Codesys (escritura en CLM-301)	
1	PMSM_01_CONTROL	AT %QW2572: WORD
	PMSM_01_CONSIGNAVEL	AT %QW2573: WORD
2	PMSM_02_CONTROL	AT %QW2584: WORD
	PMSM_02_CONSIGNAVEL	AT %QW2585: WORD
3	PMSM_03_CONTROL	AT %QW2596: WORD
	PMSM_03_CONSIGNAVEL	AT %QW2597: WORD
…	…	…
Switch	**Processmap del Codesys (lectura del CLM-301)**	
1	PMSM_01_ESTADO_ALARMAS	AT %IW2572: WORD
	PMSM_01_REALVEL	AT %IW2573: WORD
2	PMSM_02_ESTADO_ALARMAS	AT %IW2584: WORD
	PMSM_02_REALVEL	AT %IW2585: WORD
3	PMSM_03_ESTADO_ALARMAS	AT %IW2596: WORD
	PMSM_03_REALVEL	AT %IW2597: WORD
…	…	…

The records have the speed "consigna" in encoder impulses/second, which is 2048 pulses/turn. It is possible to accede to the records from the CAN reception and transmission buffer (RXPDO, TXPDO).



Estado y control PMSM

bit	Hex	
0	1	Marcha
1	2	Parada
2	4	Carga parámetros online
3	8	Reset alarmas

RXPDO=RECEPCION
TXPDO=TRANSMISION

Códigos alarma PMSM (led 4 display parpadeando)

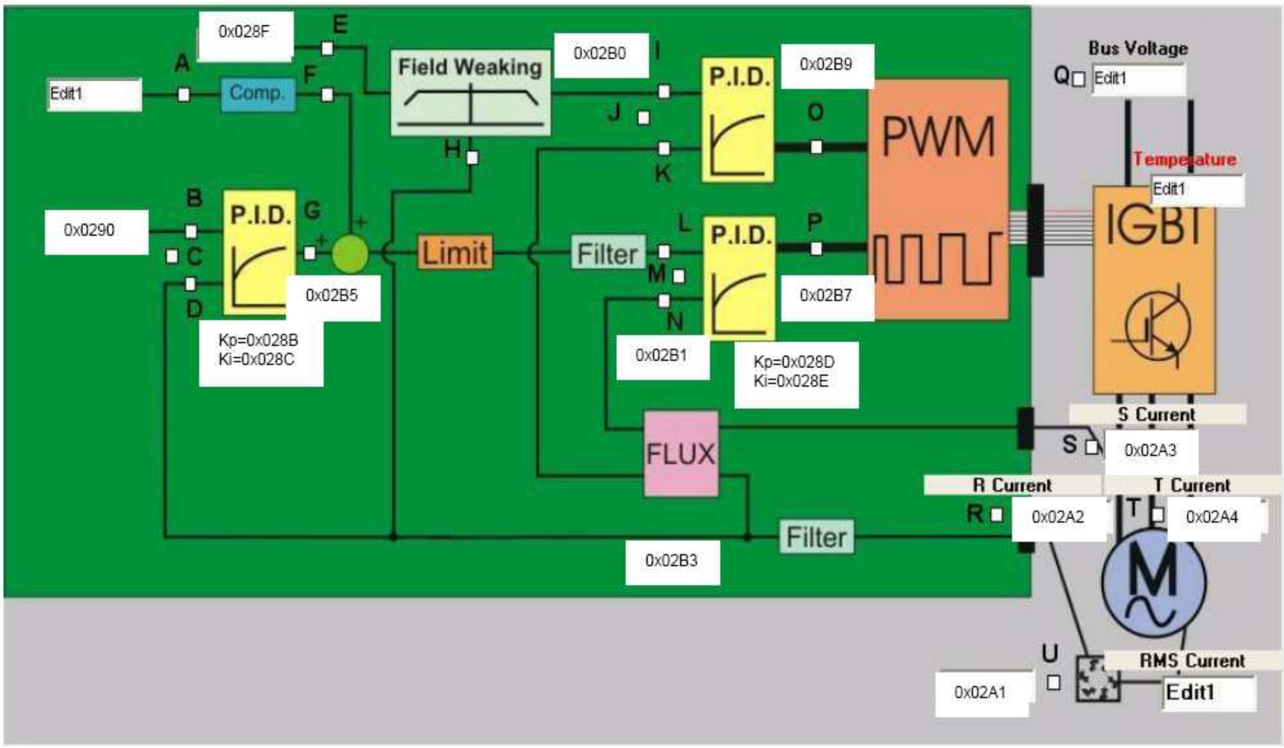
Valor	
1	Sobrecorriente de pico rama R
2	Sobrecorriente de pico rama S
3	Sobrecorriente de pico rama T
4	Sobrecorriente rms rama R
5	Sobrecorriente rms rama S
6	Sobrecorriente rms rama T
7	Alarma módulo de potencia (IGBT)
8	Alarma sonda temperatura (KTY) ALARM.> 95ºC
9	Alarma tensión baja de bus
10	Alarma error en la comunicación CAN
11	Alarma conexión errónea encoder.

Control loops records configuration

In the CODESYS block, in the MTC-3038 module properties exist the “Editable parameters” flap, where some motor control loops parameters can be modified. They would correspond with slow access record SDO (CMS block of CAN standard), so they are send just once (initial configuration).

REGISTER	COMMENT	FACTOR
Current sensor adjust IR	Registers for IR current measurement adjustment.	
Current sensor adjust IS	Registers for IS current measurement adjustment.	
Note: the IT current measurement is done matematically		
Linear sensor Poten. Adjust	Register for the adjustment of the measurement that the potentiometer gives, which indicates in hundreth the height of the knife	*Q12*
Reak current limit	Current peak so that alarm goes off. 1000H=5A.	*Q12*
RMS Current limir	RMS Current so that alarm goes off.	*Q12*
Maximum speed ramp	Value that a slope generate us if the speed value produces a sudden change or jump.	
Speed filter	Filter in the speed measurement.	
Speed PID	Kp= proportional constant speed loop.	
Speed PID	Ki= integrative constant speed loop.	
Torque PID	Kp= proportional constant speed loop.	
Torque PID	Ki= integrative constant speed loop.	
Magnetizing current reference	Reference of the magnetizing current-	

PMSM module configuration record.



Through RS-232 communication with its respective equipment, the addresses in upper graph can tested.

SBS MOTORS (horizontal movement)

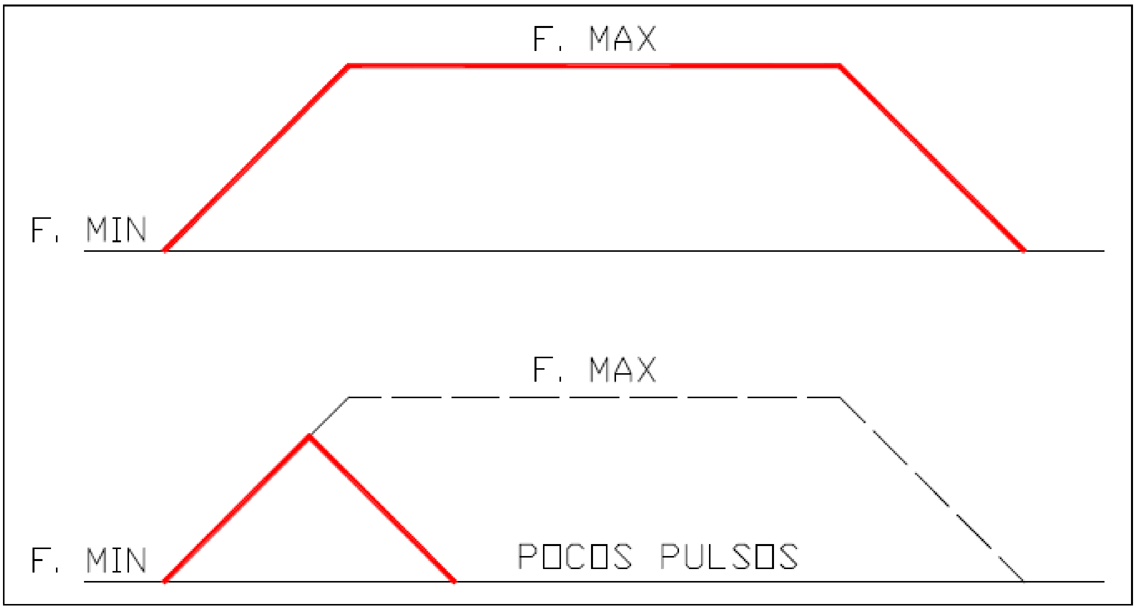
The horizontal movement of the knife is controlled by a SBS motor. This motor can start in synchronous way, starting the upper and lower knife at the same time with the synchronous order. The motor can start doing a torque stopped.

Working ways

Asynchronous
Starts in an individual way with a ramp from a minimum frequency to a maximum. The time of raise is given in tenths of second.

Deceleration
It is only applied in the asynchronous way. Goes from a maximum frequency to a minimum one. The deceleration time is the same as the acceleration time.

Pulses counting
The number of pulses that the knifes want to be moved has to be indicated, the way itself generates the acceleration and deceleration ramp from the maximum and minimum frequency. If there are not many pulses, it is possible that the maximum frequency is not reached.



Synchronous
This way allows starting several motors at the same time (example: pair of knifes upper and lower). Firstly the motors that want to be started are kept with the order “start”, when a common signal reach to all the equipments “synchronization order” all of them start at the same time. The stop can also be in synchronous way.

Synchronous way starting process

- Send to the records control of the motors that want to be started, the value “CONTROL_SBS=0x010Eh”.
- Verify which state record has located the value “ESTADO_SBS=0x010Eh”.
- Send “TRUE” to the system value “MTC3038_SINCRO(BOOL)=TRUE”. Motors star at the same time.

Switch	Processmap del Codesys (nomenclature of CLM-301)		
1	SBS_01_HORIZONTAL_CONTROL		AT %QW2574: WORD
	SBS_01_HORIZONTAL_FRE_MAX		AT %QW2574: WORD
	SBS_01_HORIZONTAL_FRE_MIN		AT %QW2574: WORD
	SBS_01_HORIZONTAL_RAMPA		AT %QW2574: WORD
	SBS_01_HORIZONTAL_REF_PULSOS_LSW	24 bits	AT %QW2576: WORD
	SBS_01_HORIZONTAL_REF_PULSOS_MSW		AT %QW2577: WORD
2	SBS_02_HORIZONTAL_CONTROL		AT %QW2586: WORD
	SBS_02_HORIZONTAL_FRE_MAX		AT %QW2586: WORD
	SBS_02_HORIZONTAL_FRE_MIN		AT %QW2586: WORD
	SBS_02_HORIZONTAL_RAMPA		AT %QW2586: WORD
	SBS_02_HORIZONTAL_REF_PULSOS_LSW	24 bits	AT %QW2588: WORD
	SBS_02_HORIZONTAL_REF_PULSOS_MSW		AT %QW2589: WORD
...	...		...
Switch	**Processmap del Codesys (reading of CLM-301)**		
1	SBS_01_HORIZONTAL_ESTADO		AT %IW2574: WORD
	SBS_01_HORIZONTAL_REAL_PULSOS_LSW	24 bits	AT %IW2576: WORD
	SBS_01_HORIZONTAL_REAL_PULSOS_MSW		AT %IW2577: WORD
2	SBS_02_HORIZONTAL_ESTADO		AT %IW2586: WORD
	SBS_02_HORIZONTAL_REAL_PULSOS_LSW	24 bits	AT %IW2588: WORD
	SBS_02_HORIZONTAL_REAL_PULSOS_MSW		AT %IW2589: WORD
...	...		...

The visualization records and the horizontal movement motor control are located in the "processmap".

MSW shares word with outputs.

It is possible to accede to the records from CAN reception and transmission buffer (RXPDO, TXPDO).

Common register to all the modes. When starting it sets to 0 until the number of pulses programmed. MSW shares word with

Quick access register to PDO (CMS block of standard CAN)

280h+switch	RXPDO_1 and RXPDO_2	
	Outputs	Pulses to move SBS horizontal

180h+switch	RXPDO_3
	Horizontal SBS control

300h+switch	TXPDO_1	
	Inputs	Present pulses SMS horizontal

200h+switch	TXPDO_3
	Horizontal SBS state

Horizontal SBS control

bit	Hex		
0	0000h	Direction	
1	0002h	Torque 1	(*a)
2	0004h	Torque 2	
3	0008h	Torque with stopped motor	
4	0010h	Asynchronous start	
5	0020h	Asynchronous deceleration	
6	0040h	Asynchronous stop	
7	0080h	Start with pulses	
8	0100h	Synchronous start	
9	0200h		
10	0400h	SBS synchronous stop	
11	0800h	Stop by pulses	
12	1000h	Reset alarm	
13	2000h		
14	4000h	(*b)	
15	8000h		

(*a) "Multiplexando" control bit 1 and 2 it is obtained …

SBSx_CONTROL (Bits 2 and 1)			
0	0	Without use	
0	1	Minimum torque	0002h
1	0	Average torque	0004h
1	1	Maximum torque	0006h

(*b) The registers "control", "max. frequency" "min. frequency" and slope share the same address in the Codesys. "Multiplexando" the SBS1 control bit 15 and 16 it is obtain…

SBSx_CONTROL (Bits 15 and 14)		
0	0	Control
0	1	Final Frequency Hz
1	0	Initial Frequency HZ
1	1	Acceleration Time tenths

Horizontal SBS state

bit	Hex	
0	0000h	Address
1	0002h	Torque1
2	0004h	Torque2
3	0008h	Torque with motor stopped
4	0010h	Asynchronous start
5	0020h	Deceleration
6	0040h	Asynchronous stop
7	0080h	Start with pulses
8	0100h	Start synchronous waiting
9	0200h	Start synchronous turning
10	0400h	SBS synchronous stop
11	0800h	Stop by pulses
12	1000h	Reset alarm
13	2000h	
14	4000h	Power alarm
15	8000h	CAN alarm

Example bits 15 and 14 of the SBS1 control register:

(1) Access motor control — SBS = 0x0016 (hex) = 0000 0000 0001 0110 (bin)
-> Starting order asynchronous to max. torque

(2) Access final frequency — SBS = 0x5388 (hex) = 0101 0011 1000 1000 (bin)
-> Frequency of 5000hz — *= 0x1388 (hex)* — *5000 (dec)*

(3) Access initial frequency — SBS = 0x8032 (hex) = 1000 0000 0011 0010 (bin)
-> Min. frequency of 50hz — *= 0x0032 (hex)* — *50 (dec)*

(4) Access to acceleration slope — SBS = 0xC064 (hex) = 1100 0000 0011 0100 (bin)
-> Acceleration slope 100dsg — *= 0x0064 (hex)* — *100 (dec)*

SBS MOTORS (vertical movement)

The vertical movement of the knife is controlled by SBS motor. This motor does not have synchronous starting mode. Has automatically photoelectric cell stop, being able to calculate the 0 point of the knife.

Working modes

Asynchronous
Starts in an individual way with a ramp from a minimum frequency to a maximum. The time of raise is given in tenths of second.

Deceleration
It is only applied in the asynchronous way. Goes from a maximum frequency to a minimum one. The deceleration time is the same as the acceleration time.

Pulses counting
The number of pulses that the knifes want to be moved has to be indicated, the way itself generates the acceleration and deceleration ramp from the maximum and minimum frequency. If there are not many pulses, it is possible that the maximum frequency is not reached.

Photocell

The motor starts and remains at the minimal frequency, until stop because of photocell detection.

Switch	Codesys Processmap (nomenclature in CLM-301)		
1	SBS_01_VERTICAL_CONTROL		AT %QW2575: WORD
	SBS_01_VERTICAL_FRE_MAX		AT %QW2575: WORD
	SBS_01_VERTICAL_FRE_MIN		AT %QW2575: WORD
	SBS_01_VERTICAL_RAMPA		AT %QW2575: WORD
	SBS_01_VERTICAL_REF_PULSOS	16 bits	AT %QW2579: WORD
2	SBS_02_VERTICAL_CONTROL		AT %QW2587: WORD
	SBS_02_VERTICAL_FRE_MAX		AT %QW2587: WORD
	SBS_02_VERTICAL_FRE_MIN		AT %QW2587: WORD
	SBS_02_VERTICAL_RAMPA		AT %QW2587: WORD
	SBS_02_VERTICAL_REF_PULSOS	16 bits	AT %QW2591: WORD
...	...		...
Switch	Codesys Processmap (Reading of CLM-301)		
1	SBS_01_VERTICAL_ESTADO		AT %IW2575: WORD
	SBS_01_VERTICAL_REAL_PULSOS	16 bits	AT %IW2579: WORD
2	SBS_02_VERTICAL_ESTADO		AT %IW2587: WORD
	SBS_02_VERTICAL_REAL_PULSOS	16 bits	AT %IW2591: WORD
...	...		...

The visualization records and the motor control are located in the processmap”

It is possible to accede to the records from CAN reception and transmission buffer (RXPDO, TXPDO).

Common register to all modes.

Quick access register to PDO (CMS block of standard CAN) →

180h+switch	**RXPDO_4** Vertical SBS control	280h+switch	**RXPDO_4** Horizontal SBS control
200h+switch	**TXPDO_4** Vertical SBS state	300h+switch	**TXPDO_4** Horizontal SBS state

Verticall SBS control

bit	Hex		
0	0000h	Direction	
1	0002h	Torque 1	(*a)
2	0004h	Torque 2	
3	0008h	Torque with stopped motor	
4	0010h	Asynchronous start	
5	0020h	Asynchronous deceleration	
6	0040h	Asynchronous stop	
7	0080h	Start with pulses	
8	0100h		
9	0200h		
10	0400h		
11	0800h	Stop by pulses	
12	1000h	Reset alarm	
13	2000h		
14	4000h	(*b)	
15	8000h		

(*a) "Multiplexando" control bit 1 and 2 it is obtained …

SBSx_CONTROL (Bits 2 and 1)

0	0	Without use	
0	1	Minimum torque	0002h
1	0	Average torque	0004h
1	1	Maximum torque	0006h

(*b) The registers "control", "max. frequency" "min. frequency" and slope share the same address in the Codesys. "Multiplexando" the SBS1 control bit 15 and 16 it is obtain…

SBSx_CONTROL (Bits 15 and 14)

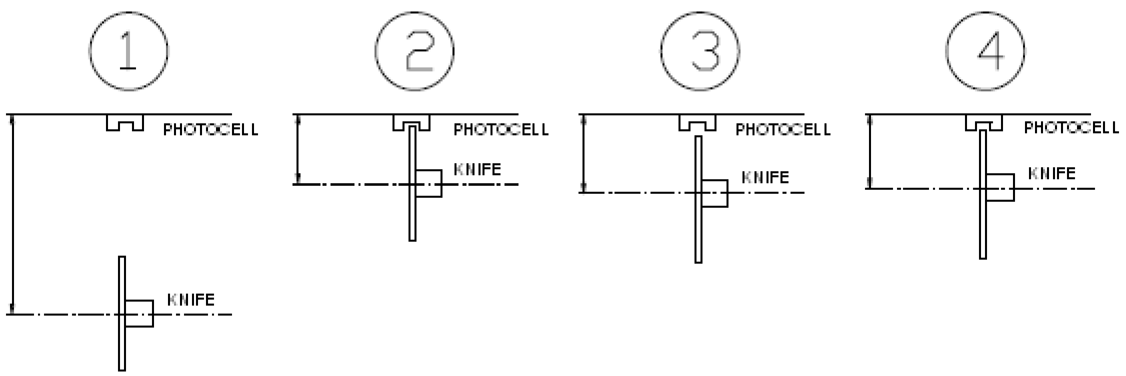
0	0	Control
0	1	Final Frequency Hz
1	0	Initial Frequency HZ
1	1	Acceleration Time tenths

Horizontal SBS state

bit	Hex	
0	0000h	Address
1	0002h	Torque1
2	0004h	Torque2
3	0008h	Torque with motor stopped
4	0010h	Asynchronous start
5	0020h	Deceleration
6	0040h	Asynchronous stop
7	0080h	Start with pulses
8	0100h	Start with photocell
9	0200h	
10	0400h	
11	0800h	Stop by pulses
12	1000h	Reset alarm
13	2000h	
14	4000h	Power alarm
15	8000h	CAN alarm

Procedure to measure the knife diameter.

As the work with a photocell is really slow this procedure is done to speed up the work. First of all a quick approximation is done in asynchronous way.



- Raise the knife in asynchronous way and be looking at the input of the photoelectric cell until it detects it, once introduced stop. ***(Point2)***
- Lower the knife in asynchronous way until the photocell stops detecting and stop. ***(Point3)***
- Start the knife in photocell way. This way the knife will stop as soon as it detects the photocell, giving a precise adjustment of the same one. ***(Point4)***

INPUTS / OUTPUTS

The module has four inputs: one for the photocell and three of general purpose (IN2-IN3-IN4). In the machines where the vertical movement is manual, the inputs IN3-IN4 will be assigned to the raising or descending movement of the knife IN3=KNIFE UP and IN4=KNIFE DOWN.

registers quick access PDO
(CMS block from CAN standard) →

300h+switch	TXPDO_1	
	inputs	Present horizontal SBS pulses

The state of the inputs is in the high part of each of the “CODESYS" registers.

Switch	Codesys processmap (CLM-301 writing)	
1	INPUTS_01	AT %IW2576: WORD
2	INPUTS_02	AT %IW2588: WORD
3	INPUTS_03	AT %IW2600: WORD
4	INPUTS_04	AT %IW2612: WORD
5	INPUTS_05	AT %IW2624: WORD
...	...	...

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0

General Prog.

Photocell

The module has two outputs: one for the electro-valve and the other for general purpose.

registers quick access PDO
(CMS block from CAN standard) →

280h+switch	RXPDO_1 and RXPDO_2	
	outputs	Pulses to move SBS horizontal

The state of the outputs is in the high part of each of the “CODESYS" registers.

Switch	Codesys processmap (CLM-301 writing)	
1	OUTPUTS_01	AT %IW2576: WORD
2	OUTPUTS_02	AT %IW2588: WORD
3	OUTPUTS_03	AT %IW2600: WORD
4	OUTPUTS_04	AT %IW2612: WORD
5	OUTPUTS_05	AT %IW2624: WORD
...	...	...

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0

General Prog.

Electro-valve

It is possible to accede the registers from the CAN reception and transmission buffers.