

DIGITAL SERVOAMPLIFIER

TGA-24-9/20

Description of the set up software S.C.D.

Edition 05/2005



TGD drives

servotechnika

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1 Introduction

Servo-controller TGA is suitable to control AC synchronous servomotor..

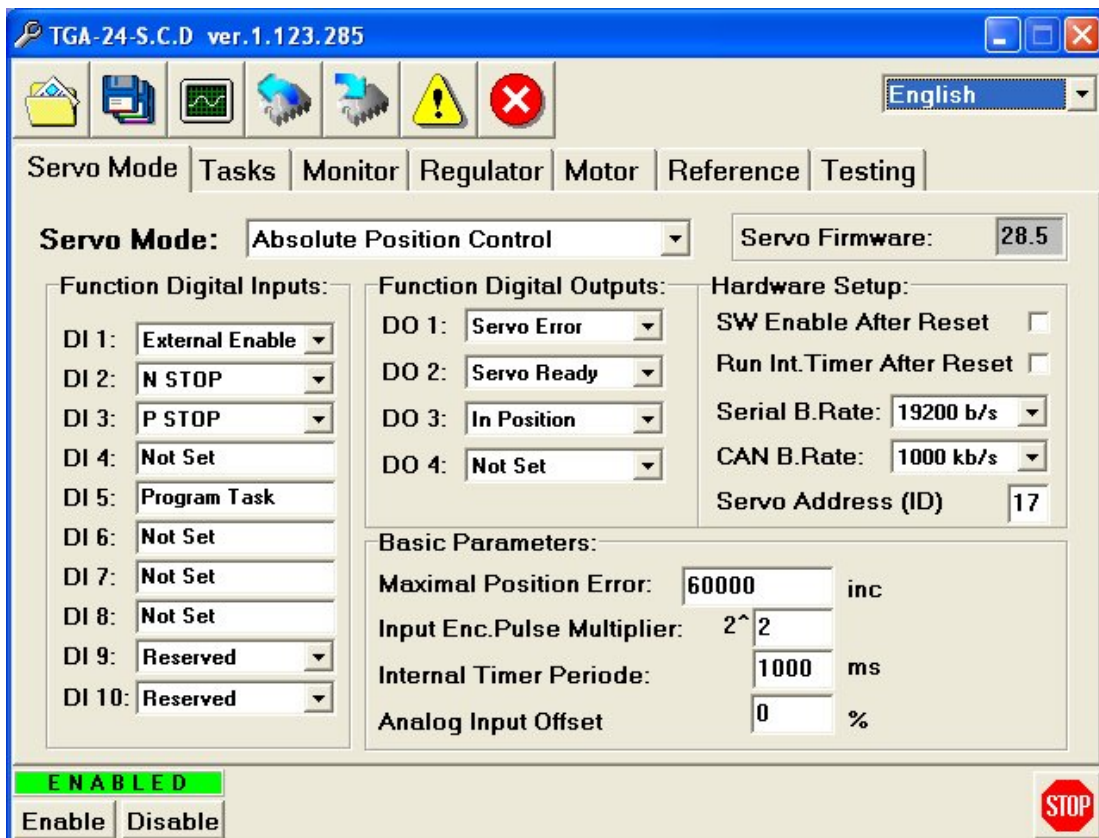
The TGA controller has pre-program several functions and operating modes usable for your applications. The function can be set by set-up software S.C.D. (Service, Control, Drive).

To install program S.C.D to your computer start the program SETUP_TGA_1_XXX.exe. The program S.C.D. communicate with servo-controller TGA through serial line RS232. The controller has to be connected with PC by communication cable (see Hardware manual). If your PC is not fitted by serial port RS232 you can use suitable converter (e.g. USB-RS232).

After starting program S.C.D. the Window offering communication port (COM1-COM8) or Offline work. After selection correct port the communication between S.C.D. program and a TGA should be set. The program should find correct communication speed automatically.



After successfully setting of the communication or offline mode the Windows will appear.



2 Function icons



Load parameters from the file to the servo-controller. The servo-controller has to be in DISABLE mode. To memorize the parameters after switching off the controller the order SAVE to the EEPROM should be executed.



Save parameters to the file.



Oscilloscope.



Reading parameters saved in EEPROM from the servo-controller.



Saving parameters to the EEPROM. Actual setting will be memorized after switching off the servo-controller.



Clear fault.



Reset servo-controller.



Stop of the servomotor (mode Digital Speed = 0 is executive)



On/Off the power stage of the servo-controller.

3 Description of the functions

3.1 MENU-Servo Mode

3.1.1 Servo Mode

The Operation Mode of the Servo Controller:

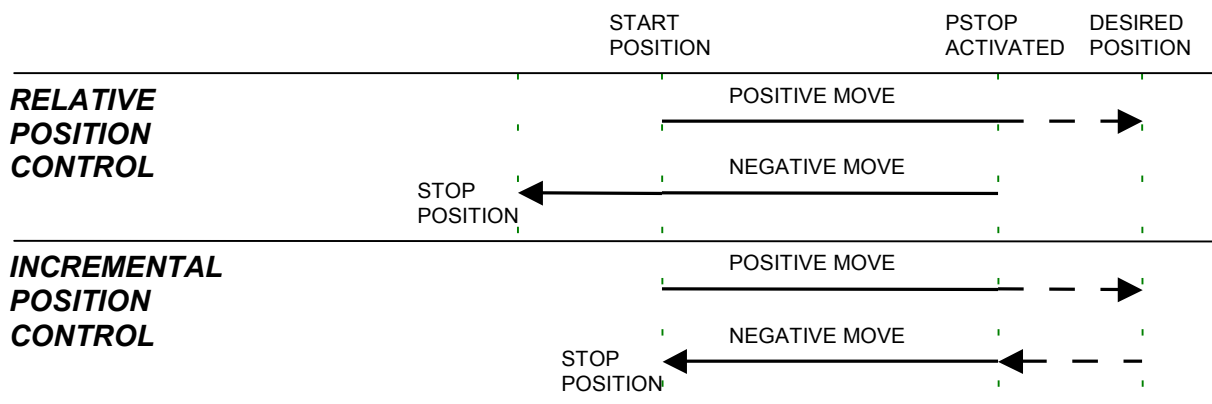
Digital Torque Control	The Torque Control with digital set-point (RS 232, CAN BUS)
Digital Speed Control	The Speed Control with digital set-point (RS 232, CAN BUS)
Analogue Torque Control	The Torque Control with analogue set-point (analogue input 0-5V- terminal X2, range 0-10V is possible to set on the card). 0V-is maximal negative value of the desired value (see MENU Motor) 2,5V-zero torque. Zero can be shifted by Analogue Input Offset 5V-is maximal positive value (MENU Motor)
Analogue Speed Control	The Speed Control with analogue set-point (analogue input 0-5V- terminal X2, range 0-10V is possible to set on the card). 0V-is maximal negative value of the desired value (see MENU Motor) 2,5V-zero torque. Zero can be shifted by Analogue Input Offset 5V-is maximal positive value (MENU Motor)
Absolute Position Control	The movement to an absolute target position, referred to the reference point. Reference point can be zero position from resolver after switching on the servo-controller or actual position can be set to zero in mode REFERENCE. The maximum range of movement is limited to $\pm 2^{31}$ increments (± 32768 motor turns). The internal profile generator calculates every 1 ms new reference position and speed according to set deceleration, acceleration and maximal speed.
Incremental Position Control	The movement relative to last target (set-point) position. The maximum range of the setting value is limited to $\pm 2^{30}$ increments. The internal profile generator calculates every 1 ms new reference position and speed according to set deceleration, acceleration and maximal.
Relative Position Control	The movement relative to actual start position. The maximum range of the setting value is limited to $\pm 2^{30}$ increments. The internal profile generator calculates every 1 ms new reference position and speed according to set deceleration, acceleration and maximal.
Stepper Motor Control	Stepper Motion Control. The drive accepts signals Pulse and Direction generated by a control system on terminal X2. The pulses are possible to multiply by a multiplied constant. Compare to a standard stepper motor the servo-drive cannot lose pulses, thanks to feedback. In case of overloading the servo-drive indicate an error. After setting the mode it is necessary to SAVE parameters to EEPROM and RESET the servo-controller.
Encoder Control	Encoder Follower-electronic gearing. A master incremental encoder or encoder output of a master servo-amplifier is connected to terminal X2. The pulses are possible to multiply by multiplied constant. After setting the mode it is necessary to SAVE parameters to EEPROM and RESET the servo-controller.
Trajectory CAN Control	Required position is generated by a control system and is sent to the servo-controller through CAN BUS. Upgrade of position should to be in period 0,7 - 2 ms.

3.1.2 Digital Inputs

The servo-controller TGA has pre-program some functions. The functions are optional.

Input	Function	Description
DI1	External enable	If input is „High“ then torque to the servomotor is enabled.
DI2	N STOP	Negative direction of the motion is blocked. Servomotor will stop on Emergency Ramp. Not active in analogue and digital torque modes.
DI3	P STOP	Positive direction of the motion is blocked. Servomotor will stop on Emergency Ramp. Not active in analogue and digital torque modes.
DI4		Function is selectable in MENU Tasks
DI5		Function is selectable in MENU Tasks
DI6		Function is selectable in MENU Tasks
DI7		Function is selectable in MENU Tasks
DI8		Function is selectable in MENU Tasks
DI9		Reserved
DI10		Reserved

NSTOP and PSTOP function in RELATIVE and INCREMENTAL POSITION modes



3.1.3 Digital outputs

Output	Function	Description
D01	Servo Error	If an error occurred the output is „High“. The faults can happened: Resolver error Overheating of the controller Over heating of the servo motor Short circuit on power stage or cable or motor Over loading of the servomotor Position error Under voltage Disable (if digital input DI1 is set)
D02	Servo ready	The output is „High“ if torque to the servomotor is enabled.
D03	In position	The output is „High“ if motor reach required position.
D04	Speed=0	The output is „High“ if motor has speed=0.

3.1.4 Servo Firmware

Number of the firmware

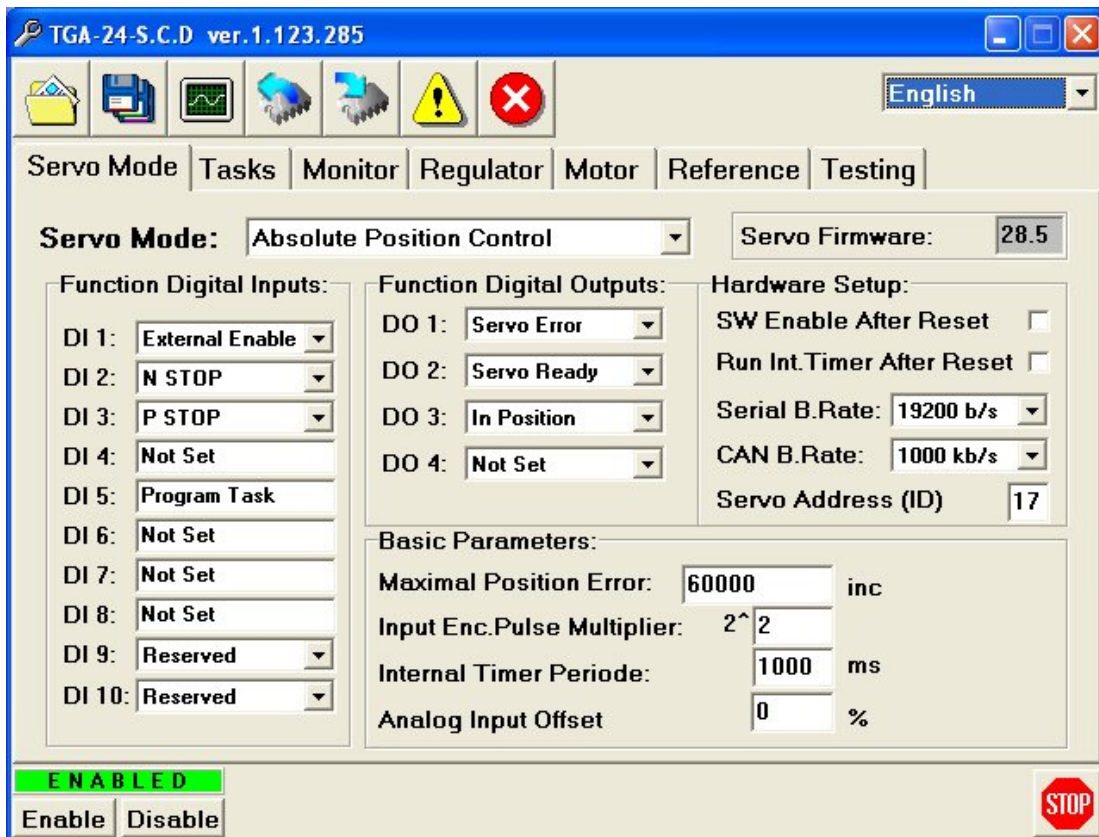
3.1.5 Hardware setup

SW Enable After Reset	If set, torque to the motor is enabled after reset.
Run Int. Timer After Reset:	If set, internal timer is started after Reset (see Tasks).
Serial B. Rate	Setting communication rate of the serial line. 9600 b/s, 19200 b/s, 38400 b/s, 57600 b/s. New rate is accepted after Saving the parameters to EEPROM and Reset.
CAN B. Rate	Setting communication rate of the CAN BUS. 125 kb/s, 250 kb/s, 500 kb/s, 1000 kb/s New rate is accepted after Saving the parameters to EEPROM and Reset.
Servo Address (ID)	Setting of the address 1-63

3.1.6 Basic Parameters

Maximal Position Error	Maximal allowable position error in increments.
Input. Enc. Pulse Multiplier	Binary exponent of the multiplier of the input pulses (ENCODER Control, Stepper Motor Control). If the value is 0 then pulses are multiplied 1.
Internal Input Period	Setting of the Period of the internal timer. (See MENU Tasks)
Analogue Input Offset	Shifting of the analogue input

3.2 MENU Tasks



It is possible to program 10 functions to the servo controller. The functions can be started by rising or falling edge of a digital input, internal timer, or signal In position or Speed=0.

3.2.1 Task Enable

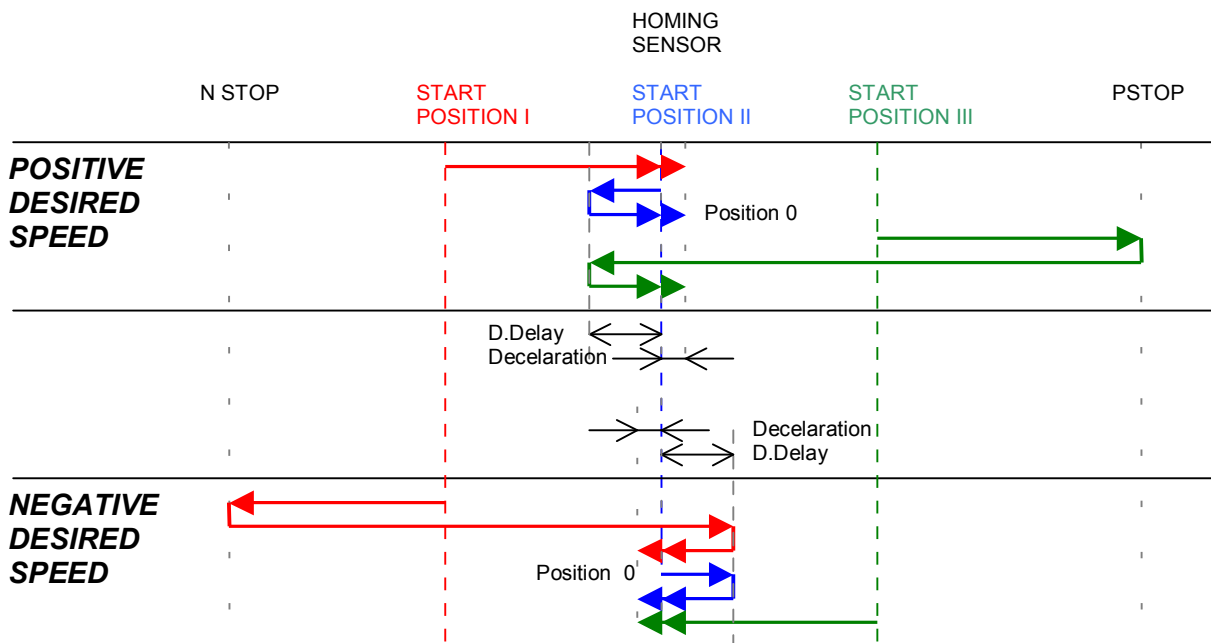
Enabling required task.

3.2.2 Task Function

It is possible to select the functions::

Absolute Position	Absolute movement
Incremental Position	Relative movement to the last target position
Relative Position	Relative movement to the last actual position
Stop Motion	Stop motion
Set Ref. Position	Set to zero actual position
Digital Speed	Speed control
Digital Torque	Torque control
Servo Reset	Reset s
Enable Internal Timer	Enabling internal timer
Disable Internal Timer	Disabling internal timer
Homing	Start Homing. Settable only in TASK No1.Reference sensor has to be connected to Input 4. When N STOP and P STOP functions are activated, motor reverse automatically. D.delay - time for go down from reference sensor when sensor is activated after start. Speed and direction of the homing is settable by Speed .

TASK HOMING description



3.2.3 Task Parameters

According to chosen function some windows are appeared to set parameters of the function.

Delay	Delay of the start of a function after a edge come.
Position/Speed/Current	Target position in increments valid for absolute, incremental and relative position modes. Desired speed in speed mode Desired current in torque mode
Speed	Maximal speed in position modes.
Acc	Acceleration (in ms to 3000 rpm).
Dec	Deceleration (in ms to 3000 rpm)

Required function can be started by the digital inputs or virtual signals.

3.2.4 Control input

It is possible to chose digital inputs 4 to 8.

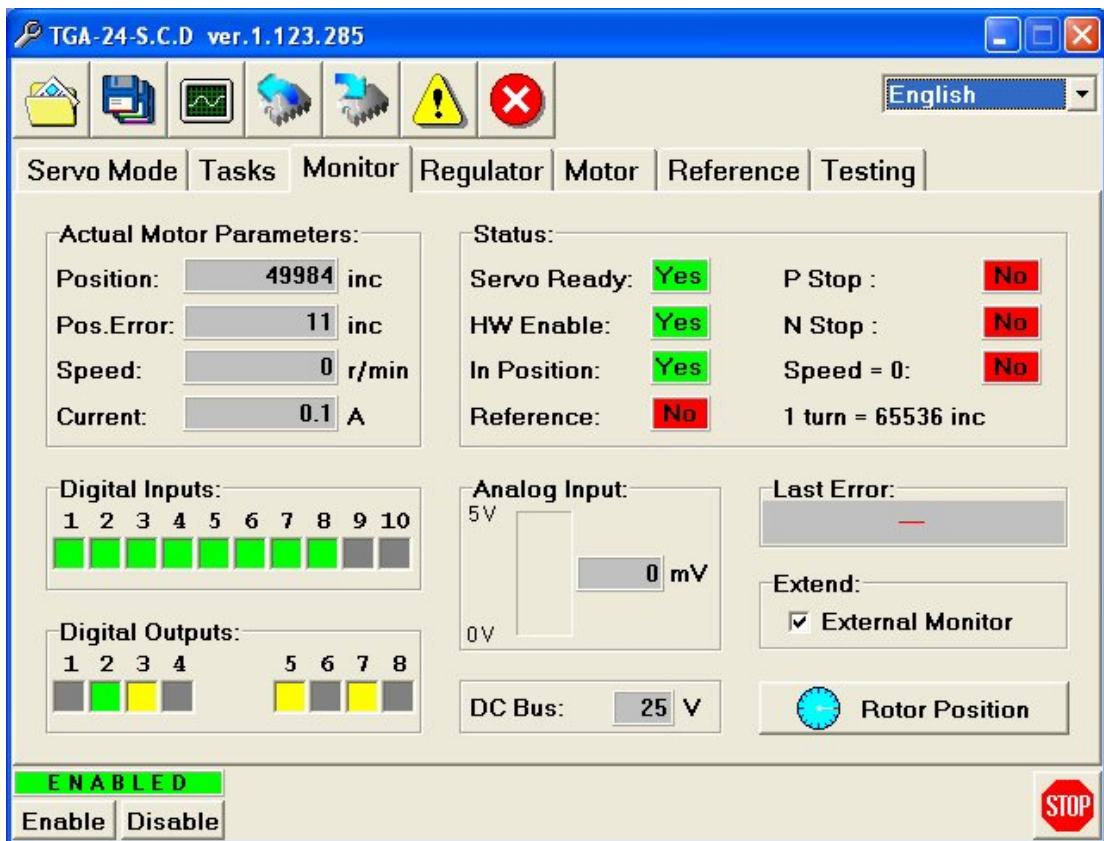
3.2.5 Virtual signal

Internal timer	The function is started by a edge of the internal timer.
In position	The function is started by internal signal In position..
Speed = 0	The function is started by internal signal Speed=0.

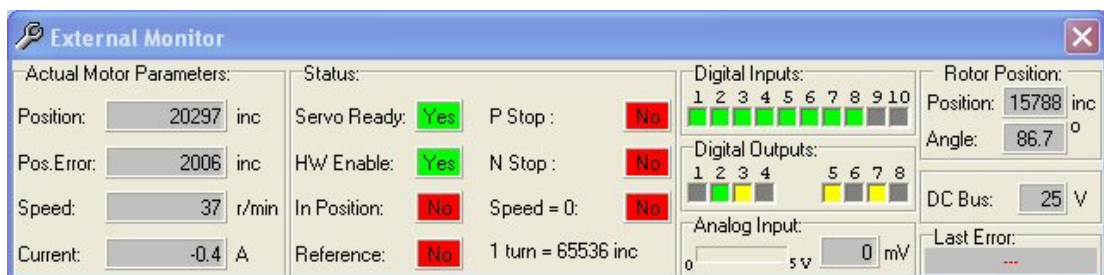
3.2.6 Run Edge

Every function can be start by rising or falling edge of the control input or signal.

3.3 MENU Monitor



Menu Monitor allows monitoring status and parameters of a servo-controller (inputs, outputs, input voltage, faults) and a servomotor (position, position error, speed, current, faults). To see the value in other modes it is possible to enable External Monitor and External Monitor window is opened.

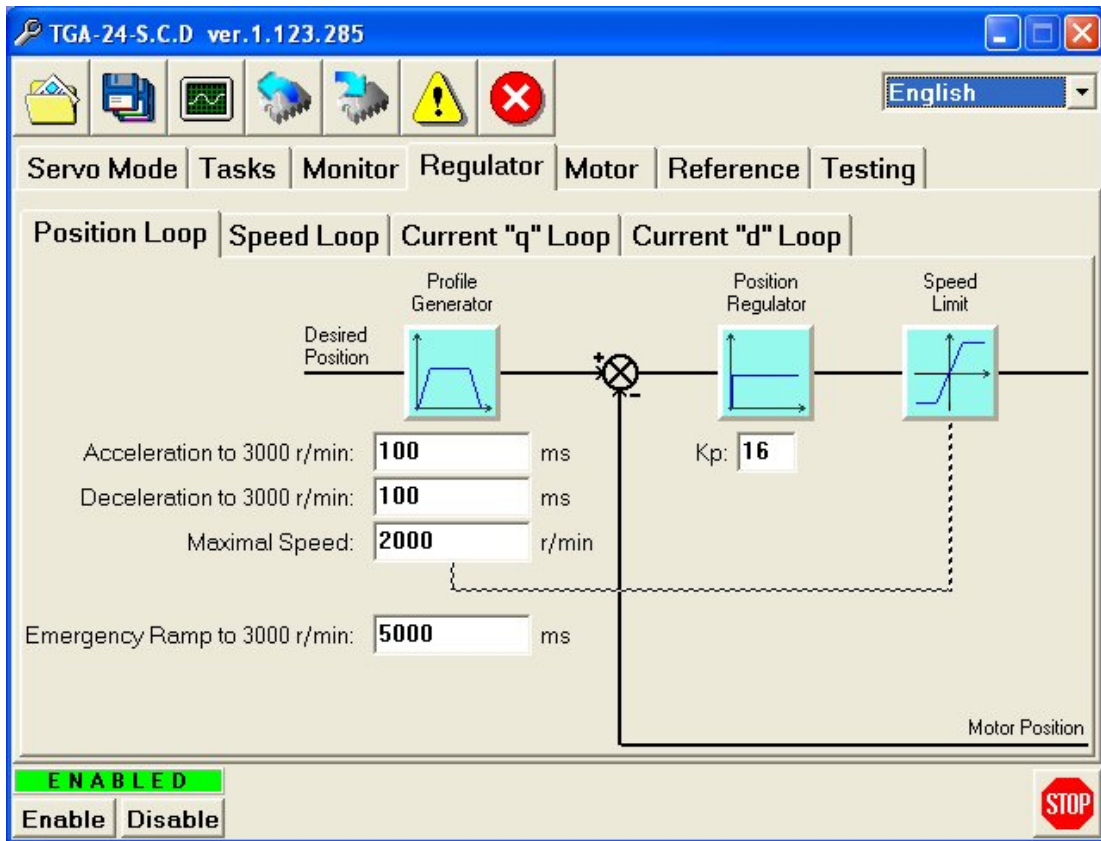


3.4 MENU Regulator

Parameters of the regulators are possible to set in the Menu. The TGA servo-controller has cascade regulation structure.

3.4.1 Position loop

Kp	Proportional gain of the position regulator. Higher value reduces position error. If the value is too high an oscillation of the servomotor can appeared.
Acceleration to 3000 r/min	Maximal allowed acceleration
Deceleration to 3000 r/min	Maximal allowed deceleration
Maximal speed	Maximal speed
Emergency Ramp	Acceleration time when N STOP and P STOP are happened



3.4.2 Speed Loop

Kp	Proportional gain of the speed regulator
Ki	Integrating gain of the speed regulator
Imax	Maximal current Iq (Q- active- current component)

3.4.3 Current “q” Loop

Regulator of Q-active current component.

Kp	Proportional gain of the iq
Ki	Integrating gain of the iq

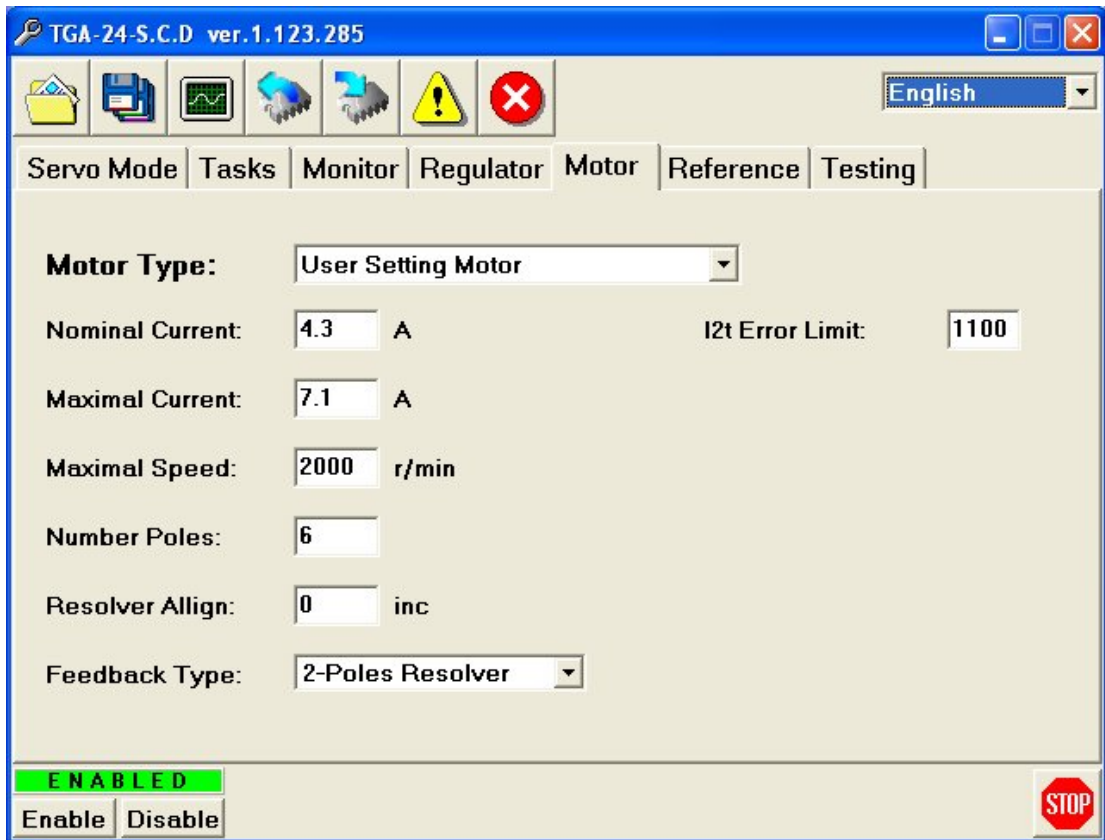
3.4.4 Current “d” Loop

Regulator of the D-reactive current component

Kp	Proportional gain of the id
Ki	Integrating gain of the id

3.5 MENU Motor

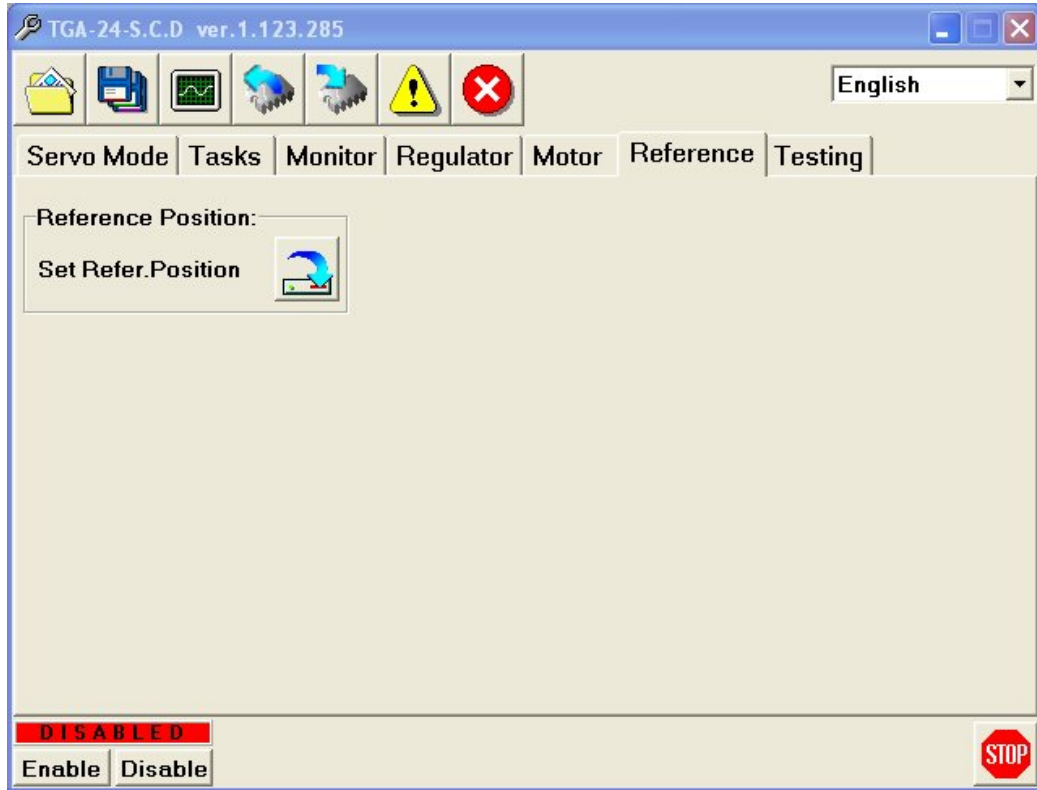
Menu “Motor” allows selecting pre-defined motor or setting parameters manually. When some pre-defined motor is chosen all parameters from Menu Motor and Regulator are set automatically.



Nominal Current	Nominal current of the motor (r.m.s. value)
Maximal current	Maximal allowable current (r.m.s. value).
Maximal speed	Nominal speed
Number of Poles	Number of poles
Resolver Align	Setting of the commutation angle
Feedback Type	Only 2-poles resolver
I2t Error Limit	Setting of the I2t characteristic. Value 1100 allows 2 times nominal current for 5 s.

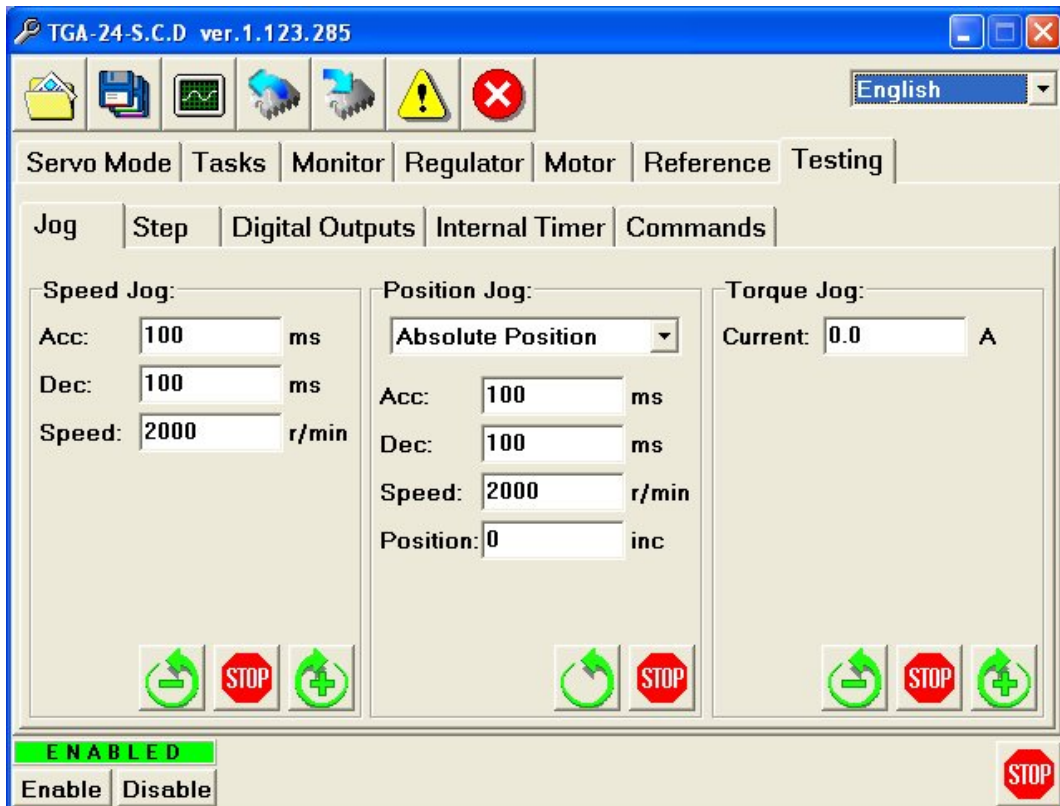
3.6 MENU Reference

Setting internal position counter to zero.



3.7 MENU Testing

Menu Testing allows testing your application through PC.



The modes is possible to test in **window Jog**:

- Digital torque control
- Digital speed control
- Absolute Position
- Relative Position
- Incremental Position

Window “Step” allows testing motion modes in step mode.

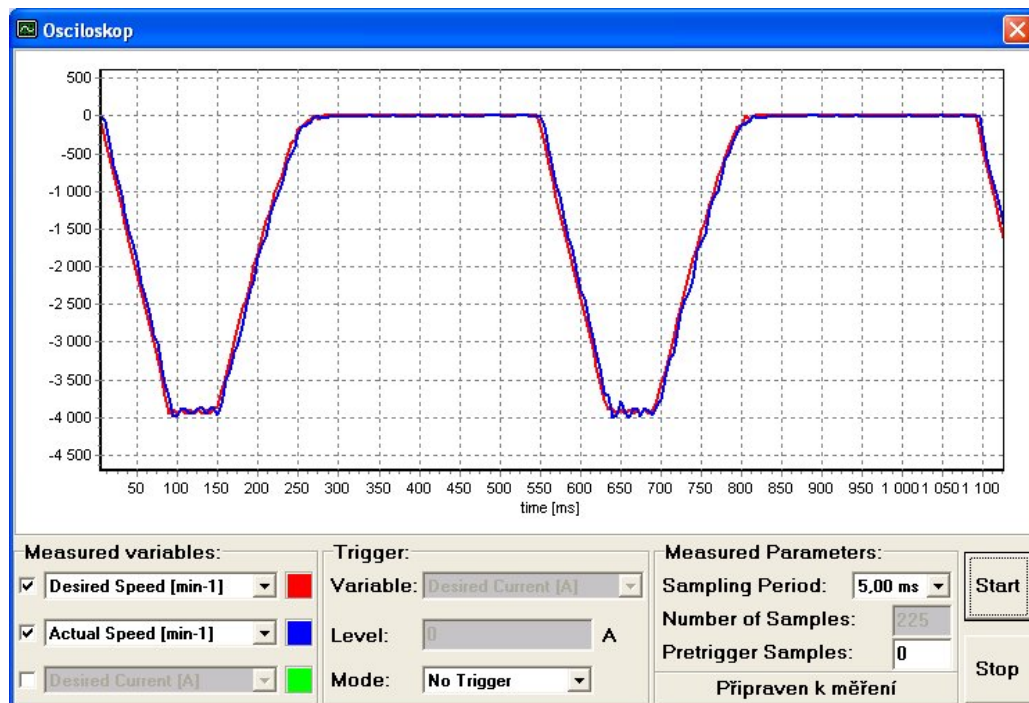
Window “Digital outputs” allows setting and resetting digital outputs.

Window “Internal Timer” allows starting and stopping internal timer. A drive will execute the function set in Menu **Tasks**.

Commands direct start of a predefined motion task 1-10.

3.8 OSCILLOSCOPE

Oscilloscope allows to graphical monitoring of the actual values of some parameters. Because of oscilloscope has not automatic scaling of each separate parameter it is recommended to monitor parameters with similar values (e.g. actual and desired speed). The zoom is activated by movement of the mouse to right-down and simultaneous pushing of the left switch.



Desired Current (A)	Actual value of the desired current.
Desired Position (inc)	Actual value of the desired position
Desired Speed (min^{-1})	Actual value of the desired speed
Actual Current „q“ (A)	Actual value of the Q-active-current component
Actual Current „d“ (A)	Actual value of the D-reactive-current component
Actual Position (inc)	Actual value of the position
Actual Speed (min^{-1})	Actual speed
Position Error (inc)	Actual position error
Rotor Angle (inc)	Actual rotor position within one turn
DC Bus (V)	Actual value of the supply voltage
Analogue In (V)	Actual value of the analogue input

3.9 FAULT DESCRIPTION

Resolver error

Check resolver cable, resolver on the motor.

Overheating of the controller

Temperature of the heat sink increased 70°C

Over heating of the servo motor

Temperature of the winding of the motor increased 140°C Check mechanism.

Short circuit on power stage, cable or motor

Check motor cable, winding of the motor.

Over loading of the servomotor

Check mechanism

Position error

Actual position is out of the allowable range. Check mechanism, power cable.

Under voltage

Voltage dropped under 15 VDC. Check power supply.

Disable (if digital input DI1 is set)

Input 1 is not activated.

4 Communication Protocol RS 232/485 description

The RS-232 protocol is a set of simple binary structures and conventions enabling a data/code exchange between a personal computer (PC) and a target controller board. It uses raw 8 bits, no parity, serial transfer at a standard speed (9600 bps, 19200, 38400, 57600bps by default).

The communication model is based on a master-slave relationship, where the PC sends a message with a command and its arguments, and the target responds immediately (within a specified time) with the operation status code and return data. The target never initiates communication; its responses are specified and always of a fixed (known) length (This is true on a logical level. On a link level, there is a replication of special start-of-message bytes, details of which follow).

4.1 Command Message

A command message is always sent from the PC to the target.

start-of-message (1 BYTE)	command (1 BYTE)	data length (1BYTE)	data part (variable length)	checksum (1 BYTE)
------------------------------	---------------------	------------------------	-----------------------------------	----------------------

start of message (SOM)	The special character defined as ASCII '+' code (0x2b)			
command	A one byte command code (see bellow)			
data length	The length of data part			
data part	Variable length data			
checksum	Two's complement checksum; computed by taking the two's complement of the sum of all bytes of a message after the SOM.			

The following code example calculates checksum for a message in standard format before it is transmitted:

```
typedef unsigned char BYTE;

struct {
    BYTE cmd;
    BYTE len;
    BYTE data[N];
    BYTE _space_for_checksum;
} message;

// prepare message
// ...

// calculate checksum
BYTE *p = &message;
BYTE sum = *p++;           // cmd field
for(int i=0; i<=message.len; i++)
    sum += *p++;           // add len and data
// store checksum after last valid data byte
*p = 0x100 - sum;

// transmit SOM byte
// ....

// transmit message and checksum (replicating each occurrence of SOM byte)
// ....
```

The start-of-message (SOM) character receives special treatment from the link protocol layer. When received, it should reset the receiver's state machine and initialise it for reception of new message. Since the data being transferred across an RS-232 line is in binary format, a byte with value equal to SOM may be contained in the message body, which could cause an undesirable reinitialization of the receiver. This is why each occurrence of SOM byte in length, data or checksum part of a message is signalled by duplicating this byte. On the other side, the receiver resets its state machine only when the SOM byte it receives is followed by a non-SOM byte. If the receiver receives two consecutive SOM bytes, it merges them to a single one.

4.2 Response Message

A response message is always sent from the target to the PC.

The format of response messages is shown in the following table:

start-of-message (1 BYTE)	status code (1 BYTE)	data part (known length)	checksum (1 BYTE)
start of message	The special character defined as ASCII '+' code		
status code	The one byte operation status code (see below)		
variable length data	the length depends on status code value. An error response message (status MSB set) carries no data; a success response message carries known data to the PC (the data length is predetermined)		
checksum	Two's complement checksum; computed by taking the two's complement of the sum of all bytes of a message after the SOM		

4.3 Commands description:

4.3.1 To read a Word

Start of the message (1byte):	2BH	
Command:	D1H	
Number of the transferring dates:	02H	
Address (2 byte):		
Check Sum:		
 <u>Answer (5 Bytes):</u>		
Start of the message (1byte):	2BH	
Status (1 Byte):	00H	No error
	81H	Unknown command code
	82H	Command checksum error
	83H	Command is too long
Data (2 Bytes):		
Check Sum:		

4.3.2 To read a DWord

Start of the message (1Byte):	2BH	
Command:	D2H	
Number of the transferring dates:	02H	
Address (2 Byte):		
Check sum:		
 <u>Answer (7 Bytes):</u>		
Start of the message (1Byte):	2BH	
Status (1 Byte):	00H	No error
	81H	Unknown command code
	82H	Command checksum error
	83H	Command is too long
Data (4 Byte):		
Check sum:		

4.3.3 To write a Word

Start of the message (1Byte):	2BH
Command:	02H
Number of the transferring Bytes:	05H
Number of the transferring Dates:	02H
Address (2 Byte):	
Dates (2 Byte):	
Check sum:	

Example:

To write to address 01A6H a Word it has to be send:
2B,02,05,02,A6,01,LB,HB,CS

Answer (3 Bytes):

Start of the message (1Byte):	2BH	
Status (1 Byte):	00H	No error
	81H	Unknown command code
	82H	Command checksum error
	83H	Command is too long

Check sum:

4.3.4 To write a DWord

Start of the message (1Byte):	2BH
Command:	02H
Number of the transferring Bytes:	07H
Number of the transferring Dates:	04H
Address (2 Byte):	
Dates (4 Bytes):	
Check sum:	

Answer (3 Bytes):

Start of the message (1Byte):	2BH	
Status (1 Byte):	00H	No error
	81H	Unknown command code
	82H	Command checksum error
	83H	Command is too long

Check sum:

Note:

List of the variables and their addresses is enclosed.

In case of the reading parameters (**Byte0=8**) the TGA answering by the same values in **Byte0-Byte2** and **Byte7**. The **Byte3-Byte6** are filled by actual values.

Example:

1/ Write desired speed 600 rpm. to the servo-controller with address=3

Speed calculation: 600 rpm. = 171798691units = 0xA3D70A3
 ID 0x603
 Address of the desired speed 0x194
 Data 0A 3D 70 A3
 Data length 0x2

Master (PLC,PC)

ID	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
603	09	01	94	0A	3D	70	A3	02

Answer of the TGA

ID	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
583	09	01	94	0A	3D	70	A3	02

2/ Read actual position from the servo-controller with address=16

Actual servo position is -10000 increments
 ID 0x60F
 Address of the actual position: 0x196
 Data -10000 incr. = 0xFFFFD8F0
 Data length 0x2

Master (PLC,PC)

ID	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
60F	08	01	96	00	00	00	00	02

Answer of the TGA

ID	5.1.2.1	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
58F	08	01	96	FF	FF	D8	F0	02	

5.2 Remote frame (monitoring):

5.2.1 Message description sent by master (PLC, PC)

DLC=0

ID
0x180+node

ID – identifier of the message in hex code
node- address (id) of the servo-controller 1-63 (0x01-0x3F)

5.2.2 Message description sent by TGA (slave)

DLC=7

ID	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
0x180+node	Status	Actual position			Dig. inputs		Dig. outputs	

ID – identifier of the message in hex code
node- address (id) of the servo-controller (0x01 – 0x3F)

Byte0 Status of the servo-controller

<i>bit 0 = Enable OK</i>
<i>bit 1 = In Position</i>
<i>bit 2 = Trajectory CAN Control is activated</i>
<i>bit 3 = Speed=0</i>
<i>bit 4 = Emergency stop 1</i>
<i>bit 5 = Emergency stop 2</i>
<i>bit 6 = Fault</i>

Byte1-4 Actual rotor position range -2^{31} to $(2^{31}-1)$ (1 turn = 65536 increments)

Byte5-6 Actual digital inputs state (negative value)

Byte5: *bit0 = in1*

bit7 = in8

Byte6 reserved

Byte7

Actual digital outputs state

Byte7: *bit0 = out1*

bit3 = out4

6 Application notes

6.1 Speed Mode

- Enable the power stage of the servo-controller

Write 2 Byte decimal value 2 on address \$1ED

- Switch mode

Speed mode \$2002

Write 4 Byte hexadecimal value \$2002 on address \$1EF

- Set acceleration

$$a = 50 \text{ n.s}^{-2}; 50 \cdot 178957 = 8947850$$

Write 4 Byte decimal value 8947850 on address \$1D4

- Set deceleration

$$a = 50 \text{ n.s}^{-2}; 50 \cdot 178957 = 8947850$$

Write 4 Byte decimal value 8947850 on address \$1D6

- Set maximal speed

$$v_{\max} = 3000 \text{ min}^{-1} = 50 \text{ s}^{-1}; 50 \cdot 17179869,184 = 858993459$$

Write 4 Byte decimal value 858993459 on address \$1D2

- Set desired speed

$$v = -1500 \text{ min}^{-1} = -25 \text{ s}^{-1}; -25 \cdot 17179869,184 = -429496730$$

Write 4 Byte signed decimal value -429496730 on address \$194

6.2 Position mode

- Enable the power stage of the servo-controller

Write 2 Byte decimal value 2 on address \$1ED

- Switch mode

Absolut position mode \$4004

Write 4 Byte hexadecimal value \$4004 on address \$1EF

- Set acceleration

$$a = 50 \text{ n.s}^{-2}; 50 \cdot 178957 = 8947850$$

Write 4 Byte decimal value 8947850 on address \$1D4

- Set deceleration

$$a = 50 \text{ n.s}^{-2}; 50 \cdot 178957 = 8947850$$

Write 4 Byte decimal value 8947850 on address \$1D6

- Set maximal speed

$$v_{\max} = 3000 \text{ min}^{-1} = 50 \text{ s}^{-1}; 50 \cdot 17179869,184 = 858993459$$

Write 4 Byte decimal value 858993459 on address \$1D2

- Set desired position

Desired position 655360 inc (1r. = 65536 inc)

Write 4 Byte signed decimal value 655360 on address \$192



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