I-Step

I-STEP

Stepper motor driver

2 independent channels stepper motor driver

I-Step 1.1.mhx

SW version 1.1, April 2008

Reference Guide

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Written by Miroslav Dvorak
Prague, Czech Republic

ComAp, spol. s r.o.
Kundratka 2359/17, 180 00 Praha 8, Czech Republic
Tel: +420 246 012 111, Fax: +420 246 316 647
E-mail: info@comap.cz, www.comap.cz

Table of contents

1. General description ... 1
   1.1 Calibration to zero end-point (CALIBR 0) ... 1
   1.2 Calibration to zero and full end-point (CALIBR 0&100) ... 2
   1.3 Without calibration process (NOCALIBR) ... 2
2. I-Step terminals, dimensions ... 3
   Jumpers ... 3
   LED Indication ... 4
3. Data ... 5
   Status ... 5
   Commands ... 5
   Data Analogue outputs ... 6
4. Setpoints ... 7
   4.1 Channel 1 set ... 7
   C1 mode ... 7
   CalibrTimeout 1 ... 7
   StepperHyst 1 ... 7
   BiasPos 1 ... 7
   NumSteps 1 ... 7
   SpeedMax 1 ... 7
   SpeedStart 1 ... 7
   StartSteps 1 ... 7
   BinarySpeed 1 ... 8
   NominalCurr 1 ... 8
   PosTolerance1 ... 8
   4.2 Channel 2 set ... 8
   Cannel 2 ... 8
   C2 mode ... 8
   CalibrTimeout 2 ... 8
   StepperHyst 2 ... 8
   BiasPos 2 ... 8
   NumSteps 2 ... 8
   SpeedMax 2 ... 8
   SpeedStart 2 ... 9
   StartSteps 2 ... 9
   BinarySpeed 2 ... 9
   NominalCurr 2 ... 9
   PosTolerance 2 ... 9
   Default settings ... 10
   Fault reset ... 10
   Control parameters of the stepper motor ... 10
   Two stepper motors control ... 10
5. Troubleshooting ... 11
6. Technical data ... 13
   Power supply ... 13
   Operating conditions ... 13
   Dimensions and weight ... 13
   Binary inputs ... 13
   Driver outputs ... 13
   CAN bus interface ... 13

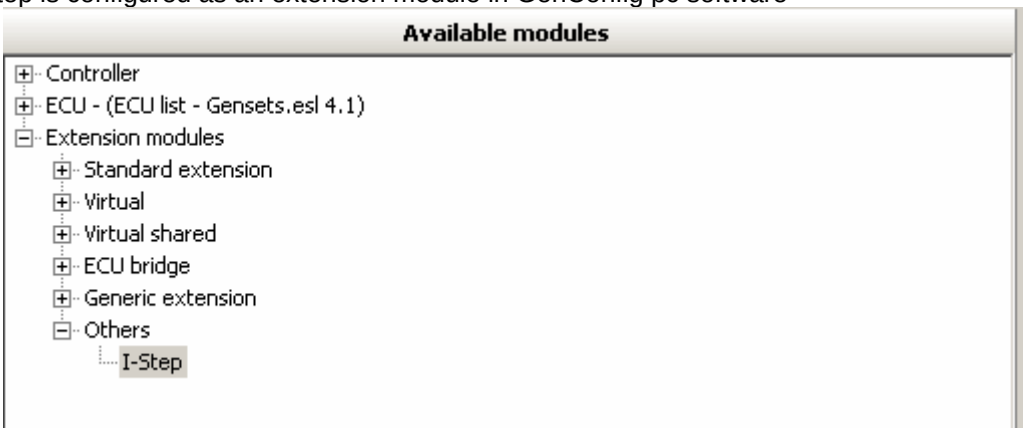
I-Step

1. General description

I-Step is a two channel stepper-motor driver. Each channel can operate in one of three modes – Calibration to zero end-point, Calibration to zero and 100% end-point and without calibration (analogue position feedback information must be used). Each channel can be set to analogue or binary control mode and each channel has its own set of parameters.
In analogue mode, the requested position of each channel is received by CAN line in 0,00 to 100,00% range.
In Binary mode the stepper position is controlled by Binary inputs Up/Down (sent via CAN bus), adjusted in accordance with the I-Step Command register.

I-Step 1.1 can operate with IS-NT-AFR 1.2 and higher NT-AFR or AFS versions.

The I-Step is configured as an extension module in GenConfig pc software



1.1 Calibration to zero end-point (CALIBR 0)

Calibration procedure is included after each system switch-on (or can be forced by appropriate command, see Tab.4). This mode is dedicated for stepper motors without position feedback. Calibration procedure is based on one 0,00% position sensor and number of steps (*NumSteps*) setpoint for full range calculation.
Calibration process must be finished until *CalibrTimeout* setpoint expires. When the calibration process is not finished in this time, the corresponding channel bit *CalibrFail* and *TimeoutFail*, see Tab.3, are set.
When the I-Step receives information the end-point position is reached, and the value Actual Position does not correspond with this position, following cases could happen:

a) The difference between the true position (end-point position is taken as the true value) and value Actual Position (internal, counted value of the I-Step) is smaller then the setpoint *PosTolerance*. In this case the value Actual Position is reset to zero value. The I-Step can operate with no limitations.

b) The difference mentioned above is higher then *PosTolerance* setpoint. In this case the bit *CalibrFail* is set and the Actual Value of corresponding channel is reset to zero. The I-Step continues in regulation process of stepper motor.

c) The above mentioned difference is higher then 3x*PosTolerance* setpoint. In this case the bit *PositionLost* and *CalibrFail* are set, the bit *CalibrDone* is reset. Any following commands for stepper position change (both from analogue and binary inputs) are ignored until the new successful calibration is done.

1.2 Calibration to zero and full end-point (CALIBR 0&100)

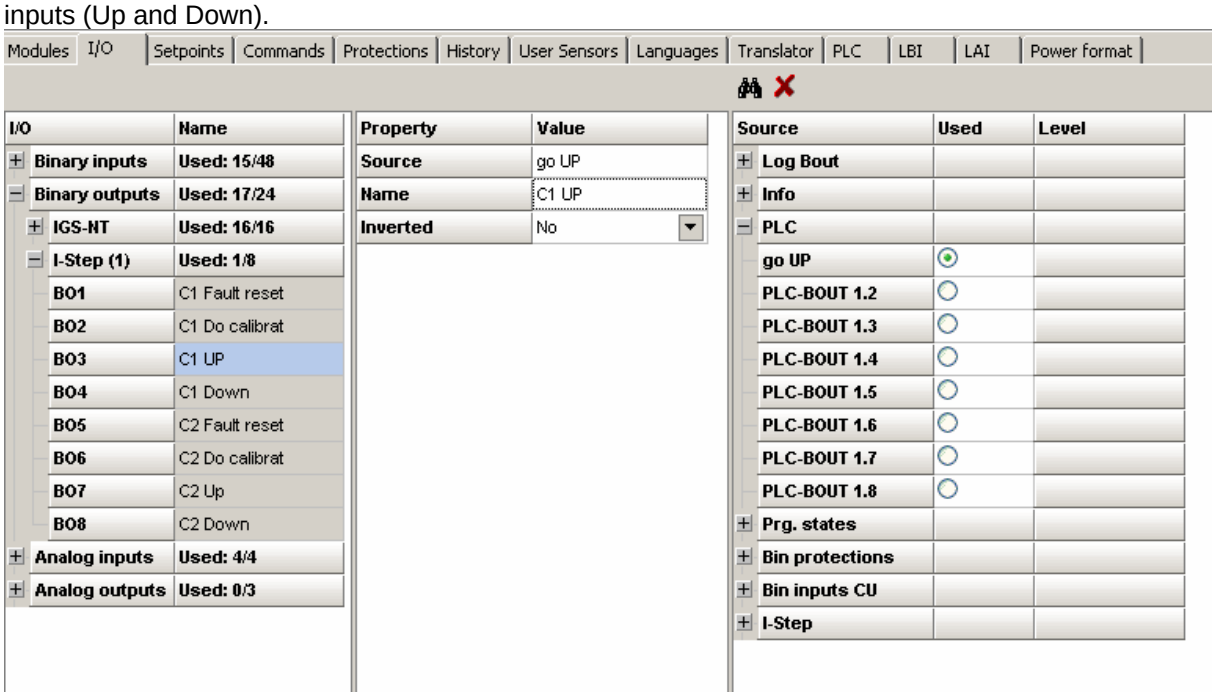
Calibration procedure is included after each system switch-on (or can be forced by command, see Tab.4). This mode is dedicated for stepper motors without position feedback. Calibration procedure is based on one 0,00% position sensor and one 100,00% position sensor. The stepper motor itself counts the number of steps during the calibration process and this value is visible in Values:I-Step: NumSteps. This value has to be rewritten into the setpoint I-Step:NumSteps in I-Step configuration (by the operator).

Calibration process is divided into 2 parts. In the first part the stepper is dedicated to go to 0,00% end-point. This must be finished until *CalibrTimeout* setpoint expires. If not, the *CalibrFail* and *TimeoutFail* bits are indicated. The second part is calibration to 100,00% end-point. This part must be finished also until *CalibrTimeout* setpoint expires (The *CalibrTimeout* period runs again from the beginning). *CalibrTimeout* is indicated also in case the I-Step counts more then 15 000 steps during this calibration part (15 000 steps is limiting number, stepper motor with higher number of steps cannot be controlled by I-Step 1.1 neither in this mode nor in the CALIBR 0 mode).

When the I-Step, during normal operational mode, receives information about end-point position (either 0 or 100% end-point), the similar cases as in the first mode (Calibration to zero end-point) arise.

1.3 Without calibration process (NOCALIBR)

In this mode no calibration process is done. The stepper motor must be equipped with an analogue feedback signal (current 0-20 mA or voltage 0-10V) determining the actual position of the stepper. This signal must be led to the controller. In the controller this value is dedicated to be compared with the requested position of the stepper motor (using the PLC block Time Comparator e.g) and corresponding binary outputs – Go UP, Go DOWN must be configured to appropriate bits in I-Step inputs (Up and Down).



When these bits are not configured in this mode, the *BinCtrlFail* bit will be activated. The minimal pulse length to be accepted by the I-Step is 120ms.

The information about the position of the stepper should be configured also to the analogue input of the I-Step module (this information must be in range 0,00 – 100,00% - the internal PLC functions can be used, see IGS-NT manuals at www.comap.cz), so the I-Step can display this actual position value.

In this mode the setpoints *CalibrTimeout, MixerHysteresis* have no meaning, are not used. In case in this mode the end-point position will be detected and there will be disproportion between this information and information receiving from the analogue feedback signal from the stepper motor, the bit *PositionLost* will be adjusted. The *FaultReset* command is necessary to be sent to the I-Step to refresh the functionality of the I-Step module.

If any channel of the I-Step is switched into another mode (by setpoint CxMode), the bit *CalibrFail* will be adjusted and it is up to operator to invoke a calibration itself, activating the corresponding bit:*StepperCalibr*. In case any I-Step channel is switched into mode Calibr 0 or Calibr 0&100, then the calibration process can be invoked by switching off and on the power supply of the I-Step module.

In all three modes both the 0 end-point and 100% end-point signals have to be configured to assure the correct functionality of the I-Step module. The end-point signals which are not necessary for appropriate mode (CALIBR_0 or NO_CALIBR) have to be configured as permanent open or close, depending on the chosen polarity of the end-point signals.

2. I-Step terminals, dimensions

The I-Step module dimensions, front sticker:

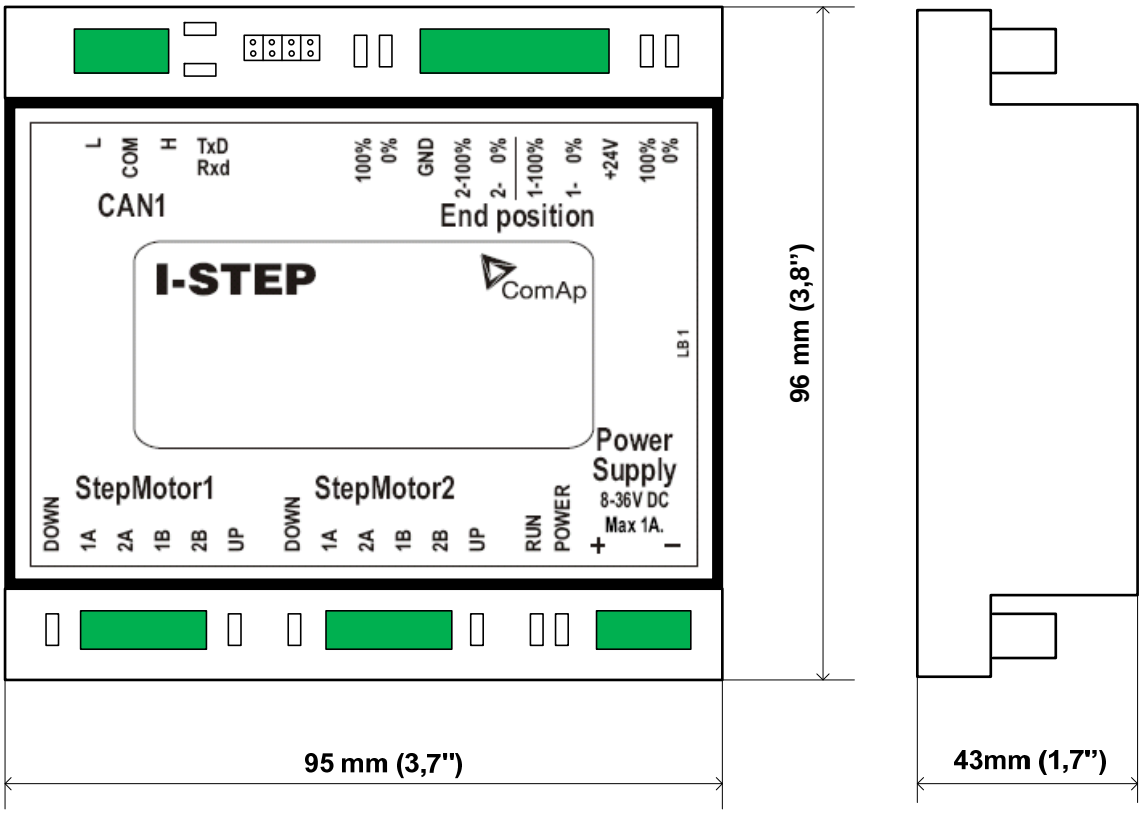


Fig. 1. I-Step dimensions, connectors layout, front sticker

Jumpers

Label	Position	Function
J1	P34	No function - reserve
J3	P36	No function - reserve
J4	P37	No function - reserve

Tab.1. I-Step jumpers description

LED Indication

LED states description:

- ON continuously lights,
- OFF continuously dark,
- F1 blink with 1 sec period,
- F2 blink with 200 ms period
- F3a,b two LED alternates with period 200ms
- F4 ”fast” blinking, dependent on the communication speed

There are following 5 LEDs on I-STEP module.

LED	State	Description
PWR	ON	The supply voltage is connected to I-STEP
RUN	OFF	I-STEP is not working
	ON	I-STEP is ready, communication OK
	F1	Communication fail.
	F2	Invalid firmware, memory fail.
DOWN 1 (or 2)	OFF	Steady state, not moving.
	ON	Moving to 0,0% direction
	F2	Calibration in process
	F3a	Calibration fail
UP 1 (or 2)	OFF	Steady state, not moving.
	ON	Moving to 100,0% direction
	F2	Calibration in process
	F3b	Calibration fail
TxD, RxD	F4	Active communication via CAN 1 line
0%, 100%	ON	*In case negative end-point logic*: no end-point is detected *In case of positive end-point logic*: end point reached
	OFF	*In case negative end-point logic*: end-point is reached *In case of positive end-point logic*: no end point is detected

Tab.2. I-Step LED description

3. Data

Following status from I-STEP can be used for states indication or alarm generation. There is separate status info from each channel.

Status

Bit	Name	Function
BI1	C1/2 Active	= 1 … I-Step channel is active = 0 … I-Step is not enabled
BI2	C1/2 Calibration	= 1 … Calibration is actually in process = 0 … No calibration is processed
BI3	C1/2 InOperation	= 1 … I-Step is in operation – stepper is revolving = 0 … Stepper is idle
BI4	C1/2 Increasing	= 1 … I-Step is actually in Increasing process = 0 … I-Step r is not in Increasing process
BI5	C1/2 Decreasing	= 1 … I-Step is actually in Decreasing process = 0 … I-Step is not in Decreasing process
BI6	C1/2 BinaryCtrl	= 1 … Stepper position is controlled via binary signal Up, Down = 0 … Stepper position is controlled via analog signal
BI7	C1/2 BinCtrlFail	= 1 … Wrong combination of binary signal Up, Down was detected, or binary signals are not configured in NO_CALIBR mode. = 0 … No binary signal problems, possibly not configured
BI8	C1/2 CalibrDone	= 1 … Calibration was successfully done = 0 … Calibration is needed
BI9	C1/2 CalibrFail	= 1 … problem during Calibration process was detected = 0 … the last calibration was successfully
BI10	C1/2 TimeoutFail	= 1 … Calibration wasn't success in given time (CalibrTimeout) = 0 … no expired timeout detected
BI11	C1/2 PositLost	= 1 … Unexpected sensor mark = 0 … no position lost indication
BI12	C1/2 CommError	= 1 … Some communication problems were detected (connection lost) = 0 … no connection lost indication
BI13	C1/2 EEPROM fail	= 1 … EEPROM fail was detected = 0 … EEPROM ok
BI14	C1/2 WrongParams	= 1 … some setpoint is out of limit = 0 … no setpoint problem
BI15	C1/2 OverProt	= 1 … Overload was detected = 0 … No overload detected
BI16	Not used	For further use

Tab.3. I-Step Status information

Hint:

It is up to operator, to configure appropriate protections on these Status information bits. For example Shutdown in case the *PositLost* bit is indicated, Warning in case *CalibrFai*l is indicated and so on.

Commands

can be handled from InteliSys-NT controller

Bit	Name	Meaning
BO1/BO5	M1/2 Fault reset	= 1 … Clear all fails indication in mixer 1/2 status register = 0 … no meaning
BO2/BO6	M1/2 Do calibrat	= 1 … Calibration process on mixer 1/2 is requested, see Note 1) = 0 … no meaning
BO3/BO7	M1/2 Up	= 1 … Move mixer 1/2 step engine Up, see Note 2) = 0 … no request to move Up
BO4/BO8	M1/2 Down	= 1 … Move mixer 1/2 step engine Down , see Note 2) = 0 … no request to move Down

Tab.4. I-Step commands

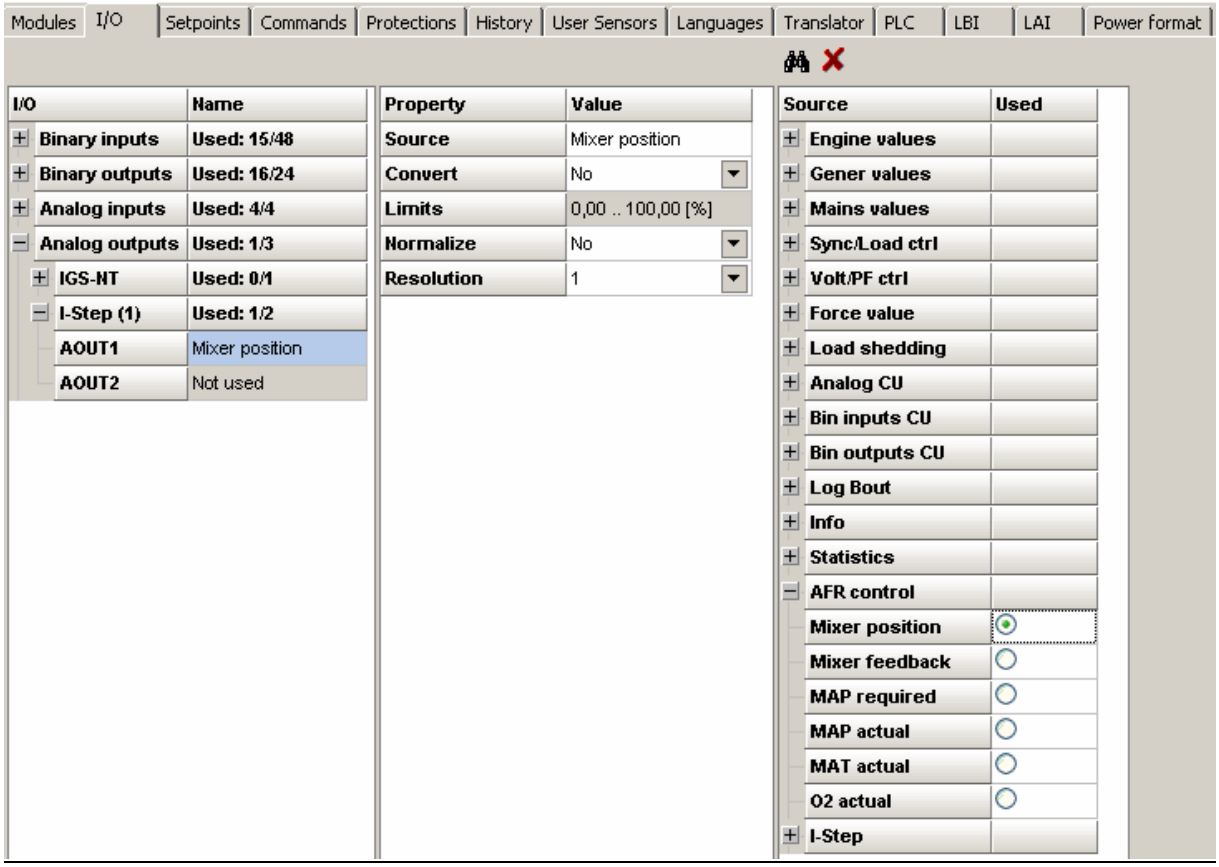
Note 1) Calibration process starts with transition 0 to 1 on binary signal “Do calibration”. Calibration process couldn’t be interrupted.
Note 2) Binary control needs both signals Up and Down to be configured in IS-NT controller. If there is Up and Down request at the same time no request is accepted.

Data Analogue outputs

	Name	Function
AOUT1	Channel 1 output	0,00 – 100,00 %
AOUT2	Channel 2 output	0,00 – 100,00 %

Tab.5. I-Step analogue outputs

On these analogue outputs configure the requested position signal, in range 0,00 – 100,00%. This signal is for example the logical output “Mixer position” from IS-NT-AFR software:



Hint:
Requested position value in 0,00 – 100,00 range only is accepted by I-Step module. Any value out of this range is limited to 0,00 or to 100,00%.

4. Setpoints

There are 2 setpoint sets; each I-Step channel has its own setpoint set.

4.1 Channel 1 set

C1 mode [CALIBR 0 / CALIBR 0&100 / NOCALIBR]

Define in which mode operates the I-Step channel.

CalibrTimeout 1 [s]

Till this time interval the calibration, or calibration part, must be done to corresponding mark (described above), otherwise the calibration timeout will be activated.
This parameter should be adjusted as time for the change from 0.00% to 100.00% position.

Step: 1 s
Range: 5 – 120 s

StepperHyst 1 [%]

The maximal difference between the requested and the actual position. Stepper motor is moving when the actual difference is higher, in absolute value, than *StepperHyst* parameter.

Step: 0,01 %
Range: 0,00 – 100,00 %

BiasPos 1 [%]

Initial stepper position in the case of binary (Up/Down) control.

Step: 0,01 %
Range: 0,00 – 100,00 %

NumSteps 1 [steps]

Number of steps for full range 100,00%. In CALIBR 0 mode this parameter is crucial for the right operation of the I-Step. In mode Calibr 0&100 this parameter should be adjusted by operator in accordance with the value, which counts the I-Step during the calibration process. (This value is visible in: Values:I-Step:NumSteps)

Step: 1 step
Range: 10 – 15 000 steps

SpeedMax 1 [step/s]

Maximal stepper motor speed (in number steps in 1sec) which is acceptable – no step lost.

Step: 1 step/s
Range: 25 – 6000 steps/s

SpeedStart 1 [step/s]

Safety speed for stepper motor starting, without step lost.

Step: 1 step/s
Range: 25 – 6000 steps/s

StartSteps 1 [step]

Number of steps for safety (no step lost) ramping from StartSpeed to MaxSpeed and from MaxSpeed to StartSpeed or zero, in the case of stepper motor stopping.

Step: 1 step
Range: 10 – 15 000 steps

BinarySpeed 1 [%/s]

Stepper speed (% per 1 sec) in the case of binary (Up/Down) control.

Step: 1 %/s
Range: 0 – 100 %/s

NominalCurr 1 [A]

Nominal stepper motor current (for protection limit).

Step: 0,1 A
Range: 0,0 – 2,2 A

PosTolerance1 [%]

Tolerance range, the end-point position detection is considered as a normal state. State above this tolerance is evaluated as "*CalibrFail*" (Calibration Fail). If the end switch detection is above 3x PosTolerance, the state will be evaluated as "*PositionLost*".

Step: 0,1 %
Range: 0,00 – 100,00 %

4.2 Channel 2 set

Cannel 2 [DISABLED / ENABLED]

Disable or enable the I-Step second channel.

C2 mode [CALIBR 0 / CALIBR 0&100 / NOCALIBR]

Define, in which mode operates the I-Step channel.

CalibrTimeout 2 [s]

Till this time interval the calibration, or calibration part, must be done to corresponding mark (described above), otherwise the calibration timeout will be activated.
This parameter should be adjusted as time for the change from 0.00% to 100.00% position.

Step: 1 s
Range: 5 – 120 s

StepperHyst 2 [%]

The maximal difference between the requested and the actual position. Stepper motor is moving when the actual difference is higher, in absolute value, than *StepperHyst* parameter.

Step: 0,1 %
Range: 0,00 – 100,00 %

BiasPos 2 [%]

Initial stepper position in the case of binary (Up/Down) control.

Step: 0,1 %
Range: 0,00 – 100,00 %

NumSteps 2 [steps]

Number of steps for full range 100,00%. In Calibr 0 mode this parameter is crucial for the right operation of the I-Step. In mode Calibr 0&100 this parameter should be adjusted by operator in accordance with the value, which counts the I-Step during the calibration process. (This value is visible in: Values:I-Step:NumSteps)

Step: 1 step
Range: 0 – 15 000 steps

SpeedMax 2 [step/s]

Maximal stepper motor speed (in number steps in 1sec) which is acceptable – no step lost.

Step: 1 step/s
Range: 25 – 6000 steps/s

SpeedStart 2 [step/s]

Safety speed for stepper motor starting, without step lost.

Step: 1 step/s
Range: 25 – 6000 steps/s

StartSteps 2 [step]

Number of steps for safety (no step lost) ramping from StartSpeed to MaxSpeed and from MaxSpeed to StartSpeed or zero, in the case of stepper motor stopping.

Step: 1 step
Range: 10 – 15 000 steps

BinarySpeed 2 [%/s]

Stepper speed in (% per 1 sec) in the case of binary (Up/Down) control.

Step: 1 %/s
Range: 0 – 100 %/s

NominalCurr 2 [A]

Nominal stepper motor current (for protection limit).

Step: 0,1 A
Range: 0,0 – 2,2 A

PosTolerance 2 [%]

Tolerance range, the end-point position detection is considered as a normal state. State above this tolerance is evaluated as "*CalibrFail*" (Calibration Fail). If the end switch detection is above 3x PosTolerance, the state will be evaluated as "*PositionLost*".

Step: 0,1 %
Range: 0,00 – 100,00 %

Default settings

C1 Mode	Calibr 0	-	**C2 Mode**	Calibr 0	
CalibrTimeout 1	120	s	**CalibrTimeout 2**	120	s
StepperHyst 1	1,00	%	**StepperHyst 2**	1,00	%
BiasPos 1	50,00	%	**BiasPos 2**	50,00	%
NumSteps 1	2500	-	**NumSteps 2**	2500	-
SpeedMax 1	500	n/s	**SpeedMax 2**	500	n/s
SpeedStart 1	500	n/s	**SpeedStart 2**	500	n/s
StartSteps 1	500	n	**StartSteps 2**	500	n
BinarySpeed 1	10	%/s	**BinarySpeed 2**	10	%/s
NominalCurr 1	1,4	A	**NominalCurr 2**	1,4	A
PosTolerance 1	2,00	%	**PosTolerance 2**	2,00	%
C1Polarity	NEGATIVE		**C2Polarity**	NEGATIVE	
			Channel 2	DISABLED	

Fault reset

There is separate fault reset for each stepper channel.

Control parameters of the stepper motor

Default setting correspond to stepper motor NANOTEC MUNICH L5618x2004-RM

- 200 steps per 1 turn
- 12.5 turns for full 100% Stepper range
- ***NumSteps*** = 2500 for full 100% Stepper range
- normal (not micro) stepping

Two stepper motors control

- I-Step module is able to control two independent stepper motors – two separate channels
- Each channel has separate request, commands, status and position signal
- The second channel is activated by setpoint Channel 2 [DISABLED / ENABLED]

5. *Troubleshooting*

- In some cases it is necessary do adjust the I-Step current to lower values (below 0,5A), otherwise the stepper will not move.

- In case the stepper is moving in opposite way, swap any 2 output wires, which led to the stepper..

- In case of NO_CALIBR mode, the binary control can be used. In this case, the pulses should be rather short. The source for pulses Speed UP and Speed DOWN could be created using the internal PLC functions in controller. The proper hysteresis should be also done, to avoid the unadvisable movement of the stepper around the requested position. . The speed of the stepper motor should be adjusted to lower values, see *Setpoints*.

  The following scheme shows the example, how to create the signals for UP and DOWN to control the stepper in binary mode;

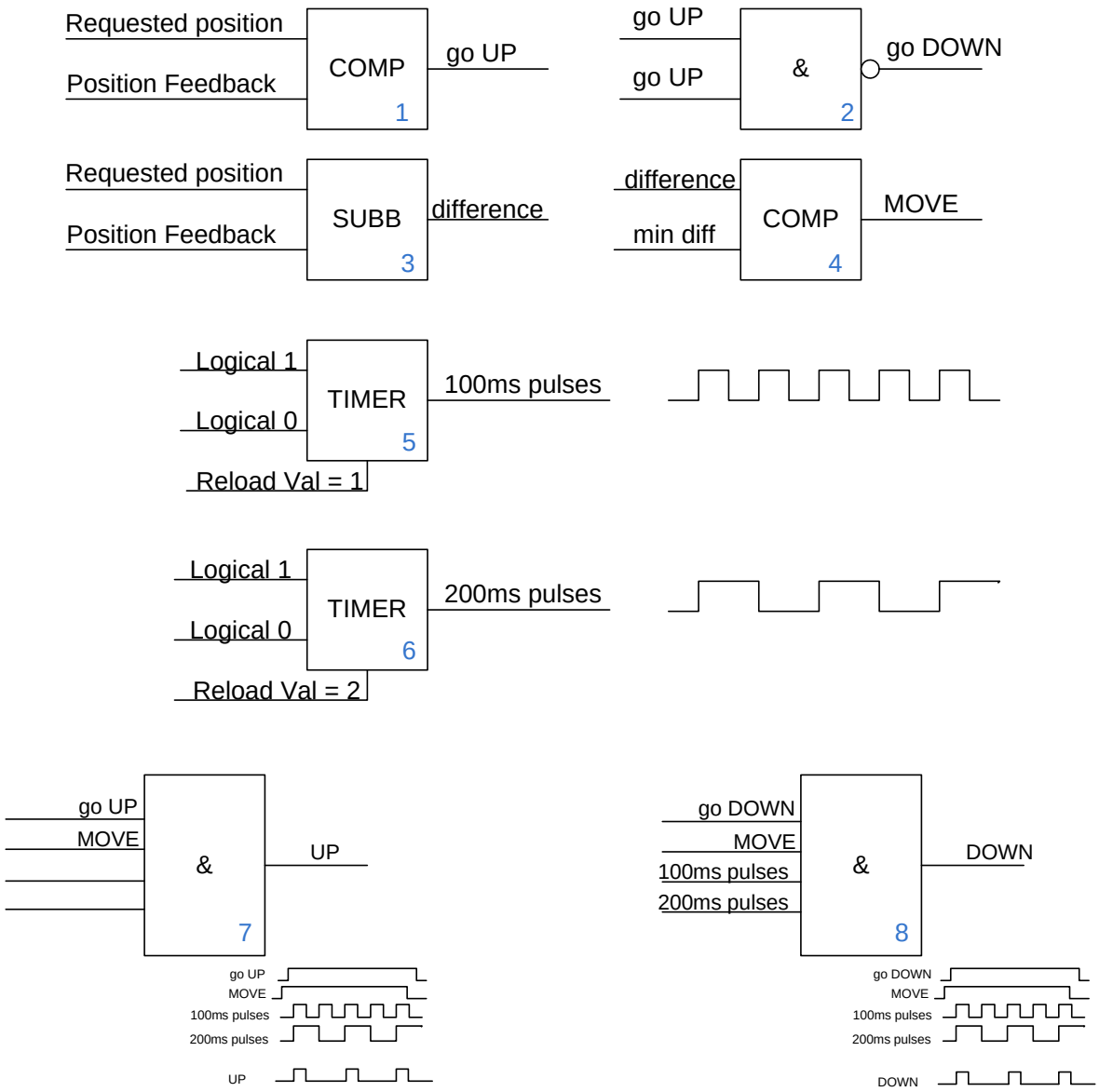


Fig. 2. PLC functions to assure the proper control of the stepper in binary mode, without calibration

Block n.1 – Comparator, which compares the requested position and actual position of the stepper motor. If the requested position is higher, stepper should move up – output **go UP**

Block n.2 – Negation of the go UP signal = **go DOWN** signal

Block n.3 – **Difference** between the Requested position and Actual position of the stepper – used for hysteresis – block n.4

Block n.4 – Comparison between the difference from block 3 and adjusted limit for **hysteresis**. When the difference between the requested position and actual position of the stepper is higher then adjusted hysteresis limit min diff, the stepper should move.

Block n.5 – 100ms rectangular signal

Block n.6 – 200ms rectangular signal

Block n.7 – **UP** = AND function of go UP signal, MOVE signal and xxxms pulses. The output is dedicated to be configured as source for UP signal of the I-Step. This signal has 100ms pulse; period of the signal is 400ms

Block n.8 – **DOWN** = AND function of go DOWN signal, MOVE signal and xxxms pulses. The output is dedicated to be configured as source for DOWN signal of the I-Step. This signal has 100ms pulse; period of the signal is 400ms

6. *Technical data*

Power supply

Voltage supply 8-36V DC
Consumption based on stepper current and number of steppers connected, see the following table:

	Consumption [mA]		
Power supply voltage [V]	No stepper connected	1 stepper @ 1A	1 stepper @ 2A
12	43	280	850
24	80	570	1700

In case both stepper channels are used, the consumption is almost double.

Operating conditions

Operating temperature -30..+70°C
Storage temperature -30..+80°C
Protection IP00
Humidity 95% without condensation
Standard conformity
Low Voltage Directive EN 61010-1:95 +A1:97
Electromagnetic Compatibility EN 50081-1:94, EN 50081-2:96
EN 50082-1:99, EN 50082-2:97
Vibration 5 - 25 Hz, ±1,6mm
25 - 100 Hz, a = 4 g
Shocks a = 200 m/s^2

Dimensions and weight

Dimensions 95x96x43 mm, DIN rail mounted
Weight 200g

Binary inputs

Number of inputs 4
Input resistance 4,4kΩ
Input range 0-36VDC
Switching voltage level for close contact indication 0-2V
Max voltage level for open contact indication 8-36V

Driver outputs

Stepper driver current outputs
Number of outputs 2 sets of stepper driver outputs
Output range 0 – 2,2A

CAN bus interface

Galvanically separated
Maximal CAN bus length 200m
Speed 250kBd
Nominal impedance 120Ω
Cable type twisted pair (shielded)

Following dynamic cable parameters are important especially for maximal CAN bus length:

Nominal Velocity of Propagation	min. 75% (max. 4,4 ns/m)
Wire crosscut	min.0,25 mm^2
Maximal attenuation (at 1 MHz)	2 dB / 100m

Recommended Industrial Automation & Process Control Cables:
BELDEN (see http://www.belden.com):

- 3082A DeviceBus for Allen-Bradley DeviceNet
- 3083A DeviceBus for Allen-Bradley DeviceNet
- 3086A DeviceBus for Honeywell SDS
- 3087A DeviceBus for Honeywell SDS
- 3084A DeviceBus for Allen-Bradley DeviceNet
- 3085A DeviceBus for Allen-Bradley DeviceNet
- 3105A Paired EIA Industrial RS485 cable

LAPP CABLE (see http://www.lappcable.com)

- Unitronic BUS DeviceNet Trunk Cable
- Unitronic BUS DeviceNet Drop Cable
- Unitronic BUS CAN
- Unitronic-FD BUS P CAN UL/CSA