SimplexMotionTool software manual

This document covers the functionality of the SimplexMotionTool software.

The SimplexMotionTool is a PC software to configure and test Simplex Motion motor units.

Simplex Motion motor units are integrated electric motor drive units with control electronics for either standalone operation or with external control through one of its digital communication interfaces.

Software features:

- Connect to a Simplex Motion device using USB or RS485/Modbus communication.
- Quick start and setup of standalone functionality
- Read and write the registers of the device. These registers control all functionality in the motor device.
- Easy access to the internal recorder of the motor device. This recorder is used to save measurement data in real time, which is useful to verify and improve performance.
- Simple mode for running the motor in speed or position feedback mode while watching real time (can also be saved to excel compatible file).
- A mode for optimizing position ramping control for fast and precise positioning.
- Event programming for customized control and functions

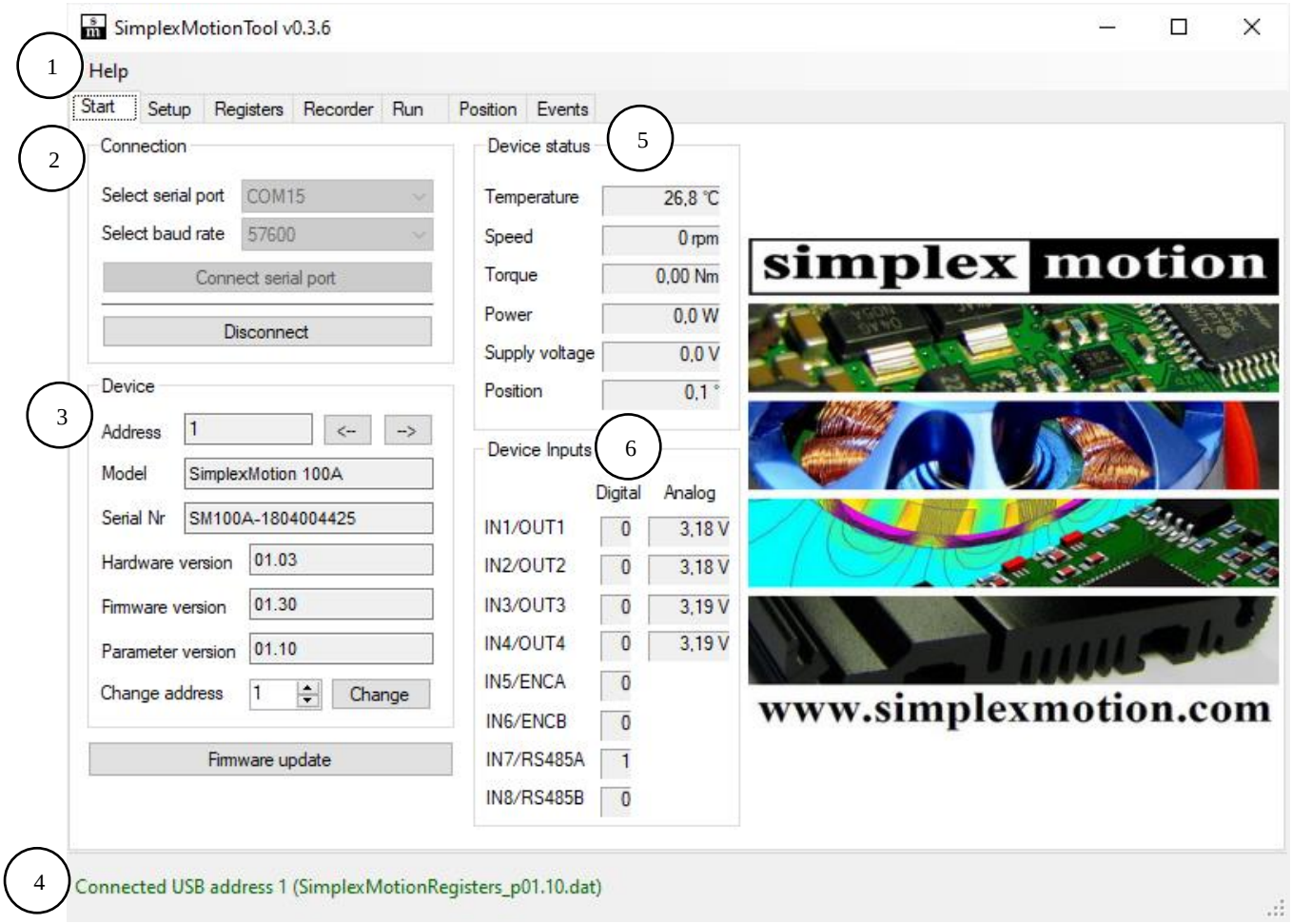
Table of contents:

1 Overview

This software runs on PC computers in Windows 10 environments. It allows connection to Simplex Motion motor devices using USB or serial RS485/Modbus communication. The most common operating modes and features are represented in the different tabs. More functions and parameters of the motors are to be found in the Motor Manual, available through the Help menu or at www.simplexmotion.com.

2 Start tab

The Start tab is used to establish connection to a Simplex Motion device. When connected to unit basic information of the unit is displayed. There is also a button to access this documentation.



1. Help – Links to manuals
   - Motor manual – Covers motor software and functions
   - Software manual – SimplexMotionTool manual (this document)

2. Connection
   Choose between Serial or USB connection. Use serial when connecting through a serial adapter (RS485/Modbus communication) such as the Demo Panel. Choose USB when connecting directly to the USB port on the motor (Only available on the SH and SM variants). In this example the motor is connected through the USB connector.

3. Device
   - Address - Select the address of the motor to connect to on the serial bus (not applicable when connecting through USB). If there is no motor with the selected address, connection is established to the device with

the closest address above. If there are several units connected to the computer at the same time it is possible to switch between them using the arrow buttons.

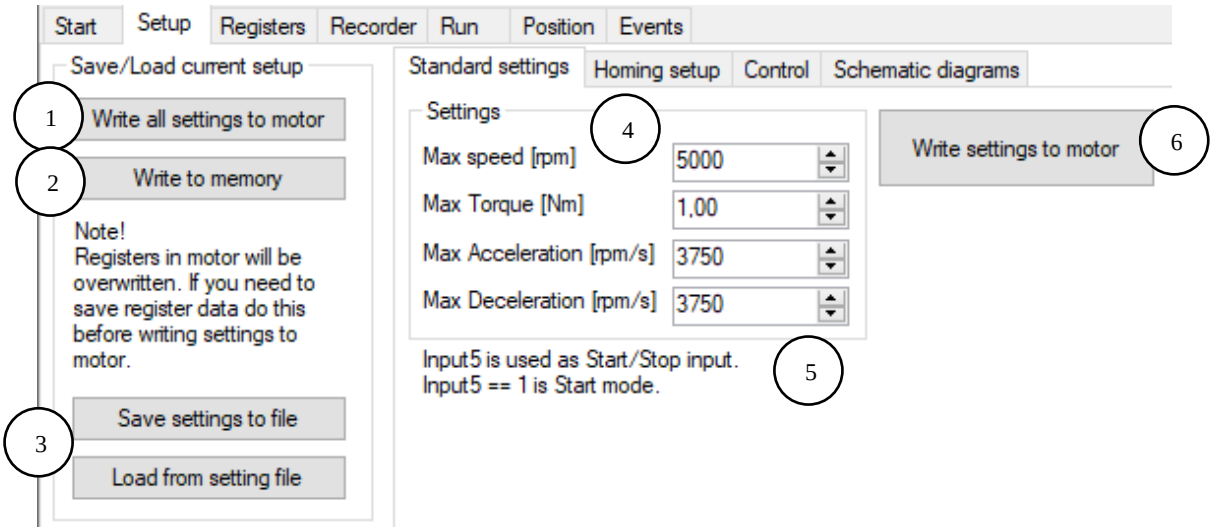
- Model – Displays the model of the connected motor
- Serial Nr – Displays the serial number of the connected motor
- Hardware version – Displays the hardware version of the connected motor
- Firmware version – Displays the firmware version of the connected motor
- Parameter version – Displays the parameter version of the connected motor
- Change address – To change the address of the motor on the serial bus, enter a new address number and click the Change button.

4. Status bar – As long as the connection is maintained, the text is green
5. Device Status – Displays basic motor data
6. Device Input – Displays the status of the I/Os

3 Setup

The Setup tab is used to make simple standalone application for the motors by using ether digital inputs or analog. It comprises of 4 tabs, Standard settings, Homing setup, Control and Schematic diagrams.

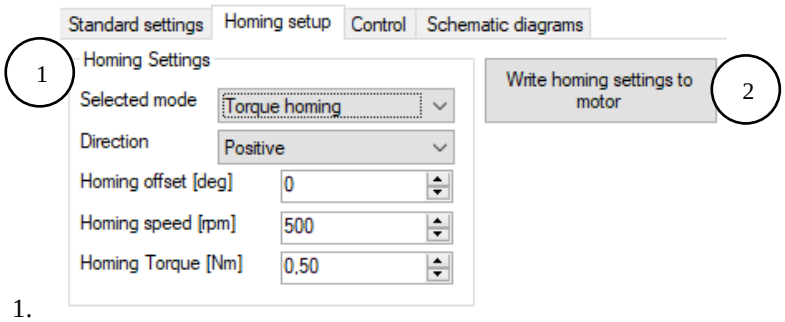
3.1 Standard settings



1. By pressing the “Write all settings to motor” button, the settings from all 3 setup tabs are loaded into the motor. NOTE! The motor will perform a factory before loading all the settings
2. Save the current settings in the motor to the non-volatile memory
3. Import or export setting from a .csv file.
4. The standard settings is used to set the maximum values used for speed, torque and acceleration.
5. Input 5 (IN5) is configured as Start/Stop when pressing the “Write all settings to motor” (1) or “Write control settings to motor” (2) button in the Control tab.
6. Load the values in the Settings boxes (4) to the motor. Used to update setting values without doing a factory reset of the motor.

3.2 Homing setup

The Homing setup tab is used to configure a homing sequence.



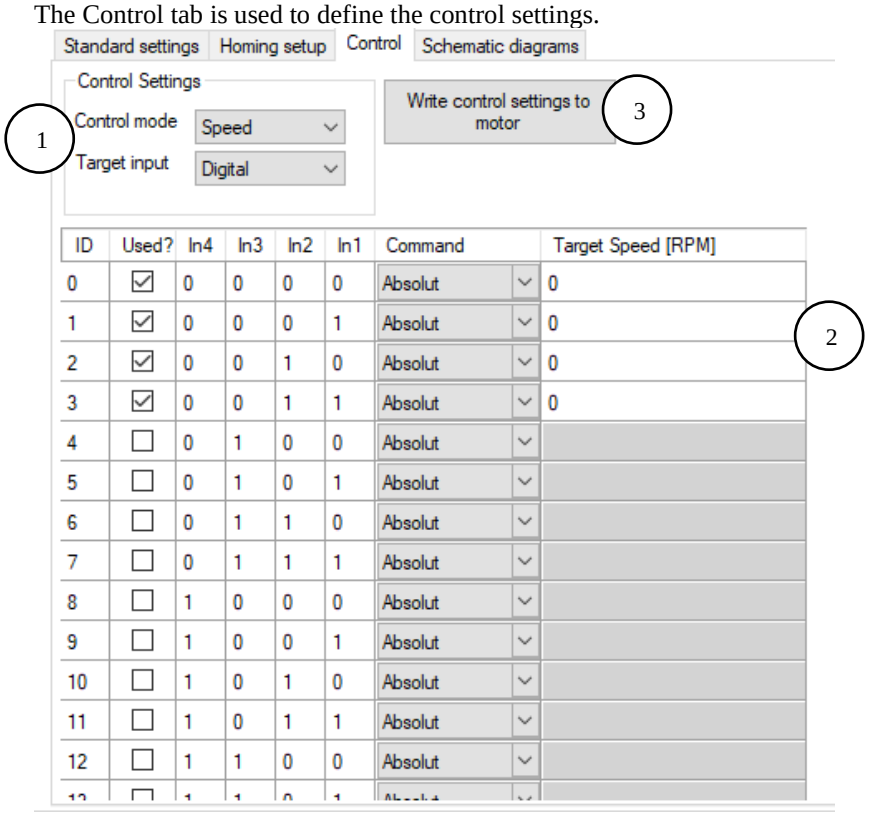
1. Homing settings
   - Selected mode:
     - No Homing – No homing will be initiated
     - Torque homing – The motor will perform a homing and stop when the set toque value is reached
     - Sensor Homing input 6 – The motor will perform a homing and stop when input 6 is activated (e.g. a limit switch)

     When homing is chosen, the motor will enter homing mode when starting up. *NOTE: Using Simplex Motion Tool v 0.3.6 or earlier, the startup mode needs to be entered manually (set register 401 to 70) and row 19 in the events tab needs to be removed (set to 0-None)*

   - Direction: Select the direction of the homing
   - Homing offset: Set an offset value for the starting position. If set to 0, the position when the homing is ended will be 0.
   - Load the values in the Homing Settings boxes (1) to the motor. Used to update homing settings and values without doing a factory reset of the motor.

3.3 Control

The Control tab is used to define the control settings.



ID	Used?	In4	In3	In2	In1	Command	Target Speed [RPM]
0	☑	0	0	0	0	Absolut	0
1	☑	0	0	0	1	Absolut	0
2	☑	0	0	1	0	Absolut	0
3	☑	0	0	1	1	Absolut	0
4	☐	0	1	0	0	Absolut	
5	☐	0	1	0	1	Absolut	
6	☐	0	1	1	0	Absolut	
7	☐	0	1	1	1	Absolut	
8	☐	1	0	0	0	Absolut	
9	☐	1	0	0	1	Absolut	
10	☐	1	0	1	0	Absolut	
11	☐	1	0	1	1	Absolut	
12	☐	1	1	0	0	Absolut	

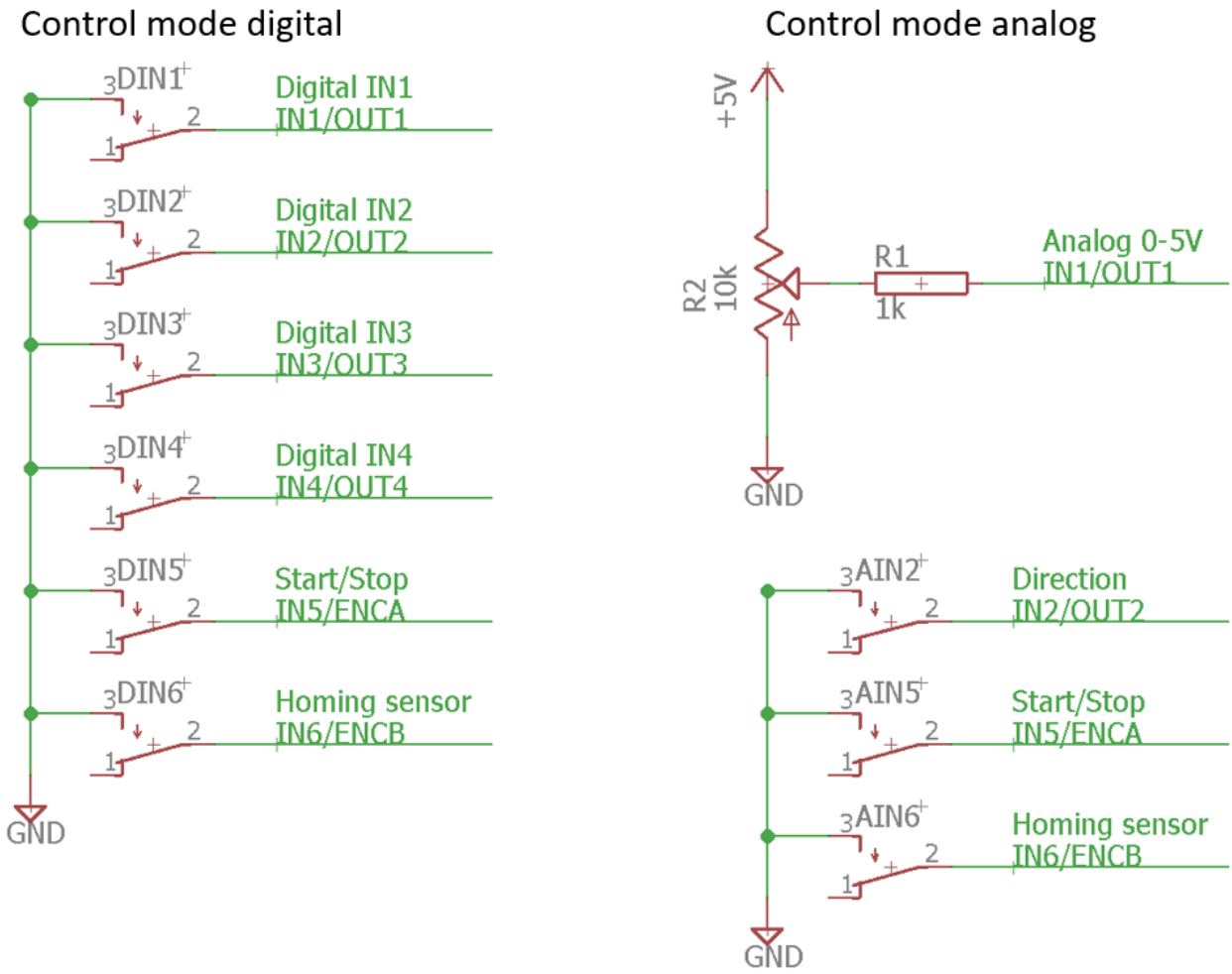
1 Control Settings
- Control mode: Select in what mode the motor should be run, Position, Speed or Torque
- Target input: Digital or Analog control.

2 Set the target values
- If Digital input is selected, 16 different speed, position or torque values can be set. IN1 – IN4 are used to for control. Each row can be configured to be absolute or relative.
- If Analog input is selected, the maximum value is set (i.e. the maximum target value when the analog signal is max). IN2 is used to change direction of rotation.

3 Load the settings and values of the Control setting (1) and Target values (2) to the motor. Used to update Control setting settings and values without doing a factory reset of the motor.

3.4 Setup Schematics

The Schematics diagram tab illustrates how switches and potentiometer should be connected when using the Setup tab control.



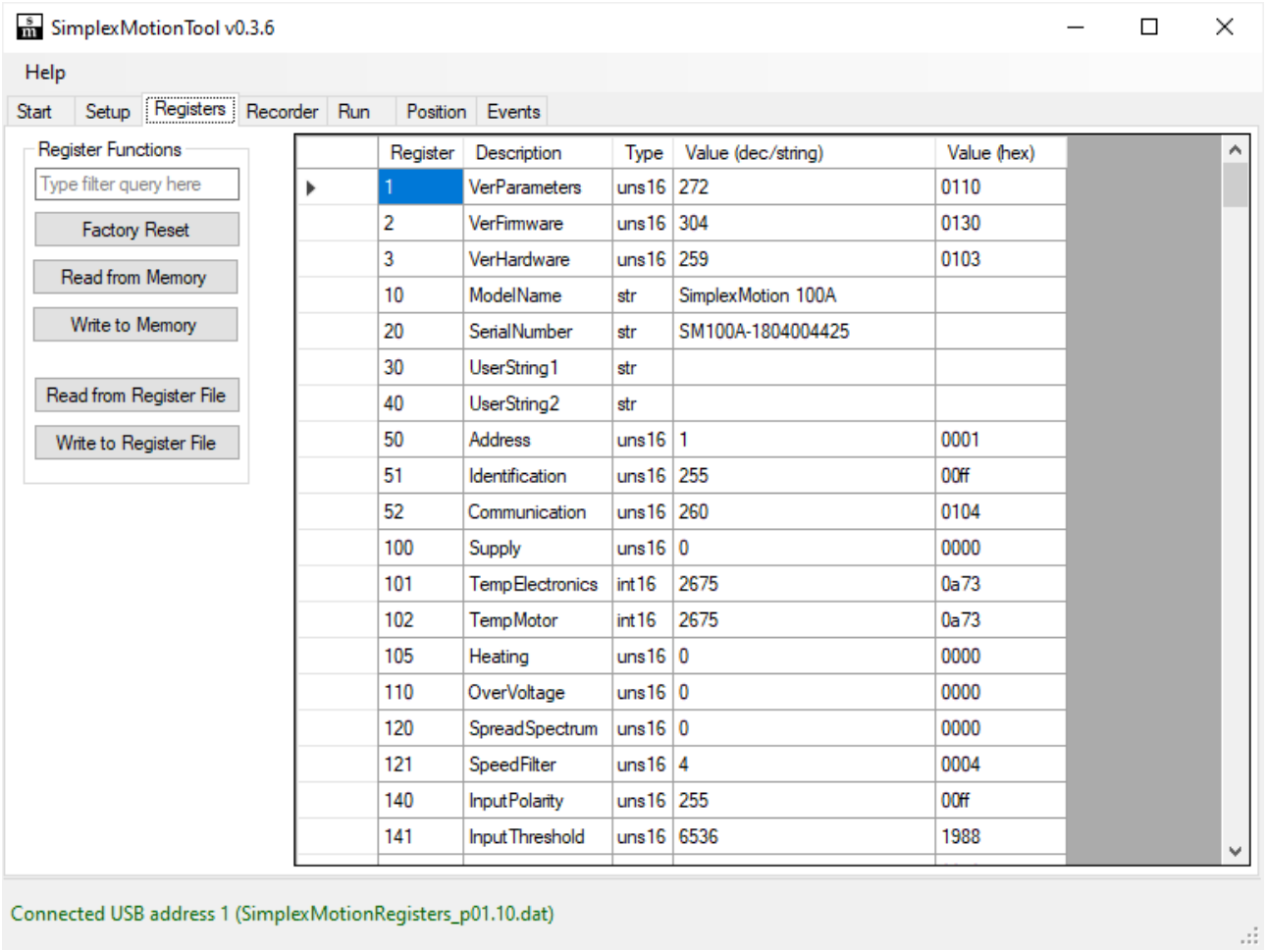
The diagram shows the mapping and connection of the different functions when using digital (left) and analog (right) modes.

- Digital inputs: The motor inputs have a pullup resistor activated as standard, which means that switches should be connected between the motor IN1-IN6 and GND.
- Analog inputs: A potentiometer connected to IN1 should be connected between the motor 5V (or 3,3V depending on model) and GND.

4 Register tab

The register tab shows all available registers in the device register map.
All functions are controlled and monitored using registers. The registers are stored in 3 different memories:

- The currently used settings (volatile memory, lost when powered off)
- Stored settings in memory (nonvolatile memory, loaded at power on)
- Factory default settings (Can be used for a reset to factory default settings)



The registers displayed in the table are updated in real time to show the currently used values in the Simplex Motion device. They can be changed by editing the values, either the decimal/string value or the hexadecimal value. The change of a value in a register is immediately reflected in the motor.

To keep the changed values after a power off/on cycle the current values has to be saved to the nonvolatile memory by pressing the ‘Write to memory’ button.

The filter function can be used to find specific registers.

5 Recorder tab

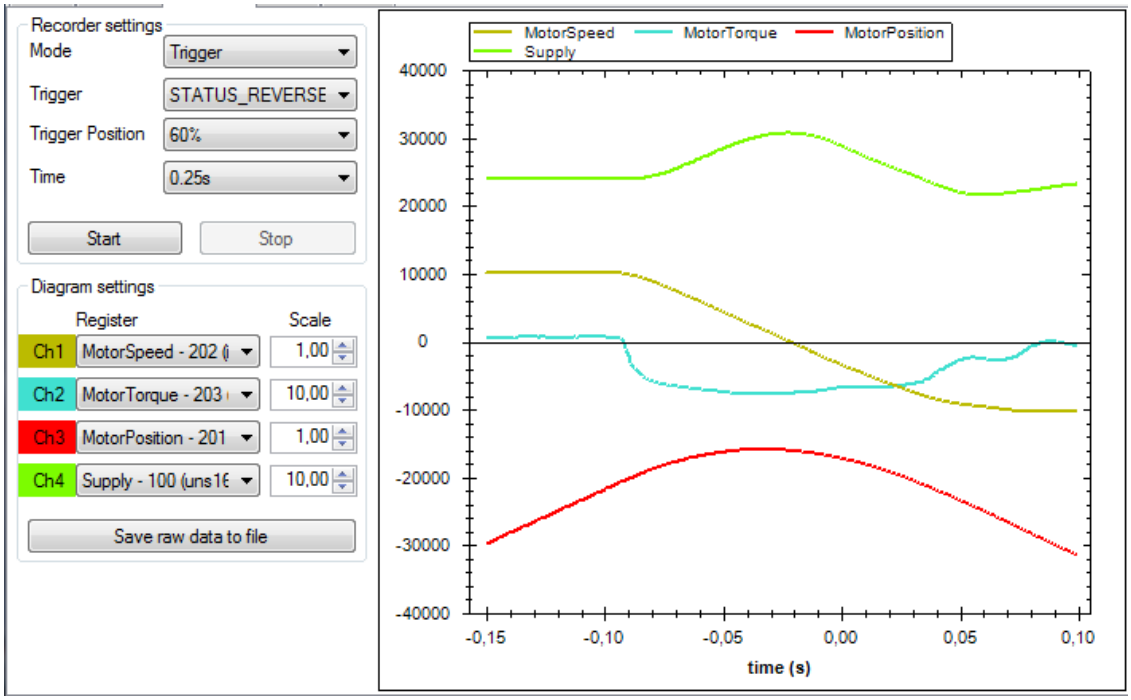
To facilitate performance validation and optimization it is necessary to be able to measure parameters in the motor device. To accomplish this there is a recorder feature within the Simplex Motion device. This tab is used to operate this recorder.
The recorder has 4 channels and record 500 consecutive values for each channel. These values are 16-bit values, which means that 32 bit registers only record the lower 16 bits.

The recorder can be used in several modes:

Mode:	Description:
Single	A single recorder sweep is performed directly
Trigger	A single recorder sweep is performed at a certain trigger condition. The trigger condition can be chosen from the bits is the status register in the device. Consult the device datasheet for further information.
Continuous	Continuous recorder sweeps are done and presented
Only download	This is a special mode that only downloads the data in the recorder memory without operating the recorder. It is mainly used for debugging purposes when this memory is used for other data.

When using Trigger mode it is possible to decide how much data should be shows prior to the time of triggering, by use of the 'Trigger position' setting.
The speed of the recorder can be changed to match the sequence of interest by use of the 'Time' setting.

The registers that should be recorded are selected by the drop-down lists for each channel. Since some registers hold small values compared to others, and the diagram uses one common Y-scale, it is also possible to scale the different channels.



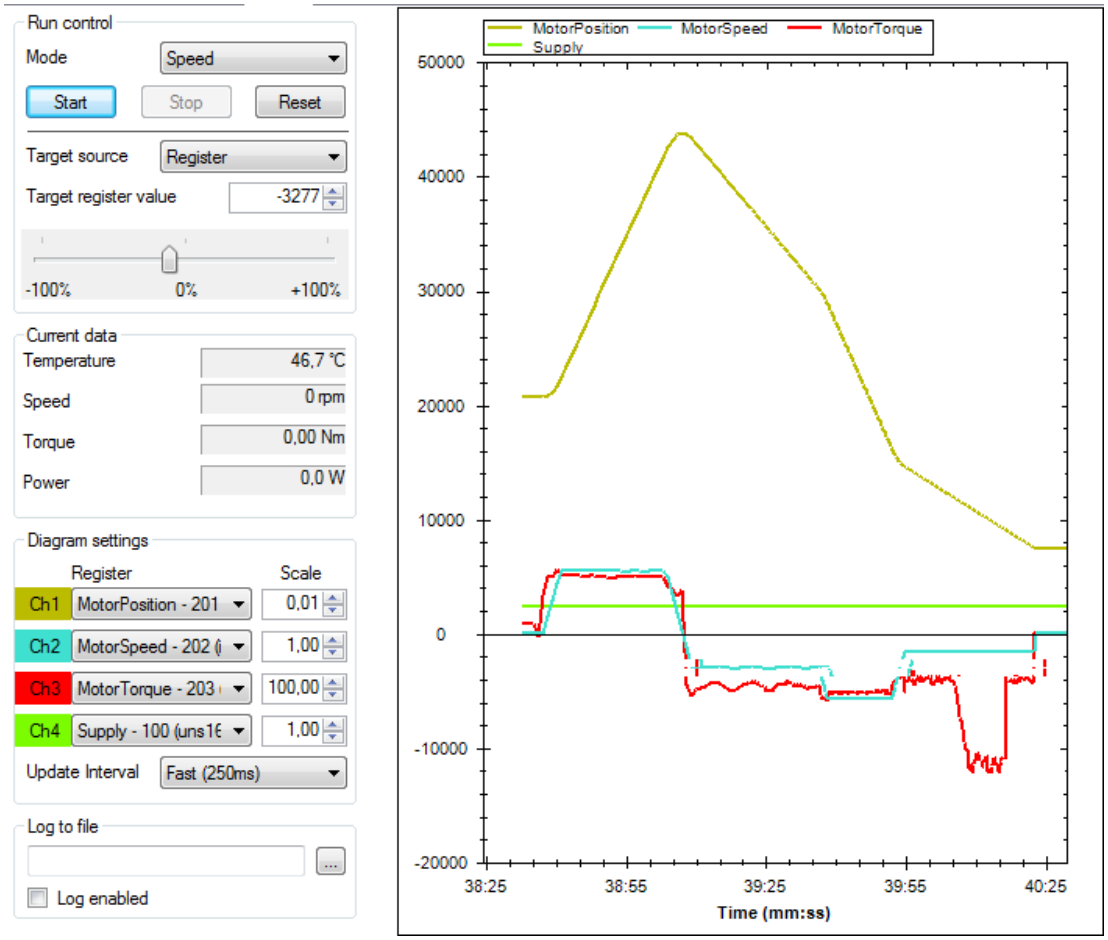
The screenshot shows a recording of some registers when the motor changes direction from positive to negative direction of rotation. In this case it takes about 0.15s to change the speed from +2300rpm to -2300rpm.

The diagram can be zoomed using the left mouse button. Using the right button allows copying or saving the diagram image. It is also possible to save the data values to an excel compatible file (*.csv).

6 Run tab

The Run tab makes it simple to quickly run the motor. It allows running the motor in speed, position or torque mode. Ramping is used for the speed and position modes to limit the motor acceleration. Select mode and target source and press start. By setting the target source to 'Register' the target value can be set directly in the 'Target register value' or by the slider control.

A selection of the more generally interesting data are shown as real time values in the current data box. It is also possible to select 4 different channels of registers to monitor more closely in graph form. This graph is in a rolling mode and is continuously updating. When switching between tabs, the collection of data is paused until the Run tab is selected again and a straight line is drawn between the last recorded values (if still available in the graph) and the new ones. The speed of data measuring can be set to Slow/Normal/Fast.
It is also possible to enable a continuous logging to a file (*.csv format).



The screenshot shows operation of the motor at a few different speeds, first in the positive direction and then in the negative direction. Note that the channel scaling has been used to allow all channels to be visible with the same Y-scale. An extra breaking load was applied to the motor at the end (at app. 40:05) as seen by the high negative value on the motor torque. This did not influence the motor speed.

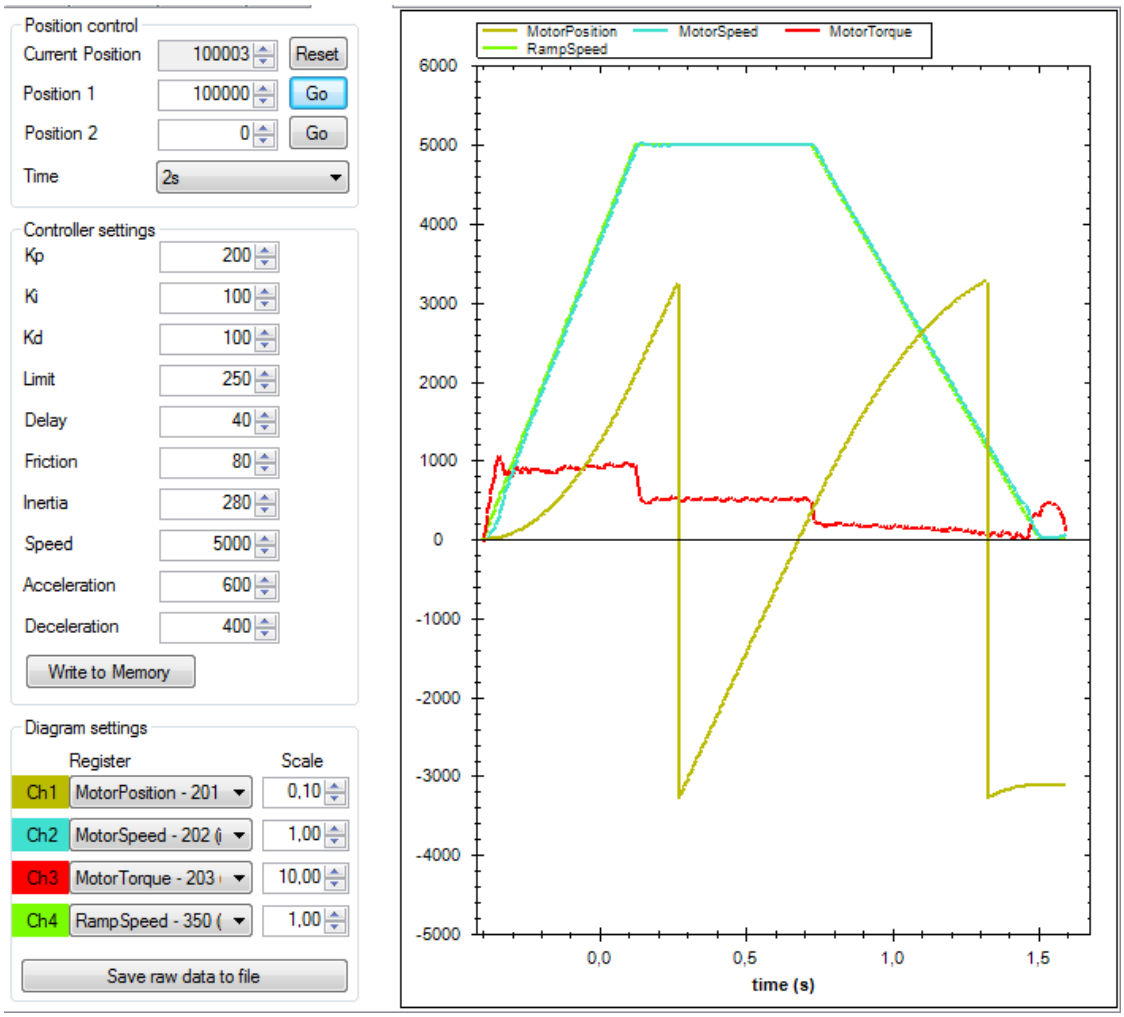
7 Position tab

The Position tab can be used for tuning and optimization of the regulator, ramping parameters and feed forward settings.
It uses the ramping position mode to run the motor between different positions. The movement is recorded and can be used to judge the performance.

A common use for the Simplex Motion devices is in position control with rapid transfers from one position to another. To accomplish this with high performance and a minimum of mechanical vibrations it is important to use ramping where the acceleration and maximum speed are controlled.
To further improve performance when dealing with high inertia loads is to use feed forward control in addition to the PID feedback regulator. If the inertia of the load is known as well as the required acceleration it is possible to directly apply the correct motor torque.

The 'reset' button resets the current motor position to 0. The 'Go' buttons runs the motor to the position entered in the adjacent fields. The recorder time can be to be set as well as what registers to plot and their scaling.

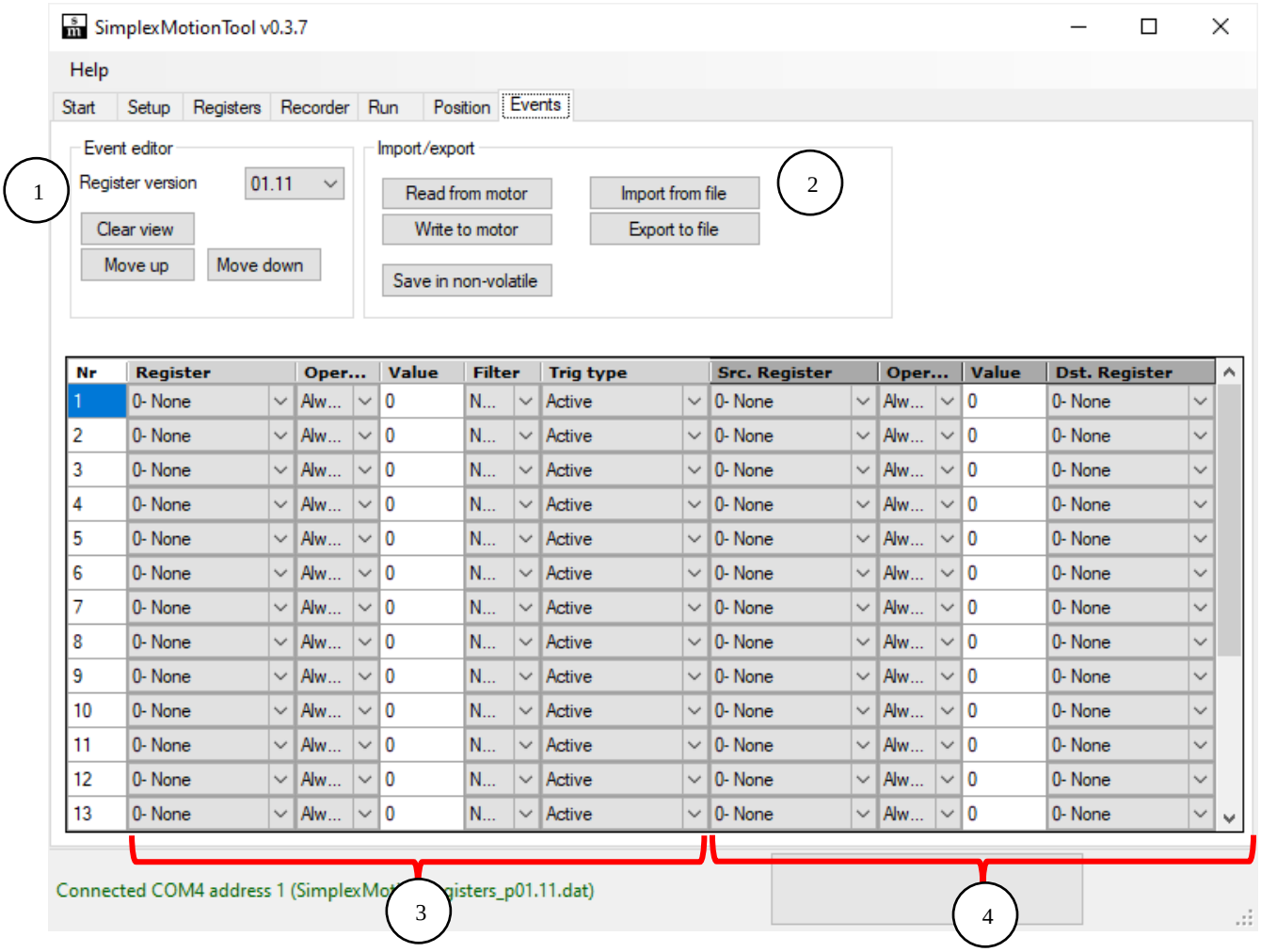
The typical parameters that are subject for tuning are accessible here. They are loaded from the devices current values when the tab is activated and can then be changed directly. Once the values have been improved, they can be written to the nonvolatile memory by the 'Write to Memory' button.



This screenshot shows a ramping move that has a higher acceleration than deceleration, and a maximum speed at 5000. Since the recorder can only handle 16bit values there is a wrap around on the Motor Position channel.

8 Event tab

The Event tab is a simple tool to programming the motor. Each event is evaluated at the rate of 2kHz. For more a more comprehensive description of the events, please refer to the Motor manual.



1 Event editor

- Register version: Depending on Register version in the motor, different registers are available
- Clear view: Clears all lines
- Move up: Move the selected row one row up
- Move down: Move the selected row one row down

2 Import/Export

- Read from motor: Read the current events from the motor (The events are not read automatically when connecting to a motor)
- Write to motor: Write the events in the table to the motor (The events are not written automatically to the motor when doing changes in the matrix)
- Save in non-volatile: Saves the events in the motor in the non-volatile memory (makes the available after power cycle)
- Import from file: Import events from a .csv file to the table
- Export to file: Export the events in the table to a.csv file.

3 Trigger fields: The Trigger fields are evaluated from 1-20 at a rate of 2kHz. The trigger field determines if the execution field of each row should be executed.

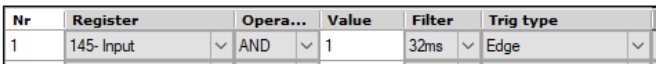
- Register: Select a register to be used for evaluation
- Operator: Select an operator:

Value:	Operator:	
0		Always true
1	=	Equal
2	!=	Not equal
3	<	Less than
4	>	Greater than
5	or	Bitwise or
6	nor	Bitwise not or
7	and	Bitwise and
8	nand	Bitwise not and
9	xor	Bitwise exclusive or
10	nxor	Bitwise not exclusive or
11	+	Add
12	-	Subtract
13	*	Multiply
14	/	Divide
15	Value	Takes data value directly

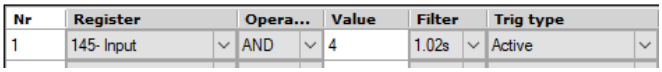
- Value: Enter a value for evaluation
- Filter: Select for how long the evaluation should be true before the event is executed. Can be used as delays before starting a sequence or for filtering a noisy signal
- Trig Type: Choose the behavior of the trigger:

Setting	Trigger type	Description
0	Active	Event is performed each time the filtered trigger condition is true.
1	Edge	Event is only performed the first time the filtered trigger condition becomes true. The trigger condition has to become deactivated again before next trigger can occur.
2	Repeat	Event is performed repeatedly while the trigger condition is true, but the filter is reset each time so that the filter creates a time delay between event executions.

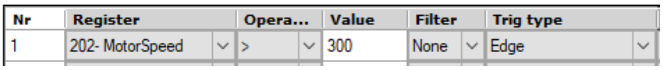
Examples:



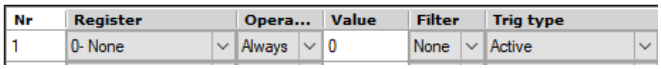
If Input1 is true (0001 = 1) after 32ms trigger execution one time



If Input3 is true (0100 = 4) after 1.02s trigger execution each time until false



If the speed is above 300, do execution one time (until going under and then above the speed again)

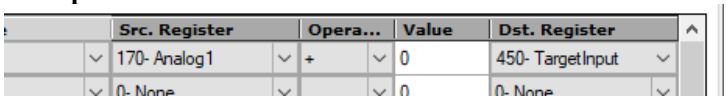


Always do execution

4 Execute fields:

- Src. Register: Select a source register to be used in execution
- Operator: Select an operator to be used in execution
- Value: Enter a value used in execution
- Dst. Register: The destination register for the execution field.

Examples:



If trigger is true, w rite “Analog1 + 0” in register 450 <TargetInput>

If trigger is true, write value 21 to register 400 <Mode>

9 Setup, behind the scenes

This section explains more in depth what happens when the 'Write to motor' button is pressed in each Setup tab.

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Standard settings tab:

- The value of Max speed is converted (Register value=rpm * 4096 / 16 / 60) written to register 351 RampSpeedMax
- Max Torque is converted to mNm and written to register 204 MotorTorqueMax
- Max Acceleration is converted (Register value = rpm/s * 4096 / 256 / 60) and written to register 353 RampAccMax
- Max Deceleration is converted (Register value = rpm/s * 4096 / 256 / 60) and written to register 353 RampDecMax

Homing tab:
No Homing

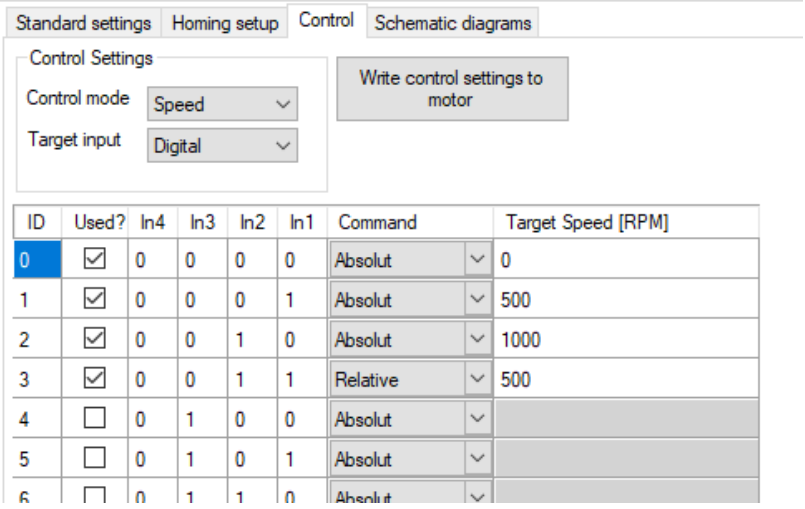
- Registers 480-483 HomeSequence1-4 are set to 0.

Torque or Sensor Homing:

- Register 480 HomeSequence1 is set according to rotate with 100% of the set homing speed in the direction chosen. The homing is completed when torque is reached or IN6 is high. (Filter is set to 0)
- Register 481 HomeSequence2 is set according to rotate with 25% of the set homing speed in the opposite direction from 480. The movement stops when torque is decreased or the IN6 is low. (Filter is set to 0)
- Registers 482-483 HomeSequence3-4 are set to 0.
- The value of Homing speed is converted (Register value = rpm * 4096 / 16 / 60) and written to register 491
- Register 492 HomeAcc is set to 1000.
- The value of Homing Torque is multiplied by 1000 and written to register 493 HomeTorque
- Depending on the value set in Control Mode in the Control tab, register 494 HomeDoneMode is set to 21 (PositionRamp), 33 (SpeedRamp) or 40 (Torque).
- Register 495 HomeChange is set to 0.
- The value of Homing offset is converted (Register value=degrees*4096/360) and written to register 496 HomeOffset32. (Register 490 HomeOffset16 in SimplexMotionTool version 0.3.6 and earlier).

Control tab:
The settings made in the control tab are transferred to the event tab and sequence registers. The structure of the programming is dependent on if digital or analog I/O control is chosen.

Digital Control:
This example shows digital speed control, with three absolute values and one relative.



The absolute values of Target Speed are converted to target values (target value = rpm * 4096 / 16 / 60) and written to the sequence target registers, SeqTarget1-16.

Register name	Type	Value (dec/string)	Value (hex)
SeqTarget1	int32	0	00000000
SeqTarget2	int32	2134	00000856
SeqTarget3	int32	4267	000010AB
SeqTarget4	int32	0	00000000
SeqTarget5	int32	0	00000000
SeqTarget6	int32	0	00000000
SeqTarget7	int32	0	00000000
SeqTarget8	int32	0	00000000
SeqTarget9	int32	0	00000000
SeqTarget10	int32	0	00000000
SeqTarget11	int32	0	00000000
SeqTarget12	int32	0	00000000
SeqTarget13	int32	0	00000000
SeqTarget14	int32	0	00000000
SeqTarget15	int32	0	00000000
SeqTarget16	int32	0	00000000

If the Control mode is torque, the values are converted from percent to target value (target value = percentage * 32767 / 100)
If the Control mode is position, the values in the setup tab are converted from degrees to target values (target value = deg*4096/360.

The Event tab looks like this:

Nr	Register	Oper...	Value	Filter	Trig type	Src. Register	Oper...	Value	Dst. Register
1	0- None	Alw...	0	No...	Active	145- Input	AND	15	620- ApplData1
2	620- ApplData1	=	0	No...	Active	510- SeqTarget1	+	0	450- TargetInput
3	620- ApplData1	=	1	No...	Active	512- SeqTarget2	+	0	450- TargetInput
4	620- ApplData1	=	2	No...	Active	514- SeqTarget3	+	0	450- TargetInput
5	620- ApplData1	=	3	No...	Edge	450- TargetInput	+	2134	450- TargetInput
6	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
7	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
8	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
9	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
10	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
11	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
12	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
13	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
14	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
15	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
16	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
17	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
18	145- Input	AND	16	No...	Edge	0- None	Value	0	200- MotorPositi...
19	145- Input	AND	16	No...	Edge	0- None	Value	33	400- Mode
20	145- Input	NOR	65519	No...	Edge	0- None	Value	0	400- Mode

Row 1
Row 1 is executed each cycle with using the Always operator.
The Input register is converted from the bit representation of the inputs IN1 - IN8 to a decimal number using and AND operator and 15 as value. Depending on the inputs 0-16 will be in ApplData1.

145 <Input>	IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1
	And							
Value = 15	0	0	0	0	1	1	1	1
	=							
620 <ApplData1>	0	0	0	0	IN4	IN3	IN2	IN1

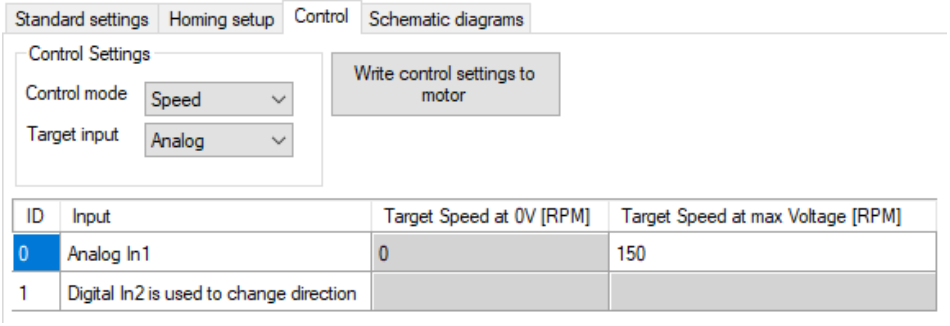
Rows 2-17
Depending on the number of IDs used in the control tab, the corresponding numbers will be filled in rows 2-17. In the example, the absolute target numbers (rows 2-4 will be written to TargetInput when the respective input combination is active.
Row 18
Each time IN5 (Start/Stop) turns from 0 to 1, the motor position is set to 0
Row 19
Each time IN5 (Start/Stop) turns from 0 to 1, the Mode is set to RampSpeed(33).
Row 20
Each time IN5 (Start/Stop) turns from 0 to 1, the Mode is set to RampSpeed(33).

The operation made in rows 18-20 is based on the following logical expressions with the binary numbers:
If IN5 is 1 (high)
xxx1 xxxx AND 0001 0000 = true
xxx1 xxxx NOR 1110 1111 = false

If IN5 is 0 (low)
xxx0 xxxx AND 0001 0000 = false
xxx0 xxxx NOR 1110 1111 = true

16 = 0000 0000 0001 0000
65519 = 1111 1111 1110 1111

Analog Control:
This example shows analog speed control:



Nr	Register	Oper...	Value	Filter	Trig type	Src. Register	Oper...	Value	Dst. Register
1	0- None	Alw...	0	No...	Active	170- Analog1	+	0	510- SeqTarget1
2	0- None	Alw...	0	No...	Active	510- SeqTarget1	*	150	510- SeqTarget1
3	0- None	Alw...	0	No...	Active	510- SeqTarget1	/	15359	510- SeqTarget1
4	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
5	0- None	Alw...	0	No...	Active	510- SeqTarget1	+	0	450- TargetInput
6	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
7	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
8	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
9	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
10	0- None	Alw...	0	No...	Active	0- None	Value	1	453- TargetMul
11	145- Input	AND	2	No...	Active	453- TargetMul	-	2	453- TargetMul
12	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
13	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
14	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
15	170- Analog1	<	500	No...	Active	0- None	Value	0	450- TargetInput
16	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
17	145- Input	AND	16	No...	Edge	0- None	Value	0	200- MotorPositi...
18	0- None	Alw...	0	No...	Active	0- None	Alw...	0	0- None
19	145- Input	AND	16	No...	Edge	0- None	Value	33	400- Mode
20	145- Input	NOR	65519	No...	Active	0- None	Value	1	400- Mode