

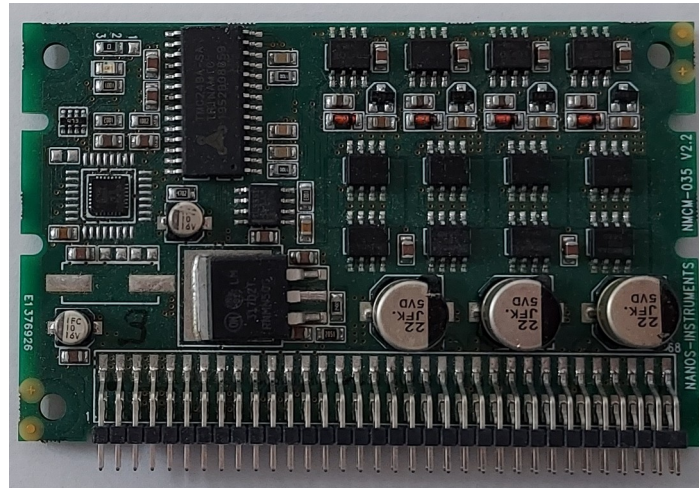
Manual

In cooperation with
Nanos-Instruments GmbH

Product: NMCM-035
Date / Rev.: 04.03.2022 / 1.01
Editors: AW/TF



NMCM-035



NMCM-035
Manual
1-Axis driver module
for stepper motors
with step/direction interface

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1. Features

- Support for bipolar two phase motors
- Motorcurrent 0.3A to 3.5A (5A peak)
- Motor Voltage 14V to 50V DC
- Logic Supply 5V DC
- Step/Dir interface
- SPI TM interface to TRINAMIC TM TMC249
- Analog interface
- Up to 64 times microstepping
- Current setting via internal and external resistors
- Up to 245kHz microstep frequency
- No heatsink required
- Programmable standby current
- Mixed-decay mode
- 68pin connector
- Size 80mm x 50mm

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2. Safety and warning notes

Before installing and operating the product, please read this product manual carefully and observe all warnings and safety instructions. Always keep this product manual within easy reach near the product.



WARNING

Failure to observe warnings may result in death, serious injury or considerable damage to property in extreme cases.



NOTE

Failure to observe notes may result in minor personal injury, damage to property due to heat generation or malfunction.

General precautions



WARNING

To avoid protection against electric shock, do not remove the cover of the housing. There is voltage inside the case which may cause electric shock. Have the unit used only by qualified personnel.



WARNING

- Installation, operation and maintenance of this product may only be performed by qualified personnel who are fully familiar with the operation of the control system.
- To prevent injury and damage, do not touch any components inside the housing - either with your hands or with any objects when voltage is present.
- Also exclude dust, dirt, flammable atmospheres and aggressive gases. The installation location should be a well-ventilated place not exposed to direct sunlight.
- Install the unit on a non-flammable wall that is as vertical as possible and transmits as little vibration as possible.
- Never disconnect the motor connection when the controller is live.
- Never apply voltage to inputs (motor, outputs) that are not designed for this purpose.
- Do not work on the wiring when voltage is applied.
- Make sure that the input voltage corresponds to that of the control.
- During proper use, the motor controls may heat up due to their design.
- Improper use, such as reversing the polarity of the supply voltage or overvoltage, may result in the formation of flames or even a fire. Injuries due to exploding components are also possible.

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NOTE

After delivery of the controller, make sure that there is no transport damage. Check whether the delivered goods correspond to the information on the delivery note and your order.



Intended use of the control unit

This product is not a household appliance, but an "unfinished machine" in the sense of the Machinery Directive 2006/42/EC, which is intended exclusively for further use for commercial purposes. This control unit is electrical equipment for controlling stepper motors and is intended for installation in machines or assembly with other components to form a machine.

Operation is prohibited until the operator has determined that the entire machine complies with the EMC Directive 2004/108/EC and EN 60204-1 on electrical equipment. The responsibility for compliance with the European Directives in the use of the machine lies with the subsequent user (Industrial Safety Regulation, Work Equipment Directive). This applies in particular to the risk assessment.

The technical data and descriptions in this operating manual have been compiled to the best of our knowledge and belief. No liability can be accepted for errors.



NOTE

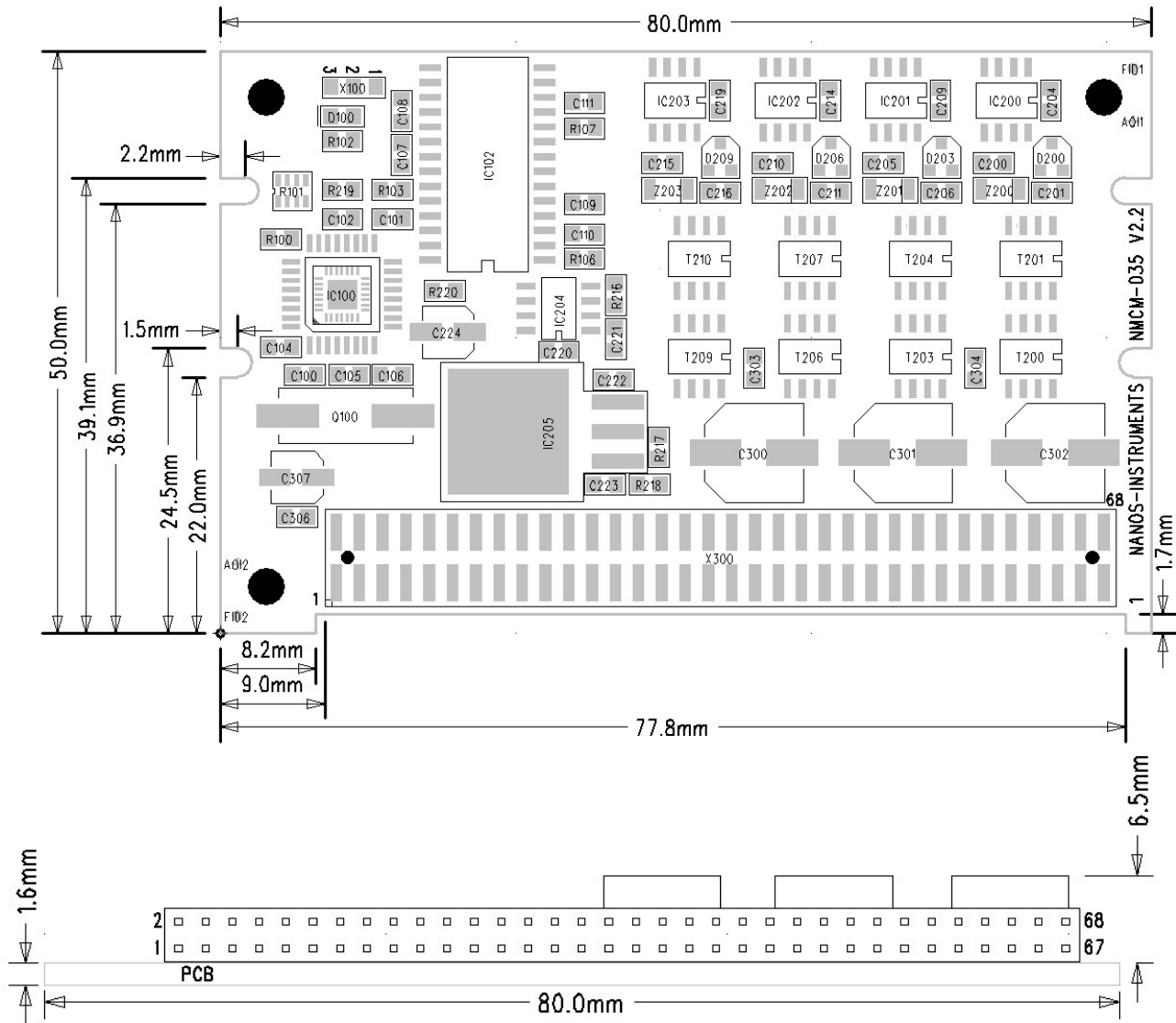
Mocontronic considers the following standards during development and production: Low Voltage Directive 2006/95/EC, Machinery Directive 2006/42/EC, Product Safety Directive 2001/95/EC, EMC Directive 2004/108/EC, Product Liability Directive 85/374/EEC.

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3. Mechanical Dimension



- Board size: 80mm x 50mm
- PCB thickness: 1.6mm
- Maximum Part height: 6.5mm
- Connector: 68pin, 2 rows, 2mm Pitch
- Mounting: 2mm Clearance on both small sides for Card Guides or Mountingholes 3.2mm

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4. Pinning

Pin	Type	Description
1	Supply	+5V +/-5%
3	Supply	+5V +/-5%
5	Supply	Vmotor 14V ... 50V
7	Supply	Vmotor 14V ... 50V
9	Supply	Vmotor 14V ... 50V
11	In	ENN 0=Enable Driver 1=Disable Driver
13	In	SPI: TMC249_CSN, S/D: leave open, AM*: TMC249_PHB
15		n.c
17	In	Reset (active low), leave open
19	In	SPE 0=Analog Mode (AM), 1=SPI or STEP/DIR (S/D)
21	In	INA
23	In	INB
25	In	SPI: TMC249_ANN (0=INA and INB provide current reference), S/D: leave open, AM*: TMC249_MDAN
27	In	STEP64EN open=8/16 microsteps GND=32/64 microsteps
29		n.c
31		n.c
33		n.c
35		n.c
37	Out	OB2 (Motor)
39	Out	OB2 (Motor)
41	Out	OB1 (Motor)
43	Out	OB1 (Motor)
45	In	RSB2 (Resistor for Motor current)
47	In	RSB1 (Resistor for Motor current)
49	Out	OA2 (Motor)
51	Out	OA2 (Motor)
53	Out	OA1 (Motor)
55	Out	OA1 (Motor)
57	In	RSA2 (Resistor for Motor current)
59	In	RSA1 (Resistor for Motor current)
61	Supply	GND
63		n.c
65		n.c
67		n.c

Pin	Type	Description
2	Supply	GND
4	Supply	GND
6	Supply	GND
8	Supply	GND
10	Supply	GND
12	In	SPI: TMC249_CLK, S/D: leave open, AM*: TMC249_MDBN
14	Out	SPI: TMC249_SDO, S/D: leave open, AM*: TMC249_ERR
16	In	SPI: TMC249_SDI, S/D: leave open, AM*: TCM249_PHA
18	In	STEP
20	In	DIR
22	In	SDEN 0=SPI, 1=S/D
24	In	STEP16 0=8/32microsteps 1=16/64 microsteps
26	In	USEMD Mixed Decay 0=off 1=on
28	In	OSC external Copper Clock (leave open)
30		n.c.
32		n.c.
34		n.c.
36		n.c.
38	Out	OB2 (Motor)
40	Out	OB2 (Motor)
42	Out	OB1 (Motor)
44	Out	OB1 (Motor)
46	In	RSB2 (Resistor for Motor current)
48	In	RSB1 (Resistor for Motor current)
50	Out	OA2 (Motor)
52	Out	OA2 (Motor)
54	Out	OA1 (Motor)
56	Out	OA1 (Motor)
58	In	RSA2 (Resistor for Motor current)
60	In	RSA1 (Resistor for Motor current)
62	Supply	GND
64		n.c.
66		n.c.
68		n.c.

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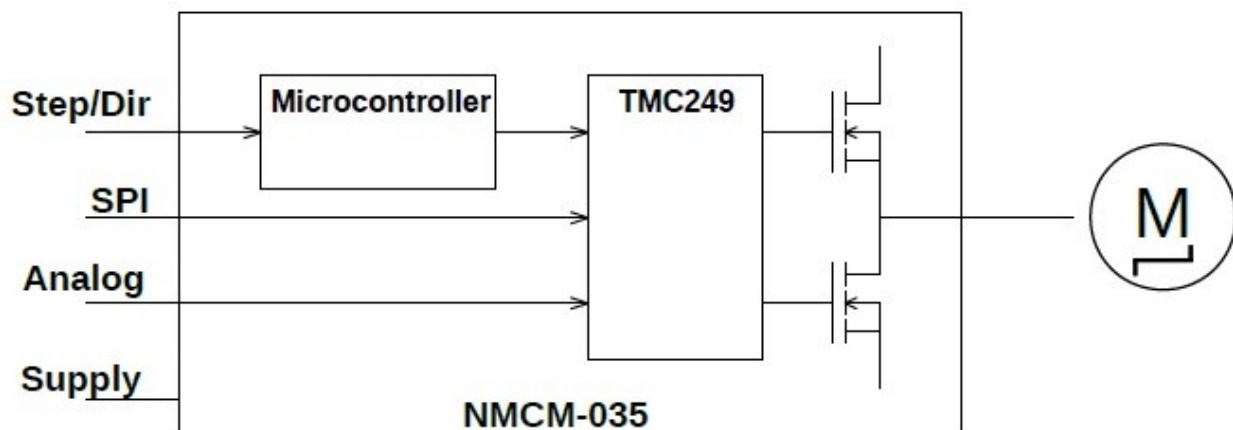




5. Ratings - technical data

Symbol	Parameter	Min	Typ	Max	Unit
V_S	Power supply	14	24	50	V
V_{+5V}	Logic supply	4,75	5	5,25	V
I_{coil}	Motor coil peak current	0	0,3 to 5	5	A
f_{chop}	Motor chopper frequency		36,8		kHz
I_{supply}	Power supply current	I_{coil}		1,4 X I_{coil}	A
f_{step}	Step frequency			245	kHz
t_{pulse_length}	Step pulse length	0,1			μ s
t_{dir_hold}	Direction hold time	2			μ s
$t_{dir2step}$	Direction to step delay	0			μ s
V_{ana}	Inx analog control range	0		3	V
f_{SPI}	SPI clock frequency			2	MHz
T_{board}	PCB temperature limit		+85	+105	$^{\circ}$ C
$T_{env @3,5A RMS}$	Environment temperature	-40		40	$^{\circ}$ C
$T_{env @2,5A RMS}$	Environment temperature	-40		60	$^{\circ}$ C
	Both: vertical mounted without cooling				

6. Block schematic



6.1 Power supply requirements

The motor supply voltage of the NMCM-035 is 14V to 50V .The module is not protected against wrong polarity. The control logic needs a +5V supply.

Please use all listed pins for the power supply inputs and ground in parallel.

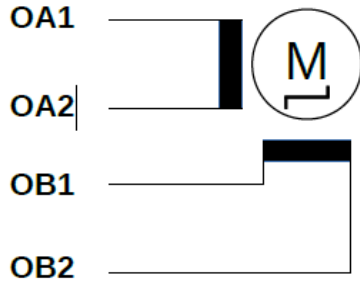
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6.2 Motor connections

This module is designed for two phase bipolar stepper motors. Use all pins to connect the motor. Don't disconnect the motor while the power supply is on, this may damage the driver stage of the module



6.3 Step/Dir

The following connections are used in Step/Dir mode:

Signal	Pin	Description
SPE	19	+5V (or left open)
SDEN	22	+5V (or left open)
STEP16	24	+5V for 16 microsteps, 0V for 8 microsteps (STEP64EN = +5V) +5V for 64 microsteps, 0V for 32 microsteps (STEP64EN = 0V)
STEP64EN	27	+5V for 8/16 microsteps 0V for 32/64 microsteps
USEMD	26	+5V (or left open) for mixed decay (recommended) 0V for slow decay
STEP	18	Pulse Input: 0V / +5V rising edge for step (minimum pulse length t_{SPulse})
DIR	20	Direction Input: 0V / +5V
ANN	25	must not connected
TMC249_CLK	12	must not connected
TMC249_CSN	13	must not connected
TMC249_SDO	14	must not connected
TMC249_SDI	16	must not connected

In Step/Dir mode the status of the module is shown by the LED:

LED on Driver stage is enabled, Power Supply is OK

LED off Driver stage is disabled or Power supply is too low

LED flashing Error*

*One of following reasons can indicate an error:

- Temperature is too high (motor stops over permitted temperature)
- Current too high (short circuit, motor is switched off until the short circuit is resolved)
- Power supply too low (motor is switched off until the voltage is in permitted range)
- Open load when a motor coil is disconnected
- Current limit is reached at high velocities

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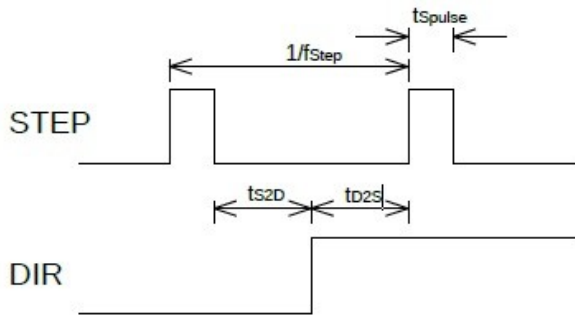


Figure 6.2: Motor connection

$$1/f_{Step} = 1/245\text{kHz} \geq 4.081\mu\text{s}$$

$$t_{Spulse} \geq 0.1\mu\text{s}$$

$$t_{s2D} \geq 2\mu\text{s}$$

$$t_{d2s} \geq 0\mu\text{s}$$

6.4 SPI

The pins 12, 13, 14, 16 are connected to TMC249. The SPI interface is enabled if SPE signal is High (+5V) or left open and SDEN signal is Low (GND).

The following connections are used in SPI mode:

Signal	Pin	Description
SPE	19	+5V (or left open)
SDEN	22	0V (GND)
CSN	13	TMC249 SPI Chip select
CLK	12	TMC249 SPI Clock
SDO	14	TMC249 SPI Data Out
SDI	16	TMC249 SPI Data In
ANN	25	+5V (or left open) for normal current setting 0V for current scaling via INA and INB
STEP64EN	27	+5V (or left open) for 16 microsteps mode (4 Bit DAC) using TMC249 register 0V (GND) for 64 microstep mode (6 Bit DAV) with extended shift register

For detailed information using the TMC249 in SPI mode please refer to the TMC249 data sheet and chapter 6.7.2 microstepping with SPI

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6.5 Analog

The following signals are required to control the module analog:

Signal	Pin	Description
SPE	19	0V (GND) Enable Analog
SDEN	22	0V (GND) Disable Step/Dir
ENN	11	0V (GND) Enable Driver
INA	21	Analog 0...2V (0...100%) current of phase A
INB	23	Analog 0...2V (0...100%) current of phase B
PHA	16	polarity phase A
PHB	13	polarity phase B
MDAN	25	+5V (or left open) for mixed decay, 0V for slow decay
MDBN	12	+5V (or left open) for mixed decay, 0V for slow decay

For detailed information on analog control, see the TMC249 data sheet.

In analog mode the status of the module is shown by the LED:

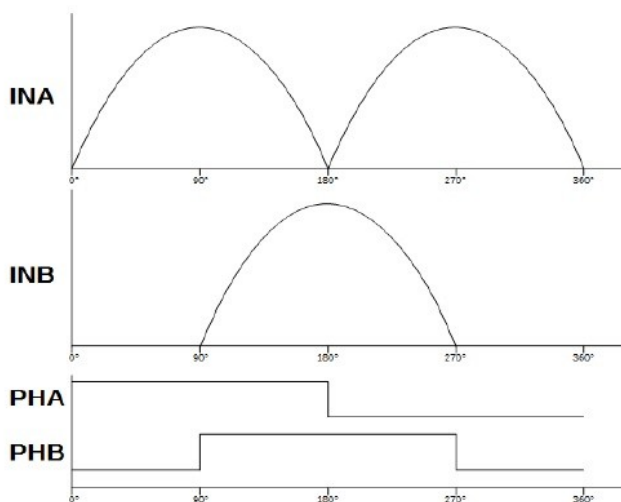
LED on Driver stage is enabled, Power Supply is OK

LED off Driver stage is disabled (ENN) or Power supply is too low

LED flashing Error*

*One of following reasons can indicate an error:

- Temperature is too high (motor stops over permitted temperature)
- Current too high (short circuit, motor is switched off until the short circuit is resolved)
- Power supply too low (motor is switched off until the voltage is in permitted range)
- Open load when a motor coil is disconnected
- Current limit is reached at high velocities



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6.6 Current settings

The connections RSA and RSB are responsible for the motor current. The following table shows the possible settings:

Peak current	RMS current	RSA1, RSB1	RSA1,RSB2
1,5A	1,1A	GND	open
3,4A	2,4A	Open	GND
5,0A	3,5A	GND	GND

in SPI mode the motor current is scaleable. The signal ANN must tied to GND and then the voltage at the connections INA and INB affects the current through the following relationship:
scaled current = set current (Table 6.3) * V ANA / 2V

The voltage of V ANA should not be grater then 2V because of thermal overload of the module. A voltage of 3V corresponds to a current of 150%.

In 64 microstep mode the voltage should not leave the range of 1.5V to 2.5V

If other current values are required, this can be set using additional external resistors:

Peak current	RMS current	RSA1, RSB1	RSA1,RSB2
1,0A	0,7A	Open	0,22R to GND
1,2A	0,85A	0,18R to GND	Open
1,7A	1,2A	GND	1,5R to GND
2,1A	1,5A	GND	0,47R to GND
2,8A	2,0A	GND	0,15R to GND
4,2A	3,0A	0,27R to GND	GND

SMD resistors with a power of 1W should be used and placed close to the connections with short traces to GND.

6.6.1 Standby current in Step/Dir mode

In Step/Dir mode the motor current is reduced when 4 seconds have passed since the last step pulse. The reduced current is determined by the voltage V ANA at the INA and INB connections. 0V corresponds to a current of 0% , 2V corresponds to 100% current. With the next step impulse the current is back to 100%.

Standby current = set current * V ANA / 2V

6.6.2 Continuous current

Due to the compact design, continuous operation at full current leads to a high temperature of the circuit board and thus to a shorter lifetime of the module.

Operation at full current is only possible with forced cooling so that the temperature remains

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below 85°C . Short-term temperatures of 105°C are permissible.

The following limits must be observed:

- 3.5A RMS (5A peak) : maximum environment temperature 40°C (module mounted vertical)
- 2.5A RMS (3.5A peak) : maximum environment temperature 60°C (module mounted vertical)
- Module mounted horizontal: use forced cooling for currents above 2A RMS
- Continuous operation with 2.5A RMS : forced cooling, module mounted vertical
- Fullstep operation: maximum current 3.5A (peak current is identical to RMS)
- Without movement, the motor current should be reduced to 70%

Note: a reduced voltage results in less heating and depends also on the motor

6.7 Mixed decay and slow decay

Mixed decay improves engine behavior at speeds ranging from a few 10 steps per second to several 100 steps per second.

For best microstepping performance it is recommended to use mixed decay for supply voltages above 24V and for low inductance motors.

In Step/Dir mode the mixed decay option can be used by connecting the USEMD input to HIGH (+5V). For slow decay tie this input to LOW (GND).

In SPI mode bit11 and bit5 in the telegram are responsible for switching to mixed decay. Refer to TMC249 datasheet for detailed information.

In analog mode the inputs TMC249_MDAN (Pin25) and TMC249_MDBN (Pin12) are set to GND for using mixed decay.

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6.8 Microstepping

The TMC249 has a microstep resolution of 4 bits. With an additional circuit, the resolution of 64 microsteps can be used on this module.

6.7.1 Microstepping with Step/Dir

The resolution is set by the STEP64EN and STEP16 inputs.

Microsteps	Step64EN	Step16
64	GND	+5V or open
32	GND	GND
16	+5V or open	+5V or open
8	+5V or open	GND

6.7.2 Microstepping with SPI

By driving the STEP64EN signal low, an additional register is added to the SPI chain. The data telegram then consists of the following bits:

TMC249 Register											Additional Register									
BIT	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Function	MXA	CA5	CA4	CA3	CA2	PHA	MXB	CB5	CB4	CB3	CB2	PHB	CB1	CB0	CA1	CA0	-	-	-	-

Please note that the respective lower bits Cx0 and Cx1 are operated inverted and values in the range 0 to 3 result in a current of zero. Effectively, this results in a resolution of 60 microsteps. Due to the modified DAC, the ramp phase dependent current scaling function of the TMC428 cannot be used as it does not produce a useful result.

For a more detailed description of the bits, please read the TMC249 data sheet.

7. Revision Historie

7.1 Dokument Revision

Version	Date	Autor	Text
1.0	04.03.2022	TF-Nanos	First revision
1.01	11.03.2022	AW	MOC revision with photo

1 Hardware Revision

Tabelle 1 - Hardware Revision

Version	Date	Autor	Text
2.2	Q1/2022	Nanos	Serial PCB

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