ADI Trinamic
TRINAMIC TMCM-1070
Module for Stepper

TRINAMIC TMCM-1070 Module for Stepper Instruction Manual

Contents

TRINAMIC TMCM-1070 Module for Stepper

Specifications

- Product Name: TMCM-1070 Stepper Motor Driver Module
- Control Interface: Step and Direction
- Current Control Modes: StealthChopTM, SpreadCycleTM
- Configuration: TTL UART interface for advanced configuration

Product Usage Instructions

Installation
Follow the mechanical and electrical interfacing guidelines provided in the manual to install the TMCM-1070 module correctly.

Wiring
Connect the motor to the motor connector and any external devices to the I/O connector as required. Ensure proper connections are made.

Configuration
Use the TTL UART connection to configure the module based on your application needs. Refer to the manual for detailed configuration instructions.

Operation
Apply power to the module and send step and direction signals to control the stepper motor. Monitor the status LEDs for any indications during operation.

FAQ
Q: What are the main features of the TMCM-1070 module?
A: The TMCM-1070 module offers features such as StealthChopTM for silent motor control, SpreadCycleTM for

high speed, stallGuard2, and coolStep.

TMCM-1070 Hardware Manual

Hardware Version V1.00 | Document Revision V1.13 • 2022-JAN-07
TMCM-1070 is an easy to use stepper motor driver module. The module is controlled via a step and direction interface. One con˝guration pin selects the current control mode between StealthChop™ for absolute silent motor control and SpreadCycle™ for high speed. A TTL UART interface allows for more advanced con˝guration and permanent parameter storage via TMCL™-IDE.

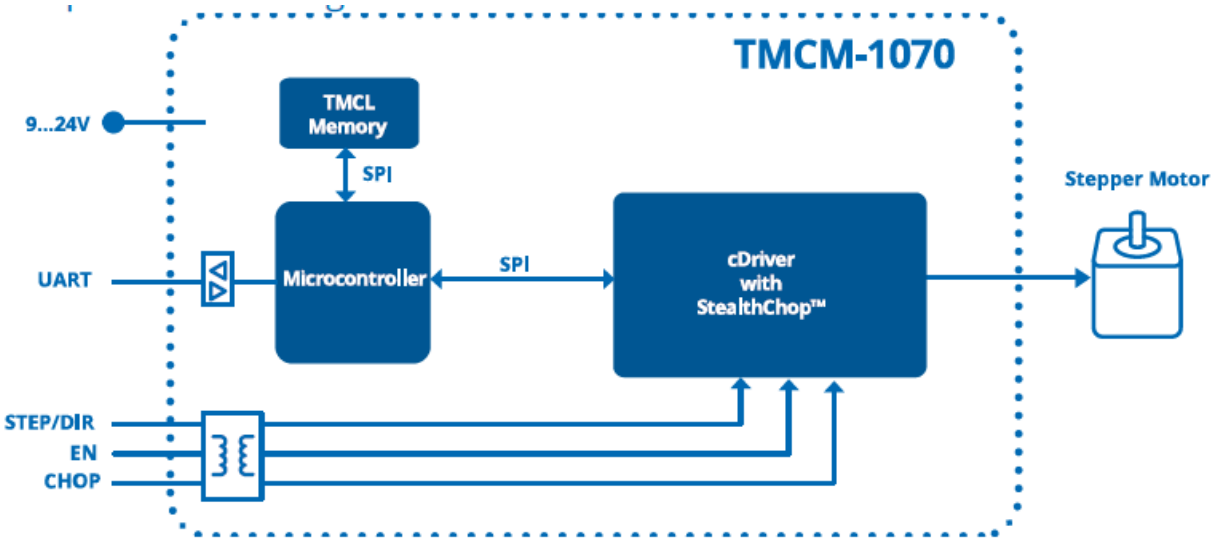
Features

- Supply Voltage +9 to +24V DC
- Step and direction interface
- MicroPlyer™ to 256 µ-steps
- StealthChop™ silent PWM mode
- SpreadCycle™ smart mixed decay
- StallGuard2™ load detection
- CoolStep™ autom. current scaling
- UART con˝guration interface

Applications

- Lab-Automation
- Manufacturing
- Robotics
- Factory Automation
- CNC
- Laboratory Automation

Simplied Block Diagram



Features

TMCM-1070 is an easy to use stepper driver unit with state of the art feature set. It is highly integrated and o˙ers a convenient handling. TMCM-1070 can be used with a simple step and direction interface and can be con˝gured using a TTL UART interface. stallGuard2 and coolStep can be con˝gured via TTL UART interface and are disabled by default.

General Features
Main Characteristics

- Supply Voltage +9V to +24V DC
- 1.2A RMS phase current (ca. 1.7A peak phase current)
- Highest micro step resolution, up to 256 micro steps per full step
- MicroPlyer™ microstep interpolator for obtaining increased smoothness of microstepping over a low frequency STEP/DIR interface
- With housing and motor mounted
- Permanent onboard parameter storage
- Simple step & direction mode
- Noiseless StealthChop™ chopper mode for slow to medium velocities
- High performance SpreadCycle™ chopper mode
- High-precision sensorless load measurement with StallGuard2™
- Automatic current scaling algorithm CoolStep™ to save energy and keep your drive cool

Optically Isolated Inputs

- Step & direction interface with up to 45kHz input frequency
- Enable input to power-on/-o˙ driver H-bridges
- Mode select input to switch between the two chopper modes

TTL UART Interface

- TTL-level UART interface for parameter con˝guration

- Interface speed 9600-115200 bps (default 9600 bps)
- TMCL-based protocol for online con˝guration and permanent parameter settings
- Bootloader for ˝rmware updates

TRINAMIC's Unique Features

stealthChop™

stealthChop is an extremely quiet mode of operation for low and medium velocities. It is based on a volt-age mode PWM. During standstill and at low velocities, the motor is absolutely noiseless. Thus, stealth-Chop operated stepper motor applications are very suitable for indoor or home use. The motor operates absolutely free of vibration at low velocities. With stealthChop, the motor current is applied by driving a certain e˙ective voltage into the coil, using a voltage mode PWM. There are no more con˝gurations required except for the regulation of the PWM voltage to yield the motor target current.

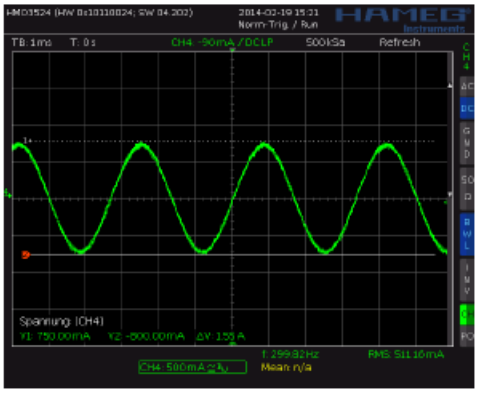


Figure 1: Motor coil sine wave current using stealthChop (measured with current probe)

spreadCycle™

The spreadCycle chopper is a high-precision, hysteresis-based, and simple to use chopper mode, which automatically determines the optimum length for the fast-decay phase. Several parameters are available to optimize the chopper to the application. spreadCycle o˙ers optimal zero crossing performance com-pared to other current controlled chopper algorithms and thereby allows for highest smoothness. The true target current is powered into the motor coils.

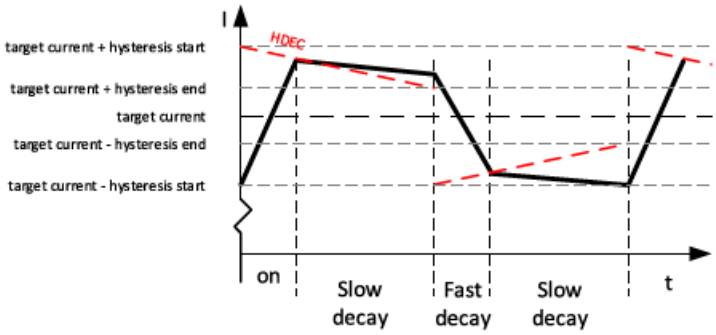


Figure 2: spreadCycle principle

stallGuard2

stallGuard2 is a high-precision sensorless load measurement using the back EMF of the motor coils. It can be used for stall detection as well as other uses at loads below those which stall the motor. The stallGuard2 measurement value changes linearly over a wide range of load, velocity, and current settings. At maximum motor load, the value reaches zero or is near zero. This is the most energy-e°cient point of operation for the motor.

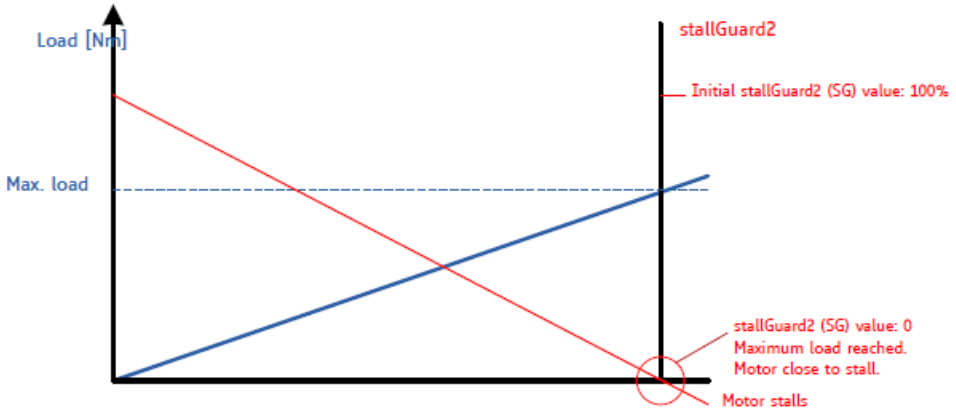


Figure 3: stallGuard2 Load Measurement as a Function of Load

coolStep

coolStep is a load-adaptive automatic current scaling based on the load measurement via stallGuard2. coolStep adapts the required current to the load. Energy consumption can be reduced by as much as 75%. coolStep allows substantial energy savings, especially for motors which see varying loads or operate at a high duty cycle. Because a stepper motor application needs to work with a torque reserve of 30% to 50%, even a constant-load application allows signi˝cant energy savings because coolStep automatically enables torque reserve when required. Reducing power consumption keeps the system cooler, increases motor life, and allows for cost reduction.

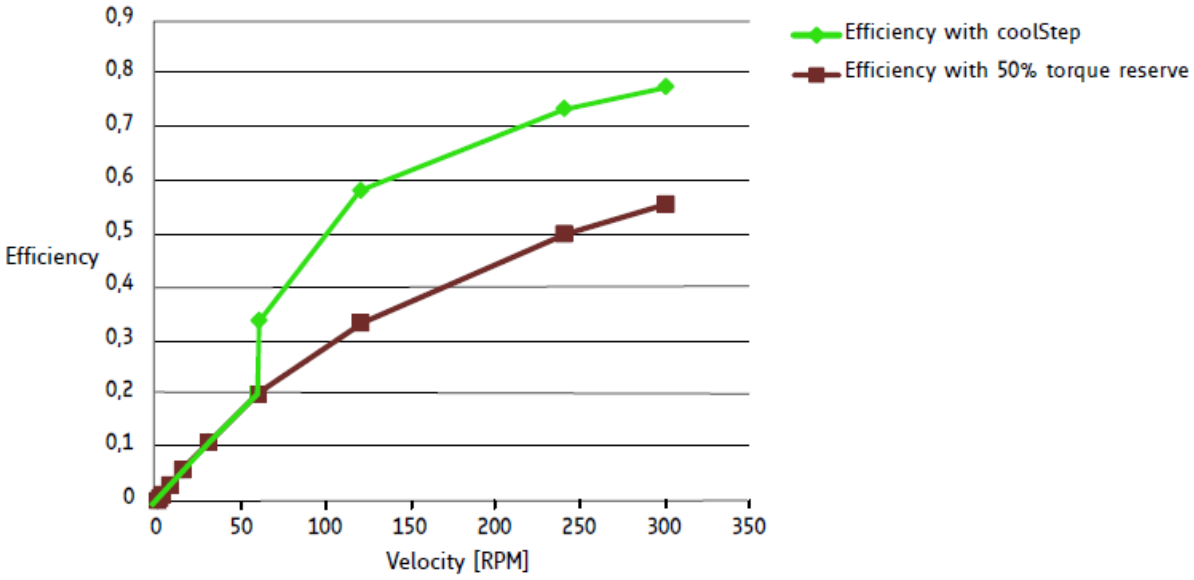


Figure 4: Energy Efficiency Example with coolStep

Order Codes

Order Code	Description	Size (LxWxH)
TMCM-1070	Controller/Driver Module without motor, +24V DC, TTL UART interface (9600bps default), S/D interface, Enable, Mode Select	42mm x 42mm x 12mm

Table 1: Order codes modules

Order Code	Description
TMCM-1070-CABLE	**Cable loom for TMCM-1070. Contains:** • 1x cable loom for motor connector with 4-pin JST PH female connector • 1x cable loom for I/O connector with 9-in JST PH female connector
TMCM-KAMINO-CLIP	Self-Adhesive top hat rail mounting clip for TMCM-1070 base module (not avail- able with PANdrive versions PD42-x-1070)
TMCM-KAMINO-AP23	Aluminum adapter plate kit for mounting of TMCM-1070 base module to NEMA23 size motors (not available with PANdrive versions PD42-x-1070)
TMCM-KAMINO-AP24	Aluminum adapter plate kit for mounting of TMCM-1070 base module to NEMA24 size motors (not available with PANdrive versions PD42-x-1070)

Mechanical and Electrical Interfacing

TMCM-1070 Dimensions and Weight
The dimensions of the TMCM-1070 are approximately 42mm x 42mm x 12mm. There are two mounting holes for M3 screws for mounting the TMCM-1070 to a NEMA17 stepper motor (screw/thread length depends on motor size).

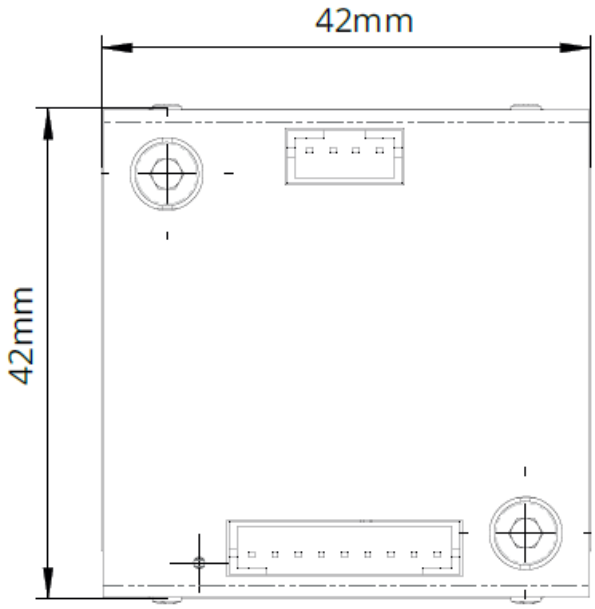


Figure 5: TMCM-1070 top view mechanical dimensions

Order Code	**L** in mm	Weight in g
TMCM-1070	12 ±0,2	≈ 32

Table 3: TMCM-1070 length and weight

Mounting Considerations
TMCM-1070 is designed to be mountable on the back of a NEMA17 motor. Alternatively it can be mounted standalone.

NOTICE

Thermal Considerations

If not mounted to a motor take care for a proper cooling. The electronics have an overtemperature shutdown, nevertheless damage to electronics or system can be caused by excessive temperature.

Top Hat Rail Mounting

To mount the drive on a top hat rail, TRINAMIC o˙ers a ˝tting top hat rail clip. The order code is provided in table 2.

Connectors and LEDs

Figure 7: TMCM-1070 connectors (pin 1 highlighted in red)

Motor Connector

Pin no.	Pin name	Description
1	A1	Motor phase A pin 1
2	A2	Motor phase A pin 2
3	B1	Motor phase B pin 1
4	B2	Motor phase B pin 2

Table 4: Motor connector pinning

NOTICE
Do not connect or disconnect motor during operation! Motor cable and mo-tor inductivity might lead to voltage spikes when the motor is (dis)connected while energized. These voltage spikes might exceed voltage limits of the driver MOSFETs and might permanently damage them. Therefore, always switch o˙ or disconnect power supply before (dis)connecting the motor.

I/O Connector

Pin no.	Pin name	Description
1	GND	Supply ground connection, also used for USB serial converter ground connection
2	V+	Supply voltage (*V DD*) +9V to +28V DC
3	DIR	Optically isolated direction input of S/D interface
4	STEP	Optically isolated step input of S/D interface
5	EN	Optically isolated enable input of motor driver H-bridges
6	CHOP	Optically isolated chopper mode selection input
7	COMM	Opto-coupler common anode or cathode, connect to ground or VCCIO (3.3V to 6V – hig her voltages possible with additional external resistors)
8	RXD	TTL-level UART receive line, use with USB serial converter TXD line to connect to PC
9	TXD	TTL-level UART transmit line, use with USB serial converter RXD line to connect to PC

NOTICE
Supply Voltage Bu˙ering / Add External Power Supply Capacitors
A su°ciently bu˙ered power supply or an external electrolyte capacitor con-nected between V+ and GND is recommended for stable operation.
It is recommended to connect an electrolytic capacitor of signi˝cant size to the power supply lines next to the TMCM-1070.

Rule of thumb for size of electrolytic capacitor: C = 1000 µF ∗ ISUP P LY
The PD42-1070 comes with approximately 40µF of onboard ceramic capaci-tors.

NOTICE
There is no reverse polarity protection on the supply input!
The module will short any reversed supply voltage and board electronics will get damaged.

NOTICE
Power Up Sequence

The TMCM-1070 must be powered up with disabled driver stage only. Depending on your con˝guration the EN input should be logically OFF (EN input either open or at the same voltage level as the COMM input).

TTL UART Connection

- To connect via the TTL UART interface to a host PC, we suggest using a USB serial converter from TTL-UART (5V) to USB interface.
- Communication with the host PC, for example when using TRINAMIC's TMCL-IDE, is done via the Virtual COM port installed by the converter driver.
- More information on the TMCL-IDE and the latest release can be found here: **www.trinamic.com**
- The converter cable must be connected to pins 1, 8, and 9 (GND, RXD, TXD) of the I/O connector.

Note Default Baud Rates
The default baud rate is 9600 bps.
In bootloader mode, the baud rate is 115200 bps.

Info USB to UART converter
For example, the TTL-232R-5V from FTDI is working with the module and has been tested. More information on this converter is available on the FTDI website: **www.ftdichip.com**

NOTICE 5V TTL UART Level
The TTL UART interface works with 5V level. Take special care when selecting a converter cable for USB connection.

Status LEDs
The TMCM-1070 has one green status LED. See gure 7 for its location.

State	Description
Blinking	MCU active, normal operation
Permanent on	Bootloader mode
Off	Power Off

Table 6: LED state description

Functional Description

Typical Application Wiring
Wire the TMCM-1070 as shown in the following ˝gures.

- Connect the the power supply to V+ and GND.
- Connect the Step and Direction signals to your motion controller.
- At power up time, the EN input must be logically o˙ (= driver stage disabled)!
- Optional: Connect UART to a TTL UART interface with 5V logic levels. To con˝gure your TMCM-1070 connect start the TMCL-IDE and use the parameterization tools. For detailed instructions refer to the TMCM-1070-˝rmware-manual.

Note
The TTL UART interface is not optically isolated. It has and requires 5V level signals.
Nevertheless, it provides basic ESD and rail-to-rail signal line protection for the TMCM-1070.

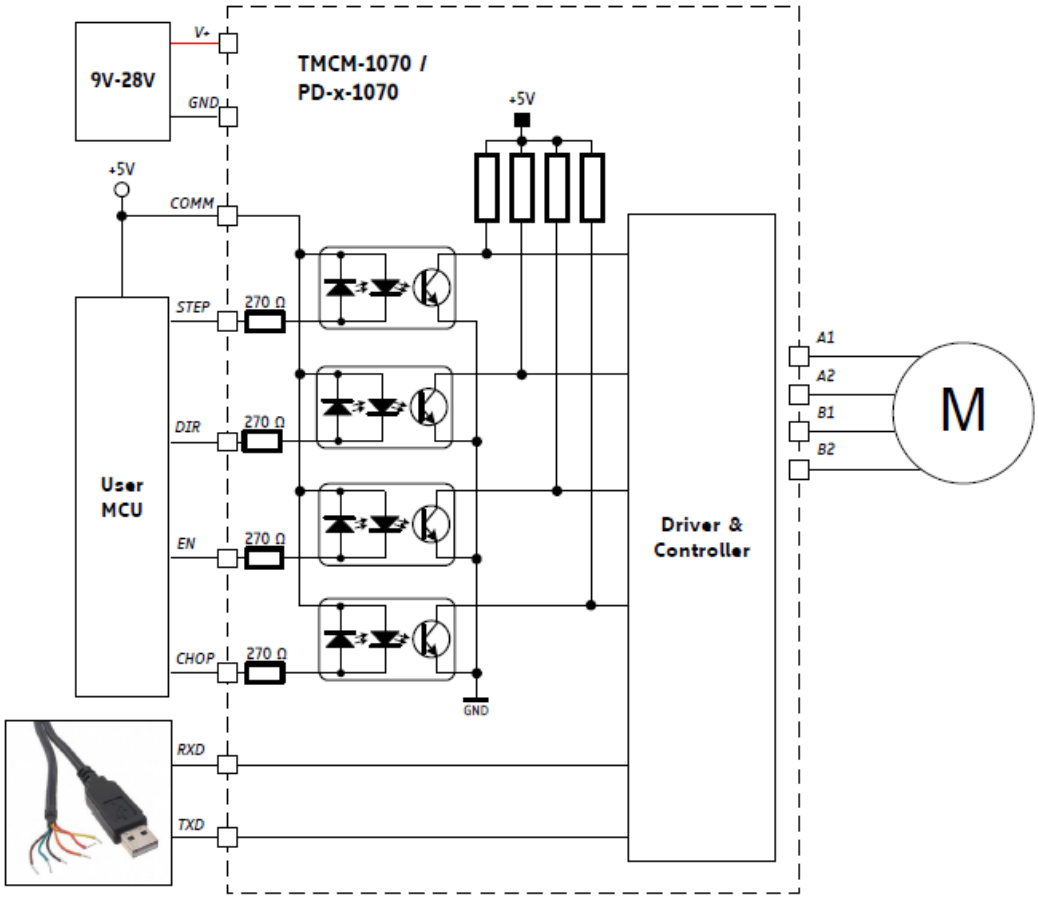


Figure 8: Typical application scenario with 5V inputs

Optically Isolated Inputs with Common Anode Input
The control inputs of the TMCM-1070 are optically isolated (not the TTL UART interface). All optocouplers share one common anode (COMM) input as shown in the ˝gure above.

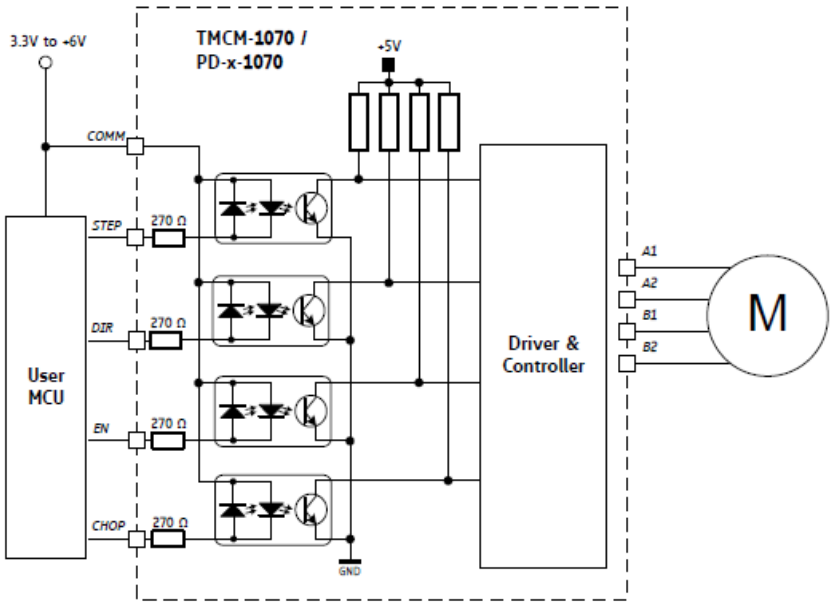


Figure 9: Inputs with common anode input with 3.3V to 6V

The typical voltage at COMM input is 5V. Nevertheless, 3.3V or voltages higher than 5V can also be used as long as the current is through the optocouplers' emitter is between 5mA to 20mA. For 3.3V operation the controller must be carefully selected with respect to its I/O ports, its actual output voltage, and the series resistor of the I/O ports. The user must make sure that the current through the optocouplers' emitter is between 5mA to 20mA.

Note
Step pulse width
With the COMM input connected to ground, the width of the step pulses should be between 2µs and 4µs, for maximum step frequency.
With a larger step pulse width, for example 50% duty cycle coming from a fre-quency generator, the maximum input frequency will be lower at ca. 9kHz. With the COMM input connected to +5V, longer step pulses are necessary.

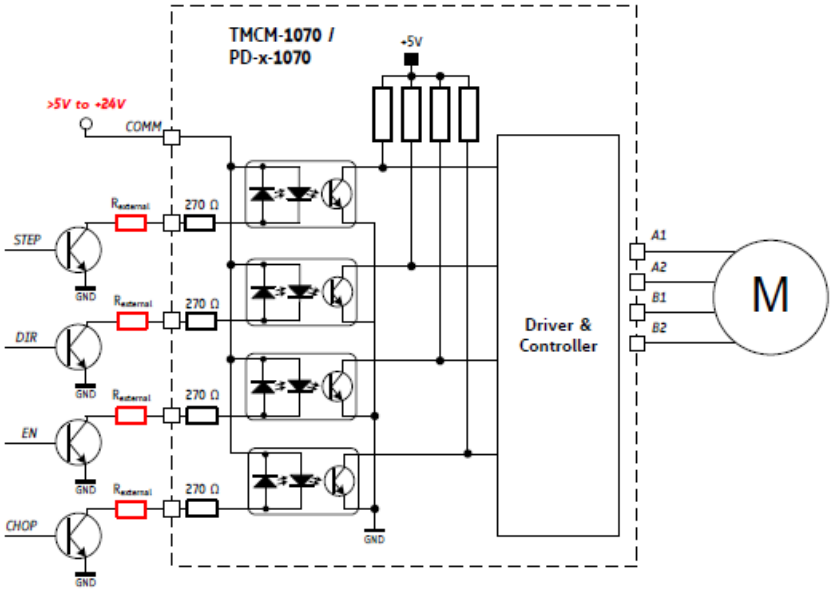


Figure 10: Inputs with common anode input with >5V to 24V

The series resistors in the TMCM-1070 are 270mOhms. For operation with voltages higher than 5V an additional external resistor Rexternal is required per input to limit the current. See Table 7 as reference for additional external resistor values.

COMM Voltage (V)	Value of $R_{external}$ (Ω)
3.3	–
5	–
9	300
12	500
15	700
24	1K5

Note
Rexternal Selection
Take care when selecting an additional external resistor. The resistor type must have a ˝tting power rating. This depends on the voltage used at COMM input.

Optically Isolated Inputs with Common Cathode Input
The optocouplers inside TMCM-1070 are bidirectional types (AC/DC). Thus, COMM can also be used as common

cathode connection with high-side (pnp style) switches instead of low side (npn style) as shown in previous ˝gures 10, 9 or 8.

Input Logic
The logic of the optically isolated inputs depends on the usage of common anode input or common cath-ode input. The following table shows the logic of the CHOP input and the logic of the EN input.

	COMM=3.3. . . 5V (Common anode)	COMM=GND (Common cathode)
CHOP=GND	SpreadCycle	StealthChop
CHOP=3.3. . . 5V	StealthChop	SpreadCycle
EN=GND	Motor enable	Motor disable
EN=3.3. . . 5V	Motor disable	Motor enable

Thermal Behavior
The default con˝guration parameters of the TMCM-1070 are set to the speci˝ed maximum current of 1.2A rms / 1.7A peak.
Typically, at this nominal current setting the stepper motor and the driver electronics will get hot. Contin-uous operation at maximum current is not guaranteed without cooling the motor since the stepper driver will switch o˙ due to its internal over-temperature protection until temperature falls below the threshold.

Note
Operation with Maximum Current Setting
For table-top testing and application bring-up the current should be reduced or the coolStep feature should be con˝gured to keep heating on a reasonable level. Especially, when there is no other cooling option for the motor. For proper and continuous operation at maximum current, the motor ¸ange must be mounted to the applications mechanical interface with good contact.

Operational Ratings and Characteristics

Absolute Maximum Ratings

Parameter	Min	Max	Unit
Supply voltage	+9	+28	V
Working temperature	-30	+40	° C
Motor coil current / sine wave **peak**		1.7	A
Continuous motor current (**RMS**)		1.0	A

NOTICE
Never Exceed the absolute maximum ratings! Stresses above those listed under "'Absolute Maximum Ratings"' may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this speci˝cation is not implied. Exposure to maximum rating conditions for extended periods may a˙ect device reliability.
Keep the power supply voltage below the upper limit of +28V! Otherwise the board electronics will seriously be damaged! Especially, when the selected operating voltage is near the upper limit a regulated power supply is highly recommended.

Electrical Characteristics (Ambient Temperature 25° C)

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	*V DD*	9	24	26	V
Motor coil current / sine wave **peak** (chopper regu- lated, adjustable via TTL UART interface)	*ICOILpeak*	0		1.7	A
Continuous motor current (**RMS**)	*ICOILRMS*	0		1.2	A
Power supply current	*IDD*		« *ICOIL*	1.4 ∗ I_{COIL}	A

I/O Ratings (Ambient Temperature 25° C)

Parameter	Symbol	Min	Typ	Max	Unit
COMM input voltage	*VCOMM*	3.3	5	6	V
Input frequency of optically isolated I/Os	*fin*			45	kHz
TTL UART input voltage	*VTTL_IN*		5	5.5	V
TTL UART low level voltage	$VTLL_L$	0		1.75	V
TTL UART high level voltage	$VTTL_H$	3.25		5	V
TTL UART output voltage	*VTTL_OUT*		5		V

Functional Characteristics

Parameter	Description / Value
Control	4-wire interface with Step, Direction, Enable, and Chopper Mode Switch
Step Pulse Width	The step pulse width should be between 2 μs and 4μs for maximum frequency. With a la rger step pulse width, for example 50% duty cycle coming from a fre- quency generator, the maximum input frequency will be lower at ca. 9kHz.
Communication	2-wire TTL UART interface for configuration, 9600-115200 bps (default 9600 bps)
Driving Mode	spreadCycle and stealthChop chopper modes (selectable with CHOP input), adap- tive automatic current reduction using stallGuard2 and coolStep
Stepping Resolution	Full, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256 step, default is 1/16 with internal interp olation to 1/256

Other Requirements

Specifications	Description or Value
Cooling	Free air
Working environment	Avoid dust, water, oil mist and corrosive gases, no condensation, no frosting
Working temperature	-30° C to +40° C

Abbreviations used in this Manual

Abbreviation	Description
COMM	Common Anode or common cathode
IDE	Integrated Development Environment
LED	Light Emmitting Diode
RMS	Root Mean Square value
TMCL	TRINAMIC Motion Control Language
TTL	Transistor Transistor Logic
UART	Universal Asynchronous Receiver Transmitter
USB	Universal Serial Bus

Table 13: Abbreviations used in this Manual

Figures Index

Tables Index

Supplemental Directives

Producer Information

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collateral Documents & Tools
This product documentation is related and/or associated with additional tool kits, ˝rmware and other items, as provided on the product page at: **www.trinamic.com**

Revision History

Hardware Revision

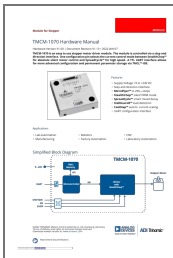
Version	Date	Author	Description
1.00	09.06.2016	BS	First Version.

Table 14: Hardware Revision

Document Revision

Version	Date	Author	Description
1.00	26.06.2016	BS	Initial release.
1.10	27.10.2017	GE	Current rating, digital inputs rating and drawings updated / cor- rected. 96 00bps default value for communication speed corrected.
1.11	2021-JUN-03	OK	Notice about EN input corrected.
1.12	2021-SEP-03	OK	Notice about step pulse length extended.
1.13	2022-JAN-07	OK	New section **5.4**.

Documents / Resources

	**TRINAMIC TMCM-1070 Module for Stepper** [pdf] Instruction Manual TMCM-1070, TMCM-1070 Module for Stepper, TMCM-1070 Module, Module for Stepper, Stepper, Stepper Module, Module

References

- Home - FTDI
- ADI Trinamic Support | Analog Devices
- User Manual