

Hardware Version V1.0

# HARDWARE MANUAL



## TMCM-1060 PD-1060

1-Axis Stepper  
Controller / Driver  
2.8A / 48V  
USB, RS485, and CAN  
Step/Dir Interface  
Integrated sens0step™ Encoder

### UNIQUE FEATURES:



coolStep™

stallGuard<sup>2</sup>™

TRINAMIC Motion Control GmbH & Co. KG  
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[www.trinamic.com](http://www.trinamic.com)



# TRINAMIC

MOTION CONTROL

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## 2 Features

The PD57/60-1060 is a full mechatronic device consisting of a NEMA 23 (flange size 57mm) or NEMA 24 (flange size 60mm) stepper motor, controller/driver electronics and integrated encoder. The electronics itself is also available without the motor as TCM-1060 module.

### Applications

Compact single-axis stepper motor solutions  
Encoder feedback for high reliability operation

### Electrical data

Supply voltage: common supply voltages +12VDC / +24VDC / +48VDC supported (+9V... +51V DC)  
(Please note: pre-series boards are limited to +40V max. supply voltage!)

Motor current: up to 2.8A RMS (programmable)

### Integrated motor (for PD57/60-1060 only)

Two phase bipolar stepper motor with 2.8A RMS nom. coil current  
Holding torque with 57mm motor: 0.55Nm, 1.01Nm, 1.26Nm or 1.89Nm  
Holding torque with 60mm motor: 1.1Nm, 1.65Nm, 2.1Nm or 3.1Nm

### Integrated encoder

Integrated sensOstep™ magnetic encoder (max. 256 positions per rotation) for step-loss detection under all operating conditions

### Integrated motion controller

High performance ARM7 microcontroller for overall system control and communication protocol handling

### Integrated bipolar stepper motor driver (based on TMC262)

Up to 256 microsteps per full step  
High-efficient operation, low power dissipation (MOSFETs with low  $R_{DS(ON)}$ )  
Dynamic current control  
Integrated protection  
High precision sensorless motor load measurement stallGuard2™  
Automatic load dependent motor current adaptation for reduced power consumption and heat dissipation (coolStep™)

### Interfaces

2 inputs for stop switches / 1 input for home switch (+24V compatible) with programmable pull-up  
2 general purpose inputs (+24V compatible) and 2 general purpose outputs (open collector)  
USB (mini-USB), RS485 and CAN (2.0B up-to 1Mbit/s) serial communication interfaces  
Step/direction interface (optically isolated)

### Safety features

Shutdown input – driver will be disabled in hardware as long as this pin is left open or shorted to ground  
Separate supply voltage inputs for driver and digital logic – driver supply voltage may be switched off externally while supply for digital logic and therefore digital logic remains active

### Software

Available with TMCL™  
standalone operation or remote controlled operation  
program memory (non volatile) for up to 2048 TMCL™ commands  
PC-based application development software TMCL-IDE available for free

Refer to separate TMCL Firmware Manual, too.

### 3 Order Codes

The PD57/60-1060 is currently available with two different stepper motor series (NEMA23 / 57mm flange size or NEMA24 / 60mm flange size) with four stepper motors of different length and holding torque each.

*Cables are not included. Add the appropriate cable loom to your order if required.*

*With NEMA 23 / 57mm flange size motor:*

Order code	Description	Length (mm)
PD57-1-1060-option	PANdrive with 0.55Nm max./holding torque	61
PD57-2-1060-option	PANdrive with 1.01Nm max./holding torque	71
PD57-3-1060-option	PANdrive with 1.26Nm max./holding torque	76
PD57-4-1060-option	PANdrive with 1.89Nm max./holding torque	96

**Table 3.1 Order codes (PD57-1060)**

*With NEMA 24 / 60mm flange size motor:*

Order code	Description	Length (mm)
PD60-1-1060-option	PANdrive with 1.10Nm max./holding torque	65
PD60-2-1060-option	PANdrive with 1.65Nm max./holding torque	76
PD60-3-1060-option	PANdrive with 2.10Nm max./holding torque	85
PD60-4-1060-option	PANdrive with 3.10Nm max./holding torque	106

**Table 3.2 Order codes (PD60-1060)**

Order code	Description	Size (mm)
TCM-1060-option	Single axis bipolar stepper motor controller / driver electronics with integrated encoder electronics and coolStep™ feature	60 x 60 x 15

**Table 3.3 Order codes (TCM-1060)**

Option	Description
-TMCL	With TMCL™ firmware
-CANopen	CANopen firmware is under development.

**Table 3.4 Firmware options**

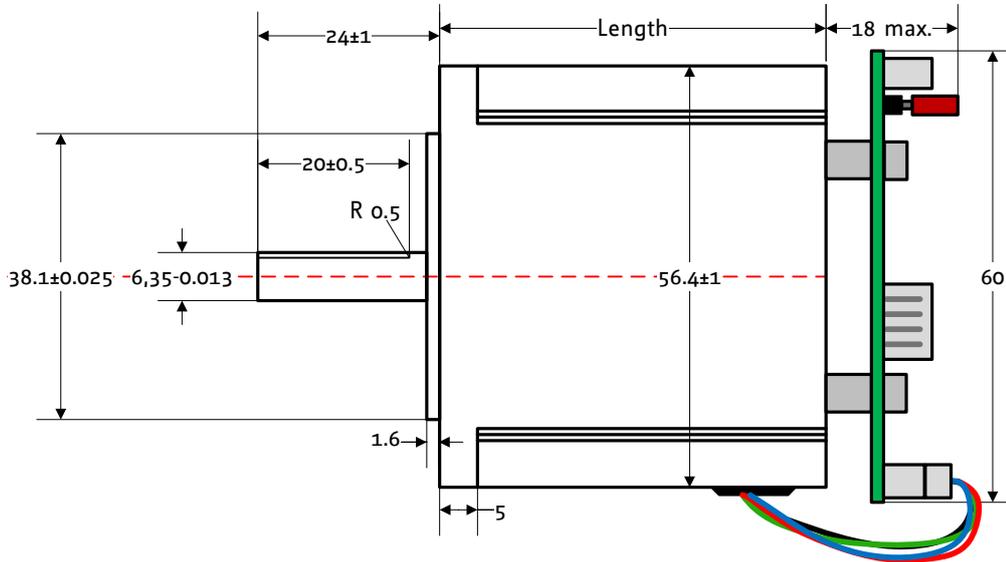
Component parts	Description
TCM-1060-CABLE	Cable loom for module and PANdrive™.

**Table 3.5 Order codes for component parts**

## 4 Mechanical and Electrical Interfacing

### 4.1 PD57-1060 Dimensions

Currently, there is a choice between four NEMA 23/57mm bipolar stepper motors with different lengths and different holding torques.



Model	Length (mm)
PD57-1-1060	41
PD57-2-1060	51
PD57-3-1060	56
PD57-4-1060	76

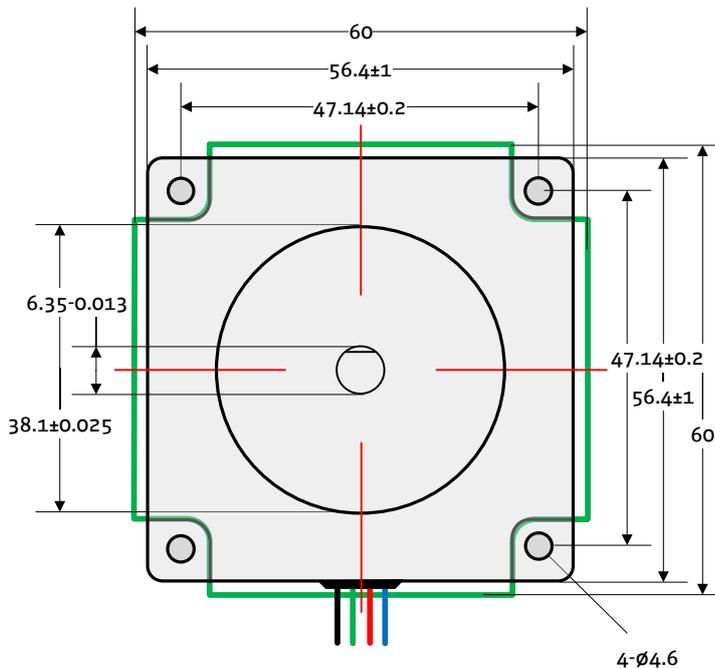
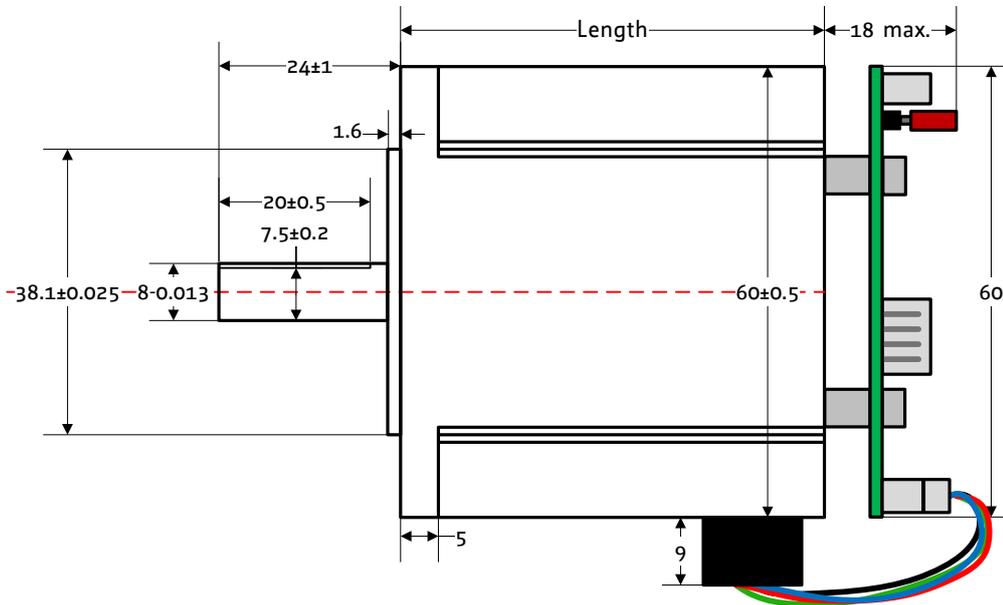


Figure 4.1 Dimensions of PD57-1060

## 4.2 PD60-1060 Dimensions

Currently, there is a choice between four NEMA 24 / 60mm bipolar stepper motors with different lengths and different holding torques



Model	Length (mm)
PD60-1-1060	45
PD60-2-1060	56
PD60-3-1060	65
PD60-4-1060	86

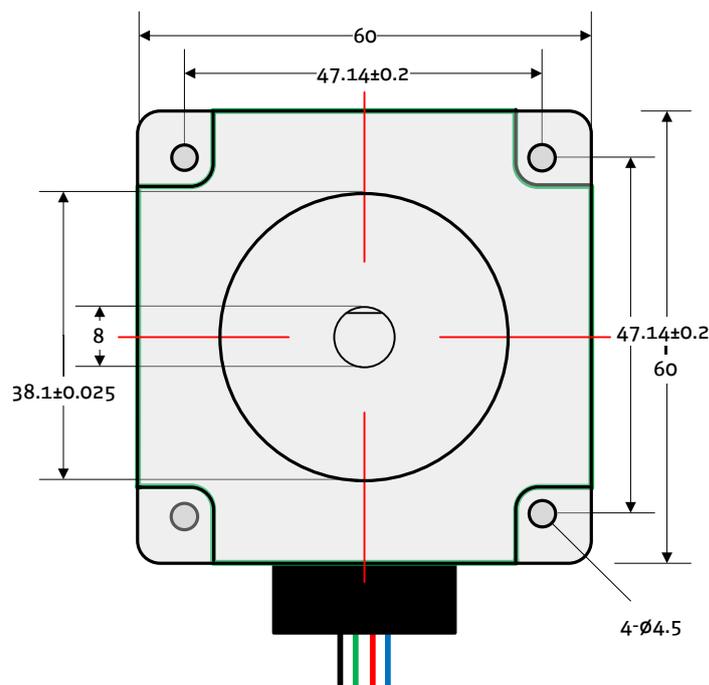


Figure 4.2 Dimensions of PD60-1060

### 4.3 PD57/60-1060 Controller/Driver Board Size and Mounting Holes

The dimensions of the controller/driver board (TMC-1060) are approx. 60mm x 60mm in order to fit on the back side of the 60mm stepper motor. Maximum component height (height above PCB level) without mating connectors is around 8mm above PCB level and 4mm below PCB level. There are four mounting holes for M3 screws for mounting the board either to a NEMA23 (two mounting holes at opposite corners) or a NEMA24 (other two mounting holes at opposite corners) stepper motor.

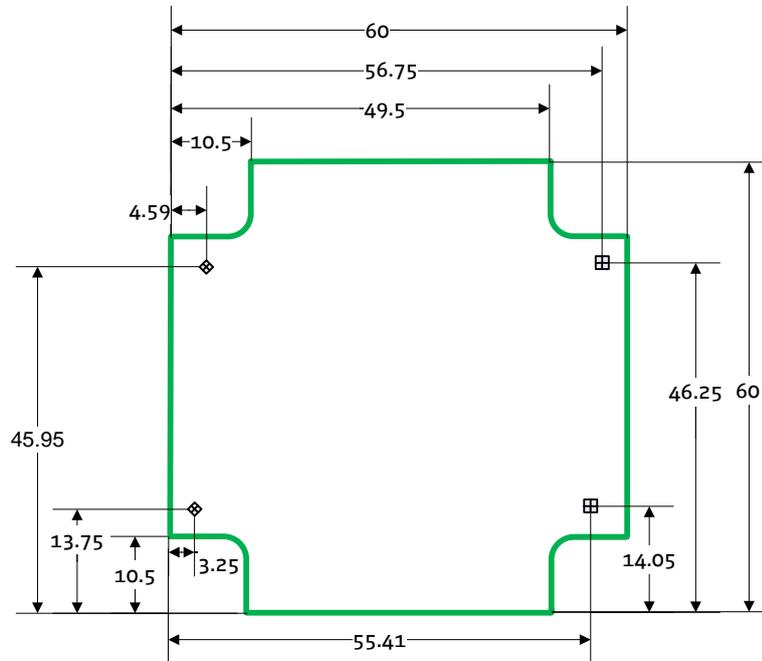


Figure 4.3 Controller/driver dimension and position of mounting holes

## 5 Motor

### MAIN CHARACTERISTICS OF THE FOUR DIFFERENT MOTORS AVAILABLE AS PART OF THE PD57-1060

Specifications	Parameter	Units	QSH5718			
			-41-28-055	-51-28-101	56-28-126	-76-28-189
Number of Leads		N°	4	4	4	4
Step Angle		°	1.8	1.8	1.8	1.8
Step Angle Accuracy		%	5	5	5	5
Rated Voltage	$V_{RATED}$	V	2	2.3	2.5	3.2
Rated Phase Current	$I_{RMS RATED}$	A	2.8	2.8	2.8	2.8
Phase Resistance at 20°C	$R_{COIL}$	$\Omega$	0.7	0.83	0.9	1.13
Phase Inductance (typ.)		mH	1.4	2.2	2.5	3.6
Holding Torque		Nm	0.55	1.01	1.26	1.89
Rotor Inertia		g cm <sup>2</sup>	120	275	300	480
Insulation Class			B	B	B	B
Max. applicable voltage		V	75	75	75	75
Max. radial force (20mm from front flange)		N	75	75	75	75
Max. axial force		N	15	15	15	15
Weight		kg	0.45	0.65	0.7	1
Length		mm	41	51	56	76
Temp. Rise (rated current, 2 phase on)		°C	+80 max	+80 max	+80 max	+80 max
Ambient Temperature		°C	-20 ... +50	-20 ... +50	-20 ... +50	-20 ... +50

Table 5.1 NEMA 23/57mm technical motor data

### MAIN CHARACTERISTICS OF THE FOUR DIFFERENT MOTORS AVAILABLE AS PART OF THE PD60-1060

Specifications	Parameter	Units	QSH6018			
			-45-28-110	-56-28-165	-65-28-210	-86-28-310
Number of Leads		N°	8	8	8	8
Step Angle		°	1.8	1.8	1.8	1.8
Rated Voltage	$V_{RATED}$	V	2.1	2.52	3.36	4.17
Rated Phase Current	$I_{RMS RATED}$	A	2.8	2.8	2.8	2.8
Phase Resistance at 20°C	$R_{COIL}$	$\Omega$	0.75	0.9	1.2	1.5
Phase Inductance (typ.)		mH	2	3.6	4.6	6.8
Holding Torque		Nm	1.1	1.65	2.1	3.1
Rotor Inertia		g cm <sup>2</sup>	275	400	570	840
Insulation Class			B	B	B	B
Weight		kg	0.6	0.77	1.2	1.4
Ambient Temperature		°C	-20 ... +50	-20 ... +50	-20 ... +50	-20 ... +50

Table 5.2 NEMA 24/60mm technical motor data

Please refer to the motor manuals on [www.trinamic.com](http://www.trinamic.com) for further information.

### CAUTION!



#### Keep the electronics free of (metal) particles!

The integrated sensOstep™ encoder uses a magnet at the end of the motor axis in order to monitor position. The magnet naturally attracts especially tiny metal particles. These particles might be held on the top side of the PCB and even worse – start moving in accordance with the rotating magnetic field as soon as the motor starts moving. This might lead to shorts of electronic contacts / wires on the board and totally erratic behavior of the module! Use compressed air for cleaning the module if necessary.

## 6 Connectors

The controller/driver board for the PD57/60-1060 offers 6 connectors including the motor connector which is used for attaching the motor coils to the electronics. In addition to the power connector there are two connectors for serial communication (one min-USB and one for RS485 and CAN) and two connectors for step/direction and general purpose input/output signals.

The GPIO connector offers two general purpose outputs, two general purpose inputs, two inputs for stop switches and one for an additional home switch. The power supply connector offers separate inputs for driver and for logic power supply and hardware shutdown-input. Leaving the shutdown input open or tying it to ground will disable the motor driver stage in hardware. For operation, this input should be tied to supply voltage.

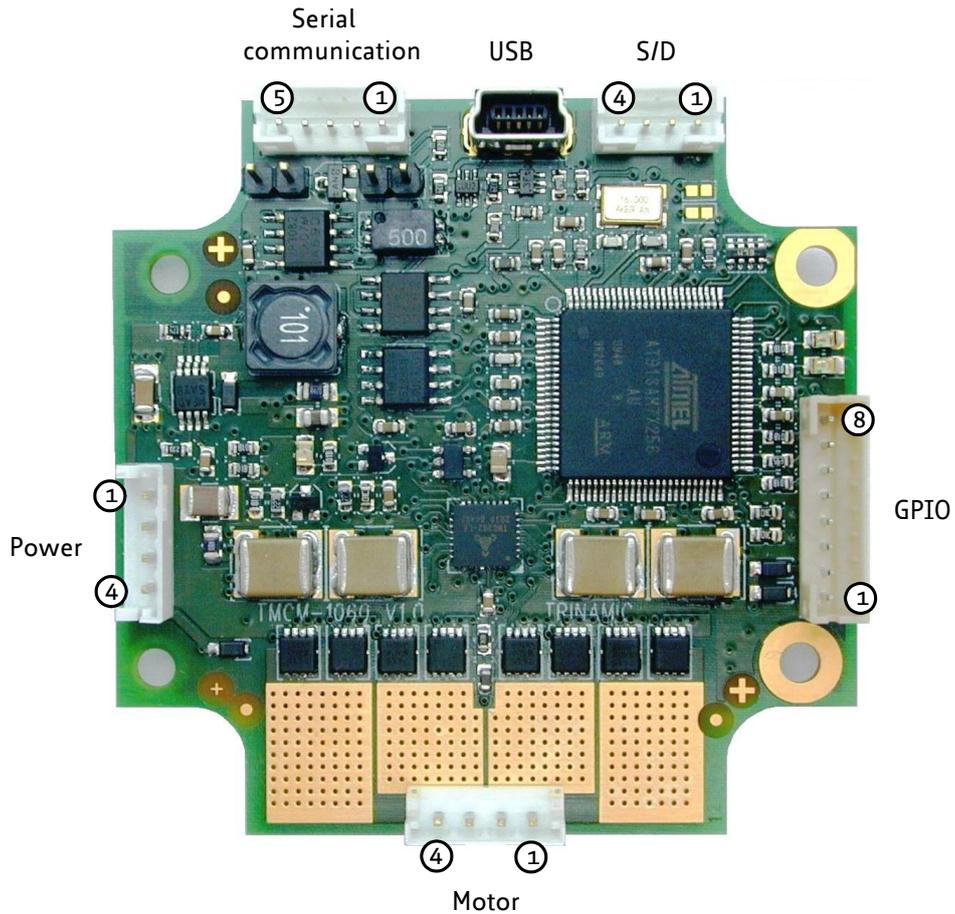


Figure 6.1 Overview connectors

## 6.1 Power Connector

This module offers separate power supply inputs for digital logic (pin 2) and driver/power stage (pin 1). Both supply inputs use common ground connections (pin 4). This way, power supply for the driver stage may be switched off while still maintaining position and status information when keeping digital logic supply active.

### +U<sub>DRIVER</sub> SUPPLY ONLY

In case only power supply is provided to the power section (pin 1), an internal diode will distribute power to the logic section. So, when separate power supplies are not required, use pin 1 and 4 for powering the module. If so, pin 2 (logic supply) and pin 3 (/SHUTDOWN input) can be connected together in order to enable the driver stage.

### ENABLING THE DRIVER STAGE

Connect /SHUTDOWN input to +U<sub>Driver</sub> or +U<sub>Logic</sub> in order to activate the driver stage. Leaving this input open or connecting it to ground will disable driver stage

To ensure reliable operation of the unit, the power supply has to have a sufficient output capacitor and the supply cables should have a low resistance, so that the chopper operation does not lead to an increased power supply ripple directly at the unit. Power supply ripple due to the chopper operation should be kept at a maximum of a few 100mV.

### GUIDELINES FOR POWER SUPPLY

- keep power supply cables as short as possible
- use large diameters for power supply cables
- add 2200µF or larger filter capacitors near the motor driver unit especially if the distance to the power supply is large (i.e. more than 2-3m)

### CAUTION!

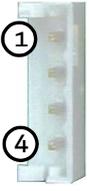
	<p><b>Add external power supply capacitors!</b></p> <p>The module contains ceramic capacitors for power supply filtering. These have been selected for high reliability and long life time. Nevertheless, the resulting capacity is rather low. This may lead to excessive supply voltage ripple depending on motor current. Also, extremely low ESR values of ceramic capacitors can lead to stability problems with some power supplies. In order to avoid this, an external (electrolytic) capacitor of sufficient size (2200µF or more recommended) should be added. Rule of thumb: add 1000µF per 1A power supply current not far away from the module between power supply wires. Please note: upper supply voltage limit must not be exceeded – not even for a short period of time! In this context it should be taken into account that the module will transfer energy from the motor back into the supply rail when the motor is working as generator e.g. during deceleration or brake conditions. In case the power supply capacitors are not sufficient for limiting power supply rising, additional measures have to be considered (e.g. suppressor diodes, brake resistor).</p> <p>In larger systems a zener diode circuitry might be required in order to limit the maximum voltage when the motor is operated at high velocities.</p>
	<p><b>Do not connect or disconnect motor during operation!</b></p> <p>Motor cable and motor inductivity might lead to voltage spikes when the motor is disconnected / connected while energized. These voltage spikes might exceed voltage limits of the driver MOSFETs and might permanently damage them. Therefore, always disconnect power supply before connecting / disconnecting the motor.</p>
	<p><b>Keep the power supply voltage below the upper limit of 51V!</b></p> <p>Otherwise the driver electronics will seriously be damaged! Especially, when the selected operating voltage is near the upper limit a regulated power supply is highly recommended. Please see also chapter 8, operating values.</p> <p><i>Pre-series boards are limited to +40V max. power supply.</i></p>

	<p><b>There is no reverse polarity protection!</b></p> <p>The module will short any reversed supply voltage due to internal diodes of the driver transistors.</p>
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A 4-pin JST EH series B4B-EH connector is used as power connector on-board.

Mating connectors (JST):

Connector housing: JST EHR-4  
 Connector crimp contacts: JST SHE-001T-P0.6 (for AWG 30-22 wires)

	Pin	Label	Description
	1	+U <sub>Driver</sub>	Module + driver stage power supply input
	2	+U <sub>Logic</sub>	(Optional) separate digital logic power supply input
	3	/SHUTDOWN	Shutdown input. Connect this input to +U <sub>Driver</sub> or +U <sub>Logic</sub> in order to activate driver stage. Leaving this input open or connecting it to ground will disable driver stage
4	GND	Module ground (power supply and signal ground)	

**Table 6.1 Connector for power supply**

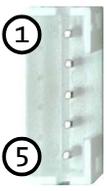
## 6.2 Serial Communication Connector

The module supports RS485 and CAN communication over this connector.

A 2mm pitch 5 pin CVIlux CI0105P1VK0-LF connector is used for serial communication:

Mating connectors (JST or CVIlux):

Connector housing CVIlux: CI01055000-A  
 Contacts CVIlux: CI01T011PE0-A  
 Connector housing JST: PHR-5  
 Contacts JST: SPH-002T-P0.5S  
 Wire: 0.22mm<sup>2</sup>

	Pin	Label	Description
	1	CAN_H	CAN bus signal (dominant high)
	2	CAN_L	CAN bus signal (dominant low)
	3	GND	Module ground (system and signal ground)
	4	RS485+	RS485 bus signal (non inverted)
5	RS485-	RS485 bus signal (inverted)	

**Table 6.2 Connector for serial communication**

## 6.3 USB Connector

A 5-pin standard mini-USB connector is available on board.

	Pin	Label	Description
	1	VBUS	+5V power
	2	D-	Data -
	3	D+	Data +
	4	ID	Not connected
5	GND	ground	

**Table 6.3 Mini USB connector**

## 6.4 Step/Dir Connector

This is an option in case the on-board controller is not used or for configuration purposes, only. The step/direction input is optically isolated and will allow direct control of the driver stage.

A 2mm pitch 4 pin CVIlux CI0104P1VK0-LF connector is used for Step/Dir signals.

Mating connectors (JST or CVIlux):

Connector housing CVIlux: CI01045000-A

Contacts CVIlux: CI01T011PE0-A

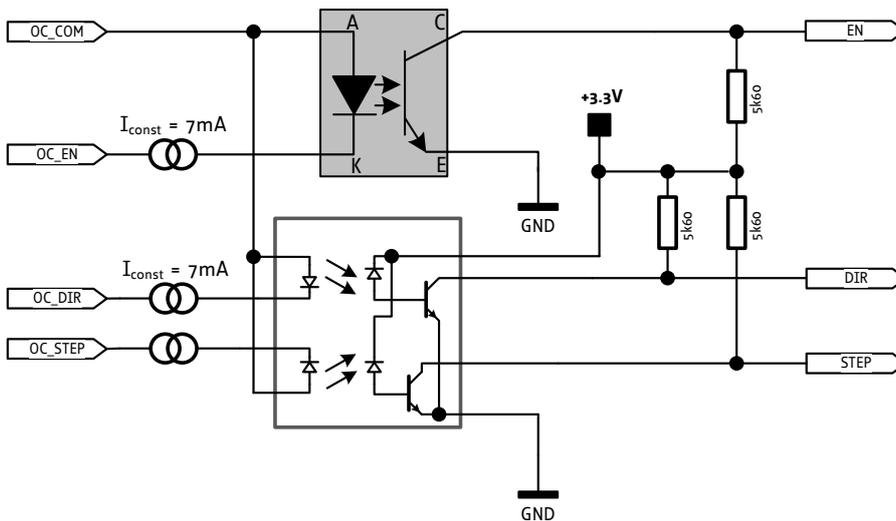
Connector housing JST: PHR-4

Contacts JST: SPH-002T-P0.5S

Wire: 0.22mm<sup>2</sup>

Pin	Label	Description
1	COM	Common supply / opto-coupler (+5V... +24V)
2	ENABLE	Enable signal
3	STEP	Step signal
4	DIRECTION	Direction signal

**Table 6.4 Connector for Step/Dir signals**



**Figure 6.2 Internal circuit of the Step/Dir interface**

## 6.5 General Purpose Input/Output Connector

A 2mm pitch 8 pin CVIlux CI0108P1VK0-LF connector is used for connecting general purpose inputs, home and stop switches to the unit:

Mating connectors (JST or CVIlux):

Connector housing CVIlux: CI01085000-A

Contacts CVIlux: CI01T011PE0-A

Connector housing JST: PHR-8

Contacts JST: SPH-002T-P0.5S

Wire: 0.22mm<sup>2</sup>

	Pin	Label	Description
	1	OUT_o	General purpose output, open collector
	2	OUT_1	General purpose output, open collector
	3	IN_o	General purpose input, +24V compatible
	4	IN_1	General purpose input, +24V compatible
	5	STOP_L	Left stop switch input, +24V compatible, programmable internal pull-up
	6	STOP_R	Right stop switch input, +24V compatible, programmable internal pull-up
	7	HOME	Home switch input, +24V compatible, programmable internal pull-up
	8	GND	Module ground (system and signal ground)

Table 6.5 General purpose input/output connector

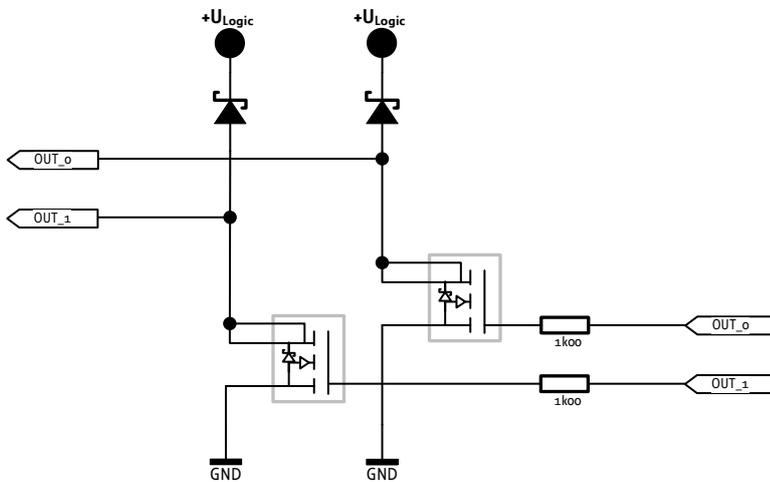
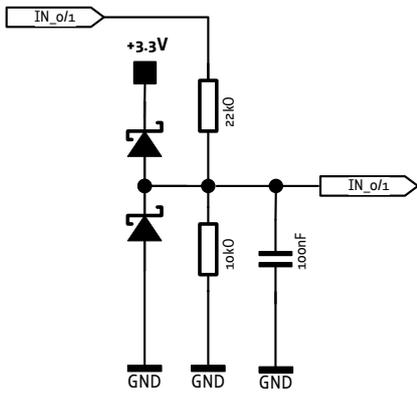


Figure 6.3 Internal circuit of the outputs



**Figure 6.4 Internal circuit of the inputs**

Please refer to the TCMC-1060 TMCL Firmware Manual for more information about the limit switches.

## 6.6 Motor Connector

Both motor coil windings (bipolar stepper motor) are connected to the motor connector.

A 2.5mm pitch 4 pin JST B4B-EH connector is used for motor connection.

### Mating connectors (JST):

Connector housing: JST EHR-4  
 Connector crimp contacts: JST SHE-001T-P0.6 (for AWG 30-22 wires)

	Pin	Label	Description
	1	OA1	Motor coil A
	2	OA2	Motor coil A
	3	OB1	Motor coil B
4	OB2	Motor coil B	

**Figure 6.5 Motor connector**

## 7 Jumpers

Most settings of the board are done through the software. Nevertheless, two jumpers are available for configuration.

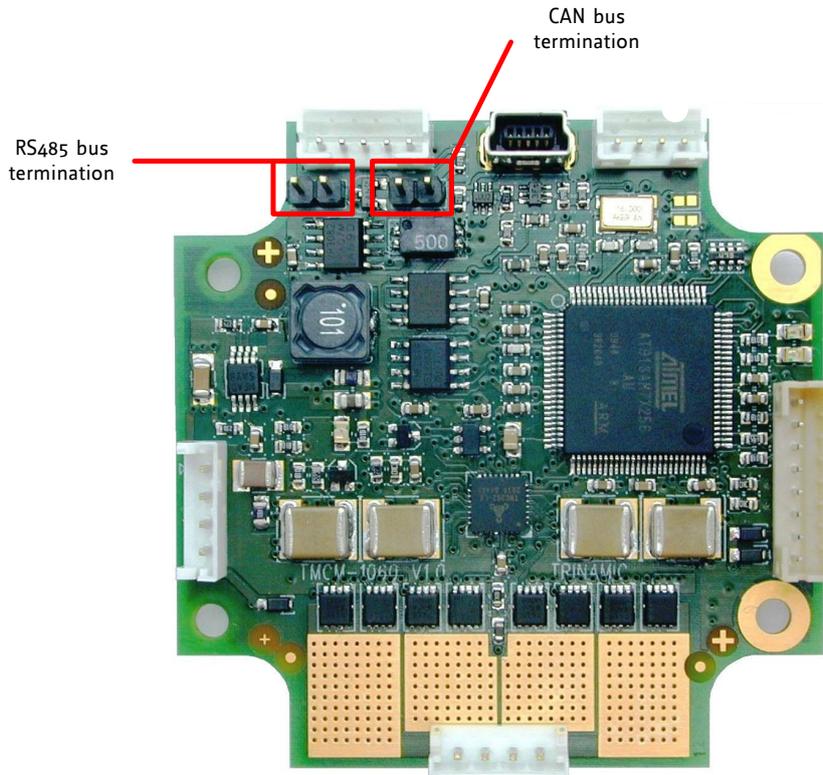


Figure 7.1 RS485 and CAN bus termination

### 7.1 RS485 Bus Termination

The board includes a 120 Ohm resistor for proper bus termination of the RS485 interface. When this jumper is closed, the resistor will be placed between the two differential bus lines RS485+ and RS485-.

### 7.2 CAN Bus Termination

The board includes a 120 Ohm resistor for proper bus termination of the CAN interface. When this jumper is closed, the resistor will be placed between the two differential bus lines CAN\_H and CAN\_L.

## 8 Operational Ratings

The operational ratings shown below should be used as design values. In no case should the maximum values be exceeded during operation.

Symbol	Parameter	Min	Typ	Max	Unit
$+V_{\text{Driver}} / +V_{\text{Logic}}$	Power supply voltage for operation	9	12, 24 or 48	51	V DC *)
$I_{\text{COIL\_peak}}$	Motor coil current for sine wave peak (chopper regulated, adjustable via software)	0		4	A
$I_{\text{COIL\_RMS}}$	Continuous motor current (RMS)	0		2.8	A
$I_{\text{SUPPLY}}$	Power supply current		$\ll I_{\text{COIL}}$	$1.4 * I_{\text{COIL}}$	A
$T_{\text{ENV}}$	Environment temperature at rated current (no forced cooling required)		tbd		°C

**Table 8.1 General operational ratings of the module**

\*) Attention: Maximum voltage for pre-series units is limited to +40VDC

Symbol	Parameter	Min	Type	Max	Unit
$V_{\text{COMMON}}$	Supply voltage for common supply input for step, direction and enable (inputs have negative logic)		5... 24	27	V
$V_{\text{STEP/DIR/ENABLE\_ON}}$	Signal voltage at step, direction and enable input (active, opto-coupler on)	3.5	4.5... 24	30	V
$V_{\text{STEP/DIR/ENABLE\_OFF}}$	Signal voltage at step, direction and enable input (inactive, opto-coupler off)	-5.5	0	2	V
$I_{\text{STEP/DIR/ENABLE\_ON}}$	Opto-coupler current when switched on (internally regulated)		8..9		mA
$f_{\text{STEP}}$	Step frequency			1 *)	MHz

**Table 8.2 Operational ratings of step/direction input**

\*) maximum frequency for +5V TTL level step signals with 50% duty cycle. For pre-series units maximum step frequency is lower.

Symbol	Parameter	Min	Type	Max	Unit
$V_{STOP\_L/R/HOME}$	Input voltage for STOP_L/R/HOME	0		24	V
$V_{STOP\_L/R/HOME\_L}$	Low level voltage for STOP_L/R/HOME	0		1.6	V
$V_{STOPL/R/HOME\_H}$	High level voltage for STOP_L/R/HOME (internal programmable 1k pull-up to +5V)	4		24	V
$V_{IN\_0/1\_digital}$	Input voltage for IN_0 and IN_1 when used as digital input	0		24	V
$V_{IN\_0/1\_analogue}$	Input voltage for IN_0 and IN_1 when used as analogue input	0		10	V
$V_{IN\_0/1\_L}$	Low level voltage for IN_0 and IN_1 when used as digital input (internal 10k pull-down)	0		1.6 *)	V
$V_{IN\_0/1\_H}$	High level voltage for IN_0 and IN_1 when used as digital input	2 *)		24	V
$V_{OUT\_0/1}$	Voltage at open collector output	0		$V_{DD} + 0.5$ **)	V
$I_{OUT\_0/1}$	Output sink current at open collector outputs			1	A

**Table 8.3 Operational ratings of the general purpose inputs/outputs**

\*) this voltage is programmable (internal 10bit ADC)

\*\*) limited to module supply voltage + 0.5V due to integrated freewheeling diode between general purpose output and module supply voltage

Symbol	Parameter	Min	Type	Max	Unit
$N_{RS485}$	Number of nodes connected to single RS485 network			64	

**Table 8.4 Operational ratings of the RS485 interface**

Symbol	Parameter	Min	Type	Max	Unit
$N_{CAN}$	Number of nodes connected to single CAN network			110	

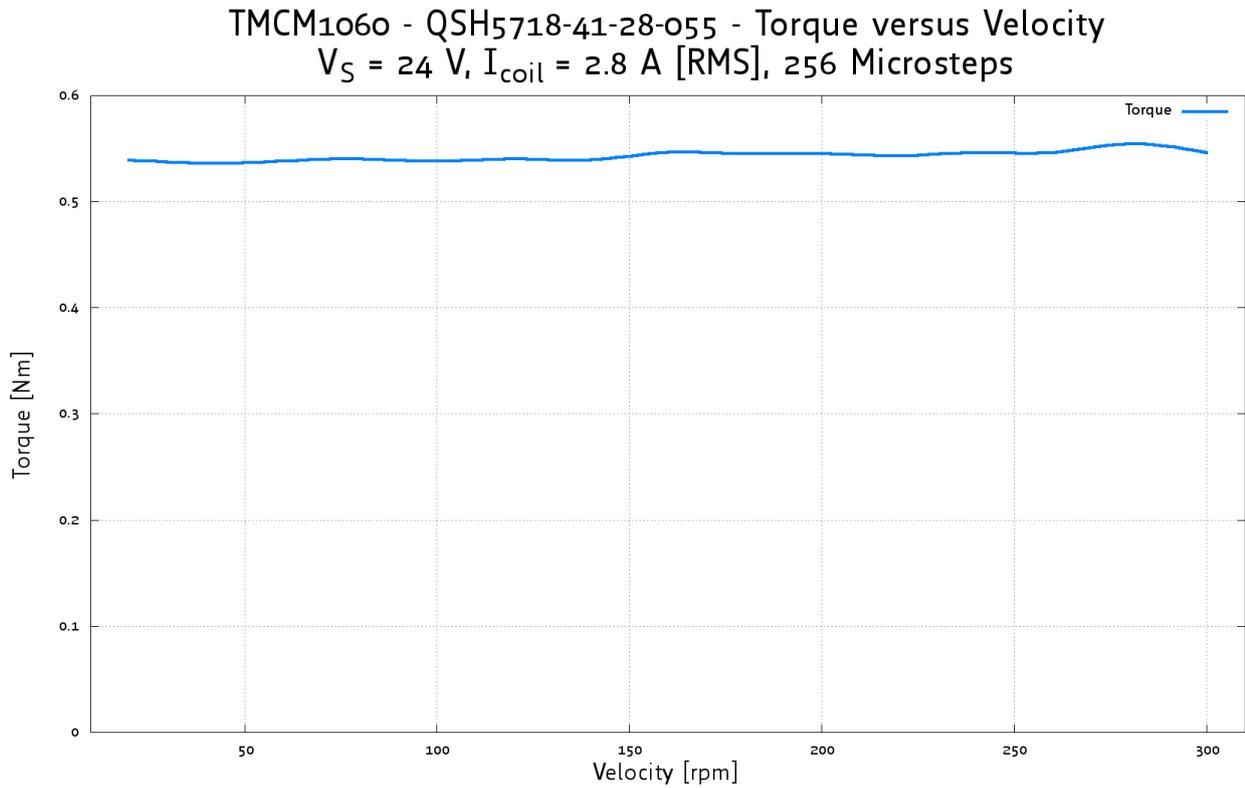
**Table 8.5 Operational ratings of the CAN interface**

## 9 Torque Curves

TRINAMIC offers the TCM-1060 in combination with two different stepper motor series: QSH5718 and QSH6018. Paragraph 9.1 will show you the curves of each PD57-x-1060 and the paragraph behind (9.2) displays the curves of each PD-60-x-1060.

### 9.1 Curves of PD57-x-1060

#### 9.1.1 PD57-1-1060 Torque Curves



**Figure 9.1 PD57-1-1060 torque vs. velocity 24V / 2.8A, 256μsteps (1)**

TMC1060 - QSH5718-41-28-055 - Torque versus Velocity  
 $V_S = 24\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

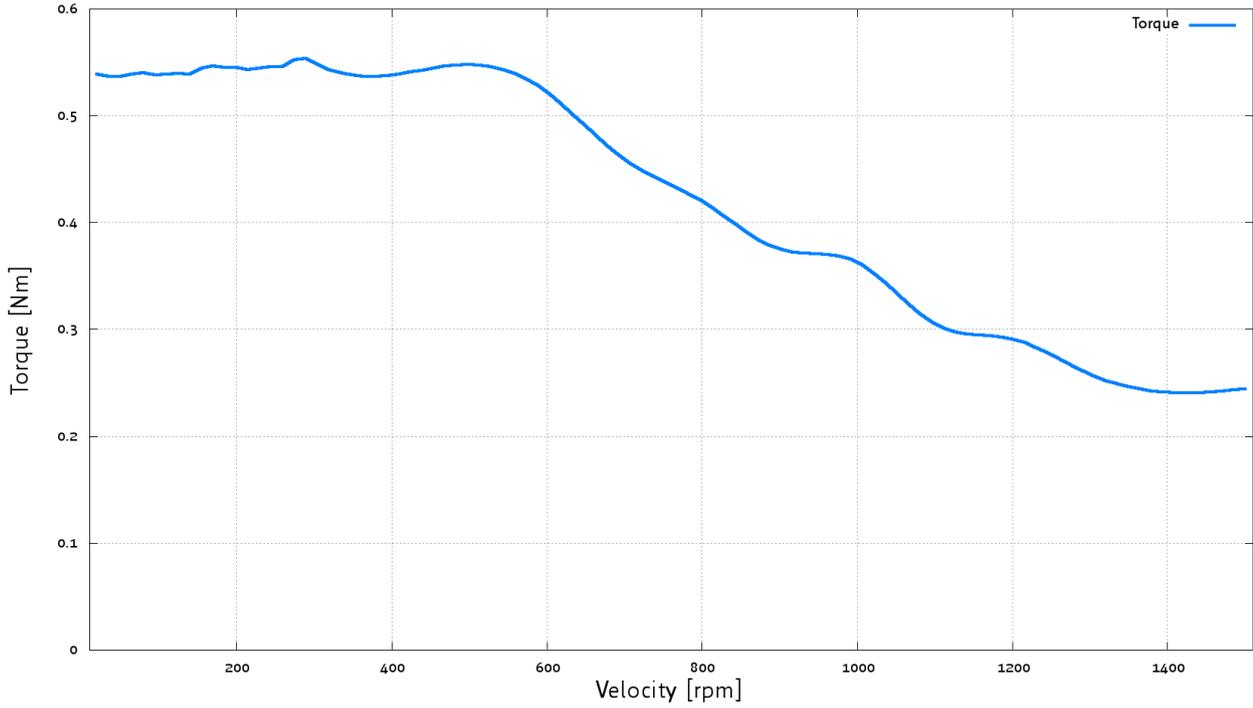


Figure 9.2 PD57-1-1060 torque vs. velocity 24V / 2.8A, 256μsteps (2)

TMC1060 - QSH5718-41-28-055 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

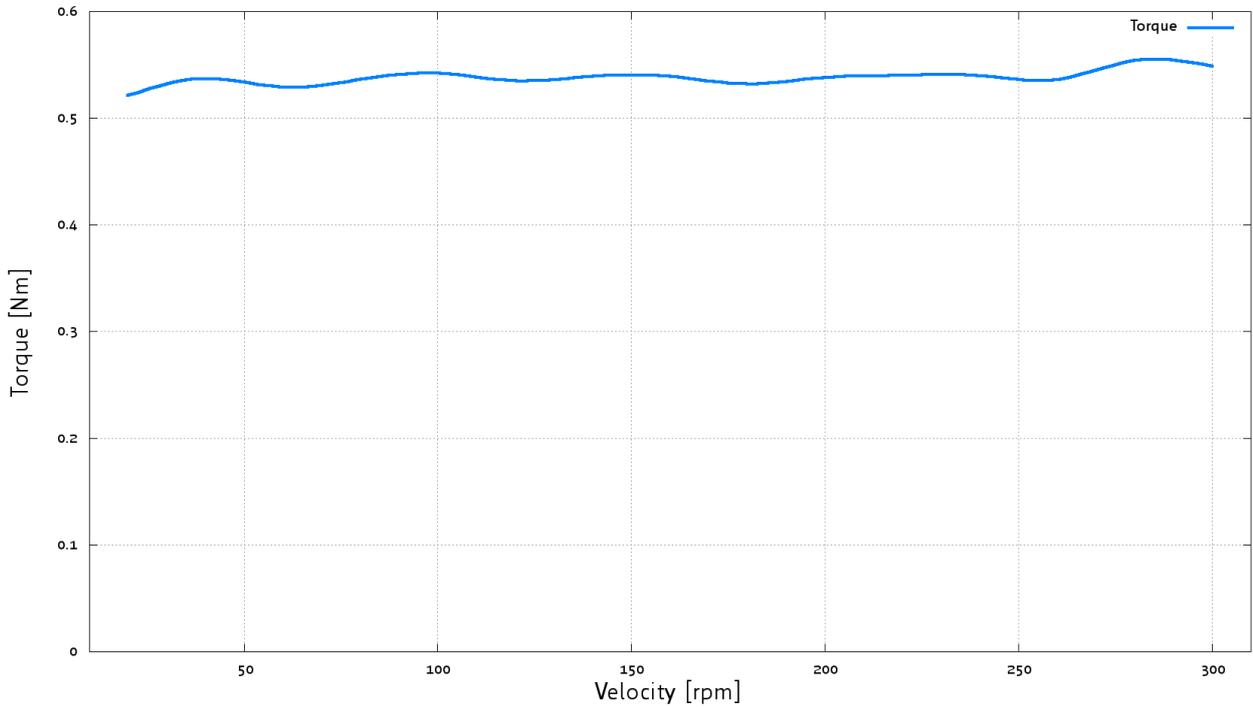


Figure 9.3 PD57-1-1060 torque vs. velocity 48V / 2.8A, 256μsteps (1)

TMCM1060 - QSH5718-41-28-055 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

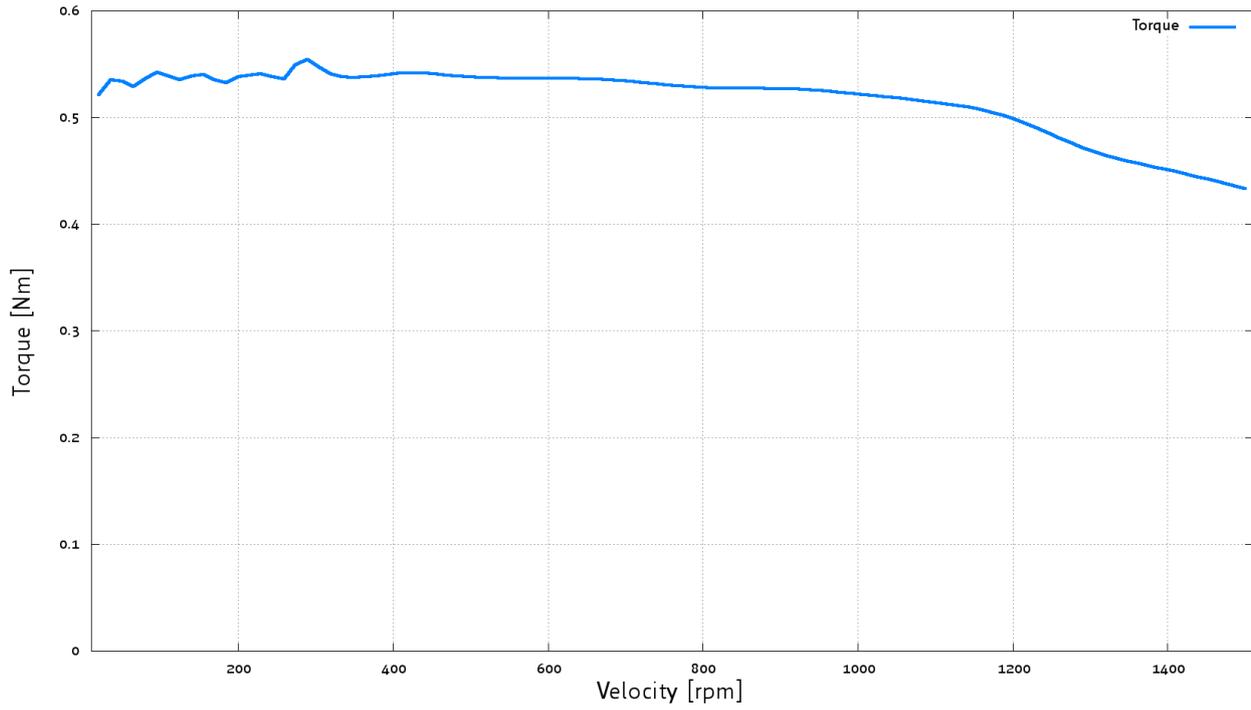


Figure 9.4 PD57-1-1060 torque vs. velocity 48V / 2.8A, 256μsteps (2)

### 9.1.2 PD57-2-1060 Torque Curves

TMCM1060 - QSH5718-51-28-101 - Torque versus Velocity  
 $V_S = 24\text{ V}$ ,  $I_{coil} = 2.8\text{ A [RMS]}$ , 256 Microsteps

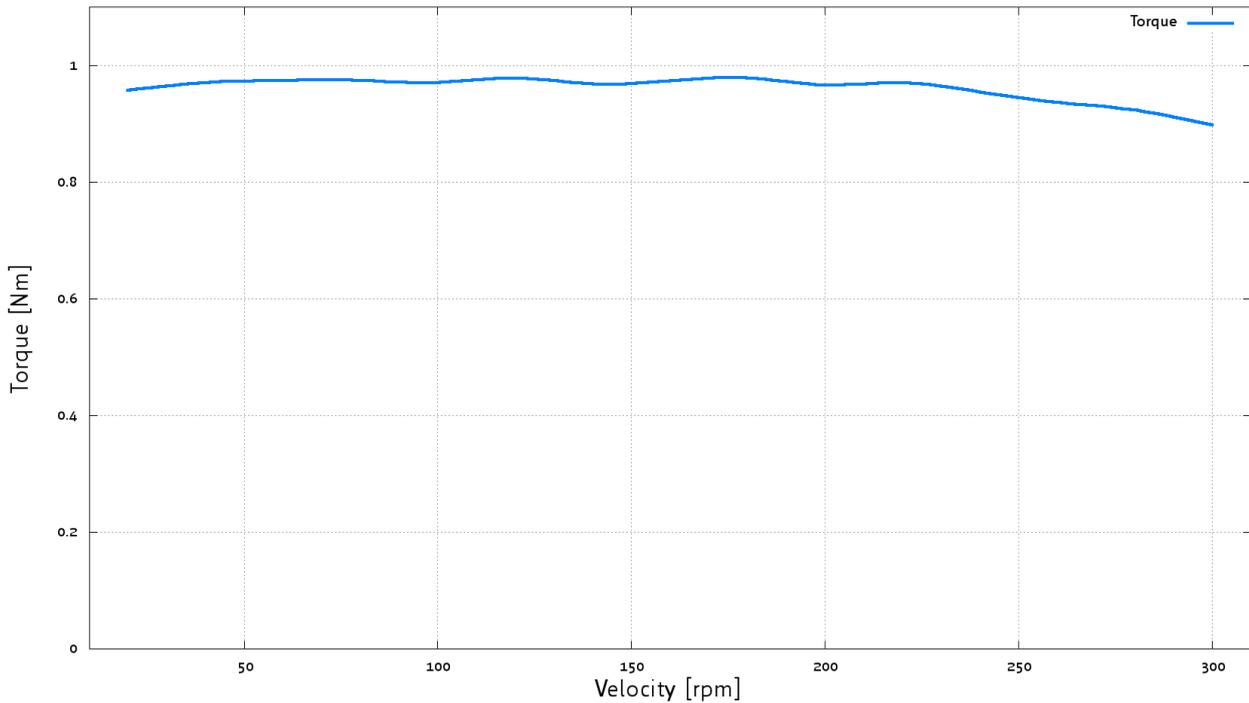


Figure 9.5 PD57-2-1060 torque vs. velocity 24V / 2.8A, 256μsteps (1)

TMCM1060 - QSH5718-51-28-101 - Torque versus Velocity  
 $V_S = 24\text{ V}$ ,  $I_{coil} = 2.8\text{ A [RMS]}$ , 256 Microsteps

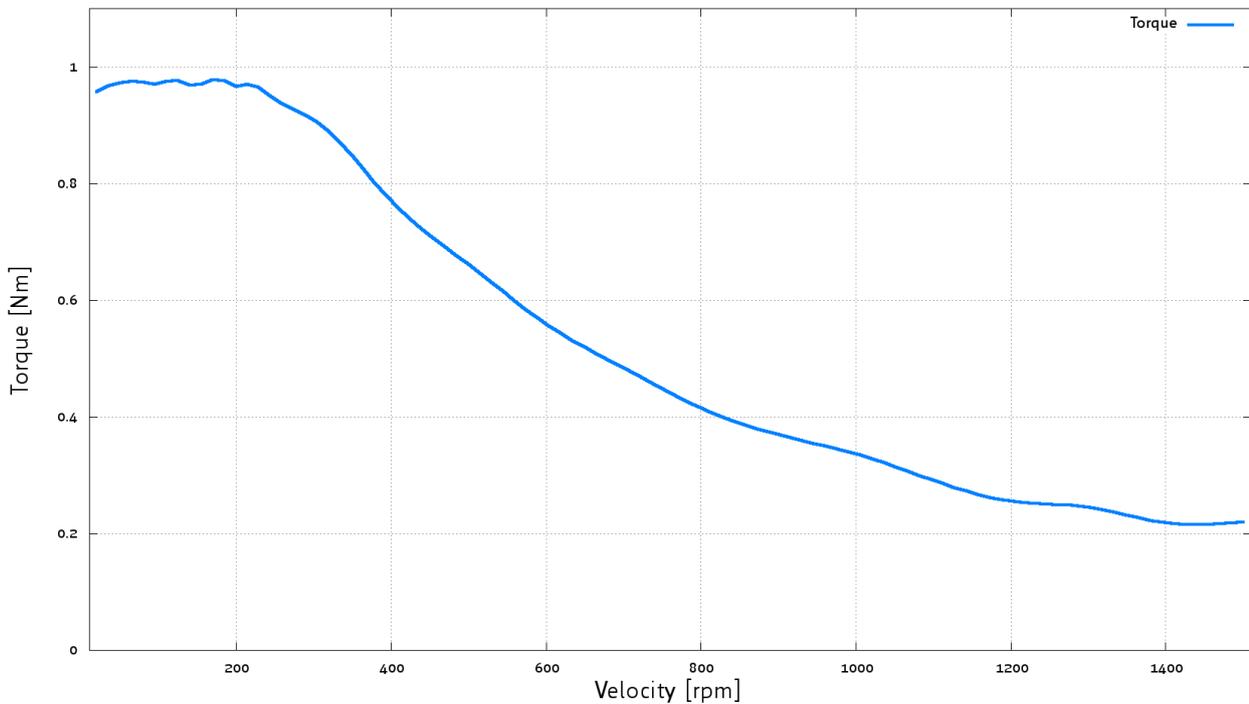


Figure 9.6 PD57-2-1060 torque vs. velocity 24V / 2.8A, 256μsteps (2)

TMC1060 - QSH5718-51-28-101 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

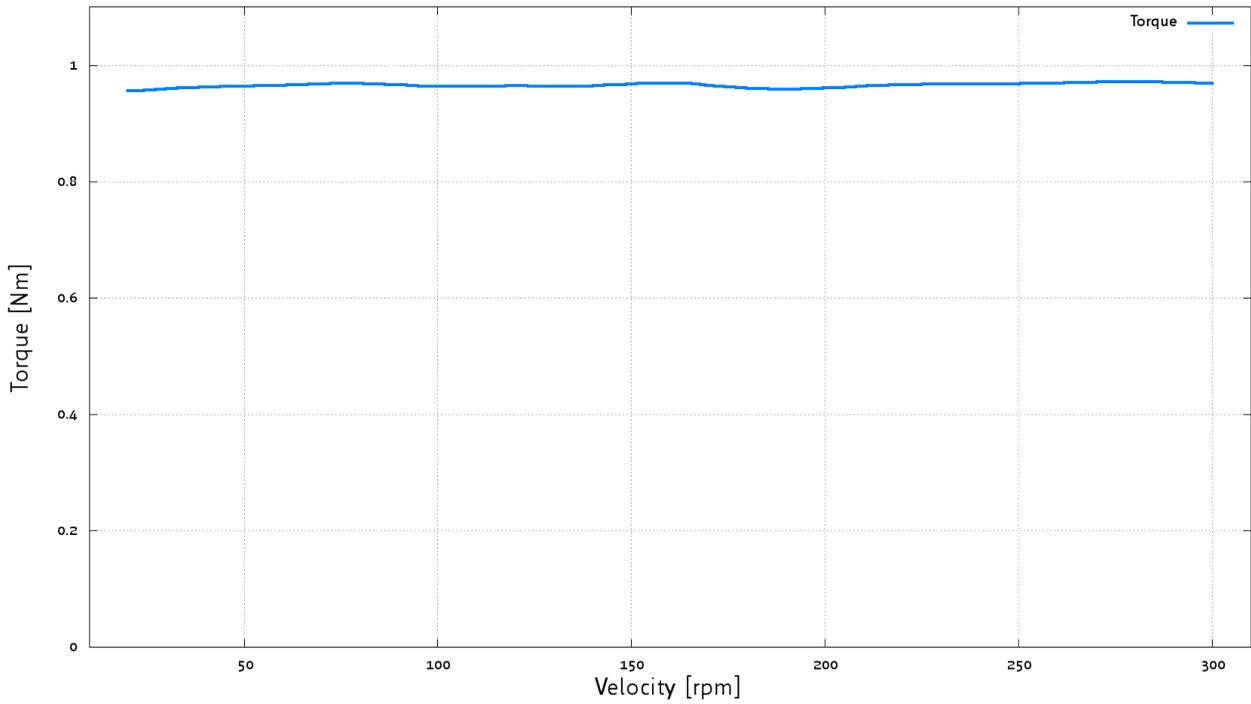


Figure 9.7 PD57-2-1060 torque vs. velocity 48V / 2.8A, 256μsteps (1)

TMC1060 - QSH5718-51-28-101 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

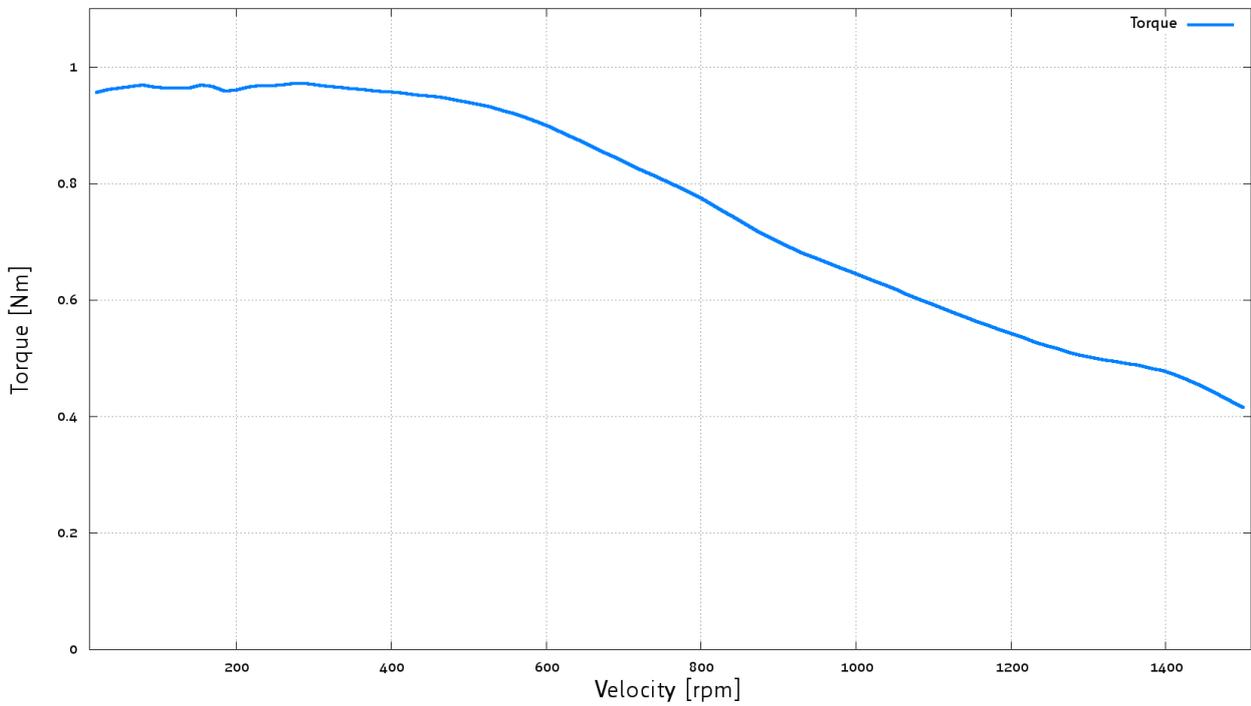


Figure 9.8 PD57-2-1060 torque vs. velocity 48V / 2.8A, 256μsteps (2)

### 9.1.3 PD57-3-1060 Torque Curves

TMCM1060 - QSH5718-56-28-126 - Torque versus Velocity  
 $V_S = 24\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

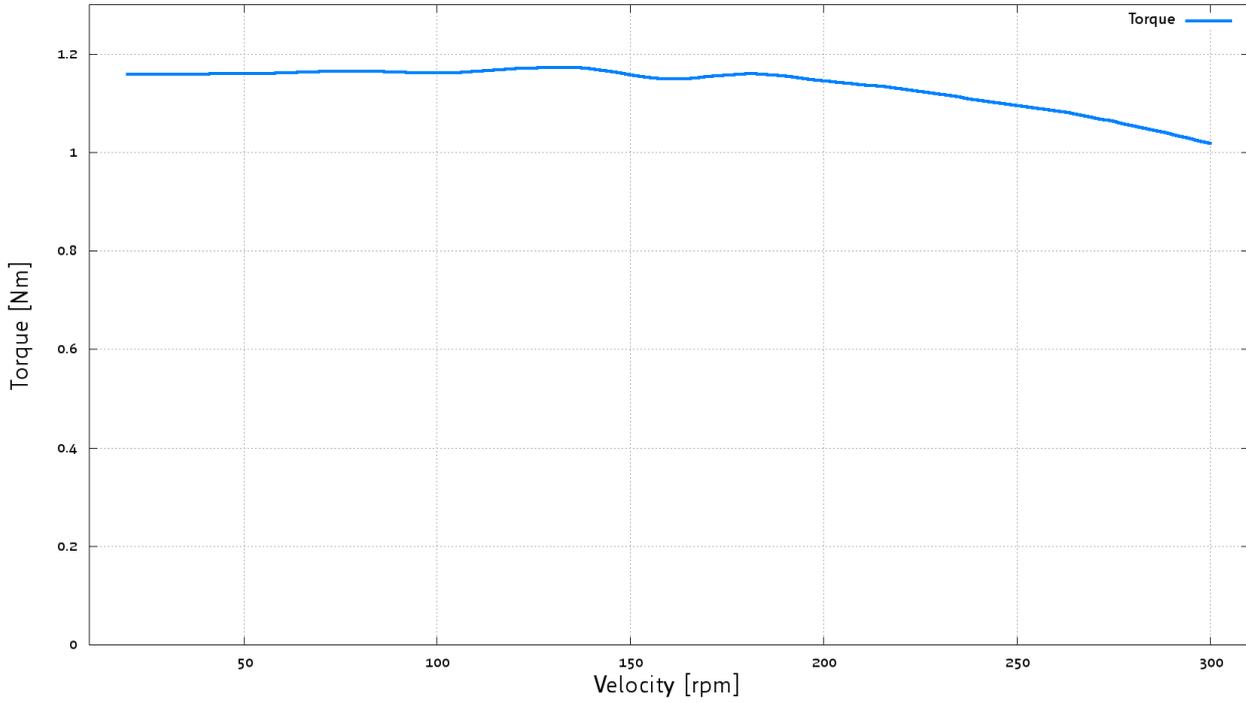


Figure 9.9 PD57-3-1060 torque vs. velocity 24V / 2.8A, 256μsteps (1)

TMCM1060 - QSH5718-56-28-126 - Torque versus Velocity  
 $V_S = 24\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

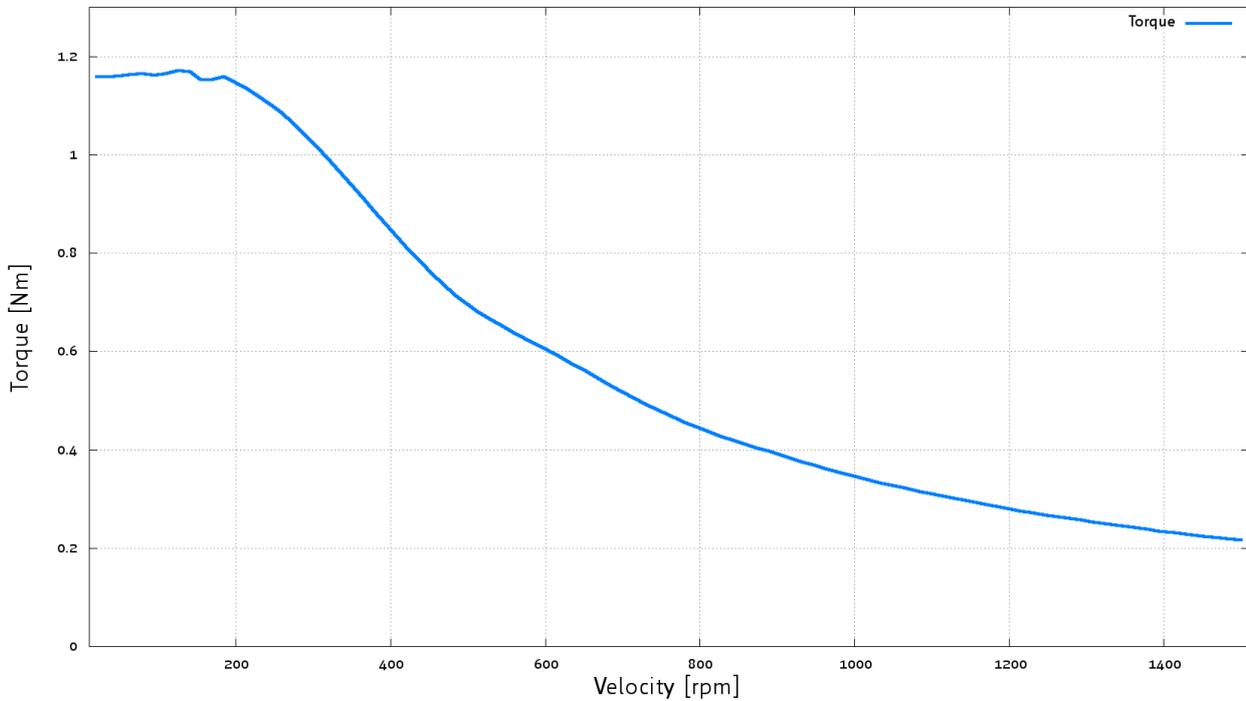


Figure 9.10 PD57-3-1060 torque vs. velocity 24V / 2.8A, 256μsteps (2)

TMC1060 - QSH5718-56-28-126 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

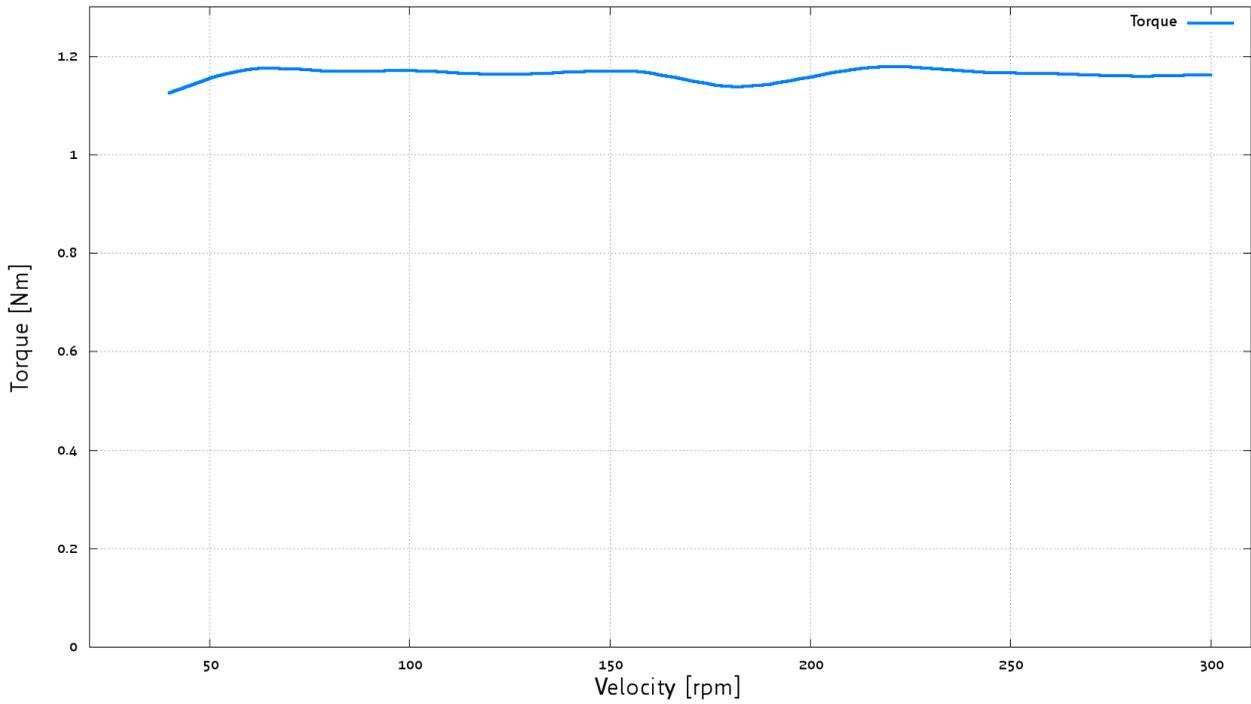


Figure 9.11 PD57-3-1060 torque vs. velocity 48V / 2.8A, 256μsteps (1)

TMC1060 - QSH5718-56-28-126 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

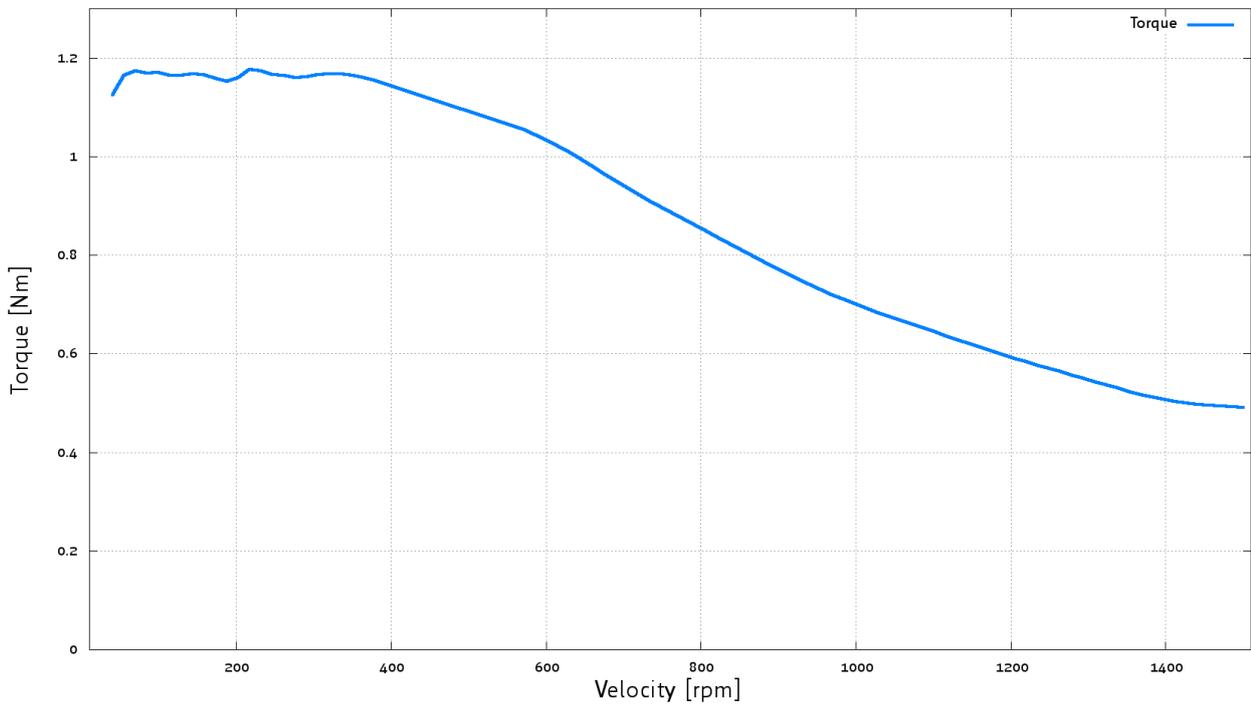


Figure 9.12 PD57-3-1060 torque vs. velocity 48V / 2.8A, 256μsteps (2)

### 9.1.4 PD57-4-1060 Torque Curves

TMCM1060 - QSH5718-76-28-189 - Torque versus Velocity  
 $V_S = 24\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

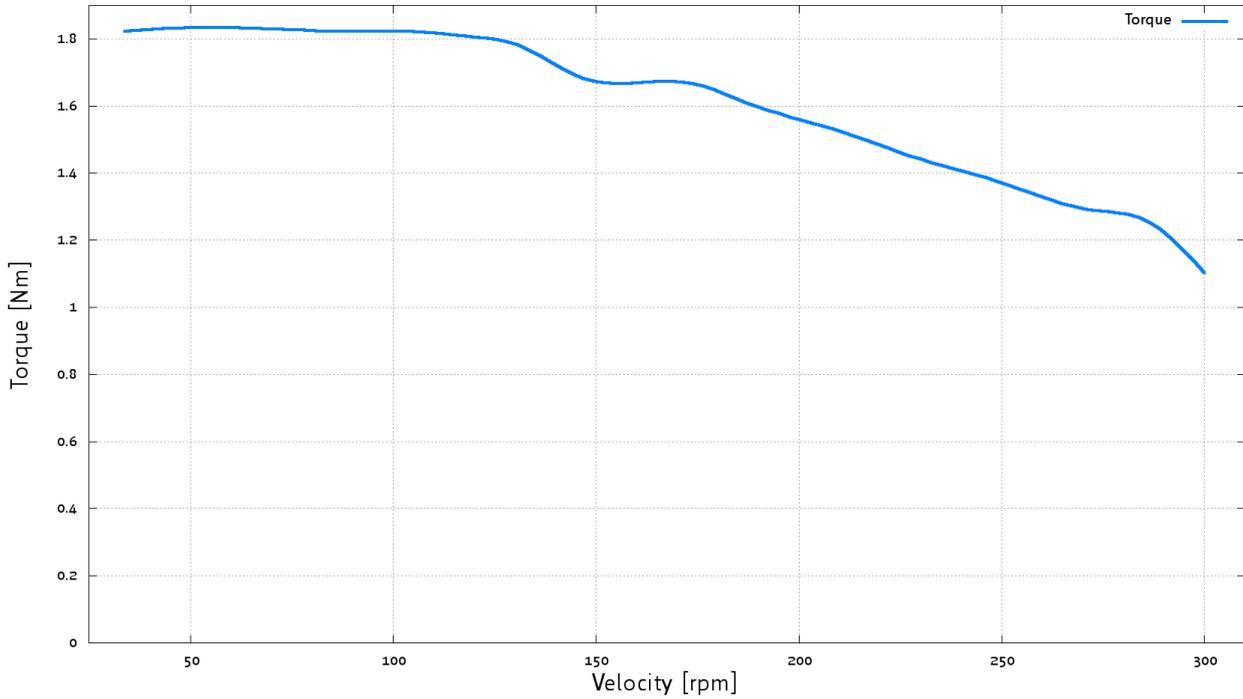


Figure 9.13 PD57-4-1060 torque vs. velocity 24V / 2.8A, 256μsteps (1)

TMCM1060 - QSH5718-76-28-189 - Torque versus Velocity  
 $V_S = 24\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

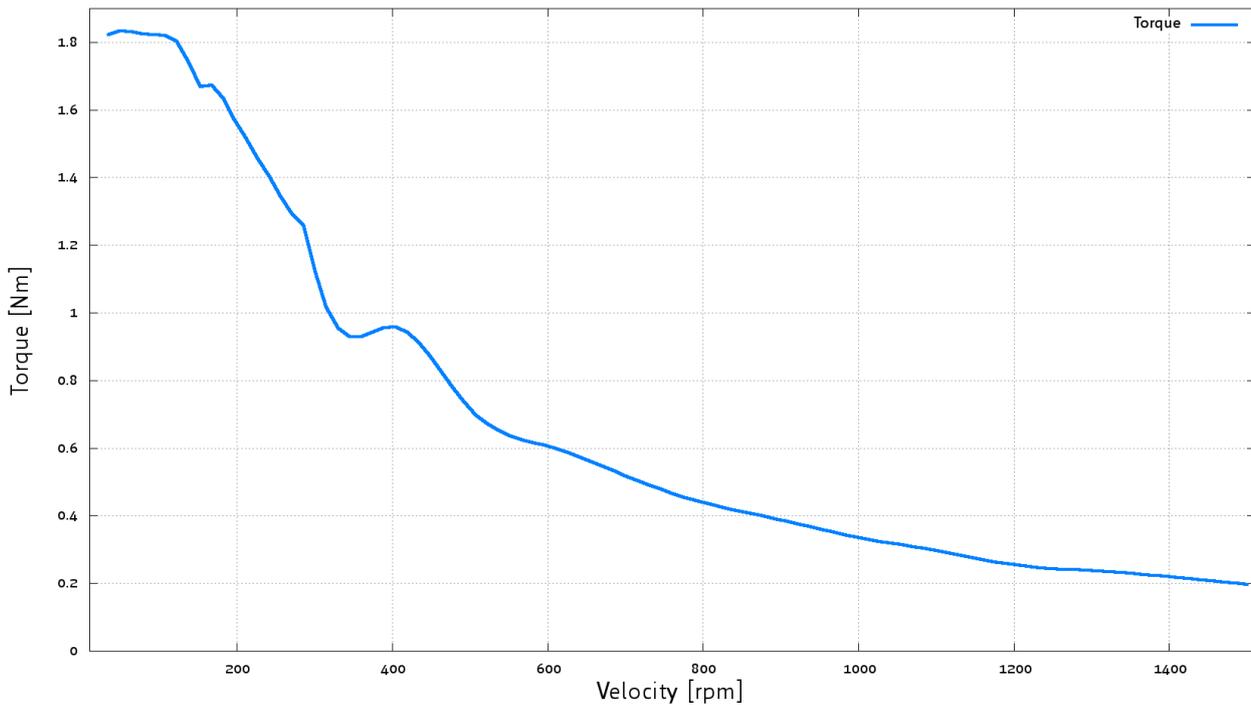


Figure 9.14 PD57-4-1060 torque vs. velocity 24V / 2.8A, 256μsteps (2)

TMCM1060 - QSH5718-76-28-189 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

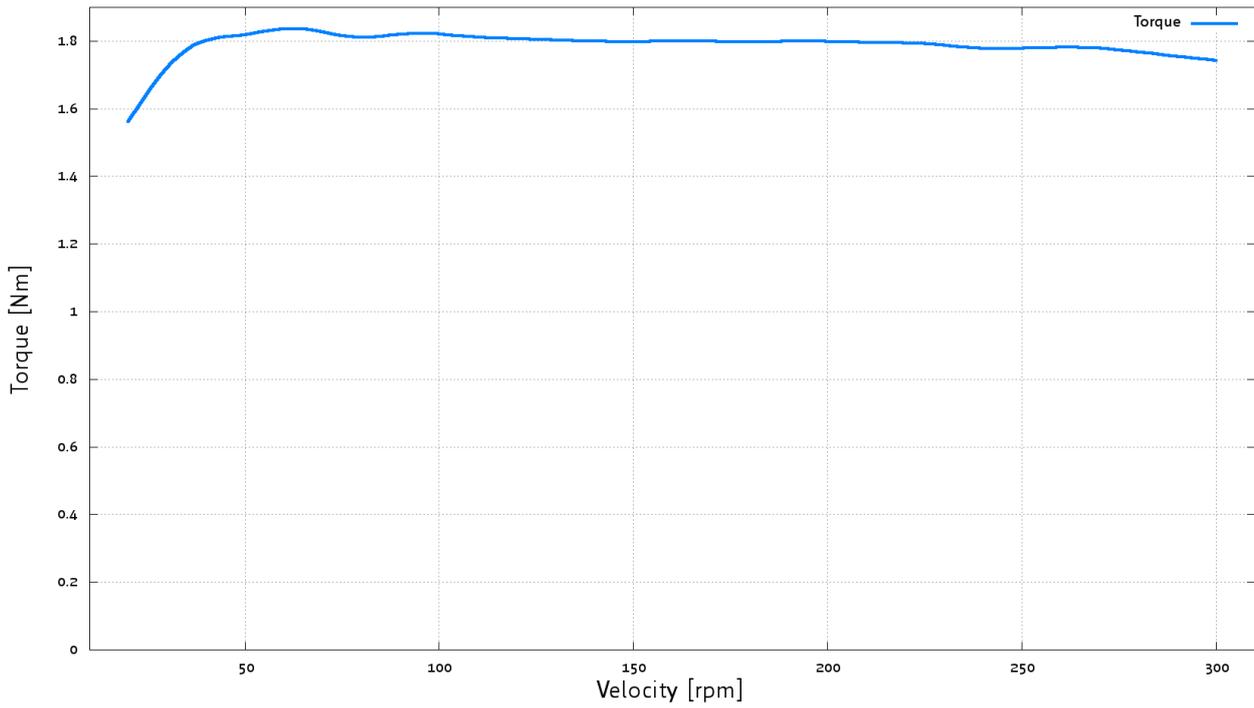


Figure 9.15 PD57-4-1060 torque vs. velocity 48V / 2.8A, 256μsteps (1)

TMCM1060 - QSH5718-76-28-189 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , 256 Microsteps

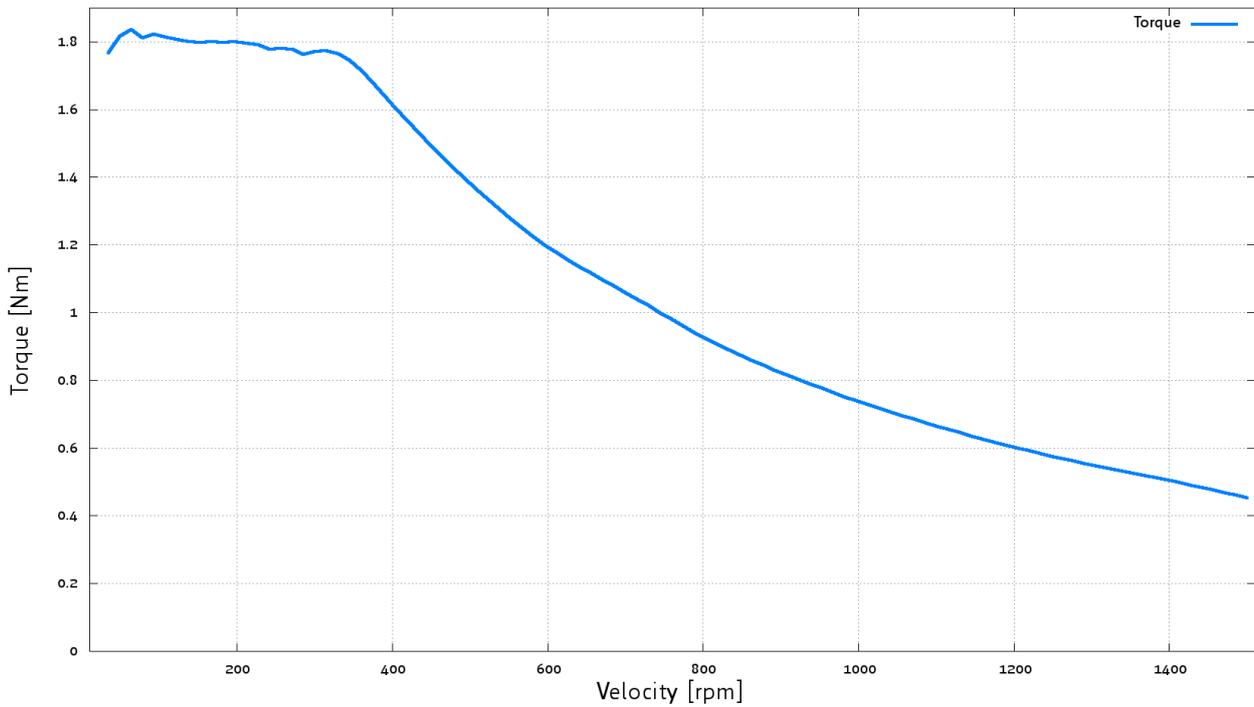


Figure 9.16 PD57-4-1060 torque vs. velocity 48V / 2.8A, 256μsteps (2)

## 9.2 Curves of PD60-x-1060

### 9.2.1 PD60-1-1060 Torque Curves

TMCM1060 - QSH6018-45-28-110 - Torque versus Velocity  
 $V_S = 24\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$

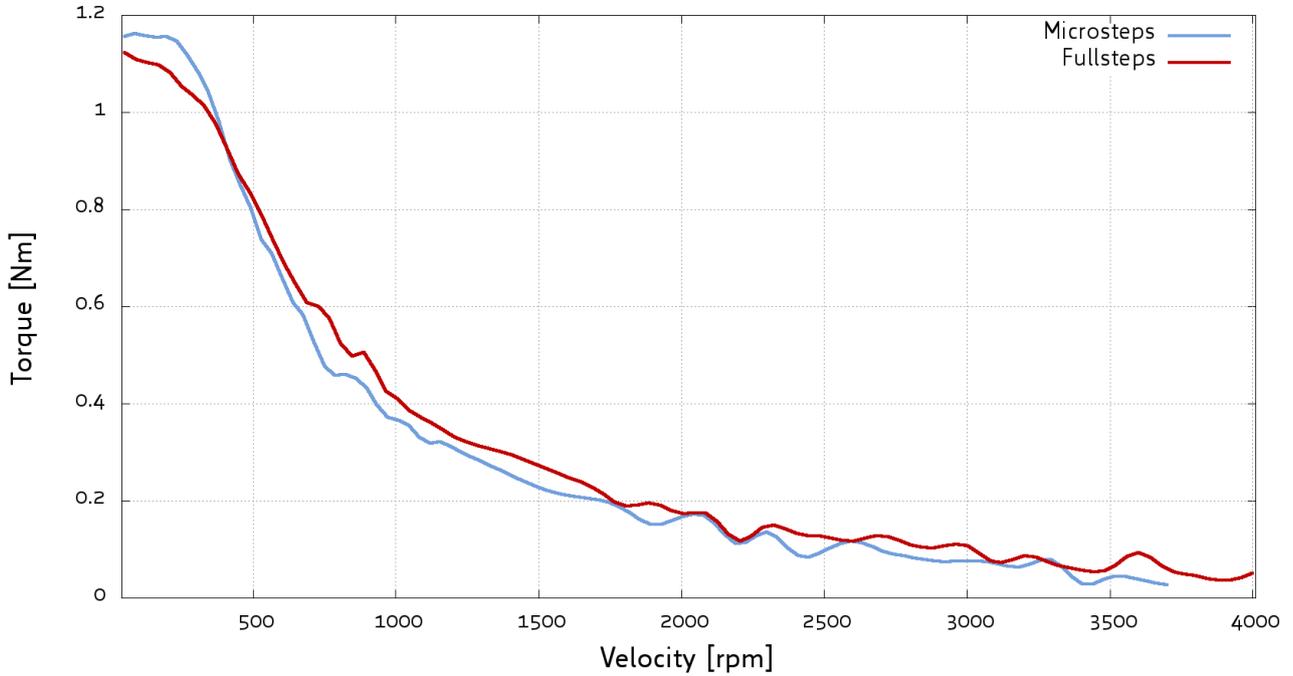


Figure 9.17 PD60-1-1060 torque vs. velocity 24V / 2.8A

TMCM1060 - QSH6018-45-28-110 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$

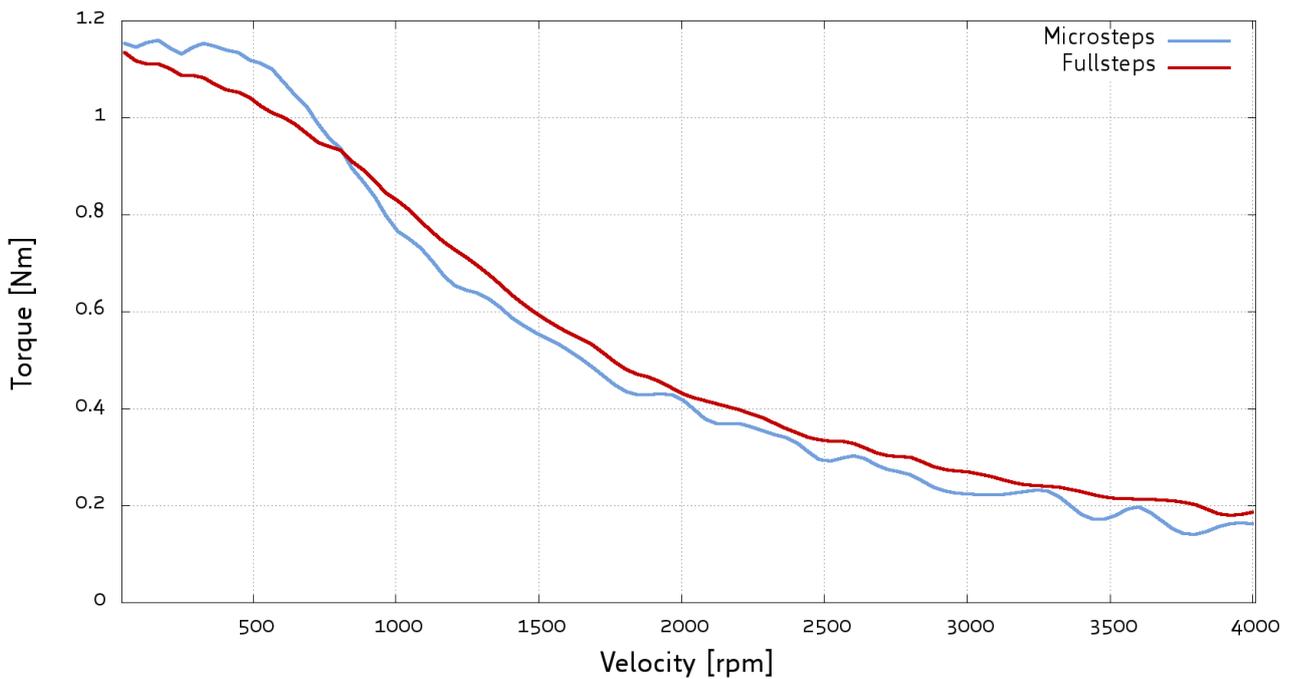


Figure 9.18 PD60-1-1060 torque vs. velocity 48V / 2.8A

### 9.2.2 PD60-2-1060 Torque Curves

TMCM1060 - QSH6018-56-28-165 - Torque versus Velocity  
 $V_S = 24\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$

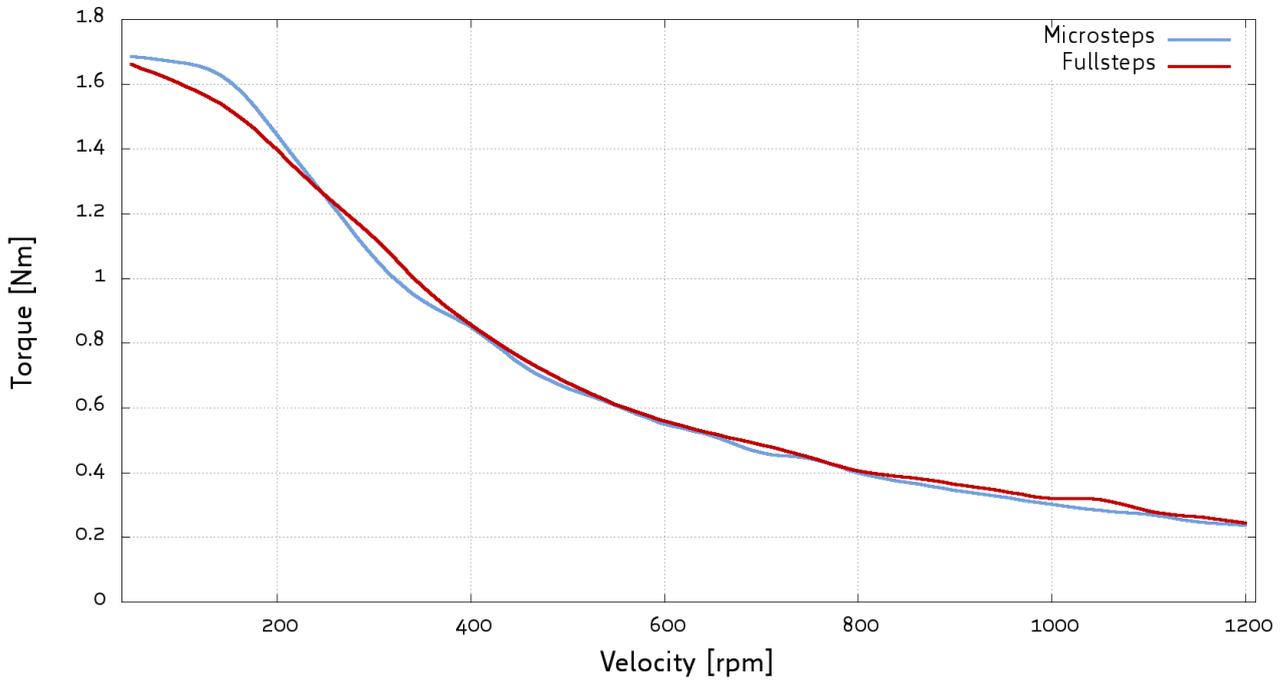


Figure 9.19 PD60-2-1060 torque vs. velocity 24V / 2.8A

TMCM1060 - QSH6018-56-28-165 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$

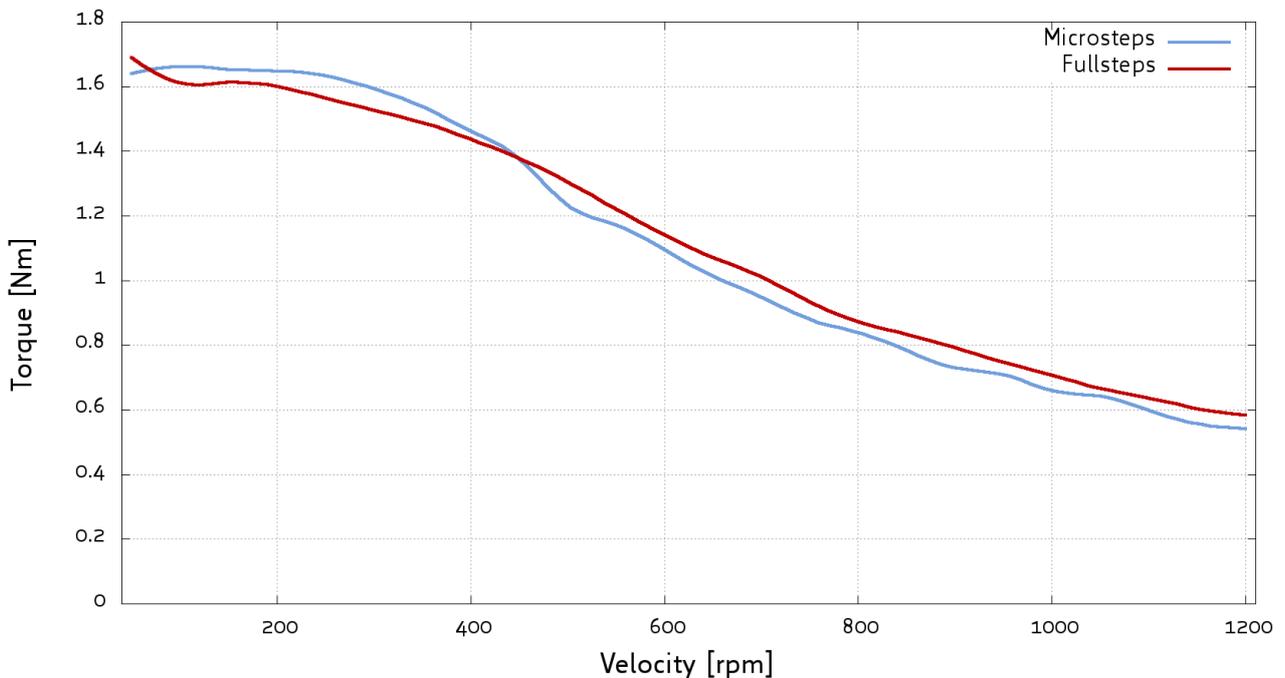


Figure 9.20 PD60-2-1060 torque vs. velocity 48V / 2.8A

### 9.2.3 PD60-3-1060 Torque Curves

TMCM1060 - QSH6018-65-28-210 - Torque versus Velocity  
 $V_S = 24\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$

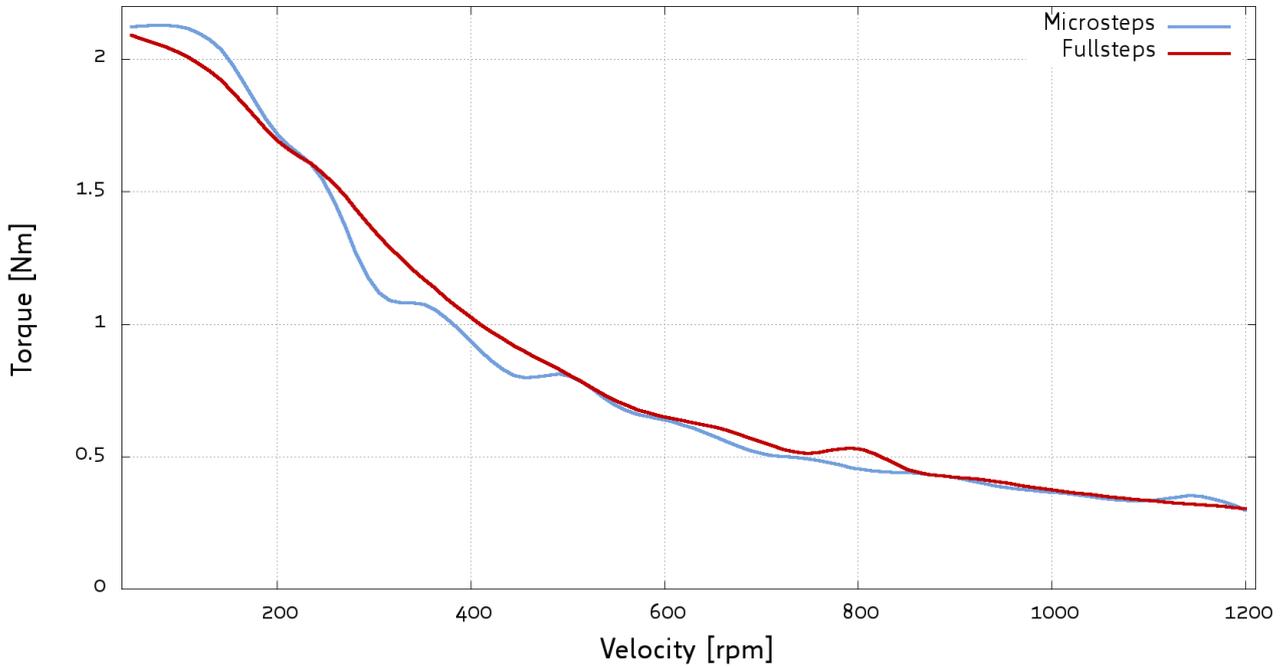


Figure 9.21 PD60-3-1060 torque vs. velocity 24V / 2.8A

TMCM1060 - QSH6018-65-28-210 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$

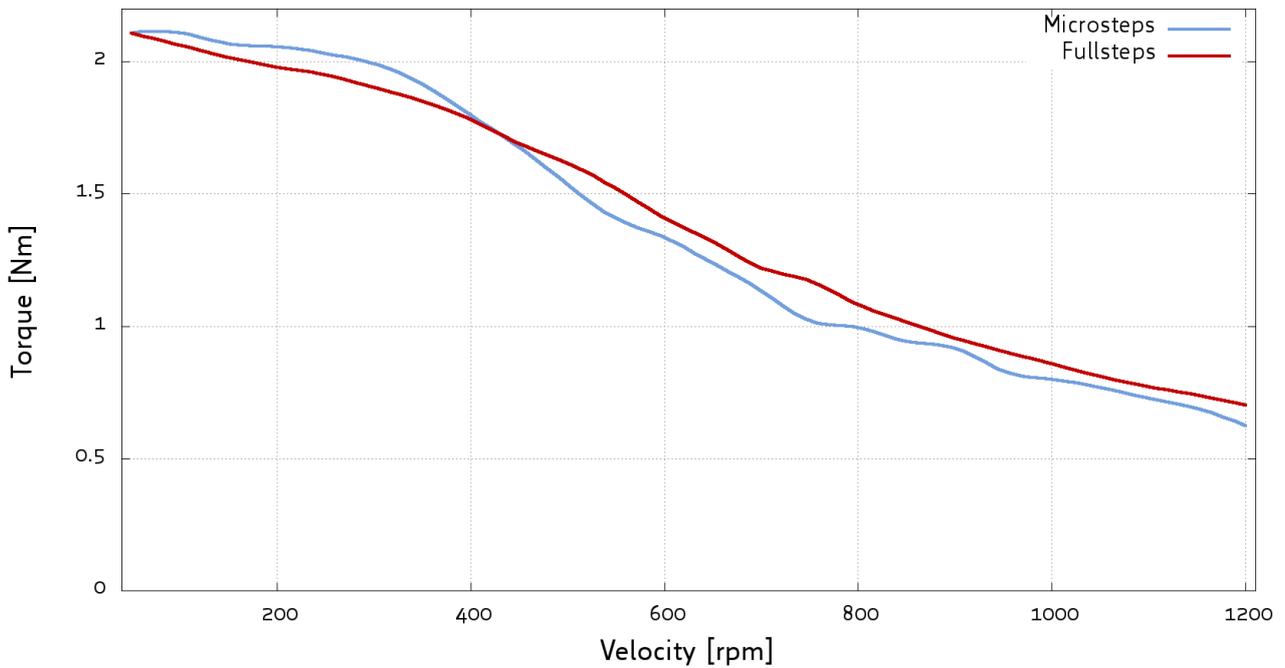


Figure 9.22 PD60-3-1060 torque vs. velocity 48V / 2.8A

### 9.2.4 PD60-4-1060 Torque Curves

TCM1060 - QSH6018-86-28-310 - Torque versus Velocity  
 $V_S = 24\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$

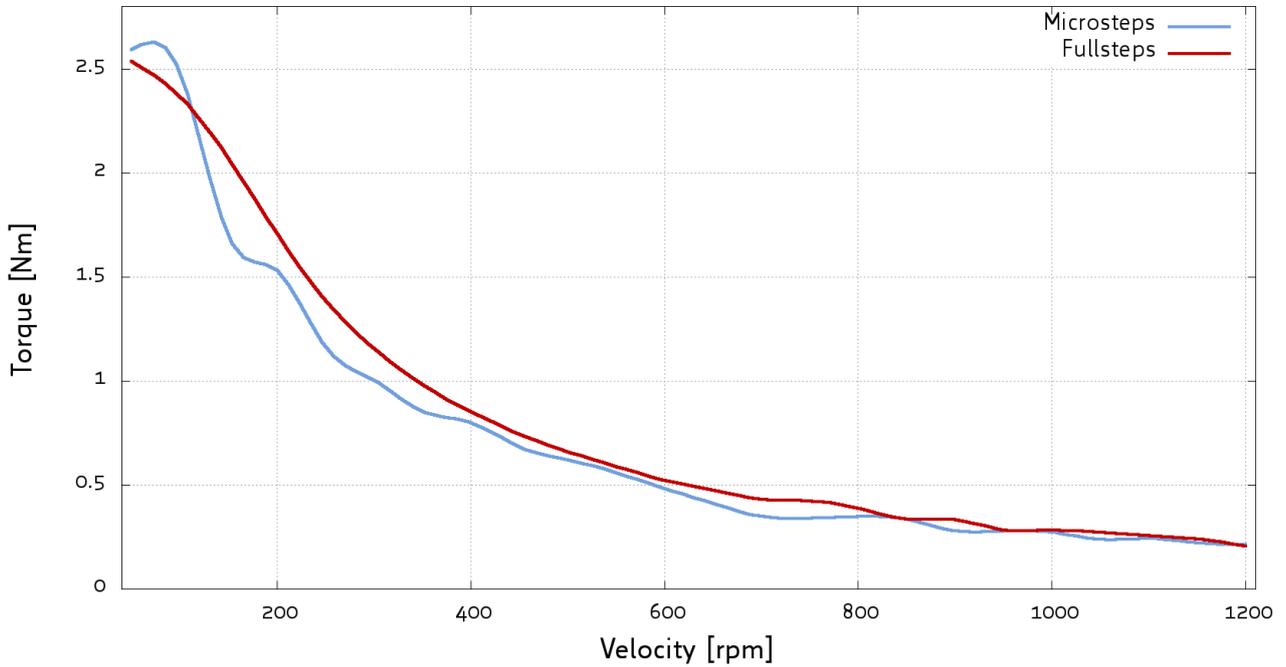


Figure 9.23 PD60-4-1060 torque vs. velocity 24V / 2.8A

TCM1060 - QSH6018-86-28-310 - Torque versus Velocity  
 $V_S = 48\text{ V}$ ,  $I_{\text{coil}} = 2.8\text{ A [RMS]}$ , Fullsteps

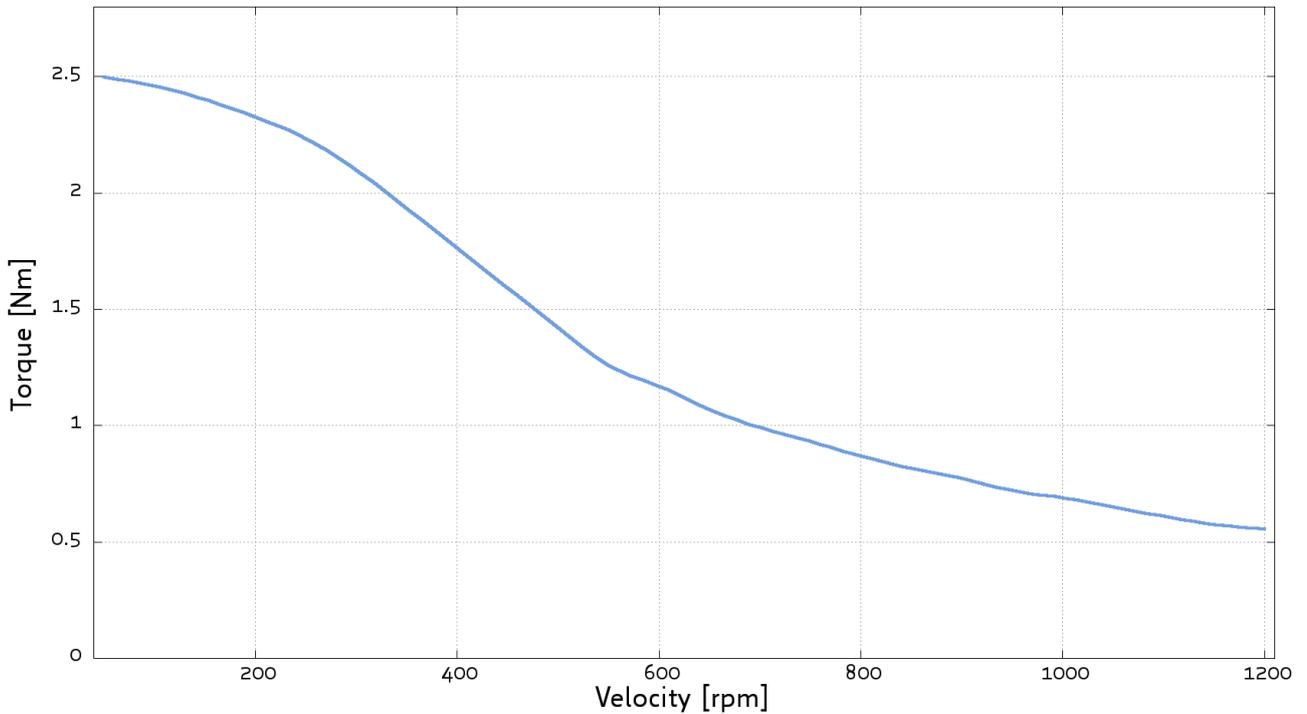


Figure 9.24 PD60-4-1060 torque vs. velocity 48V / 2.8A

## 10 Functional Description

In figure 7.1 the main parts of the PD57/60-1060 are shown. The PANdrive mainly consists of the  $\mu\text{C}$  (connected to the EEPROM TMCL memory), the TMC262 power driver with its energy efficient coolStep feature, the external MOSFET driver stage, the QSH5718 or QSH6018 stepper motor, and the integrated sensOstep encoder. Common supply voltages are +12VDC / +24VDC / +48VDC.

Please note that the maximum voltage for pre-series units is limited to +40VDC.

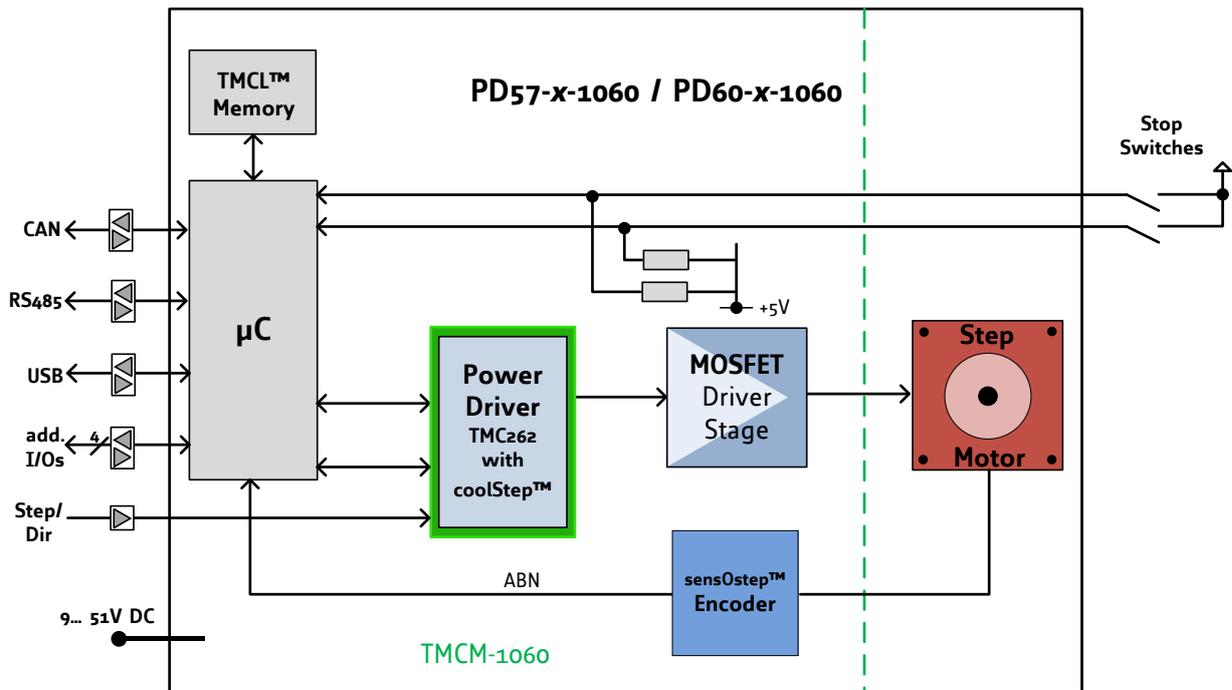


Figure 10.1 Main parts of the PD57/60-1060

### 10.1 System architecture

The TCM-1060-TMCL integrates a microcontroller with the TMCL (Trinamic Motion Control Language) operating system.

#### 10.1.1 Microcontroller

On this module, the Atmel AT91SAM7X256 is used to run the TMCL firmware. The CPU has 256KB flash memory and a 64KB RAM. The microcontroller runs the TMCL (Trinamic Motion Control Language) operating system which makes it possible to execute TMCL commands that are sent to the module from the host via the RS485, CAN or step/dir interface. The microcontroller interprets and executes the TMCL commands. In addition it is connected with the sensOstep encoder.

The flash ROM of the microcontroller holds the TMCL operating system. The TMCL operating system can be updated via the CAN interface. Use the TMCL-IDE to do this.

#### 10.1.2 EEPROM

To store TMCL programs for stand-alone operation the TCM-1060 module is equipped with a 16kByte EEPROM attached to the microcontroller. The EEPROM can store TMCL programs consisting of up to 2048 TMCL commands. The EEPROM is also used to store configuration data.

### 10.1.3 Stepper Motor Driver



The TMC262 is an energy efficient high current high precision microstepping driver IC for bipolar stepper motors. Its unique high resolution sensorless load detection stallGuard2 is used for a special integrated load dependent current control feature called coolStep. The ability to read out the load and detect an overload makes the TMC262 an optimum choice for drives where a high reliability is desired. The TMC262 can be driven with step/direction signals as well as by serial SPI™.

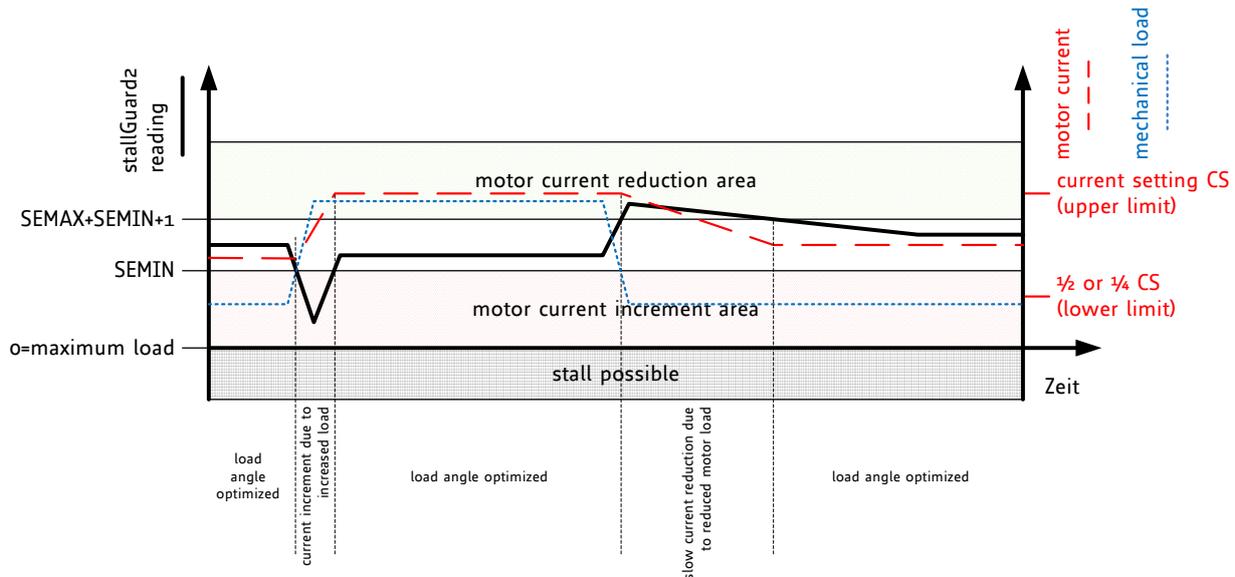


Figure 10.2: Motor current control via coolStep adapts motor current to motor load

The coolStep current regulator allows controlling the reaction of the driver to increasing or decreasing load. The internal regulator uses two thresholds to determine the minimum and the maximum load angle for optimum motor operation. The current increment speed and the current decrement speed can be adapted to the application. Additionally, the lower current limit can be set in relation to the upper current limit set by the current scale parameter CS.

### 10.1.4 sensOstep Encoder

The sensOstep encoder used in this unit is based on a magnetic angular position encoder system with low resolution. It consists of a small magnet positioned at the back end of a stepper motor axis and a Hall-sensor IC with integrated digital signal processing (e.g. for automatic gain control, temperature compensation etc.) placed above the magnet on the back side of a motor mounted printed circuit board.

The encoder offers a resolutions of 8 bit (256 steps) per revolution which is completely sufficient for detecting step losses with a standard  $1.8^\circ$  stepper motors.

## 11 TMCL

TMCL, the TRINAMIC Motion Control Language, is described in separate documentations, which refer to the specific products (e.g. PD57/60-1060 / TCM-1060 TMCL Firmware Manual). The manuals are provided on [www.trinamic.com](http://www.trinamic.com). Please refer to these sources for updated data sheets and application notes.

## 12 Life Support Policy

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## 13 Revision History

### 13.1 Document Revision

Version	Date	Author GE – Göran Eggers SD – Sonja Dwersteg	Description
0.90	2010-MAY-04	GE	Initial version
1.00	2010-AUG-20	SD	First complete version
1.01	2010-SEP-25	SD	Order codes corrected
1.02	2010-NOV-03	SD	New pictures
1.02	2010-NOV-08	GE	Minor correction
1.03	2010-DEC-07	SD	Torque curves for motor series QSH5718 added
1.04	2011-FEB-22	SD	Torque curves for motor series QSH6018 added, front page design new
1.05	2011-MAR-14	SD	Length of axis corrected (PD57-1060), minor changes
1.06	2011-DEC-02	SD	Order codes corrected, minor changes
1.07	2012-JUN-11	SD	Minor changes
1.08	2013-JUL-04	SD	<ul style="list-style-type: none"> <li>- Connector types updated.</li> <li>- Chapter <b>Fehler! Verweisquelle konnte nicht gefunden werden.</b> updated.</li> </ul>

Table 13.1 Document revision

### 13.2 Hardware Revision

Version	Date	Description
TCM-1060_V10	2010-SEP-30	Start of series production

Table 13.2 Hardware revision

## 14 References

[TCM-1060 / PD57/60-1060 TMCL™]	TCM-1060 and PD57/60-1060 TMCL™ Firmware Manual
[TMC262]	TMC262 Datasheet
[TMCL-IDE]	TMCL-IDE User Manual
[QSH5718]	QSH5718 Manual
[QSH6018]	QSH6018 Manual

Please refer to [www.trinamic.com](http://www.trinamic.com).