Trinamic CANopen quickstart guide

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1 Introduction

This quickstart guide will show the bring up of a Trinamic CANopen module based on the TMCM-1240. To get started with Trinamic CANopen modules a CANopen master is needed as well as CAN adapter which is supported by the CANopen master. TMCM-CANopen (not TMCL-IDE) is an easy to use CANopen master for the Trinamic CANopen modules. It supports reading and writing of CANopen objects as well as controlling the CiA-402 modes of a CANopen drive.

CAN adapters supported by the TMCM-CANopen tool:

- Kvaser
- ESD
- Peak
- IXXAT

For a detailed list of supported CAN adapters refer to TMCM-CANopen tool manual V1.5.0.0 (chapter 3).

2 Resources

- TMCM-1240 Hardware manual
- TMCM-1240 CANopen Firmware manual
- EDS File

For other modules, the above mentioned files are provided on their respective product webpages.

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3 Wiring

For the setup following parts are needed:

- TMCM-1240-CANopen
- Stepper motor (e.g. QSH4218-35-10-027)
- CAN adapter (here: Kvaser Leaf Light HS v2)
- Supply Voltage (24V)



Figure 1

 $+V_{MAIN}$ and Enable should be wired. $+V_{LOGIC}$ can be left open as in figure. CAN bus termination resistors must also be added (figure 1).

4 TMCM-CANopen

In this section the TMCM-1240 will be controlled with TMCM-CANopen.

4.1 Connect with the TMCM-CANopen

- 1. Open the TMCM-CANopen software
- Connect the CAN adapter to the PC. Make sure direct USB between TMCM-1240 and PC is disconnected. The CAN adapter will show up in the TMCL-IDE interface tree. Click on the CAN adapter to open the connection interface (figure 2).



💩 1.5.0.0 - TMCM-CANopen		
File Views Help		
File Views Help Interface tree X CAN-Kvaser CAN4/Kvaser Leaf Light v2 CAN-Virtual	Kvaser connection (CAN4) Connection NMT Settings L55 Bitrate [kBit/s] 1000 Search Node IDs from: 1 Progress Connect	

Figure 2

- 3. Power the module (including +V_{MAIN} and Enable) Note: It is recommended to connect to CANopen adapter first and power the TMCM-1240 after.
- 4. Connect to the TMCM module By factory defaults the module is set to node ID 1 and to the bit rate of 1000kBit/s.

🚴 1.5.0.0 - TMCM-CANopen							
File Views Help							
Interface tree X Section (CAN4)							
CAN4/Kvaser Leaf Light v2 CAN-Virtual	Connection NMT Settings LSS Bitrate [kBit/s]						
	Search Node IDs from: 1 🗘 to: 1	•					
	Progress Connect	nect					

Figure 3

5. The module is now connected to the TMCM-CANopen. The red error led will be off, while the green run led will blink (200ms on, 200ms off).



🚴 1.5.0.0 - TMCM-CANopen	
File Views Help	
Interface tree X	(Straser connection (CAN4)
🛩 🚟 CAN-Kvaser	
 CAN4/Kvaser Leaf Light v2 	Connection NMT Settings LSS
/id1/PD-1240	
🕾 Object Browser	Bitrate [kBit/s]
🗇 CiA-402 State Machine	Search Node IDs from: 1 🗘 to: 1 🗘
🗇 CiA-402 Profile Position Mode	Desgrade
CiA-402 Profile Velocity Mode	Plogless
🗇 CiA-402 Homing Mode	Connect Disconnect
Parameter Save/Restore	
PDO Receiver	
😙 PDO Transmitter	
PDO Configurator	
Device Configuration	
🗇 Expert Mode	
> 👁 CAN-Virtual	

Figure 4

Usually an .eds needs to be added to the CANopen Master. However, this is not necessary for Trinamic modules in TMCM-CANopen. For adding other .eds files to TMCM-CANopen refer to the TMCM-CANopen tool manual V1.5.0.0 chapter 4.3.

4.2 Motor run current

In this section the motor run current will be adjusted. It should be made sure that the motor run current is within the rated current of the stepper motor. The current setting (and other module settings) can be changed by using CANopen service data objects (SDO) as following:

- 1. Open the Object Browser toolbox
- 2. Scroll to object 0x2003 (Absolute Max Current 1).
- 3. Click on *Read* button to read out the motor run current setting. In the example (figure 5) the motor run current is 128 (equals 1A rms). A value of 255 means 100% of the maximum current of the drive.
- 4. Enter a new current value and *Write* to update the setting. In the example the new motor run current is 64 (equals 0.5A rms).



👗 1.5.0.0 - TMCM-CANopen						
File Views Help						
nterface tree Sobject Browser (PD-1240 / Node ID 1)						
CAN-Kvaser CAN4/Kvaser Leaf Light v2	Read / Write	Read / Write		Name	<u>^</u>	
/id1/PD-1240			> 1801	Transmit PDO Communication Parameter 2		
Object Browser			> 1802	Transmit PDO Communication Parameter 3		
CiA-402 State Machine			> 1803	Transmit PDO Communication Parameter 4		
Git 402 Drafila Draitian Mada	128	V 0x80 Read	> 1a00	Transmit PDO Mapping Parameter 1		
CIA-402 Profile Position Mode			> 1a01	Transmit PDO Mapping Parameter 2		
CIA-402 Profile Velocity Mode	64	0x40 Write	> 1a02	Transmit PDO Mapping Parameter 3		
CiA-402 Homing Mode		Ч	s > 1a03	Transmit PDO Mapping Parameter 4		
Parameter Save/Restore		Component of DCF file		Microstep Resolution 1	_	
PDO Receiver	_			Fullstep Resolution 1		
PDO Transmitter	Component of [Brake Delay Time 1		
PDO Configurator				Absolute Max Current 1		
Device Configuration				Standby Current 1		
(*) Expert Mode				Switch Parameters 1		
	Description	Description		Enable drive delay time 1		
	_			Encoder Parameters 1		
	Name:	Absolute Max Current 1	> 200c	Brake Current Feed 1		
			2010	Profile start velocity 1		
	Index:	2003	2011	Profile A1 1		
			2012	Profile V1 1		
	Sub index:	0	2013	Profile D1 1		
			2015	Ramp Wait Time 1		
	Type:	UNSIGNED8	2089	Setting Delay 1		
			208c	Velocity Dimension Index 1		
	Access:	rw	208e	Acceleration Dimension Index 1		
			2092	Chopper Blank Time 1		
	PDO mappable:	no	2093	Chopper Mode 1		
			2094	Chopper Disable Fast Decay Comparator 1	-	
			2005	Chapper Llusteresis Fed 1	×	

Figure 5

5. The new motor current setting can be confirmed using the *Read* button.

🗻 1.5.0.0 - TMCM-CANopen					
File Views Help					
Interface tree	× 🗇 Object Browser (P	D-1240 / Node ID 1)			×
CAN-Kvaser CAN4/Kvaser Leaf Light v2	Read / Write		Index	Name	ŕ
/id1/PD-1240				Transmit PDO Communication Parameter 2	
Object Browser			> 1802	Transmit PDO Communication Parameter 3	
CiA-402 State Machine			> 1803	Transmit PDO Communication Parameter 4	
CiA-402 Profile Position Mode	64	Ox40 Read	> 1a00	Transmit PDO Mapping Parameter 1	
CiA-402 Profile Velocity Mode	64	0x40 Write	ö > 1a01	Transmit PDO Mapping Parameter 2	
A CiA-402 Homing Mode			> 1a02	Transmit PDO Mapping Parameter 3	
Contract Forming Mode			> 1a03	Transmit PDO Mapping Parameter 4	
Parameter save/Restore			2000	Microstep Resolution 1	_
CO PDO Receiver	Component of [Component of DCF file		Fulistep Resolution 1	
C PDO Transmitter				Brake Delay Time 1	_
PDO Configurator				Absolute Max current 1	
Device Configuration				Standby Current 1	
🕾 Expert Mode		Description		Switch Parameters 1	
> 👁 CAN-Virtual	Description	Description		Encoder Darameters 1	
	Name:	Absolute Max Current 1	> 2000	Brake Current Feed 1	
	- tonici	hosonate max carrent r	2010	Profile start velocity 1	
	Index:	2003	2010	Profile A1 1	
	in a chi	2005	2012	Profile V1 1	
	Sub index:	0	2013	Profile D1 1	
	Sabinacia	,	2015	Ramp Wait Time 1	
	Type:	LINSIGNED8	2089	Setting Delay 1	
	.ypc.	onsiditebo		Velocity Dimension Index 1	
	Access:	Access: DW		Acceleration Dimension Index 1	
			2092	Chopper Blank Time 1	
	PDO mappable:	no	2093	Chopper Mode 1	
	b mappaole		2094	Chopper Disable Fast Decay Comparator 1	-
			2005	Channer Husteresis Fed 1	

Figure 6

4.3 **Position Mode**

In this section the motor will be controlled in position mode. For this the limit switches must be disabled (if they are not being used). The limit switches configuration can only be changed in state *switch on disabled*. Then the state machine is switched to the state *Operation enable* to run the motor.



CANopen DS402 state machine

In CANopen the DS402 (or CiA-402) state machine defines the states of the CANopen drive (e.g. which objects can be written, motor status). The state of the state machine can be changed by the object 0x6040 (Controlword). The state of the state machine can be read by the object 0x6041 (Statusword). The following figure shows the DS402 state machine and transitions:





The below table gives an overview on common states and the possible operation.

	Switch on disabled	Ready to switch on	Switched on	Operation enabled	Fault
High-level power applied	No	No	Yes	Yes	No
Drive function enabled	No	No	Yes	Yes	No
Configuration enabled	Yes	Yes	Yes	No*	No*

* depending on the configuration object



1. Open the toolbox CiA-402 State Machine and read out the status word of the DS402 state machine

🙈 1.5.0.0 - TMCM-CANopen								
File Views Help								
Interface tree X 🕅 CiA.402 State Marbine (PD-1240 / Node ID 1)								
🛩 🚟 CAN-Kvaser		13						
✓ CAN4/Kvaser Leaf Light v2	Current State Status Word							
✓ ₩ /id1/PD-1240	Fault	0+0619						
Object Browser		000018						
CIA-402 State Machine	Read status word 🗌 Cyclic polling	Bit 0: Ready to switch on	O Bit 8: Manufacturer specific					
CiA-402 Profile Position Mode								
CiA-402 Profile Velocity Mode		O Bit 1: Switched on	Bit 9: Remote					
CiA-402 Homing Mode	New State	 Bit 2: Operation enabled 	Bit 10: Target reached					
Parameter Save/Restore		Bit 3: Fault	O Bit 11: Internal limit active					
PDO Receiver	Switch on disabled	Dit 4 Maltana analylad						
🕾 PDO Transmitter	Poady to switch on	Bit 4: Voltage enabled	Bit 12: Setpoint ackn. 7 Home att.					
🕾 PDO Configurator	Ready to switch on	 Bit 5: Quick stop 	O Bit 13: Following err. / Homing err.					
Device Configuration	Switched on	Bit 6: Switched on disabled	Bit 14: Manufacturer specific					
🗇 Expert Mode	Operation enabled Ouick stop	O Bit 7: Waraing	O Bit 15: Mapufacturar spacific					
> 👁 CAN-Virtual	operation entropy	O Bit 7: Warning	O Bit 15: Manufacturer specific					

Figure 8

2. Change the status of the DS402 state machine to *switch on disabled*.



Figure 9

- 3. Open the *Object Browser* and select object 0x2005 (Switch Parameters 1).
- 4. Read out object 0x2005. It should be set to 0 by default. Write 3 to disable the limit switches



🙈 1.5.0.0 - TMCM-CANopen						
File Views Help						
Interface tree	🗇 Object Browser (F	2D-1240 / Node ID 1)				×
CAN-Kvaser CAN4/Kvaser Leaf Light v2	Read / Write			Index	Name	^
✓ ∰ /id1/PD-1240				> 1801	Transmit PDO Communication Parameter 2	
Chiert Browser				> 1802	Transmit PDO Communication Parameter 3	
CiA-402 State Machine				> 1803	Transmit PDO Communication Parameter 4	
CiA 402 Deate Machine	0	✓ 0x00000000	Read	> 1a00	Transmit PDO Mapping Parameter 1	
CIA-402 Profile Position Mode				> 1a01	Transmit PDO Mapping Parameter 2	
Cr CIA-402 Profile Velocity Mode	0	UXU	write	> 1a02	Transmit PDO Mapping Parameter 3	
CiA-402 Homing Mode				> 1a03	Transmit PDO Mapping Parameter 4	
Parameter Save/Restore				2000	Microstep Resolution 1	
PDO Receiver	Company	DCCAL		2001	Fullstep Resolution 1	
PDO Transmitter		Component of DCF file		> 2002	Brake Delay Time 1	
PDO Configurator				2003	Absolute Max Current 1	
Device Configuration				2004	Standby Current 1	
🕾 Expert Mode				2005	Switch Parameters 1	
> CAN-Virtual	Description		200a	Enable drive delay time 1		
				> 200b	Encoder Parameters 1	
	Name:	Switch Parameters 1		> 200c	Brake Current Feed 1	
				2010	Profile start velocity 1	
	Index:	2005		2011	Profile A1 1	
				2012	Profile V1 1	
	Sub index:	0		2013	Profile D1 1	
				2015	Ramp Wait Time 1	
	Type:	UNSIGNED32		2089	Setting Delay 1	
				208c	Velocity Dimension Index 1	
	Access:	rw		208e	Acceleration Dimension Index 1	
				2092	Chopper Blank Time 1	
	PDO mappable:	no		2093	Chopper Mode 1	
		1		2094	Chopper Disable Fast Decay Comparator 1	~
				2005	Chapper Llusteresis End 1	

Figure 10

- 5. Open the CiA-402 State Machine.
- 6. Switch from *Switch on disabled* to *Ready to switch on*.
- 7. Switch to Switched on

🍄 CiA-402 State Machine (PD-1240 / Node ID 1)							
Current State	Status Word						
Ready to switch on	0x0631						
Read status word Cyclic polling	Bit 0: Ready to switch on	O Bit 8: Manufacturer specific					
	O Bit 1: Switched on	Bit 9: Remote					
Now State	O Bit 2: Operation enabled	Bit 10: Target reached					
	O Bit 3: Fault	O Bit 11: Internal limit active					
Switch on disabled	Bit 4: Voltage enabled	O Bit 12: Setpoint ackn. / Home att.					
Ready to switch on	Bit 5: Quick stop	O Bit 13: Following err. / Homing err.					
Switched on	O Bit 6: Switched on disabled	O Bit 14: Manufacturer specific					
Operation enabled Quick stop	O Bit 7: Warning	O Bit 15: Manufacturer specific					

Figure 11

8. Switch to *Operation enabled* The motor is powered with hold current.



🕾 CiA-402 State Machine (PD-1240 / Node ID 1)						
Current State Switched on	Status Word 0x0633					
Read status word Cyclic polling	Bit 0: Ready to switch on	Bit 8: Manufacturer specific				
	Bit 1: Switched on	Bit 9: Remote				
Now State	O Bit 2: Operation enabled	Bit 10: Target reached				
	O Bit 3: Fault	O Bit 11: Internal limit active				
Switch on disabled	Bit 4: Voltage enabled	O Bit 12: Setpoint ackn. / Home att.				
Ready to switch on	Bit 5: Quick stop	O Bit 13: Following err. / Homing err.				
Switched on	O Bit 6: Switched on disabled	O Bit 14: Manufacturer specific				
Operation enabled Quick stop	O Bit 7: Warning	O Bit 15: Manufacturer specific				

Figure 12

9. Open CiA-402 Profile Position Mode

🚴 1.5.0.0 - TMCM-CANopen								
File Views Help								
Interface tree ×	(AD							
🗸 🖶 CAN-Kvaser	CIA-402 Profile Position Mode	(PD-1240 / Node ID 1)						
✓ CAN4/Kvaser Leaf Light v2	Parameters							
✓ ∰ /id1/PD-1240	6064 Actual position:	0						
🕙 Object Browser								
🗐 CiA-402 State Machine								
😭 CiA-402 Profile Position Mode	6083 Profile acceleration:	51 107 ≑						
CiA-402 Profile Velocity Mode	6084 Profile deceleration:	51 107 🜲						
🕾 CiA-402 Homing Mode	6081 Profile velocity:	51 200 🚔						
Parameter Save/Restore	coor realized and the second pr							
🗇 PDO Receiver	607A Target position:	0 🖨						
🕙 PDO Transmitter	Motion							
🗇 PDO Configurator								
Device Configuration	Move absolute	Move relative						
🗇 Expert Mode								

Figure 13

10. Set target position to 51200 and use *Move relative* or *Move absolute* to move the motor one motor revolution.

4.4 Velocity Mode

In this section the motor will be controlled in velocity mode.

- 1. Configure the limit switches as described in section 4.3 step 1 to 8
- 2. In the Interface tree select the toolbox CiA-402 Profile Velocity Mode



🙈 1.5.0.0 - TMCM-CANopen	
File Views Help	
Interface tree ×	CIA-402 Profile Velocity Mode (PD-1240 / Node ID 1)
🛩 😁 CAN-Kvaser	
 CAN4/Kvaser Leaf Light v2 	Parameters
✓ ₩ /id1/PD-1240	606C Actual velocity: 0
🕙 Object Browser	
🍘 CiA-402 State Machine	
CiA-402 Profile Position Mode	6083 Profile acceleration: 51107
CiA-402 Profile Velocity Mode	6084 Profile deceleration: 51107 🕏
CiA-402 Homing Mode	60FF Target velocity: 0
Parameter Save/Restore	
🗇 PDO Receiver	Motion
🗇 PDO Transmitter	
🗇 PDO Configurator	
Device Configuration	

Figure 14

3. Input the motor target velocity (0x60FF) of 51200 (equals 1rps) and click on the play button. The motor runs in velocity mode with the target velocity.

🚴 1.5.0.0 - TMCM-CANopen	
File Views Help	
Interface tree	CiA-402 Profile Velocity Mode (PD-1240 / Node ID 1)
🛩 😅 CAN-Kvaser	
✓ CAN4/Kvaser Leaf Light v2	Parameters
✓ 🕬 /id1/PD-1240	606C Actual velocity: 51200
🗇 Object Browser	
🗇 CiA-402 State Machine	
🗇 CiA-402 Profile Position Mode	6083 Profile acceleration: 51107 🗧
CiA-402 Profile Velocity Mode	6084 Profile deceleration: 51 107 💼
🗇 CiA-402 Homing Mode	60FF Target velocity: 51 200 🗧
🗇 Parameter Save/Restore	
🗇 PDO Receiver	Motion
🕙 PDO Transmitter	
🕙 PDO Configurator	
🕙 Device Configuration	

Figure 15

4. Activate the checkbox Cyclic Polling to continuously update the actual velocity (0x606C).

5 Additional Resources

• TMCM-CANopen tool manual V1.5.0.0

6 Revision History

Version	Date	Author	Description
V1.00	10.09.2021	JPX	initial version

Table 1: Document Revision

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