LinMot®

CANopen

Documentation of the CANopen Interface of the following Controllers:

- **E100-CO**
- **E200-CO**
- **E400-CO**
- **E1000-CO**
- **E2000-CO**
- **E4000-CO**

CANopen Interface 1.3.14

Usermanual

Document version 1.3.14 / FM, Sept. 2005

1. System overview

The LinMot CANopen controllers Ex00-CO support the Communication Profile CiA DS301. Further information on CANopen can be found under: http://www.can-cia.de/

The following resources are available:

1-5	T_PDO
1-5	R_PDO
1	T_SDO
1	R_SDO

The supported protocols include:

- Node Guarding
- PDO acyclic with inhibit time
- SDO Upload and Download
- NMT (Start, Stop, Enter PreOp, Reset Node, Reset Communication)
- Boot-Up Message

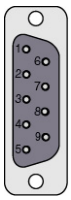
It supports all specified baud rates from 20kBaud to 1Mbaud. The baud rate can be selected by parameter or direct by BTR register.

The CANBus is on the COM Connector of the controller.

2. Connecting to the CAN bus

Pinout of the COM Connector:

DSBU 9 male:



Pin 1	RS-485 Y	Pin 6	RS-485 B
Pin 2	RS-232 TX	Pin 7	RS-485 Z
Pin 3	RS-232 RX	**Pin 8**	**CAN L**
Pin 4	RS-485 A	**Pin 9**	**CAN H**
Pin 5	**GND**		

3. CANopen Parameters

The CANopen Servo Controllers have an additional parameter tree branch, which can be configured with the distributed LinMot Talk software. With these parameters, the CANopen behaviour can be configured. The software LinMot talk can be downloaded from http://www.linmot.com under the section download, software & manuals.

Dis-/Enable

With the Dis-/Enable parameter the LinMot servo controller can be set as normal AT servo controller. So the system can be run without the CANopen going online. So in first step the system can be configured and run without any bus connection.

CANopen\ Dis-/Enable	
Disable	Servo controller behaves as an AT servo controller without CANopen.
Enable	Servo controller runs only with a CANopen connection.

Baudrate

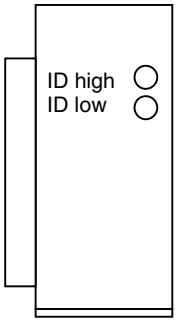
The Baudrate parameter defines the CAN bus baudrate for the CANopen connection.

CANopen\ Baudrate	
10 kBit/s	CAN bus baud rate = 10 kBit/s
20 kBit/s	CAN bus baud rate = 20 kBit/s
50 kBit/s	CAN bus baud rate = 50 kBit/s
100 kBit/s	CAN bus baud rate = 100 kBit/s
125 kBit/s	CAN bus baud rate = 125 kBit/s
250 kBit/s	CAN bus baud rate = 250 kBit/s
500 kBit/s	CAN bus baud rate = 500 kBit/s
800 kBit/s	CAN bus baud rate = 800 kBit/s
1 Mbit/s	CAN bus baud rate = 1 Mbit/s
By BTR	CAN bus baud rate is according the Bit Timing Register
BTR value	Bit Timing Register, when option “By BTR” is selected.

Node ID

The Node ID parameter defines the source of the Node ID.

CANopen\ Node ID	
Switches	The Node ID is determined by the two Hex Switches
Parameter	The Node ID is determined by parameter setting
Node ID value	The Node ID, when “parameter” is selected



Mapping TPDO1

This parameters define the mapping of the transmit PDO1. Each PDO can have 4 variables mapped (all variables are 16 bit)

CANopen\ Advanced \ Mapping \ TPDO1	
Status	Status word
Ret Val 1	Return value of CMD Interface 1 (Read Memory command)
Ret Val 2	Return value of CMD Interface 2 (Read Memory command)
Ret Val 3	Return value of CMD Interface 3 (Read Memory command)
Ret Val 4	Return value of CMD Interface 4 (Read Memory command)
Encoder Count	Actual Encoder value on ME applications
DC Link Voltage	DC Link Voltage (motor supply). The unit is 102.539mV
By Address	The mapping is defined by addresses
Addresses	This defines the addresses of the mapping, when no other option is selected. (0 = no mapping)

Mapping TPDO2..5 This parameters define the mapping of the transmit PDO1..5. Each PDO can have 4 variables mapped (all variables are 16 bit)

CANopen\ Advanced \ Mapping \ TPDO2..5	
Actual Position Mot X	Contains the actual Position of the motor X
Actual Current Mot X	Contains the actual Current of the motor X
Warning Mot X	Warnings of motor X
Error Mot X	Errors of motor X
Demand Position Mot X	Actual demand position of the motor X
Position Error Mot X	Difference between demand and actual position of motor x
By Address	The mapping is defined by addresses
Addresses	This defines the addresses of the mapping, when no other option is selected. (0 = no mapping)

Mapping RPDO1 This parameters define the mapping of the receive PDO1. Each PDO can have 4 variables mapped (all variables are 16 bit)

CANopen\ Advanced \ Mapping \ RPDO1	
Control	Control word
By Address	The mapping is defined by addresses
Addresses	This defines the addresses of the mapping, when no other option is selected. (0 = no mapping)

Mapping RPDO2..5 This parameters define the mapping of the receive PDO2..5. Each PDO can have 4 variables mapped (all variables are 16 bit)

CANopen\ Advanced \ Mapping \ RPDO2..5	
Command	Command Interface X (4 Words)
By Address	The mapping is defined by addresses

Addresses	This defines the addresses of the mapping, when no other option is selected. (0 = no mapping)

Ressources TPDO1..5 This parameters define the bus parameters of the transmit PDO1..5.

CANopen\ Advanced \ Ressources \ TPDO1..5	
Disable	The PDO is deactivated
Enable	The PDO is activated
Transmission Type	This defines the transmission type according DS 301. Default Value is 254
Inhibit Time	Defines the time between two send events in ms.

Ressources RPDO1..5 This parameters define the bus parameters of the recieve PDO1..5.

CANopen\ Advanced \ Ressources \ RPDO1..5	
Disable	The PDO is deactivated
Enable	The PDO is activated

4. Mapping of the PDO's

Mapping Table

The PDO's are default mapped according the following scheme:

Receive PDO's:

R_PDO1	R_PDO2	R_PDO3	R_PDO4	R_PDO5
Control Word	CMD MOT A	CMD MOT B	CMD MOT C	CMD MOT D
	Par 1	Par 1	Par 1	Par 1
	Par 2	Par 2	Par 2	Par 2
	Par 3	Par 3	Par 3	Par 3

Transmit PDO's:

T_PDO1	T_PDO2	T_PDO3	T_PDO4	T_PDO5
Status Word	A Pos Mot A	A Pos Mot B	A Pos Mot C	A Pos Mot D
	Current MA	Current Mot B	Current Mot C	Current Mot D
	Warn Mot A	Warn Mot B	Warn Mot C	Warn Mot D
	Error Mot A	Error Mot B	Error Mot C	Error Mot D

If the application requires, the mapping can be completely changed by the advanced parameter settings. Many applications do not require to use all resources.

Default Identifier:

The default identifiers (11 Bit identifier) are allocated by the following scheme:

10	9	8	7	6	5	4	3	2	1	0
Function Code				Node ID						

This results in the following table:

Object	Function Code (binary)	COB ID (hex)	Object for Comm. Parameter / Mapping
NMT	0000	00h	- / -
SYNC	0001	80h	1005h / 1006h
Emergency	0001	81h – FFh	- / -
T_PDO1	0011	181h – 1FFh	1800h
T_PDO2	0101	281h – 2FFh	1801h
T_PDO3	0111	381h – 3FFh	1802h
T_PDO4	1001	481h – 4FFh	1803h
T_PDO5	1101	681h – 6BFh	1804h
R_PDO1	0100	201h – 27Fh	1400h
R_PDO2	0110	301h – 37Fh	1401h
R_PDO3	1000	401h – 47Fh	1402h
R_PDO4	1010	501h – 57Fh	1403h
R_PDO5	1111	781h – 7BFh	1404h
T_SDO	1011	581h – 5FFh	- / -
R_SDO	1100	601h – 67Fh	- / -

In the Pre-Operational state, this can be changed with SDO downloads by the master.

5. Motor Commands

The commands for the motors are defined as followed:

CMD Mot X:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Toggle				MA	MB	MC	MD	Command ID							

The Toggle Bit corresponds to the "CMD Toggle response Mot X"-flag in the status word.
With the Bits MA..MD the command selects the motor. The command can be used for 1 to 4 Motors.

The following Command ID's are defined:

ID	Description
0	No operation
1	Goto Position (Par 1 = Position)
2	Goto Position with max Speed (Par 1 = Position, Par 2 = max. Speed)
3	Goto Position with max Speed and Acceleration (Par 1 = Position, Par 2 = max Speed, Par 3 = max. Acceleration)
4	Set Filter Parameter (Par 1 = max Speed, Par 2 = max. Acceleration, Par 3 = max. Current)
5	Redefine Position (Par 1 = Position to redefine to)
6	Move Home Position (Par 1 = Position Difference)
7	PVA Mode (Par 1 = Position, Par 2 = Speed, Par 3 = Acceleration)
16	Run Curve (Par 1 = Curve Number)
17	Run Curve with curve speed (Par 1 = Curve Number, Par 2 = Curve Speed)
18	Run Curve with curve Speed and Amplitude (Par 1 = Curve Number, Par 2 = Curve Speed, Par 3 = Curve Amplitude)
19	Run curve with auto Offset (Par 1 = Curve Number)
20	Run Curve with Auto Offset, curve Speed and Amplitude (Par 1 = Curve Number, Par 2 = Curve Speed, Par 3 = Curve Amplitude)
21	Set Curve Parameter (Par 1 = Curve Speed, Par 2 = Curve Amplitude, Par 3 = Curve Offset)
32	Set PID (Par 1 = P, Par 2 = I, Par 3 = D)
33	Set FF (Par 1 = FF acc, Par 2 = FF dec, Par 3 = FF frict)
34	Set Current Offset (Par 1 = Current Offset)
48	Run ME Curve (Par 1 = Curve Number)
~~49~~	~~Run ME Curve with Auto Offset (Par 1 = Curve Number)~~
50	Set ME Curve Parameter (Par 1 = Curve Amplitude, Par 2 = Offset)
64	Write Memory Word (Par 1 = Address Seg, Par 2 = Segment Offset, Par 3 = Value)
65	Read Memory Word (Par 1 = Address Seg, Par 2 = Segment Offset)

6. Control Word

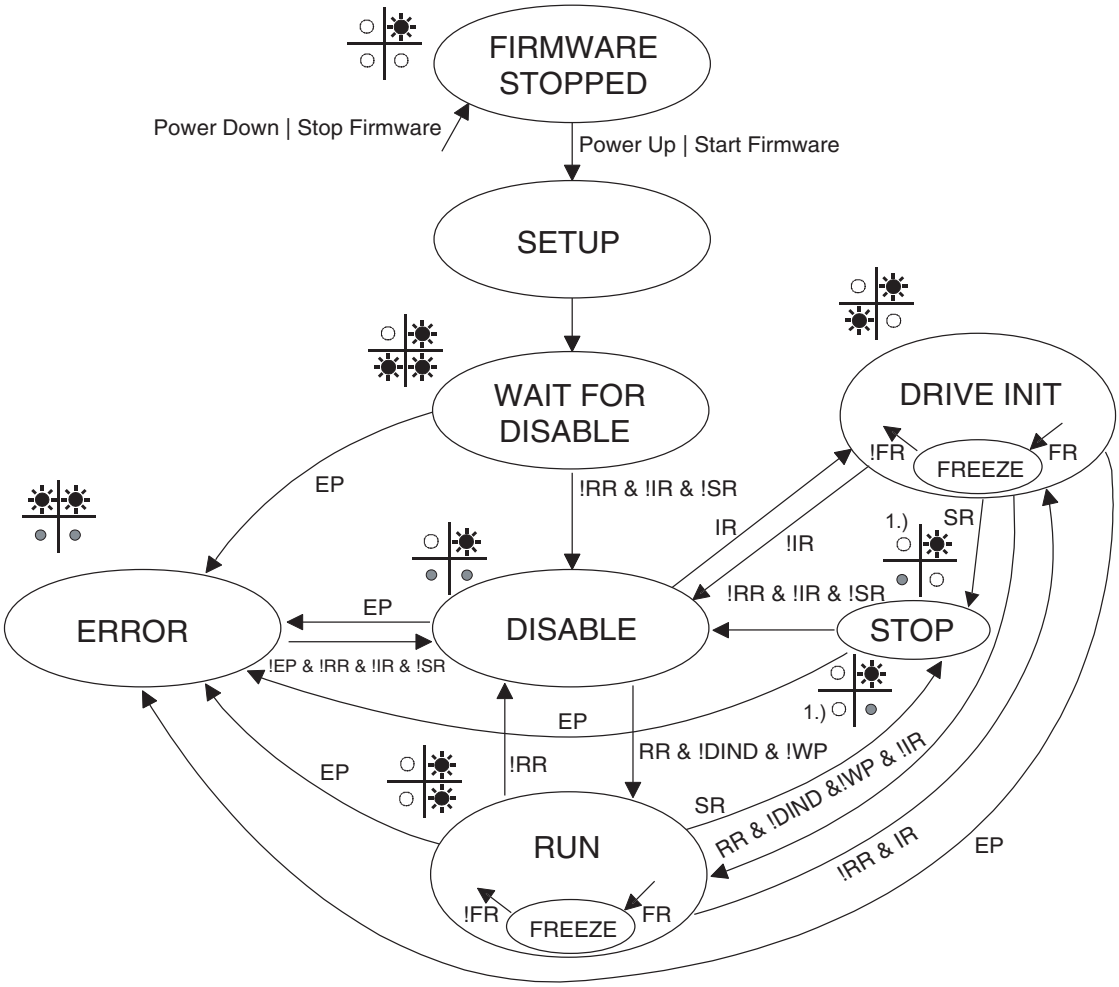
0	Reserved	Reserved (should be left to 0)
1	RUN Request (*1)	Reqest to enter RUN state
2	STOP Request (*1)	Request to enter emergency stop state
3	INIT Request (*1)	Request to enter INIT state (homing of the motors)
4	FREEZE all request (*1)	Freeze: interrupts all movements of all motors
5	Reserved	Reserved (should be left to 0)
6	Reserved	Reserved (should be left to 0)
7	Reserved	Reserved (should be left to 0)
8	Trig In 1 (Drive A) (*1)	Trigger Input 1
9	Trig In 2 (Drive B) (*1)	Trigger Input 2
10	Trig In 3 (Drive C) (*1)	Trigger Input 3
11	Trig In 4 (Drive D) (*1)	Trigger Input 4
12	FREEZE Drive A	Freeze A: interrupts the movement of Motor A
13	FREEZE Drive B	Freeze B: interrupts the movement of Motor B
14	FREEZE Drive C	Freeze C: interrupts the movement of Motor C
15	FREEZE Drive D	Freeze D: interrupts the movement of Motor D

(*1) If the signal is activated in the “IO Configuration”, the source are the digital Inputs and not the CAN Bus

7. Status Word

0	Init Done	All motors are homed
1	RUN State	The system is in the RUN state
2	ERROR State	The system is in the ERROR state
3	INIT State	The system is in the INIT state (motors are homing)
4	Disable State	The system is in the DISABLE state (motors off)
5	STOP State	The system is in the emergency stop state
6	Error pending	An error cause is still pending
7	Warning pending	A warning is pending
8	CMD Toggle response Mot A	Corresponds to the Toggle bit of the CMD of the motor Command
9	CMD Toggle response Mot B	Corresponds to the Toggle bit of the CMD of the motor Command
10	CMD Toggle response Mot C	Corresponds to the Toggle bit of the CMD of the motor Command
11	CMD Toggle response Mot D	Corresponds to the Toggle bit of the CMD of the motor Command
12	In Position Mot A	Motor A has finished the trajectory and is within the in position window
13	In Position Mot B	Motor B has finished the trajectory and is within the in position window
14	In Position Mot C	Motor C has finished the trajectory and is within the in position window
15	In Position Mot D	Motor D has finished the trajectory and is within the in position window

8. Statemachine



Input signals have to be activated in the parameter tree!
RUN signal is set in state SETUP. For changing into the state DISABLE, the RUN signal must be cleared from the active interface!

1.) From Release 1.3.9

Input Signals	Abbreviation
Set INIT Request	IR
Set RUN Request	RR
Set STOP Request	SR
Set FREEZE Request	FR
Reset INIT Request	!IR
Reset RUN Request	!RR
Reset STOP Request	!SR
Reset FREEZE Request	!FR

Internal Signals	Abbreviation
DRIVE_INIT_NOT_DONE	DIND
ERROR_PENDING	EP
WARNING_PENDING	WP

9. Errors and Warnings

In the following table the bit definitions of the errors and warnings can be found:

Bit definitions for the error state of the motors and the system:

Bit 0	Motor too hot calculated	The calculated temperature is too high (I2t protection)
Bit 1	Motor too hot sensor	The measured temperature of the motor is too hot (PTC sensors)
Bit 2	Following Error	Following Error
Bit 3	Slider missing	The Hall sensors don't have reasonable signals, because there is either no slider in the stator or the distance between magnetic strip and sensor head of the external sensor system is too big.
Bit 4	Reserved	
Bit 5	Init failt	There was an error during the INIT procedure (check position)
Bit 6	Wrong motor type	Wrong or no motor is attached
Bit 7	Curve missing	Error when starting a curve (the curve is not loaded into the Flash memory)
Bit 8	Reserved	
Bit 9	DCLV power too small	The DC Link Voltage is too low
Bit 10	DCLV power too high	The DC Link Voltage is too high. (Extensive breaking)
Bit 11	DCLV signal too small	The logic power supply voltage is too low
Bit 12	DCLV signal too high	The logic power supply voltage is too high
Bit 13	Electronic fault	The Heat sink of the controller is too hot or the short circuit protection of the power stage was triggered
Bit 14	Reserved	
Bit 15	Application error	Application specific error

Bit-Definitionen der Motor Warnungen:

Bit 0	Motor too hot calculated	The calculated temperature is high (I2t protection)
Bit 1	Motor too hot sensor	The measured temperature of the motor is too hot (PTC sensors)
Bit 2	Following Error	Following Error
Bit 3	Slider missing	The Hall sensors don't have reasonable signals, because there is either no slider in the stator or the distance between magnetic strip and sensor head of the external sensor system is too big.
Bit 4	Reserved	
Bit 5	Reserved	
Bit 6	Init not done	The Init procedure hasn't been done yet
Bit 7	Reserved	
Bit 8	Mot not in pos range	Motor is not in PosRange (to be configured with LinTalk)
Bit 9	DCLV power too small	The DC Link Voltage is too low
Bit 10	DCLV power too high	The DC Link Voltage is too high. (Extensive breaking)
Bit 11	DCLV signal too small	The logic power supply voltage is too low
Bit 12	DCLV signal too high	The logic power supply voltage is too high
Bit 13	Electronic too hot	The Heat sink of the controller is too hot or the short circuit protection of the power stage was triggered

10. Units

	LinMot	Stepper Motor
Position (*2)	19.53125 µm (1024 = 20mm)	1/8 Step
Velocity (*2)	190.735 µm/s	0.081469 Steps/s
Acceleration (*2)	238.419 mm/s^2	47.6836 Steps/ s^2
Current	23.439 mA (128 = 3 A)	23.439 mA
P (*2)	0.00234 A/mm	-
I (*2)	0.0457 A/(mm*s)	-
D (*2)	0.015A*s/mm	-
FF Friction	0.0234 A	-
FF Acceleration (*2)	0.1 mA/(m/ s^2)	-
FF Deceleration (*2)	0.1 mA/(m/ s^2)	-
Current Offset	23.4 mA	-
Curve Amplitude	0.0244 % (4096 = 100%)	0.0244 % (4096 = 100%)
Curve Speed	0.0244 % (4096 = 100%)	0.0244 % (4096 = 100%)
DC Link Voltage	102.539 mV	102.539 mV

(*2) The units are scaled when using external sensor system

11. Object Dictionary

Index	Subindex	Description	Data Type	Value
0001h–001Fh		Data Types	DEFTYPE	
0020h		Communication Parameter	DEFSTRUCT	
	0h	Number of entries	UI8	
	1h	COB-ID	UI32	
	2h	Transmission type	UI8	
	3h	Inhibit time	UI16	
	4h	Reserved	UI8	
	5h	Event timer	UI16	
1000h		Device Type	UI32	
1001h		Error register	UI8	
1018h		Idendity Object	Record	
	0	Number of Entries	UI8	4
	1	Vendor ID	UI32	0000 0156h
	2	Product Code	UI32	
	3	Revision Number	UI32	
	4	Serial Number	UI32	

12. Example

The following example shows how to startup the system and move the motor to an absolute position:

1.) Commissioning of the system according the enclosures of the controller and the motors.

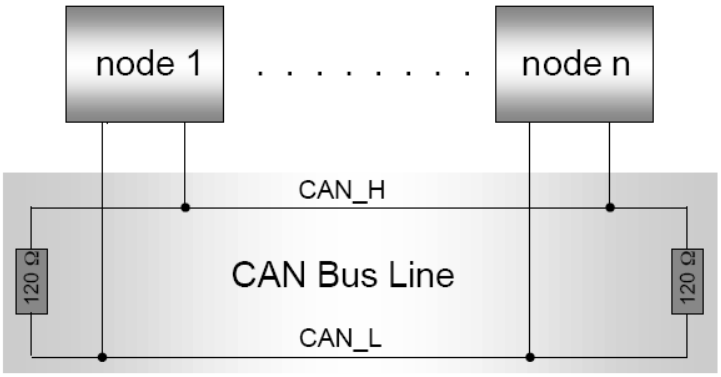
2.) Install the most recent release of LinMot Talk on your PC. Check www.linmot.com for the newest versions.

3.) Connect the COM-Port of your PC with a 1:1 connected cable to the COM Connector of the LinMot Controller.

4.) Login into the LinMot Controller with the user-ID “service” (no password required).

5.) The following configuration settings should be checked with the Parameter inspector:
- Configure the motor: \Drives\Drive A\Type\P0x-23 or P0x-37
- Set Run Mode to serial: \Drives\Drive A\Set Value Generation\Run Mode\Serial
- Set Command interface to application: \System\Command Interface\Application

6.) Connect the CAN Bus of the LinMot Controller to your CAN Master. The Baudrate of the CAN Master has to be set to 500kBit/s (this is the default setting of the LinMot CO Controller).



The cable should be a 120 Ohm shielded twisted pair with 2 signal lines and at least one ground line. Because there is no optical isolation on the LinMot Controller, there is an additional ground connection between the devices necessary (the shield of a cable is NOT a ground connection. The general rule is, that external ground connection should be at least 10 times lower impedance than the cable shield).
For debugging purpose it’s quite useful to have a Y-Cable which splits the CAN Bus from the RS232.

7.) Configure the CANopen Master to support 2 Transmit and 2 Receive PDO’s for the LinMot Controller (The default ID of the LinMot is 2).

8.) The control word is default mapped to R_PDO1, the status word to T_PDO1.
- Homing of the motors: Set INIT Request in the control word (Control = 8)
- When homing has successfully finished Set RUN Request and Reset INIT Request (Control = 2).

9.) Move the motor to an absolute position:
The Command module is mapped to R_PDO2. The simple Command to move the motor to an absolute position is Command ID 1.
- Write the target position to Par 1 (second word in R_PDO2 = 2048 = 40mm)
- Write CMD ID, select Motor and Toggle (0x8801 = Command 1 on Motor A and toggle)