

Lenze

***Tmd* series vector inverter LECOM Control Operation Manual**

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1) Scope

This document is intended to define the specific requirements for serial communication with Lenze **Tmd** series drives using LECOM-B protocol for control, status monitoring, and programming parameters. A familiarity with normal drive capabilities and operations is assumed. If this is not the case, please refer to the **Tmd** instruction manual as necessary.

2) General

When using this feature the drive can communicate with a personal computer (PC), programmable logic controller (PLC), or other external device that utilizes RS-485 serial communication for control or monitoring. RS-485 half-duplex interface allows up to 32 devices to communicate on the network using a twisted pair of wires. The wires must be terminated at both ends of the network with a resistor equal to their characteristic impedance, typically 120Ω. In noisy environments, twisted and shielded wire should be used. Ground the shield at the drive end only. This will further reduce unwanted noise and improve overall communication reliability. In addition, grounding terminal 7 on the **Tmd** is recommended when using serial communications.

3) Tmd LECOM DATA

- a) Communication medium – RS485 (LECOM-B)
- b) LECOM protocol V2.0
- c) The baud rate can be set to 1200, 2400, 4800 or 9600bps (refer to parameter c25)
- d) Character format:
 - 7 bit ASCII
 - 1 Stop bit
 - 1 Start bit
 - 1 Parity bit (even)

	DATA								
Start bit	1	2	3	4	5	6	7	Parity bit	Stop bit

4) QUICK SETUP

- a) Make all required connections to the drive (refer to instruction manual).
- b) Power up the drive.
- c) Set LECOM network address (code C09). Make sure programmed address is unique on the network. The values 00, 10, 20, 30 ... 90 must not be used since they are reserved for group addressing (see section 8.J). The LECOM –A/B protocol enables controller groups. This allows a write request to be issued to several drives at the same time, e.g. to select new setpoints or enable or inhibit the controller.

NOTE: With LECOM controller addresses which end with 0, the controller does not return acknowledgment, i.e. the host does not recognize whether the controller received the data correctly or not.

- d) Set appropriate network baudrate using drive code 'c25' (LECOM code C0125).
Prior to attempting to communicate with the drive, Parameter c25 must be appropriately programmed.
- e) Set appropriate mode of control using code C01.
In order to communicate using LECOM protocol, the **Tmd** Control source parameter C01 (LECOM C0001) must be set to one of the following values:
 - 0** – LECOM protocol. Drive is controlled via terminal and programmed via keypad, monitoring can be accomplished via LECOM network interface or keypad. Default speed source is set to be analog input.
 - 1** – Same as selection 0 but default speed source is set to c40 (LECOM C0140).
 - 2** – Same as selection 0 but drive parameters can also be changed via LECOM.
 - 3** – Control, programming and monitoring can be accomplished via LECOM connection. Programming and monitoring can also be performed locally using the drive keypad.
- f) It is now possible to communicate with the drive. In case of operating modes 0 and 1 (C0001 == 0 or 1) all parameters can be read. Operating mode 2 (C0001 == 2) adds parameter write capabilities, but without control option. If operating mode C0001 is set to 3 (LECOM control), drive can be controlled by sending appropriate commands to control word C0135.
- g) In case of C0001 = 3. Control the drive by sending appropriate messages to register C0135 (control register) and C0046 (network speed reference).

5) Operating mode.

Terminal 28 is always active and must be set to HIGH level (connected to terminal 20) during operation.

If operating mode C0001 is in LECOM protocol range (0,1,2 or 3) the controller can be inhibited under C0040 via LECOM (even in terminal control mode – 0,1 or 2).

After power up with operating mode C0001 = 3, the drive will enter the state programmed in parameter code n20 - LECOM power up state (LECOM code C1920).

If n20 (C1920) is equal to 0 (Quick Stop), the drive after power up enters the quick stop mode 'Stp'. The QSP function can be then deactivated by setting bit 3 in control register C0135.

If n20 (C1920) is set to 1 (Controller inhibit) drive will enter the inhibit state 'Inh'. Writing C0040 = 1 will enable the drive.

A) Watchdog Timer

The **Tmd** is equipped with a Serial Link "Watchdog Timer". If the Watchdog Timer is enabled, the Master MUST PERIODICALLY COMMUNICATE with the drive or the timer will timeout.

Watchdog timer setup is performed by using parameters n22 and n23 (LECOM C1922 and C1923).

Code n22 (LECOM code C1922) is used to select drive reaction to serial timeout.

- a) Selection 0 – Not active. Watchdog timer is disabled.
- b) Selection 1 – Controller inhibit. If the drive doesn't receive valid communication for period longer than the time specified in parameter n23 (C1923), it will coast to stop and status display (c61) will show inhibit state 'Inh'.
- c) Selection 2 – Quick Stop. If the drive doesn't receive valid communication for period longer than the time specified in parameter n23 (C1923), it will ramp to stop and status display (c61) will show stop state 'Stp'.
- d) Selection 3 – Trip fault 'FC3'. If the drive doesn't receive valid communication for period longer than the time specified in parameter n23 (C1923), it trips with fault 'FC3'.

NOTE: To prevent erroneous timeout trips, make sure the time set in parameter n23 (C1923) is appropriate for particular network - default value of 50ms might be too restrictive!

WARNING: Disabling the watchdog timer may cause injury to personnel and/or damage to equipment. The watchdog timer should only be disabled during configuration or diagnosis to prevent nuisance timeout trips.

6) Operating modes examples.

A) Monitoring Only Operation

- 1) Power up drive
- 2) Set code C01 to selection 0 or 1.
- 3) Simply read LECOM codes C68 (operating status), C150 (controller status) or any other readable register.
- 3) No watchdog issues apply in operating modes 0, 1, and 2.

B) Normal Control Operation Sequence.

- 1) Power up the drive.
- 2) Set code C01 to selection 3.
- 3) Close terminal 28.
- 4) Control drive operation via various commands to code C0135 (Start, Stop, Reverse direction, etc.) and change the network command speed by writing to code C46.
- 5) If serial timeout is activated (code n22 higher than 0), keep it from timing out by assuring that repeated reads or writes are performed at reasonable intervals smaller than time set in code n23 (C1923).

7) Tmd Series LECOM Control and Programming Parameter Details

Programming Mode Parameters are the parameters that can be accessed from the local keypad on the drive. To find the LECOM code number for particular parameter see Code table on page 15. The entries in Table 1 are based on **Tmd** Drive Software #1.20 (Parameter Configuration = 503). If a later revision of software were to change code definitions, drive operation could be seriously affected.

TABLE 1 - Program and Control Parameter List

(NOTE: Unless specified otherwise, all parameters use LECOM format VD)

LECOM Code Number	Parameter No.	Parameter Name	Range of Adjustment (values representing selection)	Factory Default																																							
C0001	C01	Setpoint and Control Source	<table> <tr> <td>Speed Source</td> <td>Control Source</td> <td>Program Source</td> </tr> <tr> <td>0 Analog</td> <td>Terminal</td> <td>Keypad</td> </tr> <tr> <td>1 Code c40</td> <td>Terminal</td> <td>Keypad</td> </tr> <tr> <td>2 Analog</td> <td>Terminal</td> <td>LECOM</td> </tr> <tr> <td>3 LECOM</td> <td>LECOM</td> <td>LECOM</td> </tr> <tr> <td>4 Analog</td> <td>Terminal</td> <td>Remote key</td> </tr> <tr> <td>5 Code c40</td> <td>Terminal</td> <td>Remote key</td> </tr> <tr> <td>6 Analog</td> <td>Remote key</td> <td>Remote key</td> </tr> <tr> <td>7 Code c40</td> <td>Remote key</td> <td>Remote key</td> </tr> <tr> <td>8 Analog</td> <td>Terminal</td> <td>Modbus</td> </tr> <tr> <td>9 Code c40</td> <td>Terminal</td> <td>Modbus</td> </tr> <tr> <td>10 Analog</td> <td>Modbus</td> <td>Modbus</td> </tr> <tr> <td>11 Code c40</td> <td>Modbus</td> <td>Modbus</td> </tr> </table>	Speed Source	Control Source	Program Source	0 Analog	Terminal	Keypad	1 Code c40	Terminal	Keypad	2 Analog	Terminal	LECOM	3 LECOM	LECOM	LECOM	4 Analog	Terminal	Remote key	5 Code c40	Terminal	Remote key	6 Analog	Remote key	Remote key	7 Code c40	Remote key	Remote key	8 Analog	Terminal	Modbus	9 Code c40	Terminal	Modbus	10 Analog	Modbus	Modbus	11 Code c40	Modbus	Modbus	0
Speed Source	Control Source	Program Source																																									
0 Analog	Terminal	Keypad																																									
1 Code c40	Terminal	Keypad																																									
2 Analog	Terminal	LECOM																																									
3 LECOM	LECOM	LECOM																																									
4 Analog	Terminal	Remote key																																									
5 Code c40	Terminal	Remote key																																									
6 Analog	Remote key	Remote key																																									
7 Code c40	Remote key	Remote key																																									
8 Analog	Terminal	Modbus																																									
9 Code c40	Terminal	Modbus																																									
10 Analog	Modbus	Modbus																																									
11 Code c40	Modbus	Modbus																																									
C0002	C02	Load Lenze setting	0 No action/loading complete 1 Load 50 Hz Lenze settings 2 Load 60 Hz Lenze settings 3 Load OEM settings (if present)	0																																							
C0007	CE1 CE2 CE3 CE4	Configuration – digital inputs E1, E2, E3, E4	<table> <thead> <tr> <th>Bit</th> <th>Input</th> <th>Bits Decoding</th> </tr> </thead> <tbody> <tr> <td>0-3</td> <td>E1</td> <td>1 Activate fixed setpoint 1 (JOG1) 2 Activate fixed setpoint 2 (JOG2) 3 DC Braking (DCB)</td> </tr> <tr> <td>4-7</td> <td>E2</td> <td>4 Direction of rotation 5 Quick stop 6 CW rotation</td> </tr> <tr> <td>8-11</td> <td>E3</td> <td>7 CCW rotation 8 UP 9 DOWN 10 TRIP set</td> </tr> <tr> <td>12-15</td> <td>E4</td> <td>11 TRIP reset 12 Accel/decel 2</td> </tr> </tbody> </table> <p>Attention: E1, E2, E3, E4 cannot have the same settings, otherwise "CFG" fault will be triggered. LECOM format: VH</p>	Bit	Input	Bits Decoding	0-3	E1	1 Activate fixed setpoint 1 (JOG1) 2 Activate fixed setpoint 2 (JOG2) 3 DC Braking (DCB)	4-7	E2	4 Direction of rotation 5 Quick stop 6 CW rotation	8-11	E3	7 CCW rotation 8 UP 9 DOWN 10 TRIP set	12-15	E4	11 TRIP reset 12 Accel/decel 2	CE1 = 1 CE2 = 2 CE3 = 3 CE4 = 4 (hex word = 0x0341)																								
Bit	Input	Bits Decoding																																									
0-3	E1	1 Activate fixed setpoint 1 (JOG1) 2 Activate fixed setpoint 2 (JOG2) 3 DC Braking (DCB)																																									
4-7	E2	4 Direction of rotation 5 Quick stop 6 CW rotation																																									
8-11	E3	7 CCW rotation 8 UP 9 DOWN 10 TRIP set																																									
12-15	E4	11 TRIP reset 12 Accel/decel 2																																									
C0009	C09	Network address	1 – 247	1																																							
C0010	C10	Minimum output frequency	0.0 – 240 Hz	0.0 Hz																																							
C0011	C11	Maximum output frequency	7.5 – 240 Hz	50.0 Hz																																							
C0012	C12	Acceleration time 1	0.0 – 999 sec	5.0 sec																																							
C0013	C13	Deceleration time 1	0.0 – 999 sec	5.0 sec																																							
C0014	C14	Operating mode	0 Linear with Auto Boost 1 Square law with Auto Boost 2 Linear with constant V_{min} boost 3 Square law with constant V_{min} boost 4 Vector speed control 5 Vector torque control 6 Enhanced linear characteristic with Auto-Boost 7 Enhanced linear characteristic with constant V_{min} boost	2																																							
C0015	C15	V/f reference point	25.0 – 999 Hz	50.0 Hz																																							
C0016	C16	V_{min} boost	0 – 40 %																																								

LECOM Code Number	Parameter No.	Parameter Name	Range of Adjustment (values representing selection)	Factory Default
C0017	C17	Frequency threshold	0.0 – 240 Hz	0.0 Hz
C0018	C18	Chopper frequency	0 4 kHz 1 6 kHz 2 8 kHz 3 10 kHz	2
C0021	C21	Slip compensation	0.0 – 40.0 %	0.0 %
C0022	C22	Current limit	30 – 200 %	200 %
C0024	C24	Accel boost	0.0 – 20.0 %	0.0 %
C0034	C34	Configuration – analog input	0 0...10 V 1 0...5 V 2 -10...+10 V 3 0...20 mA 4 4...20 mA 5 4...20 mA monitored	0
C0036	C36	Voltage - DC injection brake (DCB)	0.0 – 50.0 %	4.0 %
C0037	C37	Fixed setpoint 1 (JOG1)	0.0 – 240 Hz	20.0 Hz
C0038	C38	Fixed setpoint 2 (JOG2)	0.0 – 240 Hz	30.0 Hz
C0039	C39	Fixed setpoint 3 (JOG3)	0.0 – 240 Hz	40.0 Hz
C0040	--	Controller inhibit (LECOM access only)	0 Controller inhibited 1 Controller enabled Controller can also be enabled with control word C0135	0
C0043	--	Fault reset (LECOM access only)	0 No action 1 (Transition 0 -> 1) Reset current fault Faults can also be reset with control word C0135	0
C0046	C46	Frequency setpoint	0.0 – 240 Hz	
C0047	C47	Torque setpoint	0 – 400 %	100 %
C0050	C50	Output frequency	0.0 – 240 Hz	Read only
C0052	C52	Motor voltage	0 – 255 %	Read only
C0053	C53	DC bus voltage	0 – 255 %	Read only
C0054	C54	Motor current	0 – 255 %	Read only
C0056	C56	Drive load	0 – 255 %	Read only
C0057	C57	Motor torque	0 – 400 %	Read only
C0061	C61	Heatsink temperature	0 – 255 C	Read only
C0065	C65	Vector speed loop gain	0.0 – 100	30.0
C0066	C66	Vector speed stability	0.0 – 100	30.0

LECOM Code Number	Parameter No.	Parameter Name	Range of Adjustment (values representing selection)		Factory Default
			Bit	Description	
C0068	--	Operating status bit word (LECOM access only)	0 - 3	The 10th digit of the LECOM fault number (see table 9) is displayed. Example: TRIP OH = 5 (LECOM no. = 50)	Read only
			4 - 7	Last communication error 0 = No fault 1 = Check sum error 2 = Protocol frame error 3 = Reserved 4 = Invalid code number 5 = Invalid variable 6 = No access permission 7 = Telegram processing interrupted by a new telegram 15 = General fault	
			8	Control via LECOM enabled	
			9	Actual frequency above threshold C17	
			10	Direction of rotation 0 = CW 1 = CCW	
			11	Power stage transistors energized	
			12	Quick stop active	
			13	Current limit	
			14	Setpoint frequency reached	
			15	Fault occurred	
			LECOM format: VH		
C0077	C77	I_{\max} gain	0.00 – 16.0		0.25
C0078	C78	Integral action time	12 – 9990 ms		65 ms
C0084	C84	Motor stator resistance	0.00 – 64.0 ohms		0.00 ohms
C0086	C86	Motor rated power	0.00 – 99.9 kW		
C0087	C87	Motor rated speed	300 – 65000 RPM		1390 RPM
C0088	C88	Motor rated current	0.0 – 480 A		0.0 A
C0089	C89	Motor rated frequency	10 – 999 Hz		50 Hz
C0090	C90	Motor rated voltage	0 – 600 V		0 V
C0091	C91	Motor cosine phi	0.40 – 1.00		0.80
C0092	C92	Motor stator inductance	0.0 – 2000 mH		0.0 mH
C0093	C93	Drive identification			
C0094	C94	User password	0 – 999		0
C0099	C99	Software version	Returns current software version string (e.g. "1.20") LECOM format: VS		Read only
C0101	c01	Acceleration time 2	0.0 – 999 sec		5.0 sec
C0103	c03	Deceleration time 2	0.0 – 999 sec		5.0 sec
C0106	c06	Holding time – automatic DC injection brake	0.0 – 999 sec		0.0 sec

LECOM Code Number	Parameter No.	Parameter Name	Range of Adjustment (values representing selection)	Factory Default
C0108	c08	Analog output scaling	0.0 – 999	100.0
C0111	c11	Configuration – analog output (62)	0 None 1 Output frequency 0-10 V 2 Output frequency 2-10 V 3 Load 0-10 V 4 Load 2-10 V 5 Dynamic Braking	0
C0117 C0118	c17 c18	Configuration – digital outputs (A1, A2)	0 Ready 1 Fault 2 Motor is running 3 Motor is running – CW rotation 4 Motor is running – CCW rotation 5 Output frequency = 0 Hz 6 Frequency setpoint reached 7 Threshold (C17) exceeded 8 Current limit reached	c17 = 0 c18 = 1
C0120	c20	I ² t switch-off	30 – 100 %	100 %
C0125	c25	LECOM baud rate	0 9600 bps (9600,8,N,2 if C01 = 8...11) 1 4800 bps (9600,8,N,1 if C01 = 8...11) 2 2400 bps (9600,8,E,1 if C01 = 8...11) 3 1200 bps (9600,8,O,1 if C01 = 8...11)	0
C0135	-	Controller control word (LECOM access only)	Bit	Description
			0 - 1	JOG1, JOG2, JOG3 0 = C0046 active 1 = JOG1 (C0037) active 2 = JOG2 (C0038) active 3 = JOG3 (C0039) active
			2	Rotation command 0 = CW 1 = CCW
			3	Quick stop 0 = Quick stop not active 1 = Quick stop active
			4 - 8	Reserved
			9	Controller inhibit 0 = No controller inhibit 1 = Controller inhibit
			10	Reserved
			11	Trip (Fault) reset 0 -> 1 Edge from 0 to 1 causes TRIP reset
			12 - 13	Reserved
			14	DC brake (DC injection brake) 0 = DCB not active 1 = DCB active
			15	Reserved
			LECOM format: VH	
C0140	c40	Frequency setpoint command	0.0 – 240 Hz	0.0 Hz

LECOM Code Number	Parameter No.	Parameter Name	Range of Adjustment (values representing selection)	Factory Default	
C0142	c42	Start condition	0 Start after LOW-HIGH change at 28 1 Auto start if 28 = HIGH 2 Flying restart (auto start disabled) 3 Auto start if terminal 28 = HIGH, with flying restart	1	
C0143	c43	Flying restart selection	0 Search range: C11...0 Hz 1 Search range: last frequency...0 Hz	0	
C0148	c48	Motor auto-calibration	0 Calibration not done 1 Calibration enabled 2 Calibration complete	Read only via LECOM	
C0150	-	Controller status word (LECOM access only)	Bit	Description	Read only
			0	Reserved	
			1	Power stage transistors energized	
			2	Current limit reached	
			3	Reserved	
			4	Setpoint frequency reached	
			5	Actual frequency above threshold C17	
			6	Actual frequency = 0 Hz	
			7	Controller inhibit 0 = No controller inhibit 1 = Controller inhibit	
			8 -11	Controller status 0 = No error 1 = Error	
			12	Overtemperature fault	
			13	DC bus overvoltage	
			14	Direction of rotation 0 = CW 1 = CCW	
15	Read for operation 0 = Fault (not ready for operation) 1 = No fault (ready for operation)				
			LECOM format: VH		
C0160	c60	Mode selection for c61	0 Monitoring only 1 Monitoring and editing	0	
C0161	c61	Present fault	Status/error message (see table 2)	Read only	
C0162	c62	Last fault	Error message (see table 2)	Read only	
C0163	c63	Last but one fault	Error message (see table 2)	Read only	
C0164	c64	Last but two fault	Error message (see table 2)	Read only	
C0170	c70	Configuration – TRIP reset	0 TRIP reset by LOW-HIGH signal at 28 or mains switching or LOW-HIGH signal at digital input "TRIP reset" 1 Auto TRIP reset	0	
C0171	c71	Auto TRIP reset delay	0.0 – 60.0 sec	0.0	
C0173	c73	Input voltage selection	0 Low 1 High		
C0178	c78	Operating time counter		Read only	

LECOM Code Number	Parameter No.	Parameter Name	Range of Adjustment (values representing selection)	Factory Default																																		
C0179	c79	Mains connection time counter		Read only																																		
C0182	c82	S-ramp integration time	0.0 – 50.0 sec	0.0 sec																																		
C0200	--	Software identification (LECOM access only)	Software identification string (e.g.): "33STMD-M_12000" LECOM format: VS	Read only																																		
C0201	--	Software generation date (LECOM access only)	Software generation date string (e.g.): "2005-01-15" LECOM format: VS	Read only																																		
C0248	--	LECOM input selection (LECOM access only)	0 - 255 This parameter ensures compatibility with previous master-system drivers according to LECOM-A/B specification V1.0. This input is valid for all LECOM accesses; i.e. the access of a standard parameter with a LECOM input selection that is not 0 results in a fault because the addressed value does not exist. The array element can be directly addressed via a LECOM-A/B driver as from specification V2.0. This parameter should therefore not be used any longer. C0248 is included in every LECOM code bank (see C0249). The parameter value is always set to 0 when switching on.	0																																		
C0249	--	LECOM code bank (LECOM access only)	<table border="1"> <thead> <tr> <th>Code Bank</th> <th>Code Number</th> </tr> </thead> <tbody> <tr><td>0</td><td>0 - 255 (factory setting)</td></tr> <tr><td>1</td><td>250 - 505</td></tr> <tr><td>2</td><td>500 - 755</td></tr> <tr><td>3</td><td>750 - 1005</td></tr> <tr><td>4</td><td>1000 - 1255</td></tr> <tr><td>5</td><td>1250 - 1505</td></tr> <tr><td>6</td><td>1500 - 1755</td></tr> <tr><td>7</td><td>1750 - 2005</td></tr> <tr><td>8</td><td>2000 - 2255</td></tr> <tr><td>9</td><td>2250 - 2505</td></tr> <tr><td>10</td><td>2500 - 2755</td></tr> <tr><td>11</td><td>2750 - 3005</td></tr> <tr><td>12</td><td>3000 - 3255</td></tr> <tr><td>13</td><td>3250 - 3505</td></tr> <tr><td>14</td><td>3500 - 3755</td></tr> <tr><td>15</td><td>3750 - 4005</td></tr> </tbody> </table> <p>The LECOM code bank ensures compatibility with the master-system drivers according to the LECOM-A/B specification V1.0 The maximum code number is 255. With the code bank, an offset of 250 is added to the code number. The code bank addressing is not effective with extended code addressing (LECOM-A/B specification). The parameter value is always set to 0 when switching on.</p>	Code Bank	Code Number	0	0 - 255 (factory setting)	1	250 - 505	2	500 - 755	3	750 - 1005	4	1000 - 1255	5	1250 - 1505	6	1500 - 1755	7	1750 - 2005	8	2000 - 2255	9	2250 - 2505	10	2500 - 2755	11	2750 - 3005	12	3000 - 3255	13	3250 - 3505	14	3500 - 3755	15	3750 - 4005	0
Code Bank	Code Number																																					
0	0 - 255 (factory setting)																																					
1	250 - 505																																					
2	500 - 755																																					
3	750 - 1005																																					
4	1000 - 1255																																					
5	1250 - 1505																																					
6	1500 - 1755																																					
7	1750 - 2005																																					
8	2000 - 2255																																					
9	2250 - 2505																																					
10	2500 - 2755																																					
11	2750 - 3005																																					
12	3000 - 3255																																					
13	3250 - 3505																																					
14	3500 - 3755																																					
15	3750 - 4005																																					
C0625	L25	Skip frequency 1	0.0 – 240 Hz	0.0 Hz																																		

LECOM Code Number	Parameter No.	Parameter Name	Range of Adjustment (values representing selection)	Factory Default	
C0626	L26	Skip frequency 2	0.0 – 240 Hz	0.0 Hz	
C0628	L28	Skip frequency bandwidth	0.0 – 10.0 Hz	0.0 Hz	
C1810	--	SW labeling (LECOM access only)	Software label string (e.g.): "S33SLECOMM_10000" LECOM format: VS	Read only	
C1811	--	SW generation (LECOM access only)	Software generation string (e.g.): "2005-01-15" LECOM format: VS	Read only	
C1920	n20	LECOM power up state	0 Quick stop 1 Inhibit	0	
C1922	n22	Serial time out action	0 Not active 1 Controller inhibit 2 Quick stop 3 Trip fault "FC3"	0	
C1923	n23	Serial fault time	50 – 65535 msec	50 msec	
C1962	--	Extended code number (LECOM access only)	Fault	Meaning	Read only
			0	No fault	
			3	Invalid data type	
			4	Invalid subcode value	
			5	Invalid code value	
			8	No access permission	
			9	Read only parameter	
			11	Data block too long	
			14	Invalid variable	
			17	General fault	
			210	Checksum error	
			211	Telegram interruption	
			212	Invalid entry	
214	Parity error				

TABLE 2 - Fault Decoding

Value	Description	Value	Description
0	No Fault	105	EPM Fault ("F1")
11	Output Transistor Fault ("OC1")	105	Internal Fault 2 ("F2")
12	Earth Fault ("OC2")	105	Internal Fault 3 ("F3")
13	RESERVED	105	Internal Fault 5 ("F5")
50	Overtemperature Fault ("OH")	105	Internal Fault 6 ("F6")
82	Flying Restart Fault ("rF")	105	Internal Fault 7 ("F7")
20	Overvoltage Fault ("OU")	105	Internal Fault 8 ("F8")
30	Undervoltage Fault ("LU")	105	Internal Fault 9 ("F9")
16	Motor Overload Fault ("OC6")	141	Identification Fault ("bF")
73	OEM Data Fault ("GF")	142	A/D Converter Fault ("Ad")
71	Configuration Fault ("CFG")	61	Remote Keypad Fault ("JF")
51	Dynamic Brake Overheating Fault ("dF")	85	Loss of 4-20 mA Signal ("Sd5")
31	Single Phase Fault ("SF")	64	Communication Fault ("FC3")
91	External Fault ("EEr")	105	Internal Fault 4 ("F4")
72	Control Fault ("CF")	32	Loss of motor phase ("LP1")
92	Automatic Start Inhibited ("LC")	105	Internal Fault 0 ("F0")
75	Incompatibility Fault ("cF")	66	Communication Fault ("FC5")

8) LECOM - A/B PROTOCOL DESCRIPTION

The LECOM-A/B protocol is used to exchange data between Lenze controllers and a host. The LECOM-A/B protocol is based on DIN 66019, ISO 1745 and ANSI X3.28 (category 2.5 and A2, A4). These standards are similar to each other and describe the control mode of a transmission section of a transmission system.

The host, which is the master, can communicate with a slave (Lenze controller) in three modes:

- RECEIVE (see 8.H)
- SEND (see 8.I)
- BROADCAST/MULTICAST (see 8.J)

The controllers communicate by means of the ASCII code:

	0	1	2	3	4	5	6	7	8	9	0	B	C	D	I	F
0	NUL	SOH	STX	ETX	EDT	ENQ	ACK	BEL	BS	1fT	LF	VT	jFF	CR	SO	SI
1	OLE	OC1	OC2	OC3	OC4	NAK	SYN	E1B	CAN	EM	SUB	ESC	FS	GS	AS	US
2	ë ë	'!	...,	'#'	'\$'	'%'	'&'	'"	'('	')'	'.'	'+'	'"	'-	'"	'f'
3	'0'	'1'	'2'	'3'	'4'	'5'	'6'	'7'	'8'	'g'	';	';	'<'	'-	'>'	'7'
4	'@'	'11\	'8'	'C'	'0'	'E'	'P'	'G'	'H'	'I'	'J'	'K'	'L'	'M'	'N'	'0'
5	'P'	'Q'	'R'	'S'	T	'U'	'V'	'W'	'X'	'Y'	'Z'	T	'\'	'r	'A'	"
6	'"	'a'	'b'	'c'	'd'	'e'	'f'	'g'	'h'	'j'	'j'	'k'	'l'	'm'	'n'	'0'
7	'p'	'q'	'r'	's'	't'	'u'	'y'	'w'	'x'	'y'	'z'	'{'	'l'	'j'	ë~í	

Example:

"EOT" = 02_{hex} = 2_{dec}
 Character "1" = 31_{hex} = 49_{dec}

A) Code number (C1, C2)

Standard addressing

The meaning of the code numbers and the assigned parameters can be obtained from the code table (see chapter 8.B). When transmitting data, the code number are coded as follows:

The following calculation determines the two ASCII digits from the code number (value range: 0 ... 6229) (value range: 48_{dec} ... 127_{dec}):

$$C1 = \text{INTEGER}((\text{REMAINDER}(\text{code number}/790)/10)+48_{\text{dec}})$$

$$C2 = \text{REMAINDER}(\text{REMAINDER}(\text{code number}/790)/10) + \text{INTEGER}(\text{code number}/790) \times 10 + 48_{\text{dec}}$$

The INTEGER is the digit before the decimal point, the REMAINDER is an integer.

Example: $13/5 = 2$ remainder 3

$$\text{INTEGER}(13/5) = 2$$

$$\text{REMAINDER}(13/5) = 3$$

Example:

Convert code number 1002 in ASCII code C1 and C2:

$$C1_{\text{ASCII}} = \text{INTEGER}((\text{REMAINDER}(1002/790)/10) + 48) = \text{INTEGER}(212/10) + 48 = 21 + 48 = 69 = 45_{\text{hex}} = \text{„E“}_{\text{ASCII}}$$

$$C2_{\text{ASCII}} = \text{REMAINDER}(\text{REMAINDER}(1002/790)/10) + \text{INTEGER}(1002/790) \times 10 + 48 = \text{REMAINDER}(212/10) + 1 \times 10 + 48 = 2 + 10 + 48 = 60 = 3C_{\text{hex}} = \text{“<”}_{\text{ASCII}}$$

The code number C1002 is converted into the ASCII string “E<”, if they are transmitted to the controller by a host.

B) Addressing via code bank

With previous LECOM-A/B drivers, only code numbers in the range from 0 to 255 could have been addressed, since these drivers used only one byte as code number. To achieve the addressing of the wider code-number range with these drivers, use the code banking. The code-number range 0...255 is displayed as a window over the whole code-number range. This is controlled via the code C0249 (code bank). Code C0249 can always be accessed via number 249, independent of the currently set code bank.

Assignment:

Code bank	Code offset	Code-number range
0	0	0 - 255
1	250	250 - 505
2	500	500 - 755
3	750	750 - 1005
4	1000	1000 - 1255
5	1250	1250 - 1505
6	1500	1500 - 1755
7	1750	1750 - 2005

Note:

Code banking is only active when the standard addressing is being used. If the selected code numbers are higher than 255, the code-number range increases correspondingly. Only the corresponding code-number offset is selected by means of the code bank.

Example:

Set the code bank $\text{INTEGER}(1002/250) = 4$ in C0249 to address the code number 1002. C1002 is then accessed via the code number C02.

C) Addressing via input selection

Simple LECOM-A/B drivers, which only use the standard addressing, cannot address subcodes. The input selection C0248 has been developed to offer the possibility of addressing the subcodes. When using the standard addressing, the value entered in C0248 is always considered as the subcode. The code C0248 can always be accessed via number 248, independent of the currently set code bank and the sub code used.

Example:

Enter value 1 in C0248 to address the JOG value 1 in subcode 1. Now subelement 1 is always addressed when accessing C39.

Tip!

After a sub element has been accessed through C0248, C0248 should be reset to 0 to avoid the addressing of a subelement “by accident” when accessing a code.

D) Extended addressing

Another possibility is the direct addressing of parameters by means of expanded addressing.

!						SC2
---	--	--	--	--	--	-----

The abbreviations have the following meanings:

!	The ASCII character “!” = 21 hex = 33dec shows that the expanded addressing is used
CH1 to CH4	Code number in hexadecimal code: each character corresponds to a nibble of the code numbers (CH1 is the highest, CH4 is the lowest nibble).
SC1, SC2	Subcode number in hexadecimal code: Each character corresponds to a nibble of the code number word (SC1 is the highest and SC2 the lowest nibble).

The following characters can be displayed in the ASCII code:

ASCII	0	1	2	3	4	5	6	7	8	9	0	B	C	D	I	F
Dec	48	49	50	51	52	53	54	55	56	57	65	66	67	68	69	70
Hex	30	31	32	33	34	35	36	37	38	39	41	42	43	44	45	46

A code number range from 0 to 65535 can be addressed by means of these characters. A maximum of 255 subelements (field elements) can be accessed via one subcode number of each code.

Example:

1002 = “!03EAOO”

E) Parameter value (V1 to Vn)

Parameter values can be transmitted in four different formats with the following structures:

- ASCII decimal format (VD)

-	VK1	VK2	VK3	VK4	VK5	VK6	.	NK1	NK2	NK3	NK4
---	-----	-----	-----	-----	-----	-----	---	-----	-----	-----	-----

- ASCII hexadecimal format (VH)

H	VH1	VH2	VH3	VH4	VH5	VH6	VH7	VH8
---	-----	-----	-----	-----	-----	-----	-----	-----

- String format (VS)

S	VS1	VS2	VS3	VS4	VS5	VS6	O	VS240
---	-----	-----	-----	-----	-----	-----	---	-------

- Octet string format for data blocks (VO)

O	VO1	VO2	VO3	VO4	VO5	VO6	O	VO240
---	-----	-----	-----	-----	-----	-----	---	-------

The abbreviations have the following meanings:

VK1 to VK6	Integers
.	Decimal point (if required)
NK1 to NK4	Decimal codes (if required)
"H" (48 _{hex})	Character [H], transfer of parameter values in the ASCII hexadecimal format
VH1 to VH8	1 to 8 hexadecimal characters each [0 to 9; A to F]
"S" (53 _{hex})	Character [S], transfer of parameter values in the string format
VS1 to VS240	1 to 12 visible ASCII characters each (no control characters)
"O" (4F _{hex})	Character [O], transfer of parameter values in the octet string format
V01 to V0240	Data block in hexadecimal code; Each character corresponds to a nibble of the data block

Parameter value in the ASCII decimal format (I10)

The ASCII decimal format (VD) is most often used. The values consist of the following:

- 1 leading negative sign (if required)
 - 6 digits before the decimal point (VK1 to VK6)
 - 1 decimal point (if required)
 - 4 digits after the decimal point (NK1 to NK4) (if required)
- Values from -214748.3648 to 214748.3647 can be displayed.

Tip!

In the ASCII decimal format (VD), the decimal point must not be transmitted if the value does not have digits after the decimal point.

Parameter value in ASCII hexadecimal format (I/H)

The LECOM-A/B protocol supports the transmission of hexadecimal parameter values with a length of:

- 2 characters (byte value)
- 4 characters (word/integer value)
- 8 characters (double word/long integer)

In the ASCII hexadecimal format, VH1 is the most significant and VH8 the least significant hexadecimal character.

Parameter value in the string format (VS)

By means of the string format (VS) of the protocol it is possible to transmit strings with max. 20 characters in both directions. The Lenze controller can only send the string parameters (e. g. C200).

Parameter values in the octet string format (I/O)

The LECOM-A/B protocol includes the octet string format (VO) with which it is possible to transfer data blocks.

The character sequence corresponds to the filing in the memory (ascending order), i.e. the character transmitted first is the data block nibble with the lowest address. The data structure of the data block corresponds to the Intel-memory format with the following definition:

BYTE:	1st high nibble 2nd low nibble
WORD:	1st high BYTE 2nd low BYTE
DWORD:	1st high WORD 2nd low WORD

F) Controller address (AD1, AD2)

One or more bus devices (slaves) can be selected by means of the controller address, which is 2 bytes (AD1, AD2) long. The LECOM-A/B protocol supports the broadcast telegrams, i.e. a telegram is sent to a group or all other bus devices. For this, controller addresses are reserved (see BROADCAST, 8.J). Controller addresses have the following structure:

AD1	AD2
-----	-----

The abbreviations have the following meanings:

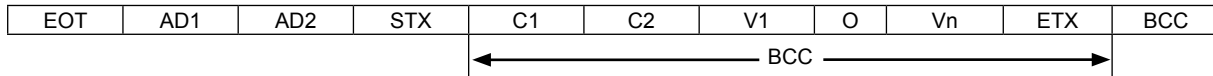
- AD1 ASCII ten-digit of the slave address (0 ... 9; 30 ... 39hex)
- AD2 ASCII one-digit of the slave address (0...9; 30 ... 39hex)

G) Block-check character (BCC)

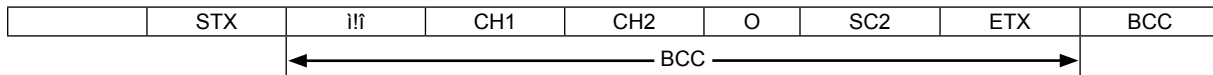
The block-check character (BCC) is used to store the transmitted data and is generated according to DIN 66219 (chapter 3).

Because of the program, the block-check character is generated by a XOR link from the following digits of the SEND telegram:

- it starts with the character directly after the STX control character
- it ends directly after the ETX control character
 - BCC can accept the value 00 ... FFhex.



or with expanded addressing:

**a.) Telegram response**

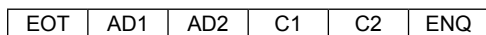
The Lenze controller must return an acknowledgement to the host. The only exception is the broadcast telegram. This telegram does not require an acknowledgement.

The Lenze controller sends two types of acknowledgements:

- Positive acknowledgement (ACK = 06hex), if:
 - no faults occur during the block storage (longitudinal and lateral parity)
 - a valid command (variable address) has been recognized
 - the variable value is within the permissible range
 - the variable value could have been changed
- Negative acknowledgement (NAK = 15hex), if:
 - one of the above listed conditions cannot be met.
- No acknowledgement, if:
 - a broadcast telegram is send
 - the controller address is not correct

H) Receive

The command RECEIVE is to request parameter values of the Lenze controllers. The code numbers of the requested parameter are transmitted via the RECEIVE telegram using the following structure:



The abbreviations have the following meanings:

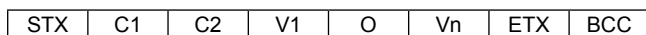
EDT (04hex) End of the (previous) transmission
 AD1, AD2 Logic unit address of the slave to be addressed Slaves
 C1, C2 Code number (two ASCII characters) or extended addressing
 ENQ (05hex) Station request

Structure and meaning of the code numbers (C1, C2) and the controller address (AD1, AD2) are described in the corresponding paragraphs of the chapter SEND (see 8.I).

a) Telegram response

The Lenze controller addressed via a RECEIVE telegram generates one of the following responses:

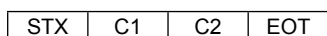
- The controller could decode the request and is now sending the requested parameter value to the host.



- The controller could decode the request, however, a check-sum fault (parity fault) occurred during transmission.



- The controller could not process the request because the requested code number does not exist.



The abbreviations have the following meanings:

STX (02hex)	Start of text
C1, C2	Code number (two ASCII characters) or extended addressing
V1 to Vn	Parameter value (n ASCII characters)
ETX (03hex)	End of text
BCC	Block-check character (00 ... FFhex)
? (3Fhex)	ASCII character “?”
EDT (04hex)	End of the (previous) transmission

Structure and meaning of the block-check character (BCG) are described in the corresponding paragraph of the chapter SEND.

b) Example 1

The current speed setpoint (code number C46) is to be read with the bus address 01 at the controller. The host sends the following RECEIVE telegram

EOT	0	1	4	6	ENQ
-----	---	---	---	---	-----

The controller can respond in three different ways:

STX	4	6	3	5	.	4	ETX	BCC
-----	---	---	---	---	---	---	-----	-----

Valid request: The current value of the parameter C46 is 35.4 (Hz) or

STX	4	6	?	ETX	BCC
-----	---	---	---	-----	-----

Invalid request: A check-sum fault (parity fault) occurred during data transmission or

STX	4	6	EOT
-----	---	---	-----

Invalid request: Parameter C46 does not exist in this controller.

c) Example 2

The current operating status (code number C68) is to be read with the bus address 25 for the controller. The operating status is bit-coded and transmitted in the hexadecimal format.

The host sends the following RECEIVE telegram

EOT	2	5	6	8	ENQ
-----	---	---	---	---	-----

The controller's response:

STX	6	8	H	0	9	0	0	ETX	BCC
-----	---	---	---	---	---	---	---	-----	-----

Valid request: The current value of the parameter C68 is “0900”. This means:

TRIP status	not active
Maximum current	not reached
Quick stop	not active
Pulse inhibit status	free
Display of the direction of rotation	CW rotation
Qmin status	not active
Controller enable	enabled
Operating fault	did not occur
Communication error	did not occur

I) Send

The command SEND is used to transmit data from the master to the slave. The master then sends a telegram with the following structure:

EOT	AD1	AD2	STX	C1	C2	V1	O	Vn	ETX	BCC
-----	-----	-----	-----	----	----	----	---	----	-----	-----

The abbreviations have the following meanings:

EDT (04hex)	End of the (previous) transmission
AD1, AD2	Logic unit address of the slave to be addressed Slaves
STX (02hex)	Start of text
C1, C2	Code number (two ASCII characters)
V1 to Vn	Parameter value (n ASCII characters)
ETX (03hex)	End of text
BCC	Block-check character (00 ... FFhex)

In the text section of the telegram, which is embedded between the control characters STX and ETX, the code number (C1. C2) and the corresponding parameter value (V1 to Vn) are transmitted to the slave.

a) Example for a SEND telegram

The maximum speed (code number C11) is to be set to the value 95.2 Hz via the bus address 34 at the controller.

The host must send the following SEND telegram:

EOT	3	4	STX	1	1	9	5	.	2	ETX	BCC
-----	---	---	-----	---	---	---	---	---	---	-----	-----

The controller can respond with two different acknowledgements:

ACK

The command could not be processed correctly. The current value of the parameter C 11 is 95.2 Hz or

NAK

The request could not be processed correctly. The parameter value was not changed.

J) Broadcast / Multicast

In a bus network, the command BROADCAST is to address all devices or a group of devices (multicast) at the same time. The structure of the BROADCAST telegram is similar to the structure of the SEND telegram. The only exception is that it does not return an acknowledgement.

The devices can be selected via their controller addresses. The following controller addresses are reserved for a BROADCAST telegram:

Controller addresses (reserved)	Controller address of groups	ASCII character	
		AD1	AD2
00	all	"0"	"0"
10	11 to 19	"1"	"0"
20	21 to 29	"2"	"0"
30	31 to 39	"3"	"0"
40	41 to 49	"4"	"0"
50	51 to 59	"5"	"0"
60	61 to 69	"6"	"0"
70	71 to 79	"7"	"0"
80	81 to 89	"8"	"0"
90	91 to 99	"9"	"0"

a) Example for a BROADCAST telegram

All controllers are to be stopped when setting controller enable (code number C40 = 0).

The host sends the following BROADCAST telegram:

EOT	0	0	STX	4	0	0	ETX	BCC
-----	---	---	-----	---	---	---	-----	-----

The controllers do not return an acknowledgement.

b) Monitoring of the slave response

The master monitors the selected slave. The slave must return a response within a defined time. Under the following circumstances the slave does not return a response to the master (time out):

- The controller address could not be recognized
- A fault (e.g. parity fault) had been detected in one or several characters, including the character " ENQ"
- The transmission path is faulty
- A BROADCAST telegram had been sent.
- The hardware does not work properly

If the master does not receive a response within a defined period of time, the transmission is tried again. The number of repetitions is limited.

The monitoring time in the master should be approx. twice as long as the maximum response time.

c) Transmission faults

After a transmission fault, the master can read CO068 and evaluate the communication error in bit 4... 7.

9) List of abbreviations

Abbreviation	Meaning
ACK	Response for positive acknowledgement of the controller
ASCII	American Standard Code for Information Interchange: 7 bit code with one free parity bit
Ctrl. enable	Controller enable
Ctrl. inhibit	Controller inhibit
DCB	DC-injection brake
EMC	Electromagnetic Compatibility
f _{dmin} ; f _{dmax}	Minimum/maximum field frequency
I _{max}	Current limit
IMP	Pulse inhibit
JOG (JOG1, JOG2, JOG3)	Fixed speed or input for activation of the fixed speed
LECOM	Lenze communication
LECOM-A	Communication medium via RS232 interface and LECOM protocol
LECOM-B	Communication medium via RS485 interface and LECOM protocol
LECOM-LI	Communication medium via optical fiber and LECOM protocol
LEMOG	PC program or IBM compatible PCs) for drive programming
NAK	Response for negative acknowledgement of the controller
Optical fiber	Optical fiber
PAR	Parameter set changeover
PC	Personal computer
PLC	Programmable logic controller, e. g. SIMATIC 55, SIEMENS
O _{min}	Frequency threshold
QSP	Quick stop
RFG	Ramp-function generator, setpoint integrator
RS232	Interface standard
RS485	Interface standard
RxD	Pin name LED (receive display)
SW	Software
TRIP	Operation fault
TxD	Pin name LED (transmission display)
UG _{max}	DC-bus overvoltage
VD	LECOM format
VH	LECOM format
VS	LECOM format

10) Glossary

Technical Term	Meaning
Baud rate	Transmission speed of data in bit/s
Broadcast	Message to all controllers
Code	For input and display (access) of parameter values.
Code number	Addressing of variables according to the format "code-subcode" (Cxxxx-xx). All variables can be accessed via the code names.
Fieldbus	For data exchange between superimposed controls and positioning controls.
Host	PC or PLC
Icon	Sign or symbol with an unambiguous message.
Interface converter	Additional module to adapt data transmissions via RS232 interface cables to RS485 (and vice versa)
LEMOC	PC program or IBM compatible PCs) for drive programming
Multicast	Message to certain controller groups
Nibble	One byte consists of two nibbles: <ul style="list-style-type: none"> • LOW nibble (bit 0 to 3) • HIGH nibble (bit 4 to 7)
Protocol	LECOM-A/B protocol
Pulse inhibit	The output of the power stage is inhibited because the controller is inhibited, the fault message TRIP is displayed or an overvoltage or undervoltage is applied.
Remaining hazards	Hazards which cannot be eliminated by design
Subcode	Defines the table position of a code
Table position	Some variables may consist of more than one value. If this is the case, the values are entered subsequently. They are accessed by means of the same code name via the subcode.