LIN to CAN Gateway
Communication Protocol Specification

MACH SYSTEMS s.r.o.

Changes

Date	Change	Changed by
27.11.2024	CAN baud rate of 50 and 100 KBd added to configuration (firmware v1.4+)	MM
7.5.2020	Public release	MM
16.4.2020	Final draft	JJ
11.3.2020	Draft	MM

Contents

1 Introduction

The LIN-CAN Gateway acts as a device which can make a bi-directional communication bridge between a CAN bus and LIN bus.

The gateway can act as:

- LIN Master
- LIN Slave
- LIN bus sniffer (receives all LIN communication and forwards into onto the CAN bus)

The gateway can be controlled by the communication protocol over CAN bus. This allows the user to:

- Configure LIN channel (Master/Slave, Baud Rate)
- Transmit and Receive LIN frames
- Configure CAN channel

The sniffing mode does not actively interact on the LIN bus. Instead, it forwards all incoming LIN communication onto the CAN bus.

The CAN and LIN channels can be configured by the user, and parameters such as baud rate can be changed. The gateway configuration can be stored into an internal EEPROM. If a valid configuration is available, it will be automatically loaded on power-up.

LIN Frame Naming Convention

LIN frame consists of a header and a response.
Header =Synch. Break + Sync. Field + Id Field
Response = Data bytes + Checksum

Name	Meaning
Master Response	a complete LIN frame which contains both header and response
Master Request	a LIN header only e.g. Master transmits a header and expects a Slave to answer by a Slave response
Slave Response	a Slave Response only e.g. Data bytes + Checksum

The following table summarizes TX/RX possibilities of the gateway for both LIN Master and Slave mode:

LIN Message Action	LIN Mode	
	Master	**Slave**
Transmit Master Response	yes	
Transmit Master Request	yes	
Transmit Slave Response		yes
Receive Slave Response	yes	
Receive LIN Frame	yes	yes

When the gateway is configured as LIN Master, an internal 1kOhm pull-up resistor between Vbat and LIN bus is automatically enabled.

2 Communication Protocol

The gateway is controlled over the CAN bus. The communication between the gateway and another system is based upon the binary protocol described below. The same message structure is used for both directions - to and from the device.
The gateway receives commands over CANID_BASE_RX and transmits responses over CANID_BASE_TX. Both base CAN identifiers can be changed per device - see Message Ids 0x25-0x26.
The gateway does not store a LIN scheduler. Instead, the user needs to maintain the scheduler at his side and he is responsible to send commands to the gateway.
LIN message buffers for transmission and reception of LIN frames are transmitted respectively received over CAN identifiers with an offset from the base CAN identifiers. This allows to carry up to 8 LIN data bytes within a CAN frame data part.

Default configuration - communication parameters:

CANID_BASE_RX = 0x123 Std Id. (the gateway receives)
CANID_BASE_TX = 0x321 Std Id. (the gateway transmits)
CAN Baud = 500 KBaud

2.1 Control Messages

Control messages are used for configuring and controlling the gateway. The user can configure LIN and CAN channels. The control messages are transmitted and received over the base CAN identifiers (CANID_BASE_RX and CANID_BASE_TX).
A CAN frame data region carries the Message Id in its first data byte and the remaining data bytes are message-specific.

CAN Frame

SOF	ID	RTR	IDE	r	DLC	Data Bytes 0 - 8		Chksum	DEL	ACK	DEL	EOF
SOF	ID	RTR	IDE	r	DLC	Message Id	Data	Chksum	DEL	ACK	DEL	EOF
1	11 bit	1	1	1	4	8 bit	0 – 56 bit (0 – 7 bytes)	15 bit	1	1	1	7

Data Byte 0 is always used as Message Id, the rest of the data bytes carry the message content.

Note: Grey parts are automatically generated by a CAN controller.

The base identifiers can be changed by the user so that multiple LIN-CAN gateways can share a single CAN bus.

2.1.1 Message Overview

The following table describes the control messages of the communication protocol over CAN bus.

ID	Name	Request Data Length	Response Data Length	Comment
0x01	BOOT_UP		0	A notification that the gateway was powered up
0x11	READ_SN	0	4	Read gateway serial number See 0
0x12	READ_HW_INFO	0	6	Read gateway HW info See 0
0x13	READ_SW_INFO	0	2	Read gateway SW info See 0
0x20	READ_LIN_CONFIGURATION	1	0	Read LIN channel configuration
0x21	WRITE_LIN_CONFIGURATION	0	1	Write LIN channel configuration
0x22	SAVE_CONFIGURATION	0	0	Save the current configuration to EEPROM
0x23	LOAD_CONFIGURATION	0	0	Loads configuration from EEPROM
0x24	DEFAULT_CONFIGURATION	0	0	Load default configuration
0x30	LIN_START	0	0	Start LIN channel
0x31	LIN_STOP	0	0	Stop LIN channel
0x61	WRITE_CAN_CONFIGURATION	1	0	See 3.1
0x62	READ_ CANID_BASE_RX	0	4	Bit 31 (MSB) = Extended Id Flag
0x63	WRITE_ CANID_BASE_RX	5	0	Bit 31 (MSB) = Extended Id Flag
0x64	READ_ CANID_BASE_TX	0	4	Bit 31 (MSB) = Extended Id Flag
0x65	WRITE_ CANID_BASE_TX	4	0	Bit 31 (MSB) = Extended Id Flag
0xFE	RESTART_BOOT	0		Reboot gateway to bootloader
0xFF	GENERAL_ERROR		2	An error occurred

2.1.2 Error Codes

The following table describes control messages' error codes.

Error Code	Comment
0xE1	Checksum error
0xE2	Bus error
0xE3	Timeout overrun
0xE4	Unknown Message Id
0xE5	Configuration Error

2.1.3 Device Information

The gateway's serial number, firmware and hardware versions can be read from the device.

Serial Number

Message Id = 0x11

Example S/N: 02030106

DATA 0	DATA 1	DATA 2	DATA 3
06	01	03	02

Firmware Version

Message Id = 0x13

DATA 0	DATA 1
VERSION MINOR	VERSION MAJOR

Hardware Version

Message Id = 0x12

Example HW Info: 000400030002

DATA 0	DATA 1	DATA 2	DATA 3	DATA 4	DATA 5
02	00	03	00	04	00

2.2 LIN Buffer Messages

2.2.1 Overview

An interaction (transmission and reception) with the LIN bus is done over CAN messages with identifiers that have an offset from the base identifiers (see 2.1). They are called "LIN buffer messages".
By this, the user can use the gateway to act as a LIN Master or LIN Slave. Over the LIN buffer messages, the user can transmit and receive LIN frames onto/from the LIN bus, and receive notifications.
Specifically, it allows to:

- Transmit Master Responses
- Transmit Master Requests and receive its response
- Transmit Slave Responses
- Receive LIN frames
- LIN error notifications (timeouts etc.)

2.2.2 Frame Identifier Mappings

LIN identifiers are mapped onto CAN identifiers by offsets. The DLC (Data Length Code) value of a CAN frame is used to distinguish between frame and notification types.

Mapping Name	Direction	CAN Id	Default CAN Id Range	LIN Master Usage	LIN Slave Usage
Frames	CAN > LIN	CANID_BASE_RX +1 + LIN_ID	0x124 to 0x163	Transmit a LIN frame onto the LIN bus: **DLC=0:** Transmits a Master Request **DLC>0:** Transmits a Master Response with <DLC > data byte count	Configure Slave buffer for reception or Slave Response transmission: **DLC=0:** Receive from LIN **DLC>0:** Enables Slave Response with <DLC > data byte count
Notifications	LIN > CAN	CANID_BASE_TX + 1 + LIN_ID	0x322 to 0x361	**DLC>0:** Data being sent/received onto/from the LIN bus notifications. **DLC=0:** LIN communication timeouts notifications	

				Note: Applies to the sniffer mode, too.

LIN_ID (LIN Identifier): 0 to 0x3F

As described above, the CAN identifier for a particular LIN identifier can be calculated:

CAN_ID = (CANID_BASE +1 + LIN_ID)
where LIN_ID is LIN Frame identifier (0 - 63).

2.2.3 Mapping Example

Consider the default configuration where CANID_BASE_RX = 0x123 and CANID_BASE_TX = 0x321.

When LIN-CAN gateway receives a LIN frame with LIN Id=0x10 with, say, 8 data bytes, it transmits a CAN frame with CAN Id = (0x321+1+0x10) = 0x332 and DLC=8 and the data bytes carry the original LIN frame data bytes.

Similarly, when the LIN-CAN gateway receives a CAN frame with CAN Id = (0x123 + 1 + 0x05) = 0x129 and DLC=2, the it transmits a Master Response LIN frame with LIN Id=0x05 and 2 data bytes that carry the original CAN frame data bytes.

The following table summarizes the usage of DLC of CAN frames for LIN buffer messages for the default configuration.

LIN Id	**CAN Id** (to gateway)		**CAN Id** (from gateway)	
-	0x123	Control Message	0x321	Control Message
0x00	0x124	**Master:** DLC > 0 – transmit master response DLC = 0 – transmit master request **Slave:** DLC > 0 – configure slave response TX buffer DLC = 0 – configure slave RX buffer	0x322	**Master, Slave, Sniffer:** DLC > 0 – data received/ sent from/to LIN bus DLC = 0 – timeout error SLAVE
0x01	0x125		0x323	
0x02	0x126		0x324	
0x03	0x127		0x325	
…	…		…	
0x3F	0x163		0x361	

More examples on how to use LIN Master and LIN Slave can be found in chapters 4.2 and 4.3 respectively.

3 CAN bus Configuration

3.1 Write Configuration

Message ID 0x61 - The user can change the baud rate.

Data[0]	Baud Rate, Sample Point
0x00	125 KBd, 85 %
0x01	250 KBd, 85 %
0x02	500 KBd, 85 %
0x03	1 MBd, 85 %
0x04	100 KBd, 85 %
0x05	50 KBd, 85 %

4 LIN bus

4.1 Channel Configuration

4.1.1 Read Configuration

MessageId=0x20

Response:

DATA 0
LIN Configuration

4.1.2 Write Configuration

MessageId=0x21

Data section of a packet:

DATA 0
LIN Configuration

Configuration Register:

bit 7							bit 0
-	CHECKSUM	AMLR	AUTOSTART	MODE1	MODE0	BAUD1	BAUD0

Bit 7 **Reserved**

Bit 6 **Checksum Type**
0 – Classical Checksum
1 – Enhanced Checksum (except for 0x3C and 0x3D identifiers)

Bit 5 **AMLR - Automatic Message Length Recognition**
0 – Message length is taken from LIN Id field (as defined in LIN v1.x)
1 – Message length is recognized automatically (variable data-length as defined in LIN v2.x)

Bit 4 **Auto-start**
0 – LIN channel is NOT automatically started on power-up

1 – LIN channel is automatically started on power-up

Bit 2..3 **Mode**
00 – LIN Slave
01 – LIN Master
10 – Sniffer
11 – Reserved

Bit 0..1 **Baud Rate Selection**
00 – Reserved
01 – 9600
10 – 19200
11 – Reserved

Responses:

1) Gateway reconfigured

DATA 0 - status
0x01

2) Gateway cannot be reconfigured

DATA 0 - status
0x00

Possible reasons:
- Wrong baud rate type selected.

Default LIN Configuration:
- Master
- Enhanced checksum
- 19200 Baud
- Auto-start disabled
- Automatic Message Length Recognition

4.2 Master Mode

4.2.1 Master Response

To transmit a master response frame:

- Calculate a CAN Id for the LIN Id you want to transmit onto the LIN bus (Chapter 2.2.2).
- Transmit the CAN frame with DLC and data bytes you want to send onto the LIN bus.
- The gateway acknowledges it by transmitting a CAN frame (the same CAN Id as the command, DLC = 0).
- The gateway transmits the LIN frame.
- The gateway transmits a CAN frame bus (Notification CAN Id, DLC>0).

Channel	Direction	Frame Name	Frame Id	Frame Type	Data Length	Data	Other Properties
CAN 1	TxReq		0x129	Std. Frame	6	0x01 0x02 0x03 0x04 0x05 0x06	
CAN 1	Rx		0x129	Std. Frame	0		
CAN 1	Rx		0x327	Std. Frame	6	0x01 0x02 0x03 0x04 0x05 0x06	
LIN 1	Rx		0x005	HeaderResponse	6	0x01 0x02 0x03 0x04 0x05 0x06	Checksum: 65

4.2.2 Master Request

To send a master request frame:

- Calculate a CAN Id for the LIN Id you want to transmit onto the LIN bus (Chapter 2.2.2).

- Transmit the CAN frame with DLC = 0.
- The gateway acknowledges it by transmitting a CAN frame (the same CAN Id as the command, DLC = 0).
- The gateway transmits a LIN header onto the LIN bus, and receives the response.
- The gateway transmits a CAN frame bus (Notification CAN Id, DLC > 0).

Channel	Direction	Frame Name	Frame Id	Frame Type	Data Length	Data	Other Properties
CAN 1	TxReq		0x12E	Std. Frame	0		
CAN 1	Rx		0x12E	Std. Frame	0		
LIN 1	TxReq		0x00A	SlaveResponse	5	0x05 0x04 0x03 0x02 0x01	Checksum: 26
CAN 1	Rx		0x32C	Std. Frame	5	0x05 0x04 0x03 0x02 0x01	

In case a LIN slave does not transmit a response, the gateway will transmit a CAN frame with notification ID and DLC = 0. This means a LIN timeout occurred.

In case of other errors (bus error, checksum error…) gateway sends error packet according to standard configuration protocol.

Channel	Direction	Frame Name	Frame Id	Frame Type	Data Length	Data	Other Properties
CAN 1	TxReq		0x12E	Std. Frame	0		
CAN 1	Rx		0x12E	Std. Frame	0		
CAN 1	Rx		0x32C	Std. Frame	0		
LIN 1	Rx		0x00A	LIN Error Frame	0	Timeout Error - No slave response	Checksum: 00

4.2.3 Possible Errors

- Gateway is not LIN Master
- LIN channel is not running

4.3 Slave Mode

If the gateway is configured as a slave, LIN buffers direction can be configured as RX (receives data from LIN bus) or TX (transmits data as an answer to a master request).

Configuration of slave buffers is cleared once a LIN channel is started. Therefore, make sure you configure slave buffers after the channel has been started. When a channel is running, it is not possible to modify slave buffer configuration.

4.3.1 Slave Response Buffer- Direction RX

To set buffer direction to RX (receive from LIN):

- Calculate a CAN Id for the LIN Id you want to transmit onto the LIN bus (Chapter 2.2.2).
- Transmit the CAN frame with DLC = 0 to configure a slave response RX buffer.
- The gateway acknowledges it by transmitting a CAN frame (the same CAN Id as the command, DLC = 0).
- Once the configured LIN Id frame is received from the LIN bus, the gateway transmits a CAN frame bus (Notification CAN Id, DLC > 0).

Channel	Direction	Frame Name	Frame Id	Frame Type	Data Length	Data	Other Properties
CAN 1	TxReq		0x125	Std. Frame	0		
CAN 1	Rx		0x125	Std. Frame	0		
CAN 1	Rx		0x323	Std. Frame	8	0x11 0x22 0x33 0x44 0x55 0x00 0x00 0x00	
LIN 1	TxReq		0x001	HeaderResponse	8	0x11 0x22 0x33 0x44 0x55 0x00 0x00 0x00	Checksum: 3E

If the slave that is supposed to transmit a response does not respond, the gateway will transmit a CAN frame with a Notification Id and DLC = 0. This means that timeout in communication occurred. In case of other errors (bus error, checksum error…), the gateway transmits an error information over a control message (Chapter 2.1).

4.3.2 Slave Response Buffer- Direction TX

To set buffer direction to TX (transmit to LIN):

- Calculate a CAN Id for the LIN Id you want to transmit onto the LIN bus (Chapter 2.2.2).
- Transmit the CAN frame with DLC > 0 to configure a slave response TX buffer.
- The gateway acknowledges it by transmitting a CAN frame (the same CAN Id as the command, DLC = 0).
- Once the configured LIN Id slave response is transmitted onto the LIN bus by the gateway, the gateway transmits a CAN frame bus (Notification CAN Id, DLC > 0).

Channel	Direction	Frame Name	Frame Id	Frame Type	Data Length	Data	Other Properties
CAN 1	TxReq		0x130	Std. Frame	6	0x11 0x22 0x33 0x44 0x55 0x66	
CAN 1	Rx		0x130	Std. Frame	0		
CAN 1	Rx		0x32E	Std. Frame	6	0x11 0x22 0x33 0x44 0x55 0x66	
LIN 1	Rx		0x00C	SlaveResponse	6	0x11 0x22 0x33 0x44 0x55 0x66	Checksum: 4D

4.3.3 Possible Errors

- Gateway is not slave
- LIN Channel is not running
- Buffer is already used

4.4 Sniffer Mode

When the gateway is configured as a sniffer, it listens on the LIN bus and forwards all communication onto the CAN bus with notification identifiers as described in chapter 2.2.2. The sniffer mode is passively listening on the bus.

DLC > 0 LIN data frame received
DLC = 0 LIN bus timeout

Channel	Direction	Frame Name	Frame Id	Frame Type	Data Length	Data
CAN 1	Rx		0x33F	Std. Frame	7	0x01 0x02 0x03 0x04 0x05 0x06 0x07
CAN 1	Rx		0x32E	Std. Frame	0	
CAN 1	Rx		0x32D	Std. Frame	3	0x01 0x02 0x03
CAN 1	Rx		0x33F	Std. Frame	7	0x01 0x02 0x03 0x04 0x05 0x06 0x07
CAN 1	Rx		0x32D	Std. Frame	3	0x01 0x02 0x03
CAN 1	Rx		0x32E	Std. Frame	0	

5 Message Examples

The following examples consider the default configuration.

5.1 LIN Channel Configuration

LIN Master Mode, 19200 Baud, Enhanced Checksum, AMLR = 1, Channel Auto-start

Stop channel -> configure channel -> start channel

Channel	Direction	Frame Name	Frame Id	Frame Type	Data Length	Data
CAN 1	TxReq		0x123	Std. Frame	1	0x31
CAN 1	Rx		0x321	Std. Frame	2	0x31 0x01
CAN 1	TxReq		0x123	Std. Frame	2	0x21 0x76
CAN 1	Rx		0x321	Std. Frame	2	0x21 0x01
CAN 1	TxReq		0x123	Std. Frame	1	0x30
CAN 1	Rx		0x321	Std. Frame	2	0x30 0x01

5.2 Transmit LIN Master Response

Master response with LIN Id = 0xC.

Channel	Direction	Frame Name	Frame Id	Frame Type	Data Length	Data
CAN 1	TxReq		0x130	Std. Frame	6	0x11 0x22 0x33 0x44 0x55 0x66
CAN 1	Rx		0x130	Std. Frame	0	
CAN 1	Rx		0x32E	Std. Frame	6	0x11 0x22 0x33 0x44 0x55 0x66

Note: The gateway's LIN channel has to be configured as LIN Master.

5.3 Configure Slave TX buffer

Configure Slave TX buffer for LIN Id = 0xC.

Channel	Direction	Frame Name	Frame Id	Frame Type	Data Length	Data
CAN 1	TxReq		0x130	Std. Frame	6	0x11 0x22 0x33 0x44 0x55 0x66
CAN 1	Rx		0x130	Std. Frame	0	

Note: The gateway's LIN channel has to be configured as LIN Slave.

5.4 Configure Slave RX buffer

Configure Slave RX buffer for LIN Id 0xB and receive data from master.

Channel	Direction	Frame Name	Frame Id	Frame Type	Data Length	Data	Other Properties
CAN 1	TxReq		0x12F	Std. Frame	0		
CAN 1	Rx		0x12F	Std. Frame	0		
CAN 1	Rx		0x32D	Std. Frame	3	0x01 0x02 0x03	
LIN 1	TxReq		0x00B	HeaderResponse	3	0x01 0x02 0x03	Checksum: 6E

Note: The gateway's LIN channel has to be configured as LIN Slave.

6 Factory Reset

The device can be reset to factory defaults.

Load default configuration to RAM:

Press and hold the side button until the green LED goes on (for approx. 5 seconds) and release the button immediately. A configuration stored in EEPROM will not be overwritten and thus, it will be loaded again on next power-up.

Load default configuration to RAM and EEPROM:

Press and hold the side button until the red LED goes on (for approx. 10 seconds) and release the button immediately. This will load the default configuration into RAM and EEPROM, too.

7 Contact

MACH SYSTEMS s.r.o.
www.machsystems.cz
info@machsystems.cz
Czech Republic

Company Registration: 29413893
EU VAT number: CZ29413893