

**Analog Devices, Inc.
Protocol 4 Flash/EE Programming via LIN
using CANoe.LIN**

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Purpose

The purpose of this document is to describe an application which demonstrates programming the ADuC703X device's integrated Flash/EE using *CANoe.LIN (v6.1 (SP2))* from Vector (<http://www.vector-informatik.de>).

This is a draft document and is subject to change.

It is assumed that the user is familiar with CANoe.LIN and with the LIN 2.0 specification.

Overview

The ADuC703X device from Analog Devices Inc. supports the programming of the device's integrated Flash/EE via LIN. This feature is targeted towards automotive applications where the ADuC703X can be integrated into a *LIN network cluster* as a *LIN slave node*, thereby enabling the device to be programmed as required without the need to physically dismount the electronic control unit (ECU) that houses the ADuC703X device.

This document describes a demonstration LIN programmer that enables the programming of an ADuC703X device via LIN. The application uses Vector's CANoe [2] with the LIN bus option (referred to as CANoe.LIN) and the *CANcaseXL* hardware with a single LIN channel.

The LIN programmer application adheres to the LIN download protocol specified in [1].

Introduction

This document provides the user with a simple step-by-step procedure on how to program the ADuC703X using the CANoe.LIN-based LIN downloader application.

Setup

The first step is the connection and configuration of the physical hardware involved. This section describes the setup of the hardware components used in the application. The ADuC703X device, acting as a LIN slave, should be connected via the LIN bus to the LIN Master, which in this case is emulated by the Vector CANcaseXL hardware. As LIN messages are transmitted on the bus by the LIN Master according to a predefined schedule, all LIN traffic will be traced and can be observed on the PC using CANoe.LIN (version 5.1). The hardware interconnection is illustrated in figure 1.

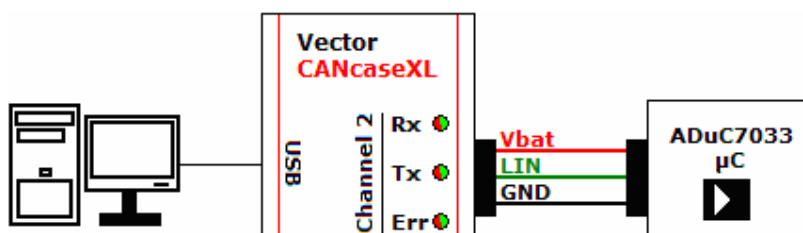


Figure 1. Hardware setup for CANoe.LIN LIN downloader application

Vector CANcaseXL

The Vector CANcaseXL hardware with LIN channel is connected to the host PC via USB. The CANcaseXL, or equivalent Vector hardware, is configured via the *Vector Hardware Configuration* window, which is accessed by going to:

- *Start > Control Panel > Vector Hardware*

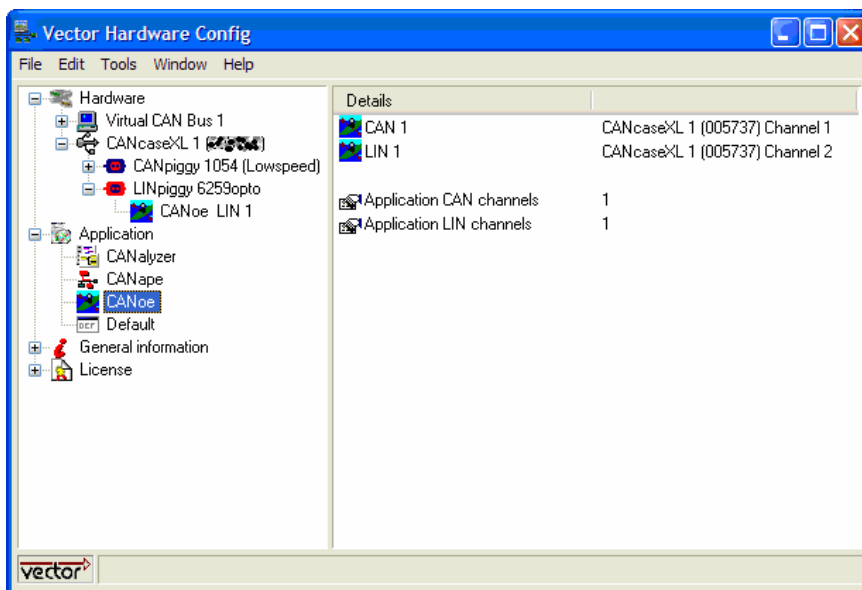


Figure 2. Vector CANcaseXL hardware configuration

Figure 2 shows the CANcaseXL configuration for the CANoe application. The LIN bus, named LIN 1, is active on Channel 2 (via the LINpiggy 6259opto).

Note: Interconnecting Pin3 and Pin4 of the D-Sub connector on the XL Interface causes the internal voltage supply of the LINpiggy to be disconnected. Since the recessive level on the bus depends on the supply voltage of the Master it is advisable to operate the LINpiggy with an external supply voltage that is also used by the other bus nodes, i.e. the ADuC703X. Only then can cross currents be prevented between the individual nodes on the LIN bus.

ADuC703X Microcontroller

The ADuC703X device contains serial downloader firmware which implements the LIN download protocol as described in [1].

The step-by-step procedure of programming the flash on the ADuC703X device via LIN using CANoe.LIN is described in this section.

1. Open the CANoe configuration file: “Protocol4FlashEEPProgramming.cfg”



The CANcaseXL is setup to simulate the LIN Master. The 'ADuC703X' is implemented by a real ADuC703X device (i.e. node).

— Simulated
— Real

2. Specify the file to be programmed to Flash/EE via LIN

Firstly the user should generate the required binary file using the separately supplied '*Binary LIN Data Generator (BLDGenee)*' program. The generated '.blf' file is a binary formatted file which contains the data that is to be programmed to the ADuC703X's integrated Flash/EE via LIN. For instructions on how to use the '*BLDGenee*' program, the user should refer to [3, 4].

Note: The generated '.blf' file should be saved to the same directory as that of the CANoe application's configuration (.cfg) file, in this case 'Protocol4FlashEEPProgramming.cfg'.

The user must then manually code the filename of this '.blf' file into the CAPL program block that represents the LIN Master. The file that implements the LIN Master CAPL program block is '*Protocol4FlashEEr.can*'. In order to open '*Protocol4FlashEEr.can*' do the following:

- Left-click the pencil icon on the 'ADuC703X' node in the 'Simulation Setup' window of CANoe.LIN as shown in figure 4.

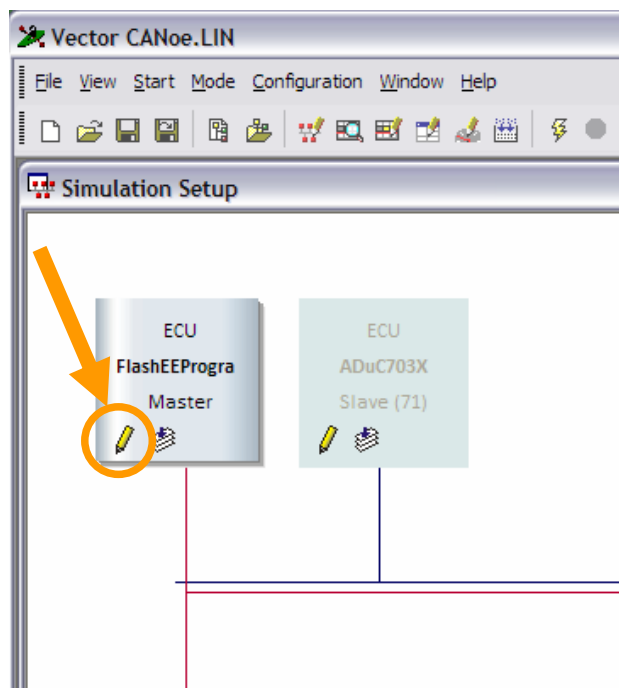


Figure 4 - Opening the LIN Master CAPL program block

The location where the '.blf' filename is to be coded into '*Protocol4FlashEEr.can*' is shown in figure 5. This depicts the '*Variables*' window pane. Scroll down this pane, the '*char caAppCode[32]*' variable is located beneath the commented out header section. The user must equate this variable to the name of the '.blf' file created using '*BLDGenee*' program.

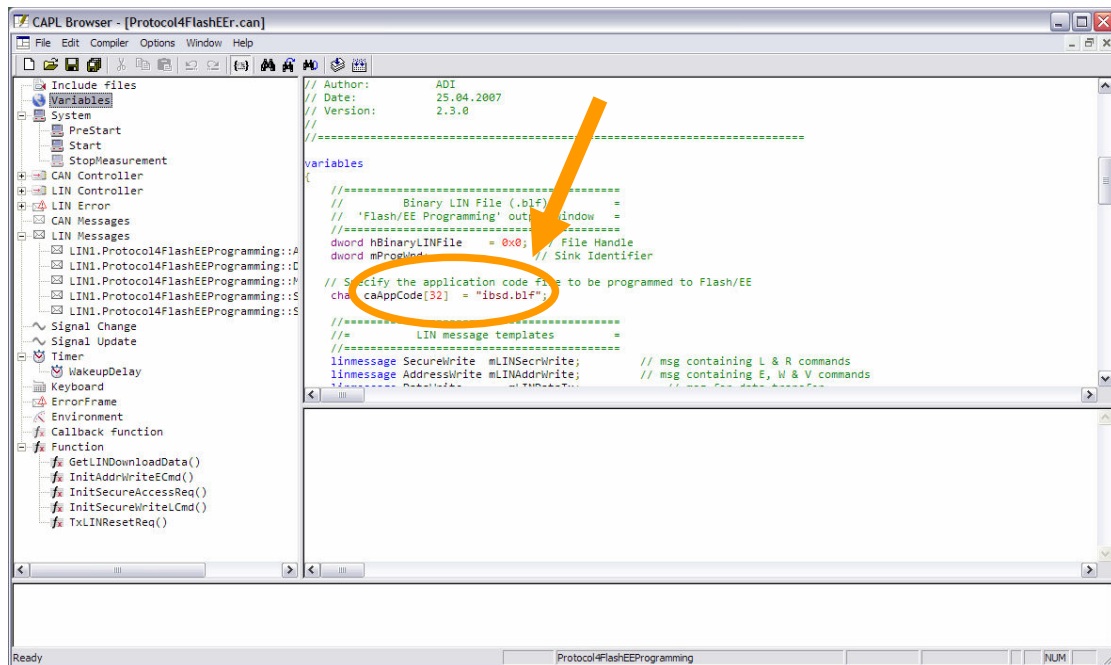


Figure 5 - LIN Master CAPL program block (Protocol4FlashEEr.can)

3. Enter download mode of the ADuC703X device

After Reset the kernel checks the *nTRST* pin of the ADuC703X device to see which state it is in. If *nTRST* is held LOW ('0') the kernel monitors location 0x00080014 in Flash/EE memory. LIN Download mode is entered if the 32 bit content at location 0x00080014 is not either:

- the correct Page 0 Checksum
- or
- the Code Development value (i.e. 0x27011970)

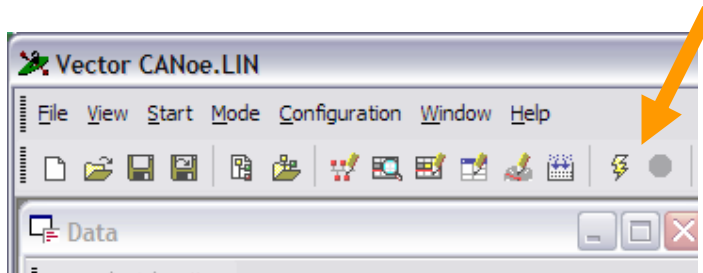
Entering LIN Download mode is described in more detail in [1]. For convenience, a typical entry procedure, which could be implemented in user code, is briefly described here:

- i. Corrupt the value at location 0x00080014 in Flash/EE memory by writing (without erasing) to address 0x00080014.
- ii. Perform a Reset (ensuring pin *nTRST* is held low).

Note: By default, the *nTRST* pin (Pin 11) on ADuC703X device has an internal pull-down resistor. The user must ensure that *nTRST* is not being pulled HIGH ('1'), for example by the presence of external pull-up resistor circuitry.

4. Start the simulation

To start the LIN downloader application, on the CANoe.LIN window click the 'Start' icon or press the F9 key.



The simulation starts the LIN hardware in sleep mode. Subsequently the LIN hardware (which should be in master mode) sends a LIN wake up frame enabling the LIN slave to wake up correctly.

5. Transmit 'CorruptRoutine' message

This element of the LIN downloader supports the implementation of some user-specific software routine (residing in the device Flash/EE memory), the purpose of which is to corrupt location 0x00080014 of Flash/EE memory in order to enable reprogramming of a previously programmed part.

The absence of such a routine will not affect the LIN downloader, as the corresponding PID will simply not be recognised by the Slave node (i.e. ADuC703X).

Upon starting the simulation a specific LIN message is transmitted to the ADuC703X device (LIN Slave). The byte values of this LIN message can be modified in the *'InitCorruptRoutineReq()'* function of file *'Protocol4FlashEEr.can'*, via the CAPL Browser. Upon recognising this message the application software, embedded on the device itself, will corrupt location 0x00080014 and reset the part, thereby entering LIN Download Mode in the Kernel.

Subsequently, Flash programming via LIN commences.

6. Enter LIN Download Mode

When the CANoe simulation has been started the *'AssignFrameId'* request, corresponding to the required *'SecureWrite'* PID, is automatically transmitted. Subsequently, the enter *LIN Download Mode 'L' command* is sent automatically. The combination of the aforementioned *'AssignFrameId'* request and the *'L' command* enables the user to access LIN Download mode on the ADuC703X device.

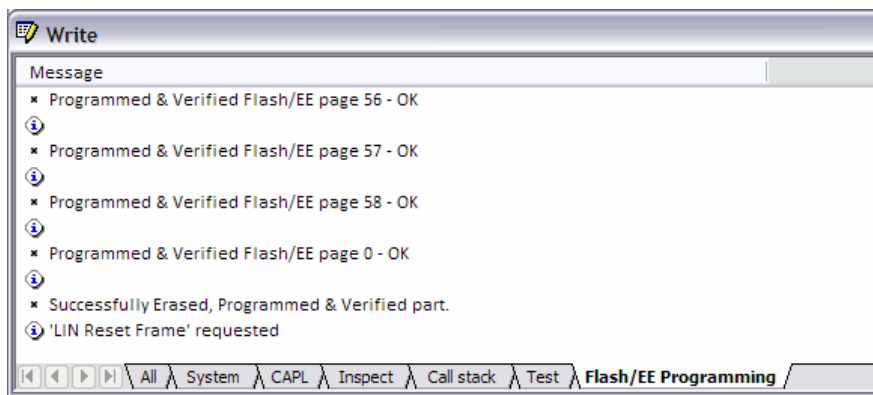
The ADuC703X Flash/EE Programming via LIN download sequence is automatically started, and the specified *'.blf'* file is programmed to flash.

7. Observe the Flash/EE Programming via LIN download sequence

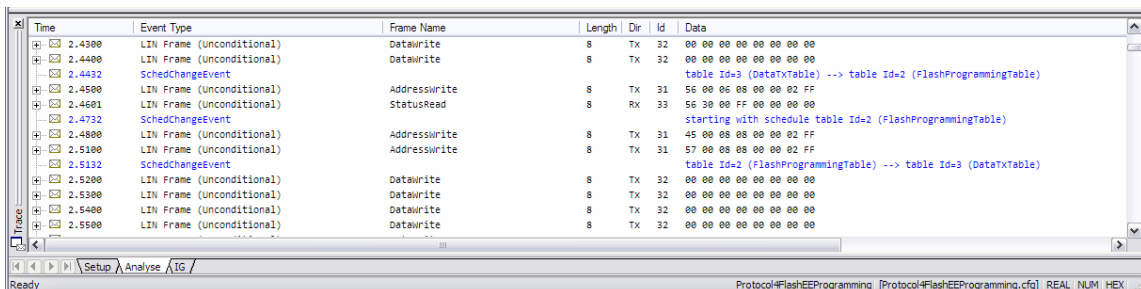
Two useful methods of observing the progress of the ADuC703X Flash Programming via LIN are described in this section.

- i. When the CANoe application is started a tab called '*Flash/EE Programming*' is added to the write window. Information about the progress of the flash programming is output here, including:
 - The current flash page being programmed
 - Whether it was verified as having been programmed ok
 - Various other notification messages, e.g. LIN download completion, LIN data transfer interruption, reset requested, etc.

The following figure illustrates these points.



- ii. By selecting the CANoe. LIN '*Trace*' window, the user can observe LIN messages transmitted and received during the flash programming sequence.



8. Send adhoc LIN commands

All LIN commands specified in [1] may be transmitted manually by the user.

This functionality is provided via the '*Interactive Generator*' feature of CANoe, which enables the user to specify the values of a particular LIN command prior to transmitting it.

With the CANoe application running and flash programming of the specified file completed (and prior to a 'LIN Reset Frame' command), the user may transmit LIN commands by pressing keys as shown in table 1. The values that are transmitted are specified in the 'Data Field' as illustrated down the right hand side of figure 6.

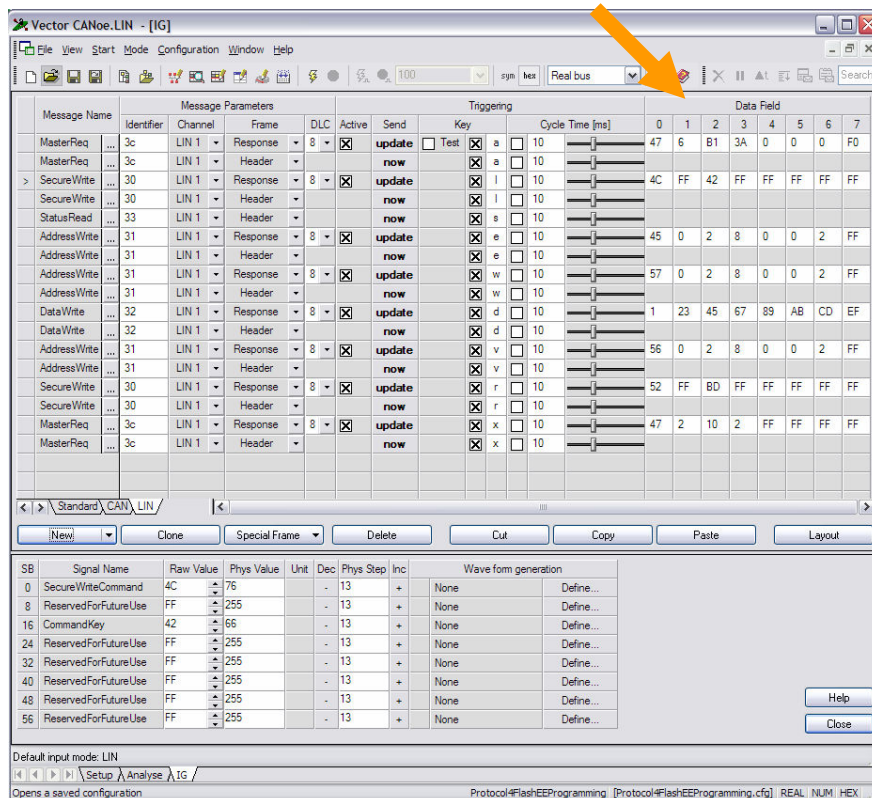


Figure 6 – CANoe Interactive Generator for Protocol 4 for Programming Flash/EE via LIN

LIN Diagnostic Command	Key	Description	Returns
<i>AssignFrameId</i>	a	Assigns the specified id to the mandatory <i>SecureWrite</i> PID	No response
<i>SecureWrite: Enter LIN Download Mode Frame 'L'</i>	l	Enters LIN download mode; enables all subsequent commands	Previous command sent and status of command
<i>AddressWrite: LIN Erase Flash Frame 'E'</i>	e	Erases the specified number of flash pages (in bytes) starting at the specified location	Previous command sent and status of command
<i>AddressWrite: LIN Write Flash Frame 'W'</i>	w	Specifies the start address in flash to which the specified amount (in bytes) of data is to be transferred to flash	Previous command sent and status of command
<i>DataWrite: LIN Flash Data Frame</i>	d	Transmits the specified 8 bytes of data	No response
<i>AddressWrite: LIN Verify Flash Frame 'V'</i>	v	Calculates the checksum of the specified programmed flash page	Previous command sent, status of command and checksum of page flashed
<i>SecureWrite: LIN Reset Frame 'R'</i>	r	Resets the ADuC703X	No response
<i>StatusRead</i>	s	Requests a response from the ADuC703X. A <i>StatusRead</i> may only be transmitted after the following commands: L, E, W, or V	Depends on the previous LIN command frame

Table 1 – Interactive Generator LIN command keys

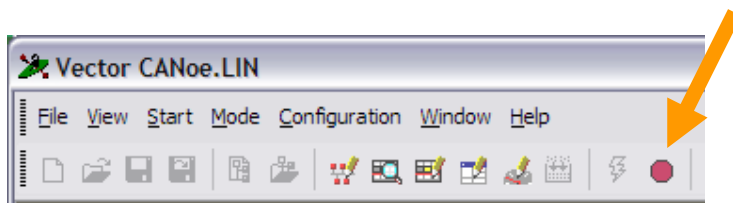
9. Reset the ADuC703X node

The ADuC703X is reset via transmitting a '*LIN Reset Frame*', as described in Table 1. Following a reset no further LIN commands can be sent until the next Flash/EE Programming via LIN sequence is started.

In this implementation, a LIN Reset Frame is automatically transmitted upon completion of Flash programming via LIN.

10. Stop the simulation

To stop the LIN flash programming application; on the CANoe.LIN window click the 'Stop' icon or press the 'Esc' key.



The CANoe.LIN measurement is stopped and no further "Protocol 4 Flash/EE Programming via LIN" commands may be transmitted.

References

- [1] Analog Devices Inc., 'Technote AN-947: Flash/EE Programming via LIN', Rev. 0, 2007.
- [2] Vector Informatik GmbH, 'CANoe.LIN User Manual', Version 6.0, 2006.
- [3] Analog Devices Inc., 'Hex-to-Binary LIN Data Generator – GUI Version', Rev. 1.3, June 2007.
- [4] Analog Devices Inc., 'Hex-to-Binary LIN-downloadable File Generator – Command Line Version', Rev. 3.0, May 2007.