INCA-LIN V7.3

User's Guide

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Content

1 Introduction

The LIN protocol (Local Interconnect Network) is a de-facto low-cost standard for communication with intelligent sensors and actuators in motor vehicles. It is used in all instances where the bandwidth and versatility of CAN are not required.

With the add-on INCA-LIN in combination with a LIN hardware interface, INCA supports the display and recording of signals on the LIN bus in their physical representation (LIN monitoring). While measuring and calibrating ECUs with ETK or CAN, you can also monitor the communication on the in-vehicle LIN bus. The time stamps of the data samples are synchronized with all other data sources within INCA to enable causal analysis as well as error tracking within the investigated system.

Basis for the easy configuration of the interface hardware and the selection of signals to be measured is the LIN Description File (LDF, *.ldf). The LDF file contains the descriptions of the LIN bus cluster including signals, frames, nodes, encodings and configuration parameters.

At present INCA supports the LIN versions V1.2, V1.3, V2.0 and V2.1.

1.1 General Description

In typical LIN use cases, users often would like to carry out several tasks at the same time:

- Measuring and calibrating ECUs with ETK / CAN
- Monitoring the in-vehicle LIN Bus with synchronized time stamps
- Recording signals and analyzing them later

In these tasks, the user would like to

- work with physical signals (temperature, current, …)
- use LIN Description Files (LDF) for configuration (the LDF format specification is part of the LIN standard)

INCA-LIN can fulfil all these requirements.
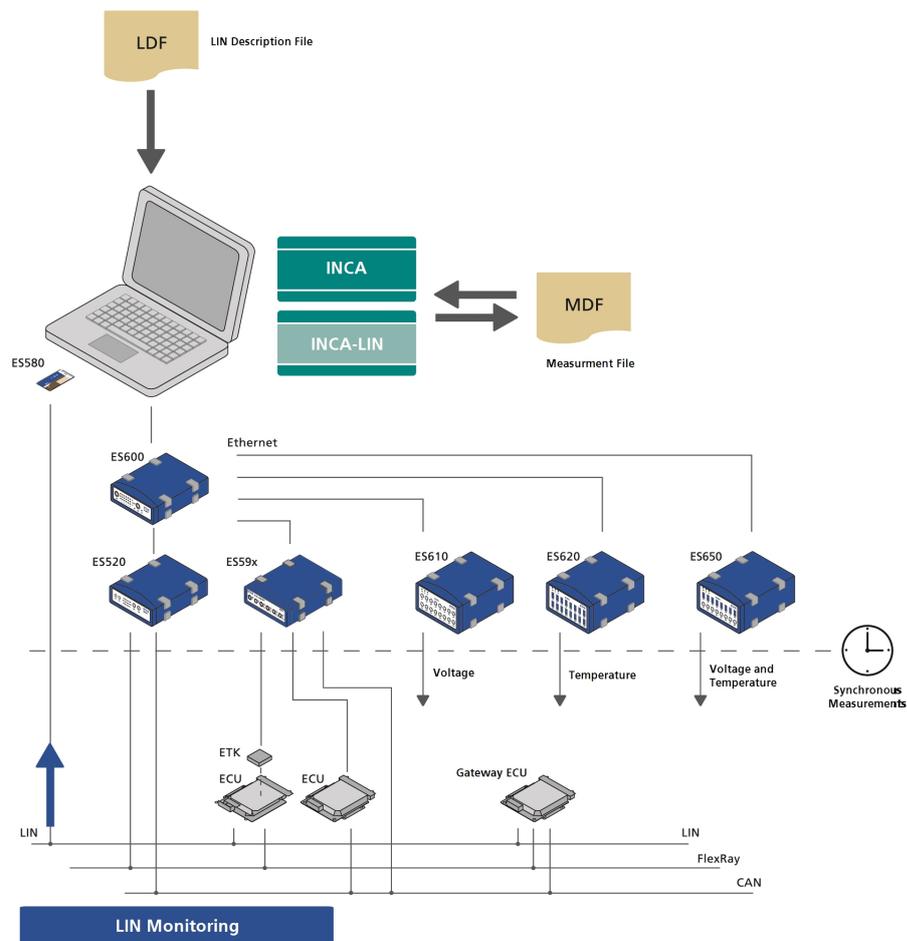
The INCA-LIN monitoring device remains completely passive. It does not participate in the LIN communication and therefore cannot disturb or influence the LIN communication in any way.

> **ⓘ Note**
>
> The INCA-LIN add-on provides the LIN functionality. The support of LIN hardware in INCA is provided by means of the corresponding hardware add-ons for INCA. The hardware add-ons are delivered with the hardware modules, and they can be downloaded from the ETAS website at http://www.etas.com/en/download_center.php.

1.2 Special Features at a Glance

In general, the LIN monitoring functionality is very similar to the CAN and FlexRay monitoring functionality.

The INCA-LIN add-on includes the following special features:

- **Writing imported LDF files back to the file system**

  It is possible to write LDF files that you have imported into INCA back to the file system. For that purpose select the LDF file in the "Database Objects" listbox of the Database Manager and then select **Write → LDF** from the context menu.

  It is not possible, however, to edit LDF files in INCA. In INCA, LDF files can only be imported or written back to the file system without being edited.

- **Support and pre-configuration of dynamic frames**

  INCA-LIN supports the pre-configuration of dynamic frames, i.e. of frames where the frame assigned to a certain frame ID can change over time. To make sure that the frames are interpreted correctly, you can pre-select the frame that is to be used for signal encoding when INCA is connecting to a LIN bus that is already running. The corresponding setting can be entered in the Hardware Configuration Editor in the "Dynamic Frames" option of the LIN Monitoring device.

  The selection is valid for the time from the measurement start to the next assignment of a frame by the LIN master. If this field is empty, no signal data get measured for this frame ID until the LIN master assigns a frame.

  > **ⓘ Note**
  >
  > Dynamic frames are used only if they are defined in the corresponding LDF file.

- **Easy signal selection by pre-ordered groups for nodes and frames**

  INCA automatically generates groups for all frames and all nodes that are listed in the LDF file. The groups contain sub-groups for each individual frame or node respectively, thus structuring the available signals, which makes the selection of specific signals in the Variable Selection Dialog a lot easier.

- **Monitoring of LIN frame raw data**

  Sometimes not all data present on the LIN bus is represented in the LDF. By means of the option "Show frame raw data as variables", which can be set in the Hardware Configuration Editor for the LIN Monitoring device, INCA-LIN offers the possibility to monitor the raw data of the 8 Byte payload for each of the 64 LIN frames. This enables you to monitor LIN frame contents even with no signals defined in the LDF file.

- **Monitoring the LIN bus status as a variable (Power Management)**

  In addition to the variables that are defined in the LDF file, INCA-LIN offers a variable LIN_PowerManagement (included in the group _LIN_BusStatus). The value of this variable indicates the current status of the LIN bus, thus

enabling you to record the bus status information along with other measure data. This can provide useful hints, e.g. in cases where the bus communication is interrupted.

1.3 Definitions

LIN

The LIN bus (Local Interconnect Network) is a small and slow network system that is used as a low-cost sub-network of a CAN bus to integrate intelligent sensor devices or actuators in today's cars.

The LIN specification is enforced by the LIN-consortium and is continuously enhanced to meet current networking needs.

INCA V7.3 supports the following versions of the LIN specification:

- LIN V1.2
- LIN V1.3
- LIN V2.0
- LIN V2.1

For detailed information on the LIN specification see the web pages of the LIN consortium at http://www.lin-subbus.org/.

LDF

LDF is as part of the LIN specification a file format used to describe an entire LIN cluster. The LDF format contains information regarding LIN nodes, frames and signal values with physical conversions.

INCA uses LDF files to provide the measurable signals, to calculate physical values and for the configuration of the hardware interface.

The LDF files have to be provided by the vehicle manufacturer.

2   Installation

This chapter is for all users who install the INCA-LIN add-on on a PC. It also contains information on hardware and software requirements and the preparation required for installation.

2.1   Package Contents

The INCA-LIN add-on consists of the following items which have to be ordered separately:

- INCA-LIN software license
- CD ROM
    - Program files for the INCA-LIN add-on
    - Manual in PDF format (Acrobat Reader)
    - Product information in PDF format (Acrobat Reader)

2.2   System Requirements

INCA-LIN requires the following hardware and software:

- INCA V7.1.x or higher
  Please refer to the INCA Installation Guide for the INCA system requirements.
- INCA-LIN hardware interface

2.3   Installing INCA-LIN from CD-ROM

Please note that you must have administrator privileges to install the INCA-LIN add-on.

To install the INCA-LIN Add-on

1. Make sure that INCA is installed on your computer and that the release number of the INCA installation is compatible with the release number of the INCA-LIN add-on.
2. Close all active programs.
3. Insert the CD with the installation program into the CD-ROM drive of your computer.
4. If the installation CD does not start automatically, either execute the autostart.exe program on the CD to start the user interface of the CD or search for the Inca_AddOn-LIN.exe program on the CD and double-click it to start the installation routine manually.
5. Follow the instructions in the installation routine to install the INCA-LIN add-on on your computer.

3 Using the INCA-LIN Add-on in INCA

This chapter gives an example of how INCA-LIN can be used in INCA. It describes a typical course of action for LIN monitoring.

Before you can start monitoring the LIN bus via INCA, you have to prepare INCA for that task. Working with INCA-LIN comprises the following basic tasks:

- Setting up the workspace in the Database Manager
- Configuring the LIN hardware in the Hardware Configuration Editor
- Configuring the experiment and starting monitoring in the Experiment Environment

The course of action resembles the usual procedure for preparing and carrying out measurement tasks. For LIN monitoring, however, LDF files are used. These are handled in the same way as A2L projects, CANdb or FIBEX files.

The following sections describe the basic procedures applied when working with LIN from within INCA. In some cases there is more than one way of performing a task, e.g. LDF files can be added either in the Database Manager or in the Hardware Configuration Editor. The following description provides an example of one typical course of action.

3.1 Setting up the Workspace

In the first step of preparing LIN monitoring, you create a new database and workspace and add an LDF file to the database.

The LDF file has to be provided by the vehicle manufacturer. It contains a description of the configuration of the measurement hardware as well as of the signals which are available through the LIN bus.

The following example is using the LIN Network SpaceCar V2.ldf demo file, which is installed together with the INCA-LIN add-on.

To set up the Workspace

1. To create a new database, select **Database → New**.
2. In the "New Database" dialog, enter `LIN_Demo`.
3. Click **OK**.
4. Create a top folder in the database and therefore select **Edit → Add → Add top folder**.
5. Rename the new folder `Demo` and press <ENTER>.
6. To create a new workspace, select the top folder you want to create the workspace in. (Here, select the Demo folder).
7. Select **Edit → Add → Workspace**.
8. Rename the new workspace LIN Network and press <ENTER>.
9. To add an LDF file to the database select the top folder Demo.

10. Select **Edit → Add → LDF**.

    A dialog pops up where you can select the desired LDF file.

11. Select the LDF file and click **Open**.

Note that when you select the LDF file in the "Database Objects" listbox of the Database Manager, additional information on the LDF file is displayed in the "LDF" listbox, e.g.

- the path and file name of the original LDF file as well as its change date;

- the version of LIN protocol used in the LDF file (e.g. 1.3, 2.0);

- additional information if the file does not fully comply to the LDF spe-cification and other warnings that occured during import.

3.2   Configuring the LIN Hardware

After having set up the workspace, you must add the hardware to your con-figuration. In the case of LIN monitoring, you assign an LDF file to the hardware used. The LDF file contains hardware and signal related information such as for-mulas for automatic conversion to physical signal values, therefore making com-plex parameter entries obsolete.

To add the LIN Hardware

1. In the Database Manager, select the "LIN Network" workspace.

2. Click the **Configure Hardware** icon above the "Hardware" listbox to start the Hardware Configuration Editor.

   In the Hardware Configuration Editor, add the LIN hardware and assign the LDF description:

3. Select **Device → Insert**.

   The "Add hardware device" dialog appears, showing a list of inter-faces with available devices.

4. Expand, for example, the "ES592" folder by clicking on the **+** sign in front of it, then expand the "LIN" folder.

5. Select the entry "LIN-Monitoring".

6. Click **OK**.

   A dialog appears, where you can select the LDF file with the description of the LIN communication.

7. Select the LDF file that is already present in your database.

8. Click **OK**.

In the next step you can set the hardware parameters of the LIN monitoring device.

To configure and initialize the LIN hardware

1. In the "Hardware devices" list, select the "LIN-Monitoring:1" node.

2. Select the "LIN-Monitoring Parameters" tab.

A table with LIN-specific parameters is displayed.

The following table lists the parameters on the **LIN-Monitoring Parameters** tab and explains their meaning:

Parameter Name	Explanation
Show frame raw data as variables	With this option, you can determine whether you can select the raw data of the 8 Byte payload for each of the 64 LIN frames. In the "Variable Selection" dialog, the individual frames are represented by 64 variables that are generated by INCA. Each frame consists of a header area and a response, whereas INCA shows only the response as a byte array of 8 bytes, one for each frame.
LIN version	Shows the LIN version that is used in the LDF file.
LIN speed	Shows the LIN data transmission rate (kBaud). The transmission rate is defined in the LDF file.
Configuration	The LDF file can contain a block `Node_composition_definition` with one or more configurations. The configurations define which LDF nodes will be used. This parameter determines which of the configurations defined in the LDF file will be used for LIN Monitoring. If the LDF file does not contain configuration variants, the string -- gets displayed.
Dynamic Frames	This parameter is only displayed if the LDF file contains a corresponding section. The LDF file specifies that the frame assigned to this frame ID can be changed over the time. This field determines which frame is to be used for initial signal decoding. The selection is valid for the time from the measurement start to the next assignment of a frame by the LIN master. If this field is empty, no signal data get measured for this frame ID until the LIN master assigns a frame.

After having got this background information, you can now go on with configuring the interface and initializing the hardware:

1. In the list of LIN parameters, click in the field on the right of the "Show frame raw data as variables" field.

2. Click it once again to open the list and select **Yes**.

    Setting this option to **Yes** enables you to select the raw data of each individual frame.

3. In the list of LIN parameters, click on the **+** sign in front of the "Dynamic Frames" field to open the tree structure.

4. Double click on the field next to the "Frame ID 2" field and select the entry **VL1_LSM_Frm1**.

    This frame will now be used by default for signal decoding until the LIN master explicitly assigns another frame.

    > ### 🛈 Note
    >
    > The "Dynamic Frames" parameter is displayed only if dynamic frames are defined in the assigned LDF file. The demo file used in this example contains such dynamic frames.

5. Click **Apply** to make your new settings become valid.

6. Select **Hardware → Initialize hardware**.

The icon in front of the **LIN-Monitoring:1** entry displays the connection status. The green icon indicates that the initialization has been successful and a connection to the device has been established.

You have now finished hardware configuration and can close the Hardware Configuration Editor.

3.3 Configuring the Experiment and starting LIN Monitoring

In the Experiment Environment you can select all signals for monitoring which are defined in the LDF file.

Moreover it is possible to monitor the raw data of individual LIN frames and the bus status of the LIN network.

To configure the Experiment

1. In the Database Manager, select the LIN Network workspace.

2. Click the **Start Experiment** icon above the "Experiment" listbox to open a new experiment in the Experiment Environment.

3. Select and configure the variables you would like to add to the experiment.

4. In the "Experiment" window, select **Variables → Variable Selection**.

The "Variable Selection" dialog opens.

5. In the "Sources" list, select the device **LIN-Monitoring:1**.
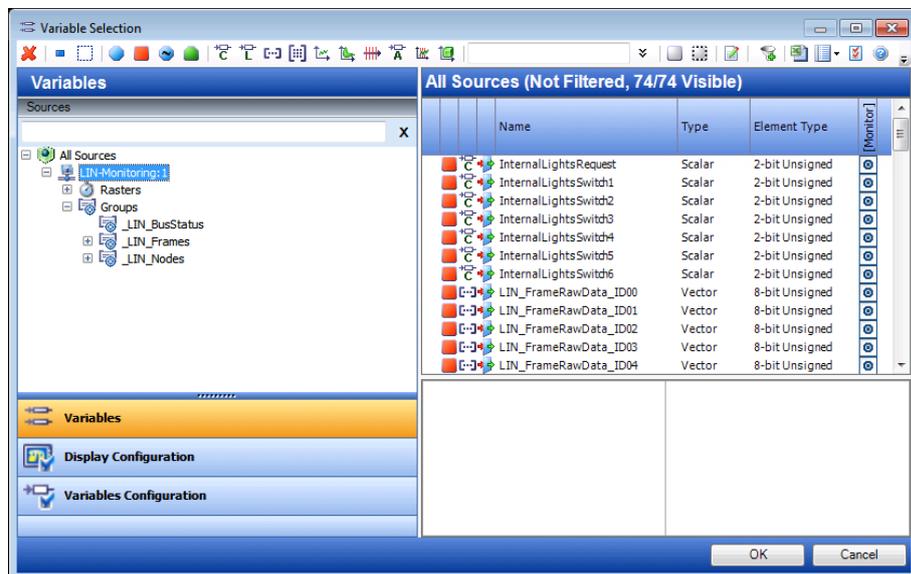
The variables list now shows all variables in alphabetical order that belong to this device. It might happen that you do not see the variables that you expect or that there are no variables displayed at all; in this case please verify that there is no filter being used. If required, you can deactivate all filters by clicking on the "Clear all filters" ✖ icon in the toolbar.

If you are interested only in variables for individual nodes or frames, you can expand the tree in the "Sources" list by clicking on the **+** sign left of the device and then browse through the tree structure to select only the desired node or frame. The variables list only displays the variables of the selected node or frame (see "Selecting Variables by Frames or Nodes" on page 16). Summarizing these explanations, you can select variables in one of the following ways:

- You click on the LIN device and select the desired signals from a complete list of signals for that device.

- You expand the tree structure of the LIN device by clicking on the + sign in front of it, further expand one of the groups for frames or nodes and click on the desired items. Afterwards you can select the desired variables from a subset containing signals associated with the selected frames or nodes.

  All groups are represented by a the following icon in the tree view of the "Sources" list:

6. In the variables list, select all variables you would like to monitor.

   Further information is displayed in the information pane of the dialog as soon as you select a variable.

7. Click **OK** to add the selected variables to the Experiment window.

   The selected variables are displayed in the standard measure window.

8. To select frame raw data that you would like to monitor as well: open the "Variable Selection" dialog.

9. In the "Sources" list, select the device **LIN-Monitoring:1**.

10. Below, open the "Groups" book, then open the "_LIN_Frames" book and select the sub-entry **_LIN_FrameRawData**.

    The variables list now displays 64 entries representing the individual frames. Their names consist of the name of the frame they belong to, with a suffix _ID00 to _ID63 appended.

   > ### ⓘ Note
   >
   > The frame raw data are displayed only if the parameter "Show frame raw data as variables" was set to `Yes` during hardware configuration.

11. Select one of the entries in the variables list.

    A sub-dialog opens which shows the response of the frame as a byte array of 8 bytes.

12. Mark all items in the sub-dialog to monitor the complete response and click **Close**.

13. In the same way, add other entries for monitoring frame raw data as desired.

14. Add the variable which is used for monitoring the bus status of the LIN network:

15. In the "Sources" list, select the group _LIN_BusStatus.

16. The variable LIN_PowerManagement is displayed in the variables list.

17. Mark the variable in the variables list.

18. Click **OK** to add all selected variables to the Experiment window.

19. Select **Experiment → Save**.

20. The "Save as" dialog appears. In the list "Database Objects" select the Demo folder to add the experiment to the folder. Then enter the name Monitoring_Exp in the list "Item name" and click **OK**.

Now that you have prepared the experiment, you are ready to start monitoring the physical values of the signals on the LIN bus as well as some frame raw data and the bus status.

To start Monitoring

1. Click <F11> to start visualization without recording.

or

Click <F12> to start recording.

4 Tips and Tricks

This section provides some help information for tasks which might be difficult to understand or can be optimized by means of little tips and tricks.

4.1 Selecting Variables by Frames or Nodes

When you determine which variables are to be used in the INCA Experiment Environment for measurement and calibration tasks, you usually first select a device or a function of that device and then select the desired variables from a plain list in the "Variable Selection" dialog.

In case of CAN Monitoring devices, the variables are also grouped by CAN frames so that you can either select the variables from a list of all variables or from a sub-list of variables belonging only to the selected CAN frame.

According to the same principle, the variables of a LIN device are also grouped by frames or nodes. For that purpose, the groups _LIN_Frames and _LIN_Nodes are automatically added to the LIN monitoring device in the "Sources" list of the "Variable Selection" dialog.

In the "Variable Selection" dialog, each group is depicted by the following icon: (also see screenshot below):
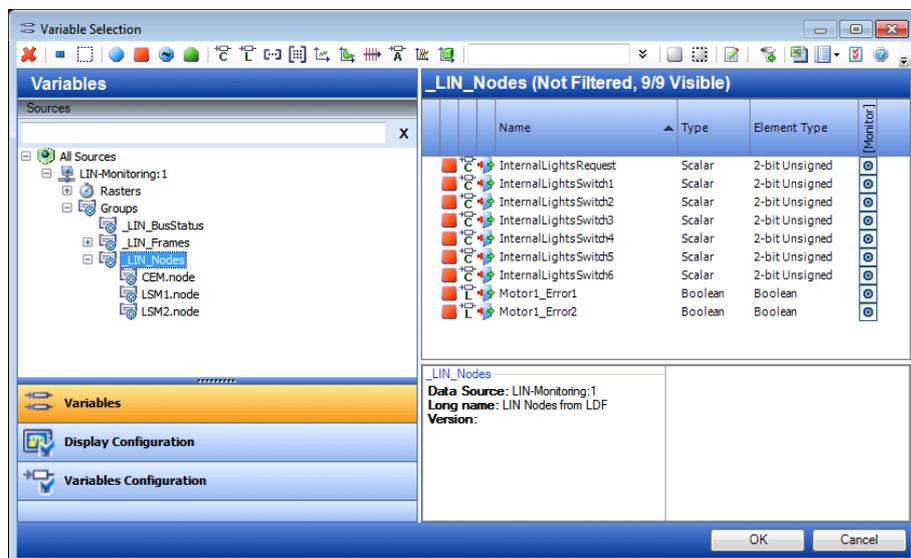
- Grouping by frames:
  When you select a frame in the group _LIN_Frames in the "Sources" list, the variables list shows all signals published in the selected frame.

> **Note**
>
> Depending on the description in the LDF file, the same signal can occur in different frames.

- Grouping by nodes:

  When you select a node in the group _LIN_Nodes in the "Sources" list, the variables list shows all signals of the selected node (i.e. signals that are published by the node).

4.2 Viewing Frame Raw Data

INCA-LIN offers an option to monitor the raw data of the 8 Byte payload for each of the 64 LIN frames. Each frame consists of a header area and a response, whereas INCA shows only the response as a byte array of 8 Bytes, one for each frame.

With this option enabled in the Hardware Configuration Editor, additional LIN raw data variables are available in the Variable Selection dialog.

In this way, INCA-LIN offers the possibility to select the data of each frame separately in INCA without interpreting them as signals. This enables you to monitor LIN frame contents even with no signals defined in the LDF file.

4.3 Monitoring the Bus status of the LIN Network

The LIN network is not always fully operational; there are also times when it is not connected, in stand by mode or being initialized.

To make the bus status transparent for INCA, the INCA-LIN add-on automatically offers an additional variable that is not part of the LDF file and that displays the current status of the LIN bus. The variable can have the following values:

- power off
- initializing
- operational
- stand by

When you select the variable LIN_PowerManagement for measurement, the bus status over time gets measured along with the "real" LIN signals on the LIN bus. This is useful in such cases, for example, where you come across parts of the measurement where no or doubtful signals seem to be sent on the LIN bus. A further analysis of the data might indicate that the LIN network was not operational at that time.

4.4 Displaying Additional Information on Variables and Groups

The LDF file can contain some additional information on variables and groups that is not directly displayed in INCA, e.g. the frame ID of the frames. You can view this information by selecting the corresponding item and then selecting **About variable** or **About variable container** from the context menu in the Variable Selection dialog.

5   Restrictions

This product has been manufactured with the utmost care for quality, usability and completeness in terms of users' expectations.

Nevertheless, there are constraints that need to be considered when using this product.

5.1   Signal Groups according to LIN V1.3 not supported

Signal groups according to LIN V1.3 (i.e. signals that consist of 2 or more merged signals) are not supported. The signal groups are obsolete in later LIN specifiation (replaced in LIN specification V2.0 by signal arrays).

If an LDF file uses signal groups according to LIN V1.3, these get ignored, and only the signals making up the signal groups can be used. If a specific use case requires signal groups, you can use calculated signals to provide the same functionality.

5.2   Multiple Physical Units for One Signal not supported

INCA-LIN does not support multiple physical units for one signal. INCA always displays the unit of the physical range with the smallest max value that is listed for the signal in the LDF file.

5.3   Handling of LIN Signal Encodings

The following sections describe the handling of LIN signal encodings in cases where the used encoding is not directly supported or handled in a special way.

Combination of Physical and Logical Signals

INCA-LIN supports mixed LIN signal encodings of the types "physical" and "logical".

As oscilloscopes, however, hardly can display logical and physical values at the same time INCA replaces such signals by two signals:

- one signal with the extension .logical with the logical encoding assigned and
- one signal with the extension .physical with the physical encoding assigned.

An according note is displayed in the LDF info pane of the Database Manager or LDF file selection dialog.

Restrictions in "ASCII" and "BCD" Signal Encodings

INCA-LIN supports the signal encodings "ASCII" and "BCD". However, the ASCII and BCD support contains the following restrictions:

- **Arrays**:

    For array signals only the length of 1 or more complete bytes (8 bit, 16 bit, etc.) is allowed.

- **Scalars**:

    For scalar signals, up to 16 bits are allowed. However, only the first 8 bits are used for decoding:

Type of Encoding	Bit Range	Decoding
ASCII	0x0000 to 0x007F	ASCII characters interpreted as string
ASCII	0x0080 to 0xFFFF	string: "value not defined"
BCD	0x0000 bis 0x00FF	packed BCD interpretation 00..99
BCD	0x0100 bis 0xFFFF	string: "value not defined"

Restriction in "Physical Range" Signal Encoding

INCA-LIN supports the LIN signal encoding "Physical Range". Even multiple physical ranges are supported. However, if multiple physical ranges are used, gaps between the value areas are not allowed.

If INCA-LIN encounters signals of the type "Physical Range" with gaps between the physical ranges, it assigns the encoding IDENTICAL, i.e. no formula for the calculation of the physical signal is applied.

An according note is displayed in the LDF info pane of the Database Manager or LDF file selection dialog.

Interpretation of Signals with Exceeded Limits

Whenever signals are used where a physical formula is assigned and the hex values exceed the defined limits, INCA displays the value of the corresponding limit (i.e. the allowed maximum/minimum value of the signal).

5.4 ASAM MCD-3 (new)/ ASAP3

[1] When using the remote control functionality (ASAM-MCD3 MCD or ASAP3) you need to select "FRAME AVAILABLE" from the available rasters to monitor LIN signals.

5.5 Maximum Identifier Length

The maximum identifier length of named objects in the LDF is limited to 32 characters.

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[1] ASAM MCD 3 V2.00.02 (object oriented model), dating from 04.04.2005

Longer identifiers are truncated on the right side. If the resulting identifier is not unique, INCA-LIN will postfix the identifier with an additional index (e.g. .n01).

5.6 Channel Postfix Name Definition

Since LIN 2.1 a postfix for all named objects in the LDF file is supported.

The resulting identifiers must follow the normal C rules for variable declaration.

Invalid characters (i.e. characters that are not A...Z, 0...9 or _) of the channel postfix name are replaced by an underscore. See also "Maximum Identifier Length" on the previous page.

6   ETAS Contact Addresses

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