ETAS INCA V7.6

Tutorial

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INCA V7.6 I Tutorial R01 EN I 03.2026

Contents

1 Introduction

This tutorial teaches the INCA novice all elementary steps applicable to two typical tasks performed with INCA: measurement and calibration. The tutorial does not require any knowledge of INCA.

1.1 Intended Use

INCA and INCA add-ons are developed and approved for automotive applications and procedures as described in the user documentation for INCA and INCA add-ons.

INCA and the INCA add-ons are intended to be used in industrial labs and in test vehicles.

ETAS GmbH cannot be made liable for damage that is caused by incorrect use and not adhering to the safety information.

1.2 Target Group

This software product and this user guide address qualified personnel working in the fields of automotive ECU development and calibration, as well as system administrators and users with administrator privileges who install, maintain, or uninstall software. Specialized knowledge in the areas of measurement and ECU technology is required.

1.3 Classification of Safety Messages

Safety messages warn of dangers that can lead to personal injury or damage to property:

DANGER

DANGER indicates a hazardous situation that, if not avoided, will result in death or serious injury.

WARNING

WARNING indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

CAUTION indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE indicates a situation that, if not avoided, could result in damage to property.

1.4 Safety Information

Observe the following safety information when working with INCA and INCA add-ons:

WARNING

Risk of unexpected vehicle behavior

Calibration activities influence the behavior of the ECU and the systems that are connected to the ECU.

This can lead to unexpected vehicle behavior, such as engine shutdown as well as breaking, accelerating, or swerving of the vehicle.

Only perform calibration activities if you are trained in using the product and can assess the possible reactions of the connected systems.

WARNING

Risk of unexpected vehicle behavior

Sending messages via bus systems, such as CAN, LIN, FlexRay, or Ethernet, influences the behavior of the systems connected to it.

This can lead to unexpected vehicle behavior, such as engine shutdown as well as breaking, accelerating, or swerving of the vehicle.

Only perform the sending of messages via a bus system if you have sufficient knowledge in using the respective bus system and can assess the possible reactions of the connected systems.

Adhere to the instructions in the ETAS Safety Advice and the safety information given in the online help and user guides. Open the ETAS Safety Advice in the INCA help menu **? > Safety Advice**.

1.5 Data Protection

If the product contains functions that process personal data, legal requirements of data protection and data privacy laws shall be complied with by the customer. As the data controller, the customer usually designs subsequent processing. Therefore, he must check, if the protective measures are sufficient.

1.6 Data and Information Security

To securely handle data in the context of this product, see the INCA Help section “Data and Information Security”.

2 INCA Basics

INCA is a measuring, calibration, and diagnostic system that provides comprehensive measuring support. INCA aids you in all essential tasks during control unit calibration, evaluates the measured data, and documents the calibration results.

INCA lets you read measured data from the control unit and the engine in parallel. The program helps you determine measured engine data such as lambda, different temperatures and voltage values, etc. With INCA, you don't just get a tool that will adapt to a variety of different control units, but also a system that will optimize a wide range of different vehicle components.

INCA is an "open system". Consistent implementation of the ASAM-MCD standard and support for data exchange formats that are established in this environment allow this program to be used for any ECU interfaces (can be customized to any manufacturer's control units) and to be integrated in existing data processing infrastructures.

INCA consists of a measurement and calibration core system which can be enhanced by various add-ons and customized extensions (e.g. INCA-MIP, INCA-QM-BASIC, INCA-FLEXRAY) that can be integrated in INCA. In addition to that, INCA offers open interfaces which allow for the adaptation of INCA core capabilities as well as the remote control of INCA by other applications.

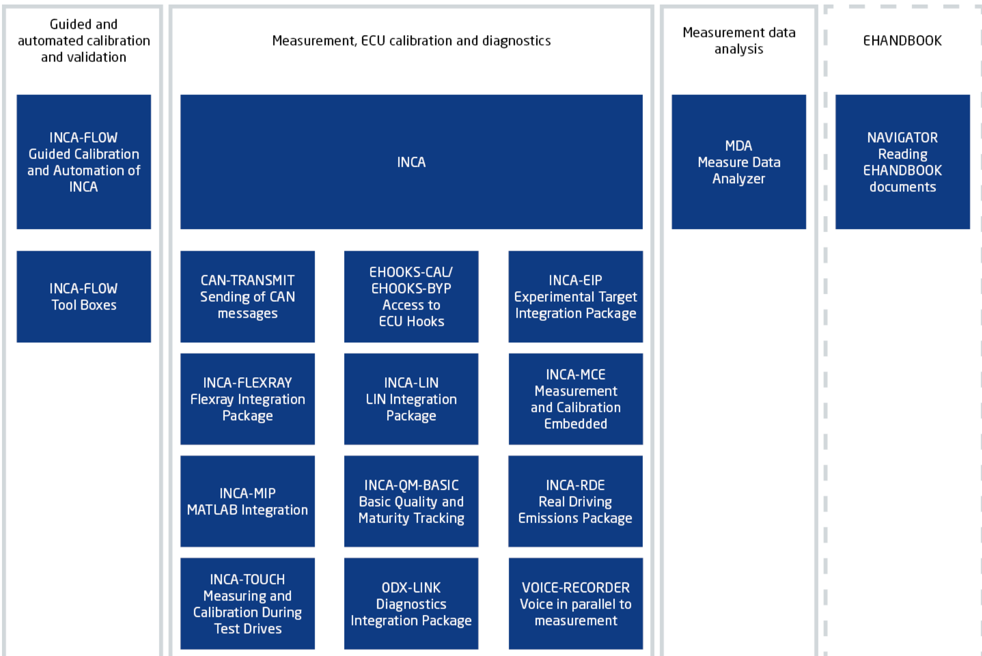


Fig. 2-1: INCA System Overview

2.1 Concepts

This section introduces the main concepts and procedures used in the tutorial:

Measurement task

The state of the engine is assessed using sensors. A sensor measures an engine parameter and makes the value available to the ECU as a number. The measurement task consists of sampling all sensor values over a certain period of time, and recording them. The resulting record documents the engine behavior for a certain set of calibration values.

Calibration task

It is the task of the ECU (Electronic Control Unit) to control the engine so it exhibits a desired behavior. The ECU uses a feedback process to do this: it measures the state of the engine using sensors, and then changes the state of the engine towards the desired behavior using actuators. The new state is measured and adjusted again and again, until an equilibrium is reached. Calibration is the process of adjusting the feedback parameters in such a way that the car exhibits the desired behavior when the equilibrium state is reached. Because the state of the car changes as it is driven, there are many of these equilibrium states, usually called process points. A car is non-linear system, and the control algorithm cannot rely on mathematics to determine the feedback values. Instead it looks up the required actuator settings in a set of tables, using the sensor values as lookup criterion. The calibration task consists of setting the values in the tables. The same ECU can have different valid sets of calibration values implementing a different behavior, one set for a fast car, for example, and another set for an economical car.

Memory Emulation

Classically, the ECU memory consists of read-only memory for calibration data. This means that the calibration data can't be changed directly. You use hardware, such as the ES800 system in combination with INCA, to bridge the ECU's read-only memory with random access memory. The calibration data are then loaded into the INCA random access memory, enabling calibrators to change the data on the fly without having to change the contents of the actual ECU memory.

Some modern ECUs use the CAN bus protocol, which provides calibration support. If CAN calibration support is implemented in the ECU program, it is possible to change the ECU data on the fly without having to emulate the ECU memory. To make CAN possible the ECU contains a programmable semi-permanent memory, the contents of which remains available after a power cycle.

Variables, measure variables, calibration variables (characteristics, curves, and maps)

The term variable is used as a collective name for both measure variables and all types of calibration variables.

In general, a measure variable is a value passed by a sensor, and can be used as a lookup value for calibration variables. Moreover, it is possible to measure derived or calculated characteristics, or, with corresponding settings, also calibration variables.

There are three types of calibration variables:

1. Characteristics are fixed values used as constants by the ECU program after they are adjusted during the calibration process.
2. The ECU uses look-up table to determine the required value of an actuator setting as a function of measure variables (see Calibration Task). If one variable is used to look up one output value, the table is called a curve, because it can be represented graphically as an xy-curve.
3. A look-up table using two or more measure variables to find one output value is called a map, because of the analogy to an elevation map; think of the input variables as the coordinates, and the output value as the elevation of a certain location on the map.
   Maps that derive the output value from three or more input values are called multi-dimensional maps.

Process point

For any curve or map, the process point is the current lookup value passed to the ECU. The process point changes with the value of the measure variable used as lookup criterion into the curve or map. The process point can be visualized on the map; in a tabular calibration editor the cell holding the current lookup value is 'selected'. As the process point changes, the selection moves across the cells of the table.

Database and Database Manager

All data created while performing calibration and measurement tasks (workspaces, experiments, projects, datasets, measurement variables catalogues, and CAN-DB descriptions) are kept in a database. In order to effectively use and organize the data INCA features the **Database Manager**, allowing you to access, reorganize and create data through a graphical user interface. The **Database Manager** is the INCA main window, which is the window you see after starting up INCA.

INCA can handle more than one database at a time. This allows you to segment your data into several sets, each corresponding to a single experiment or vehicle, and store them in their own database. This makes the data more transparent and enhances INCA's performance.

Workspace

A workspace is the umbrella combining the experiment, the project, and the hardware configuration into a consistent file set you can save and load between calibration sessions.

Experiment

An experiment is a predefined set of windows filled with those variables and maps needed to perform a certain calibration or measurement task. An experiment is stored in the database and allows you to quickly set up INCA for a certain task by loading it.

Project

A project consists of the definition of all values related to calibration, and a dataset reflecting a certain version of the ECU program and calibration values. The project is stored in two files: a `*.a2l` and a `*.hex` file, and referenced in the database.

The A2L description file (`*.a2l`) contains the physical description of the data and/or parameters of the control unit program, e.g.:

- Structural information
- Memory size
- Address ranges (e.g. of each measured signal and parameter)
- Names of the measured signals and parameters

The hex file (`*.hex`, `*.s19`; Intel hex or Motorola format) contains the control unit program consisting of the code and the data. The contents of this file can be directly loaded into the control unit and executed by the respective processor.

Hardware Configuration

The hardware configuration defines the hardware used for a certain task and, for application hardware, the project to be used and the corresponding dataset.

Dataset

The values making up the characteristics, curves and maps are stored in permanent memory in the ECU, and accessed by the ECU processor. A set of calibration values stored in the database is called a dataset. Datasets are versioned; a certain version corresponds to a certain calibrated behavior. Datasets are stored in *.hex or *.s19 files and referenced in the database.

INCA provides the Memory Page Manager to manage different datasets (working and reference datasets). This is a versatile tool which you can use to copy memory contents in any direction. For example, it allows you to read data versions into and from the control unit or copy data from the working data version to the reference data version or vice versa.

The different datasets of the working page and reference page are stored separately in INCA as the working dataset and the read-only reference dataset. Read-only datasets are identified by a red frame.

When loading the first HEX file, the code portion is mapped to the control unit project (transparent to the user). The data portion of this HEX file is stored as the so-called "Master" dataset. The master dataset is then used to also create the required working dataset.

User profile

A user profile is a collection of settings for a certain user determining the look and feel of the INCA user interface. A profile can be saved and loaded between sessions. This allows users to quickly configure the INCA user interface settings to fit their requirements. Profile settings include start behavior, window size, window arrangement, paths and many more.

Measure Data Analyzer

The Measure Data Analysis (MDA) program is an offline instrument for displaying and analyzing recorded measurement data. It runs in its own program window and works in display mode or in analysis mode. Its appearance and functions resemble those of an oscilloscope in the INCA Experiment Environment. Online measurement, however, is not possible in MDA.

2.2 Concepts Applied to the Calibration Process

Fig. 2-2 shows the calibration cycle, and the role of INCA in the measurement and calibration processes. The engine's behavior is dictated by calibration data present in the ECU. During a calibration session the calibrator works on the calibration data to optimize the engine's behavior.

1. By emulating parts of the ECU's memory INCA allows dynamic changes to the calibration data.
2. By providing a window on the on-line data in the ECU INCA allows calibrators to inspect the engine's behavior and see if their changes have the desired effect.
3. The recording capabilities integrated into INCA allow the tester to present the test data in a report.

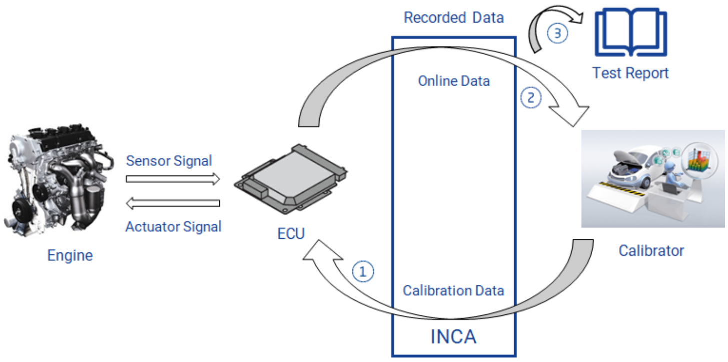


Fig. 2-2: The Calibration and Measurement Applications

Fig. 2-3 shows a functional block diagram of INCA. INCA interfaces with the ECU and can directly access its memory. A graphical user interface allows the user to interact with the ECU.

1. INCA can emulate the ECU memory.
2. The ECU then uses the data in INCA as if they were its own.
3. This allows the calibrator to manipulate the calibration data and ECU program on the fly without having to change the actual ECU memory.
4. INCA can access the ECU memory directly. Measurements can be recorded to be used in reports.

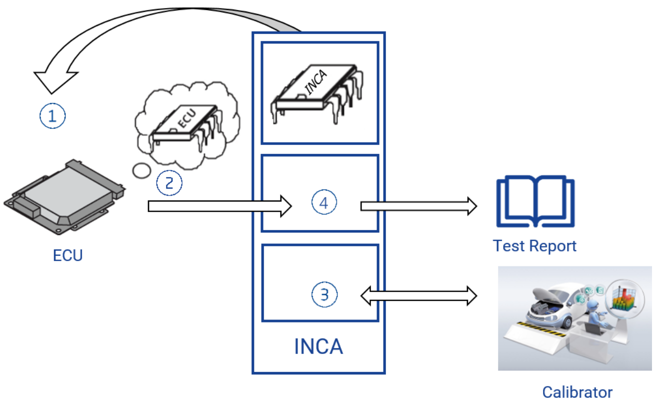


Fig. 2-3: Memory emulation

3 Preparation

Before starting with the tutorial you must prepare the system.

You must have an INCA system installed and running on the computer you want to use for the tutorial. INCA can be started from an icon on the desktop, or from the **Start** menu.

> **Note**
>
> The tasks in the tutorial can be performed in demo mode, meaning you do not need any actual hardware. The hardware is simulated by the ETK Test Device and the VADI Test Device. The devices are installed along with the INCA software; you do not have to install them separately.

Make sure that the following files are present in the `<INCA base>`[1] `\ETASData\INCA7.5\Data\Demo` directory:

- `0400.hex`
- `0400.a2l`

Make sure that the computer you use for this tutorial has an Internet browser installed on it, and that the extension `.HTM` is associated with the browser.

Overview and objectives

Lambda calibration optimizes the way that fuel is burned in the engine in order to reduce overall fuel consumption and emissions. The Lambda value specifies the air-fuel-ratio of the air-fuel mixture that gets burned inside the cylinder. According to theory you need 14.7 kilograms of ambient air to completely burn 1 kilogram of fuel. Before the introduction of Engine Control Units (ECUs), the only way to make sure the engine would run in any environment (during a cold start, for example) was to adjust the amount of air let into the engine below the theoretical amount, making the mixture richer in fuel. The result of this was that not all the fuel in the mixture was burned, and the exhaust gas would be rich in unburned and half-burned fuel. This method of running the engine with too little air is called rich engine management.

ECUs enabled using the measured value fuel rest in the exhaust gas (Lambda) in a control loop making the engine use less fuel. The new method is called lean engine management. In this tutorial you analyze and calibrate the control loop enabling lean engine management: the value of the Lambda sensor in the exhaust pipe is used to control the air throttle at the engine inlet.

[1] Disk drive or root directory containing the corresponding folder

What you have learned after completing the tutorial

At the end of the tutorial you will be able to perform measurement and calibration tasks well enough to be able to work out the finer details of INCA's functionality with the aid of the on-line help system as a reference as you practice your skills during your first real assignments with INCA. In addition, you will have a profile and a sample workspace and experiment at your disposal that you can use to jump-start your future calibration assignments.

4 Lesson: Creating the Database

Learning time: 15 minutes.

4.1 Objectives

You will ready the INCA system for the Lambda calibration task by setting up the database you need to carry out the task.

4.2 Review of the Most Important Concepts

Database and Database Manager

All data created while performing calibration and measurement tasks (workspaces, experiments, projects, datasets, measurement variables catalogs, and CAN-DB descriptions) are kept in a database. In order to effectively use and organize the data INCA features the **Database Manager**, allowing you to access, reorganize and create data through a graphical user interface. The **Database Manager** is the INCA main window, which is the window you see after starting up INCA.

INCA can handle more than one database at a time. This allows you to segment your data into several sets, each corresponding to a single experiment or vehicle, and store them in their own database. This makes the data more transparent and enhances INCA's performance.

4.3 Tasks

After starting INCA you see the user interface (see image in the next chapter Create a New Database), the **Database Manager**. The top left field, **Database Objects**, that shows the database tree structure is referred to as the navigator field in this tutorial. The navigator field shows all elements in the current database. The structure you see reflects the database structure, not the hierarchical structure outlined in the concepts chapter. You can expand and collapse folders in the database by clicking the **+** and **-** icons, and select objects in the folders by clicking them, like in Windows Explorer.

The other fields provide information about the object currently selected in the navigator field.

The bottom left field is used for general comments about the item which is selected in the field above.

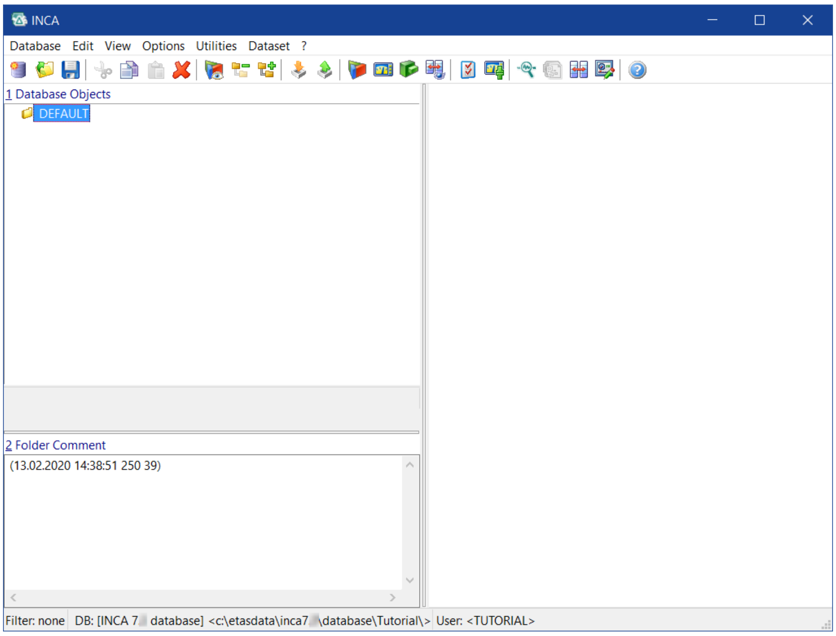
The right side of the **Database Manager** is variable. Which fields are displayed here, as well as the information in them, also depends on the type of object selected in the navigator field.

4.3.1 Create a New Database

It is recommended that you create a new database for every new experiment. This practice keeps the data transparent and the data volume associated with individual experiments manageable.

To create a new database

1. Select **Database** > **New**.
2. In the "New Database" dialog, enter `Tutorial`.
3. Click **OK**.



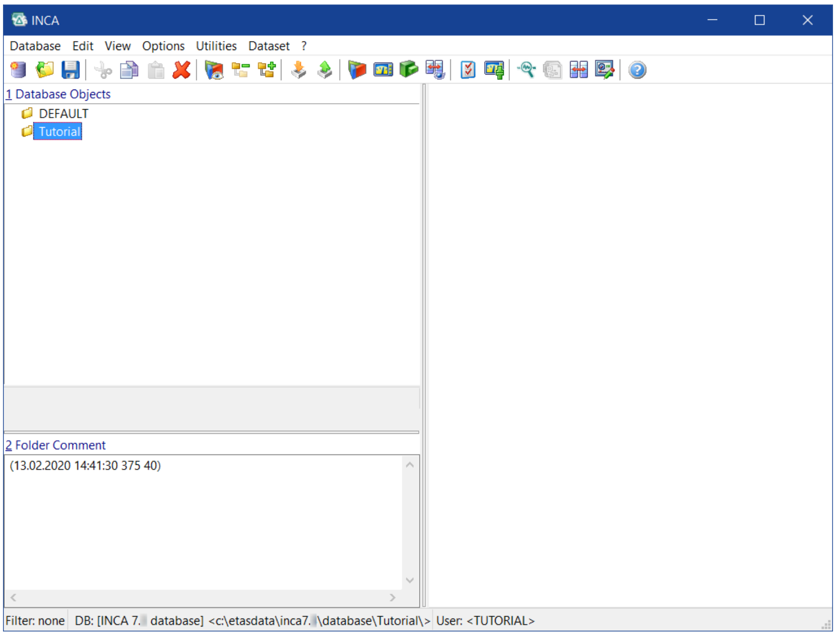
After this, the navigator field is empty except for the item `DEFAULT`, which is a default and empty folder. The second field in the status bar along the bottom of the screen indicates which database is active: `DB:<Tutorial>`.

4.3.2 Create a Top Folder in the Database

To be able to create database items such as workspaces, experiments, and projects, you must first create a top folder. In the next few lessons you create folders with the other database elements as sub-folders under the top folder.

To create a top folder

1. Select **Edit** >**Add**>**Add top folder**.
2. Rename the new folder `Tutorial` and press <ENTER>.



The top folder is displayed in the navigator field as shown in the screen shot above. Below the top folder you create the other folders in the other lessons of the tutorial.

4.4 Questions

Answer the following questions to test your understanding of the subject matter presented in this lesson.

1. The right side of the **Database Manager** always contains the same fields.
   A. True
   B. False
2. Arrange the following steps in the correct order:
   A. Create database structure
   B. Create database
   C. Create top folder

4.5 Summary

In this lesson you learned how to create a new database with its top folder.

5 Lesson: Setting Up a Workspace

Learning time: 30 minutes

5.1 Objectives

In this lesson you set up a workspace for Lambda calibration. The workspace contains an experiment as well as a project with its hardware configuration. In addition, you learn to configure the hardware module by adding an auxiliary measurement device.

5.2 Review of the Most Important Concepts

Workspace

A workspace is the umbrella combining the experiment and the project into a consistent file set you can save and load between calibration sessions.

Project

A project consists of the definition of all values related to calibration, and a dataset reflecting a certain version of the ECU program and calibration values. The project is stored in two files: a `*.a2l` and a `*.hex` file, and referenced in the database.

The a2l description file (`*.a2l`) contains the physical description of the data and/or parameters of the control unit program, e.g.:

- Structural information
- Memory size
- Address ranges (e.g. of each measured signal and parameter)
- Names of the measured signals and parameters

The hex file (`*.hex`, `*.s19`; Intel hex or Motorola format) contains the control unit program consisting of the code and the data. The contents of this file can be directly loaded into the control unit and executed by the respective processor.

Hardware Configuration

The hardware configuration defines the hardware used for a certain task and, for application hardware, the project to be used and the corresponding dataset.

Dataset

The values making up the characteristics, curves and maps are stored in permanent memory in the ECU, and accessed by the ECU processor. A set of calibration values stored in the database is called a dataset. Datasets are versioned; a certain version corresponds to a certain calibrated behavior. Datasets are stored in `*.hex` or `*.s19` files and referenced in the database. These files are binary images of the ECU memory, and beside the calibration data they also contain the ECU program itself.

INCA provides the Memory Page Manager to manage different datasets (working and reference datasets). This is a versatile tool which you can use to copy memory contents in any direction. For example, it allows you to read data versions into and from the control unit or copy data from the working data version to the reference data version or vice versa.

The different datasets of the working page and reference page are stored separately in INCA as the working dataset and the read-only reference dataset. Read-only datasets are identified by a red frame.

When loading the first HEX file, the code portion is mapped to the control unit project (transparent to the user). The data portion of this HEX file is stored as the so-called "Master" dataset. The master dataset is then used to also create the required working dataset.

5.3 Tasks

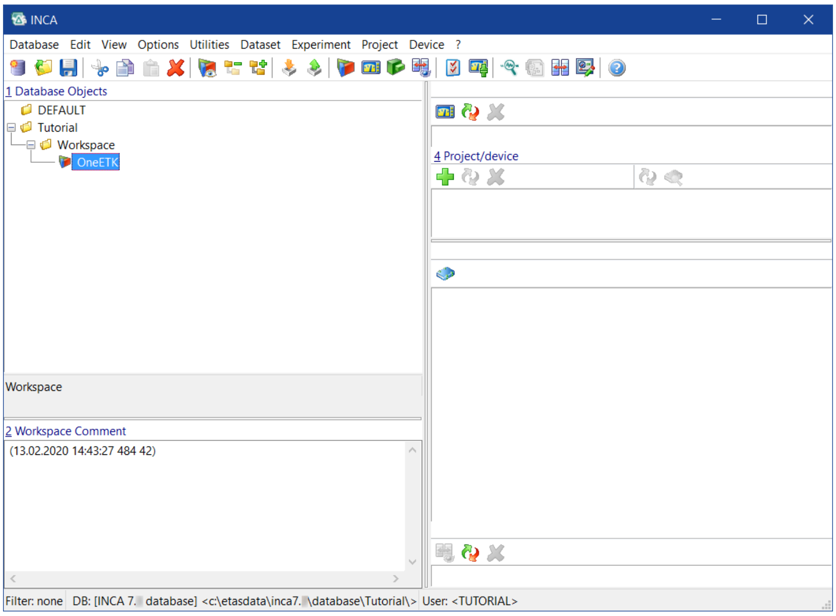
5.3.1 Create a Workspace

First you must create a new workspace in the database.

To create a workspace

1. Select the top folder you want to create the workspace in. Here, select the Tutorial folder.
2. Select **Edit** > **Add** > **Add** Folder.
3. Rename the new folder to `Workspace` and press <ENTER>.
4. Make sure the Workspace folder is selected.

5. Select **Edit** > **Add** > **Workspace**.
6. Rename the new workspace `OneETK` and press <ENTER>.



The name `OneETK` is chosen to reflect the environment used in this tutorial: a setup with a single ETK. An ETK is a parallel interface to the ECU used by INCA.

If the new workspace is selected you see some empty fields on the right side of the **Database Manager** that contains the experiments, projects, and hardware for the workspace. To be able to fill these fields with the appropriate experiment, project, and hardware, you must first create them.

In order to be able to use a database object in your workspace, you must assign it explicitly to the workspace.

In this lesson you create the project and the hardware description. In the next lesson you create the experiment.

5.3.2 Create and Assign a Project

After assigning the A2L file to the project, INCA is able to access and interpret the memory contents of the described ECU. Note that this also means that while working with this description, INCA can access only the exact ECU described by the description file, and no other.

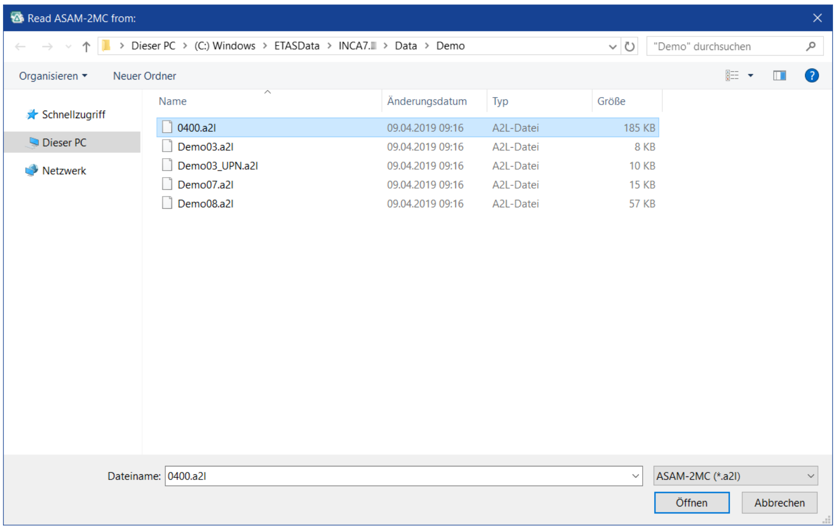
The project is placed in a new project folder, which is placed directly under the top folder, not as a subfolder to the workspace folder. This enables you to use the project hardware for different experiments, which use different workspaces. Although such a database folder structure is not one-to-one with the INCA use model, it allows full leverage of all the database elements you create. This approach works well for beginners, but keep in mind that there are many ways to organize your data. In the future you may want to develop other schemes to fit the requirements of a certain project.

The ECU cannot work without values for the characteristics, curves and maps, so in addition to the description of the ECU memory, INCA needs an initial set of calibration data to work with. Note that the calibration data are not part of the description file, and you can have many calibration datasets in a single project, each representing a different phase in the calibration, or a different calibration profile.

<u>To create and assign a project</u>

1. Select the top folder Tutorial.
2. Select **Edit** > **Add** > **Add Folder**.
3. Rename the new folder `Project_0400`.
4. Make sure the `Project_0400` folder is selected.
5. Select **Edit** > **Add** > **ECU project (A2L)**.

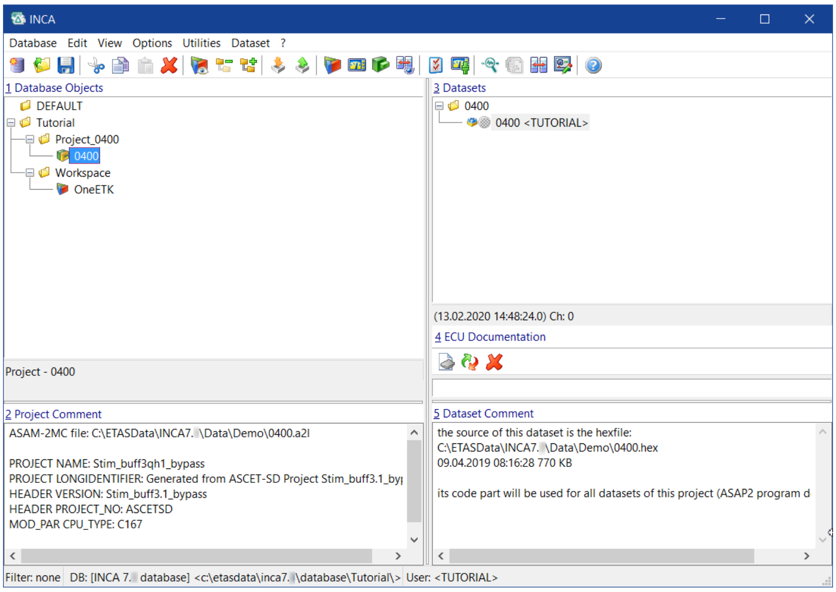
   The "Read ASAM-2MC from:" dialog pops up.

6. Browse to the `<INCA base>\ ETASData\INCA7.5\Data\Demo` directory, select the file 0400.a2l and click **Open**.

   The "Select Data File" dialog appears.

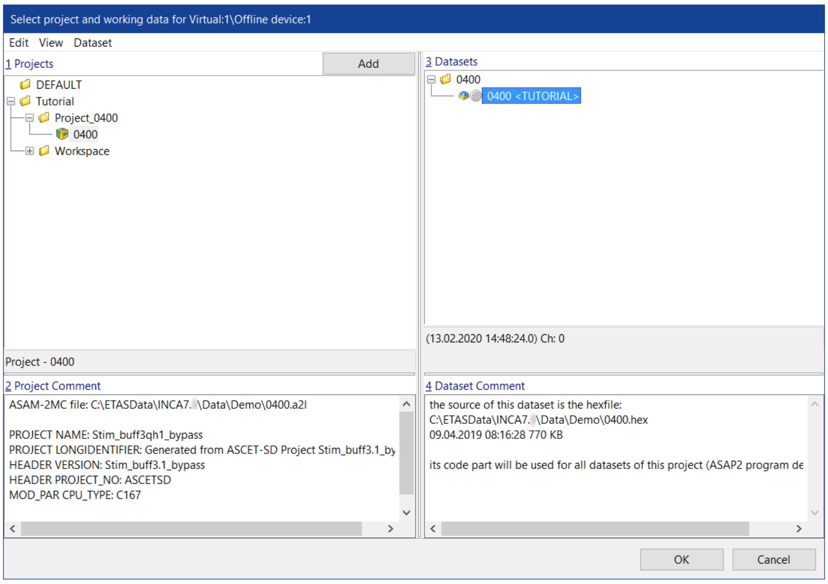
7. Browse to ‹INCA base›\ETASData\INCA7.5\Data\Demo directory, select the file 0400.hex, and click **Open**.



Note that only the description, not the calibration dataset, is shown as a separate database item in the database navigator field. If you select the new project description `0400` in the navigator field you see all calibration datasets valid for this description in the **Datasets** field on the right-hand side of the **Database Manager**. Continue with assigning the newly created project to the `OneETK` workspace:

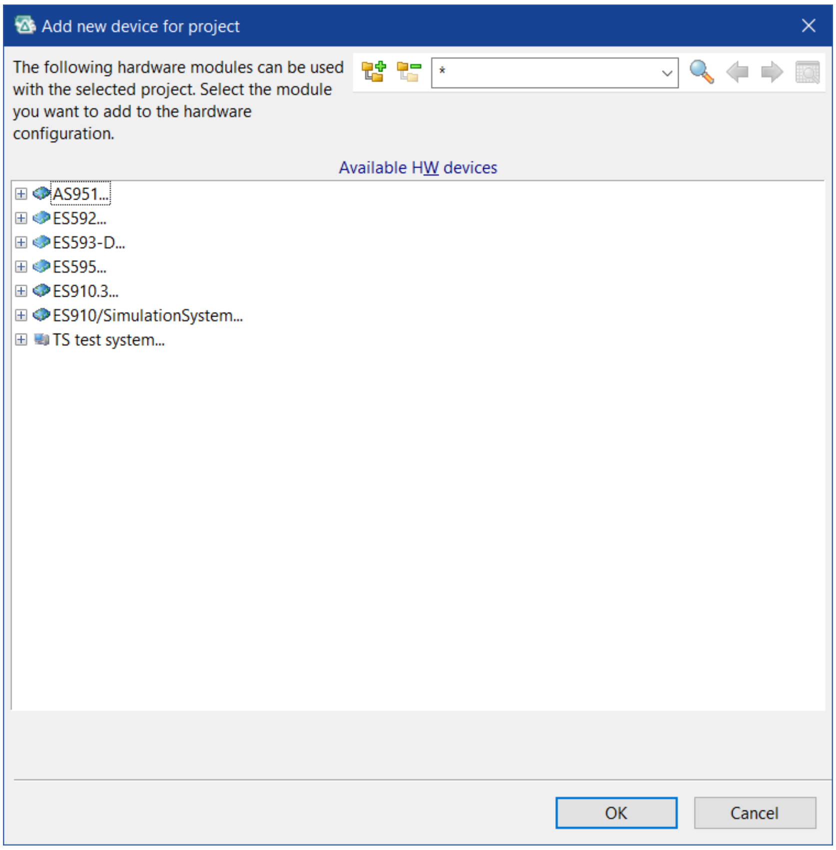
8. Select OneETK workspace in the Workspace folder.
9. **Select Project** > **Add Project/Dataset**.

   The "Select project and working data" dialog appears.
10. Select the 0400 project in the navigator field on the left-hand side of the dialog.
11. Select the master dataset 0400 in the Datasets field on the right-hand side of the dialog.



12. Click **OK**.

The "Add new device for project" dialog opens.

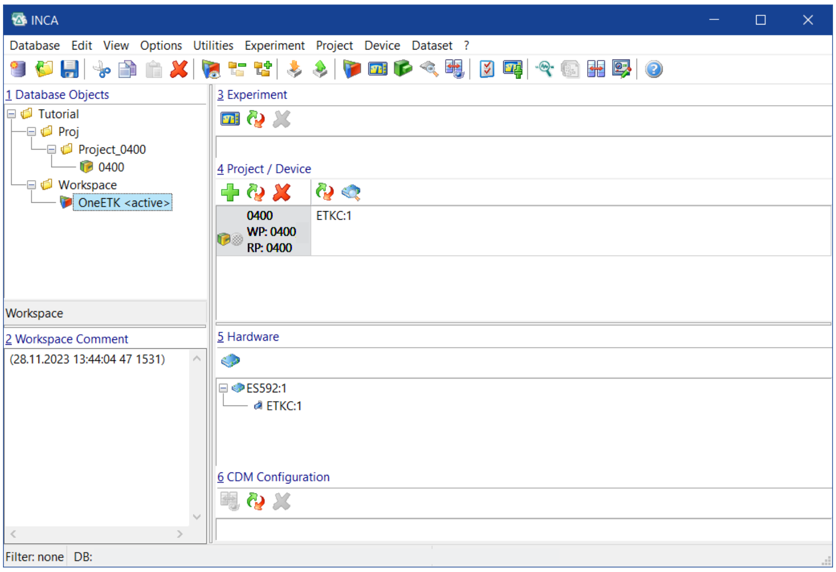


If you do not explicitly assign a device and close this dialog with **Cancel**, an offline device is assigned by default after selecting a project/dataset. This hardware is intended as a placeholder if you do not select a device right now and want to prepare your experiment at first.

In the present example, a ES592 is to be used instead of the offline device.

13. Under ES592, select device ETKC.
14. Click **OK**.

Now select the `OneETK` workspace in the navigator field, and have a look at the fields on the right-hand side of the **Database Manager**.



You see:

- The **Experiment** field at the top contains the experiment assigned to the workspace. Because you have not assigned an experiment yet, this field is empty. You assign an experiment in "Lesson: Setting Up an Experiment" on page 36.
- Two boxes in the **Project/Device** field.
  The left box has three entries indicating the currently used project data.
- The top entry (`0400`) is the name of the project description.
- The next entry (`WP: 0400_1`) is the name of the currently used working dataset (WP means working page and refers to a 'page' of memory with the working dataset). Note that you have neither created a working dataset, nor assigned the name `0400_1`. Because a project must have a working dataset, `0400_1` was created and named automatically by INCA using the master dataset you loaded earlier as a basis (the use of working and reference datasets is explained in "Lesson: Calibration" on page 69).
- The last entry (RP: `0400`) is the currently used reference dataset (RP means Reference Page), referring to a read-only copy of the master dataset.
- The right frame contains the `ES592:1`and the `ETKC:1` entry that is the hardware module currently used. Since a project in INCA must always have a hardware module, we have selected this hardware module temporarily.

5.3.3 Configure the Project Hardware

To be able to perform the tutorial without real hardware, the hardware must be simulated. For this reason, the ES592 is replaced with a test system in this step.

Note

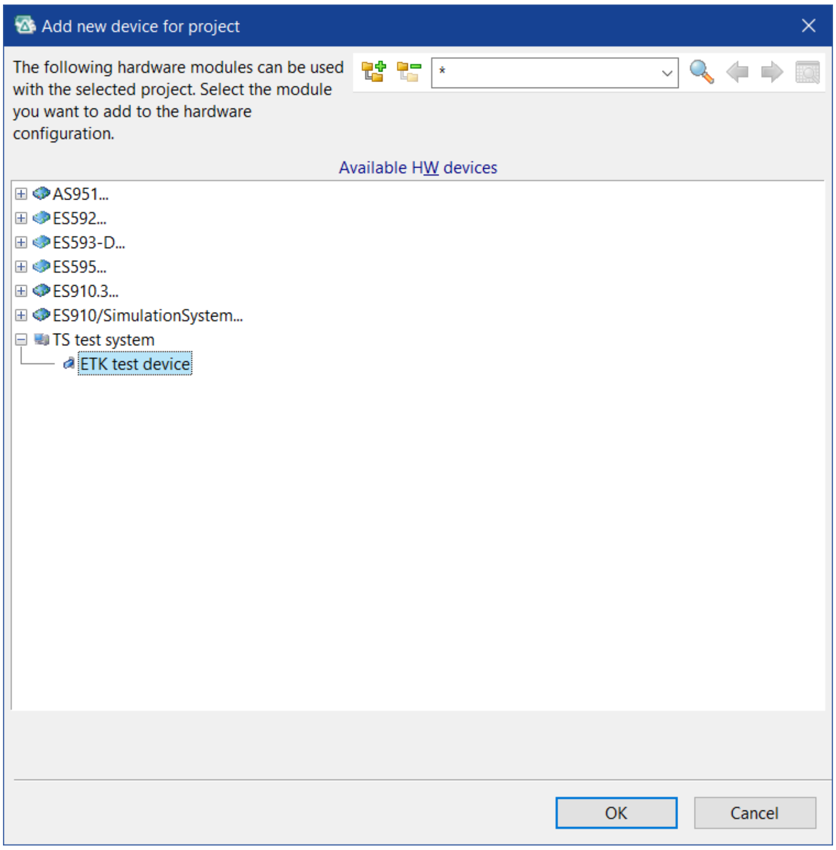
The TS test system simulates a real hardware. The test system can be used to measure simulated measured values and change calibration variables without using real hardware. However, the test system does not perform any raster check and is, therefore, not suitable for preparing a real experiment. It is used solely for exercise purposes.

In this tutorial you add the `ETK Test Device` hardware to the `OneETK` workspace.

To configure the project hardware

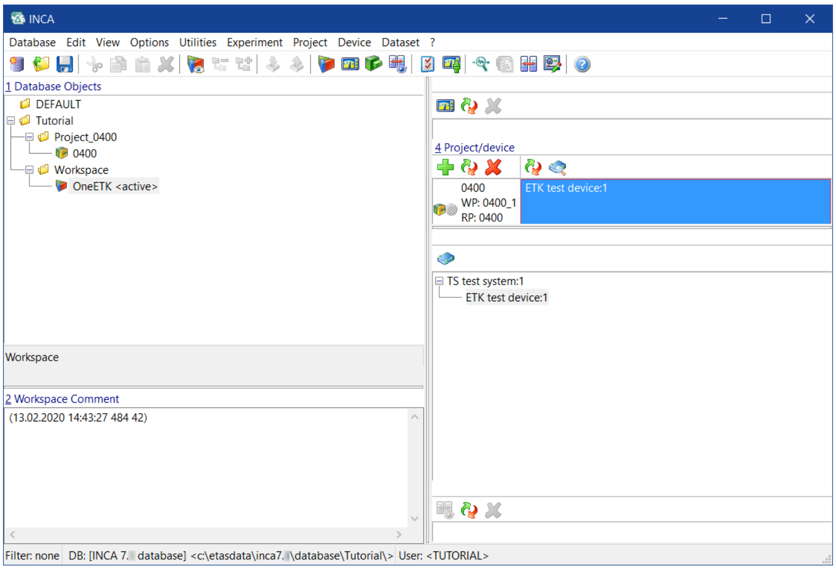
1. Select the `ETKC:1` hardware module in the right frame of the **Project/Device** field in the **Database Manager**.
2. Select **Device** > **Replace Device**.
3. INCA analyzes the project and displays the **Add new device for project** dialog, with a list of hardware interfaces and associated devices.

   The list is based on specifications given in the project description file.



4. Select the `ETK test device` listed under the `TS test system` inter-

face, and click **OK**.

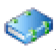


Now, if you select the `OneETK` workspace again, you see that the current hardware module has changed to `ETK test device:1`, and that the same device is listed for the `TS test system:1` interface in the **Hardware** field. The ES592 device has been replaced by the new device, and has disappeared.

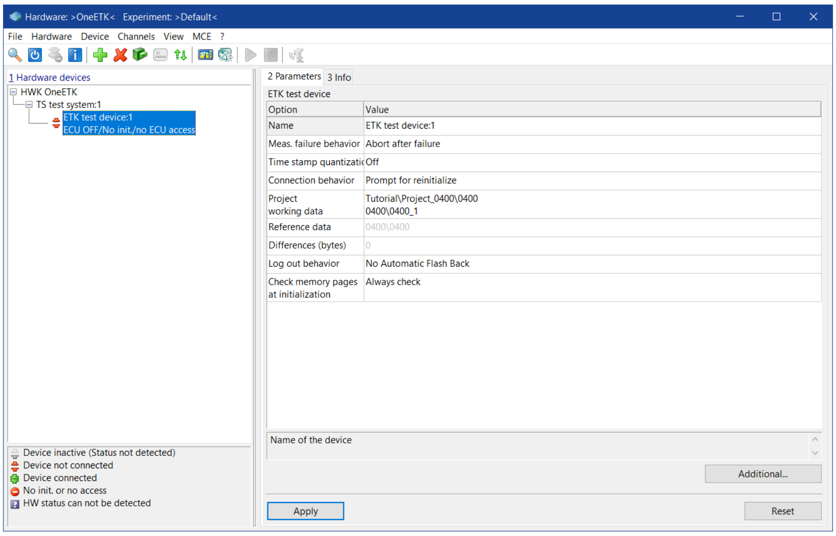
The hardware module you have defined can access the ECU using the definitions given in the project description file. Often, however, you want to use additional measurements from hardware components external to the ECU. Because these modules aren't specified in the project description file, you must provide the description of the values returned by the modules yourself. This task is called 'configuring the device'. As an example, you now add the VADI test device..

> **Note**
>
> If real INCA hardware is connected to the computer, you can also have INCA automatically search for available devices by using the menu option **Hardware** > **Search for hardware**. In this tutorial, however, the devices are simulated, and are added manually.

To add the additional VADI hardware component

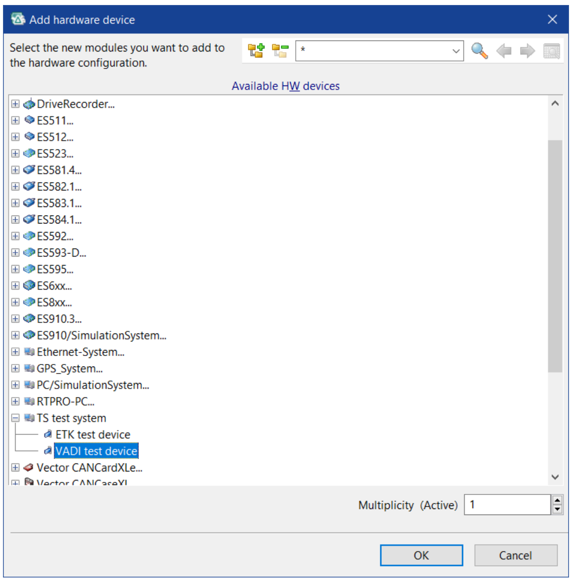
1. Select the `OneETK` workspace.
2. Select **Device** > **Configure Hardware** or click .

   The **Hardware Configuration Editor** appears.



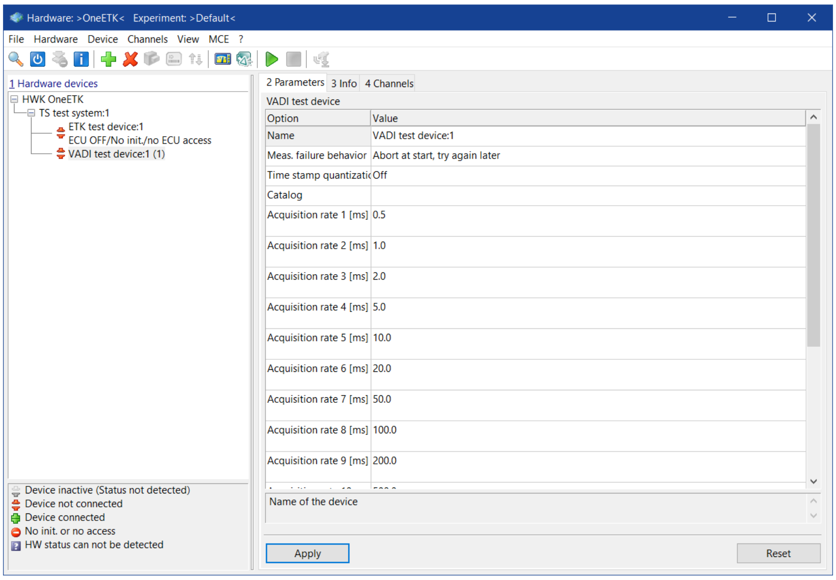
By displaying `Hardware: >OneETK<` in its title bar the window indicates that the device to be configured is added to the hardware module of the `OneETK` workspace. The Hardware Devices field at the left-hand side of the window shows the dependencies of the devices in a tree structure. Do not confuse this tree structure with the navigator field of the **Database Manager**; the Hardware Configuration Editor shows hardware components only. The right-hand side of the Hardware Configuration Editor shows the configuration parameters for the device to be configured. The information is distributed over several forms accessible through the tabs along the top of the forms. Proceed by adding the new VADI device:

3. Select the `TS Test System:1` interface in the **Hardware Devices** field of the **Hardware Configuration Editor**.
4. Select **Device** > **Insert**.
5. The **Add Hardware device** dialog appears, showing a list of available devices.



6. Select `VADI test device` from the list, and click **OK**.

7. You return to the **Hardware Configuration Editor**. The entry `VADI test device:1 (1)` is added to the devices listed in the **Hardware devices** field.



If you now select the `VADI test device:1 (1)`, the right-hand side of the **Hardware Configuration Editor** shows the parameters for the new device. The form with the **Parameters** tab allows you to set parameters for the entire module. The form with the **Info** tab gives information about the device. The form with the **Channels** tab allows you to configure the individual channels of the VADI device.

For this tutorial, keep the default values, created automatically when you added the device, for all the parameters of the VADI device.

Note the stop icons displayed in front of the devices listed in the **Hardware devices** field of the **Hardware Configuration Editor**. The stop sign means that the device is specified, but not yet active. To activate the devices, you must initialize them. When you initialize devices, INCA attempts to establish a connection to all the devices specified in the hardware module. For those devices where the initialization was successful, the icon changes to a sign with an up arrow to indicate the device is active.

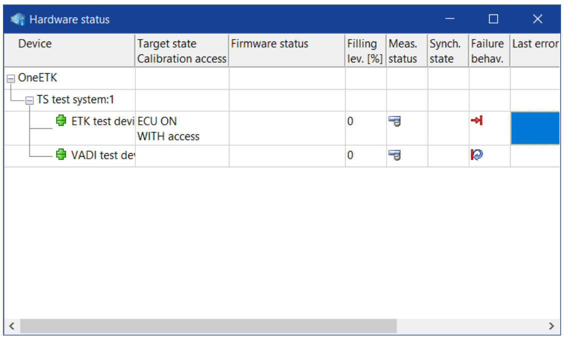
Note

In this tutorial, you can initialize the devices even though no actual hardware is connected to the computer because the devices are simulated. In a real workspace, in which you are using real and non-simulated hardware, you can successfully initialize and enable these devices only if they are connected and have a current firmware status. The firmware status is displayed in the Hardware status dialog window or in the bottom toolbar of the experiment. Additional information about the hardware status is available in the online help of the Hardware Configuration Editor under "Hardware Status Display".

<u>To show the hardware status and initialize the hardware devices</u>

1. Select **Hardware** > **Hardware Status**.

   INCA initializes the hardware and shows the results, as well as other status information, in the **Hardware Status** dialog.

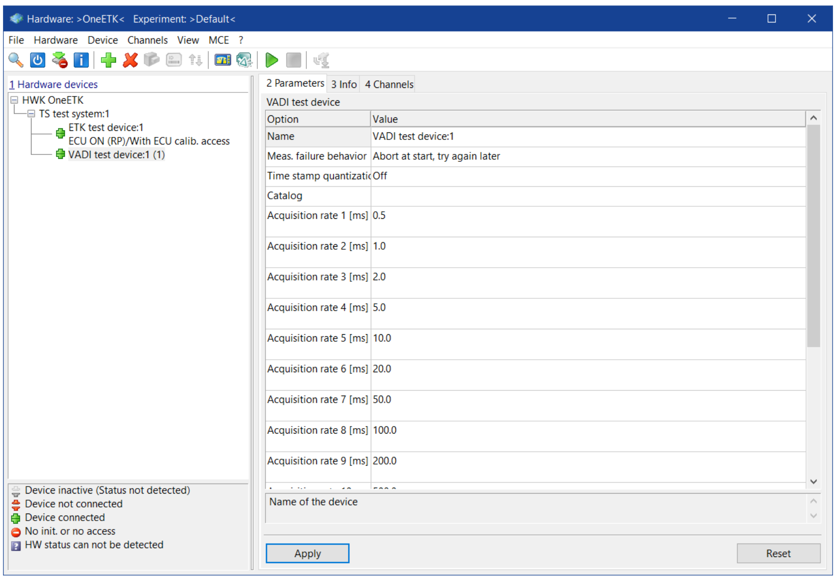
   

   Note

   If the hardware is not automatically initialized, automatic initialization might be switched off. This is useful in cases such as preparing work-space and/or experiment offline, when you don't need to access the hardware. To enable automatic hardware initialization, go to the Data-base Manager and select **Experiment** > **Experiment without full HW access.**

   The contents of the **Hardware Status** dialog are continuously refreshed. This makes it a useful monitoring tool in environments where the con-nection to the hardware devices are subject to change. Under such con-ditions you can evoke the **Hardware Status** dialog and leave it open as long as appropriate.

2. Close the **Hardware Status** dialog and return to the **Hardware** window.

The hardware devices are automatically initialized. In the **Hardware Devices** field, the icons change from red to green.

3. Close the **Hardware** window to go back to the **Database Manager**.

5.4 Questions

Answer the following questions to test your understanding of the subject matter presented in this lesson.

1. A workspace contains only a hardware description for the current experiment.

   A. True

   B. False

2. Which of the following items are part of the project description file:

   A. Memory layout of the ECU.

   B. Most recent calibration dataset.

   C. Master dataset.

   D. Format of the characteristic, curves and maps.

   E. Format of the variables returning sensor values.

3. Match the tasks below with the appropriate user interface element used to perform them:

Tasks:

   A. Add a new device.

   B. Set the acquisition rate of an auxiliary measurement device.

   C. Initialize hardware.

   D. Create a project folder.

   E. Load a project description file.

User Interface elements:

   A. **Database Manager**

   B. **Hardware Configuration Editor**

5.5 Summary

In this lesson you created the `0400` project, loaded its project description, as well as a master dataset. You configured the hardware used to access the project ECU, as well as the auxiliary VADI device.

6 Lesson: Setting Up an Experiment

Learning time: 30 minutes

6.1 Objectives

In this lesson you learn how to add variables and windows to an experiment and how to configure them.

6.2 Review of the Most Important Concepts

Experiment

An experiment is a predefined set of windows filled with those variables and maps needed to perform a certain calibration or measurement task. An experiment is stored in the database and allows you to quickly set up INCA for a certain task by loading it.

Variable

The term variable is used as a collective name for both measure variables and all types of calibration variables.

Measurement Variables

In general, a measure variable is a value passed by a sensor, and can be used as a lookup value for calibration variables.

Moreover, it is possible to measure derived or calculated characteristics, or, with corresponding settings, also calibration variables.

6.3 Tasks

6.3.1 Create and Assign an Experiment

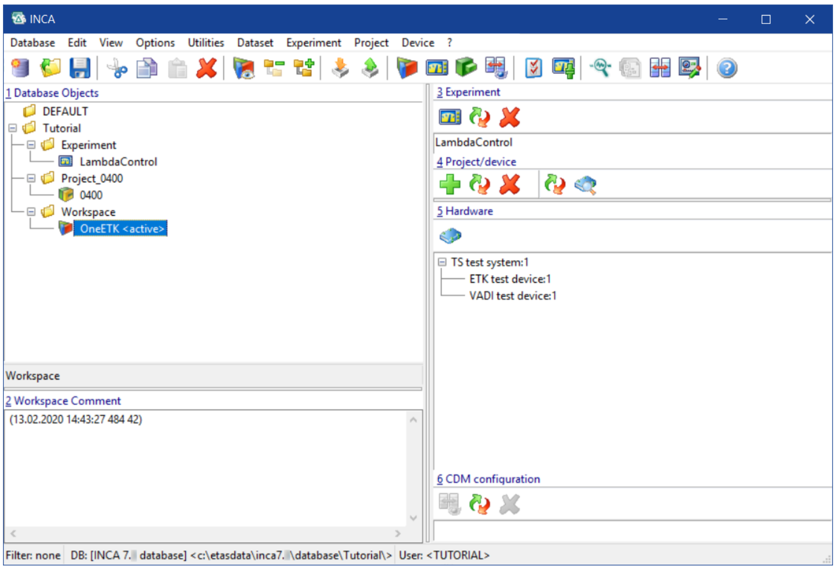
It is possible to use the same experiment in different workspaces within the database, independent of its location. It is recommended to create a separate folder for experiments in order to keep the database clearly structured. Therefore in this tutorial, the experiment is placed in a new experiment folder directly under the top folder, not as a subfolder to the workspace folder.

Note

INCA 7.1 uses a new oscilloscope for experiments. The experiment created in this tutorial already uses this oscilloscope automatically. Experiments created in older INCA versions can be converted so that the new oscilloscope can also (exclusively) be used in these. This tutorial indicates when this is possible using appropriate notes.

<u>To create and assign an experiment</u>

1. Select the top folder, `Tutorial`.
2. Select **Edit** > **Add** > **Add Folder**.
3. Rename the new folder `Experiment`.
4. Make sure the `Experiment` folder is selected.
5. Select **Edit** > **Add** > **Experiment**.
6. Rename the new experiment `LambdaControl`.
7. Select the `OneETK` workspace in the navigator field.
8. Select **Experiment** > **Change Experiment**.
9. The **Select Experiment** dialog appears. In the **Database Objects** field, expand the `Experiment` folder.
10. In the **Database Objects** field, select the **LambdaControl** experiment and confirm with **OK**.



If you now select the `OneETK` workspace in the navigator field of the **Database Manager**, you see that the `LambdaControl` experiment appears in the Experiment field at the top right of the **Database Manager**.

> **Note**
>
> The experiment you have created is automatically assigned the symbol for experiments using the new oscilloscope ( ).
> Experiments that support the old oscilloscope are assigned a modified symbol ( ) so that they can be differentiated.

6.3.2 Run the Experiment

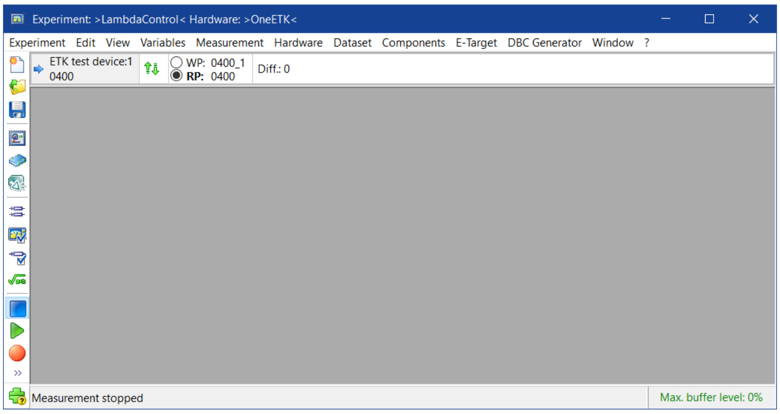
Experiments run in the **Experiment Environment**. The **Experiment Environment** is a self-contained user interface like the **Database Manager**, but is specialized for doing experiments. If you launch the **Experiment environment** in a specific working environment, the window for the experiment for that working environment is the default. In this way, you can start measurement or calibration activities without having to set up an experiment.

> **Note**
>
> If you are running an experiment from an older INCA version for the first time, a dialog box will appear for automatically converting the experiment for the new oscilloscope. Confirm this dialog box with **Yes** if you would like to exclusively edit this experiment in INCA 7.1 in the future. Additional information on using experiments in different INCA versions can be found in our online help.

To run the Experiment

1. Select the `OneETK` workspace in the navigator field of the **Database Manager**.
2. Select **Experiment** > **Run experiment**.

   The **Experiment** window opens.

   The window is configured according to the presets for the experiment assigned to the workspace that was selected when you ran the experiment. The title bar of the window, Experiment: "Lambda Control" Hardware: "OneETK", indicates this. Because the experiment is new and has not been set up yet, the window is empty. In the remainder of this lesson you set up the Lambda Control experiment for the measurement task you perform in the next lesson.

6.3.3 Select the Variables Used in the Experiment

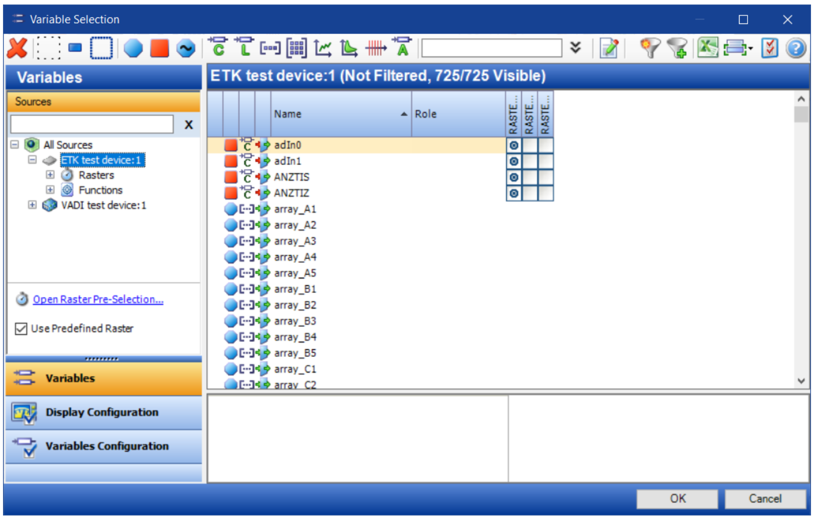
The variables return values measured by the sensors connected to the project ECU. Only a subset of the values measured by the ECU is needed for the `LambdaControl` experiment. After selecting the variables of interest, they are displayed in child windows to the **Experiment** window in a format of your choice.

In this lesson you limit yourself to selecting the variables needed for the measurement task you perform in the next lesson. Calibration variables (characteristics, curves, and maps) are selected the same way as measurement variables. You will add calibration variables in the "Lesson: Calibration" on page 69 exercise dealing with calibration activities.

To select the variables for the Lambda control experiment

1. In the experiment environment, select **Variables** > **Variable Selection**.

   The **Variable Selection** dialog opens.



The **Sources** field at the left-hand side of the window lists all hardware devices in the hardware configuration of the current workspace. When you select a certain device, the variables list on the right hand side lists all characteristics, curves, and maps accessed through the device.

Note

Only the icons of variables actually used are described in the tutorial. The complete description of the icons is located in the online help.

Each entry in the variables list is preceded by three icons providing some information on the variable.

The first icon shows whether it is a measure or calibration variable:

Measurement

Calibration

The second icon indicates the type of the variable, i.e. whether it is for instance a scalar, a curve or a map.

Scalar

Boolean (logical)

Vector

Matrix

Curve

Map

Axis

ASCII

Curve axis

Multi-dimensional map

The third icon indicates your access rights for the variable.

Readable and writable

Readable only

In this lesson you use only measure variables, which have a red square as their first icon.

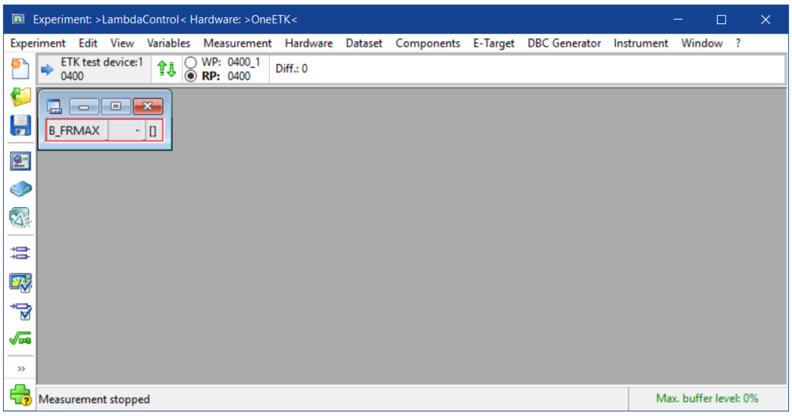
1. Expand the `ETK Test Device:1` entry in the "Sources" field of the "Variable Selection" dialog.
2. Expand the tree structure of the `Functions` entry.

   A list of functions appears.
3. Select `LambdaRegelung` from the list.

   The entries in the **Variables** field are now limited to those measure and calibration variables associated with the Lambda control function.
4. Scroll through the list and select the variable `B_FRMAX`.

   The following symbol assigned to the variables indicates that they will be added to the experiment.
5. Click **OK** to have it displayed in the default window.

   The selected variable is now added to the Experiment window. It is displayed as a line in **Measure window [1]**.



You may have noticed that the list of variables contains many entries that are not of interest to the measurement you are setting up. This makes the process of searching for the appropriate variables tedious. In this lesson you are only interested in measure variables and INCA provides a built-in filter allowing you to limit the list of variables to show only measure variables. In the lesson covering the calibration task you use another filter, limiting the list to only calibration elements such as characteristics and maps. Before selecting the rest of the measurement variables, turn on the filter for measured values:

To use filters for variable selection

1. Select **Variables** > **Variable Selection**.

   The **Variable Selection** dialog opens. Note that `B_FRMAX` is marked with a blue rectangle . This indicates that the variable is already being used in the experiment.

2. Click .

   The list of variables is limited to measures variables only. Scroll down the list, and select the following variable:

   `B_FRMIN`

   You can speed up the search for a certain variable by typing the first letters of its name.

3. Type the letters `dt`.

   The letters are displayed in the toolbar in the edit box of the alphabetical filter. The datalist is automatically filtered according to the entry so that only variables starting with DT are displayed (the search is not case-sensitive).

4. Select the variable `DTVKA`.

5. Using the same method, select the following variables:

   `FRPS`

   `RTV`

6. Remove your entries from the alphabetical filter.

7. In the toolbar, click on the following icon to check which variables are added.

8. Select all variables in the list.

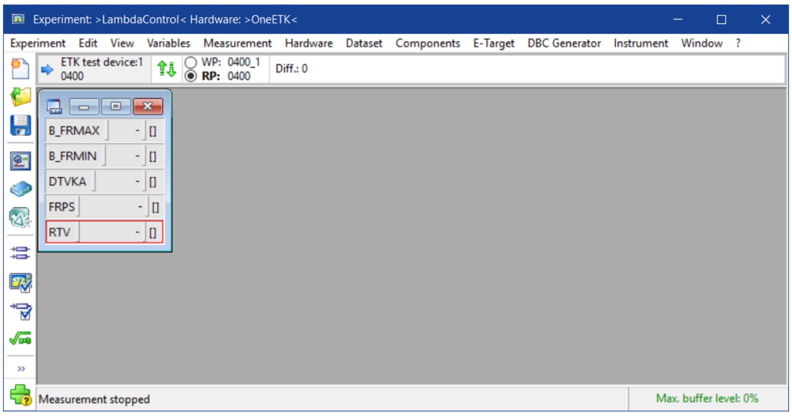
9. Right-click on the lists of variables and select **Add to** > **Layer_1** > **Measure window [1]** from the context menu.

10. Click on **OK**.

    All variables are added as lines to **Measure window [1]**.

Note

When you use the alphabetical filter to search for variables, you can also use wildcards (e.g. *,?). With these wildcards, you can search for variables where you only know parts of their names.



Rasters are used to determine the intervals in which measure values are measured. Which rasters are available is defined in the ECU's projection description file. You can record only a certain number of measure variables in one raster. The raster filling display indicates whether further variables can be measured in the desired raster.

To assign a raster upon variable selection

1. Select **Variables** > **Variable Selection**.

   The **Variable Selection** dialog opens.

2. In the **Sources** field, click on the entry `ETK Test Device:1`.
3. Select the following variables from the variables list using the filters:

   `LR_P_Anteil`

   `LR_I_Anteil`

   `FR`

   `FLR_AP`

4. Remove your entries from the alphabetical filter.
5. In the toolbar, click on the following icon to check which variables are added.

   You can see in the variables list that **Raster_A** is being selected for all of the four variables. In the information at the bottom on the right you can see that the raster filling level for **Raster_A** is 3%.

   You change the raster of a variable by moving the check mark in the raster matrix in the column of the corresponding raster.

6. For the variables `FR` and `FLR_AP`, select **Raster_B**.
7. For the variables `LR_P_Anteil` and `LR_I_Anteil`, select **Raster_C**.
8. Click **OK**.

   The variables that you have selected in this session are displayed in a new **Measure window [2]**.

Note

If you do not assign the variable to a window upon selecting it, it is displayed in a standard window. In "Lesson: Settings and user profiles" on page 101, you learn how to define a standard window for a variable.

Up until now, all variables are presented in measure windows and in identical layout: the variable name display, followed by the corresponding numeric value. This display type is appropriate for some variables, but you may want to display other variables in a different format, e.g. in an **Oscilloscope** or a **Measure table**.

Oscilloscopes, for example, present the chronological progression of variables graphically, thus allowing for a varied view of analog and digital variables in multiple display ranges.

To define during the variable selection in which window a variable is displayed

1. Select **Variables** > **Variable Selection**.

   The **Variable Selection** dialog opens.
2. In the **Sources** window, click on `ETK-Testdevice:1`.
3. From the variables list, select the following variables with the help of the filter:

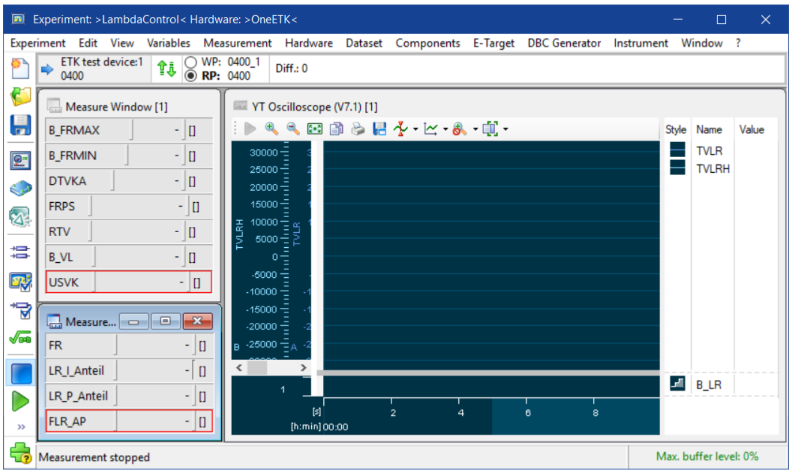
   `B_LR`
   `B_VL`
   `TVLR`
   `TVLRH`
   `USVK`
4. Delete your entries from the alphabetical filter.
5. In the toolbar, click on the following icon to check which variables are added.

   
6. Press and hold <CTRL> and highlight the following variables:

   `B_VL`
   `TVLR`
   `TVLRH`
7. In the context menu, select **Add to** > **Layer_1** > **New** > **YT-Oscilloscope**.
8. Hold <CTRL> pressed and select the following variables:

   `B_LR`
   `USVK`

9. In the context menu, select **Add to** > **Layer_1** > **Measure Window [1]**.
10. Click **OK**.



> **Note**
>
> There are restrictions towards possible combinations of variable types for window types. A detailed description of all combinations and restrictions goes beyond the scope of this tutorial. The online help of INCA describes which combinations of variable types to window types are possible.

In the experiment, the variables are now distributed across **Measure window [1]**, **Measure window [2]** and the **YT-Oscilloscope**. The **YT-Oscilloscope** enables a more detailed view of the variables than the measure window. It is divided into an analog (top) and digital (bottom) area and can be controlled using its toolbar. The variables contained therein are located in the signal list (right).

As long as the experiment contains only a few elements, you can distribute the variables via the context menu of the variables onto the respective windows as outlined above. But this approach is generally very confusing for extensive experiments. In this case, it is better to select the variables in the list of variables and to arrange them in the **Display Configuration**.

6.3.4 Configuring the Display of the Experiment

<u>To arrange the experiment via the display configuration</u>

1. Select **Variables** > **Variable Selection**.

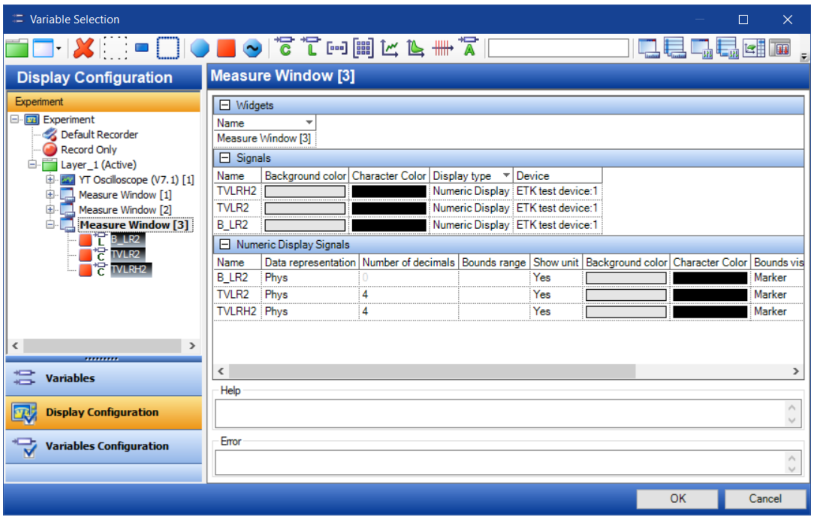
   The **Variable Selection** dialog opens.
2. In the **Sources** window, click on `ETK-Testdevice:1`.
3. Use the filters to select the following variables from the list of variables:

   `B_LR2`
   `TVLRH2`
   `TVLR2`
4. Delete your entries from the alphabetical filter.
5. Click on the "Display Configuration" tab.

In the **Display Configuration** area, you can see that the selected variables are ordered below the **Measure window [3]** entry.

6. Click on the new measure window.

   In the tabular area you can see the properties of the **Measure window** and the variables it contains.



In more complex experiments, the windows can be organized in layers. Therefore, the `Experiment` folder has a subfolder in the **Display Configuration** window with the name `Layer_1`.

7. Press and hold <CTRL> and highlight the following variables in the tree view in the "Display Configuration" window:

   `TVLR2`

   `TVLRH2`

8. Drag the variables `TVLR2` and `TVLRH2` from **Measure window [3]** to the **YT-Oscilloscope** entry and deposit them there.

   The variables were moved into the **YT-Oscilloscope**.

9. Click on the following icon in the toolbar to activate the filter for Boolean variables:

   In the **Display Configuration** area, all windows containing a Boolean variable are opened and all other variables are hidden.

10. In the context menu for variable `B_LR2` in **Measure window [3]** , select **Cut**.

11. In the context menu for the **Measure window [1]**, select **Paste**.

    The variable is moved to the **Measure window [1]**.

12. In the context menu for the now empty **Measure window [3]**, select **Delete**.

    Measure window [3] will be deleted.

13. Click on the following icon in the toolbar to deselect the set filter.

14. In the context menu of **Measure window [2]**, select **Change Widget To** > **Measure Table**.

    Measure window [2] is converted into a measure table-type window.

    The conversion from a measure window-type window to a measure table-type window can be recognized by the symbol preceding the window name changing from to . The term "Measure window" in the tree structure refers, however, to the name of the window and is therefore not altered by INCA. That is why you rename your window to a more suitable name.

15. Highlight **Measure window [2]** and select **Rename** in the context menu. Then replace the current name with the new name, **Measure table**.
16. Move the following variables from **Measure window [1]** to **Measure table [2]**:

    `DTVKA`

    `FRPS`

    `RTV`

    `USVK`

17. Highlight **Layer_1** and select **Rename** in the context menu. Then replace the current name with the new name, `Layer_Measure`.

    In the **Display Configuration** area you can see that the experiment now contains the following elements:

    - **Layer_Measure**
    - **Measure window [1]**
    - **Measure table [2]**
    - **YT-Oscilloscope [1]**

    > **Note**
    >
    > Elements that were selected in the variable selection, but have not yet been added to the experiment, are identified by a gray bar.

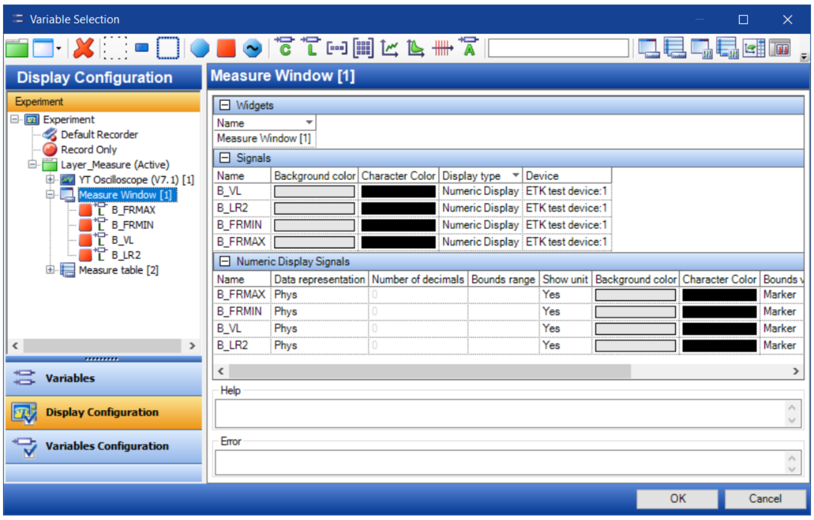
18. Click **OK**.

To change the display type of variables

1. In the Experiment Environment, select **Variables** > **Display Configuration**.

   The Variable Selection dialog opens on the **Display Configuration** tab.

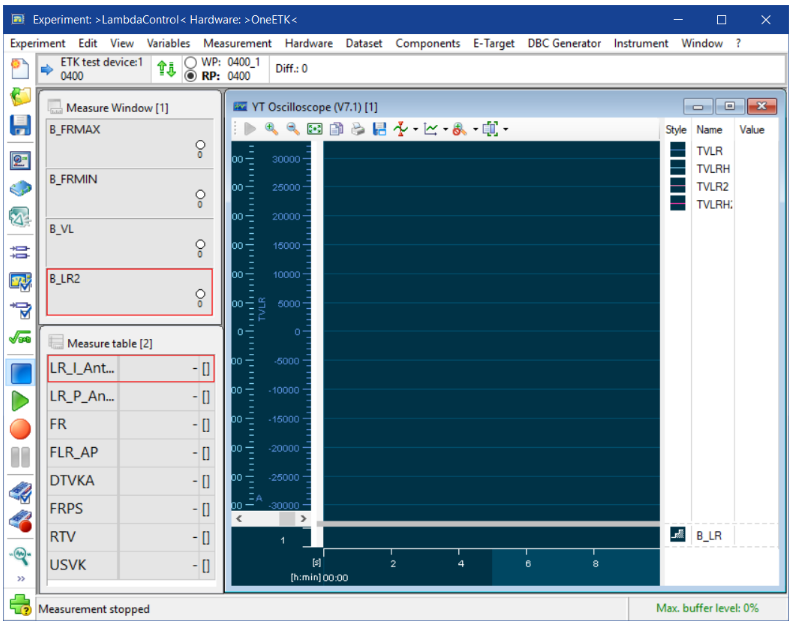
2. In the Display Configuration area, click on **Measure window [1]**.



3. For each of the variables representing bits (those with names beginning with B_):
   a. In the **Signals** table, double-click on the cell of the corresponding variable in the **Display Type** column.

      A list of possible display types for the assigned window appears.
   b. Change the setting from `Numeric Display` to `Bit Display`.
4. Click **OK** to return to the experiment environment.

   Note that the display of the bit signals in **Measure window [1]** has changed.

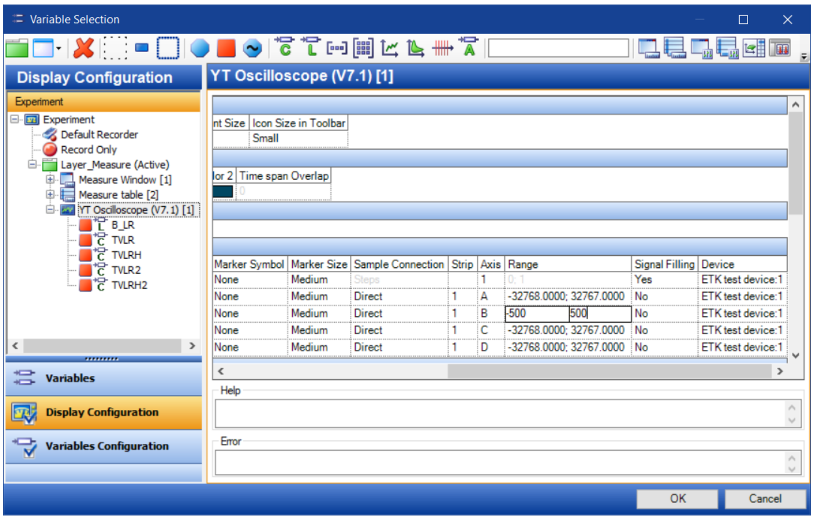


All settings for each variable can be changed in this way.

To change the axis range for a variable in the YT-Oscilloscope

1. Right-click in the oscilloscope window and select **Properties** from the context menu.

   The "Variable Selection" window opens in the "Display Configuration" tab. The tab displays the properties for the "YT-Oscilloscope" window.

2. For variable `TVLRH`:
   a. In the **Signals** table, find the **Range** column, and double-click on the `TVLRH` variable cell.
   b. Replace the left value (the minimum y-axis value) with `-500`.
   c. Click on the right value (the maximum y-axis value) and replace it with `500`.
   d. Confirm the changes with <ENTER>.

3. Click **OK** to return to the experiment environment.

   Observe the change to the y-axis for the `TVLRH` variable in the **YT-Oscilloscope**.

> **Note**
>
> You can also change the axis range using the scroll function of your mouse. Move your mouse pointer over the desired axis and move it up or down with the mouse button pressed or move the scroll wheel to scroll the axis, and do the same with holding <CTRL> key pressed to change the scale.

To change the color of a variable in the YT-Oscilloscope

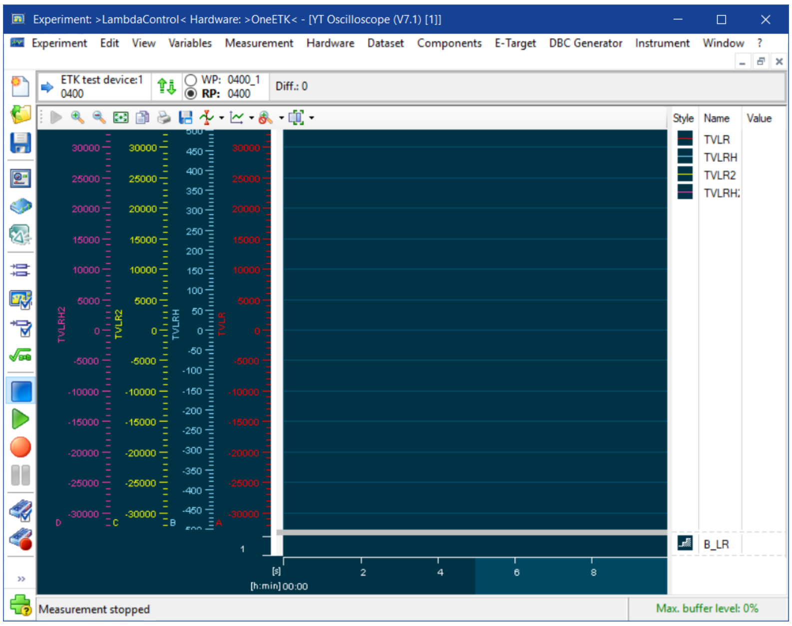
1. Once again, right-click in the oscilloscope window and select **Properties** from the context menu.

   The "Variable selection" window will open on the "Display configuration" tab.

2. For the variables `TVLR` and `TVLR2`:
   a. In the "Signals" table, find the "Color" column and double-click on the `TVLR` variable cell.

      A dialog window for color selection will appear.
   b. Select a red color field and click **OK**.
   c. Using the same method, change the color of `TVLR2` to a yellow color.
3. Click **OK** to return to the experiment environment.

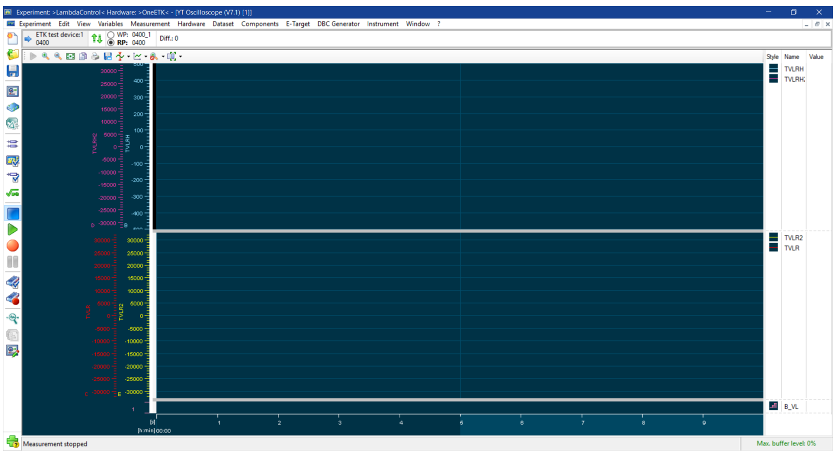
   Observe the simultaneous change to the y-axis for the `TVLR` and `TVLR2` variables in the **YT-Oscilloscope**.



<u>To distribute variables in a YT-Oscilloscope across additional strips</u>

1. For the variables `TVLR` and `TVLR2`:
   a. Press and hold <CTRL> and highlight variables `TVLR` and `TVLR2` in the oscilloscope signal list.
   b. Open the context menu in the oscilloscope window.
   c. Select **New Strip for Selected Variables**.

      The variables are moved to a new strip in the analog display area.

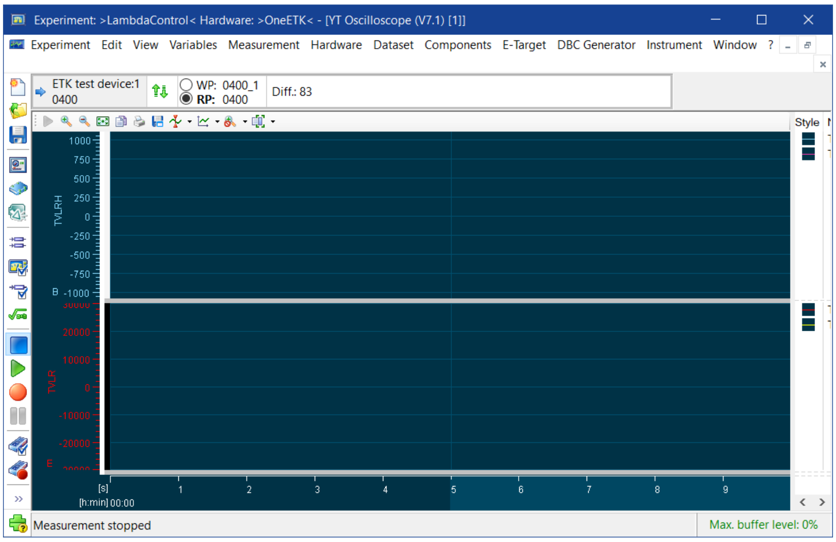


To assign a shared axis to variables in the YT-Oscilloscope

> **Note**
>
> The first variable axis in the signal list is used as the shared axis. If necessary, observe the order of the variables before assigning them to a shared axis. You can change the order by clicking on a variable and dragging it to a new location within the list using your mouse.

1. For variables `TVLRH` and `TVLRH2`:
   a. Press and hold <CTRL> and highlight variables `TVLRH` and `TVLRH2` in the oscilloscope window signal list.
   b. Open the context menu in the oscilloscope window.
   c. Select **Common Axis for Selected Variables**.

      The variables are now displayed together on a shared axis.
2. Do the same for TVLR and TVLR2 to display them on a shared axis.
3. In the experiment environment menu, select **Experiment** > **Save**.



The experiment is now saved and you can load it at any time by selecting the `OneETK` workspace in the **Database Manager** and selecting **Experiment** > **Open**. You can also load another experiment by selecting **Experiment** > **Open** in the **Experiment** window.

INCA stores not only the variables, but also their formats and the exact size and location of the windows in which they are displayed. Practice changing the size of the **Measure window [1]** and moving it. Re-save the experiment to apply the new layout.

6.4 Questions

Answer the following questions to test your understanding of the subject matter presented in this lesson.

1. All numerical variables must be displayed in the same window.
   A. True
   B. False
2. You can display several variables in a single "YT-Oscilloscope" window.
   A. True
   B. False
3. A workspace can have more than one experiment assigned to it.
   A. True
   B. False

6.5 Summary

You set up the `LambdaControl` experiment for the measurement task by selecting the variables to be measured, and changing their display formats. You also changed the display range of a "YT-Oscilloscope" window. You changed the window layout and saved the experiment so you can load it later as a shortcut.

7 Lesson: Measuring

Learning time: 45 minutes

7.1 Objectives

In this lesson you make measurements, and record the results. A Recorder Manager is available, which helps you in managing individual recordings and starting them according to current needs.

In this lesson, you will use the Recorder Manager to create one recorder for manual recordings, one for recordings with fixed duration and one for automated recordings. For the automated recordings, you will also specify triggers used for starting and stopping the recording process.

7.2 Review of the Most Important Concepts

Measurement task

The state of the engine is assessed using sensors. A sensor measures an engine parameter and makes the value available to the ECU as a number. The measurement task consists of sampling all sensor values over a certain period of time. It is also possible to record the sampled values in a file and save it to disk. The resulting record documents the engine behavior for a certain set of calibration values.

7.3 Tasks

7.3.1 Load the Lambda Calibration Experiment

The measurements applied in this lesson are used together with the experiment you created in the preceding lesson. You can quickly restore the configuration in the experiment environment by simply loading the experiment.

<u>To load the Lambda calibration experiment</u>

1. Select the `OneETK` workspace in the navigator field of the **Database Manager**.
2. Select **Experiment** > **Open**.

   The **Experiment** window opens, and **Measure window [1]** and other measure windows are restored with the variables and layout you defined in the previous lesson.

7.3.2 Start and Stop a Measurement without Recording

When you tell INCA to start measuring the measure variables displayed in the **Experiment environment** are updated. The value fields of the numerically displayed variables turn into changing numbers and the **Oscilloscope window** come to life.

To start measuring

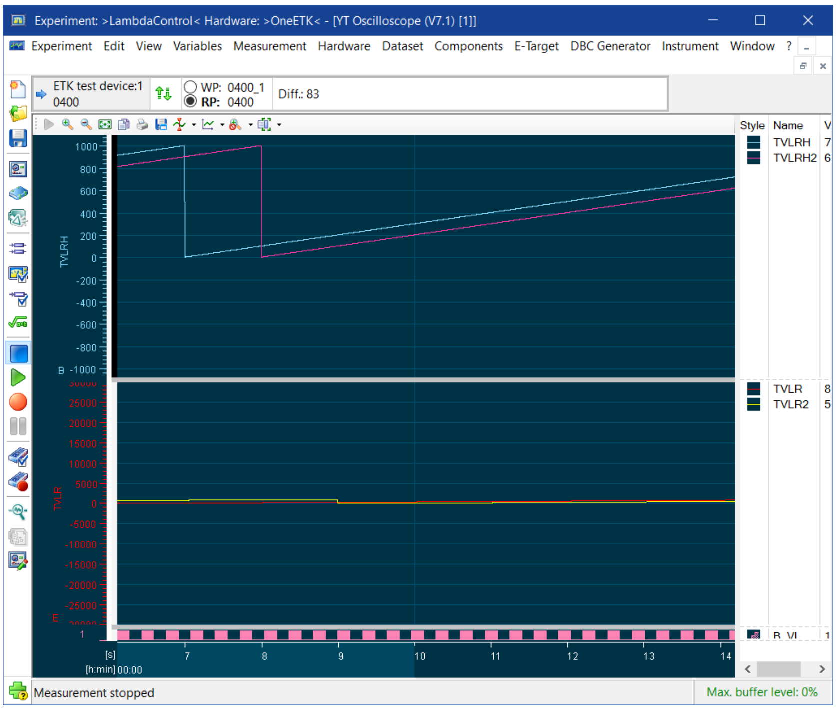
1. Select **Measurement** > **Start Visualization**.

When using this feature routinely, it is more convenient to use the accelerator key code ‹F11› to start a measurement.

To stop measuring

1. Select **Measurement** > **Stop Measuring**.

When using this feature routinely, it is more convenient to use the accelerator key code ‹F9› to stop a measurement.



7.3.3 Analyzing Measurements in the YT-Oscilloscope

To analyze measurement data in a **YT-Oscilloscope**, you can stop their display independently of experiment recording. When they are no longer displayed, it is possible to move the time axis freely, to increase its display, and to assign samples with a cursor.

Prior to recording, you can insert additional boundaries in order to visually highlight bounds for measurements.

To stop displaying in the YT-Oscilloscope

1. Once again, start with a measurement. To do so, select **Measurement** > **Start visualization**.
2. After a few seconds, find the oscilloscope window toolbar and click on **Play/Pause** ( ).

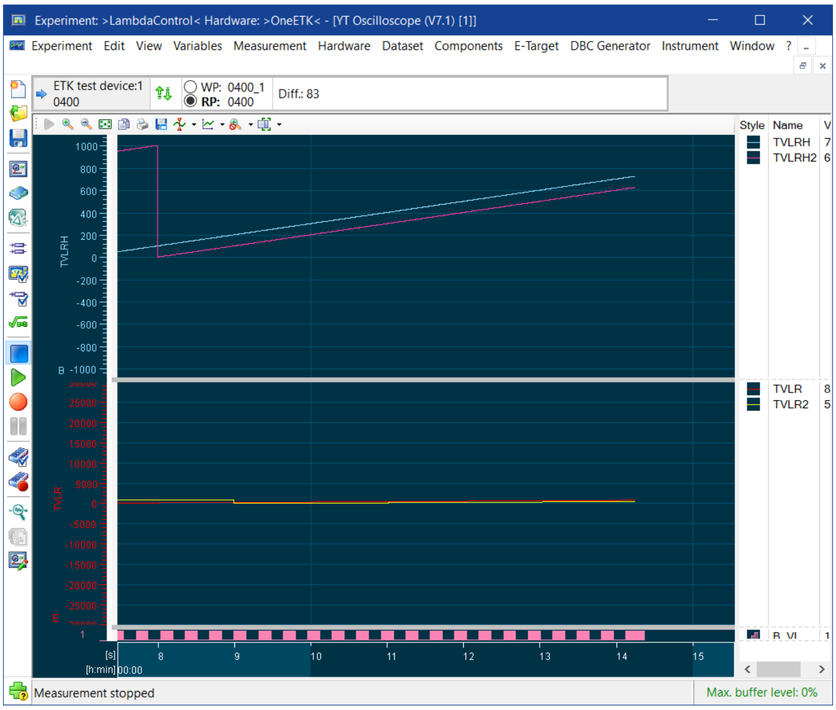
   This will stop the display in the oscilloscope window.

> **Note**
>
> This does not stop the measurement. When reinstating the display in the oscilloscope, the display position automatically jumps to the current point in time of the measurement.

To move the time axis

1. Left-click on the time axis in the oscilloscope window and press and hold the mouse button.
2. Move the mouse left or right.

   The display scrolls depending on the mouse motion.

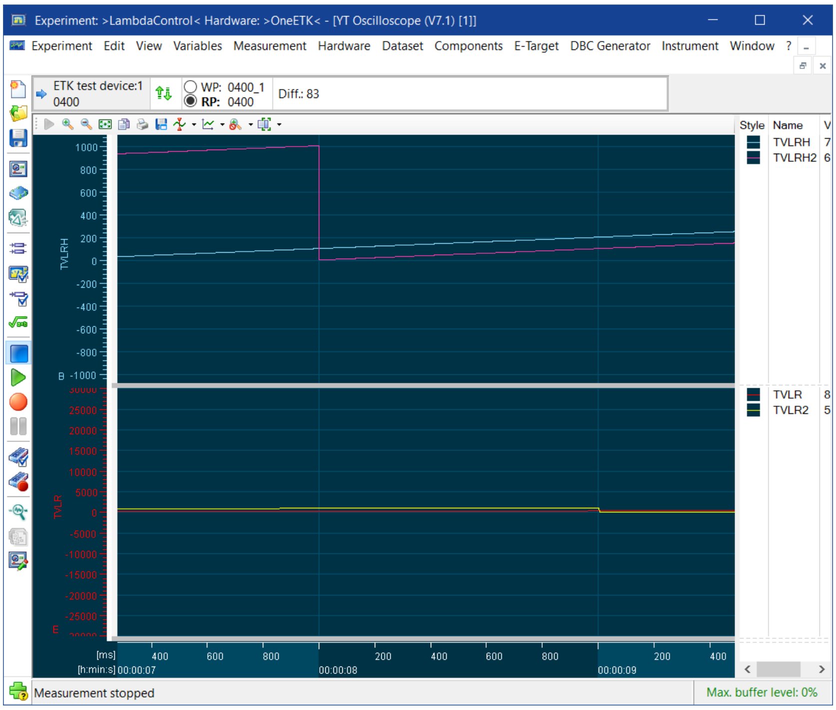


To increase the display size

1. In the oscilloscope window toolbar, click on **Zoom in** ( ).

   The display will grow larger. The time axis scale will decrease accordingly.
2. Continue clicking **Zoom in** until you have reached the desired enlarge-

ment.

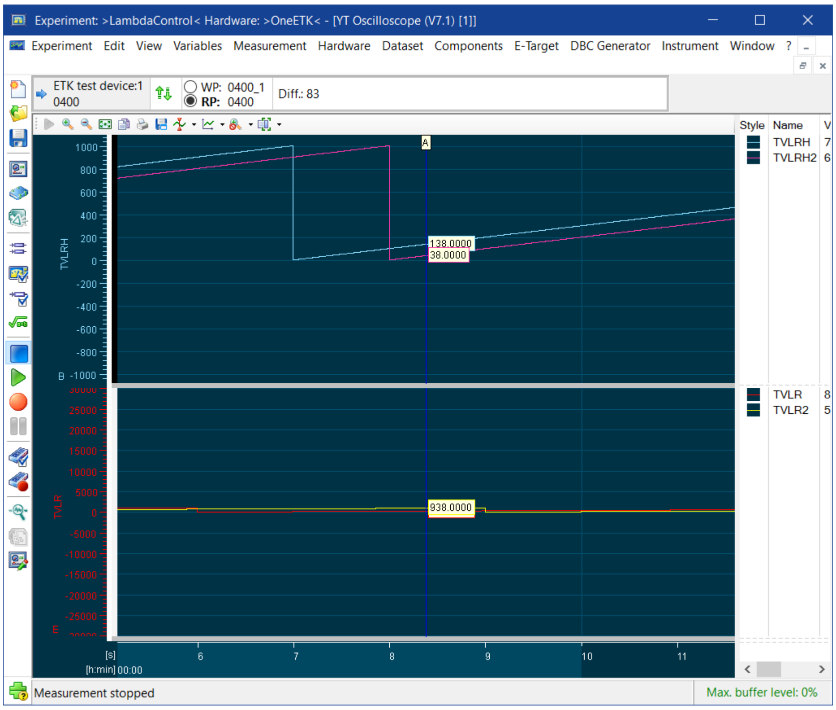


To add a cursor

1. In the oscilloscope window toolbar, click on **Cursor** ( ) > **Add cursor**.

   A cursor will appear in the center of the time axis. In addition, a column is added in the signal list which shows the signal values where the cursor is.
2. Double-click on the split bar left of the signal list to enlarge it and make the additional column visible.
3. Move the mouse over the cursor until it is highlighted.
4. Drag the cursor to the desired location on the time axis.

> **Note**
>
> Observe the tool tips at the intersection of signals and cursor when the latter is moved.



<u>To reinstate the display</u>

1. In the oscilloscope window toolbar, click on **Play/Pause** (▶).

   The display will be reinstated in the oscilloscope window. The time axis will jump to the current point in time of the measurement.

<u>To add a border line</u>

> **Note**
>
> It is best to add a border line before starting visualizing the display of measurement data. Otherwise, visualization will restart after it has been added.

1. Stop the measurement in progress. To do so, select **Measurement** > **StopMeasuring**.
2. Right-click in the oscilloscope window and select **Properties** from the context menu.

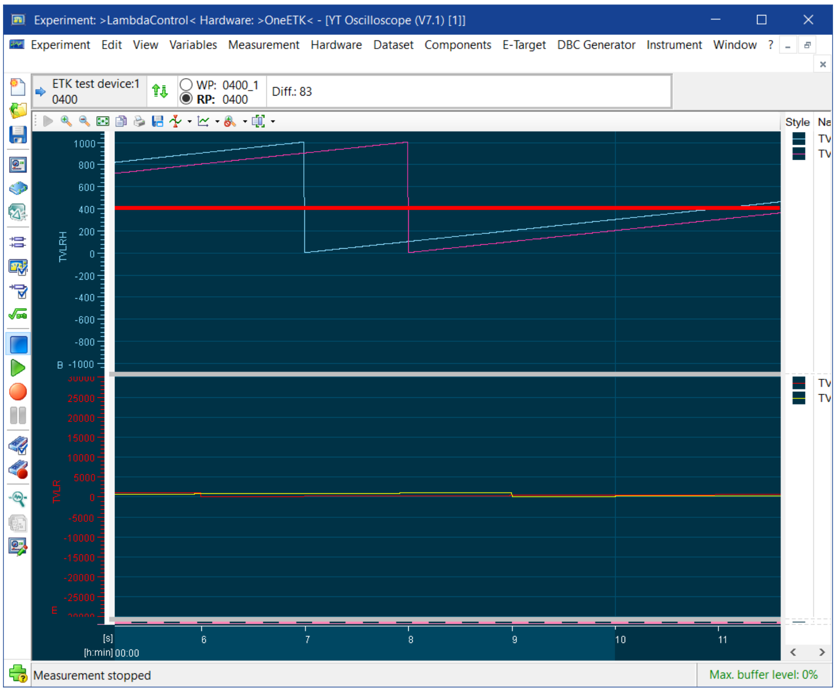
   The "Variable Selection" window will open with the "Display Configuration" tab.
3. Right-click in the "Border Lines" table and select **Add** from the context menu.

   A border line will be added as a row in the table.
4. Double-click in the **Value** column field.

   A dialog box for entering boundary values will open.
5. In the **Axis** field, select the value `A`.
6. Enter `400`.
7. Click **OK** to return to the display configuration.

8. Click **OK** again to return to the experiment environment.

   Observe the boundary in the `TLVR` and `TLVR2` variable y-axis.



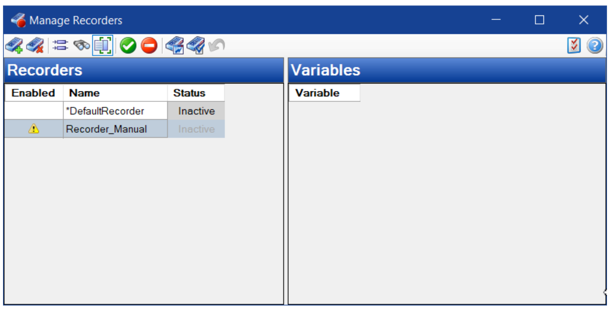
7.3.4 Create a Recorder for Manual Recordings

You are in the Experiment Environment. To create a recorder for manual recordings and start it subsequently, do the following:

To create the recorder

1. Select **Measurement** > **Open Recorder Manager (Ctrl+F11)**.

   The "Manage Recorders" dialog box opens.



2. Select **Create new recorder (Ctrl+N)** from the context menu.

   A new recorder with the name **Recorder** is added to the recorder list.

3. Press **F2** to rename the recorder to `Recorder_Manual`.

To add variables to the recorder

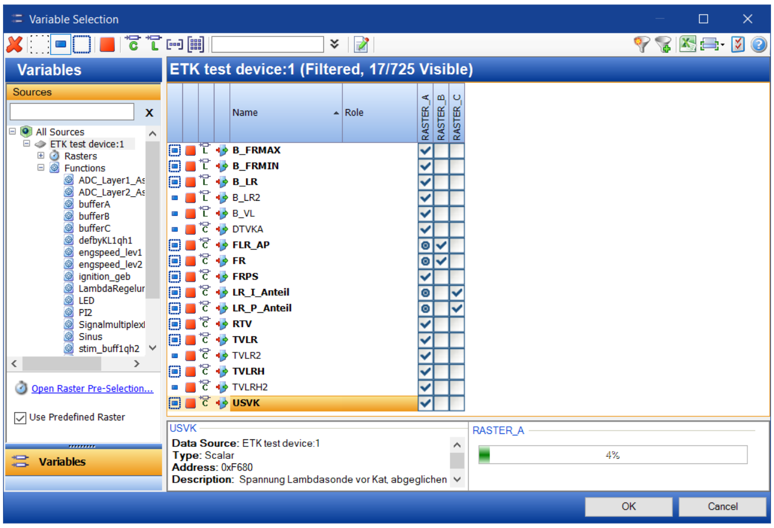
1. In the "Recorder_Manual" context menu, select the **Add variables (Ins)** command.

   The "Variable Selection" dialog opens.

2. In the toolbar, click on the following icon to filter the variables that have already been selected.

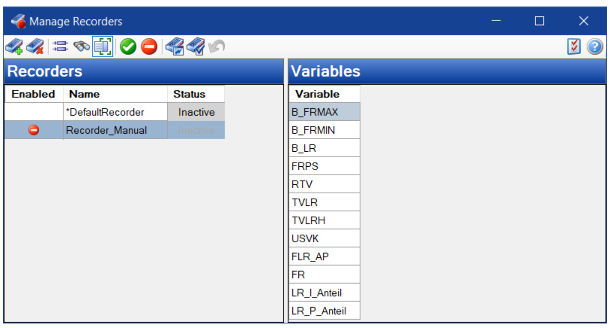
   The variable list shows all variables that are already part of the experiment.

3. Select the following variables from the list:
   - `B_FRMIN`
   - `B_FRMAX`
   - `B_LR`
   - `FLR_AP`
   - `FR`
   - `FRPS`
   - `LR_I_Anteil`
   - `LR_P_Anteil`
   - `RTV`
   - `TVLR`
   - `TVLRH`
   - `USVK`

4. Click **OK**.

   The variables are now listed in the variables list of the recorder.

To specify the file in which the recording is stored

1. Click on `Recorder_Manual` and select **Open Recorder Configuration (Enter)** from the context menu.

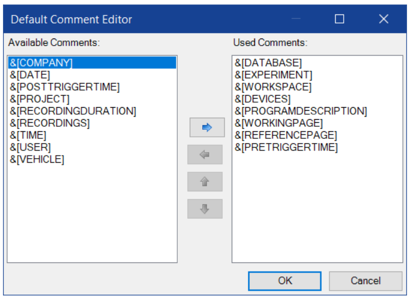
   The **Recorder Configuration** dialog appears.
2. Select the "Output File" tab.
3. In the "Path" field, enter `<INCA base>\ETASData\INCA\Measure`.

   The "File" field automatically shows the name of the recorder.
4. If the fields **Use date/time in file name** and **Auto increment file name** are not yet being displayed, click on to expand the view and display hidden fields.
5. Replace the automatically assigned file name `Recorder_Manualdat` with `Tutorial`.
6. In the **Format** field, select the `yyyy-mm-dd` entry.

   For the next recording with this recorder, the current date is automatically added to the file name of the new output file.
7. Activate the **Insert default comment** check box.

   The default comment can be expanded with additional comment fields or personal entries. All these data are saved with the measurements in the file.
8. Click on **Edit**.

   The **Default Comment Editor** dialog opens.

9. Hold **‹Ctrl›** pressed and click on the following comment fields:

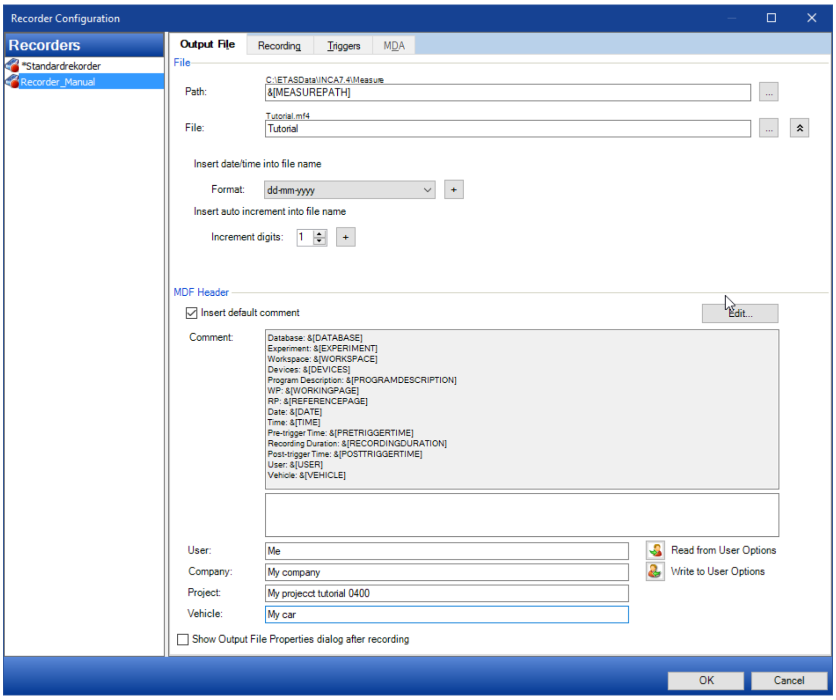
   `&[USER]`

   `&[VEHICLE]`
10. Click on the following button to move the selected comment fields from the **Available Comments** column to the **Used Comments** column.

    
11. Click **OK**.

    For the next recording of the output file, the comment fields that have already been used in the default comment and the comment fields `&[USER]` and `&[VEHICLE]` are being entered.
12. Fill in the fields **User**, **Company**, **Project** and **Vehicle**.

13. Disable the check box **Show Output File Properties dialog after recording**.



To define the trigger conditions

1. In the "Recorder Configuration", select the "Triggers" tab.
2. Activate **Trigger on**.
3. Open the drop-down list in the **Start Trigger** field and select the entry `MANUAL`.

   `Recorder_Manual` starts if **F5** is pressed during the recording.
4. Click **OK** to go back to the Manage Recorders dialog.

To define event markers for the default recorder

> **Note**
>
> Use the event markers to manually identify events in the "Default Recorder" during a measurement.

1. Click on `Default Recorder` and select **Open Recorder Configuration (Enter)** in the context menu.

   The "Recorder Configuration" dialog appears.
2. Select the "Recording" tab.
3. Enable the "Show Comment" check box.
4. In the **Comment** field, enter `Manual Event Markers`.
5. Click **OK** to go back to the "Manage Recorders" dialog.

7.3.5 Make a Recording Using a Fixed Recording Interval

When specifying the recording interval you must choose between two different modes of recording. You can either use a fixed recording interval, which is started when you give the (manual) command to start recording, or you can automate the recording by specifying a so-called trigger, which is a certain condition to become true after you give the (manual) command to start recording. The two modes are mutually exclusive.

First, do a recording using a fixed time interval.Fig. 7-1 shows the recording process when using a fixed time interval.

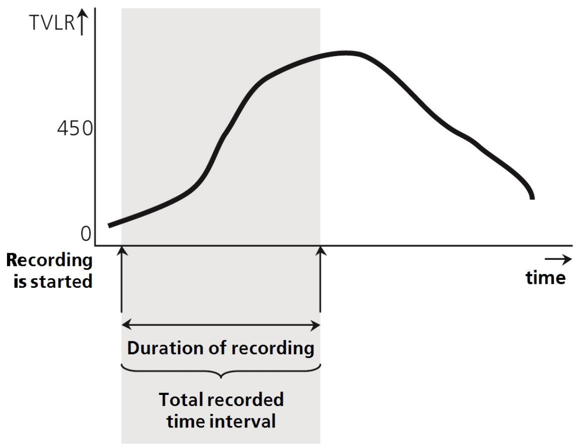


Fig. 7-1: Recording process when using a fixed time interval.

To do a measurement using a fixed recording interval

1. Create a new recorder (see "Create a Recorder for Manual Recordings" on page 57).
2. Rename this recorder to `Recorder_Period`.
3. Add the same variables as in the previous example (see "Create a Recorder for Manual Recordings" on page 57).
4. Select the "Output File" tab in the Recorder Configuration.
5. In the **Path** field, enter `<INCA base>\ETASData\INCA7.5\Measure`.
6. Rename the output file to `Tutorial2`.
7. In the "Recorder Configuration", select the "Triggers" tab.
8. In the **Recording Duration** field, enter the value `30` seconds.
9. Click **OK** to go back to the Manage Recorders dialog.

7.3.6 Creating a Recorder for an Automated Measurement

You can automate a measurement using triggers for starting and stopping the measurement. A trigger is a mechanism that is automatically executed after an event (such as starting the recording process). The trigger activates the measurement when the outcome of a logical expression, the trigger condition, changes from false to true. Since the logical expression is a function of a measure variable it is really the value of the measure variable that causes the measurement to start.

In the following example you specify the following trigger: start recording the variables measured in the current experiment setup as soon as the engine speed exceeds 450 rpm.

To analyze the engine behavior before and after the transition marked by the trigger event you need to record measurement values both before and after the trigger event occurs. INCA enables you to do this by continuously storing the values it measures in a buffer, even if you are not recording at the time. The time interval to be recorded before the start trigger event happens is called pre start trigger time. The interval that is recorded after the stop trigger event happens is called post stop trigger time.

The relation between the pre start trigger time and post stop trigger time is illustrated in Fig. 7-2.

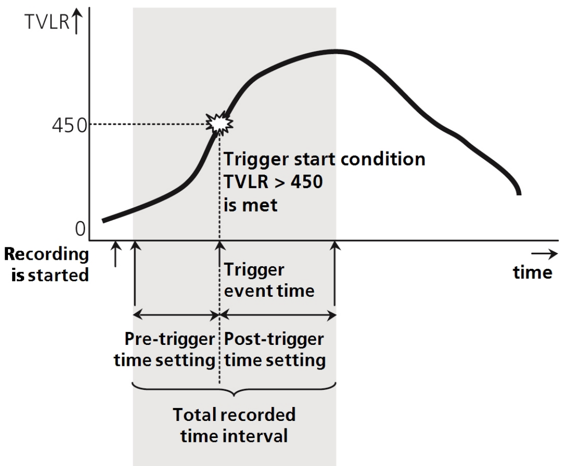


Fig. 7-2: Relation pre start trigger and post stop trigger times.

Instead of specifying a post stop trigger interval, you can also specify a trigger to stop the measurement, for example engine speed to drop below 300 rpm.

To make a recording using a start trigger and a fixed duration

1. Create a new recorder (see "Create a Recorder for Manual Recordings" on page 57).
2. Rename this recorder to `Recorder_Trigger`.
3. Add the same variables as in the previous example (see "Create a Recorder for Manual Recordings" on page 57).

> **Note**
>
> You can also select recorder variables, copy them to a clipboard, and insert them in other recorders.

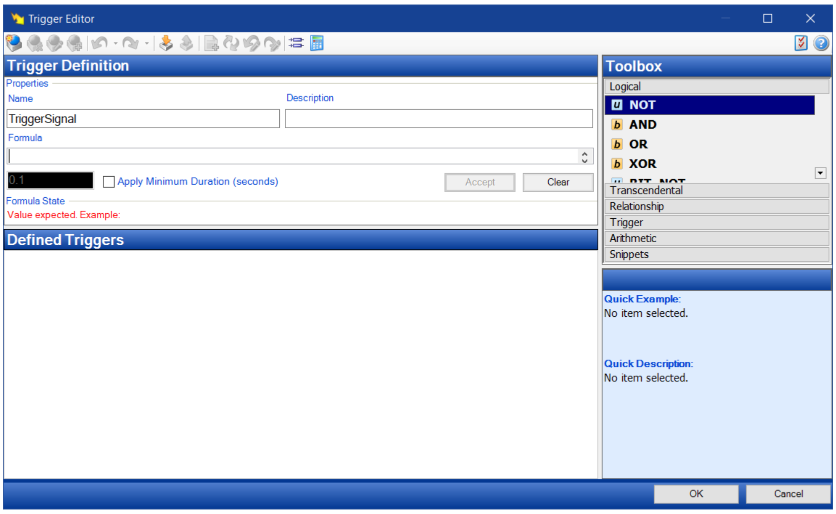
4. Select the "Output File" tab in the **Recorder Configuration**.

5. In the **Path** option, set `<INCA base>\ETASData\INCA\Measure`.
6. Rename the output file to `Tutorial3`.
7. Set **Auto increment** to **1** and click .

To define the trigger conditions

1. In **Recorder Configuration**, select the "Triggers" tab.
2. Activate the checkbox **Trigger on**.
3. Click on the  button right of the **Start Trigger** drop-down list.

   The "Trigger Editor" appears.

   The trigger editor is used for defining trigger conditions. All existing trigger definitions are collected in a list and can be set as start or stop triggers at a later time.
4. In the **Name** field at the top of the dialog box, you can set a name for the condition. This name can be used to define additional triggers. Change the default name `TriggerSignal` to `TVLRover450`.
5. To select variables for the formula, click the following icon in the toolbar:

   The "Variable Selection" Dialog opens.
6. In the **Sources** window, click on `All Sources` so that all variables are displayed in the list of variables.
7. Then select the variable `TVLR` from the list and click on **OK** to go back to the "Trigger Editor".

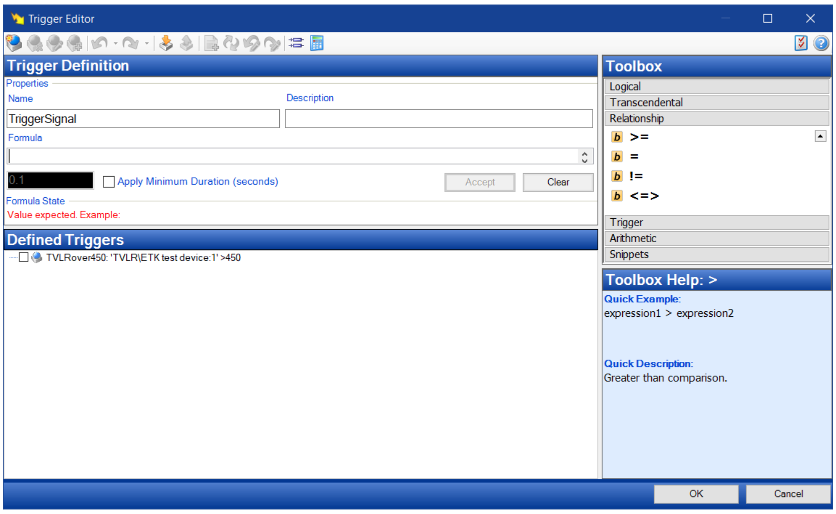
   The variable name and the name of the device were entered in the **Formula** field.

   Now you want to enter an operator. The toolbox on the right of the editor offers a large number of operators, grouped according to their type.
8. In the Toolbox, click the **Relationship** tab.

   A list with operators that can be used for defining relations appears.

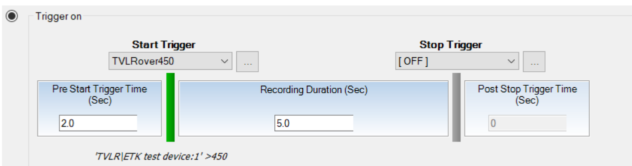
9. Double-click the **>** operator to add it to the formula.
10. Click into the edit box of the **Formula** and type the value `450`.
11. Click on **Accept**.

    The trigger condition is entered in the **Defined Triggers** field.



All trigger conditions you have defined using different names are listed in the **Defined Triggers** field. After collecting several conditions in this field, you can later on quickly activate a certain condition as start trigger or end trigger by selecting it in the Recorder Configuration on the "Triggers" tab. The selected condition will then be used as the current condition for recording.

12. Click **OK** to go back to the Recorder Configuration.
13. In the **Start trigger** drop-down list, select the `TVLRover450` trigger condition.
14. In the **Pre-Start Trigger Time (Sec)** field, enter a value of `2` seconds.
15. In the **Recording Duration (Sec)** field, enter a value of `5` seconds.



16. Click **OK** to go back to the **Manage Recorders** dialog.

7.3.7 Perform Recordings

Depending on which recorders are enabled and which ones are disabled, you can control which recording will be performed. Some functions such as opening the Measure Data Analysis (MDA) after a recording is only available for the default recorder. The default recorder can be renamed, but it cannot be deleted.

To enable recorders

1. Start in the "Manage Recordes" dialog and select `Recorder_Manual`.
2. Select **Enable Recorder (Space)** from the context menu.

   In the **Enabled** column, the symbol changes from to .
3. Select `Recorder_Period`.
4. Select **Enable Recorder (Space)** from the context menu.

   In the **Enabled** column, the symbol changes from to .
5. Select `Recorder_Trigger`.
6. Select **Enable Recorder (Space)** from the context menu.

   In the **Enabled** column, the symbol changes from to .

To start recording for all enabled recorders

You have two options for starting the measurement. Using the first method, you can start all enabled recorders, including the default recorder; using the other method, you can start all enabled recorders, excluding the default recorder.

You are in the Experiment Environment.

1. Select **Measurement** > **Start recording (F12)**.

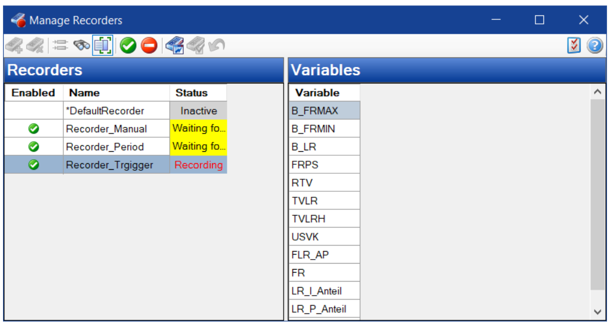
   This initiates the following events:

   a. `*DefaultRecorder` starts recording immediately.

   b. `Recorder_Manual` waits for the manual trigger.

   c. `Recorder_Period` starts recording immediately. After 30 seconds, the recording of `Recorder_Period` stops. The recorded values are saved in the output file `Tutorial2.mf4`. If a file `Tutorial2.mf4` already exists, it will be overwritten.

   d. `Recorder_Trigger` waits for the trigger condition to be fulfilled. As soon as the value of the variable TVLR exceeds 450, the recording will be started.



2. Press the key **F5** to start recording with `Recorder_Manual`.

To set an event marker in the default recorder

1. Press and hold ‹CTRL› + ‹K› to add an event marker to the `default recorder`.

   The "Insert User Comment" dialog box appears.

2. Click on **OK** if you want to use the defined comment, or enter a new comment.

   The marker is inserted at the location in the recording file at which you called the function and can be displayed for the measuring data analysis.

To stop the started recordings

The recording with `Recorder_Period` has already been automatically stopped after 30 seconds. The recordings of `Recorder_Period` have been saved in the file `Tutorial2.mf4`.

1. Select **Measurement** > **Stop Measuring (F9)**.

   This initiates the following events:

   a. The recording of `Recorder_Manual` is finished. The recorded values are saved in the output file `Tutorialyyyy-mm-dd.dat` (whereby yyyy-mm-dd corresponds to the current date). If a file with this name already exists, it will be overwritten.

   b. The recording of `Recorder_Trigger` is finished. The recorded values are saved in the output file `Tutorial301.mf4` (this is the name Tutorial3 with an appended two-digit number). If a file with the name `Tutorial301.mf4` already exists, the new file will be named `Tutorial302.mf4`.

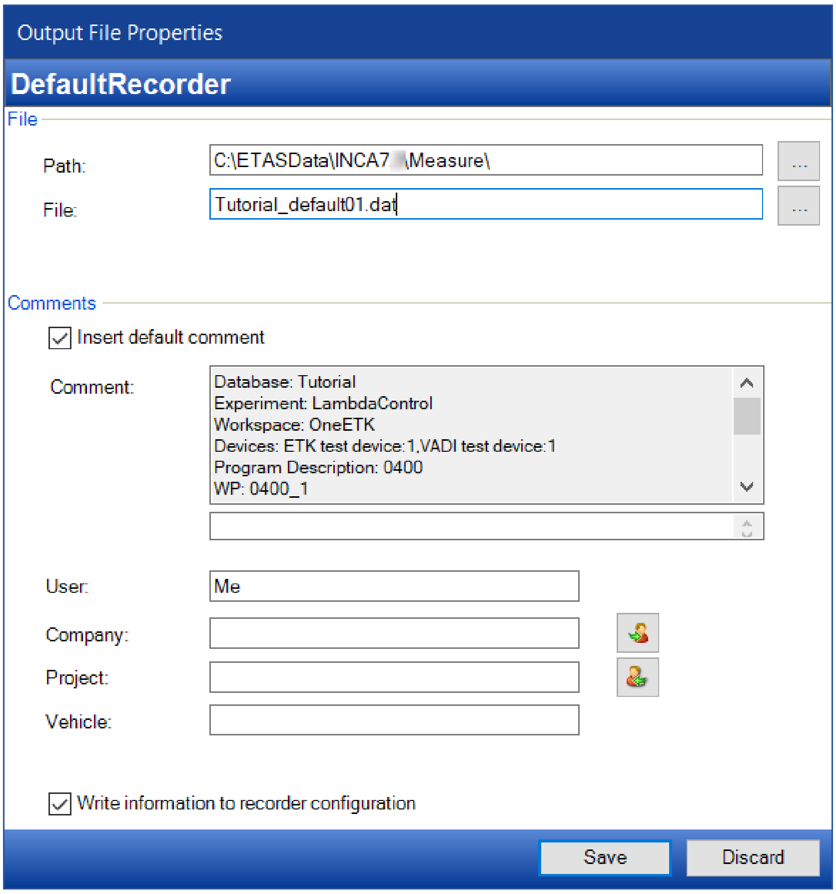
   c. The recording of `*Default Recorder` is being finished. The "Output File Properties" dialog box opens.

2. Replace the automatically assigned file name in he **File** field with `Tutorial_default01.mf4`.

3. You can amend the default comment with your own information as well as personal information for the project. All these data are saved with the

measurements in the file.

4. Click **Save**.



To start recordings for all enabled recorders apart from the default recorder

1. In the Experiment Environment, select **Measurement** > **Start Visualization** <F11>.

   The individual recorders react as described in the previous section.

2. Press the <F5> key to start recording with `Recorder_Manual`.

To stop the recordings

The recording with `Recorder_Period` has already been automatically stopped after 30 seconds.

1. Select **Measurement** > **Stop Measuring** <F9>.

   This initiates the following events:

   a. The recording of `Recorder_Manual` is finished. The recorded values are saved in the output file `Tutorialyyyy-mm-dd.dat` (whereby yyyy-mm-dd corresponds to the current date). If a file with this name already exists, it will be overwritten.

   b. The recording of `Recorder_Trigger` is finished. The recorded values are saved in the output file `Tutorial302.dat`. If a file with the name `Tutorial302.dat` already exists, the new file will be named `Tutorial303.dat`.

7.4 Questions

Answer the following questions to test your understanding of the subject matter presented in this lesson.

1. How many conditions can you define for a start trigger?
   A. 1
   B. 2
   C. Many
2. How many conditions can be made to apply simultaneously for a start trigger?
   A. 1
   B. 2
   C. Many
3. If a stop trigger has been defined, the posttrigger time is ignored.
   A. True
   B. False
4. If a start trigger is activated, the recording duration setting is ignored.
   A. True
   B. False
5. Which command starts recording with the default recorder?
   A. Start visualization
   B. Start recording

7.5 Summary

In this lesson you measured the variables defined for the `Lambda Control` experiment. You made a manual recording, a recording with fixed duration and a triggered recording and saved all results into a file.

8 Lesson: Calibration

Learning time: 80 minutes

8.1 Objectives

In this lesson you display and calibrate the calibration elements associated with the Lambda control experiment. You learn to use and manipulate calibration datasets. For calibration you use tabular as well as graphical calibration editors, and change single values as well as ranges of values.

For modifying several calibration variables and activating them at once, you will learn how to work with calibration scenarios.

8.2 Review of the Most Important Concepts

Calibration task

It is the task of the ECU (Electronic Control Unit) to control the engine so it exhibits a desired behavior. The ECU uses a feedback process to do this: it measures the state of the engine using sensors, and then changes the state of the engine towards the desired behavior using actuators. The new state is measured and adjusted again and again, until an equilibrium is reached. Calibration is the process of adjusting the feedback parameters in such a way that the car exhibits the desired behavior when the equilibrium state is reached. Because the state of the car changes as it is driven, there are many of these equilibrium states, usually called process points. A car is non-linear system, and the control algorithm cannot rely on mathematics to determine the feedback values. Instead it looks up the required actuator settings in a set of tables, using the sensor values as lookup criterion. The calibration task consists of setting the values in the tables. The same ECU can have different valid sets of calibration values implementing a different behavior, one set for a fast car, for example, and another set for an economical car.

Variables, measure variables, calibration variables (characteristics, curves, and maps)

The term variable is used as a collective name for both measure variables and all types of calibration variables.

In general, a measure variable is a value passed by a sensor, and can be used as a lookup value for calibration variables. Moreover, it is possible to measure derived or calculated characteristics, or, with corresponding settings, also calibration variables.

There are three types of calibration variables:

A. Characteristics are fixed values used as constants by the ECU program after they are adjusted during the calibration process.
B. The ECU uses look-up tables to determine the required value of an actuator setting as a function of measure variables (see Calibration Task). If one variable is used to look up one output value, the table is called a curve, because it can be represented graphically as an xy-curve.
C. A look-up table using two or more measure variables to find one output value is called a map, because of the analogy to an elevation map; think of the input variables as the coordinates, and the output value as the elevation of a certain location on the map.
   Maps that derive the output value from three or more input values are called multi-dimensional maps.

Process point

For any curve or map, the process point is the current lookup value passed to the ECU. The process point changes with the value of the measure variable used as lookup criterion into the curve or map. The process point can be visualized on the map; in a tabular calibration editor the cell holding the current lookup value is 'selected'. As the process point changes, the selection moves across the cells of the table.

Dataset

The values making up the characteristics, curves and maps are stored in permanent memory in the ECU, and accessed by the ECU processor. A set of calibration values stored in the database is called a dataset. Datasets are versioned; a certain version corresponds to a certain calibrated behavior. Datasets are stored in *.hex or *.s19 files and referenced in the database. These files are binary images of the ECU memory, and beside the calibration data they also contain the ECU program itself.

Calibration Scenario

Using the Calibration Scenario Editor, you can configure several calibration scenarios within the Experiment Environment. Each scenario contains a set of calibration variables. These can be calibrated individually from each other. Afterwards you can easily activate complete scenarios on the ECU, i.e. when switching to that scenario, a complete set of calibration variables gets modified on the ECU at once. This feature allows you to compare the behavior of variables that belong together, thereby optimizing data in an efficient way. Such a set of calibration scenarios including the corresponding settings is called a calibration scenario configuration. In addition to that, it is also possible to save individual calibration scenarios in external files (e.g. CVX) for data exchange.

8.3 Tasks

8.3.1 Add Calibration Variables to the Experiment

To change calibration variables, they must be added to the experiment. The calibration variables are added in the same way as described for measurements in Lesson: Setting Up an Experiment. The calibration variables are displayed in the Experiment Environment in separate calibration windows, which are also called editors.

In "Lesson: Setting Up a Workspace" on page 22 you loaded a master dataset to initialize the project with calibration data. This means that when viewing calibration elements they have appropriate values.

Adding calibration variables to the experiment is done in the same manner as adding measure variables. Some helpful hints:

- In the "Variable Selection" dialog, the first symbol before the names of the calibration variables always is a blue circle.

- There is a filter you can use to select calibration elements in the variables list of the "Variable Selection "dialog. Apply the filter by clicking the icon for calibration variables in the toolbar of the "Variable Selection" dialog.
- When selecting calibration variables in the "Variable Selection" dialog you can mix characteristics, curves, and maps freely.

Using the skills you acquired in "Lesson: Setting Up an Experiment" on page 36 to add the following characteristic values. Use the filters from the toolbar and the alphabetic filter.

1. Add the following scalar arith. elements:

   `FRMAX`

   `FRMIN`

2. Add the following curve:

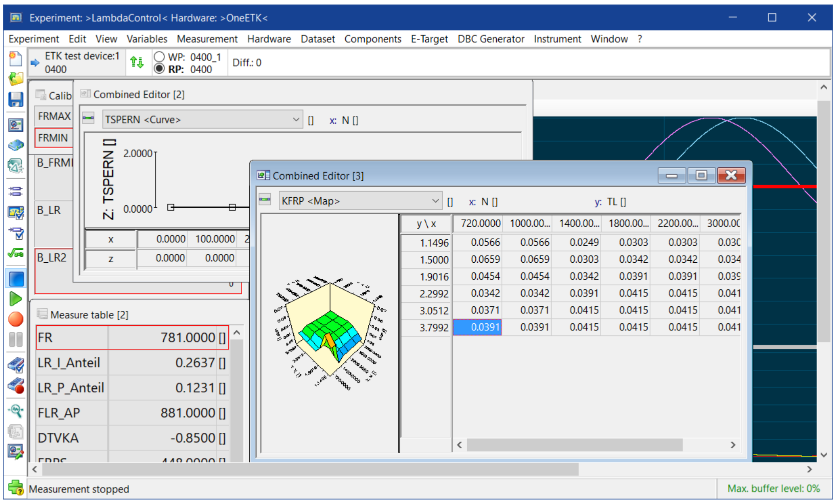
   `TSPERN`

3. Add the following maps:

   `KFRP`

   `KFRI`

`KFRTV`



Note that the following editors have been added to the experiment:

Both characteristics are presented in the **Calibration window** [1]. The curve is displayed in graphical and tabular form in the **Combined Editor** [2]. The maps are presented in graphic and tabular form in the **Combined Editor** [3] . By setting a different variable using the combo box at the top, you can switch maps in the **Combined Editor** [3].

As you may have noticed by now, the experiment is very confusing. In the next lesson, you will learn how to divide the display of the experiment into layers by using the display configuration in the Variable Selection dialog.

<u>To divide the experiment into layers</u>

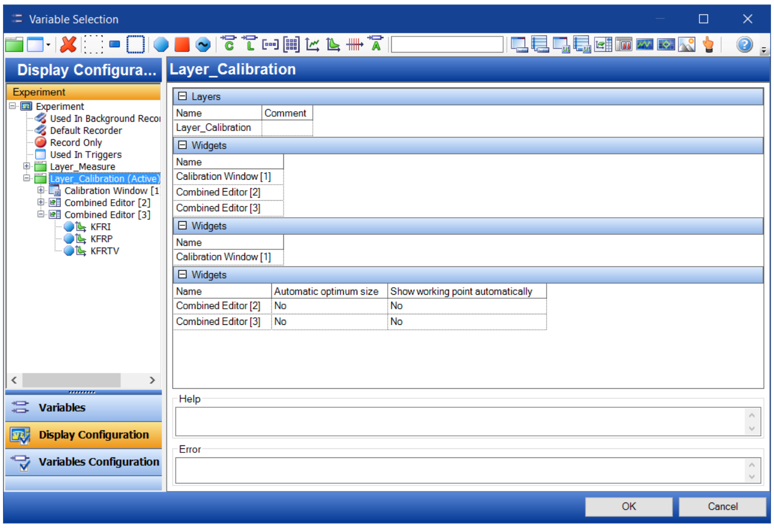
1. Select **Variables**>**Display Configuration**.

   The "Variable Selection" dialog opens on the "Display Configuration" tab.

2. In the toolbar, click on the following icon to add a new layer:

3. Rename the new layer to `Layer_Calibration`.
4. Click on **Calibration window** [1], press and hold the <SHIFT> key and highlight all windows down to **Combined Editor** [3].
5. Select **Cut** from the context menu.
6. Click on `Layer_Calibration` and select **Paste** in the context menu.

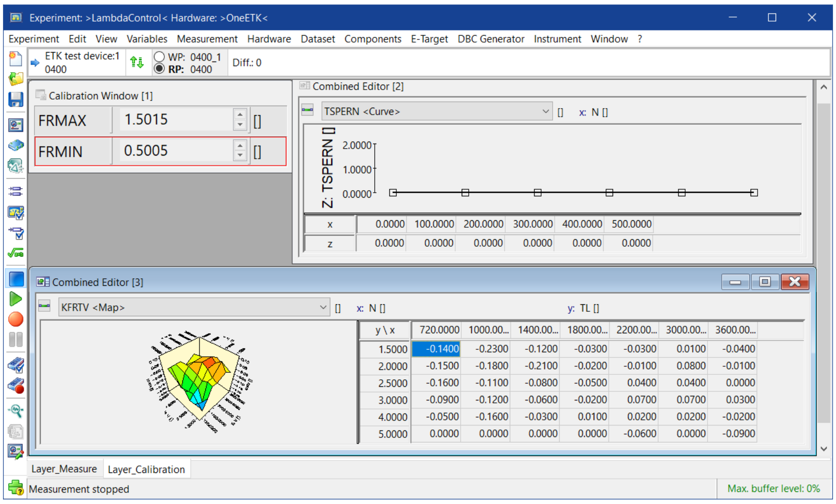


7. Click **OK** to adopt the settings and to return to the experiment environment.

   In the bottom area of the experiment, the layers `Layer_Measure` and `Layer_Calibration` can be selected via tabs.

8. Click on the `Layer_Calibration` tab.

9. Move and scale the editors so that all can be viewed very well.



8.3.2 Switch Between the Reference and Working Datasets

As you have seen in "Lesson: Calibration" on page 69, INCA keeps several copies of the calibration data with the project: a reference and a working dataset, shown in the project information as Reference Page RP and Working Page WP.

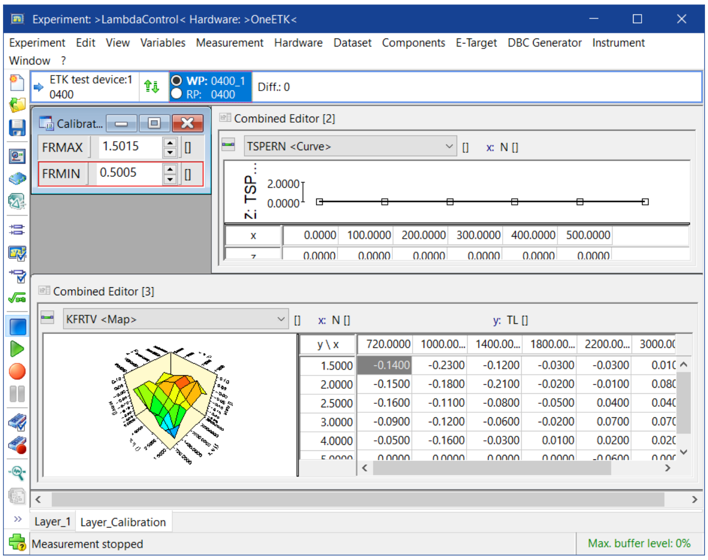
The reference page is read-only. You use it to compare the behavior of the engine. Also, you may want to return to the reference dataset in case your calibrations do not work out as expected, and you want to reset the calibration.

The working page can be modified. This is the dataset you use to do calibrations.

INCA allows you switch easily between the reference and working pages. You can see whether you are using the reference or working page by watching the background of the calibration editor windows: if they are gray the reference page is active, if they are white the working page is active.

To switch between reference and working page

1. Directly below the menu bar of the "Experiment" window you see a toolbar. Near the center of the toolbar are two radio buttons, one labeled **WP** and one labeled **RP**. The names of the corresponding datasets are displayed right to the radio buttons; in this tutorial they are 0400_1 for the working dataset and 0400 for the reference dataset.
2. Click the radio button labeled **WP** to switch to the working page.



3. Select **Experiment** > **Save**.

8.3.3 Download the Current Version of the Calibration Data to the ECU

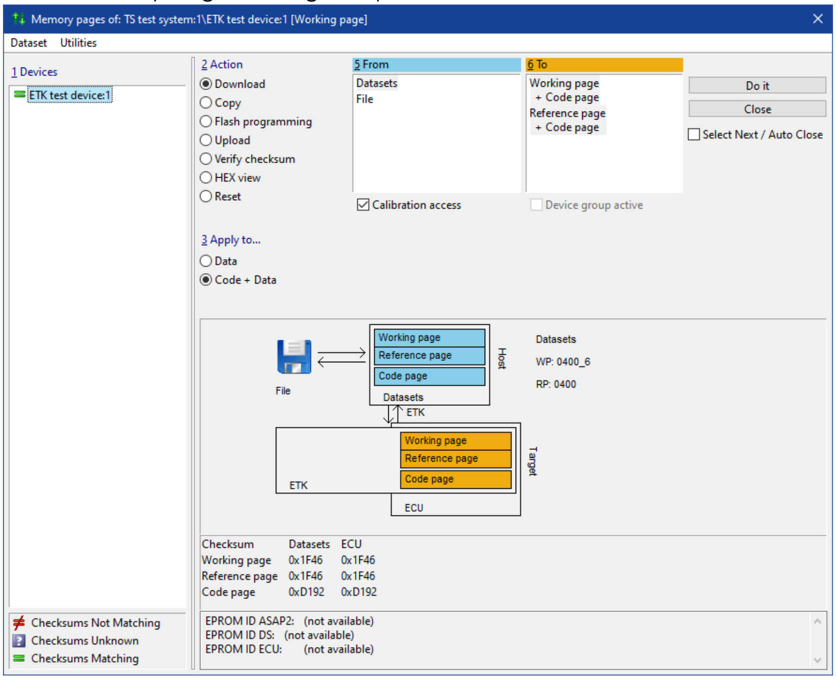
If a connection to the ECU is made, it is possible to access the calibration data in its memory. Note that in a real setting the hardware typically contains a version of the calibration data which is different from the data you loaded for the project. To ensure that you are calibrating using the appropriate version of the calibration data, you must transfer the calibration data to the ECU.

To download the current version of the calibration data to the ECU

1. Select **Hardware** > **Hardware status**.

   Verify the hardware status to ensure that there is an active connection to the ECU. Then close the hardware status view.
2. Select **Hardware** > **Manage memory pages**.

The "Memory Page Manager" opens.



The Memory Page Manager allows you to perform several actions on the calibration data. All actions involve moving calibration data from one place to another. The Devices field shows all the ECUs in the current hardware configuration, including the checksum calculation status. The set of radio buttons in the Action field allows you to select the action to be performed. The From and To fields list the possible source and destination locations of the calibration data. The graphic in the center of the window summarizes the action you are programming. It updates dynamically according to the selections you make. Use the graphic to double-check that the programmed action is what you want to ensure that the hardware won't be damaged when you actually move the data.

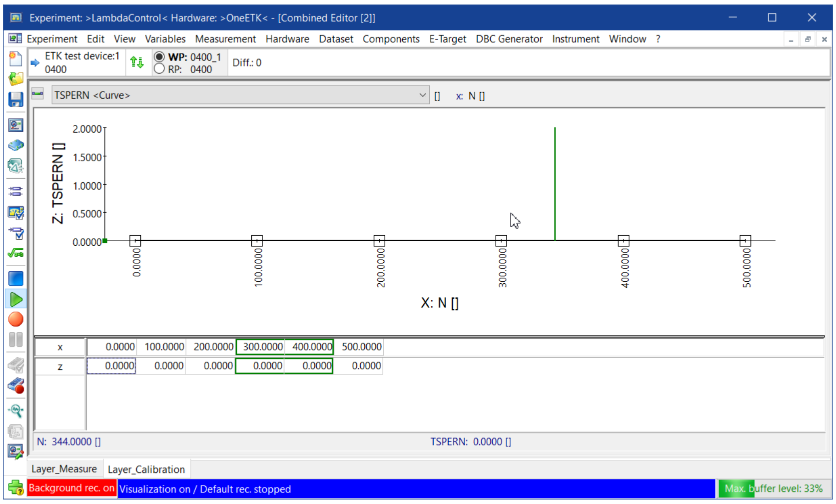
3. In the **Action** field, activate **Download**.
4. In the **Apply to** field, activate **Code + Data**.
5. In the **From** field, select **Datasets**.
6. In the **To** field, press and hold <CTRL> and select `Working page+Code page` and `Reference page+Code page`.
7. Click **Do It** to start the action and click **Close** to return to the experiment.

8.3.4 Show Process Point

Now that there is an active connection to the ECU, you can show the process point on the curves and maps.

<u>To show the process point on the TSPERN curve</u>

1. In the context menu of the **Combined editor [2]**, which displays `TSPERN`, select **Set Editor on Process Point**.
2. Select **Measurement** > **Start Visualization**.



Note that the process point is visualized in the **Combined editor [2]** with the `TSPERN` map by a green frame around the table entry that corresponds to the process point.

3. Stop measuring.

8.3.5 Perform the Calibration Task

WARNING

Calibration activities influence the behavior of the ECU and the systems controlled by the ECU. This may result in unexpected behavior of the vehicle and thus can lead to safety critical situations.

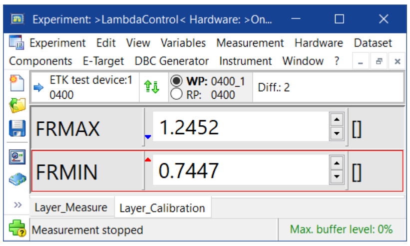
Now it is time to do the actual calibrations.

To calibrate the scalars

1. In the **Experiment environment**, ensure that the working page is active.
2. Select the **Calibration window [1]** with the characteristics `FRMAX` and `FRMIN`.
3. Double-click the value in the edit box to the right of the parameter name `FRMAX`.
4. All digits constituting the value in the cell are selected. Type `1.25` and press <ENTER>. The setting is rounded to 1.2452, the nearest value available according to the description of the parameter in the project descrip-

tion file.

5. Change `FRMIN` to `0.75` using the same method.



In the following exercise, you first enter new values for the `TSPERN` curve in the table and then refine the calibration using the graphical display.

To calibrate the TSPERN curve

1. Maximize the window of the **Combined editor [2]**.
2. Change the values in the cells using the same methods as for changing parameter values:

   `x=0: z=0.5`

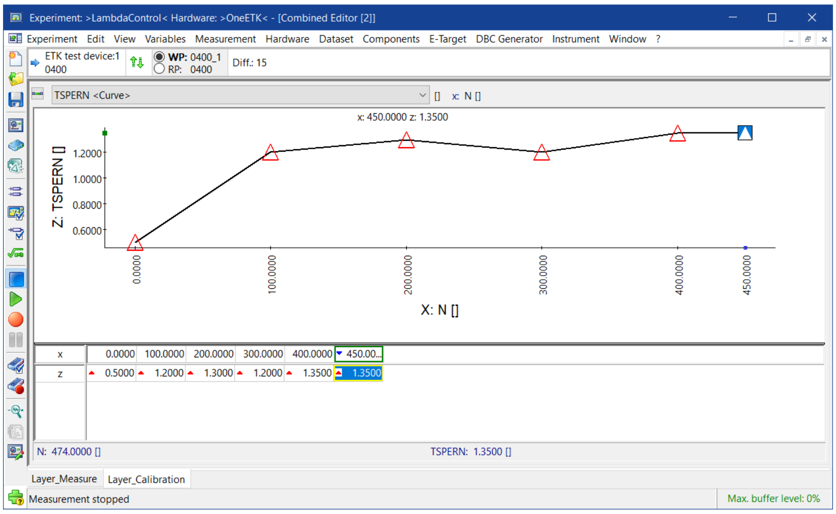
   `x=100: z= 1.2`

   `x=200: z=1.3`

   `x=300: z=1.2`

   `x=400: z=1.35`

   `x=500: z=1.35`
3. Change the value for `x=500` by reducing the x-value from `500` to `450`



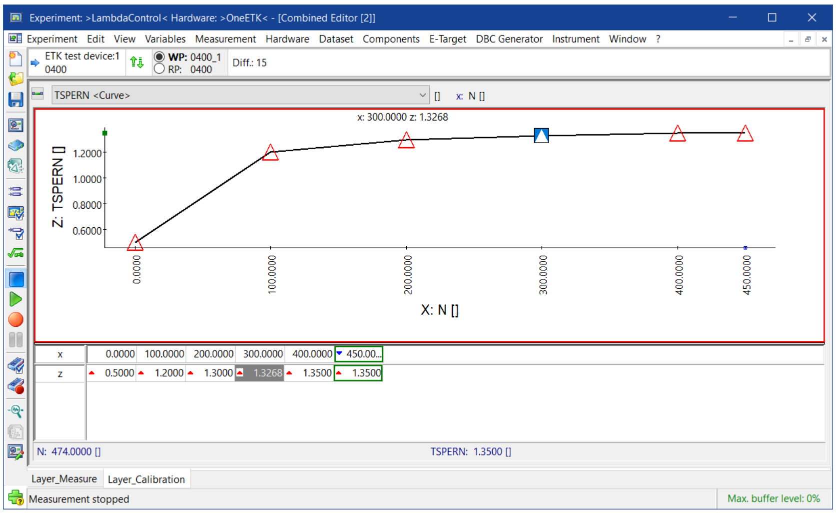
   The curve now appears in its new shape, according to the values you entered in the table. Note that the curve is not smooth.

To smoothen the curve using the graphical area of the editor

1. Click the little triangle on the curve representing the value of **`TSPERN`** at `x=300`.

   A colored mark indicates you can now change the value for `x=300`.

2. Drag the triangle to a new position on the chart so the curve looks smooth.



3. Restore the **Combined editor** to its normal size.

Entering the new values for all the entries in the `TSPERN` table was fairly time consuming. In order to facilitate the calibration task INCA allows you apply changes to an entire range of values using a single command. In the following exercise you apply three such changes to ranges of map values.

Note

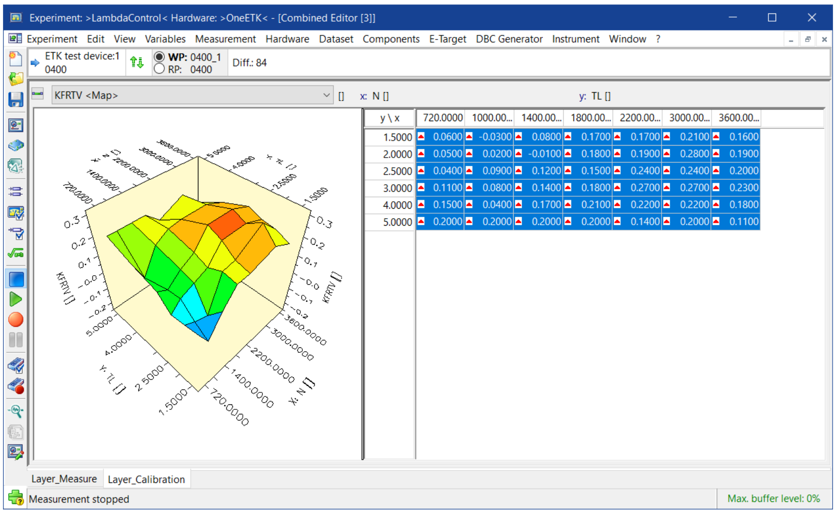
When calibrating the arith. elements, also consider the **Diff** counter in the upper area of the experiment. It counts the total number of performed changes in bytes, thus allowing a quick overview of the differences between the reference and working page.

To calibrate all values of a map

1. Select the `KFRTV` map in the **Combined editor [3]** and maximize this window.
2. Select one value in the map table.
3. Select **Edit** > **Select All Values** to select all table entries.
4. In the context menu of the marked entries, select **Add Offset**.

   The "Add Offset" dialog appears.
5. Enter `0.2` in the edit box and click **OK** to go back to the **Combined editor**.

All values were increased by 0.2.

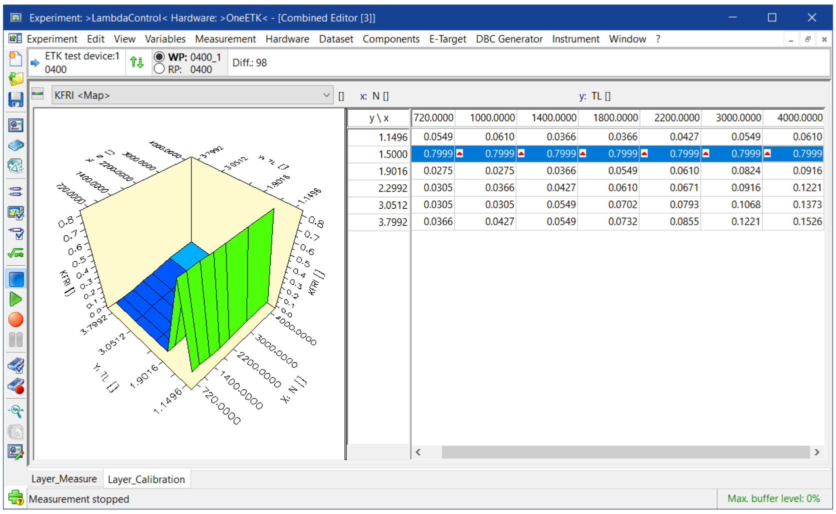


To fill a map with a value

1. Select the `KFRI` map in the **Combined editor [3]**.
2. Select all values with `y=1.5` by dragging the mouse over the appropriate cells while keeping the left mouse button depressed.
3. In the context menu of the selected values, select **Fill With Values**.

   The **Fill with value** dialog appears.
4. Enter `0.8` in the edit box and click **OK** to go back to the **Combined editor**.

   All values in the selected series were set to `0.799`

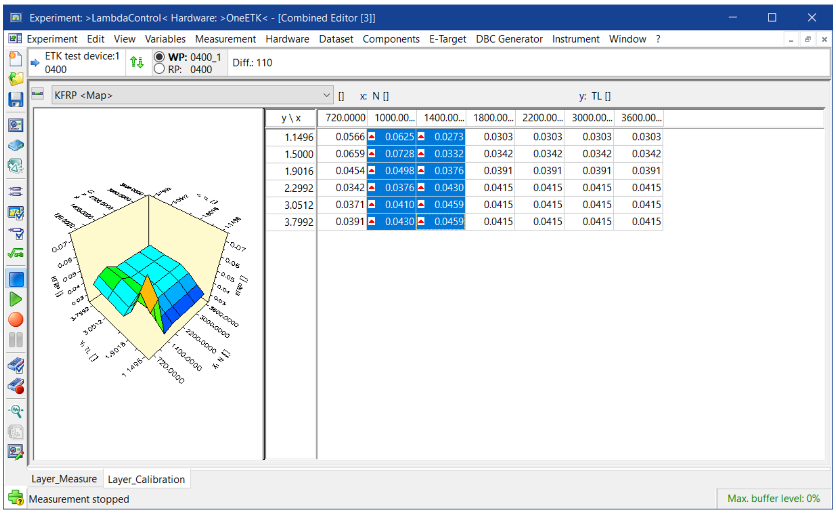


To multiply values in the map with a single value

1. In the **Combined editor [3]**, select the `KFRP` map.
2. Select all values with `x=1000` and `x=1400` by dragging the mouse over the appropriate cells while keeping the left mouse button depressed.
3. In the context menu, select **Multiply by Factor**.

   The "Multiply by factor" dialog opens.
4. Enter `1.1` in the edit box and click **OK** to go back to the **Combined editor**.

All selected values were increased by `10%`.



5. Restore the **Combined editor** to its normal size.

8.3.6 Save the New Calibration Dataset

The changes to the calibration elements are automatically saved as soon as you make them.

At this point, all you need to do is save the experiment to retain the calibration windows for future use.

But if you are making changes to a group, you should document your work and save the dataset of changes in a file exchange format.

You will learn how to do that in Lesson: Managing Calibration Datasets.

8.3.7 Edit Several Calibration Variables and Activate them at Once

You can use calibration scenario configurations to edit several variables and activate them at once. In contrast to the procedures used in the previous section, modifications of calibration values are not automatically saved and applied.

To create a new calibration scenario configuration

1. In the "Variables" menu of the Experiment Environment, select the **New Calibration Scenario Configuration** command.

   The "Calibration Scenario Editor" opens.

2. In the  menu, select the **Add Variables** command.

   The "Variable Selection" dialog opens.

3. Select the following variables:

   `FRMAX`

   `FRMIN`

   `TSPERN`

   `KFRP`

   `KFRI`

`KFRTV`

4. Click **OK**.

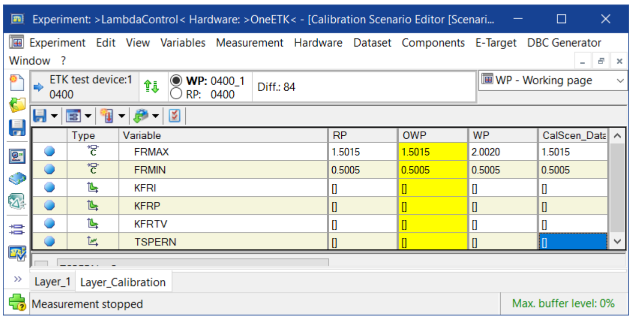
   The variables are added to the calibration scenario configuration.

<u>To create an external calibration scenario</u>

1. In the "Scenario" menu, select **New scenario**.

   A new scenario with the name `Scenario-01` is created.
2. In the "Save" menu, select **Save configuration**.
3. Select **Rename scenario** from the context menu of the new scenario.

   The "Rename scenario" dialog box opens.
4. Enter `CalScen_Data` as its new name.
5. Click **OK**.



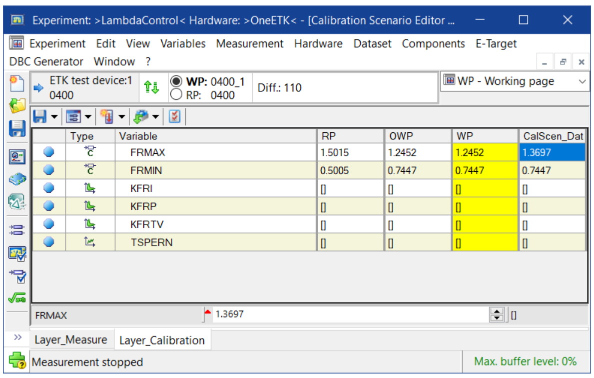
<u>To edit the calibration variables</u>

1. Verify that the working page is enabled (see "Switch Between the Reference and Working Datasets" on page 73).
2. In the `CalScen_Data` column, click on the value of the variable `FRMAX`.

   In the lower part of the window, the editor which is used for editing the calibration values is displayed.
3. Click on the value in the editor.
4. Select **Multiply by Factor** in the context menu.

   The "Multiply by Factor" dialog box opens.
5. Enter the value **1.1**.
6. Click **OK**.

   The selected value is multiplied by 1.1.

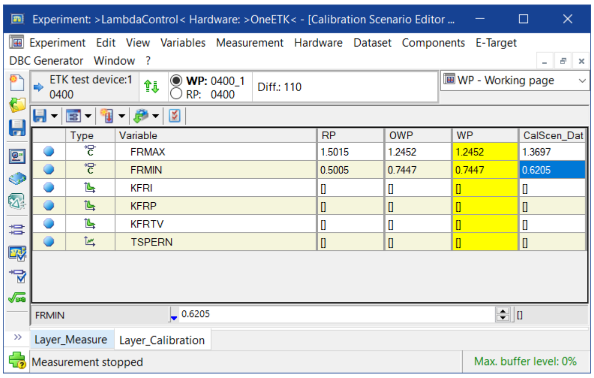


7. In the `CalScen_Data` column, click on the value of the variable `FRMIN`.

   In the lower part of the window, the editor which is used for editing the calibration values is displayed.
8. Click on the value in the editor.
9. Select **Divide by a Divisor** in the context menu.

   The "Divide by a Divisor" dialog box opens.
10. Enter the value **1.2**.
11. Click **OK**.

    The selected value is divided by 1.2.



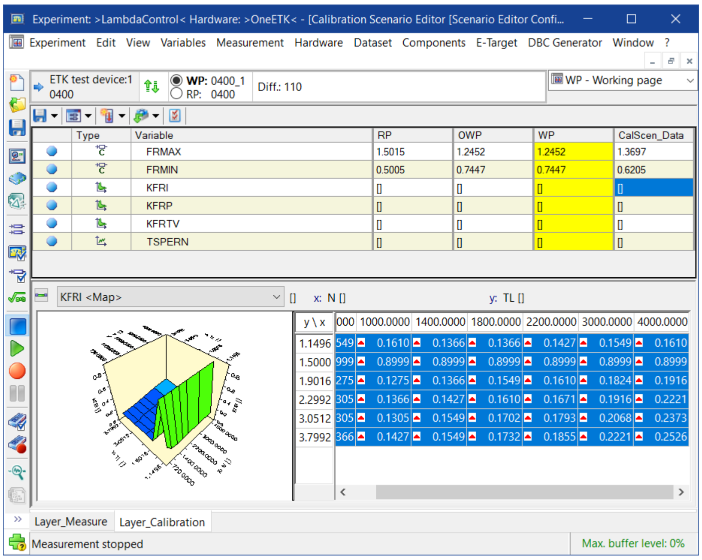
12. In the `CalScen_Data` column click on the value of the variable `KFRI`.

    In the lower part of the window, the editor which is used for editing the calibration values is displayed.
13. Maximize the window of the Calibration Scenario editor and scale the graphic so that you can recognize it.
14. Select **Optimize Column Size** from the context menu of the table,.

    The columns of the table are adjusted accordingly to the size of the values.
15. Click on the first value and press ‹CTRL + A› to mark all values.
16. Select **Add offset** from the context menu.

    The "Add offset" dialog box opens.
17. Enter the value `0.1`.
18. Click **OK**.

    The value `0.1` is added to all selected values of the map.

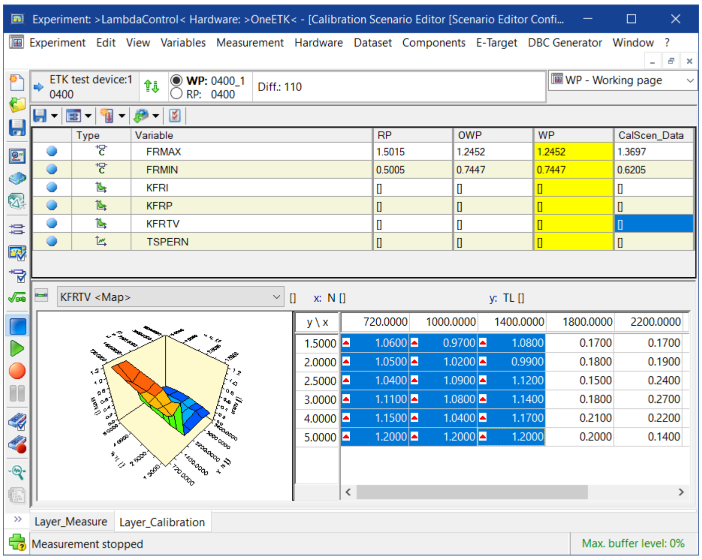


19. In the `CalScen_Data` column click on the value of the variable `KFRTV`.

    In the lower part of the window, the editor which is used for editing the calibration values is displayed.

20. In the editor select the values in the first three columns.
21. Select **Increment** from the context menu.

    All selected values are incremented by a preset value.



You have now finished editing the calibration variables.

22. In the **Save**  menu select **Save configuration**.

<u>To activate the edited scenario</u>

1. Restore the **Calibration Scenario Editor** to its normal size.
2. Click in the `CalScen_Data` column.
3. Select **Activate scenario** from the context menu.

   Observe the values in the editors of the experiment, they are changed by activating the calibration scenario.

The values of the calibration scenario are directly copied to the working page.

Note

When you perform the calibration task online, the values are enabled on the ECU immediately upon activating the scenario.

To store the scenario as an external file

1. Click in the `CalScen_Data` column.
2. Select **Save scenario as** from the context menu.

   The "Save as" dialog box opens.
3. Enter `CalScen_Data` for the file name.
4. Select `CVX files (*.csv)` for the file format.
5. Click **Save**.
6. Close the experiment to return to the database management.

   A confirmation dialog appears asking whether the original values for the working page should be restored.
7. Respond with **No**.

Note

Only those calibration variables that are part of the scenario are written to the data exchange file. If you save the external scenario in an existing file, all previously saved variables get deleted.

8.4 Questions

Answer the following questions to test your understanding of the subject matter presented in this lesson.

1. How many curves can you calibrate in a single combined editor in 3D display?
   A. 1
   B. 2
   C. Many
2. How many parameter values can you calibrate in a single operation?
   A. 1
   B. 2
   C. Many
3. How many map values can you change in a single operation?
   A. 1
   B. 2
   C. Many
4. Which of the following descriptions best describes changing the display format of a calibration element?
   A. Use the menu of the calibration editor to get a list of displayed calibration elements and their format settings. Change the setting for the appropriate calibration element.
   B. Move the calibration element to a new window. Before the new window is displayed, you can set the format to the desired format.
   C. Right-click the element and select the desired format from a context menu.

8.5 Summary

In this lesson you added the calibration elements for the Lambda control experiment to the Experiment window. You know the difference between reference and working page. You calibrated characteristics, a curve, and some maps by applying changes to both individual values and ranges of values.

Moreover you have created a scenario by means of the Calibration Scenario Editor in order to activate several calibrations at once. You have saved the calibrated variables in a data exchange file to be able to use them elsewhere.

9 Lesson: Managing Calibration Datasets

Learning time: 45 minutes

9.1 Objectives

You can use the Calibration Data Manager for managing calibration datasets. You document your calibration task, save the results in a data exchange file, compare different datasets and merge different datasets into a new reference dataset.

9.2 Review of the Most Important Concepts

Calibration Data Manager (CDM)

The **CDM** allows you to manage and analyze datasets that have been generated during a calibration task.

In the **CDM** it is possible to list, copy and compare complete datasets or their contents.

Dataset

The values making up the characteristics, curves and maps are stored in permanent memory in the ECU, and accessed by the ECU processor. A set of calibration values stored in the database is called a dataset. Datasets are versioned; a certain version corresponds to a certain calibrated behavior. Datasets are stored in *.hex or *.s19 files and referenced in the database. These files are binary images of the ECU memory, and beside the calibration data they also can contain the ECU program itself.

Data exchange file

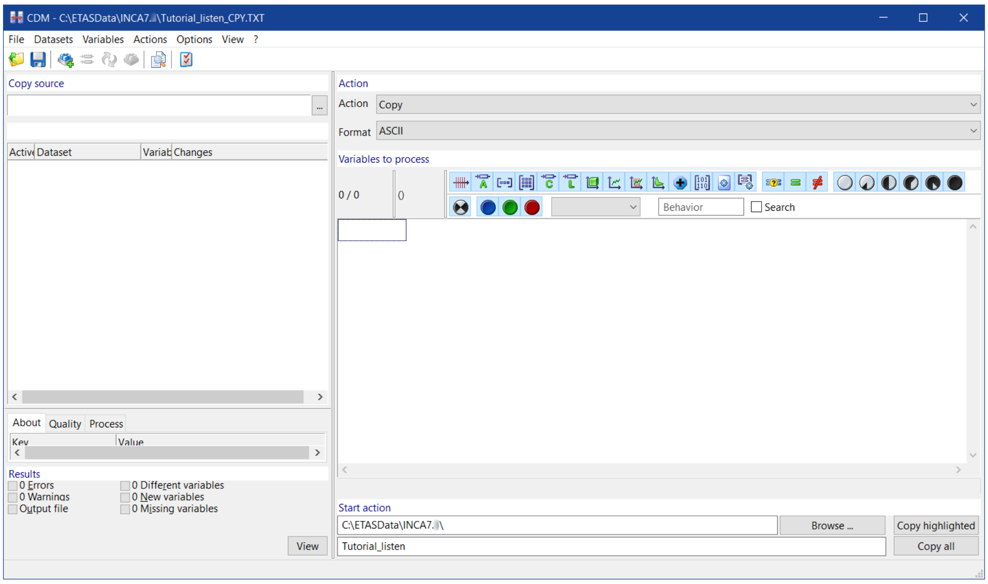
Files in a data exchange format allow you to provide the datasets that have been created in a calibration task for being used in other programs or by other users.

9.3 Tasks

When performing calibrations over the course of a project it is useful to be able to manipulate and compare different versions of the calibration dataset you are working on. With the **CDM** you are able to perform these tasks. The **CDM** can be started from the **Database Manager**, and runs in its own application window, just like the **Experiment** window.

For working in the **CDM**, you can distinguish between two main use cases. For the calibrator it is useful to document his work and save it to a data exchange file. The task of the responsible calibrator consists of merging the different calibration datasets into a new dataset.

The CDM offers three main possible actions: List, Compare, and Copy. All three actions which you can perform with the CDM have similar user interfaces. It is best to start the CDM and look at its layout.



9.3.1 Start the Calibration Data Manager

<u>To start the Calibration Data Manager (CDM)</u>

1. In the "Database Manager", select **Utilities** > **Calibration Data Manager**

   or

2. click .

   or

   <CTRL>+<F11>.

   The "CDM" opens.

3. In the **Action** drop-down list, select `List`.

   The **Action** field in the top-right corner of the **CDM** shows for which action it is configured. The labels of the buttons at the bottom right of the window change accordingly. Now it is displaying **List**.

   The result of an action is always a file. The file path is displayed in the title bar. If you generate a new configuration, INCA generates this path automatically by using the system variable `${EcuProjectPath}\`.

4. Click on **Browse..** to select a permanent directory for your output files.

   The **Directories** dialog appears.

5. Browse to the `..\ETASData\INCAx.y\CDM\..` directory.

6. Click **OK**.

7. In the field **Output base name**, enter `Tutorial` and click <ENTER>.

The result file path in the title bar has changed to reflect the changes you made.

To be able to use a single file path for output files with the same name, INCA adds an action control code to the file name, e.g. `Tutorial_CPY.TXT`. The action control codes are **_LST**, **_CPY** and **_CMP** for the `copy` and `compare` actions, respectively.

Select the `Copy` option from the **Action** list field and look at the changes to the output file name in the title row.
INCA added the action control code _CPY to the name.

8. Change back to the `List` action.

   The **Format** field below the **Action** field specifies the output format for the file to which INCA exports the result of the action. Selecting a certain format determines the extension of the output file.

9. Click the arrow button of the **Format** combo box, and select `HTML` from the drop-down list. Observe the changes to the output file name in the title row. The file name should now read `<INCA base>\ETASData\INCA\CDM\Tutorial_LST.HTM`.

   The **Variables to process** group below the **Format** field contains a list box with the variables the action is applied to. The label above the list box shows how many variables of a total number of variables available in the project are selected for the action.

To select a source dataset

1. Select **Datasets** > **Select source dataset**.

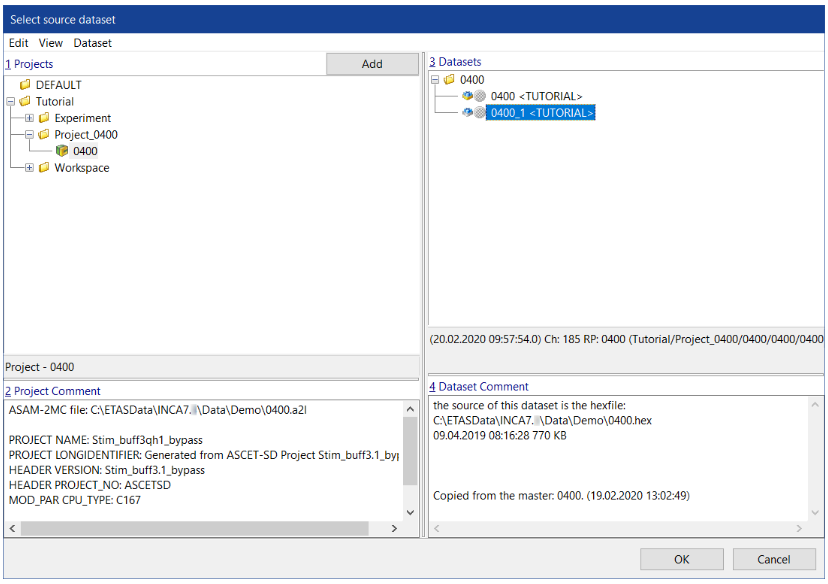
   The "Select source dataset" dialog appears.

2. Expand the tree structure of the `Tutorial` database and navigate to the folder `Project _0400`. Select the project `0400`.

   The datasets `0400` and `0400_1` appear in the right half of the dialog in the **Datasets** field.

3. Select the `0400_1` dataset in this field, then click **OK** to get back to the

CDM.



<u>To add variables</u>

1. Select **Variables** > **Add**.

   The "Variable Selection" dialog opens. Further information on the Variable Selection dialog can be found in "Lesson: Setting Up an Experiment" on page 36.

2. Using the procedures that you learned in "Lesson: Calibration" on page 69, select the following calibration variables:

   FRMAX

   FRMIN

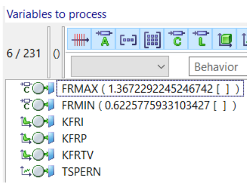
   TSPERN

   KFRP

   KFRI

   KFRTV

3. Click **OK** to return to the **CDM**.



The fields **List source** and **All datasets** in the **CDM** define the datasets that serve as source and destination for the action to be performed. Their use depends on which action is performed, and is explained below, in the sections dealing with the individual actions.

The **Results** group in the bottom-left corner contains six custom controls that look like LEDs. Each of these controls reports on a specific aspect of the performed action, e.g. errors or warnings. The number to the right of the LED indicates how many errors, warnings, etc. were reported for the aspect related to the control. The status of these controls is continually updated as the action progresses. Click any of the LED controls to review details about the aspect related to the control.

9.3.2 Compare Calibration Datasets

In order to retrace which variables have been modified by the calibrator in his calibration task and in which way, the CDM can show the differences between reference dataset and calibration dataset using the **Compare** function.

To compare the reference dataset with your calibration dataset

1. In the **Action** drop-down list, select `Compare`.
2. From the **Format** list field, select the `HTML` entry.
3. In the window area "Comparing destination", select the entry **Add dataset** from the context menu.

   The dialog box "Select destination dataset" opens.
4. Select the dataset `0400` as destination dataset and click **OK**.
5. In the **Variables to process** window, select **Add all** from the context menu.
6. In the bottom part of the window, change the entry for the **Output base name** to `Tutorial_compare`.
7. Click on **Compare all**.

   In the "Results" window in the lower left, you can see that differences between source and target were found for twelve variables.
8. Click on the red controls and view the reports on the individual results.
9. Close the reports.
10. Click on **View** to open the results file.

    The "Open File" dialog opens, showing all files in the working directory `<Inca base>\ETASData\INCA\cdm`.
11. Select the file `Tutorial_compare_CMP.HTM`.
12. Click **Open**.

    Your web browser is launched, showing the compare results. Modified calibration variables are displayed in red in the HTML file.
13. Close the web browser.

> **Note**
>
> You can also call up the application data manager directly from within an experiment. Steps 1. to 6. in this tutorial are then automatically performed for the reference and working pages of the experiment. See our online help for additional information about this process.

9.3.3 List Calibration Datasets

With the **List** action you can document all modifications that result from your calibration task.

As an example, it can be useful that all calibrators use the **List** action in order to write their calibration datasets into an external file and give it to the responsible calibrator. To ease the task of the responsible calibrator, you can write only the variables into the file that have actually been modified.

To list the calibrated variables

1. In the **Action** drop-down list, select `List`.
2. In the **Format** drop-down list, select `CDF`.
3. Make sure that in the **List source** list box, **0400_1** is still selected as source dataset and that in the dataset list below the reference dataset 0400 is used.
4. In the context menu in the "Variables to process" window, select the **Select/show all differences** entry.

   The list of variables is reduced to all those variables that are different in the two datasets.
5. Change the entry in the field **Output base name** into `Tutorial_list`.
6. Click on the **List all** button at the bottom right.
7. You can see in the "Results" window area at the bottom on the left that a new results file has been generated.

9.3.4 Copy Calibration Datasets

The task of the responsible calibrator consists of collecting the calibration datasets from the individual calibrators and merging them in a new dataset. For this task he needs the **Copy** action. In this task it is advantageous to create a new destination dataset by copying the reference dataset. In a subsequent step, the calibrations performed by the calibrators can be integrated, and the responsible calibrator can write-protect the new dataset to prevent further modifications in this dataset.

To copy the calibrations into a new dataset

1. In the **Action** drop-down list, select `Copy`.
2. In the **Format** drop-down list, select `ASCII`.
3. Select **Datasets** > **Read source from file** > **Read from file**.

   or

   Right-click in the "Copy Source" window area and select **Read from file** from the context menu.

   The dialog box "Open data exchange file as source" opens.
4. Select the file `Tutorial_list.cdfx.`
5. Click **Open**.

A dialog opens.

6. Click on **Overwrite**.

   The list box "Copy source" now shows the file `Tutorial_list.cdfx`.

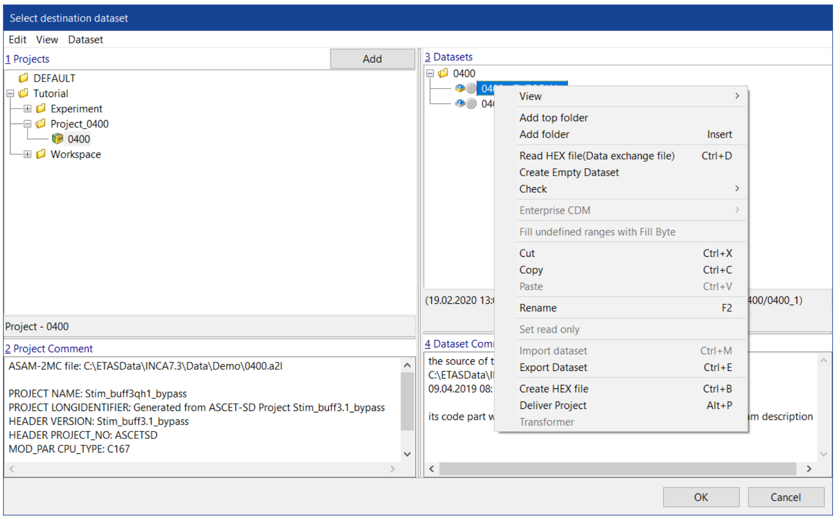
7. In the context menu of the destination dataset `0400` select **Remove**.

8. Select **Datasets** > **Add destination dataset**.

   The dialog box "Select destination dataset" opens.

9. Expand the tree structure of the `Tutorial` folder and navigate to the folder `Project _0400`. Select the project `0400`.

   the datasets `0400` and `0400_1` are displayed in the **Datasets** list box in the right half of the dialog.



10. Select **Copy** from the context menu of the dataset `0400`.

11. Select **Paste** from the context menu of the **Datasets** list box.

    A new dataset named `0400_2` is generated and added to the list of data-sets. The dataset is selected.

12. Click **OK** to return to the CDM.

    In the following steps you can use the new datasets for copying the cal-ibrated variables into it.

13. Select **Add all** from the context menu of the **Variables to process** list box.

    The six variables that have been calibrated as well as auxiliary variables are added to the list box.

14. Change the entry in the field **Output base name** into `Tutorial_copy`.

15. Click on the **Copy all** button in the lower right.

    The "Results" window (bottom left) displays that there are 225 new vari-ables. These are the additional calibration variables in the target dataset, but not in the CDFX file.

16. Click on the red controls  and view the reports on the individual results.

17. Close the reports.

If the new dataset is okay, set it to write-protected. This will prevent any unintended changes. Moreover you can use it as a new reference dataset for further calibration activities.

To activate write-protection for a dataset

1. Select **Freeze working data** from the context menu of the destination dataset **0400_2**.

   A dialog box opens which prompts you to enter a name for the write-protected dataset.

2. Enter `0410` and press `<Enter>`.

   The dataset is now protected against further modifications. Since a write-protected dataset cannot be modified, a new destination dataset `0410_1` has been created.

To copy the contents from further data exchange files, replace the file in the **Copy source** list box by the desired data exchange file and repeat the copy action.

It is possible to apply actions in the Calibration Data Manager to several destination datasets at once.

For exercise purposes, compare the dataset from an application engineer with the original reference dataset and your newly created reference dataset.

To compare two destination datasets with a source dataset

1. In the **Action** drop-down list, select `Compare`.
2. In the **Format** drop-down list, select `HTML`.
3. Select the dataset `0400` as source dataset.
4. Select the not write-protected dataset `0410_1` as your first destination dataset.
5. Select **Datasets** > **Read destination from file** > **Read from file**.
6. In the `<INCA base>\ ETASData\INCA7.5\cdm` path, select the data exchange file `Tutorial_list.cdfx` as the second target dataset.
7. Click on **Open**.

   The data exchange file gets added to the **Comparing destination** list box.

8. Select **Add all** from the context menu of the **Variables to process** list box.
9. Change the entry in the field **Output base name** into `Tutorial_compare_2`.
10. Click on **Compare all**.

    The "Results" window area at the bottom on the left shows the results of the compare action.

11. Click on the red controls and view the reports on the individual results.
12. Click on **View** to open the results file.

9.4 Questions

Answer the following questions to test your understanding of the subject matter presented in this lesson.

1. Which of the following actions can be performed using the **CDM**?
   A. Database import.
   B. Copying a dataset.
   C. Writing calibrations of variables into an HTML file.
   D. Database export into a CVX file.
   E. Listing all calibration variables and their values into a CVX file.
2. Which actions are available in the **Actions** field of the CDM?
   A. Copy, list, compare.
   B. Export, Import.
   C. Add, remove, duplicate.
3. Which dataset will be overwritten in a **copy** action?
   A. Source dataset.
   B. First destination dataset.
   C. Second destination dataset.

9.5 Summary

In this lesson you have learned how you can use the Calibration Data Manager and its actions to manage and edit your calibration datasets.

10 Lesson: Data Management

Learning time: 25 minutes.

10.1 Objectives

You can use the Calibration Data Manager for managing calibration datasets. You document your calibration task, save the results in a data exchange file, compare different datasets and merge different datasets into a new reference dataset.

10.2 Review of the Most Important Concepts

Dataset

The values making up the characteristics, curves and maps are stored in permanent memory in the ECU, and accessed by the ECU processor. A set of calibration values stored in the database is called a dataset. Datasets are versioned; a certain version corresponds to a certain calibrated behavior. Datasets are stored in *.hex or *.s19 files and referenced in the database. These files are binary images of the ECU memory, and beside the calibration data they also contain the ECU program itself.

Database Objects

Database objects are all elements of the INCA database that are listed in the **Database Objects** list box. Examples are workspaces, experiments and projects.

10.3 Tasks

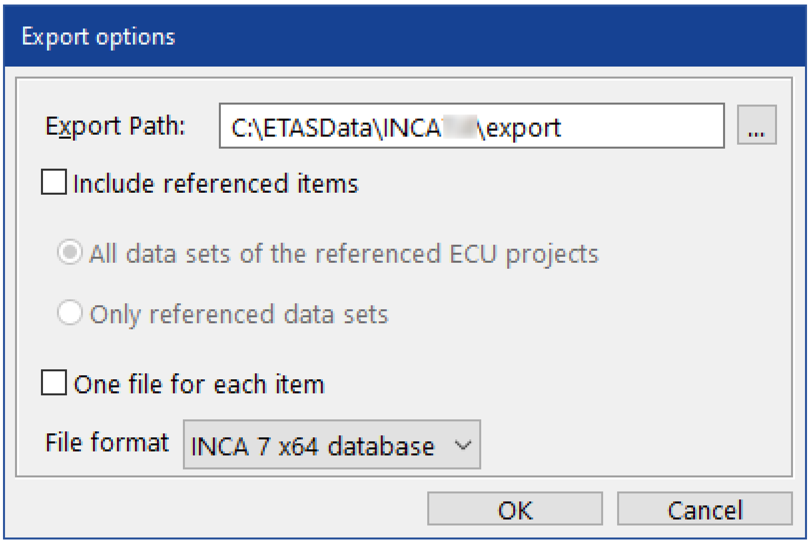
In this lesson you export the data you created in INCA and import them into a new database. You learn how to manage your data within the database.

10.3.1 Export the Database

When exporting the database, the data as well as the folder structure are written to a file.

<u>To export the database to a file</u>

1. In the **Database Objects** field of the Database Manager, select the `Tutorial` folder.
2. Select **Edit** > **Export**.
3. The "Export options" dialog appears. Make sure the two check boxes are unchecked and click **OK**.



4. The "Export file" dialog appears. Change the file name in the **File name** field to Tutorial-copy.exp64.
5. Click **Save** to export the file and to return to the "Database Manager".

10.3.2 Create an Empty Database

Using the skills you acquired in Lesson: Creating the Database, create a new empty database called `Tutorial-copy` containing only an empty `DEFAULT` top folder.

10.3.3 Import the Exported Database into the Empty Database

You now import the data you exported before into the empty database. The import function automatically creates the folder structure present in the database you exported from, so that you do not have to set it up before doing the import. When setting up a database for a new ECU which is similar to an ECU you have already used in the past you can use this mechanism to jump start your project: import the old project and make the necessary adjustments, rather than starting from scratch.

To import the data

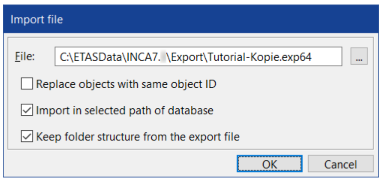
1. In the **Database Manager**, select the `DEFAULT` folder of the `Tutorial-copy` database.
2. Select **Edit** > **Import**.

   The "Import Options" dialog appears.
3. Click on the following button:

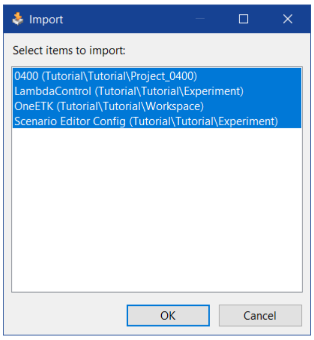
   

   A dialog window for the file selection appears.
4. Navigate to `<INCA base>\ETASData\INCA7.5\Export` and select the file `Tutorial-copy.exp64`, which you previously created during the export of the `Tutorial` database, and click on **Open**.

5. You get back to the "Import file" dialog. Make the following settings:



   - Deactive the option **Replace objects with same object ID**. This makes sure that the imported objects will be inserted as copies of the original objects, even if the original objects are part of the database.
   - Activate the option **Import in selected path of database**. This makes sure that the imported objects will be placed into the selected folder.
   - Activate the option **Keep folder structure from the export file**. This makes sure that the original folder structure will be kept, instead of placing the objects flat into one folder.
6. Click **OK**.
7. The **Import dialog** box appears. Make sure all entries in the list box are selected and click **OK**.



8. The "Import results" dialog appears, listing the items that have been imported. This dialog is for your information only; no action is required. Click **OK** to return to the **Database Manager**.

The imported items are created in the `Tutorial-copy` database. The folder structure is the same as the folder structure of the `tutorial` database.

Using the import and export function of the Database Manager, you cannot only write complete databases to an export file, but also individual database objects such as workspaces, experiments, projects and datasets. Moreover, it is possible to reuse elements of experiments such as layers and measure and calibration windows within the INCA database or to export and import them.

Note

Further information on the export and import functionality is provided in video tutorials which you can access via the INCA help menu: **?** > **Video Tutorials**.

10.3.4 Reuse Elements of Experiments

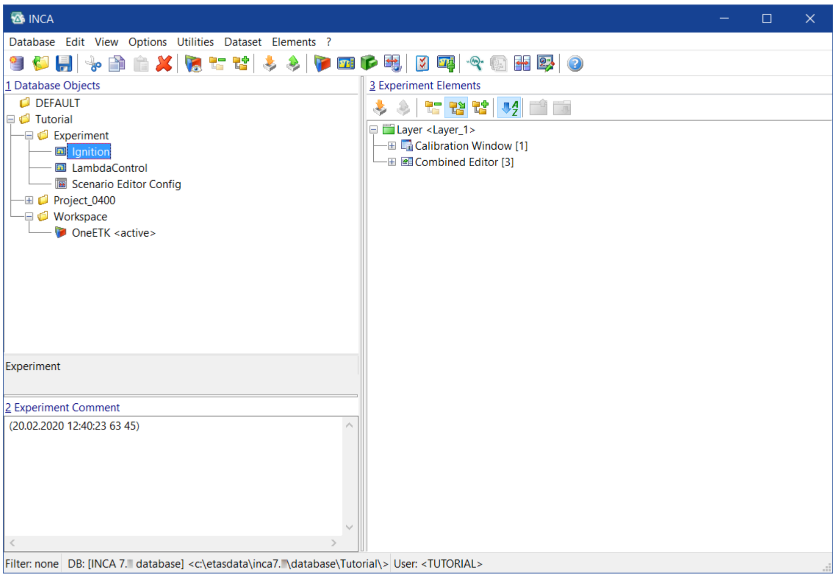
When working with INCA, it is often useful to reuse parts of your work.

To reuse elements of an experiment in a new experiment

1. Add a new experiment to the Experiment folder in the **Database Objects** list box.
2. Rename the new experiment into `Ignition`.
3. Select the experiment `LambdaControl`.

   The **Experiment Elements** list box lists all layers as well as all measure and calibration windows that are used in the `LambdaControl` experiment.
4. Mark the **Combined Editor [3]** and the **Measure Window [1]**.
5. Select **Copy** from the context menu.
6. Click on the experiment `Ignition`.
7. Select **Paste** from the context menu in the **Experiment Elements** list box.

   A new layer and the measure and calibration windows that you copied are added to the experiment `Ignition`.



10.3.5 Manage Database Objects

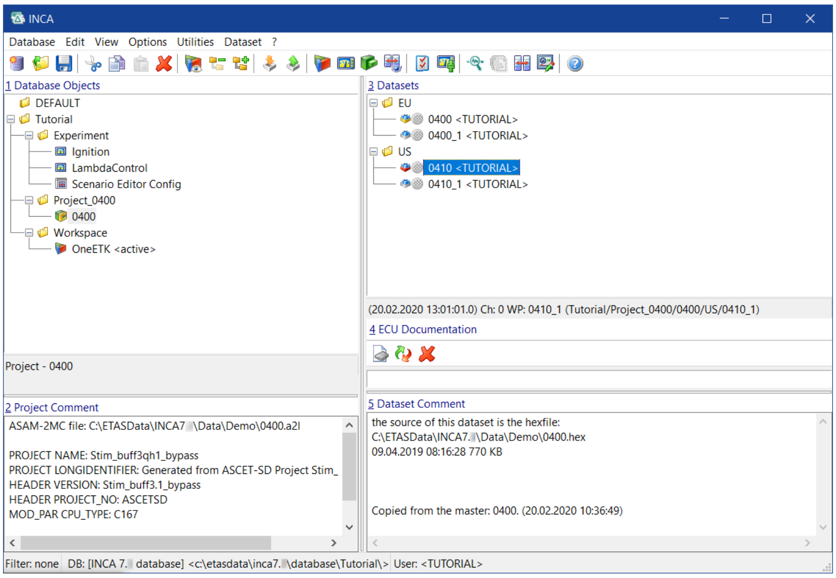
Your daily calibration work might include creating different calibration datasets for the same calibration task, all of them being derived from the same reference dataset. As an example, this can be the case if there are different requirements for the European and the American markets. In this case, you can organize your work by moving the two datasets into different folders.

To organize your datasets

1. In the **Database Objects** list box, expand the tree structure of the folder **Project_0400**.
2. Select the project `0400`.

   The **Datasets** list box list all datasets that you have created in this tutorial.
3. Rename the folder `0400` into `EU`.
4. Select **Add top folder** from the context menu of the **Datasets** list box.

5. Rename the new top folder into `US`.
6. Mark the datasets `0410` and `0410_1` that you created in the previous "Lesson: Managing Calibration Datasets".
7. Select **Cut** from the context menu.
8. Select **Paste** from the context menu of the folder `US`.



10.4 Questions

Answer the following questions to test your understanding of the subject matter presented in this lesson.

1. Which of the following elements are stored in the file resulting from a database export?
   A. Project hardware configuration
   B. Folder structure
   C. Experiment window layout
   D. Project master dataset
   E. Project working dataset
   F. Changes to the calibration elements
2. How can you reuse database objects within the Database Manager?
   A. Drag the database object to another place.
   B. Copy and paste a database object.
   C. Export and import a database object.
3. How should a database be structured?
   A. Top folder > Workspace, Experiment, Project
   B. Top folder > Subfolder > database object

10.5 Summary

In this lesson you exported a database and reimported it into a new database. Moreover you learned how to reuse database objects and elements of experiments.

11 Lesson: Settings and user profiles

Learning time: 15 minutes

11.1 Objectives

In this lesson, you customize several settings in INCA, and save them in a user profile.

You also learn how to exchange user-specific settings with colleagues using the import and export function.

11.2 Review of the Most Important Concepts

User profile

A user profile is a collection of settings for a certain user determining the look and feel of the INCA user interface. A profile can be saved and loaded between sessions. This allows users to configure the INCA user interface settings to fit their requirements. Profile settings include start behavior, window size, window arrangement, paths and many more.

11.3 Tasks

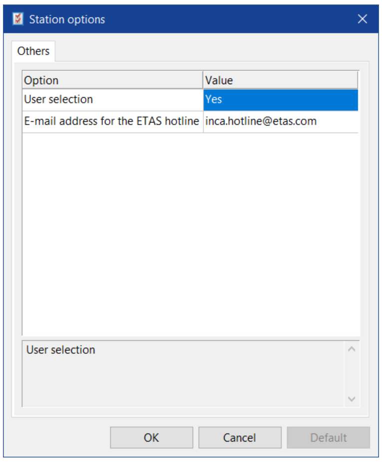
11.3.1 Enable the Use of User Profiles

By default the use of user profiles is disabled. To be able to use user profiles, the use of user profiles must be enabled in the station options.

To enable the use of user profiles

1. Select **Options** > **Station options** from the "Database Manager".

   The "Station options" dialog appears.
2. Click the cell to the right of the cell with the value `User selection`.
3. Click the same cell again.



4. A list with the options `Yes` and `No` appears. Select `Yes` to enable the use of user profiles, and click **OK** to go back to the "Database Manager".

11.3.2 Create a New User

A user profile is always associated with a user. You can define users in any way you like. A user can be a person, but you can also make user profiles for groups, or even for different tasks by the same user.

To create a new user

1. Select **Options** > **User** > **Add**.
2. The **Enter the new user title** dialog appears.
3. In the edit box, type `Student` as the name for the new user whose profile you are creating. Note that the profile name is the name of the user; you cannot have more than one profile for a user.
4. Click **OK** to create the new user profile and to go back to the "Database Manager".

11.3.3 Change to the New User Profile

You can only change the profile of the current user. Therefore, before customizing the profile, you must first change to the user you created in the previous section.

To change to the newly created user

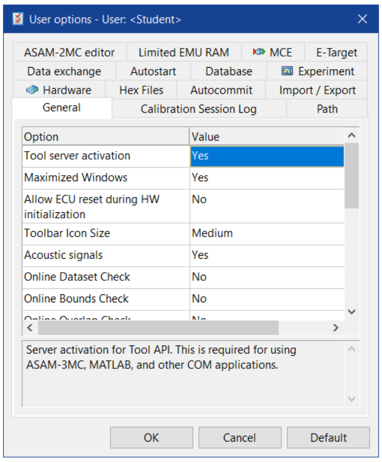
1. Select **Options** > **User** > **Change**.
2. The **Select the title you want to change** dialog appears.
3. All users known to INCA are listed. Select `Student` and click on **OK** to return to the "Database Manager".

11.3.4 Making Changes to a User Profile

When newly created, the user profile is a copy of the default user profile.

To start the user profile editor

1. Select **Options** > **User Options** > **Open**.
2. The **User options** dialog appears. The settings in this dialog make up the user profile.



Select the tabs to get an overview of the various possibilities. In the remainder of this section you change several of these settings as an exercise.

First, change the appearance of INCA. You change a font properties and disable maximizing of windows so new windows you open are not automatically maximized. Note that all settings you make in the user profile change the appearance of all INCA windows.

To change the appearance of INCA

1. Select the **Experiment** tab from the **User options** dialog.
2. A list with several options appears. Click the cell to the right of the cell with the value `Adjust font in the variable views if the view size is changed`.

   A list with the options **Yes** and **No** appears.
3. Select **No**.

With this setting you have defined that in standard measure windows in the **Experiment Environment**, only fixed font sizes are used which do not depend upon the window size.

4. Select the **General** tab.
5. Using the same method as before, change the setting for `Maximized windows` to `No`.

Another change that could be useful if you usually calibrate calibration elements of a certain type is to change the type of calibration editor that is used directly after you select the element in the **Variable Selection** dialog. In this exercise, you define the Table Editor as Default Calibration Editor for arithmetic values.

To change the default calibration editor type

1. Click the **Experiment** tab.

   A list with several options appears. The entries enclosed in brackets in the **Value** column indicate that there is a list with further options behind the cell.

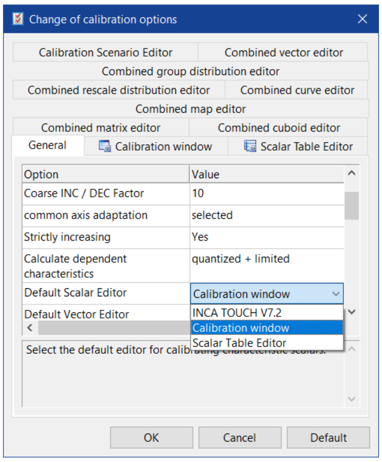
2. Click the cell to the right of the cell with the value `Calibration`.
3. Click the same cell again.

   The "Change of calibration options" dialog appears with a list of general calibration options.

4. Click the **General** tab. Click the cell to the right of the cell with the value `Default Scalar Editor`.
5. Click the same cell again.

   A list with possible editors for scalars appears.

6. Select `Calibration Window` from the list.

   Every arithmetic value selected for calibration is now being displayed in a Calibration Window.

7. Click **OK** to go back to the "User options" dialog.
8. Click **OK** to close the "User options" dialog.

Export your user profile to forward your user options to colleagues.

To export user options

1. Select **Options** > **User Options** > **Export**.
2. The "Export user settings" dialog appears.
3. Go to the directory `<INCA base>\ ETASData\INCA7.5\Data\Demo.`
4. In the **File name** field, enter `INCAoptions_<Name>.zip` and click on **Save**.

11.3.5 Importing User Options

You can use the user options of a colleague by using the import function.

To import user options

1. Select **Options**>**User Options** > **Import**.

   The "Import user settings" dialog appears.
2. Go to the directory `<INCA base>\ ETASData\INCA7.5\Data\Demo.`
3. Select the `INCAoptions_<Name>.zip` file and click on **Open**.

11.4 Questions

Answer the following questions to test your understanding of the subject matter presented in this lesson.

1. An entry enclosed in brackets (< >) in an option table means there is no value assigned to the setting.
   - A. True
   - B. False
2. When creating a new user profile all settings are empty.
   - A. True
   - B. False
3. Arrange the following steps in the correct order:
   - A. Change to a new user
   - B. Turn on the **One file for each item** setting
   - C. Click the "Export Import" tab
   - D. Save the user profile
   - E. Enable the use of user profiles
   - F. Create a new user
4. How many user profiles can you define?
   - A. 1
   - B. 2
   - C. Many
5. How many user profiles can you define for one user?
   - A. 1
   - B. 2
   - C. Many

11.5 Summary

You created a new user and created a profile for this user. You imported user options of a colleague. You familiarized yourself with the various user options you can use for customization. You customized the profile by changing the appearance of INCA and changing the default calibration editor for arithmetic values. You saved and exported your user profile.

12 Answers

12.1 Lesson: Creating the Database

1. False
2. B,C,A

12.2 Lesson: Setting Up a Workspace

1. True
2. A, D, E
3. A = Hardware Configuration Editor
   B = Hardware Configuration Editor
   C = Hardware Configuration Editor
   D = Database Manager
   E = Database Manager

12.3 Lesson: Setting Up an Experiment

1. False
2. True
3. False

12.4 Lesson: Measuring

1. Many
2. A
3. False
4. False
5. B

12.5 Lesson: Calibration

1. Many
2. A
3. Many
4. None

12.6 Lesson: Managing Calibration Datasets

1. B, C, E
2. A
3. B, C

12.7 Lesson: Data Management

1. A, B, C, D, E, F
2. B
3. B

12.8 Lesson: Settings and User Profiles

1. False
2. False
3. Steps should be in the following order:
   Enable the use of user profiles>
   Create a new user>
   Change to a new user>
   Click the "Export Import" tab>
   Turn on the **One file for each item** setting>
   Save the user profile
4. Many
5. A

13 Further Reading

Unless otherwise stated, the following additional documents are provided with the basic INCA installation and can be found in one of the INCA folders `Manuals` or `Help`. Further documents might be provided with INCA add-on products.

Documentation for Standard Users

- INCA Help (available through INCA [1])
- INCA Getting Started
- INCA Video Tutorials[2]

Documentation for Special Use Cases

- Serial (X)ETK Calibration Concepts — Limited Emulation RAM
- Serial Calibration with InCircuit2

Documentation for Tool Integration

- INCA ASAM-ASAP3 Interface
- INCA ASAM-MCD-3MC V1.0.1 Interface
- INCA Tool-API Documentation (help)
  cebra\INCA Tool-API Documentation.chm[3]

Documentation for Suppliers

- ECU Document Interface (EDI) for INCA (PDF)[4]

Specifications

- CVX (Calibration Values Exchange)[5]
- CDF (Calibration Data Format) [6]

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1) The INCA Help is automatically installed together with INCA and can be accessed via the INCA **?** menu or by pushing F1.

2) The INCA video tutorials can be installed together with INCA (optional) or viewed in the ETAS YouTube channel. You can access an overview and the videos themselves via the INCA **?** menu.

3) The Tool API documentation is automatically installed together with the Tool API component and can be accessed by double-clicking the help file.

4) This document can be obtained from the ETAS download center (type: technical documentation).

5) This document can be obtained from the ETAS download center (type: specification).

6) The CDF specification is available for download on the web pages of the ASAM Association for Standardization of Automation and Measuring Systems under www.asam.net.

14 Contact Information

Technical Support

For details of your local sales office as well as your local technical support team and product hotlines, take a look at the ETAS website:

www.etas.com/hotlines

ETAS offers trainings for its products:

www.etas.com/academy

ETAS Headquarters

ETAS GmbH

Borsigstraße 24	Phone:	+49 711 3423-0
70469 Stuttgart	Fax:	+49 711 3423-2106
Germany	Internet:	www.etas.com

15 List of Abbreviations

This manual uses the following abbreviations:

- **AUTOSAR** – **AUT**omotive **O**pen **S**ystem **AR**chitecture
- **ASAM-MCD** – **A**ssociation for **S**tandardisation of **A**utomation and **M**easuring Systems (**M**easurement, **C**alibration and **D**iagnosis)
- **CAN** – Bus System for Data Communication (**C**ontroller **A**rea **N**etwork)
- **CCP** – **C**AN **C**alibration **P**rotocol, standard protocol based on MCD-1a
- **CDM** – **C**alibration **D**ata **M**anager
- **DB** – **D**ata**b**ase
- **DBM** – **D**ata**b**ase **M**anager
- **ECU** – **E**lectronic **C**ontrol **U**nit
- **EE** – **E**xperiment **E**nvironment
- **ETK** – **E**mulator-**T**ast**k**opf (emulator test probe)
- **EXP** – **Exp**eriment
- **FIBEX** – **Fi**eld **B**us **Ex**change
- **HWC** – **H**ard**w**are **C**onfiguration
- **INCA** – **IN**tegrated **C**alibration and **A**cquisition Systems
- **MDA** – **M**easure **D**ata **A**nalyzer
- **MDF** – **M**easurement **D**ata **F**ormat
- **RP** – **R**eference **P**age
- **WP** – **W**orking **P**age
- **WS** – **W**ork **S**pace
- **XCP** – e**X**tended **C**alibration **P**rotocol

Figures