Multi ECU Operation with INCA
Technical Note

Content

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1 Scope

ETAS INCA provides measurement, calibration and diagnostic access to one or multiple ECUs in parallel. Further it allows access to multiple bus types like CAN, FlexRay and LIN and to measurement modules from ETAS or third party suppliers.
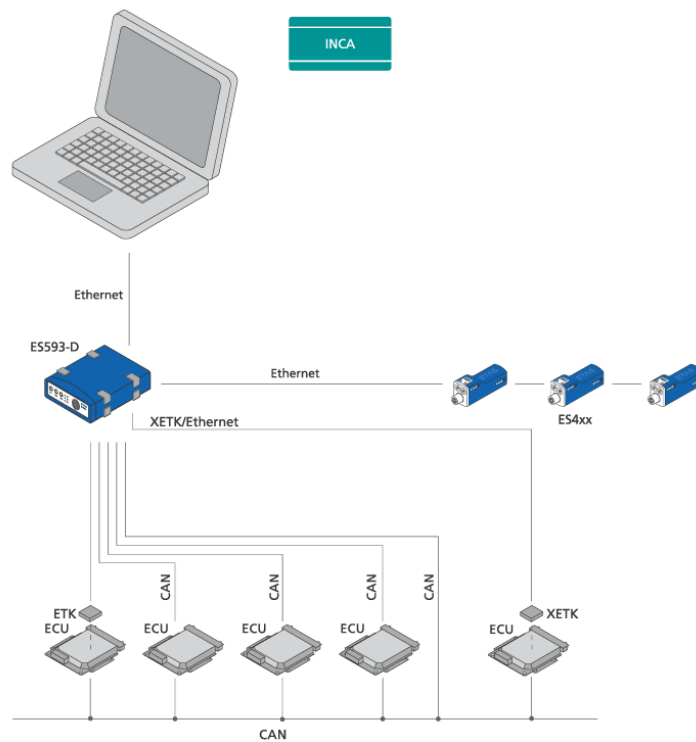
This document provides hints and tips how to utilize the capabilities of INCA, when working with multiple ECUs in parallel. It addresses users, who are already familiar with the base functionality of INCA.

2 Preconditions

2.1 A2L Preparation

ETAS Hardware is connected to the INCA PC via Ethernet to grant a fast data communication with high bandwidth. In case multiple devices are used, they can be cascaded using the ES600 Network Module or the Ethernet ports provided by the ECU access modules ES59x.

In a setup with multiple hardware devices it must be ensured, that all hardware modules use IP addresses in the same Ethernet Subnet (e.g. 192.162.40.x). In most cases this is done automatically by the ETAS Network Manager coming with INCA. Further information about the ETAS network manager can be found in the INCA manual.

In case of XCPonEthernet based ECUs, the ECU's IP address is defined in the XCP section of the A2L file. The user has to ensure, that the IP address defined here is within the Ethernet subnet used by INCA and other devices. If an adaptation of the Ethernet address in the A2L file is needed, this has to be done before importing the A2L file into INCA. Note that this may require a reconfiguration of the ECU or the ECU access hardware (see below)!

It must be ensured that the IP addresses within the subnet are unique!

For the XETK and other XCPonEthernet devices, there are several possibilities for assigning an IP address when using INCA:

If the XETK is used as XETK device, an IP address within the selected subnet will automatically be assigned to the XETK by the ETAS Network Manager on the PC, just like for other ETAS hardware devices, ensuring that no IP conflicts occur for the ETAS devices within the subnet.

However, XETK ECU can also have a fixed IP address, configured via the XETK Config Tool (XCT). The same applies for ETAS measurement devices ES4xx, ES63x or ES930. In this case, the fixed IP address will have priority and will not be changed by the ETAS Network Manager. If this is the case, the user needs to make sure manually that the address range defined by ETAS Network Manager does conflict with the fixed IP addresses. The same condition applies for fixed IP addresses used for non-ETAS XCPonEthernet devices in the network.

If the XETK is inserted as plain XCPonEthernet device in INCA, the A2L file must contain an XCPonEthernet section and the IP address given in the A2L file will be used by INCA. The XETK itself then must have been configured with a static address (the same as given in the XCP section of the A2L file) with the XETK Config Tool (XCT) in advance.

If non-ETAS XCPonEthernet devices are used, the IP addresses of these devices must be configured in a way that they match the Ethernet subnet used by the ETAS Network Manager. Please check the user manuals of these devices for guidance how to configure the IP address.

Note: For ease of use ETAS recommends the use of dynamic IP addresses, so that the ETAS Network Manager can assign the addresses automatically.

The Ethernet card of the PC and the IP address range which shall be used for communicating with the ETAS hardware can easily be configured in the network settings of INCA. These can be found in the INCA Database Browser in the menu [Utilities/ETAS Network settings...].
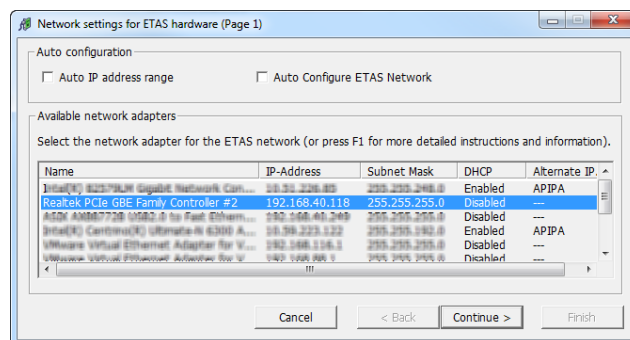

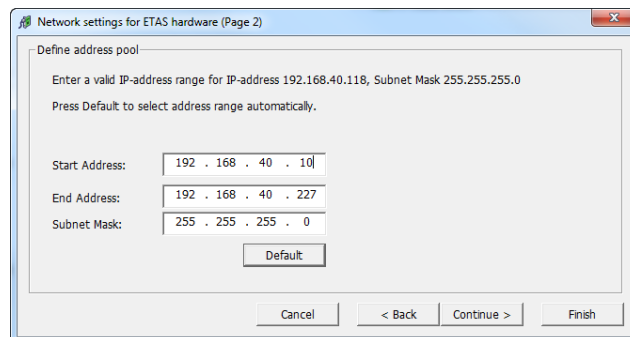Figure 1: Selecting PC network interface for ETAS tools

Figure 2: Setting IP address range for ETAS hardware

2.2   Cabling

Multiple possibilities how to set up a multi ECU system exist. It mainly depends on the available cabeling in the vehicle and on the ECU interfaces used.

A wiring set-up for multi ECU use cases in a car ideally would look like this:
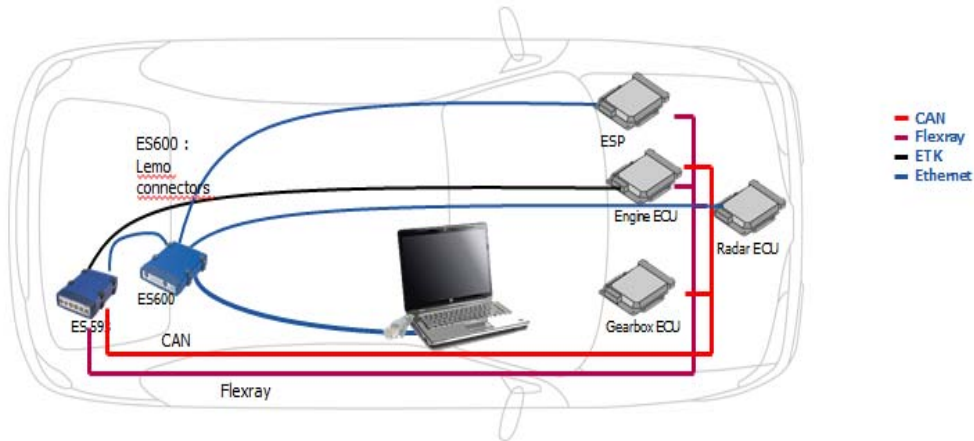
Figure 3: Proposed set-up to connect multiple ECUs to INCA

In such a set-up only one cable needs to be routed into the passenger compartment and connected to the INCA PC. Via the switch (ES600), all ECUs and the CAN and FlexRay buses are still directly accessible for single ECU measurement and calibration.

If a vehicle was not build up for multi ECU projects from the beginning, the wiring of some ECU may require locating the ES600 directly in the passenger compartment.
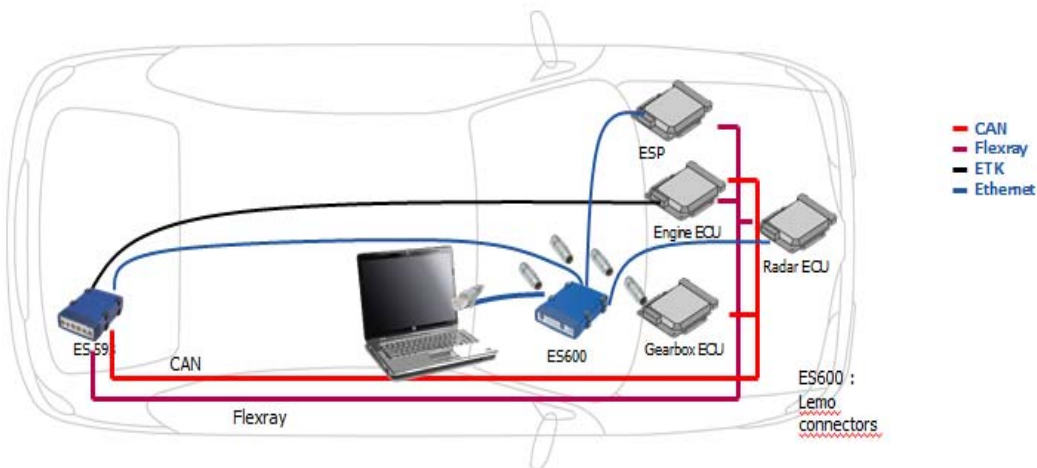

Figure 4: Possible alternative set-up to connect multiple ECUs to INCA

In case some ECU connection cable do not have the ETAS standard Lemo connectors, but RJ45 connectors, either the connector cable to the ETAS XETK can be exchanged to one with a Lemo connector or an adapter cable RJ45toLemo can be used (available via ETAS Engineering).

3   Multi ECU Set-up in INCA

INCA can be used to connect to multiple ECUs and/or multiple buses simultaneously.

Depending on the ECU and bus access needed, this can require multiple ES59x devices, for example, if more than on ETK ECU is accessed.

For each device, at least a matching A2L file describing the ECU access and data contents needs to be available and imported into INCA for measurement.

For calibration tasks, also a data set (typically hex/s19 file) must be available.

For flashing an ECU hex/s19 file containing code and data and a flash configuration is required. The flash configuration can either be a ProF configuration or an ODX description for the use with ETAS ODX-FLASH or ETAS ODX-LINK.

In case the ECU comes with a restricted measurement, calibration and/or flash access for security reasons, a Seed&Key DLL is required in addition.

These multi ECU workspaces can be created just like single ECU workspaces using 'Insert hardware devices' (icon) in the INCA Hardware Configuration editor (HWC). If the setup is known, multiple projects assigned to different hardware devices can be added consecutively. The list of available devices depends on the INCA add-ons installed:
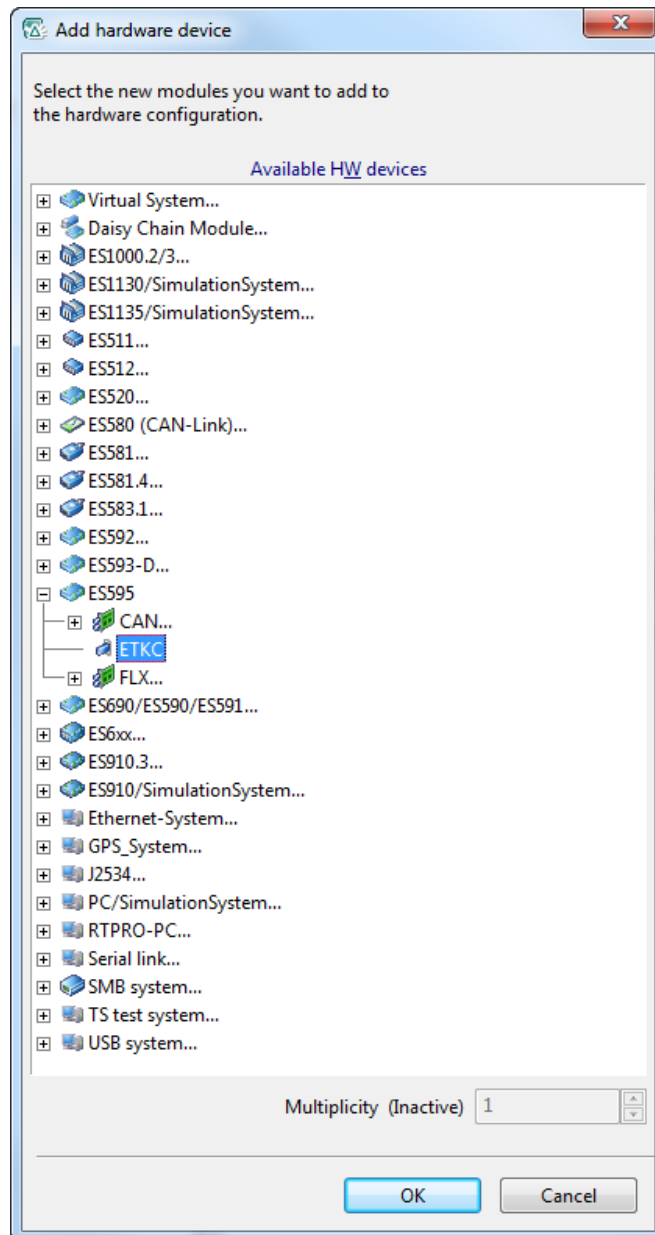
Hardware devices already in use are greyed out in the selection list.

Alternatively to the manual configuration, an automatic 'Search for connected devices' (icon 🔍) can be performed in the INCA Hardware Configuration Editor. For this all devices need to be powered and running.

Make sure to assign the right ECU project (A2L/Hex) to the correct device, especially if the same device is available more than once.

For example a multi ECU set-up with two ETK ECUs would be connected like:

Figure 5: Connection set-up with two ETK ECUs connected to ES59x devices using the integrated Ethernet switch of one of the ES59x.

In INCA the corresponding Hardware Configuration would look like this:
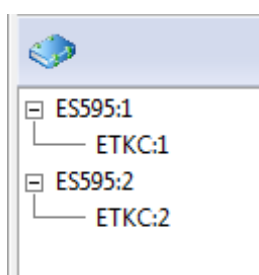

Figure 6: Hardware representation of the set-up above in INCA

Additional devices with Ethernet based communication, like XETKs or XCPonEthernet devices can be connected to an ES600 switch directly. These Ethernet systems will show up on the same level as ES59x devices:

A multi ECU setup with two XETK equipped ECUs or two ECUs with XCPonEthernet interface would look like:
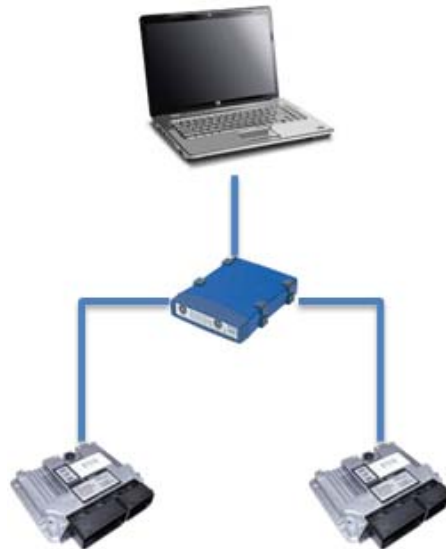
Figure 7: Connection set-up with an ES600 and two XETK ECUs

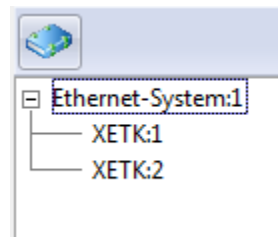In INCA, the set-up with two XETK equipped ECUs would look like

Figure 8: Hardware representation of the set-up above in INCA, added as XETK devices

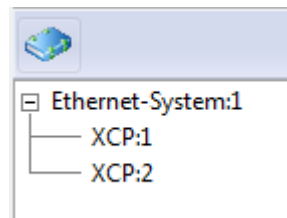Or, with XCPonEthernet ECUs, respectively:

Figure 9: Hardware representation of the set-up above in INCA, added as XCPonEthernet devices

A mixed system with one ETK ECU, two XCPonEthernet ECUs and one ECU connected via XCPonCAN would look like:

```
┌─────────────────────────┐
│  ◈                      │
├─────────────────────────┤
□ Ethernet-System:1
├─── XCP:ACC
└─── XCP:ESC
□ ES595:1
├─□ CAN:1
│  └─── XCP:1
└─── ETKC:1
```
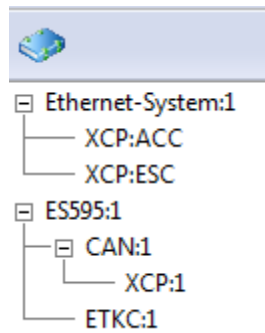
Figure 10: Hardware representation of a setup of multiple ECUs with different ECU accesses

To each added device in the Hardware Configuration editor INCA assigns a unique name. For ease of use the user can change these names to more meaningful ones (e.g. ACC, ESP, Engine ...)

4 Working with Multi ECU Experiments

4.1 Preparation - Flashing

To run a calibration and measurement experiment in a multi ECU set-up, a consistent combination of software versions and data sets for all ECUs is required. For this, some of the ECUs may have to be updated by flashing with INCA or another 3rd party flash tool.

Before starting the experiment, INCA initializes the hardware and checks for each ECU the consistency of the code and data available in INCA and the one running on the ECU by performing a checksum calculation:
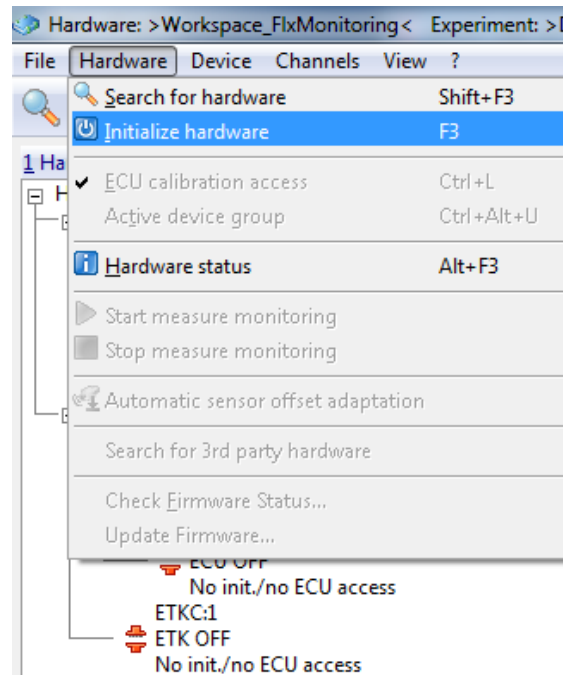

Figure 11: Initializing the INCA workspace with multiple ECUs

If an inconsistency of the code or reference data is detected during this check, INCA will open the Memory Page Management allowing flashing of the ECU.
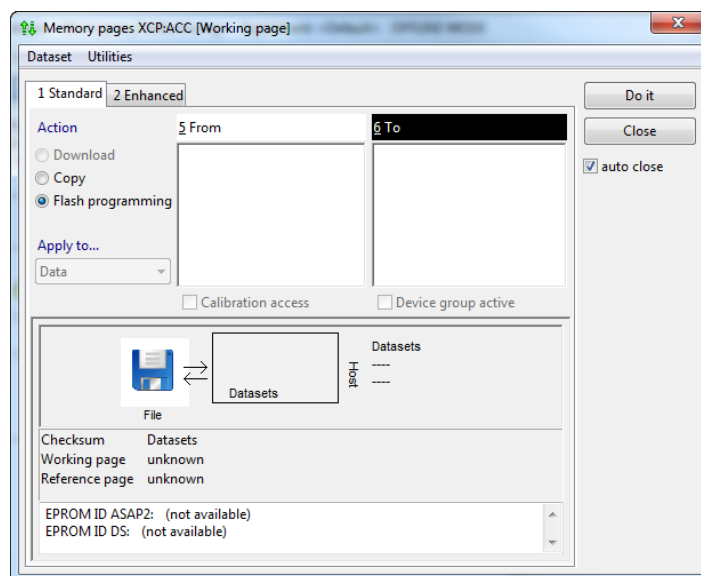
Figure 12: Updating (flashing) an ECU from the ICNA workspace

In case the ECU is flashed with an external tool, it must be flashed before the hardware initialization takes place in INCA.

Once all ECUs are updated with consistent code and data versions, the experiment can be started.

4.2 Variable selection

Once the INCA experiment is started, you can add measurement labels and calibration parameters from the different ECUs to the Experiment Environment via the INCA Variable Selection Dialog (VSD):

By selecting "All Sources" you will see all labels from all connected ECUs, busses and measurement devices in the Variable Selection Dialog. Depending on the number of connected devices, this list can be very long and confusing. Also, you will see all available measurement rasters for data acquisition supported by every ECU.
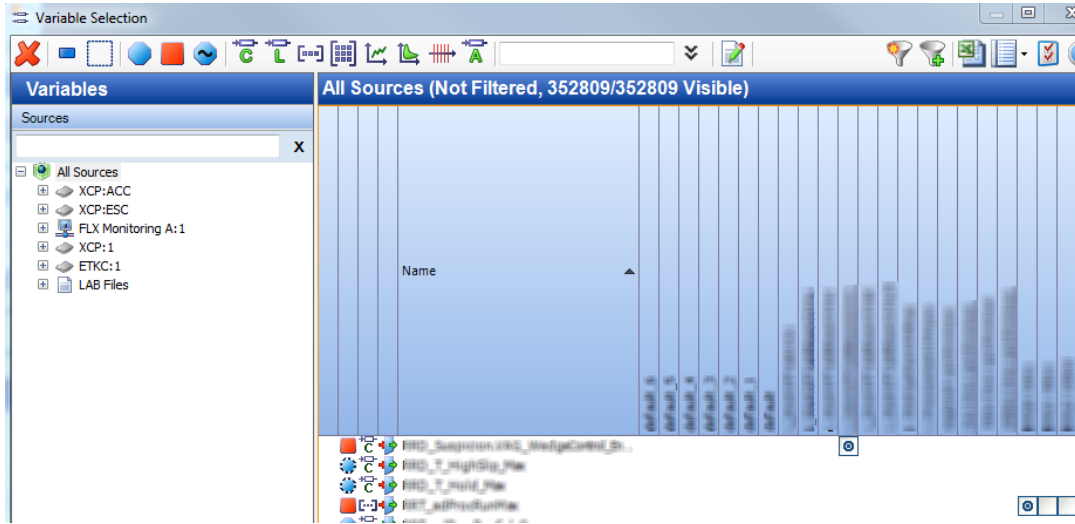
Figure 13: Variable selection dialog for all ECUs in workspace

By selecting a single device/ECU on the "Variables" pane you can reduce this list to all labels from one specific device and the list of acquisition rasters to those available on that ECU.
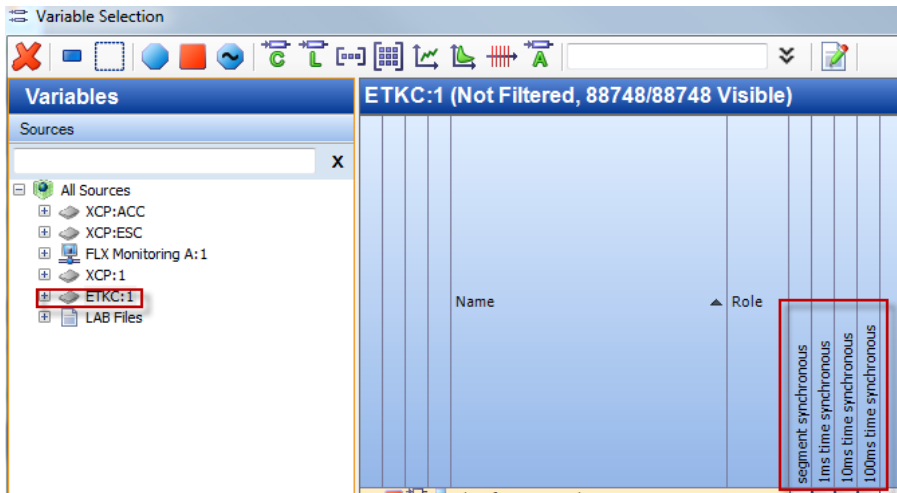

Figure 14: Variable selection dialog for one ECU

By using the various filters provided in the menu bar of the Variable Selection Dialog you can further reduce this list. Alternatively you can use so called LAB files (text files) to define a set of labels outside of INCA and use this list as filter in the Variable Selection Dialog.

4.3   Working with LAB files

For the creation of an experiment in a multi ECUs setup, LAB files can be of great help. Such a LAB files contains a list all measurement labels and calibration parameters needed for a specific calibration task. Here is an example for a simple LAB file:

```
[RAMCELL]

Epm_nEng

InjCtl_qSetUnBal

[LABEL]

AirCtl_mDesBasEOM0_MAP
```

It is a text file with the file extension ".lab", containing a list of labels, designated as [RAMCELL] (measurement labels) and [LABEL] (calibration parameters), respectively.

In a multi ECU project, based on four ECUs for example, the variable selection dialog could look like following:
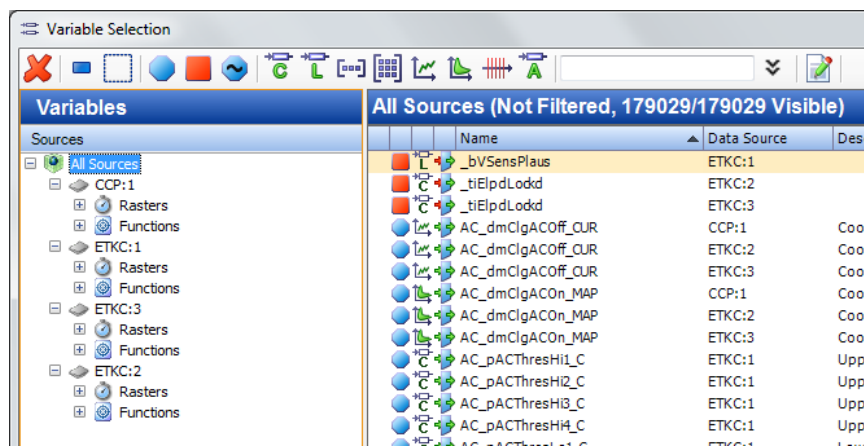

Figure 15: Sample variable selection dialog with 4 ECUs

You can use a LAB file as described above and apply it to "All Sources" or a specific device like "ETKC:3", just by a right click on "All Sources" or "ETKC:3"
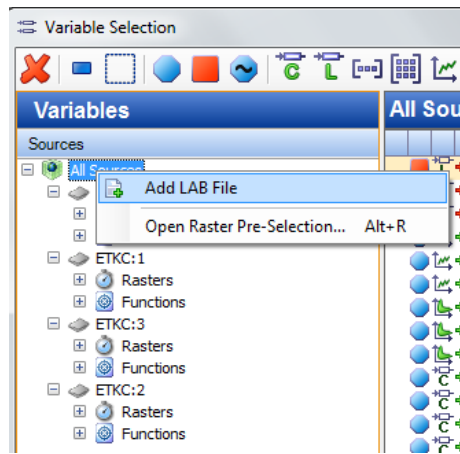
Figure 16: Adding a LAB file to the VSD project of 4 ECUs

The LAB file is used as a filter and only labels existing in the LAB file and corresponding measurement rasters will be shown in the Variable Selection Dialog:
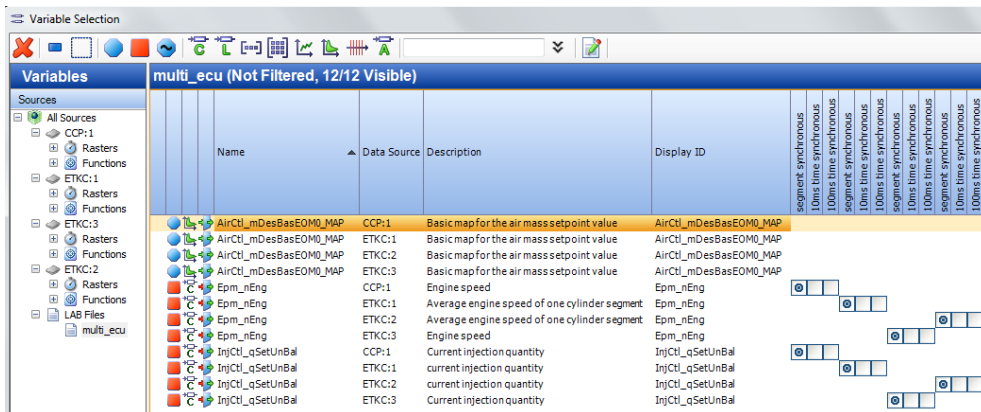

Figure 17: Applying the LAB file to the VSD project of 4 ECUs

4.4   Experiment environment

In case label names are not unique over the entire multi ECU project, meaning several devices come with labels having the same name, it is recommended to activate the "Show device name", in the variable display options, which can be found in the menu [Variables/Variable name display setup...]. Once activated, each label name will be extended by it device in the Experiment Environment.
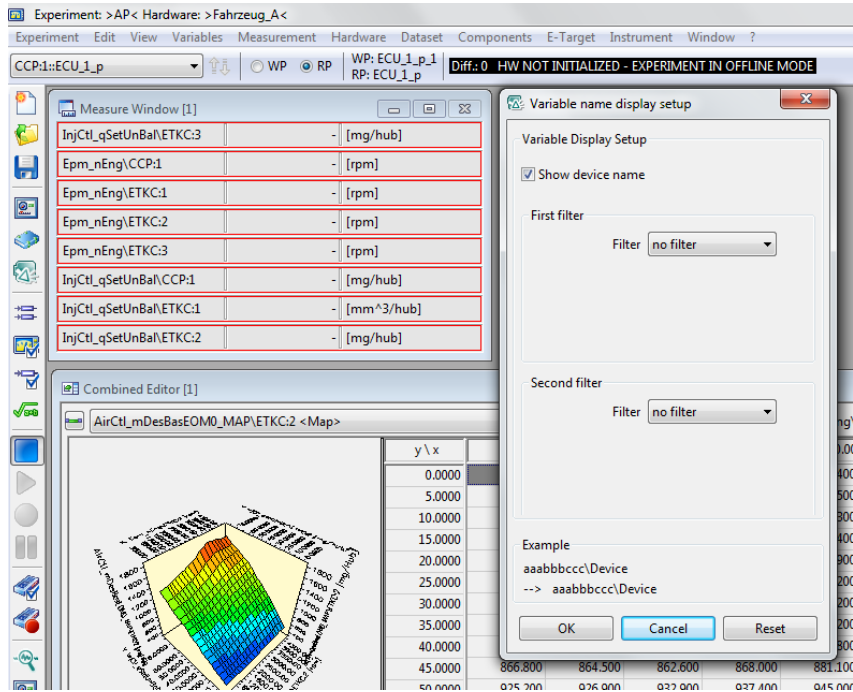
Figure 18: Displaying of device names

 Once the variables have been selected and the experiment has been configured, the measurement for the multi ECU set-up can be started.

For calibration, each ECU has to be switched from its Reference Page (RP) to its Working Page (WP).

INCA allows switching data pages for each ECU separately. The "WP" and "RP" buttons in the experiment window apply to the ECU currently selected. To switch data pages for another ECU, the respective ECU has to be selected from the drop down list first before a page switching can be performed:
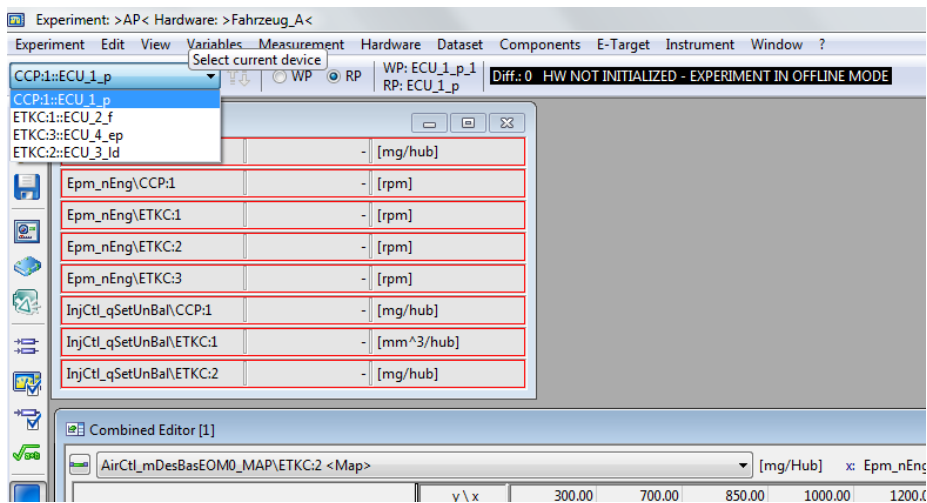
Figure 19: Activating an ECU for page switching

4.5 Grouping of ECUs (Master/Slave ECUs)

If two identical ECUs shall be calibrated in parallel, for example if a V-engine has a separate ECU for each of the 2 cylinder banks, INCA offers a feature to group ECUs.

In this case, calibration values with the same name will be calibrated in parallel, e.g. if a calibration value is selected and calibrated on one ECU, INCA will automatically also calibrate the same label on the other ECUs that are part of the group.

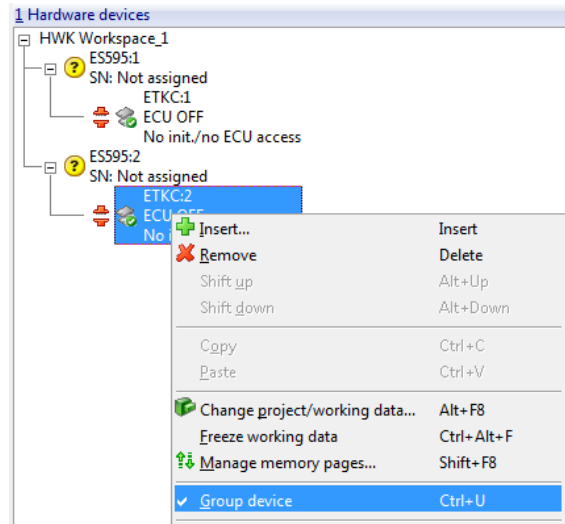First, the ECUs have to be added to a group. Only one group is allowed.

Figure 20: Grouping two ECUs

In the Variable Selection Dialog, INCA will show the grouped ECUs in a "Grouped" hierarchy and also will create a section containing the differences between the two ECU descriptions:
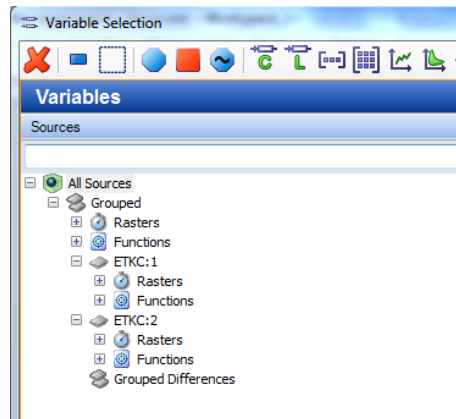

Figure 21: Grouped ECUs in the Variable Selection Dialog

In the Experiment Environment, a calibration value can be selected from each of the ECUs.
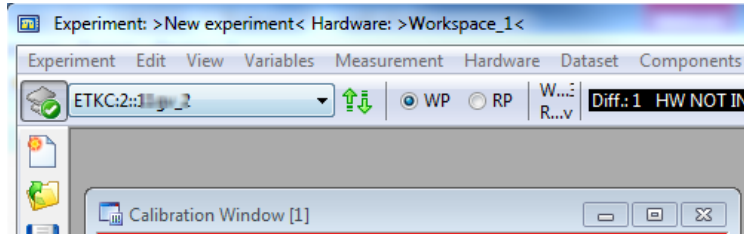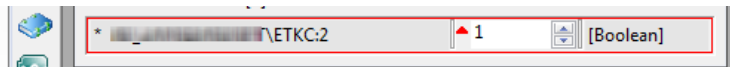
Figure 22: Calibrating the same label on two ECUs in parallel

If the value of a label is changed on one ECU, INCA will automatically change the value on the other ECU in the group accordingly. If the same label from both ECUs is selected in the experiment, the changed value will be updated in both calibration windows.

5 ETAS Contact Addresses

ETAS GmbH

Borsigstrasse 14	Phone:	+49 711 3423-0
70469 Stuttgart	Fax:	+49 711 3423-2106
Germany	WWW:	www.etas.com

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