

Measurement and Calibration Software for Automotive Electronic Control Units (ECUs)

NI ECU Measurement and Calibration Toolkit

- Universal Measurement and Calibration Protocol (XCP) master functionality on CAN and Ethernet (TCP and UDP)
- CAN Calibration Protocol (CCP) Version 2.1
- Access to ECU physical values (DAQ and STIM lists) for measurement and stimulation applications
- Access to internal ECU characteristics (1D to 3D) for calibration applications
- Ability to import ASAM-defined (.A2L) database files
- Detailed examples as starting points for measurement and calibration applications

Operating Systems

- Windows Vista/XP/2000
- LabVIEW Real-Time
- LabWindows™/CVI Real-Time

Recommended Software

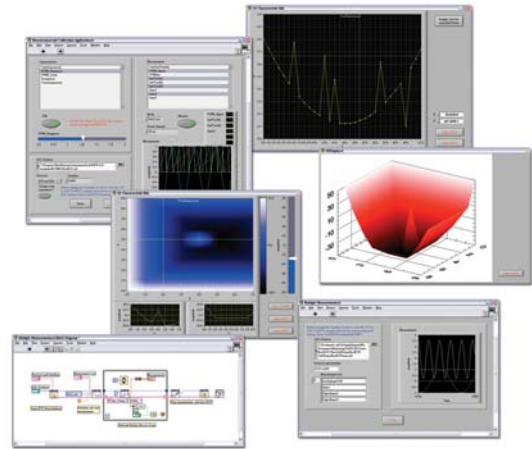
- LabVIEW
- LabWindows/CVI

Other Compatible Software

- Microsoft C/C++

Applicable NI CAN Interfaces

- USB-CAN
- PCI-CAN Series 2
- PXI-CAN Series 2
- PCMCIA-CAN Series 2



Overview

The NI ECU Measurement and Calibration Toolkit extends the NI LabVIEW, NI LabWindows/CVI, and Microsoft C/C++ programming environments to help you develop applications for the design, test, and validation of automotive electronic control units (ECUs). The ECU Measurement and Calibration Toolkit offers a low-cost alternative to the expensive turnkey measurement and calibration tools on the market. It provides high-level, easy-to-use functions based on the Universal Measurement and Calibration Protocol (XCP) and CAN Calibration Protocol (CCP), so you can read and write to internal ECU variables and characteristics as defined in ASAM (.A2L) database files. By using (.A2L) database files, the toolkit automatically applies all scaling information and returns data in engineering units for easy analysis, presentation, and logging. In addition, the ECU Measurement and Calibration Toolkit offers high-quality examples for typical use case applications such as how to measure ECU variables or how to manipulate ECU characteristics using 1D to 3D user interfaces.

ECU Measurement and Calibration

Most ECUs interact with other ECUs, external sensors, and actuators on a Controller Area Network (CAN). During the development and verification phase of an ECU, engineers access the ECU for acquired data (measurement) or to adjust parameters inside the ECU itself (calibration). Because the bandwidth and number of identifiers for a CAN network are limited, the Association for Standardization of Automation and Measuring Systems (ASAM) has specified the CAN Calibration Protocol (CCP) – a protocol layer based on CAN – to access the measurement and calibration data in an ECU.

To build on the functionality of CCP, ASAM defined the new protocol specification Universal Measurement and Calibration Protocol (XCP), an improved and generalized version of CCP. The X represents the various transportation layers used by the members of the XCP protocol family – for instance, XCP on CAN, XCP on TCP/IP, XCP on UDP/IP, and XCP on USB.

ASAM (.A2L) Database

The ASAP description file (ASAP2 or ASAM MCD 2MC) is used to describe the ECU internal memory configuration. An ASAM MCD 2MC description file with the file extension .A2L contains information and access locations for the relevant data objects in the ECU, such as ECU data structure, conversion procedures for representation in physical units, descriptions of the available measurement channels and characteristics inside the ECU, and descriptions of how to access the ECU over CAN.

Note: ECU Measurement and Calibration Toolkit use requires an existing ASAM MCD 2MC database file. You can generate these files through various third-party utilities. A database editor for ASAM MCD 2MC databases is not included in the toolkit.

Programming

The ECU Measurement and Calibration Toolkit API is divided into three main function categories – the high-level channel-based functions that implement the CCP and XCP protocols, the generic low-level CCP functions, and the generic low-level XCP functions. The channel functions implement the CCP and XCP protocols so that they are transparent to the user, providing an easy way to access ECU internal data through named

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channels. For most cases, it is sufficient for the toolkit to handle the underlying CCP and XCP communication. Nevertheless, the toolkit offers direct access to the low-level CCP and XCP commands if you need a nonstandard timing behavior or independent user-defined command sequence.

Channel Functions

With the toolkit channel functions, you have a number of ways to access memory content in an ECU. The starting point is always the creation of a database task, which is the link to a valid ASAM MCD 2MC database file (.A2L file), and the selection of the protocol (CCP or XCP). With the database task reference, it is possible to create an ECU task reference, which links to the selected ECU. Depending on the application scenario, you can use the ECU task reference to:

- Create a measurement task to measure ECU internal data continuously or on demand
- Directly read/write 0D to 2D characteristics
- Read/write single measurement values on demand

ECU Measurements

An ECU measurement, called *ECU Data Acquisition (DAQ)* in the CCP and XCP specifications, is a definition of specific procedures and CAN messages sent from the slave device (ECU) to the master device for fast data acquisition.

The XCP protocol offers synchronous data transfer in both directions, from Master to Slave (data acquisition list) and from Slave to Master (STIM list). With XCP, you can have several simultaneously active data acquisition lists. The sampling and transfer of each data acquisition list is triggered by individual events in the slave. To reduce the transfer rate, you can apply a transfer rate prescaler to the data acquisition lists.

ECU Characteristics

An ECU characteristic represents an ECU internal memory range with defined access methods through the CCP protocol. The memory range of a single characteristic can be structured in three ways:

- 0D – a single value
- 1D – a curve of values
- 2D – a field of values

A characteristic can be defined as read only or read and write accessible.

CCP and XCP Functions

The ECU Measurement and Calibration Toolkit channel functions do not expose the method used for ECU memory access. However, some applications may need specific CCP or XCP command sequences or custom designed commands that are not included in the CCP or XCP protocols. For these applications, the ECU Measurement and Calibration Toolkit CCP functions and XCP functions provide access to the ECU information at a very low level.

XCP-Spy Utility

XCP-Spy is an application that monitors, records, and displays XCP communication commands and parameters called by your ECU Measurement and Calibration Toolkit application using the XCP protocol. Use the included XCP-Spy to analyze your application's XCP communication and to verify that the communication with your ECU slave is correct.

NI ECU Measurement and Calibration Toolkit Licensing Information

National Instruments offers three ECU Measurement and Calibration Toolkit licenses: ECU Measurement and Calibration Toolkit Development License for Windows, ECU Measurement and Calibration Toolkit Deployment License for Windows, and ECU Measurement and Calibration Toolkit Deployment License for LabVIEW Real-Time.

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