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Product information and technical data on CANape Options are presented in separate documents.
1 Overview

1.1 Introduction

The parameters of a control algorithm can only be determined to a limited extent using a laboratory model. While the algorithms of the functions are a permanent fixture in the ECU program, parameter values such as characteristic maps and curves can only be determined and optimized by measurements at the test bench and in driving trials. Solving these challenging ECU development tasks is only possible with a versatile high-performance tool.

1.2 Overview of Advantages

> Open and flexible platform, since it is based on standards
> Measurement data can be acquired time-synchronously from many different sources
> Convenient calibration and management of parameters and direct transmission to server- or cloud-based calibration management systems
> High-performance interface to ECUs and sensors (radar, LIDAR, video ...) with outstanding measurement data rates
> Reliable ADAS logging solution for comprehensive testing
> Easy to incorporate analog measurement equipment with high sampling rates
> Open interfaces for hardware integration with third-party suppliers
> Analysis of measured data including even fully automated data mining and reporting.
> Convenient visualization of Simulink and Stateflow models
> Rapid prototyping platform as an efficient runtime environment for code and models
> Complete solution, because A2L files can be generated directly from the linker-map file, and powerful tools such as the ASAP2 Studio and DBC Editor are already integrated

Figure 1: CANape user interface with simultaneous use of multiple configurations.
1.3 Application Areas

CANape is an all-round tool for ECU calibration. With CANape, you can solve all necessary tasks in this field – conveniently and reliably:

> From functional development of the software to rapid prototyping solutions and the production-ready ECU
> At the work desk, on the test bench or on test drives
> In data logging, parameter calibration, ECU and vehicle diagnostics or verification and visualization of object recognition algorithms for driver assistance systems

1.4 Features

The primary application area of CANape is in optimizing parameterization (calibration) of electronic control units. During a measurement process, you can simultaneously calibrate and record signals. The communication between CANape and the ECUs takes place via protocols such as XCP or via microcontroller-specific interfaces with the VX1000 measurement and calibration hardware. CANape offers diagnostic access, bus analysis as well as integration of analog measurement technology, video and GPS data. Calibration data management and convenient measurement data evaluation, including reporting, make CANape a complete tool for ECU calibration.

1.5 System Requirements

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<th>Recommended</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>Intel Core i5 3.0 GHz or higher</td>
<td>Intel Core 2 Duo 2.6 GHz</td>
</tr>
<tr>
<td>Memory (RAM)</td>
<td>4 GB (special tasks may place greater demands on the system. Please contact CANape Support if you need further assistance)</td>
<td>2 GB (32-bit) or 4 GB RAM (64-bit)</td>
</tr>
<tr>
<td>Hard drive capacity</td>
<td>≥ 2.0 GB (depending on options used and required operating system components)</td>
<td></td>
</tr>
<tr>
<td>Screen Resolution</td>
<td>1280 x 1024 or higher</td>
<td>1024 x 768</td>
</tr>
<tr>
<td>Graphics Card</td>
<td>DirectX 9.0c or higher</td>
<td></td>
</tr>
<tr>
<td>Operating System</td>
<td>Windows 10/8/1/7 (32-bit and 64-bit)</td>
<td></td>
</tr>
</tbody>
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1.6 Supported Bus Interfaces and ECU Interfaces

> Vector hardware for CAN, CAN FD, Ethernet/BroadR-Reach, LIN, FlexRay, MOST and K-Line
> Vector VX1000 measurement and calibration hardware for high-performance access to the ECU via debugging and trace interfaces such as JTAG, DAP, LFAST, RTP/DMM, Nexus AUX and AURORA.

1.7 Functional Extension by Supplemental Options

> Option Driver Assistance for verifying object detection algorithms in developing driver assistance systems as well as to visualize the vehicle position and object detection positions on maps
> Option vCDM for convenient exchange of parameter sets and values within a team
> Option Simulink XCP Server to conveniently measure signals and calibrate parameters in Simulink models over the CANape interface at runtime without instrumentation in the model
> Option Bypassing with the VN8900 network interface and the VX1000 measurement and calibration hardware provides you with a high-performance fully-featured bypassing solution. At model runtime on the VN8900 real-time hardware, you acquire the necessary input data from the ECU via the VX1000 system, XCP on Ethernet, XCP on CAN, CAN, FlexRay or I/O.
> Option Thermodynamic State Charts for display of thermodynamic data and informative state charts for online and offline analysis
> Option vMDM for direct connection between CANape and vMDM (Vector Measurement Data Management) for the provision and analysis of measurement data
> Option MCD3 extends CANape with the ASAM MCD-3 V1.0 automation interface for measurement and calibration
1.8 Additional Usage Scenarios

1.8.1 CANape under „EULA“

In addition to Section 2.1 of the "End User License Agreement for Vector Standard Software Products", the following usage scenarios are permitted for CANape; "CANape automation or remote access to CANape is allowed with a device license if CANape is operated in order to access a real system with Vector hardware (VN, VT, VX) (for example at a test station or in a server environment)."

1.8.2 CANape under “ELA”

In Addition to Section 2.1 and 2.2 of the “Enterprise Licensing Terms and Conditions for Vector Standard Software Products” the following usage scenarios are permitted for CANape; "Automation of CANape or remote access to CANape is allowed with a device license and/or named user license if CANape is operated to access a real system with Vector hardware (VN, VT, VX) (for example at a test station or in a server environment)."

1.9 Further Information

Various documents related to CANape are available on the Internet. With the demo version, you get sample configurations for various application areas and a detailed online Help function in which all CANape functions are described. In addition, you will benefit from valuable know-how in the form of technical articles, product videos and application notes. For more information, go to the CANape web page.

2 Basic Functions

The basic functions of CANape include:

- Synchronous real-time acquisition of all input values. Precise time synchronization (PTP/IEEE802.1AS) during measurements together with UTC timestamps and GPS-based master clock.
- Acquisition of sensor data for ADAS development, such as, e.g. video and radar sensors with more than 100 MByte/s
- Online calibration via CCP/XCP and real-time stimulation and bypassing via XCP
- Offline calibration of HEX files and other binary files
- Seamlessly integrated diagnostics via KWP2000, UDS and DoIP
- Full access to the vehicle’s OBD data
- Offline evaluation of measurement data from manual evaluation to automated data mining with integrated script language "CASL" (Calculation and Scripting Language) or user-generated DLLs
- Runtime environment for "software in the loop" solutions – algorithms that will run later in the ECU can be integrated in CANape as DLL
- Fast and secure flashing of binary files and parameter sets
- Powerful management of calibration data, comparing and merging of parameter sets with CDM Studio. For small teams right through to globally distributed enterprises, the vCDM database-supported platform is the optimum solution for the professional management of calibration data.
- Automation interface for measuring and calibrating via C-API, COM, ASAP3, ASAM MCD-3 MC or iLinkRT
- Universal I/O interface for the integration of any required measurement systems. The integration includes both the configuration and the actual transfer of the measurement data.
- Automation of processing sequences thanks to the integrated function language CASL
- Integrated function library, e.g. for computing several signals or filtering signals with noise
- Convenient visualization of Simulink and Stateflow models incl. display of values, navigation through the model levels, search mechanisms and the direct adjustment of parameters
- Simple creation and integration of user-specific displays and controls
- Display of the current GPS vehicle position on electronic maps (including for offline use) greatly simplifies the interpretation of the recorded measurement data
Extensive printing and reporting functionalities

3 Measurement Data Acquisition

CANape acquires internal ECU measurement parameters synchronous to ECU processes via the CCP and XCP measurement and calibration protocols. Data measured from the ECUs are logged time-synchronous with other measured data (from serial bus systems, GPS, audio, video or from other measuring equipment) and are represented in many different ways. The multi-recorder concept makes it possible to configure different measurements and start and stop them independently of one another. Each recorder saves its measured values in a separate file.

Features of measurement data acquisition and visualization in CANape include:

- Various window types and user-definable panels for graphic representation
- The ASAM measurement data format MDF 4.x writes measurement files without a time-consuming post-process for sorting. MDF 4.0 also supports measurement files with a size over 4 GB.
- CAN bus data may be recorded in either BLF or MDF 4.x format
- Detailed display of DAQ list utilization in the measurement configuration
- Optimized DAQ lists configuration enables maximum data transfer independent of data types
- Analysis of bus communication in the Trace window
- Structures defined in the ECU source code can be used as measurement objects
- Virtual signals can be calculated online with the help of an internal script language or with MATLAB/Simulink models by combining real variables from various sources
- Extensive trigger options for data logging including pre-trigger and post-trigger times (also for audio and video)
- Time-synchronous acquisition of scalar values and arrays
- Decoding of encrypted CAN messages
- Use of CANape as a stand-alone data logger
- Configuration of the Vector data loggers for CCP and XCP measurements including seed & key handling
- Data rates of more than 100 MByte/s are possible from the ECU depending on the interface used with the VX1000 measurement and calibration hardware
- Reliable and time-synchronous documentation of driving situations via audio, video and image recordings without keyboard input

Figure 2: Visualizing and comparing signals from different measurement files in one or more windows
3.1 Distributed High-Performance Recording (DHPR)

In the field of ADAS development and autonomous driving, larger data volumes have to be gathered and recorded more and more often. For these use cases, CANape 15.0 now offers the possibility of measuring XCP-on-Ethernet devices in a “high-performance mode”. In addition, this extension permits measurement date, video streams and radar raw data to be recorded synchronously using multiple PCs. With this setup, measurement data rates of over 1 GByte/s can be achieved.

- Configuration as well as start, stop, and trigger control, are all defined as usual in CANape’s graphical user interface on a main PC
- Ideal utilization of PC resources by the new mode
- Distribution of measured data on different storage media
- Time-synchronous distribution of the measurement tasks to several PCs
- Visualization of control signals of the distributed recorder
- Only one CANape license required

![Figure 3: Scalable decentralized recorder solution for very large data rates in ADAS environment (> 1 GByte/s)](image)

3.2 Measurement and Calibration Hardware with Maximum Transmission Rates

The VX1000 System is a modular solution with a data throughput of more than 100 MByte/s for measurement and calibration tasks. It can be used in the vehicle, on test benches or in the laboratory. To achieve maximum data throughput with minimal effects on ECU execution times, data is accessed via microcontroller-specific data trace and debug interfaces.

By using the standardized XCP on Ethernet protocol, in addition to interfacing with CANape you can interface to other measurement and calibration tools as well. Depending on the controller used, a measurement may have practically no effect on the controller.
3.3 Evaluation of Measured Data and Data Mining

CANape offers you numerous options for easy processing and evaluation of data from previous measurements – either manually or automatically:

- Support for different measurement data formats thanks to import and export converters. CANape works directly with the unconverted MDF, HDF5 and Excel formats.
- Script-driven and automated evaluation of measurement files
- Arithmetic evaluations using the integrated script language CASL, your own C/C++ based functions or MATLAB/Simulink models
- Convenient search function and analysis of large quantities of data via the data mining user interface
- Convenient linking of search conditions permits efficient description and execution of complex analyses
- Display of signals over a time axis or XY representation
- Manual study of signal responses by zoom, search functions, and measurement cursors
- Comparison of measurement results through the overlaid display of results.
- Input of comments for offline analysis
- Use of customizable print templates
- Import and export of different measurement file formats
- Export of sequences from measurement files with synchronous video segments
- Easy handling of measurement files with the Measurement File Manager
Programming skills are not required to execute evaluations that have already been created. Programming skills are also not needed to create simple evaluations whose scope is limited to the use of existing mathematical functions. However, programming skills are required to create elaborate and complex evaluations.

### 3.4 Supported Measuring Systems for Analog/Digital Measurement Variables

The following measurement systems can be integrated in CANape:

- Vector I/O solutions
- All measurement data acquisition devices connected to the PC via the CAN bus, e.g. devices from the companies CSM, Caetec, IMC or Ipetronik
- AD-Scan MiniModul pro from CSM (2 Mbit/s bandwidth with overclocked CAN bus for up to 10 kHz sampling rate)
- XCP Gateway from CSM
- ETAS measurement module series ES400 and ES600
- Mx-SENS 8 over XCP on Ethernet from Ipetronik
- Analog and digital measurement hardware from NI, including the DAQmx series
- DEWE-xxx and DEWE2 from DEWETRON
- QuantumX and SoMat eDAQ from HBM
- ADwin systems from Jäger Computergesteuerte Messtechnik
- KiBox from Kistler
- faceLAB from Seeing Machines (video systems for acquiring visual perspectives in the areas of driving safety research and human-machine interaction)
- Dikablis from Ergoneers (video systems for acquiring visual perspectives in the areas of driving safety research and human-machine interaction)
Figure 7: CANape supports many measurement solutions from a wide variety of producers. The DAIO interface is an open interface for integrating nearly any input or output systems.

An open interface is available for integrating other measurement systems: the DAIO (Digital / Analog IO) interface for high-performance analog measurement solutions. Users can create the drivers needed for this themselves. In development, Vector can support you with sample programs, a driver generator and other services.

4 Status Monitoring

The Status Monitor supports troubleshooting and functional monitoring of systems by analyzing their states, state transitions and events, which originate from different information sources, such as XCP, bus, I/Os, etc. A special focus here is on the analysis of AUTOSAR ECUs that contain many different software components. The Status Monitor is constructed similar to a logic analyzer and offers the following functionality:

> Monitors the states of AUTOSAR Runnables and measures ECU utilization
> Reads out Runnable states via the VX1000 measurement and calibration hardware
> Allows you to conveniently analyze binary signals and digital I/Os
> Detects priority inversions within an ECU

5 Calibration/Parameter Setting

Representation in parameter setting is either alphanumeric or graphic. User-configurable panels give the user a customized interface for displaying and calibrating characteristic parameters. The following functionality is offered in parameter setting/calibration:

> You can set parameter values either online in the ECU’s memory or offline in the cache of CANape. The Offline mode lets you process ECU parameters before or after measurement without requiring a connection to the ECU.
> Parameter calibration in parallel to measurement data acquisition
> All of an ECU’s parameters can be calibrated in a single window, the Parameter Explorer
> Structures with parameters can be viewed in their entirety in the Parameter Explorer
> Generation of a parameter set based on a specific time point in the measurement file
> Merging of parameter sets to make new version levels and feed the data back into software development via C, H or MATLAB files
Parameter set files are managed in vCDMstudio.

Parameter set files can be loaded, visualized and edited in calibration windows. This also enables batch operations on parameter set files.

Figure 8: Numeric and graphic calibration windows enable convenient modification of characteristic curves and maps.

5.1 Calibration Data Management (vCDMstudio)

A parameter set contains the values of parameters specified in the ECU description file. The integrated vCDMstudio manages these parameter sets and supports various file formats. CANape offers this related functionality:

- Parameter sets are saved in symbolic, address-independent parameter set files. They are processed independent of the ECU program version at which they were created.
- Visualization and editing of the contents of parameter sets
- Multiple parameter sets can be opened simultaneously to compare, merge or edit them
- Automation interface for merging, exporting and comparing parameter set files
- Generate flashable binary files from parameter sets
- Supports the XML-based PaCo and CDF formats, in which supplemental meta-information may be stored for each parameter value, e.g. maturity level, values history, author, date and comments
- Ability to copy characteristic curves and maps with different number of axis points by using interpolation
- Ingenious filter mechanisms for defining views of parameter sets
- Generation of reports in various formats including Excel
- Export and import of configurations
Figure 9: You can use vCDMstudio to manage the extensive parameter sets of your ECUs by a simple method with continual traceability.

5.2 Easy Collaboration on Parameter Sets Within a Team

Calibration is team work. For this reason, it is necessary to exchange parameter sets easily between team members and process them together. Data exchange based on file hand-offs between individual users runs the risk of data conflicts and loss of data.

- By means of the CANape “vCDM” option you ensure the easy exchange of parameter values without loss within your team. The access is directly in CANape without any other application.
- Invited users can access a data set, process it locally, and then synchronize changes with the central data set.
- Conflicts which occur when the same parameters are modified by multiple users are displayed and resolved.
- Server-based mobile database solutions support remote tests where access to the central CDM system is not available. Thus, the team always uses the same data source.

In order to store the data set centrally, a new or existing vCDM server can be used. Or, use the Vector cloud solution, with which the entire operation is provided by Vector.

Figure 10: In this type of installation, the vCDM server is available on a computer in the enterprise network. If there is a vCDM server, then Option vCDM can be run on this.
5.3 Server-based Calibration Data Management with vCDM

Data created during calibration (program and data revision levels, description files, and various documentation) can be managed in a database, process-conformant, using the stand-alone software tool vCDM (Vector Calibration Data Management) and can be saved for reuse in other projects. Management of variants, versions and configurations gives you the ability to master the high complexity of calibrations with confidence.

In CANape, you can download your work packets from the database and conveniently load finished parameter set files directly back into the database system.

6  Flashing

In flashing new program versions, both the CCP/XCP and diagnostic protocols are supported.

The easiest way to perform diagnostic-based flashing is to use vFlash projects. The flash tool from Vector supports over 50 different flash specifications with user-friendly templates. It is designed for all users at automotive OEMs and suppliers whose tasks include (re-)programming ECUs. vFlash lets you flash very efficiently in the laboratory, at programming stations, in laboratory mock-up vehicles and in road vehicles. The process involves implementing ECU-specific sequences in vFlash projects. You can select these projects in CANape and use them directly for flashing.

7  Support of Model-based Software Development

The interplay between CANape and the toolchain from MathWorks is multifaceted.

Basic functionality in CANape:

- Export measurement files in MAT-formats (e.g. the HDF5-based format 7.3)
- Export parameter files in M-script (for transferring parameter values to the Workspace)
- Export A2L and parameter files to M-script (to initially create predefined A2L objects in the Workspace)
- Visualize Simulink/Stateflow models in CANape to conveniently search for objects, display measurement values and calibrate parameters
- MATLAB can use the C-API of CANape to obtain read and write access to object information from ECUs, buses, etc., and to remotely control CANape. M script functions are available for this in MATLAB.
- The code for CANape can be generated from models using “Simulink Coder” generator. After compiling and linking, DLLs are available which utilize CANape as a runtime environment. An XCP Slave is automatically integrated in code generation, so that the DLLs can also be measured and calibrated over XCP.

The “Simulink XCP Server” option provides CANape with a user interface for measurement, parameterization and visualization of models in Simulink. In functional development, the data are transferred to CANape per the XCP on Ethernet protocol at model runtime in Simulink. This lets you access parameters in Simulink exactly as if the application were running in an ECU.

![Figure 11: Simulink run-time does not match real-time. CANape adapts itself fully to the time behavior of the model.](image)

After a computation cycle, you analyze the data in CANape and use parameterization features such as calibration windows or vCDMstudio to change model parameters directly in CANape. Afterwards, the next computation cycle is run with new parameterization. Since the computation of models often runs faster than in real time (dependent on their complexity and
processing power), short iterative cycles can be achieved. DLLs, which are generated via Simulink models or C-code, compute signal values during the measurement for visualization or for bypassing of functions in the ECU.

7.1 Rapid Prototyping

CANape enables the use of standard PCs in place of cost-intensive rapid prototyping hardware. Functional development is performed by MATLAB/Simulink. After code generation using Simulink Coder resp. TargetLink and the compiler run, the Simulink model can be run as DLL in CANape on any computer. Even without using code generators, existing code can be utilized via a supplied C++ project for DLL generation. XCP is then used to access all internal model measurement variables and parameters (including integrated binary components). To stimulate the algorithms, you can use both measurement values and the contents of already logged measurement files.

7.2 Visualization of Simulink/Stateflow Models

You can use the Simulink Model Explorer to visualize the Simulink/Stateflow model directly in CANape – independent of the runtime environment of the code. The link between the model and the A2L file lets you easily navigate through the model and access parameters and measured values directly.
In the “Algorithm Designer,” you can graphically link existing DLLs to signals and to one another.

Figure 14: Existing DLLs and CANape functions are graphically displayed with their inputs and outputs. The ports are linked to signals or other ports in a way that is comparable to Simulink.

8 Bypassing

You can implement PC-based bypassing with XCP mechanisms DAQ/STIM. This involves measuring input variables of the relevant ECU function via XCP. On the PC, the Simulink model is used to compute the output variables, which are time-synchronously transmitted back to the ECU by XCP stimulation. For short round trip times, the bypasses are computed on the Vector VN8900 network interface with integrated real-time computer, and measurement and stimulation access are computed using the VX1000 hardware.

Multiple bypass functions can also be run in parallel on the VN8900 for different ECUs or the same ECU. The VN8900 can also be used as a stand-alone solution. In this case, the bypass is first configured with CANape, and it is downloaded to the VN8900. After CANape has been disconnected, the calculation is performed autonomously on the VN8900. Stand-alone use is limited to one ECU.
The “Vector Tool Platform” is a system extension for PC-based Vector network interfaces for CANape and CANoe. For MATLAB/Simulink models used in CANape, a VN8900 network interface can be used as execution platform to achieve a significantly improved real-time behavior. With the new “Extended Real Time” component, the properties important for executing models, such as latency and determinism, are improved. Algorithms that were generated for use with “Extended Real Time” can be executed there under real-time conditions. Through the more constant calculation time with significantly reduced maximum deviations, smaller guaranteed time limits can be maintained and, at the same time, the reaction time improved. Particularly when executing time-critical bypass calculations with very small timeout tolerances, this is a significant advantage.

The “Extended Real Time” component can be used on the VN8911 and VN8912A interfaces.

Using the program’s C-like functional and script language CASL, it is possible to calculate both virtual signals and flow sequences in CANape in an automated way. The integrated editor offers a convenient development environment including a script debugger. This also makes enables the development of diagnostic-specific .Net-scripts, which are not only used in CANape, but also in CANoe and Indigo.
10 Automation Interfaces

CANape offers several powerful automation interfaces, e.g. ASAM MCD-3 (MC), to give client applications access to ECU data. Typical use cases are test benches or applications for automatic parameter calibration.

CANape Option MCD3 with its iLinkRT implementation significantly increases CANape’s performance in transmitting to the test bench. In this case, the measurement is configured over the ASAP3 interface, while the measured data is transported to the test bench computer by Ethernet.

11 Database Editors

To allow convenient editing of the various description files, CANape offers a number of editors that can handle:

- ECU description files in ASAP2 format
- CAN description files in DBC format

as well as viewers for:

- FlexRay description files in FIBEX format
- LIN description files in LDF format
- Diagnostic description files in ODX format
- CANdela diagnostic description files in CDD format
- FlexRay and CAN description files in the AUTOSAR system description format

12 Calibration Concepts

The calibration concept answers the question of how parameters in the ECU can be changed during an ECU’s development and calibration phases. There is not one calibration concept that exists, rather several. Which concept is utilized usually depends very much on the capabilities and resources of the microcontroller that is used.

CANape supports the following methods:

- Parameters in Flash
- Parameters in RAM
- Flash overlay
- Dynamic flash overlay allocation
- RAM pointer based calibration concept per AUTOSAR
  - Single pointer concept
  - Double pointer concept
- Flash pointer based calibration concept


13 Diagnostics

Besides handling diagnostics for individual ECUs, CANape also gives the user a look at vehicle functions across ECUs by means of functional addressing. Besides CAN and FlexRay, the K-line is also supported as a physical interface. CANape can also be used to symbolically access diagnostic data and services. The description files may exist either in ODX format or in the Vector CDD format. If no special diagnostic description file exists, the supplied generic files for UDS and KWP2000 enable symbolic access to functions and raw data.

As a diagnostic tester CANape offers these functions:

- Diagnostic console from which you can select, parameterize and execute diagnostic functions
- Window for displaying and processing fault memory, symbolic display of DTCs, and environmental data
> Integrated access to measurement, calibration and diagnostic data, e.g. with visualization of fault memory entries in the Graphic window
> ODX-controlled flash programming by script
> Analysis of all aspects of diagnostic communication in the Trace window: messages, transport protocol data, protocol data, and diagnostic data
> Address-oriented access to A2L-defined ECU data via diagnostic functions
> Visualization of the chronological flow of diagnostic functions
> Scripts for automating diagnostic sequences
> .Net, as a script language, provides many new diagnostic functions and enables exchange of scripts between Vector diagnostic tools – this eliminates the need to maintain different scripts.
> Easy-to-use automation interface for executing diagnostic services
> Functional addressing, e.g. use of a diagnostic function to query the IDs of multiple ECUs
> Support of 3D servers on request
> Access to OBD data with dedicated display in the OBD window
> Support of DoIP (Diagnostics over Internet Protocol)

14 Development of Driver Assistance Systems

CANape supports time-synchronous logging of vehicle, sensor and video data. Reference cameras capture the environment and supply the video data.

Option Driver Assistance lets developers of ADAS systems visualize the sensor data in the Video window. This involves overlaying the sensor data as graphic objects (e.g. rectangles and lines) in 3D perspective over the video image from the reference camera and visualizing them in a side view or from a bird’s eye perspective.

You can verify the acquired data and evaluate the reliability and operating safety of the system based on the video image, regardless of whether the system is a radar system such as Adaptive Cruise Control (ACC), a lane detection system or a parking assistant.

In addition to being overlaid in the video image, the acquired data can also be shown with accurate positioning on a map. If Internet access is available, the global map materials of OpenStreetMap is available to you. Additionally supported is Shobunsha Super MappleG, which can also be used without an Internet connection. OpenStreetMap material can be

Figure 17: Structured display of the supported diagnostic functions. All DTCs including the environment data are displayed.
downloaded and used offline too. It is also possible to incorporate your own bitmaps instead of maps, e.g. to display test routes.

Figure 18: Option Driver Assistance – Object verification for checking algorithms in the development of driver assistance systems.

14.1 Occupancy Grid Presentation in Video and GPS Window

For the development of autonomous vehicles, environment models of the vehicle's surroundings are required in the ECU. A frequently used model is the “Occupancy Grid”. In this process, the environment is divided up into small sections and each section is assigned a probability that there is something in that section or not.

For this purpose, sensor data from around the vehicle are merged by special algorithms and are evaluated. The result is the probability of an obstacle present at a clearly defined position in relation to the vehicle. The probability of presence is represented by a standardized numeric value. These data are saved in a two-dimensional characteristic diagram which reflects the environment. This is an enormously important factor for an autonomous vehicle in order to be able to make decisions on the potential for further travel in a direction.

CANape handles Occupancy Grid measuring and processing using a 500 x 500 grid with one byte per grid point. By using color functions and the new Occupancy Grid overlapping object you visualize and validate the captured environment of the vehicle as determined by the analysis algorithm of the ECU. For this purpose the Occupancy Grid can be displayed in the video window (three-dimensionally), in bird’s eye view or in GPS window.

14.2 Algorithms for Image Processing

You can use a DLL interface to integrate algorithms for image processing. Here, the video image is transferred to the algorithm as an input signal. The algorithm is able to analyze and manipulate the video data, e.g. to mark detected road signs in the video image. The algorithm can be optimized over XCP in this process. As a result, it is unnecessary to start the entire code generation process to optimize the algorithm.

An image processing blockset is available for easy generation from a Simulink model.

During the measurement, the DLL can be used to process the directly acquired video data. If video data already exists in the form of files, the algorithm analyzes the video files in the same way during data evaluation.
Figure 19: Different input sources for stimulating a virtual video-based ECU in CANape. Real online data acquired from the ECU via the VX1000 measurement and calibration hardware – from a camera or a logged video sequence.

15 Visualizing the Vehicle Position on a Map

In in-vehicle measurements, CANape records GPS data, and visualizes the vehicle’s current position on a stored map that is shown in a GPS display window. In offline evaluation, the vehicle position is visualized time-synchronous to the measurement data. This greatly simplifies interpretation of the logged measurement data, since geographical conditions can be considered in the evaluation. If an Internet connection is available in data evaluation, the mapping materials of OpenStreetMap may be used. As an alternative, OpenStreetMap maps can also be used as an offline variant. In developing Car2x applications, the CANape GPS window supports you by visualizing multiple objects on the map.

Figure 20: Efficient interpretation of logged measurement data by considering geographic aspects in evaluations in the GPS window

15.1 Application Areas

The ability to synchronize to a geographic position during a test drive and display the position on a map makes it much easier to understand certain events in context. This means that the user can trace the behavior of the ECU reliably, e.g. during upshifting on a mountain.
15.2 Supported Map Materials

The following map materials may be used:

- OpenStreetMap (lets you use map materials offline that have been downloaded beforehand, e.g. on test drives without an Internet connection)
- Shobunsha Super MappleG
- Integration of own maps in the form of graphic files

15.3 Functions

The CANape Option GPS offers the following functionality:

- Creation of freely configurable and scalable GPS display windows
- Display of the vehicle position in the GPS display window
- Configurable display of previously driven route. For example, the vehicle speed can be shown as a sequence of colors.
- Simultaneous visualization of geographical and vehicle-specific data in different display windows
- Synchronization of the measurement cursor with the vehicle position on the map
- Simultaneous display of multiple vehicles (e.g. in Car2x communication) or objects
- The level of detail in the map display changes depending on the zoom setting

16 Hardware Interfaces and Protocols

CANape supports all relevant standard interfaces and protocols in the automotive industry (others upon request):

- Support of CAN, CAN FD, Ethernet, BroadR-Reach (100BASE-T1), SOME/IP, FlexRay, LIN, SAE J1939 and GMLAN
- CCP
- XCP on CAN, CAN FD, FlexRay, Ethernet, Automotive Ethernet, RS232
- Diagnostic protocols:
  - KWP2000 on K-Line
  - ISO 14230 (KWP2000 on CAN) and ISO 14229 (UDS). ISO/TF2 and VW-TP2.0 transport protocols
  - ISO 14229 (UDS) over FlexRay with the ISO transport protocol and the "AUTOSAR" and "BMW" transport protocols upon request
  - DoIP (Diagnostics over Internet Protocol, ISO 13400)
- High-speed controller interfaces such as JTAG, DAP, LFAST, RTP/DMM, Nexus AUX and AURORA by Vector’s VX1000 measurement and calibration solution
- Integration of measurement technology and hardware interfaces of third-party manufacturers
17 Engineering Services

Vector supports you with both know-how and with tailor-made complete solutions for your project tasks, so that you can fully concentrate on your ECU development. Services ranges from consultation, e.g. on the development process for an A2L file, to the development of data evaluations to placement of a field application engineer at your business site.

For more information on the open interfaces in CANape that make it possible to implement your own individual functions, please refer to this separate document (PDF).

18 Training

As part of our training program we offer various training classes and workshops for CANape, XCP and vCDM at our classrooms and at customers’ sites. We can also arrange an individual date for you at your premises – just contact us.

18.1 CANape Fundamentals Workshop

In this workshop, you will get to know all about CANape both as a measurement and analysis tool and as a calibration and diagnostic tool. After an introduction to the fundamentals of the XCP protocol, you will configure the CANape display windows in order to acquire and display measurement data from many different sources. You will then be introduced to the data mining function with which you can automate the analysis of your measurement data. The calibration functions, data management and diagnostic functions are also on the agenda. For detailed information on this three-day workshop, visit: https://vector-academy.com/canape_training_en

18.2 XCP Fundamentals Seminar

In this seminar, you will be introduced to the fundamentals of the XCP protocol. After this introduction, you will get to know models for synchronous data transfer and calibration. The seminar will also look at the special properties of the XCP Transport Layer. Practical example sequences will round off the one-day seminar. For detailed information visit: https://vector-academy.com/xcp_training_en
18.3 Vector Calibration Data Management (vCDM) Seminar

Robust, reliable management of all calibration data is the prerequisite for quality and efficiency in the ECU calibration process. Specifications, software versions, description files and documentation must be available and accessible at all times. In this seminar, you will find out how vCDM supports you in these tasks. The focus will be placed on the practical calibration process.
For detailed information visit: https://vector-academy.com/vcdm_training_en

For more information on all our other training offerings, visit: www.vector-academy.com.