ETAS

DRIVING EMBEDDED EXCELLENCE

MDF Big Data Support

Description

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Contents

1 Introduction and Overview

1.1 Scope

MDF files contain measurement data. To be able to interpret the measured values it is necessary to know on which base it was measured. On one side there is meta information about the measured objects (ECU, networks …) and the measurement equipment (measure modules, interfaces …). On the other side there is the calibration data in the ECU that was used while measuring. The calibration data is often modified while the measurement is running. To interpret the measurement values in detail it makes sense to have the calibration data and its changes available.

This document describes how calibration data and calibration changes can be added to MDF files.

1.2 Definitions and Abbreviations

A2L File
ASAM MCD-2 file that contains the ECU description and how the calibration data in the binary can be interpreted.

ASAP2
ASAM MCD-2 MC Standard

BINARY FILE
File that describes the memory dump of an ECU (Hex, S19 …)

ECU
Electronic Control Unit

MDF
ASAM MDF file format

Recorder Activation
The recorder is active but waiting for a trigger to start

Recorder Start
The recorder starts recording

2 Basic Idea for Calibration Data storage in MDF

Most of the ECU support a two page concept for calibration. A reference page that cannot be changed and a working page where the calibration data is editable. The ECU can be switched to use either the reference or the working page.

To reproduce the calibration while analyzing the measurement data offline it is necessary to have the reference page, the working page, the interpretation description of the pages and a signal that states which page the ECU used.

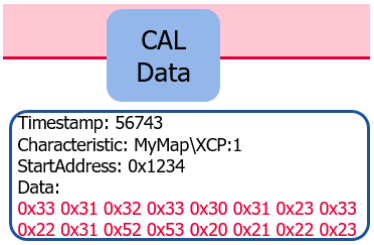
The content of the working and the reference page can be stored in two binary files. The interpretation of the pages is given in the A2L file. All three files can be stored as attachment in the MDF file (ATBLOCK).

The signal that states the used page can be stored as event in the MDF file.

The calibration changes while recording can be stored as a special calibration event that describes the change. (Value array with start address inside the binary file)

2.1 CAL Data Event

The CAL Data Event stores the individual calibration events.



Timestamp:	Time distance from starting point of MDF file
Characteristic:	Reference to the related device / A2L file
StartAddress:	Address inside the binary file
Data:	Byte array that covers the raw values that were calibrated

Fig. 1 CAL Data Event

2.2 Recording Time

The MC tool memorizes at recorder activation the reference and working page. Together with the A2L file it writes this to the MDF file (maybe later, not at recorder activation to save time). Whenever a calibration action (by tool user, remote control …) takes place the MC tool writes a calibration event to the MDF file. For each page switch the MC tool writes a page switch event to the MDF file.

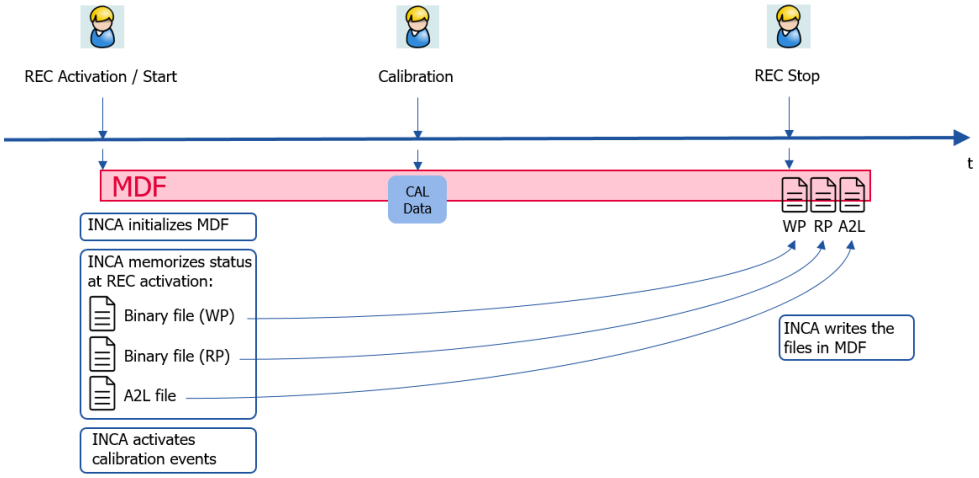


Fig. 2 Calibration recording

2.3 Analyzing Time

The MDA tool extracts from the MDF file the attached files with the reference and working page data and the A2L description file. To show the user the calibration data of the working page of a dedicated point in time the MDA does the following: It copies all calibration event data over the working page until the last event before the dedicated point in time. Then it interprets the working page by the A2L description file.

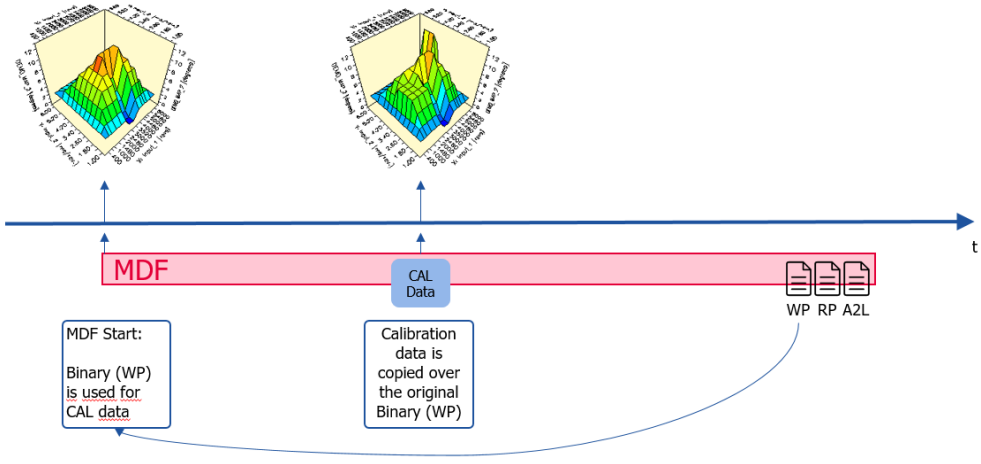


Fig. 3 Calibration analyzing

2.4 Referencing the Calibration Data by MDF Meta Data

To ensure that the MDA tool is able to assign correctly the different files (binary, description …) the Meta Data in the MDF file contains links to the different files.

MDF supports a <common properties> entry for Meta Data in the HDBLOCK. Here adds the MC tool info about the files attached to MDF file.

```
...
  <tree name="target">
    <e name="module">Engine</e>
    <e name="type">Software</e>
    <e name="path">XCP:1</e>
    <tree name="description">
      <e name="description file">demo\descriptions\engine.a2l</e>
      <e name="checksum ecu side">0x1EF3</e> <!-- code part -->
      <e name="checksum tool side">0x1EF4</e> <!-- code part -->
      <e name="file id">897E2A</e>
      <e name="node id">93A64B</e>
    </tree>
    <tree name="dataset rp">
      <e name="description file">demo\datasets\engine.hex</e>
      <e name="checksum ecu side">0x42F1</e> <!-- data part -->
      <e name="checksum tool side">0x56A3</e> <!-- data part -->
      <e name="file id">8734BC</e>
      <e name="node id">93A64B</e>
    </tree>
    <tree name="dataset wp">
      <e name="description file"> demo\datasets\engine_1.hex</e>
      <e name="checksum ecu side">0x34C1</e> <!-- data part -->
      <e name="checksum tool side">0x34C1</e> <!-- data part -->
      <e name="file id">66D723</e>
      <e name="node id">93A64B</e>
    </tree>
   </tree>
...
```

Fig. 4 Meta Data in MDF HDBLOCK to reference the files in MDF

2.5 Copying Calibration Event Data over the Working Page

Both, the working page and the calibration event data is stored as binary information. By this the data can be updated easily.

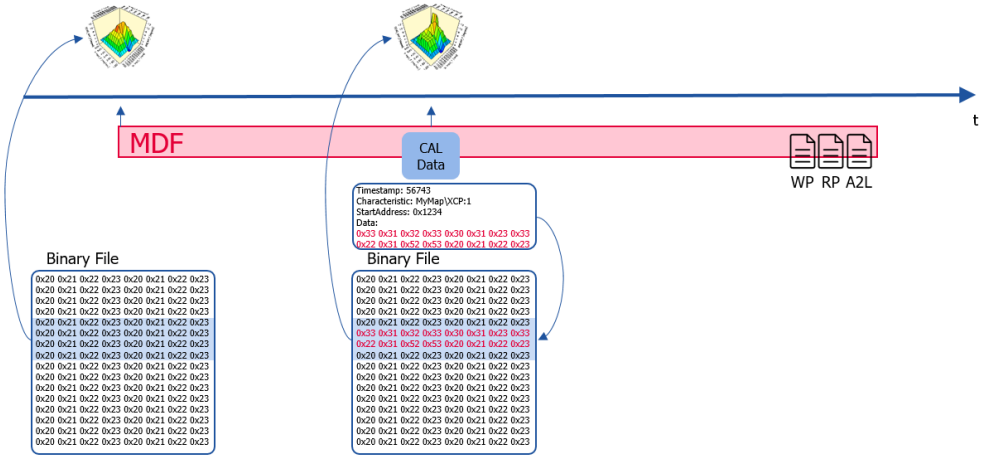


Fig. 5 Update Binary Data with Calibration Event Data

> **NOTE**
>
> The CAL Data Event may contain not the complete data of a characteristic. It may contain only the changed part.

2.5.1 Time Stamps

The MC tool writes to each CAL data entry the time stamp when it does the calibration. By this the MDA tool gets the time relation between measurement values and calibration values.

> **NOTE**
>
> The accuracy of CAL data time stamps depends on the performance of the calibration channel.
>
> The calibration operation needs some time. The MC tool gets no feedback when exactly the calibration was executed on the ECU.
>
> By this it may happen that a CAL data time stamp is earlier as the real calibration happened.

3 Recording with Trigger

If the MC tool starts or stops recording with a trigger there is no major change. If there is a re-triggering two cases are important.

3.1 Calibration while waiting for Trigger

The MC tool records calibration changes already while waiting for the trigger to ensure that all calibrations are up to date.

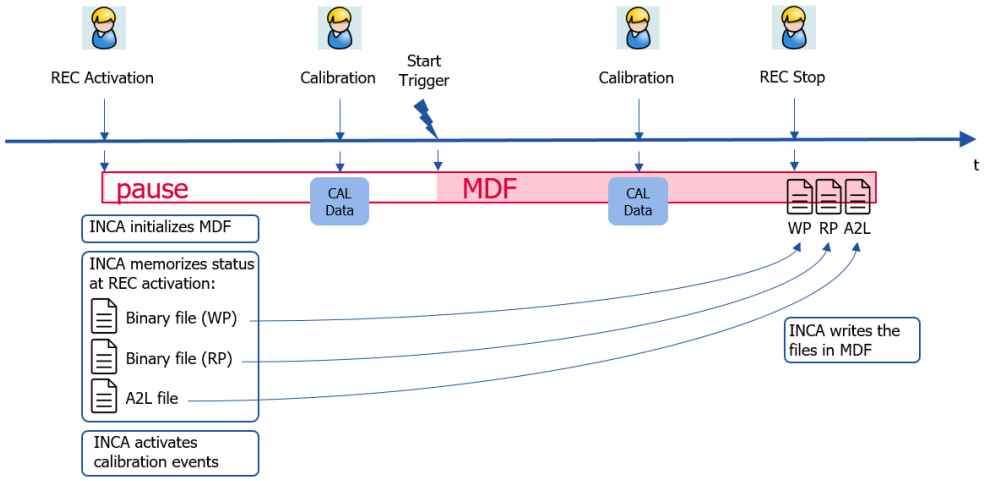


Fig. 6 Calibration while waiting for Trigger

3.2 Re-Triggering with the same MDF file

The MC tool records calibration changes independent of pause to ensure that all calibrations are up to date.

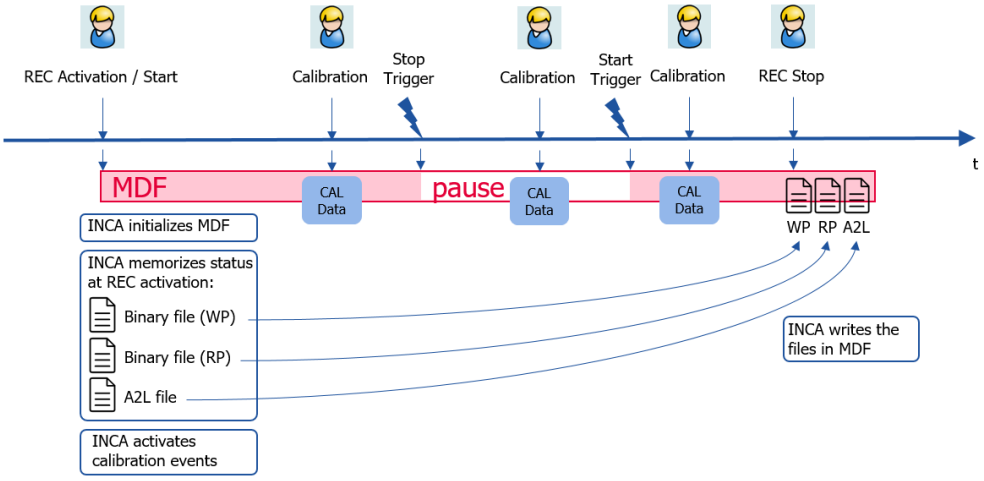


Fig. 7 Re-Triggering with the same MDF file

3.3 Re-Triggering with the new MDF files

When the MC tool writes with every stop trigger a new MDF file it is necessary that each MDF file contains all information. The MC tool writes the files of the first activation to each MDF file.

Additionally the calibration changes of the former MDF file are necessary as the binary file of the first start recorder is used.

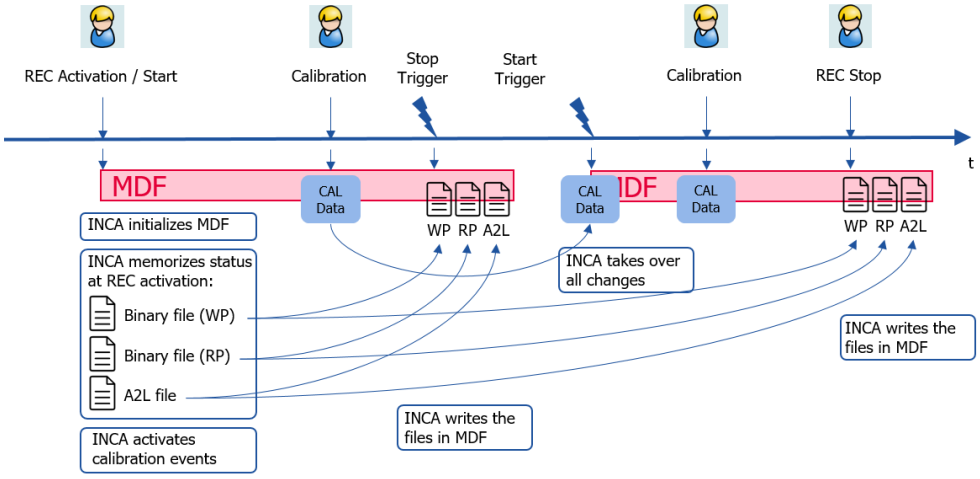


Fig. 8 Re-Triggering with the new MDF files

NOTE

The CAL Data Events taken over from the former MDF file may be merged to one for optimization.

The CAL Data Events taken over from the former MDF file will get the time stamp of the starting point of the new MDF file.

4 MDF Entries

INCA writes the Big Data information to MDF V4 files. For the different entries INCA uses MDF standard mechanisms.

4.1 Files

MDF supports ATBLOCKs to store attachments. An attachment can be any kind of file. See [MDF] chapter 5.11. INCA writes the files compressed (zipped) to the ATBLOCK. See [MDF] chapter 5.11.

4.1.1 Reference to the ATBLOCK

INCA writes the file name + path in the MDF Meta Data (see Referencing the Calibration Data by MDF Meta Data).

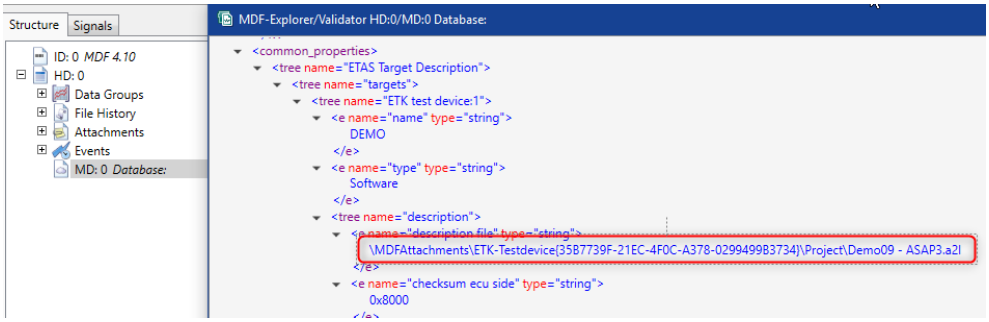


Fig. 9 File path and name in MDF Meta Data

As reference INCA uses the original file name (not the database name) and a path. The path is necessary when multiple files have the same name. INCA generates for this a relative path with the following structure:

\MDFAttachments\<device_name>[<GUID>]\<classification>\<original_filename>

- MDFAttachments is fix
- <device_name> is the device name from the INCA hardware configuration
- <GUID> is an ID generated by INCA
- <classification> is 'Project' for ECU description files; 'RP' for the reference page; 'WP' for the working page

Note: INCA uses this relative path additionally to prepare (zip) the related files when the measurement starts. INCA deletes the files when the MDF file is written.

INCA writes the same name + path to the ATBLOCK as tx_data.

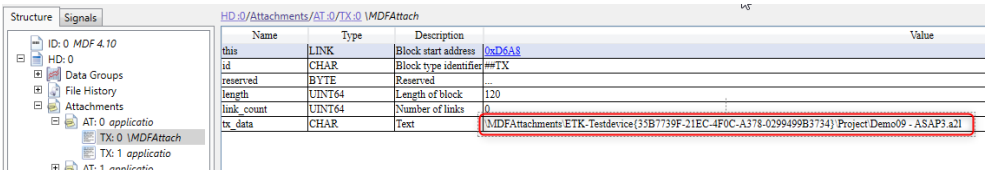


Fig. 10 File path and name in MDF ATBLOCK

4.2 Calibration Events

For each ECU device INCA generates a Channel Group named "Calibration" that contains 5 signals (CNBLOCKs):

- Time
  the time stamps of the calibration actions
- Address
  the physical values represent the addresses that have been calibrated
  - address 0 indicates a page switch
  - The addresses shall be stored in an unsigned integer. The size of the data field shall be wide enough to cover the addresses needed
- ActiveCalibrationPage
  references to which page is active, and tracks also page switches
  refers to the active page and tracks page switches
  - The active calibration page shall be stored in an unsigned integer. The size of the data field shall be wide enough to cover all pages.
  - The impl / phys conversion is a value to text conversion
    - 0 to "Reference Page"
    - 1 to "Working Page"
    - All other known values are further pages
    - Default is "unknown"
- StateSynchronized
  shows the data synchronization between INCA and the ECU while recording
  - The state synchronized shall be stored in an unsigned integer. The size of the data field shall be 1 bit
    - 0 means that the ECU does not match the current INCA Working Page
    - 1 means that the ECU matches the current INCA Working Page
- Data
  For Data INCA uses a CNBLOCK with variable length (VLSD). This means that Data contains the offset to the real calibration value arrays in the related SDBLOCK. (See Fig. 11)
  - The data (offset) shall be stored in a signed integer. The size of the data field shall be 8 byte

All CNBLOCKs shall reference in the Source Information to the device the calibration events belong to.

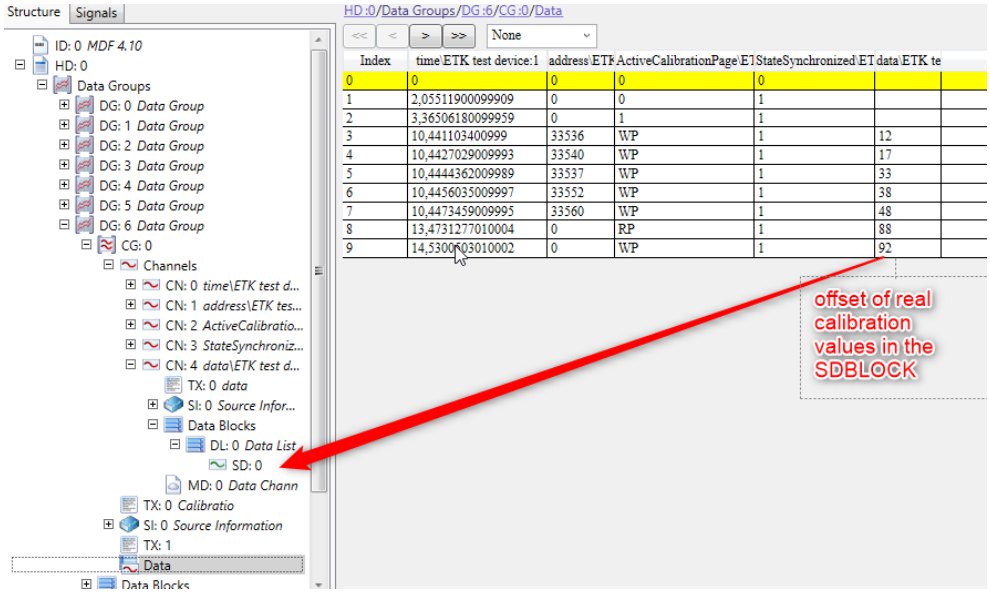


Fig. 11 Calibration event and offset of data

5 INCA Support

INCA supports the Big Data recording optionally. The user decides which information INCA shall write to the MDF file.

5.1 Option Settings

In the INCA user options for the Experiment exists a set of options to control the Big Data behavior.

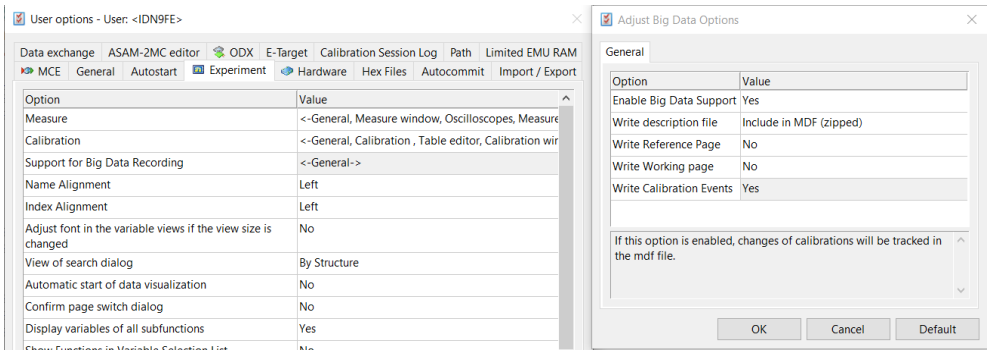


Fig. 12 INCA User Options

5.1.1 Enable Big Data Support

If this option is set to 'No' INCA does not write any calibration events nor A2L or Hex files to the MDF file.

NOTE

The Meta Information of the MDF file is not affected

5.1.2 Write Description File

If this option is set to 'Include in MDF (zipped)' INCA writes the related description files of all devices (A2L) to the MDF file.

5.1.3 Write Reference Page

If this option is set to 'Include in MDF (zipped)' INCA writes the reference pages of all ECU devices as Hex files to the MDF file.

5.1.4 Write Working Page

If this option is set to 'Include in MDF (zipped)' INCA writes the working pages as Hex file to the MDF file.

5.1.5 Write Calibration Events

If this option is set to 'Yes' INCA writes for each calibration action a calibration event to the MDF file.

6 Further Documents

[MDF] ASAM MDF Measurement Data Format V4.1.1 Date: 2014-06-04

7 Contact Information

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Figures