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Calibration Tool for ECU based on CCP

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Abstract: ***This paper gives idea about how different types of ECU connect with (Control Area Network Calibration Protocol) CCP based Calibration tool. Calibration tool is developed with the help of LABVIEW platform. The presented work was to develop a methodology and a suitable tool for the calibration and measurement of different communication parameter of ECU. Calibration tool is largely used in automobile industry because it plays a crucial role in the process of development of electronic control units (ECUs).calibration gives optimized set of ECU parameters for improving vehicle performance.***

Keywords: ECU, CCP, Calibration tool, LABVIEW

1. Introduction

The extensive application of embedded system was developed extremely in industrial control fields for improving efficiency of automotive system. Safety and comfort of vehicle depends on various embedded electronic control systems, so modern automotive is equipped with different types of Electronic control units (ECUs).ECU is also called as Engine Control Management (ECM) that controls a series of actuators on an internal combustion engine to ensure optimal engine performance. This literature describes a novel intention method for CAN calibration protocol based Calibration tool which is connected to ECUs. In this way mater-slave type communication is established between Calibration tool (mater device) and ECUs (slave device) using the CAN 2.0B (11-bit and 29-bit identifier), which includes 2.0A (11-bit identifier). CCP is CAN based application protocol which is used for getting measurement and calibration data of ECUs.Two message objects of CCP[3] are very important for launching connection between master and slave device. These message objects are CRO and DTO. Transfer of CRO and DTO between mater and slave device is fixed. CRO is used to send CCP instructions to the slave device. DTO is used to direct responses and measurement records to the master device. In advanced automobiles specifically, such as hybrid electric vehicles and pure electric vehicles, the number of ECUs is increasing great. Electronics accomplishes 90% innovations in automotive industry. In that 80% innovation is because of software [3].Improvement cost of ECU is because of software. Because different types of software provides platform for handling complexity and functionality of the systems. In this way ECU is developed with new ideas in automotive sector.

In early 80's the vehicles began to be equipped with electronic unit with the need arose the importance of real time communications within the vehicle. To fulfill the need for multiplexed communication, the "Robert Bosch GmbH" company designed the CAN network. Controller chips for CAN are available from several semiconductor constructors. ASAP is Arbeitskreis zur Standardisierung von Applikationssystemen and it is explained in English as Standardization of Application/Calibration Systems task force The CAN Calibration Protocol is portion of the ASAP. It was established and presented by Ingenieurbüro Helmut Kleinknecht; a creator of calibration structures. CCP is used in numerous practices in the motorized industry [3].

2. ECU Communication with Calibration Tool

ECU communication with CCP master device is the process for defining how different steps are required for ECU connect and ECU calibration and measurement processes. ECU communication provides idea about which types of data base files of ECU are required for establishing connection. Calibration process offers ECU side and tool side calibration when connection is present between them. Calibration tool is implemented in Lab-VIEW. ECU Measurement and Calibration (ECU MC) Toolkit [5] software available in LabVIEW [7] provides the low cost testing, data acquisition, measurement and calibration of the vehicle. This toolkit consists of different types of blocks related to automotive application. ECU has different communication factor, based on, for which purpose ECU is used. Each ECU contains A2L file and Hex file which includes information about the parameters of the ECU. If communication properties are enclosed by A2L file then we can directly open communication with nominated ECU, otherwise communication properties are manually set Using CCP. ECU contains two types of Hex file, some of the ECU contains Intel Hex and some ECU contains Motorola S19 format. Input for calibration tool is Hex file and A2L file for launching communication with ECU. These file format is explained in brief below.

2.1ECU File Format

2.1.1 Intel Hex

```
: nnaaaattddddddddddddddddddddddddddddddd.cc
```


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Sr. No	*Field content*	*Indication*	*Description*
1)	Start code	:	ASCII colon indicates start of data record.
2)	Byte count	nn	Two Hex digit and Count of number of data bytes in record. (In ASCII/HEX).
3)	Address	aaaa	Four hex digit and Load the address of data record. (in ASCII/HEX).
4)	Record type	tt	Two Hex digit defines data field from 00 to 05 Record type. (00=Data, 01=End of file).
5)	Data	dd	Actual data bytes in record (two ASCII Characters per data byte)
6)	Checksum	cc	Checksum of count, address, and data. It is least significant byte of the two's complement of the sum of the values of all fields except fields 1 & 6

2.1.2 Motorola S19

Stnnaaaaddddddddddddddddddddddddddddddddd.cc

Sr. No	*Field content*	*Indication*	*Description*
1)	Start code	S	ASCII 'S' indicates start of data record.
2)	Record type	t	One digit Record type, '1','2','3'=data, '9'=end of file.
3)	Byte count	nn	Two hex digit Count of number of bytes in record (including address and checksum).
4)	Address	aaaa	Four, six or eight hex digits as determined by the record type .Load address of data record.
5)	Data	dd	Actual data bytes in record (two ASCII Characters per data byte).
6)	Checksum	cc	Checksum of count, address, and data. It is the least significant byte of one's complement of the sum of the values denoted by the two hex digit pairs for the byte count, address and data field. [8]

2.1.3 A2L File Format

A2L file is ASAP2 description file. This A2L file comprises all information on the appropriate data entities in the ECU such as communication factors, characteristic curves and maps. This Material is essential for every object in ECU, entities are like memory address, storage structure, data type and translation rules for transforming these data entities into physical units. In another count, an A2L also comprise of the constraints for communication between CAN and the ECU.[3]

2.2 ECU Page Concept

The application of ECU supports a two-page concept for loading data which is reflected both in the tool as well as in the ECU. On PC working page and reference page is present and on ECU side RAM and Flash memory is present. Generally the ECU works with data from the flash. The ECU can be swapped between the RAM and flash at any time so that critical states that may occur because of careless calibration can be rectified at any time by switching to the safe flash data level. A checksum can be created over all four pages to check whether the data in the PC and ECU correspond to each other. Any changes in the RAM can be removed by the data being transferred from the ECU into the PC. This may be by keeping the work page in the PC and by restoring it to the ECU in the next session with a download. It is therefore better to save the data directly in the ECU flash so that it can be restored to the RAM in the next session in a quick CopyFlashToRam. Saving in the flash can either take place externally with a flash tool. This procedure is referred to below as "CopyRamToFlash". Flow of uploading data on Working page or reference page.

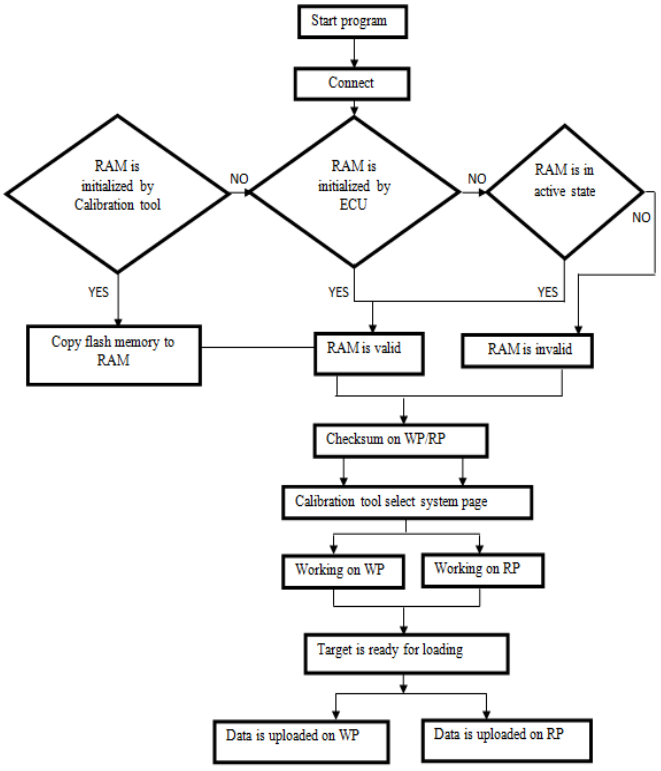


Figure 1: Flowchart of Process for uploading data on System page

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3. Proposed Methodology

3.1 Method of interfacing Between ECU and Calibration Tool

A Calibration tool forms an integrated environment for measurement, ECU calibration and diagnostics. Calibration tools are very important in the process of ECU development and ECU testing. Also Calibration tool deals a wide multiplicity of roles ranging from pre calibration of function copies on the PC, ECU flash program design, measurement data analysis, and calibration data management to programmed optimization of ECU parameters. The created calibration and measurement data can be handled and assessed constantly.CCP is software interface between calibration tool (mater device) and ECU (slave device).Calibration tool is developed on Laboratory Virtual Instrument Engineering Workbench (Lab-VIEW). LabVIEW communicates with ECU through NI USB CAN hardware toolkit. Interfacing of ECU and calibration tool is as shown in Figure 2.

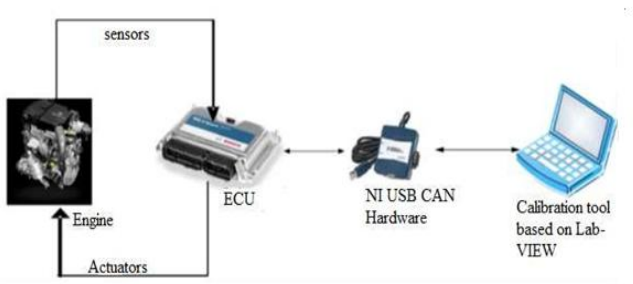


Figure 2: Interfacing of ECU with calibration tool

3.2 Method of Design of Calibration Tool

Development of tool for ECU calibration and testing is implemented on Lab-VIEW.ECU measurement and calibration tool kit software which is present in Lab-VIEW provides different functional block which are used for different phases of calibration tool like ECU connect, ECU Measurement, ECU calibration and ECU flashing.

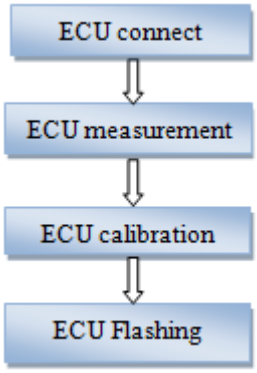


Figure 3: Design of calibration tool

Firstly ECU connection established then According to requirement we select characteristic variables for calibration then Measurement variable will change .once we have done changes we can flash data permanently. Simple flow of design of calibration tool is as shown in Figure 3

3.3 Method of Calibration Process

ECU calibration is the process of determining the optimal calibration tables for an engine. This multistep practice comprises designing tests, gathering data, evaluating the data and modifying lookup tables to model the engine. This method helps to find the optimal stability of engine performance, emissions and fuel economy. The calibration tool which can be develop using LabVIEW will be used for ECU development and ECU testing as well as for setting of electronically measured structures on the experiment workbench and in the automobile. Also tool offers a catholic multiplicity of functions ranging from pre calibration of function replicas on the PC, ECU flash program writing, measurement data exploration, and calibration data supervision to automated optimization of ECU factors. The produced calibration and measurement data can be treated and appraised continuously. Process of the interfaced ECU calibration as shown in Fig 4

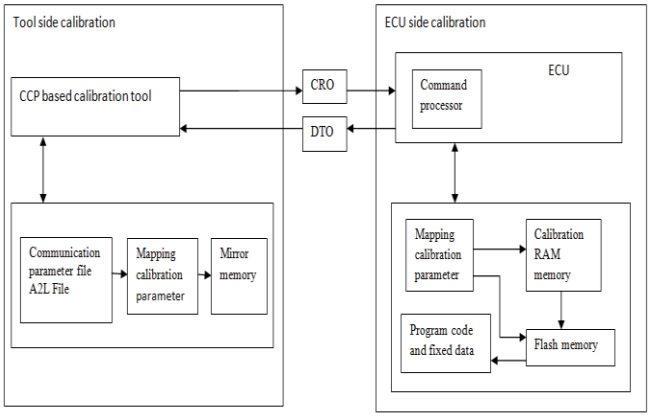


Figure 4: Calibration method for interfacing with ECU

The master device is a calibration tool presenting the data transfer on the CAN by directing commands to the slave devices. The CCP based calibration tool (master device) uses A2L file from the slave device (ECU) to update the calibration data, counting the explanation and address of the ECU factors to be calibrated. The ECU communication parameter file contains all calibration objects. These objects can be loaded, protected and erased by the calibration stand. Once the calibration method starts, the values of the Electronic Control units are copied.

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4. Experimental Results

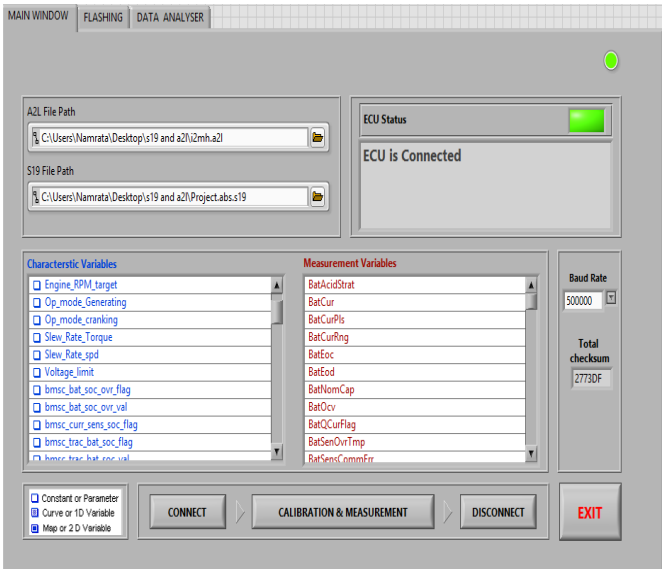


Figure 5: Front panel for calibration tool

Figure 5 shows Front panel of main Window which shows two palates as Flashing and data analyzer.ECU connected status is displayed on main window and calculated Total checksum is showed. List of characteristic variables and measurement variables is presented.

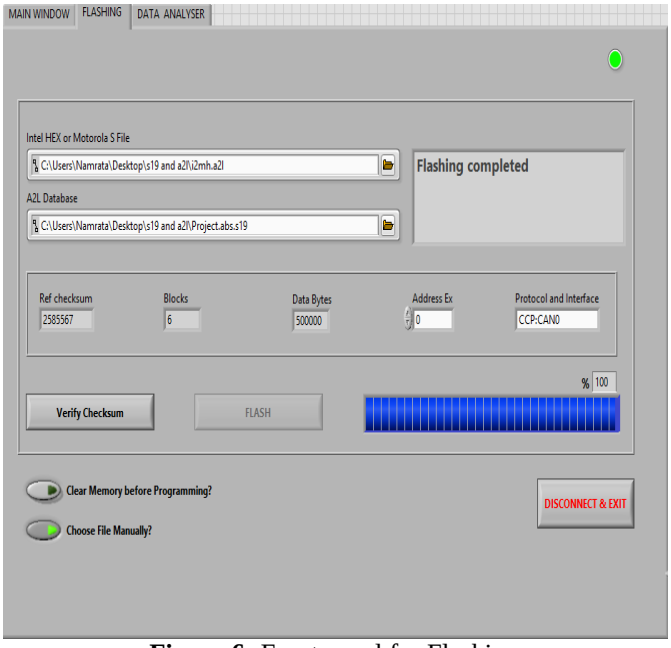


Figure 6: Front panel for Flashing

Figure 6 shows front panel of flashing process. In main window calibration and measurement block select ECU parameters for calibration according to requirement then once changes are done then we can flash data permanently on ECU. After flashing, checksum of updated file is calculated.

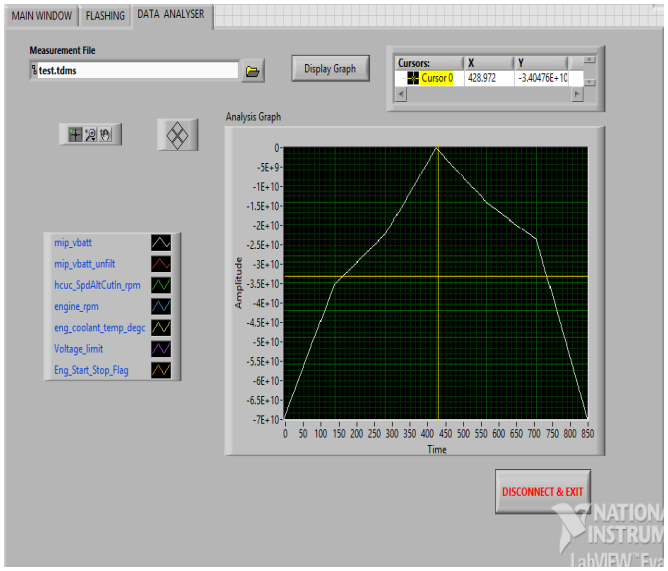


Figure 7: Front panel for data analyzer

Figure 7 shows graph of Selected ECU parameter before calibration, measurement of ECU parameter value is displayed on data analyzer.

5. Conclusion

CAN calibration protocol based tool is developed on Lab-VIEW which is capable of reading Intel Hex file and Motorola S19 file. Different types of ECUs can connect successfully with this calibration tool. Calibration Of ECU is done with getting optimal results according to requirement. Calibration tool is used to access the ECU at run-time. This allows acquiring and modifying measurement data and parameters, so the ECU algorithms can be modified and optimized.

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