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

Stnnaaaaddddddddddddddddddddddddddddddd.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.

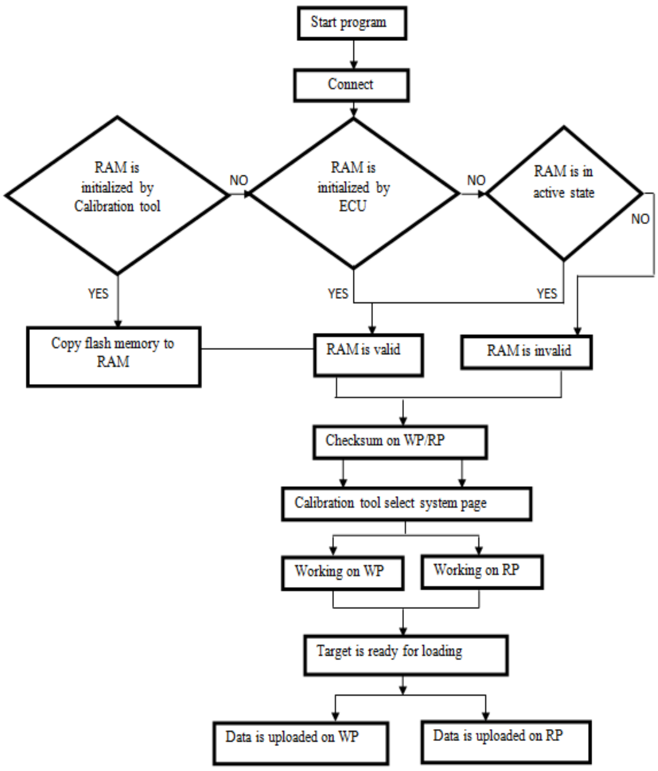

Figure 1: Flowchart of Process for uploading data on System page

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.

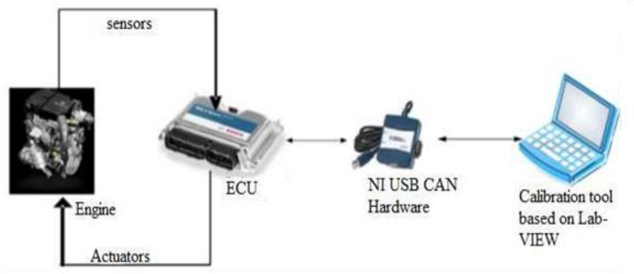

Figure 2: Interfacing of ECU with calibration tool

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.

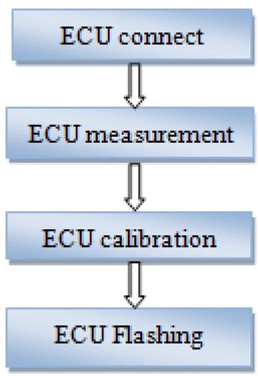

Figure 3: Design of calibration tool

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

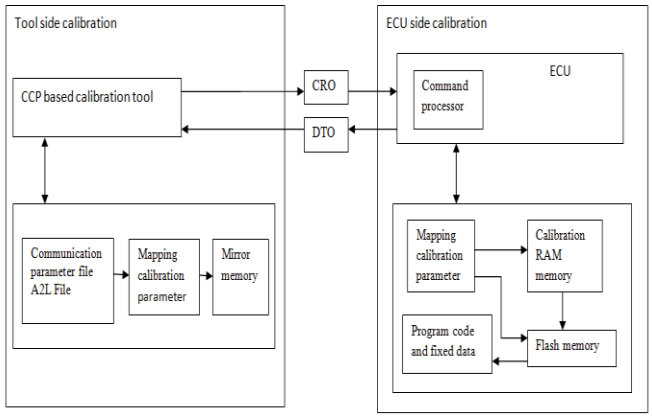

Figure 4: Calibration method for interfacing with ECU

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

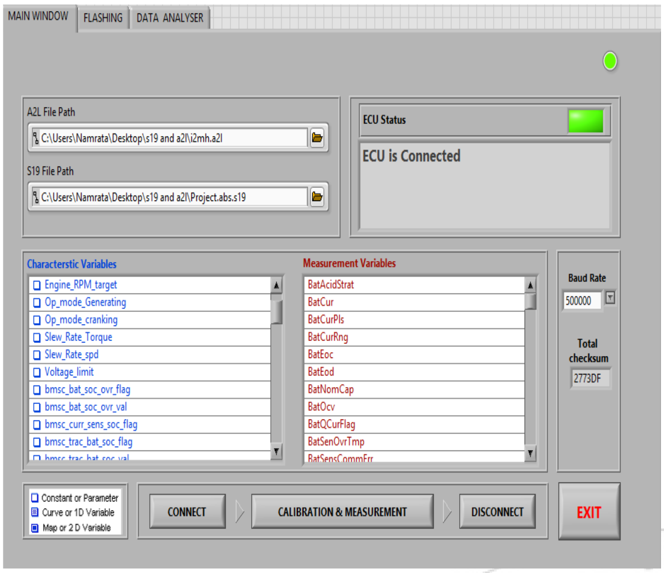

Figure 5: Front panel for calibration tool

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.

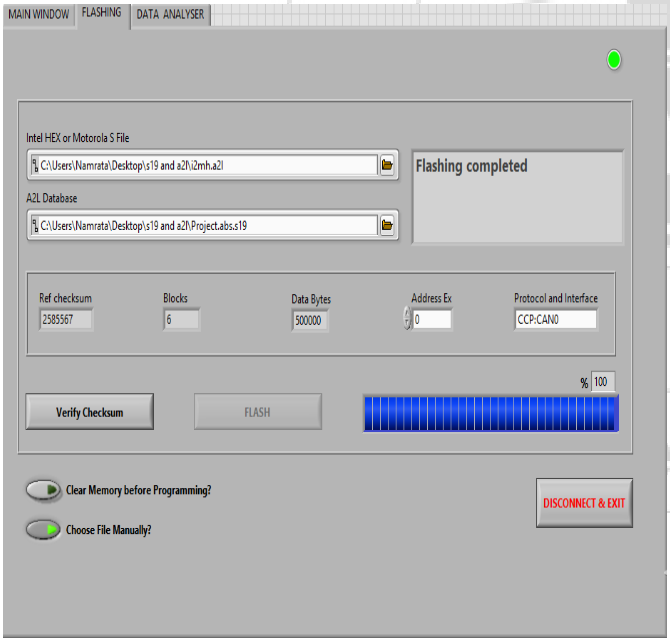

Figure 6: Front panel for Flashing

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.

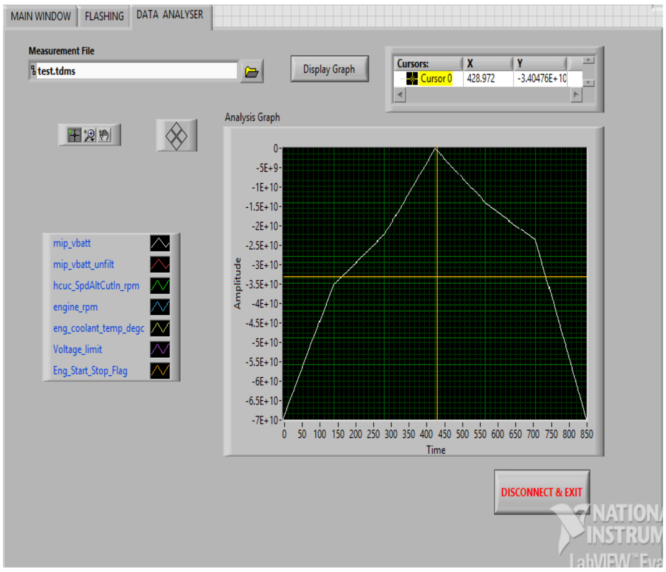

Figure 7: Front panel for data analyzer

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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