

APPARATUS AND METHOD TO DETERMINE A DISCONNECT BETWEEN A VEHICLE BATTERY AND AN ECU

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TECHNICAL FIELD

This invention relates to vehicle Electronic Control Units such as Engine Control Units, connected to a battery via a power supply regulator, and relates to means to
10 determine if there has been a disconnect. It has particular application to determining whether ECU memory such as RAM including Keep Alive Memory (KAM) need to be re-initialised.

BACKGROUND OF THE INVENTION

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Electronic/Engine Control Units (ECUs) operate to provide a whole range of control functions for vehicle engine systems. There may be various types of such ECUs such as an Engine Control Module (ECM), a Transmission Control Module (TCM) and such like. These ECUs use
20 stored data for their appropriate control functions and it is important that, in the case of power disconnect, this data is not lost.

Therefore such ECUs generally utilize a dedicated memory referred to as a Keep Alive Memory (KAM) to store data which need to be retained even
25 after the ECU is powered off. This memory is powered directly from battery supply via a dedicated regulator.

The integrity of the KAM is maintained as long as the battery is ON (working OK and connected) and the regulator output is stable. When the
30 battery goes off (i.e. becomes disconnected) the KAM data becomes unreliable. The ECU (software) needs to know if a battery disconnection happened (during normal operation).

Typically in order to determine if the battery has become disconnected to a
35 working battery, the regulator is a high function, dedicated power supply regulator with integrated circuit; it is provided and built into the hardware

to detect and retain the battery disconnect information. In operation the methodology (software) will read the battery disconnect information from the regulator IC to verify the integrity of the KAM.

- 5 The conventional arrangement and methodology of battery disconnection detection requires dedicated integrated regulator IC. Hence this becomes expensive especially when it comes to low and medium range of Electronic Control Modules where every penny matters. A cost effective method of battery disconnection detection is always preferred.

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It is an object of the invention to provide a low cost system.

SUMMARY OF THE INVENTION

- 15 In one aspect is provided, in a system comprising an vehicle ECU, said ECU being supplied with power from a vehicle battery via power supply regulator, and said ECU including a KAM memory, a method of determining whether there has been a power disconnect comprising the steps of:

- a) determining if one or more data units in the KAM has become corrupted
- 20 b) determining that there is a power disconnect if the condition in step a) is fulfilled.

Said power supply may not have means to provide said ECU with data concerning a power disconnect.

- Step a) may comprise using Error Correction coding (ECC) and said KAM
- 25 memory is an ECC enable memory

Step a) may comprise:

- i) reading a data unit from the KAM including a first ECC error code associated and stored with the data unit;
- ii) determining by the ECU a second error code from said data unit;
- 30 iii) comparing said first and second data units.

Step b) may comprises discarding or re-initialising KAM data

In a further aspect is provided a system comprising a vehicle Electronic Control Unit, connected to a vehicle battery via a power supply regulator, where said Electronic Control Unit includes a Keep Alive Memory, and said Electronic

- 5 Control Unit and said KAM are powered via said power supply regulator, where said ECU is adapted to determine whether there has been a power disconnect between the regulator and ECU/KAM, by being adapted to determine if KAM data has been corrupted

Said KAM may be an EEC enabled memory

- 10 Said ECU may be adapted to read one or more data units stored in the KAM along with an first associated ECC code, and apply a deterministic method to said data unit to determine a second ECC code, and adapted to compare said codes to determine if the Kam has become corrupted.

- Said power supply may not be adapted to provide said ECU with data concerning
15 and power disconnect.

BRIEF DESCRIPTION OF THE DRAWINGS

- The present invention is now described by way of example with reference to the
20 accompanying drawings in which:

- Figure 1 shows a block diagram representing the prior art systems;
- Figure 2 shows figure 1 in more detail with the prior art methodology;
- Figure 3 shows a system and methodology according to one example of the invention.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

Prior Art

- 30 Figure 1 shows a block diagram representing the prior art systems which shows the ECU 1 which contains a KAM 2 (memory). Reference numeral 3 represents other ECU software or hardware which communicates with the KAM – they are located as part of, i.e. integrated into the ECU microprocessor 5. So the figure

shows that the KAM and ECU may be provided on a single microprocessor 5. line. The battery (not shown) has connect terminals 6 to a dedicated hardware regulator 4, and there are connections from the regulator 4 to the ECU/KAM unit processor. The regulator may be considered as part of the ECU or alternatively
 5 separate from the ECU. In the example battery disconnect information is provided to the ECU. Voltage is provide to the KAM from the battery via the regulator along lines V_{KAM} and to the ECU microprocessor via line V_{CC} . In known methodology the ECU (software) reads the battery disconnect information from via dedicated regulator via data lines 7. This information is then used to check the
 10 validity of the KAM data by the ECU software. In the event of battery disconnect the KAM data will be discarded and reinitialized.

Figure 2 shows figure 1 in more detail with the prior art methodology. A flow chart shows the methodology in software block 3. In step S1 the method starts. At
 15 step S2 it is determined if there has been a battery disconnect. This decision is based on data from the dedicated regulator which may be in the form of a battery disconnect flag. If there has been a battery disconnect then the process proceeds to step S3 where the KAM data is erased. If not the process proceeds to step S4 where the KAM data is read. After these steps the procedure progresses to step S5
 20 where the next steps are taken before the process ends at step S6.

As mentioned the conventional arrangement and methodology of battery disconnection detection requires dedicated (and this expensive) integrated hardware i.e. a dedicated IC.

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Description of the Invention

In aspects of the invention the expensive dedicated regulator is replaced with a simple regulator . The simple regulator may only provide voltage to the
 30 ECU/KAM. There may be no data that is transmitted to or from the regulator to the ECU/KAM. The simple regulator is thus less expensive.

In order to determine whether there has been a battery disconnect, methodology is carried out by the ECU to check that the KAM data has not been corrupted

consequential to any disconnect. Thus some function of the previously dedicated regulator in terms of checking for battery power disconnects is provided within the ECU/ECU microprocessor. So in other words there is an internal error checking process within the ECU (ECU/KAM unit/microprocessor) to check the validity of the KAM data, and if the data is not valid, assuming a disconnect of power has occurred. So the problem of expensive hardware based battery disconnection detection is solved by using an error detection function feature of the ECU/KAM microprocessor. The invention make use of the microprocessor function to generate an exception (error condition) when methodology within it reads an uninitialized memory location/corrupted data.

Memory modules in modern microprocessors often include inbuilt ECC (Error Correction Coding) software and functionality. In such ECC schemes, when data is sent from one unit to another, the originating unit sends the original data as well as a fixed number of check bits (or parity data), which are derived from the data bits by some deterministic algorithm. The receiving unit applies the same algorithm to the received data bits and compares its output with the received check bits; if the values do not match, it is assumed that an error has occurred at some point; i.e. the original data may have become corrupted.

So in an example the KAM memory includes ECC facility such that e.g. the memory uses check/parity bits when storing (e.g. in an encrypted code) or writing data to memory; the ECC code is stored at the same time. When data is read, or extracted from the memory, the ECC code (i.e. the parity bits check bits (checksum)) is determined, and this ECC code (generated when the data is) read is compared to the ECC stored code. If the code that was read doesn't match the stored code, and ECC error is reported. The term "error code" should be interpreted as including any parity/check bits or checksum determined by a deterministic algorithm in respect of KAM data or data unit.

So in one aspect the KAM memory is an ECC enabled memory, and the ECU/microprocessor reads one or more data units form the KAM and applies methodology to determine/calculate the code and then compare the code to that

extracted from the KAM with the data unit. Reads from uninitialized or corrupted ECC enabled RAM will cause ECC errors as the stored ECC and calculated ECC will not match. So in one aspect an ECU carries out methodology in conjunction with an ECC enabled KAM such that after a battery disconnect an ECC exception (error) will be generated as the ECC would not have been initialized after a battery disconnect. So in the methodology the ECC exception is used as an indirect indication of battery disconnect. Such information is then used to validate the integrity of the KAM memory.

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Figure 3 shows a system and methodology according to one example of the invention, showing an ECU 10 with a KAM 11 which is connected and powered by a simple regulator 12 which does not have the ability to detect battery disconnection. The KAM is powered by V_{kam} which stays active as long as battery is alive. A microprocessor 13 is powered by V_{cc} which is controlled by Ignition(IGN). Once IGN is turned off, V_{cc} will go off and Microprocessor will shut down. However the V_{kam} will still supply power to the KAM. The KAM memory 11 within the microprocessor has inbuilt ECC.

20 In the methodology detection of whether there has been a battery disconnect and /or thus whether the KAM data read is reliable or likely to have been corrupted is as follows, and will be described by way of example and with reference to the flowchart in figure .

25 The ECU software is shown by block 14 which also shows a flowchart of methodology according to one aspect. Following start up at S1, one unit of data (32bits) will be read from a fixed location of the KAM at step S2. The code for this data unit is extracted from the KAM and compared with a code generated from the read data (by the ECU software/methodology or by the Microprocessor KAM hardware) at step S3 where it is determined if there is a ECC error. If the V_{kam} was stable (no battery disconnection) the read will be successful and no ECC error shall be reported. The method will continue to execute the usual routines normally. E.g. where data is read from the KAM at step S4.

However if the V_{kam} was interrupted (due to battery disconnection), the KAM will generate an ECC error (exception), as shown by the signal X. In this case an ECC error is detected. The ECC error may be detected by the method by reading the data or a data unit, and determining the code (checksum or parity bits) and comparing it to the stored code for the data unit.

If an ECC error is detected the KAM data is not read. The whole KAM data is cleared at step S5 and a KAM integrity error is reported. In this way a battery loss is indirectly detected.

After steps S4 and S5 the method proceeds to step S6 where any proceeding steps are taken, and ends at step S7.

The methodology to detected loss of power to the Electronic Control Unit (ECU) eliminates the need of dedicated hardware or ASIC (Application Specific Integrated Circuit) used to detect loss of battery, and helps to reduce the cost of the ECU.

So in embodiments a prerequisite is that the KAM memory within the microprocessor should have ECC capability or that it can be determined that the KAM memory data has been corrupted. Most of the state of the art microprocessor memories have built in ECC. So the invention can be applied to a wide range of ECUs without modifying the hardware.

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CLAIMS

- 5 1. In a system comprising an vehicle ECU, said ECU being supplied with power from a vehicle battery via power supply regulator, and said ECU including a KAM memory, a method of determining whether there has been a power disconnect comprising the steps of:
 - a) determining if one or more data units in the KAM has become corrupted
 - 10 b) determining that there is a power disconnect if the condition in step a) is fulfilled.
2. A method as claimed in claim 1 wherein said power supply does not have means to provide said ECU with data concerning a power disconnect.
3. A method as claimed in claim 1 or 2 where step a) comprises using Error
 - 15 Correction coding (ECC) and said KAM memory is an ECC enable memory
4. A method as claimed in claim 1 to 3 where step a) comprises:
 - i) reading a data unit from the KAM including a first ECC error code associated and stored with the data unit;
 - ii) determining by the ECU a second error code from said data unit;
 - 20 iii) comparing said first and second data units.
5. A method as claimed in claims 1 to 4 where step b) comprises discarding or re-initialising KAM data
6. A system comprising a vehicle Electronic Control Unit, connected to a vehicle battery via a power supply regulator, where said Electronic Control Unit
 - 25 includes a Keep Alive Memory, and said Electronic Control Unit and said KAM are powered via said power supply regulator, where said ECU is adapted to determine whether there has been a power disconnect between the regulator and ECU/KAM, by being adapted to determine if KAM data has been corrupted

7. A system as claimed in claim 6 where said KAM is an EEC enabled memory

8. A system as claimed in claims 6 or 7 where said ECU is adapted to read one or more data units stored in the KAM along with an first associated ECC code, and apply a deterministic method to said data unit to determine a second ECC code, and adapted to compare said codes to determine if the Kam has become corrupted.

9. A system as claimed in claim 6 to 8 where said power supply is not adapted to provide said ECU with data concerning and power disconnect.