LOCAL INTERCONNECT NETWORK BASED MASTER CONTROLLED ALTERNATOR CONTROL UNIT

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Abstract— The Local Interconnect Network (LIN) -controlled alternator-regulator device is used to optimize performance in intelligent automotive charging systems for increased efficiency, improved fuel economy management. Intelligent vehicular charging systems are used when dynamic control of the alternator output and torque is desired for optimal charging of battery, electrical power management system, and alternator-engine interaction. The LIN device can be uniquely used for compatibility with up to 15 other modules on the bus, and all the data can be transmitted or received in a single pass. The LIN interface provides a simplified method of reliably achieving the bi-directional communication required for maximum alternator performance. The LIN serial interface is used by the Alternator Control Unit (ACU) to transmit the voltage. The signals transmitted to the ACU which is PIC18F452 from the regulator include load response setup, load response time, threshold speed and the voltage set adjust value through LIN interface bus. The voltage value is displayed on LCD and other four parameters are available across USB 2.0 based port. The ACU communicates with alternator through LIN Protocol, and ACU also communicates through USB, LCD peripherals etc.

Keywords— LIN, ACU, LCD

I. INTRODUCTION

The Alternator Control Unit (ACU) is a device that is used to simulate other units. It always acts as master device, based on protocols like LIN, BSS and PWM. The slaves are mostly generator regulator. However, the systems are to be laid out in general that the slaves not yet defined can be controlled. The device is called alternator control unit because it can control or drive regulator inside an alternator. An alternator is a mechanical part which converts mechanical energy into electrical energy. The slaves must be based on either of the protocol mentioned earlier. Only in such a condition it can be driven by the ACU device.

The functioning of ACU-alternator combination is as following: when the ACU and regulator in an alternator are connected, transmission of data values from ACU occur. The data may be voltage, excitation current, load response time and speed. The regulator has the job of maintaining the voltage and thus the vehicle system voltage is maintained at constant level across the engine’s complete speed range. The regulator supplies the input voltage to rotor. When the rotor rotates, its magnetic field induces an alternating voltage on the stator winding which provides the current when the alternator is loaded. The alternating current generated by stator cannot be used to charge the battery or power the electronic sub-assemblies. The alternating current can be transferred to direct current by the rectifier circuit connected to stator. The direct current from the stator charges the battery. Some amount of the output current is applied back to the rotor. This process is repeated until the values parameters are changed in ACU.

The application of the ACU is in the motor vehicle environment. This can be specified into two fields:

Laboratory/Vehicle environment and Test station environment. Based on the application fields, the ACU can be of two types: ACU board and ACU box. The ACU box is typically used in real motor vehicle or in a laboratory situation where the generator regulator combination is tested. In a test station environment, ACU board is integrated to a test system. In this paper the ACU box is discussed in detail. The ACU devices are manufactured only in Berghof automations, Germany.

II. LIN PROTOCOL

Local Interconnect Network (LIN) is an idea for low cost automation networking, which complements the existing portfolio of automotive multiplex networks. The LIN standard includes the specification of the transmitting protocol, the transmitting medium, the interface between development tools and the interfaces for software based programming. The main properties of the LIN bus are: single master with multiple slaves’ concept, speed up to 20 Kbit/s, low cost single-wire implementation.

The LIN workflow concept, (Fig 1), helps for the implementation of a seamless chain of design and development tools. It enhances the speed of development and the reliability of the LIN cluster. The slave nodes are connected to the master forming a LIN cluster. The corresponding node capability files are parsed by the system defining tool to generate a LIN description file (LDF) in the system definition process. The LDF is parsed by the System Generator
LIN consists of two version types that is used in this work. These are LIN v2.0 and LIN v1.3. The LIN v1.3 is a subset of LIN v2.0 and latter is recommended version for all new developments. A LIN 2.0 master node can handle clusters consisting of both LIN v1.3 slaves and LIN v2.0 slaves. The master device avoids requesting the new LIN v2.0 features from a LIN v1.3 slave such as enhanced checksum as an improvement, reconfiguration and diagnostics of the LIN, automatic baud rate detection and response error status monitoring. A LIN v2.0 slave nodes cannot function with a LIN v1.3 master node.

The entities that are transferred on the LIN bus are frames. A frame (Fig 2) consists of a header (provided by the master task) and a response (provided by a slave task). The header consists of a break and sync pattern followed by an identifier. The identifier uniquely defines the purposed frame. The task of the slave is to provide the response associated with the identifier and to transmit it, as depicted below. The response consists of a data field and a checksum field.

The lead time is the time required to manufacture and dispatch the product after the order is raised. As a general device is concerned, the failure or any type of repair is a common condition. So when it happens to ACU box, the problem cannot be rectified by the customers but it has to be sent to the manufactures. So this is not really a practical method for customers. The ACU box has five parameter inputs: regulator type, baud rate, voltage, excitation current and load response time. These parameters are mostly required to drive the regulator (Fig 5). The alternator regulator needs these parameters’ values as inputs, from ACU to produce the output. Each parameter has a particular range of value. These values can be given by the customers depending on the slave. Here comes another limitation to the ACU box. Even though the ranges are already mentioned all the values in that range is not available. This affects the customer requirement.
Every device runs with a software protocol. The ACU box is based on the protocols of LIN, BSS, and PWM. When the customer is concerned, the device is complicated with two another protocols. BSS is an outdated protocol, which is not in use and PWM is a future protocol, currently not fully developed. For the customer, the only protocol suitable is LIN. The complexities of the hardware and the limited user interface commands make the device least user friendly. To resolve the drawbacks and limitation in existing ACU, a new ACU box is developed based on LIN protocol with LCD interface.

IV. NEWLY DEVELOPED ACU

A new ACU box is developed based on Local Interconnect Network (LIN) protocol with LCD interface. The box is now completely digitalized. The goal of the development is to find a solution which covers the different application areas without having to carry out new application oriented developments. Also it is possible to easily integrate the new protocols which are expected in near future. The parameters of regulator type, baud rate, voltage, excitation current, cut off, load response time and speed are improved by increasing their limitation and number of inputs. The descriptions of the values are given in Fig 6. The new ACU box contains only limited components (Fig 7) such as microcontroller, LCD, switches, A/D converters etc. The microcontroller used is PIC18F452 and switches are used as inputs. Four input switches are increment, decrement, enter and back. These switches help to follow the commands that displays on LCD when the ACU is connected to regulator. Since the device is based on LIN protocol, the parameter values are transferred on the basis of protocol. The L/com port pin behind the device is used to transfer the frame to the slave.

The functioning of the ACU box can be explained using the block diagram (Fig 7). When the power button is put on, system initializes and the displaying starts. Once the physical connection is established between the master and slave, the inputs can be given. The user interface can be done through the four switches. The analog input values given through the switches are converted to hex value through A/D converter. This conversion is required because of the unique property of the LIN protocol. The converted values are put together into a single frame and transmitted to regulator by LIN frame features. The regulator sends a response frame back to ACU. The transmission and reception takes place continuously as long as the communication between the master and slave is necessary. With the aid of oscilloscope attached to the hardware, the frames transfer can be seen.

CONCLUSION

The analysis and simulation is carried out for the developed ACU box. This explains that the complexity of the hardware is reduced. As the numbers of hardware components are reduced and if it is developed in a lab, the cost is efficiently minimized. The functioning of the ACU box is simplified by reducing the number of protocols into a single protocol, namely the LIN. Similarly, by increasing the number of input parameters in ACU, the device has turned out to be more user friendly and meets the customer requirements. These changes and improvements show that new ACU box is more advantageous than the existing ACU box.

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Fig 6: Table of parameters

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>RANGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulator</td>
<td>LIN1, LIN2, PWM1, PWM2</td>
</tr>
<tr>
<td>Baud rate</td>
<td>9600, 19200</td>
</tr>
<tr>
<td>Voltage</td>
<td>10V to 16V</td>
</tr>
<tr>
<td>Excitation current</td>
<td>0A to 13A</td>
</tr>
<tr>
<td>Cut-off</td>
<td>ON, OFF</td>
</tr>
<tr>
<td>Load response time</td>
<td>0sec to 13sec</td>
</tr>
<tr>
<td>Speed</td>
<td>0 to 6000rpm</td>
</tr>
</tbody>
</table>

Fig 7: Block diagram of proposed design

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