Design of The CAN Bus Booster Pack and The Implementation of The CAN Protocol on the TIVA C Launchpad Evaluation Board

G. SriSaiteja, K.N.V. Khasim
M.Tech(EmbeddedSystems), Asst.Prof
Gokaraju Rangaraju Institute of Engineering & Gokaraju Rangaraju Institute of Engineering & Technology (GRIET), Hyderabad

Abstract

This paper is about the practical design of a CAN Bus Boosterpack and the implementation of the CAN protocol on the TIVA C Launchpad evaluation board. The boosterpack board contains a CAN transceiver that can make communication between applications possible via the CAN controller module, present in the TIVA C Launchpad. The CAN booster pack will be designed around an MSP 2551 CAN transceiver that will be connected through the CAN TX and CAN RX signals of the CAN module on the launchpad. The transceiver will connect the CAN bus between applications and the CAN controller module on the launchpad. The Boosterpack board is designed using the Cadsoft Eagle and the programming of the board is done in the Code Composer Studio (CCStudio) v5.5, and using Tivaware v2.1.

Key words: TIVA C Launchpad, TM4C123GXL Microcontroller, CAN Protocol etc.

1. INTRODUCTION

CAN protocol, protocol for LAN (Local Area Network) communication. It is a multi-channel transmission system, where when a unit fails, it does not affect others. All systems connected to the CAN bus are accessible via the control unit on the CAN bus interface for sending and receiving data. The CAN Bus Boosterpack contains the CAN protocol features, which can be used on the TIVA C Launchpad. TIVA C Launchpad is a single board microcontroller designed by the Texas Instruments (TI). It contains an ARM cortex M4U-based microcontroller namely TM4C123GXL. The TIVA C Series TM4C123G Launchpad evaluation board is a low-cost evaluation platform, with an excellent level of processing power. The stackable headers of the Launchpad evaluation board demonstrate how easy it is to expand the functionality of the TIVA C Series Launchpad when interfacing to other peripherals. A Boosterpack on TIVA C Launchpad evaluation board is an interface between applications and the evaluation board, which is connected to the Launchpad through its pin handlers. It can be having any application, for example, a boosterpack for Bluetooth dongle, an LCD display, an RTC controller etc., here; a CAN boosterpack of such is to be designed.

2. RELATED WORK

The implementation of the CAN protocol on an evaluation board is done previously. For example it was done on the ARDUINO evaluation board. But the major difference between that of the ARDUINO board and the TIVA C board is the operating speed. The speed of the TIVA C Launchpad is 80 MHz; this makes it 4 times faster than ARDUINO.

3. PROPOSED SYSTEM

The following figure shows the proposed system, in block level representation. The TIVA C Launchpad evaluation board, on which, the process has to be done, a PC to provide the required power supply, and to program the Board. The CAN Bus Boosterpack is connected to the board via the stackable headers present on the Launchpad evaluation board. The end use of the boosterpack can be of the OBD-II protocol or any other applications.

Fig (1) – Proposed System

4. HARDWARE
4.1 TIVA C Launchpad
TIVA C Launchpad is a single board microcontroller designed by Texas Instruments (TI). It contains an ARM cortex M4U-based microcontroller namely TM4C123GXL. The TIVA Series TM4C123G Launchpad Evaluation Board is a low-cost evaluation platform for ARM Cortex-M4F-based microcontrollers. The stackable headers of the TIVA Series TM4C123G Launchpad Boosterpack XL interface demonstrate the ability of the Launchpad to interface to other Boosterpack add-on boards. There are 40 I/O pins that have multi-personality, meaning they can be configured as digital inputs or outputs, analog inputs or outputs, or other functions, allowing a great variety of applications, just the multiple serial ports have the ability to interface with other modules, as test cards or communication modules, etc. Among those pins, there are included the GND and POWER (3.3 v) pins.

4.2 TM4C123GXL MICROCONTROLLER
The TM4C123GH6PM is a 32-bit ARM Cortex-M4-based microcontroller with 256-kB Flash memory, 32-kB SRAM, and 80-MHz operation; USB host, device, and OTG connectivity; a hibernation module and PWM; and a wide range of other peripherals. Most of the microcontroller signals are routed to 0.1-in (2.54-mm) pitch headers. An internal multiplexer allows different peripheral functions to be assigned to each of these GPIO pads. The TI TM4C123GXL microprocessors are based on ARM cortex-M4F processor. The ARM Cortex-M4F processor provides a high-performance, low-cost platform that meets the system requirements of minimal memory implementation, reduced pin count, and low power consumption, while delivering outstanding computational performance and exceptional system response to interrupts. The TM4C123GH6PM controller supports both asynchronous and synchronous serial communications.

4.3 DEVELOPMENT OF THE CAN BUS BOOSTERPACK
TIVA C Series Boosterpacks expand the available peripherals and potential applications of the TIVA C Series Launchpad. Boosterpacks can be used with the TIVA C Series Launchpad or the on-board TM4C123GH6PM microcontroller as its processor. The two double rows of stackable headers are mapped to most of the GPIO pins of the TM4C123GH6PM microcontroller. The expansion headers are referred to as the Boosterpack interface. These rows are labeled as connectors J1, J2, J3, and J4.

MCP 2551 CAN TRANCEIVER
The CAN Bus Boosterpack for the TIVA C Launchpad evaluation board will be designed around an MCP 2551 CAN transceiver. The MCP2551 is a high-speed CAN, fault-tolerant device that serves as the interface between a CAN protocol controller and the physical bus. The MCP2551 device provides differential transmit and receive capability for the CAN protocol controller on the TIVA C Launchpad. It operates at speeds of up to 1 Mb/s. It also provides a buffer between the CAN controller and the high-voltage spikes that can be generated on the CAN bus by outside sources.

Fig (2) – TIVA C Launchpad Evaluation Board
Fig (3)–MCP 2551

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Pin Name</th>
<th>Pin Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TXD</td>
<td>Transmit Data Input</td>
</tr>
<tr>
<td>2</td>
<td>Vss</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>Vdd</td>
<td>Supply Voltage</td>
</tr>
<tr>
<td>4</td>
<td>RXD</td>
<td>Receive Data Output</td>
</tr>
<tr>
<td>5</td>
<td>VREF</td>
<td>Reference Output Voltage</td>
</tr>
<tr>
<td>6</td>
<td>CANL</td>
<td>CAN Low-Level Voltage I/O</td>
</tr>
<tr>
<td>7</td>
<td>CANH</td>
<td>CAN High-Level Voltage I/O</td>
</tr>
<tr>
<td>8</td>
<td>Rs</td>
<td>Slope-Control Input</td>
</tr>
</tbody>
</table>
FUNCTIONAL INTERFACING OF THE BOOSTERPACK

The J1 connector and the J3 connector which are on the left side of the board are the ones required for the operation of the CAN BUS Boosterpack. The interfacing needs the use of 4 header pins from the J1 and J3 connectors, they are 1.02, 1.07 pins of J1 connector and the 3.01, 3.02 pins of J3 connector. The CANH, CANL pins on the MCP2551 are used for the output CAN protocol applications, along with the 5V and the GND.

<table>
<thead>
<tr>
<th>PIN ON MCP2551 CAN TRANSCEIVER</th>
<th>J1 CONNECTOR</th>
<th>J3 CONNECTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>TxD</td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>VSS</td>
<td></td>
<td>3.02</td>
</tr>
<tr>
<td>Vdd</td>
<td></td>
<td>3.01</td>
</tr>
<tr>
<td>RxD</td>
<td>1.07</td>
<td></td>
</tr>
<tr>
<td>Rs</td>
<td>GND</td>
<td></td>
</tr>
<tr>
<td>CAN H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vref</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig (5) – Functional pin interfacing of the Boosterpack

4.4 THE CAN (Controller Area Network) Bus Boosterpack

The CAN bus Boosterpack design is according to the Launchpad dimensions of the TIVA C Launchpad. It is designed using the CADSOFT EAGLE software, and it is designed around a MCP 2551 CAN transceiver.

5. IMPLEMENTATION

The implementation of the CAN protocol using the CAN Bus Boosterpack is mainly in the OBD-II protocol applications. The CAN Bus Boosterpack can be used for OBD-II applications via a DB-9 serial port.
6. WORKING

The working of the CAN Bus Boosterpack can be tested by using a code to make the LED on the TIVA C Launchpad blink depending on the temperature conditions using the CAN protocol, as there exists a temperature sensor on the TIVA C Launchpad evaluation board, the LED will blink if the temperature is more than the given value or it will be in OFF state. Here, the output, i.e. the LED blinking is via the transferring of temperature value through CAN.

Here, the Transmission and reception are done on the same board.

7. CONCLUSION

The CAN Bus Boosterpack for the TIVA C Launchpad can be used for the OBD-II protocol applications and some other applications. As the operating speed of the TIVA C Launchpad is more than that of most other microcontroller evaluation boards, it is faster and reliable for these applications. As it is shown, the serial port is not soldered to the CAN Boosterpack board, it will be improvised in the future.

8. REFERENCES

[2] Karl Henrik Johansson, Martin Törngren, and Lars Nielsen,