International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue-01
January 2018

CAN Protocol Based Monitoring System for Microgrid

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Abstract—*MICROGRID is a smaller electrical grid used in rural areas for the production of electricity in low scale. In this type of grids the fluctuations are most common in the demand of supply. To maintain the grid stability and the power quality, a microgrid must continually monitor the demand and accordingly regulate the generation. This paper brings into light the need for the implementation of CAN communication protocol in a microgrid and the necessity of its implementation in a microgrid for monitoring the demand fluctuations in the grid. This paper also gives the advantages of using an FPGA and the implementation of the CAN protocol in FPGA.*

Keywords—CAN,FPGA,ARM,Microgrid,monitoring

I. INTRODUCTION

In rural areas ,it is very hard to supply power from a power plant due to its long distance from the plant. For this purpose, we use a micro grid to supply power to the rural areas. Microgrids can also be used in islands where there is a problem of supplying the electricity. Microgrid or independent smaller power grids are smaller setups which use diesel generators and diesel backup system to generate electricity. But with advancements in the grid technology, microgrid have started integration of renewable energy sources such as wind and solar. As micrograds are very small they are easily effected by fluctuations in the demand of supply and the power quality. Micrograds must continually monitor the demand and accordingly regulate the generation. An unstable grid can lead to black outs and even worst damage aspects on the grid. For monitoring the parameters in a micro grid we can use microcontrollers at different places. There is a need for these microcontrollers to communicate with a central master controller for delivering the acquired data to the master controller where it will be delivered to the user. For establishing the communication between these microcontrollers for the transfer of data, we use CAN protocol[1]. This paper also presents about the implementation of the CAN protocol in the FPGA devices. These FPGA devices can be reconfigured easily and as per the interest of the user they can be moulded[10]. We also use an ARM microcontroller along with the FPGA in our prototype for the implementation of the CAN protocol.

II. CONTROLLER AREA NETWORK

Control area network (CAN) protocol is a serial communication, 2-wired protocol which is presently used in large scale for the industrial and automobile applications. CAN protocol is a multi master protocol where the control of the system can be decentralized and thereby eliminating the single point of failure. The other advantages of CAN protocol include:

- The network is of light weight and low cost
- The messages are broadcasted.
- Involves arbitration and prioritization of messages.
- Any CAN participants, field devices and process control computers can exchange data.
- Data consistency is maintained all over the system.
- Mail box identifiers which are unique.
- Each node performs acceptance filtering.
- If the message is corrupted, it can be retransmitted automatically.
- Response is of real time.
- Design requirements are simplified.
- System design is flexible.
- High reliability is ensured
- Traffic is kept undisturbed.
- Communication link established is accurate.
- Minimized radiation and high radiation resistance stands as the key high light.

III. METHODOLOGY

A. Proposed System

For the purpose of our prototype we are using an ARM Cortex M3 based microcontroller and a cyclone IV based FPGA as shown in fig 1. We are using MCB1700 board which contains LPC1768 which is an ARM Cortex M3 based microcontroller and two CAN ports

On the other side we are using Cyclone IV based FPGA. Now, Let us discuss about the details of an FPGA. FPGA could be considered as a blank slate where we can design any digital circuit[9]. The required functionality can be designed when the system is under use that is even after the device is manufactured and even after its installation is completed in the product. In some cases, the system can be configured even after the device has been shipped to the customer. A Programmable hardware can be provided to the developer of embedded system using an FPGA [8]. Some of the advantages of an FPGA are as follows. By the use of an FPGA, the number of chips used can be considerably reduced. High degree of flexibility is offered by the platform FPGA. In our prototype we are using a chip called

e-ISSN: 2348-6848
p-ISSN: 2348-795X
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MCP2515 which is a CAN controller that is interfaced to FPGA .All the registers of MCP2515 can be accessed by an FPGA through an SPI protocol. In an FPGA we implement an NIOS II soft core processor. Now we connect CAN high and CAN low pins of one of the CAN ports in MCB1700 to CAN high and CAN low pins of an FPGA board. Now our hardware setup is ready for implementation.

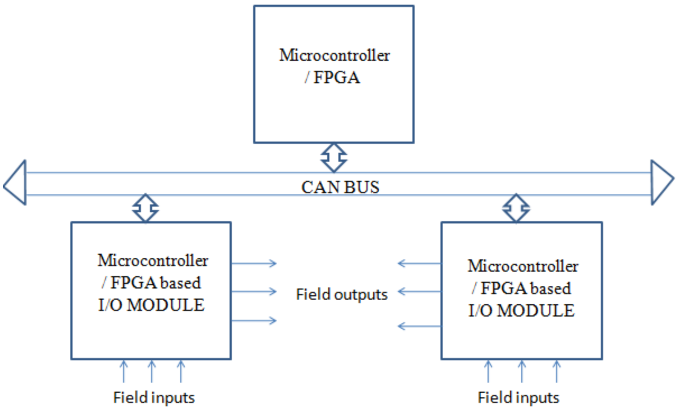

Figure 2.proposed block diagram

B.Software Algorithm

In the case of designing an algorithm, we have two processes to be considered. One is CAN transmission, and the other one is CAN reception. These can be explained by two flow charts which are given below. Before dealing with the transmission and reception processes in CAN, let us discuss about the CAN software architecture.

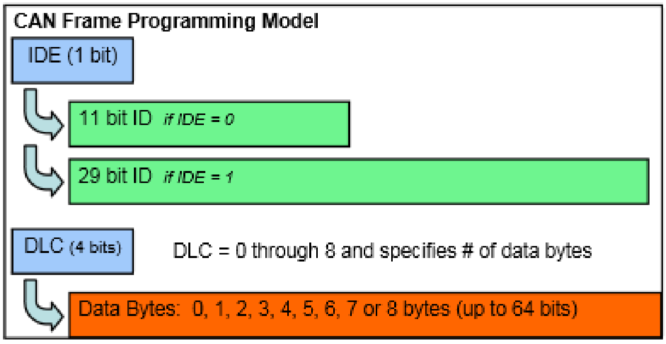

Figure 2.CAN programming model

The figure 2 shows the CAN frame programming model.We have followed this design in building our software.First,we define the value for IDE,then depending on the IDE ,we define the identifier.Now we define the value for DLC field and depending on this we define the data.All these values are then stored in the respective registers of the microcontroller.CAN transmission can be discussed from the flow chart of figure 3.

First, we configure the CAN interface on both the microcontrollers. Now we load the CAN information into the respective registers and transmit buffers and then transmit the message.

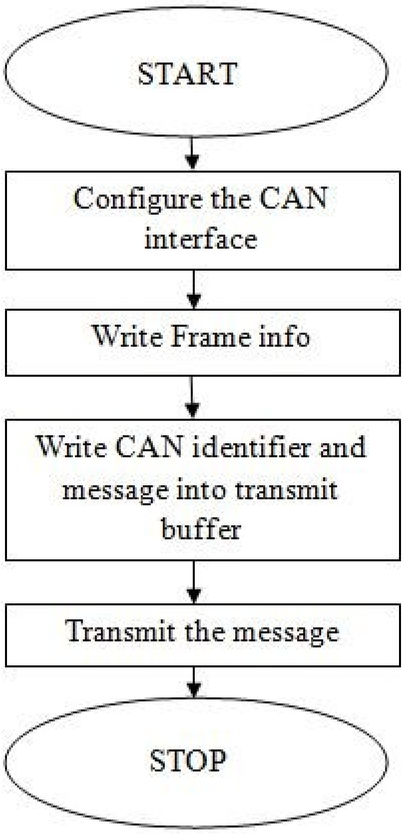

Figure 3.CAN transmission flow chart

Now, let us discuss about the CAN receiving. The main flavour of the CAN communication lies in the receiving of the message where the acceptance filtering come into action.First the message which is broadcasted on the CAN bus will reach every node.Near each and every node there will be an acceptance fitering of the message based on the identifier.The message is accepted only if any of the message identifier is matched with the identifier in acceptance filter RAM or else the message will be discarded by the receiving node.This can be explained by this flow chart of figure 4.

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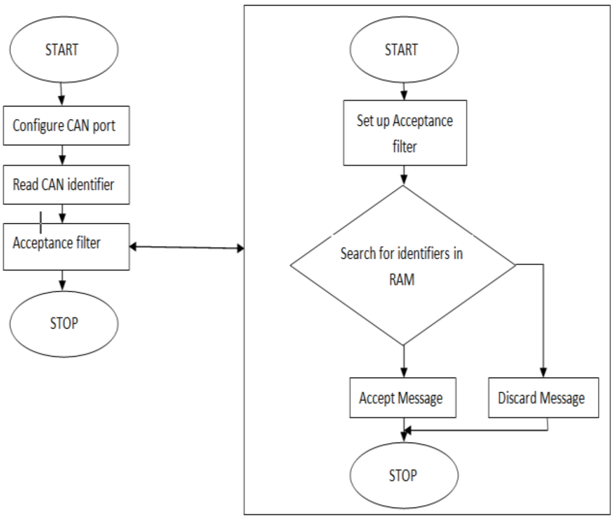

Figure 4. CAN reception block diagram

Initially, the CAN port in the microcontroller has to be configured according to the requirement. As soon as the message has been received at the CAN port its identifier will be checked with the acceptance filtering .If the identifier matches with any of the identifiers present in the acceptance filter RAM then the message will be accepted or else the message will be discarded.

IV. WORK FLOW

The flow chart below describes the working principle of our prototype.

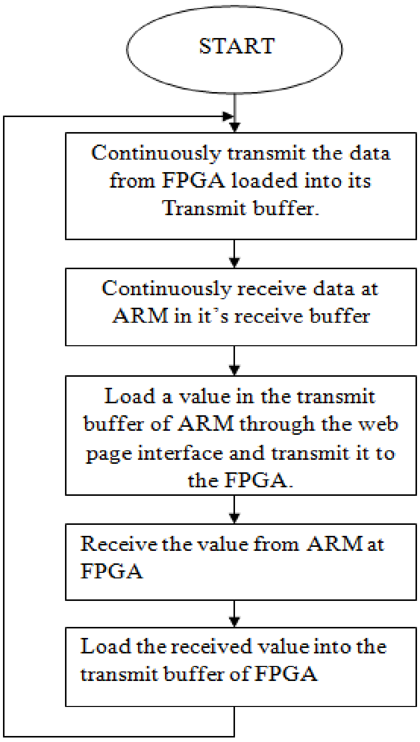

Figure 5. Execution block diagram

Firstly, we start the transmission from FPGA as shown in fig 3 and receive the data at ARM microcontroller as shown in fig 4. Now we have transmitted a value from ARM by loading a value into it's transmit buffer and received it at FPGA and this value is transmitted back to ARM.

V. RESULT AND DISCUSSION

We have tested our set up in a step by step process.

We have transmitted two values from FPGA and received those values at ARM and this can be seen on the ARM board as follows

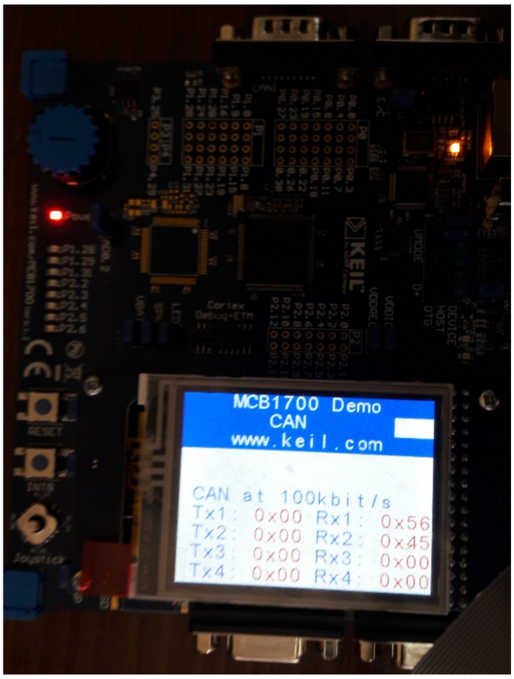

Figure 6. Data transmission from fpga to arm

Now we have transmitted a value from ARM and received that value at FPGA and transmitted this back to ARM .This can be viewed on the ARM board as follows.

Figure 7. Data transmission from arm to fpga and fpga back to arm

The above results are obtained. By this we have tested the communication occurring from both sides between the microcontrollers and this can be implemented in real time with many microcontrollers increased and connected together through a common CAN bus.

VI. CONCLUSION

The advantages of this project include as follows. The CAN communication protocol used is a multimaster protocol in which if a central controller fails to work its position can be taken by any of the field controller, so that the system does not fail completely. This network is of low cost and light weight. This communication well suits for real time applications. Data can be easily exchanged between the CAN participants. The use of FPGA helps us to design and include the desired peripherals on the FPGA and mould the project according to our requirements.

This project can be used in the railways, street cars, trams and for many industrial applications.

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