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Controller Area Network in Modern Home Automation

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ABSTRACT: The word automation brings to mind devices that operate with minimal human intervention. In other words, acting or operating in a manner essentially independent of external influence or control. It finds application in controlling industrial equipments, home appliances, computer peripherals and robots. The controller area network (CAN) protocol was originally developed to use in the automotive industry, but it was recently discovered that it is suited for a broader class of applications in various automated environments. It incorporates a slight modification to the basic CSMA/CD protocol and was initially developed to be used in the automotive industry in order to solve the cabling problems found on some kinds of vehicles. However, due to its versatility, CAN can also be adopted as a control network for industrial applications. CAN is a two-wire, half duplex, high-speed network system and is well suited for high-speed applications using short messages. A CPU is needed to manage the CAN protocol. The PIC18F458 Microcontroller is used as the CPU that can manage bus arbitration, assigning priority for the message, message addressing and identification. In general, Microcontroller is a programmable device also known as the microprocessor with peripherals in one component. The architecture of PIC18F458 is dedicated to CAN network applications. With the help of the Microcontroller we can control range of functions.

In this project, to implement CAN based home automation two nodes are constructed. The Node1 is interfaced with the Node 2. CAN uses only short messages, which means the maximum utility of the load is 64 bits. The commands for home automation are given through RF Transmitter, Keypad setup. The RF Receiver gets the information For controlling the devices connected with the node1 and node2from the PC is given to the node2 through serial port. From node2 the command is transferred to the node1 through CAN cable. Similarly the information from the two nodes also reported to the PC through CAN network. CAN offers high-speed communication rate up to 1M Bits/sec thus allows real-time control. In addition, the error confinement and the error detection feature make it more reliable in noise critical environment. CAN is a two-wire, half duplex, high-speed network system and is well suited for high-speed applications using short messages. A CPU is needed to manage the CAN protocol. The PIC18F458 Microcontroller is used as the CPU.

KEYWORDS: CAN, CSMA/CD, RF TX and Rx

I. INTRODUCTION

For existing wireless home automation it needs more number of RF receivers and therefore varies the frequency range. The signals that we sent may lose because of electromagnetic waves. And for the multitier home automation, the cost and complexity will be high. Finding out the area of fault will be difficult. Also here we can control only limited number of devices. This project aims at reducing the number of wires inside the home. This Project is designed using CAN because it is a two wire, serial, high speed multimaster system. The CAN bus is primarily used in embedded systems, and as its name implies, is the network established among microcontrollers. It uses only one RF transmitter and receiver. It uses CSMA/CD+AMP (Carrier Sense Multiple Access/Collision Detection with Arbitration on Message Priority). Before sending a message the CAN node checks if the bus is busy. It sends the messages according to the priorities. It also uses collision detection. We can control number of devices with uninterrupted and scalable output.

II. BASIC CAN PROTOCOL

CAN is based on a CSMNCD channel access technique, modified to enforce a deterministic resolution of collisions on a network which uses a priority scheme based on the identifiers of the exchanged objects. The CAN protocol adopts a layered architecture which is based on the OS1 reference model, even though it is not fully OS1 compliant. As with other networks conceived for the factory automation environment, it relies on a reduced protocol stack, consisting only of the following three communication layers: physical layer; *data* link layer; application layer.

The network, transport, session and presentation layers have been eliminated so as to obtain a streamlined protocol which provides shorter response times. It is worth noting that up to now only the physical and the data link layers have been standardized [2] [lo], however a standard proposal was recently completed for the application layer [9]. In this paper interest is focused mainly on the data link layer: in fact most of the features of CAN which concern topics such as the sharing of the bandwidth among the different stations and the access delays they experience depend on the mechanisms adopted at this level. According to a well-known model developed for LANs, the data link layer is, in turn, divided into two sublayers, namely: medium access control (MAC);***0*** logical link control (LLC).

2.1 CAN physical layer

As for the 802.3 networks, **CAN** is based on a bus topology. The most distinctive feature of its physical layer with respect to other kinds of networks is the set of the levels (logical values) the bus can assume. In fact the bus can assume one of two complementary logical values *dominant* and *recessive.* The dominant value can be considered equivalent to the logical value *0,* while the recessive value corresponds to the logical value 1. It is worth noting that if several nodes transmit dominant and recessive bits at the same time, the resulting value of the bus will be dominant. In other words CAN behaves in a very similar way to the open-collector wirings in electronic circuits, thus a wired-or logical function is implemented among all the devices connected to the network.

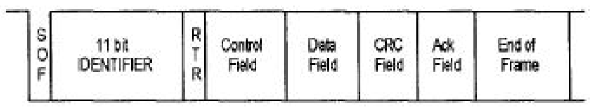

Figure 1: Format of the basic CAN frame

Fig. 1 shows the format of a basic CAN frame. The *start* of *frame* (SOF) field consists of a single dominant bit. The *identifier* field and the *remote transmission request* (RTR) bit form the *arbitration* field which is used by the MAC mechanism to resolve any contentions. The MAC can start transmitting a frame as soon as it detects that the bus is free, that is when no frame is being transmitted and at least three recessive bits *(intermission* bit field) have been received. During the initial arbitration phase, each transmitter compares the bit just transmitted with the level observed on the bus. When a recessive bit is being transmitted by a node and a dominant level is monitored on the bus, the node must abort its transmission immediately since it has lost the contention. Another attempt to send the frame will be made after the transmission of the current (winning) frame is completed. This situation is depicted in Fig. 2 where three stations try to send a message at the same time and cause a collision. The arbitration mechanism ensures that when a collision occurs all the transmitting stations except one will stop their transmissions. In this way the contention is deterministically resolved, and neither information nor time is lost. Since the first field in each MAC frame following the SOF bit is the identifier of the exchanged object, it is clear that the lower the numerical value of the identifier is, the higher the priority of the message will be.

2.2 MAC sub layer

Layer. Its most important functions are: encapsulating the frames being transmitted; encapsulating the received frames; managing The MAC sublayer is the lower part of the data link transmission and reception on the shared medium; detecting and signaling any error which occurs uring transmission and receptions.

III. EXCHANGED DATA VIA CAN NETWORK

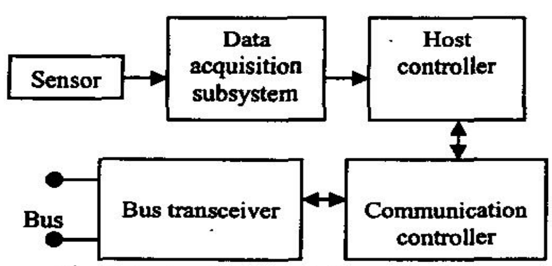

Fig.3: Analog data acquisition subsystem

Data exchanged by the multiplexed CAN network are:Analog or frequency data: (motor,temperature,consumed electric power, instantaneous speed..).The system for data acquisition and data processing is shown in fig.3It illustrates all

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components for the data acquisition (Data Acquisition Subsystem),for the data processing(Host controller) and for the data communication(Communication Controller).[3]

Discreet data ;(state word) represents the calculator state and incorporate three parts (the first informs on the calculator normal working state and phase, the second informs on the direct entrance state on the calculator.Supervisions data, represents the calculator state in relation with the own diagnosis of the calculator and with the diagnosis of the data link quality.Data with higher criticality level: it is the first variation data whose exploitation permits the time control of activators for every application.Data with weak criticality level: it is the slow variation data in relation to the frequency of the used control strategies development

IV. BUS LENGTHS

The maximum bus length for a CAN network depends on the bit rate used. It is required that the wave front of the bit signal has time to travel to the most remote node and back again before the bit is sampled. This means that if the bus length is near the maximum for the bit rate used, one should choose the sampling point with utmost care - one the other hand, one should always do that!

Bus length (meters)	Maximum bit rate (bit/s)
40	1 Mbit/s
100	500 kbit/s
200	250 kpit/s
500	125 kbit/s
6 km	10 bit/s

Table 1

4.1 Bit timing

CAN has advanced features for coping with the time delays found in long bus lengths (in comparison to the bit rate) and coping with differences in clock crystal frequencies for nodes on the bus. Each bit is divided into four segments - the synchronization segment, the propagation segment and the phase segments one and two. Each segment consists of one or more time quanta.

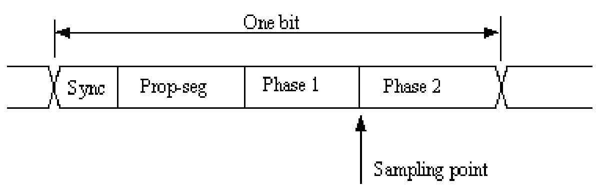

Fig 4.

4.2 Bit segments (as in implementations like Intel 527 and C167CR)

In most implementations of CAN controllers the segments seem to be implemented in a different way than described in the standard. The synch segment looks as in the standard and consists of one time quantum. The big difference is that the propagation segment and the phase segment 1 in Normally there is only one sample point for each bit. In this case, the sample point is in the edge between TSEG1 and TSEG2. However, some CAN controllers can also sample each bit three times. In this case, the bit will be sampled three quanta in a row, with the last sample being taken in the edge between TSEG1 and TSEG2.

Three samples should only be used for relatively slow baudrates.

1) *Calculation of baudrate and sample point*

a)Baudrate

The baudrate of the bus can be calculated from:

Baudrate = $f_{crystal}$ / (2*n*(BRP+1)) where n is the number of time quanta for one bit and is defined as :
n = SYNCHSEG+TSEG1+TSEG2

BRP is the value of the Baud Rate Prescaler.

Warning: some CAN controllers (like Intel 526) has an other way of calculating the number of time quantas in a bit! Consult your users manual.

the standard have been combined into one segment, TSEG1. Phase segment 2 is left untouched, but is renamed to TSEG2.

V. RF TRANSMITTER & RECEIVER:

There are three Wireless RF Modules Transmitter, Receiver and a Transceiver. These RF Modules are designed to serve as a tool for electronic design engineers, developers, hobbyists and students to perform wireless experiments. These modules make it easy for any NON RF Experienced developer to add Wireless RF Remote Control to their project. NO RF Knowledge required. The RF Modules are in a PCB (Printed Circuit Board) form with a 17 Pin 0.1 Inch spacing header that fits directly into most all prototyping boards. They are easy to use boards that include encoders, decoders, addressing, RF data processing and even the antenna, in a simple fully range tested board that is ready to plug right into your project. Just apply +5VDC, ground, and the communication pins you require and enjoy hassle free wireless communications.

The Transmitter, Receiver and Transceiver all have 9600 baud serial interfaces and stand-alone, 3 functions switch inputs and outputs. The modules can communicate over distances up to 250 feet. The boards operate on +5V and easily interface to your Basic Stamp 2 or Basic Stamp 2sx.

Two Modes of Operation:

- Connecting GND to the Mode pin places the module in Switch Mode.
- Connecting +5V to the Mode pin places the module in Serial Mode.

Switch Mode:

The transmitter, receiver and transceiver have 4 address pins (labeled ADDR1 – ADDR4), providing 16 address combinations. Placing 0V or 5V on the 4 address pins sets the unit's address (in a binary fashion). For example, placing 0V on all pins sets the address to zero. Placing 5V on all pins sets the address to 15.

*Result and discussion***:**

By the completion of this project it can be concluded that the fully automated model designed to operate the inside electronic components of home is the foolproof system to overcome the disadvantages of existing model.

The source code is written in C language, which is very simple. Thus this model could be a perfect solution for the problems existing with present system at cost, which are considerably cheaper for all the characteristics it possesses.

The overall advantages of this project are,

1. Number of wires is reduced.
2. Estimated cost is low.
3. This project is with respect to real time.
4. Trouble free and effective system.

Applications

This project can be used to

1. Industrial automation

2. Office and hospital automation

3. Vehicle automation

VI. CONCLUSION

In summary, affordable, mass-market technology may be utilized to automate home living environments to promote health independence, disease prevention, security and active engagement of the elderly population. The tool kit for independent living can be retro-fitted to any existing home and may assist the elderly with daily tasks and monitor activity to establish the effectiveness of intervention or predict illness before the onset of a chronic condition. Its incorporation into the home will provide a safe and stimulating environment for the elderly to live independently and age in place.

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