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CAN Bus Integration for Enhanced Industrial Control and Safety

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Abstract: In the current era safety analysis is a enhanced security system which is need vigorously. With the intent to make an efficient safety measurement for industry automation is the priority. This can be done by using various communication protocol for efficient and real time solution. In our project we come across one such series protocol bus called controller area network (CAN) for industry safety measurement and automation to sense high temperature, gas leakage, and decreased light intensity. A major advantage of industry automation and process control will increase the flexibility and convertibility in the manufacturing process. The main aim of this project is to provide more safety in industry by implementing monitoring and controlling unit for parameters like temperature, gas leakage and decreased light intensity. In the proposed system we use MPLAB software to understand the synthesis of Comtroller area bus protocol, pic micro controller, CAN controller MCP2515 and CAN transceiver MCP2551 are used with various sensors to develop the model

Keywords- Controller Area Network (CAN), CAN Controller MCP2515 and CAN Transceiver MCP2551.

I. INTRODUCTION

The Controller Area Network is a message-based serial field bus technology. The protocol is based on multi-masters. Robert Bosch created CAN, which was made public in 1986. It is created to lower the cost of wiring for the automotive sector[1]. The use of computers in vehicle monitoring and control systems is currently widespread, and the percentage of automotive electronics that are micro-controller-based keeps rising across the board. An excellent foundation for linking modules is the CAN bus. All module have the capability to interact with one another via CAN. It serves as a valuable resource in a networked system that demands rapid and dependable communication and where data integrity is crucial. The CAN protocol is strong and employs cutting-edge error management and verification. Data transfer between nodes is achievable through the CAN protocol, which offers a maximum signalling rate of 1 mbps[1]. CAN does not transfer sizable data blocks point-to-point from node A to node B under the control of a central bus master, unlike a conventional network like USB or Ethernet. The term "Industrial Automation and Control Systems" (IACS) refers to the group of people, equipment, and software that can influence or affect how safely, securely, and dependably an industrial process runs[8]. Industrial automation is the use of technology, such as computer software and robotics, to control machines and processes to replace humans in performing specific functions. Capabilities are primarily focused on manufacturing, quality control, and material handling processes. A control system uses control loops to manage, command, direct, or govern the behaviour of other equipment or systems[9].

II. LITERATURE SURVEY

This research project demonstrates how to transfer data between a virtual and real environment using CAN bus. The robot simulator CoppeliasSim has been used to build a virtual environment The analogue value is read by the remote master and sent back to the simulator via the local master.[1] In real-world circumstances, the scene might readily. A brand-new kind of short-range wireless technology is called ZigBee. Here, ZigBee protocol communication equipment is used, and a ZigBee wireless sensor system is designed and set up.[2]

The MCP2515 IC operates as a standalone CAN controller and includes an integrated SPI interface for communication with microcontrollers. In contrast, the TJA1050 IC serves as a bridge between the MCP2515 CAN controller Ic and physical CAN bus[3]. Four different types of sensors, including alcohol sensors, temperature sensors, fuel level sensors, and distance measurement sensors, are utilized in this study. These are employed in accident avoidance and prevention.[4] The presented system uses Microchip Technology's MCP2515 which is a stand- alone ControllerArea Network (CAN) controller that implements the CANspecification, version 2.0B and MCP25.[5] CAN bus communication employs wired connections and operates based on message priority. The speed of CAN controller MCP2515 is 1MbpS up to 420 meters and it will change with change or variation in length of system.[6] This paper is focused on basically a microcontroller-based temperature indicator system which displays temperature in the range of - 55°C to + 125°C in 0.5°C incremental accuracy. The MCU runs only voltages ranges from 4.0V to 5.5V[7]. The advantages of CAN bus are highlighted in contrast to other serial buses like MOD bus.[8] The primary use of CAN is in automobile electronics, where it connects various components such as engine control units, sensors, and antilock braking systems, all operating at maximum bit rates.[9] Each node in an ECM system has two error counters: received and transmitted error counters, which seeks to analyse the security of the CAN protocol.[10]

III. METHODOLOGY

Industrial automation should operate quickly and precisely. There shouldn't be any gearbox errors. There ought to be less wire, and wiring that is simpler. Two PIC micro-controllers are employed in this setup. Two micro-controllers exchange data with each other using CAN modules[10]. Readings from temperature sensor, LDR and gas sensor are sent to the first micro-controller. Utilizing MPLab View software, all parameters are tracked. CAN allow us to link every item with just two wires.The effective data transfer rate is up to 1Mbps[6]. Information between ECUs (Electronic Control Unit) is exchanged using the CAN Protocol. Different sensors are employed to provide the driver an accurate result such as temperature sensor, LDR and gas sensor.

The main goal of our project is to ensure safety in the industry by implementing, monitoring and control units in place for things like temperature, pressure, smoke, and gas leakage[4]. We employ various sensors, such as a temperature sensor to detect high temperatures, a gas sensor to detect gas leakage, and an LDR to control the light's ON and OFF operation.

The PIC Micro-controller is in charge of all of the device operations. It is used as the foundation for this project. As inputs, we employ the temperature sensor, gas sensor, and LDR sensor[7]. The output is the relay, which is connected to the light, the L293 driver, which is connected to the DC Motor, and the buzzer.

Buzzer activation indicates that a gas leak was detected by the gas sensor. Relay modules switch relays capable of handling loads using low-level data signals. This switches another device on or off. When the temperature rises above a certain threshold, the L293 driver senses it and activates the dc motor.

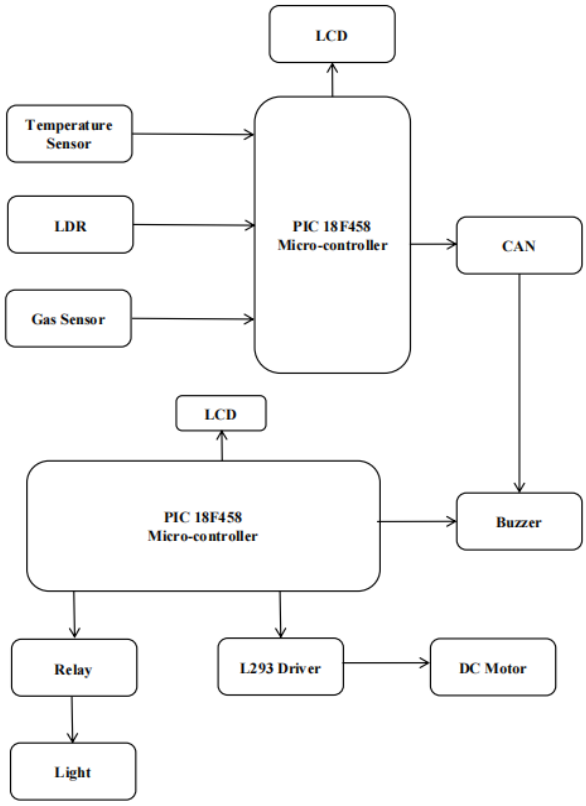

Fig 1. Block Diagram

IV. IMPLEMENTATION

As our project suggests, there are several reflections in industry that should be avoided, thus we connected sensor devices to microcontroller for error detection and automatic correction without manual work. It is composed of two parts: the transmitter side and the receiver side[10]. In transmitter side, it comprises of three different types of sensors, including temperature, LDR, and gas leakage. These sensors are employed to measure the signals that come from the machinery's surroundings. Upon measurement, these analog signals are converted into digital signals and subsequently compared to the real signals. The PIC microcontroller 18F458 is crucial to the management of all the devices. Any changes in these sensors will be notified to the reciever part and the required action takes place[5]. In the receiver side, there is a CAN transmitter and receiver that uses to provide data to the microcontroller and convey faults to it. These values are shown on the LCD, in comparison to the actual values, and then the right value is set. The program is written in Embedded C and then synthesised and simulated using MPLAB IDE software. After the simulation the program is dumped to the PIC micro-controller.

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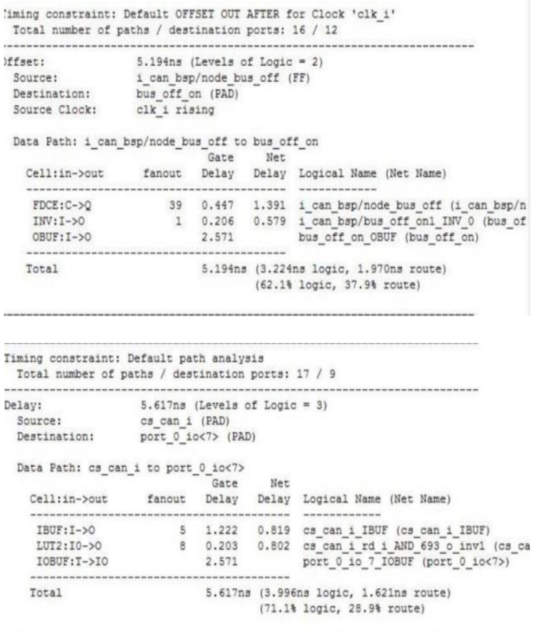
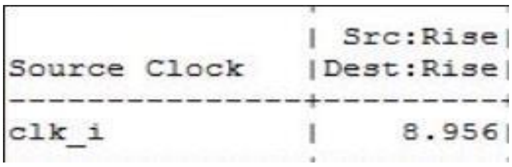
SYNTHESIS AND SIMULATION USING HDL

The timing constraints for this synthesis report are as shown:



```
Timing constraint: Default OFFSET OUT AFTER for Clock 'clk_i'
  Total number of paths / destination ports: 16 / 12
-------------------------------------------------------------------------
Offset:              5.194ns (Levels of Logic = 2)
  Source:            i_can_bsp/node_bus_off (FF)
  Destination:       bus_off_on (PAD)
  Source Clock:      clk_i rising

  Data Path: i_can_bsp/node_bus_off to bus_off_on
                                Gate     Net
    Cell:in->out      fanout   Delay   Delay  Logical Name (Net Name)
    ----------------------------------------  ------------
     FDCE:C->Q            39   0.447   1.391  i_can_bsp/node_bus_off (i_can_bsp/n
     INV:I->O              1   0.206   0.579  i_can_bsp/bus_off_on1_INV_0 (bus_of
     OBUF:I->O                 2.571          bus_off_on_OBUF (bus_off_on)
    ----------------------------------------
    Total                      5.194ns (3.224ns logic, 1.970ns route)
                                       (62.1% logic, 37.9% route)

-------------------------------------------------------------------------

-------------------------------------------------------------------------
Timing constraint: Default path analysis
  Total number of paths / destination ports: 17 / 9
-------------------------------------------------------------------------
Delay:               5.617ns (Levels of Logic = 3)
  Source:            cs_can_i (PAD)
  Destination:       port_0_io<7> (PAD)

  Data Path: cs_can_i to port_0_io<7>
                                Gate     Net
    Cell:in->out      fanout   Delay   Delay  Logical Name (Net Name)
    ----------------------------------------  ------------
     IBUF:I->O             5   1.222   0.819  cs_can_i_IBUF (cs_can_i_IBUF)
     LUT2:I0->O            8   0.203   0.802  cs_can_i_rd_i_AND_693_o_inv1 (cs_ca
     IOBUF:T->IO               2.571          port_0_io_7_IOBUF (port_0_io<7>)
    ----------------------------------------
    Total                      5.617ns (3.996ns logic, 1.621ns route)
                                       (71.1% logic, 28.9% route)
```

The Clock Domain Crossing (CDC) for this synthesis report is as shown:



Source Clock	Src:Rise Dest:Rise
clk_i	8.956

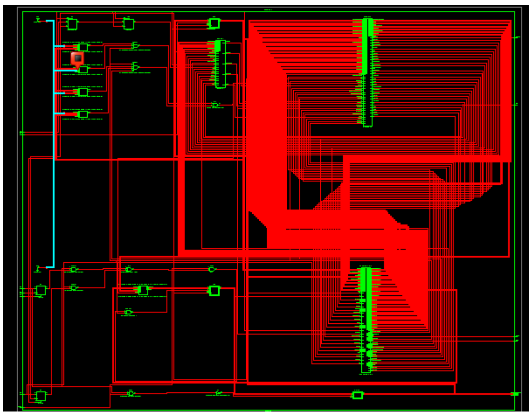


Figure 1 SYNTHESIS AND SIMULATION

RESULTS AND DISCUSSION

Enhancing productivity, improving quality, and reducing poer consumption are critical goals in industrial automation. To achieve these objections, our distributed system employs the CAN bus for transmitting data and processing variables from field devices, including boilers and other industrial equipment. This approach ensures high-speed data transmission and incorporates muliple error-checking mechanisms. By installing monitoring and control units for variables like temperature, gas leakage and decreased light intensity to increase safety in industry. In the suggested system, we employ MPLAB IDE to comprehend the synthesis of the CAN bus protocol, the MCP2515 CAN controller, the MCP2551 CAN transceiver, and a variety of sensors to build the model, this fulfills the aim of the project.

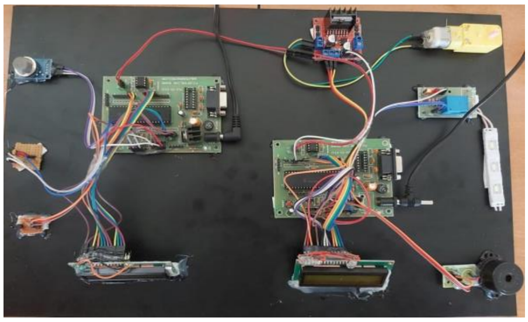


Fig 2. Implementation of CAN based industrial automation

CONCLUSION

Applications needing a high volume of reliable brief messages in harsh operational settings are best suited for CAN. CAN is particularly effective in scenarios where data must be accessed from multiple locations and system-wide data consistency is essential, owing to its message-oriented approach rather than being address-based. As a result, we conclude that two controllers is facilitated by the CAN protocol. This project is based on industrial automation and process control, which places more value on adaptability and flexibility in the production process. By keeping industrial machinery from working at excessive temperatures, gas leakage and decreased light intensity, it increases machine safety. This protocol is strong and employs cutting-edge error management and verification. This is advantageous for motor control because it permits errors and failures to occur without bringing the entire system to a halt.

FUTURE SCOPE

Future networking technologies for linking electrical devices that need frequent, straightforward communications will continue to choose the CAN bus protocol. Although Ethernet TCP/IP is a popular replacement for the CAN bus, it still falls short of providing the same low resource requirements, low-cost implementations, reliability, and error recovery capabilities. IoT devices, applications for industrial automation, connected medical devices, and even more demanding and sophisticated applications like satellites and spacecraft will all continue to use CAN networks.

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