Automatic Cab Signalling System for Rail Engine

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Project Report

on

AUTOMATIC CAB SIGNALLING SYSTEM FOR RAIL ENGINE

Submitted in the partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

In

ELECTRONICS AND COMMUNICATION ENGINEERING

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Because, Life is all about taking the right decisions

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

SREENIDHI INSTITUTE OF SCIENCE AND TECHNOLOGY

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CERTIFICATE

This is to certify that the project report entitled ***"Automatic Cab Signalling System For Rail Engine"*** is being submitted by

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in partial fulfilment of the requirements for the award of **Bachelor of Technology** degree in **Electronics and Communication Engineering** to **Sreenidhi Institute of Science and Technology** affiliated to **Jawaharlal Nehru Technological University, Hyderabad** (Telangana)**.** This record is a bona fide work carried out by them under our guidance and supervision. The results embodied in the report have not been submitted to any other University or Institution for the award of any Degree or Diploma.

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DECLARATION

We hereby declare that the work described in this thesis titled **"*Automatic Cab Signalling System For Rail Engine*"** which is being submitted by us in partial fulfilment for the award of Bachelor of Technology in the Department of **Electronics and Communication Engineering,** Sreenidhi Institute Of Science and Technology is the result of investigations carried out by us under the guidance of **Mr.K. N. S. Ganesh, Assistant Professor, Department of ECE, Sreenidhi Institute of Science and Technology, Hyderabad.**

No part of the thesis is copied from books/ journals/ internet and whenever the portion is taken, the same has been duly referred. The report is based on the project work done entirely by us and not copied from any other source. The work is original and has not been submitted for any Degree/Diploma of this or any other University.

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We hereby declare that the work described in the Project report, entitled "Automatic Cab Signalling System For Rail Engine" which is being submitted by us in partial fulfillment for the award of Bachelor of Technology in the Dept. of Electronics & Communication Engineering, Sreenidhi Institute of Science & Technology affiliated to Jawaharlal Nehru Technological University Hyderabad, Kukatpally, Hyderabad (Telangana) is the work on our own effort and has not been submitted elsewhere. We are very thankful to ECE Dept. Sreenidhi Institute of Science and Technology for providing an initiative to this group project and giving valuable timely suggestions over the work. We convey our sincere thanks to Mr.N.S.Ganesh, Assistant Professor(ECE),Dr.S.N. Chandra Shekhar,Associate professor(ECE) Dr. S.P.V. SUBBA RAO, Head of the Department (ECE), Sreenidhi Institute of Science and Technology, Ghatkesar, for his kind cooperation in the completion of this work. We even convey our sincere thanks to Dr.C.TOMMY, Executive Director and Dr.M.SHIVA REDDY, Principal, Sreenidhi Institute of Science and Technology, Ghatkesar for their kind cooperation in the completion of the group project.

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ABSTRACT

Signalling is one of the most important aspects of Railway communication. Trains were driven “on sight”. But several unpleasant incidents accentuated the need for an efficient signalling system. The driver has to run the train according to the signal present in the signal post placed at many points, these signal posts arranged side by the tracks are main guide lines for the engine driver. This system was in use for many decades, but as the technology has been up graded in almost all the fields, a sophisticated signalling system must be enforced for the benefit driver. In this regard this project work has been taken up which is aimed to enhance the technology by displaying the signal condition in front of driver. In other words, the signal present in the signal post laid by the track must be displayed in front of the engine driver in advance. This is the main purpose of this project work.

In general signals for the trains are located side by the railway track, these signals arranged over a signal post can be viewed from long distance, based on these signals the engine driver controls the train accordingly. Sometimes due any reason the driver may not notice the signal , this leads to a severe accidents. To avoid such kind of accidents, it is essential to display the signal condition automatically over the dashboard of the engine, i.e. in front of the driver. This additional feature provides further safety, in this regard in addition to the normal signals laid side by the track, in advance, I.e. if we can able to display the status of signal over the dash board of rail engine, it will be quite useful for the driver to control the train in advance. As the track side signal post contains three indicators, three different codes are generated from embedded system and this code is transmitted through IR sensor. As these signals are controlled through keys manually, corresponding code data will be generated according to the color of signal light. Whenever the train came near to the signal post, the data will be acquired through IR sensor package that is coupled with rail engine aside and corresponding signal light will be energized automatically over the dash board. When the system receives yellow or red signal, it raises an alarm for a moment, by which driver will be alerted in advance.

CONTENTS

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION OF AUTOMATIC CAB SIGNALLING SYSTEM FOR RAIL ENGINE

Most flagging frameworks for trains use trackside sign to control the protected development of trains and guide drivers. A variety light sign shows various tones to approve train developments. Many have extra markers to show which course has been set up for the train and what direction it should head. The greater part of the track side sign posts all through the running track conations 3 markers, they are Red, Green and yellow. Red means stop, Green means continue to its greatest speed breaking point, and yellow means mindfulness to decrease the speed generally showing that the following sign is red. In certain spots over the scaffolds and sharp turnings, the yellow sign remaining parts for all time on the grounds that at these spots the train speed should be decreased.

In the event that a train passes a green sign - demonstrating a free way forward - the way to the following sign or station is held for the train. At the point when a train passes a sign it will become red. The accompanying train will stop at the sign, until the train ahead exits the way, the accompanying train is attempting to hold, by passing another sign, leaving the station, or redirecting of to one more way at switch. Signals are possibly perceived via trains assuming they are put on the right-hand side seen according to the driver's point of view. As portrayed over, the driver should follow the signs cautiously and in like manner the train should be controlled proficiently. In some cases the driver might avoid the perspective on target side sign, this may prompts serious mishap. To stay away from such basic circumstance, here this extraordinary sort of transmission framework is planned by which the transmission present over the trackside signal post data will be sent to the motor lodge through remote correspondence framework planned with IR based information correspondence framework. At the point when the train comes to approach to the sign post, ahead of time at littlie away from the sign post, the sign data will be sent to the taxi that will be shown as unambiguous variety before the driver. At the point when the taxi gets explicit sign information, the caution will be empowered briefly and this course of action is made to alarm the driver ahead of time.

One more benefit of utilizing this framework is, during winter and because of the haze, the driver may not perceive the shade of sign over the track side sign post, in such condition the sign present over the external sign post will be shown over the scramble leading body of the rail motor, i.e., before driver.

For demo reason, little length of metal track will be laid over a wooden board and 3 smaller than expected signal posts will be introduced a side of track. Each sign post contains 3 markers and these pointers can be controlled physically. With the assistance of an inserted framework built with 89c2051 regulator chip, wanted sign can be stimulated by initiating the comparing key. For three markers, 3 control keys are utilized and are communicated with regulator chip. Like this 3 arrangements of control circuits are utilized for 3 sign posts. At the point when any key is enacted the comparing code as 8 digit information will be produced and sent through demodulating circuit planned with 555 clock chip and IR Drove. The point by point depiction of these circuits alongside information recipient circuit will be made sense of in following part.

Presently coming to the taxi flagging, a railroad security framework imparts the situation with the track side sign condition or data to the taxi, i.e., driver's compartment. The sign data can be ceaselessly refreshed when whole track course is furnished with this sort of correspondence framework. Utilizing same correspondence framework, the situation with the track or other data like forthcoming extensions data or turning data, and so on, additionally can be sent utilizing same innovation. This data can be shown in text structure to peruse effectively by the train driver. The least complex frameworks show the trackside signal, while additional refined frameworks likewise show passable speed, area of adjacent trains, and dynamic data about the track ahead. Taxi signs can likewise be essential for a more extensive train security framework that can naturally apply the brakes halting the train on the off chance that the administrator doesn't answer suitably to a risky condition. Moreover many highlights can be added to the framework utilizing this innovation, however since it is a model module, the impediment is being confined to show the situation with just track side sign condition in running rail driver taxi.

Presently coming to the implanted frameworks, here four frameworks are utilized and every one of them are built with 89c2051 Microcontroller chips. This is a 20 pin IC and having 2 Kb memory inside in its ROM. This is a low voltage elite execution CMOS 8-bit microcontroller chip with Streak programmable and erasable read-just memory (PEROM). The gadget is made utilizing Atmel's high-thickness non-unstable memory innovation and is viable with the business standard MCS-51 guidance set. Microcontrollers are progressively being utilized to execute correspondence and instrumentation frameworks. It is along these lines essential to comprehend Microcontroller based frameworks well. Today, microcontrollers have turned into a fundamental piece of all rationale gadgets. Committed framework that utilization microcontrollers, have unquestionably worked on the useful, functional and execution based details. The structural changes in instrumentation and control frameworks where and are because of the processing and correspondence capacity of the Miniature regulator gadgets. Miniature regulator should be treated as an instrument for registering and correspondence. Information on microcontrollers is significance full and exceptionally fulfilling in the event that it is applied to plan an item that is valuable in the business or for the general public overall. This is a subject, which has direct pertinence to modern item improvement and robotization. In this venture work, microcontroller is customized to carry out the role of encoding and deciphering methods, which is fundamental for any biomedical instrument.

Any Miniature regulator, that capabilities as per the program written in it. Here the program is ready in such a manner, so the framework carries out the role of send the information of sign post data. Also the other framework that will be introduced in the rail motor is modified as decoder by which the information got through IR signal locator will be decoded and shown as noticeable shaded lights.

The program is only a guidance set, this is much of the time ready in parallel code, and are alluded as machine code, there by this product is called as machine language. Composing a program in such a code is a talented and exceptionally drawn-out process. It is inclined to mistakes in light of the fact that the program is only a progression of 0's and 1's and the guidelines are not effectively grasped from simply checking the example out.

An option is to involve an effectively understood type of shorthand code for the examples 0's and 1's. Miniature regulator can peruse and it can store the data got from the outside gadgets. Miniature regulators are devoted to one undertaking and run one explicit program. The program is put away in ROM (read-just memory) and by and large doesn't change. Assuming there are any changes in the capability, or blunders in the product, the current program should be deleted from the chip and again adjusted program should be stacked in the chip through chip burner. The definite portrayal of these regulators is made sense of in following parts.

Obviously the above capabilities can't be performed without microcontrollers, hence these gadgets are supposed to be heart of the correspondence frameworks, presently a days there is no such electronic gadget or instrument that works without microcontroller. Subsequently miniature regulators are progressively being utilized to configuration a wide range of correspondence frameworks, instruments, control frameworks, robots, and so forth. It is in this way essential to comprehend miniature regulator based control frameworks well.

1.2 MOTIVATION

The motivation behind implementing an Automatic Cab Signalling System (ACSS) for rail engines stems from several key factors, each contributing to the overarching goal of enhancing railway safety, efficiency, and reliability:

Safety Improvement: The foremost motivation is to improve safety for passengers, crew, and the public. Railway accidents, including collisions and derailments, can have catastrophic consequences. ACSS helps mitigate these risks by providing real-time monitoring, automatic speed control, and collision avoidance capabilities.

Reducing Human Error: Human error is a significant factor in many railway accidents. ACSS minimizes reliance on human operators for critical safety functions, reducing the likelihood of errors such as overspeeding, missed signals, or failure to respond promptly to hazards.

Enhanced Operational Efficiency: Railway operators are constantly seeking ways to optimize operations and maximize the capacity of their networks. ACSS enables more efficient use of railway infrastructure by dynamically adjusting train speeds, managing traffic flow, and minimizing delays caused by manual intervention.

Capacity Expansion: With growing demand for rail transportation, especially in urban areas and along major corridors, there is a need to increase the capacity of existing railway networks. ACSS allows for higher train frequencies, improved scheduling, and tighter control over train movements, thereby enhancing network capacity without compromising safety.

Meeting Regulatory Requirements: Regulatory agencies impose stringent safety standards and signaling protocols that railway operators must adhere to. ACSS helps ensure compliance with these regulations by providing a robust safety framework, reliable communication systems, and data-driven monitoring capabilities.

Enhancing Passenger Confidence: Public perception of railway safety is crucial for attracting passengers and maintaining trust in the system. By implementing advanced safety technologies like ACSS, railway operators demonstrate their commitment to passenger safety, which can increase confidence and encourage modal shift from other forms of transportation.

Minimizing Environmental Impact: Efficient railway operations contribute to reducing greenhouse gas emissions and mitigating the environmental impact of transportation. ACSS helps optimize train movements, reduce idling time, and minimize energy consumption, supporting sustainability goals and environmental stewardship.

Technological Innovation: ACSS represents the convergence of cutting-edge technologies such as sensors, communication systems, and artificial intelligence. The motivation to harness these technologies and leverage their potential for improving railway safety and efficiency drives the development and adoption of ACSS solutions.

In summary, the motivation behind implementing an Automatic Cab Signalling System is multifaceted, encompassing safety imperatives, operational efficiencies, regulatory compliance, passenger satisfaction, environmental considerations, and the pursuit of technological advancement.

1.3 OBJECTIVE

The objective of an Automatic Cab Signalling System (ACSS) for rail engines is to enhance safety, efficiency, and reliability in railway operations. Here are the key objectives of implementing such a system:

- Safety Enhancement: The primary objective is to improve safety for passengers, crew, and the public by reducing the risk of collisions, derailments, and other accidents. The ACSS ensures that trains operate within safe speed limits, maintain appropriate distances from other trains, and adhere to signal indications.
- Collision Avoidance: ACSS helps prevent collisions between trains by providing automatic braking or speed control in case of potential conflicts, such as when a train approaches another train too closely or when it exceeds the safe speed limit.
- Reduced Human Error: By automating certain aspects of train operation, ACSS reduces the reliance on human operators and minimizes the risk of human error leading to accidents. It provides additional layers of protection against mistakes such as overspeeding, disregarding signals, or missing trackside hazards.
- Improved Operational Efficiency: ACSS optimizes train movements by dynamically adjusting speed and routing based on real-time conditions such as track occupancy, maintenance activities, and schedule changes. This leads to more efficient use of railway infrastructure and resources.
- Enhanced Capacity: By maintaining safe distances between trains and facilitating smoother operation, ACSS allows for increased train frequencies and higher capacity utilization of railway lines without compromising safety.
- Enhanced Communication: The system facilitates seamless communication between trains and the control center, enabling quick dissemination of critical information such as speed restrictions, track conditions, and emergency alerts.
- Data Collection and Analysis: ACSS collects data on train movements, speed profiles, and system performance, which can be analyzed to identify areas for improvement, optimize operations, and enhance overall system reliability.
- Compliance with Regulations: ACSS helps railway operators comply with regulatory requirements related to safety standards, signaling protocols, and operational procedures, ensuring a high level of safety and regulatory compliance across the railway network.

Overall, the objective of implementing an Automatic Cab Signalling System is to create a safer, more efficient, and reliable railway transportation system that meets the needs of passengers, freight operators, and other stakeholders while adhering to stringent safety standards and regulatory requirements.

CHAPTER 2
LITERATURE SURVEY

2.1 LITERATURE SURVEY

List of papers

Rosberg, T., Thorslund, B., 2020. Reenacted and genuine train driving in a lineside Programmed Train Assurance (ATP) framework climate. Diary of Rail Transport Arranging and The executives, 16, Article 100205. doi:10.1016/j.jrtpm.2020.100205.

Rosberg, T., Thorslund, B., 2022. Radio correspondence based technique for examination of train driving in an ERTMS flagging climate. European Vehicle Exploration Survey, 14, Article 18. doi:10.1186/s12544-022-00542-5.

Rosberg, T., Cavalcanti, T., Thorslund, B., Prytz, E., Moertl, P., 2021. Driveability Examination of the European Rail Transport The board Framework (ERTMS) - A Deliberate Writing Survey. Diary of Rail Transport Arranging and The board, 18, Article 100240. doi:10.1016/j.jrtpm.2021.100240.
Rosberg, T., Thorslund, B., 2022. Influence on driver conduct from ERTMS speed-sifting. Submitted to Diary of Rail Transport Arranging and The executives.

Announcement of commitment

As a base for this doctoral undertaking, a pre-study was performed along with Birgitta Thorslund "Forstudie tagsimulering och ERTMS" (Rosberg and Thorslund, 2018). The exploration area of train reenactment and ERTMS were figured out and a heading for the doctoral venture set. The task was given to VTI by Swedish Vehicle Organization (Trafikverket) addressed by Magnus Wahlborg and Per Köhler. Per Köhler started the plan to gauge how train driving way of behaving is associated with various sign targets and slowing down bends. The writing study for Paper 1 was performed by me with help from Birgitta Thorslund. I played out all the train estimations and information post-handling and composed a large portion of Paper 1 with normal input from Birgitta Thorslund and Anders Lindström.

For Paper 2 Birgitta Thorslund and I proceeded with the cooperative work with the writing study and research questions. My thought behind the estimation strategy introduced in the paper was brought into the world at a concentrate on visit at Trafikverket telecom office in Örebro during august 2019. The train estimation approval with its specialized arrangement and information post-handling, trailed by the technique writing computer programs, was performed by me. Pär Johansson at Trafikverket Kapacitetscenter had important contribution to the technique improvement. At long last, I composed the paper with customary criticism from Birgitta Thorslund. Markus Bohlin helped enormously in amending the paper.

The principal draft of Paper 3, introducing a deliberate writing survey, was composed by Thiago Cavalcanti. With Thiago choosing to begin another profession past rail line research, I took lead on reexamining the paper furthermore, presented driveability with regards to a Human-Innovation Association model (HTO). In coordinated effort with Birgitta Thorslund more distributions were incorporated, which expanded the attention on human and innovation parts of driveability. Peter Moertl and Erik Prytz contributed with human factor ability and evaluated the paper.

In the fourth undertaking, and Paper 4, Birgitta Thorslund, Krister Gällman, and I played out the information assortment together. I have arranged and planned the review, arranged the programming of the train test system with all fundamental programming for the field explore. At last, I composed the principal draft of the paper, to which Birgitta contributed with input and amendment. Mats Berg, Oskar Fröidh and Behzad Kordnejad contributed with significant info and input to this theory. The exploration commitment of the postulation is portrayed in Area 4.

CHAPTER 3

BLOCK DIAGRAM & ITS DESCRIPTION

3.1 BLOCK DIAGRAM OF THE PROJECT

TRANSMITTER

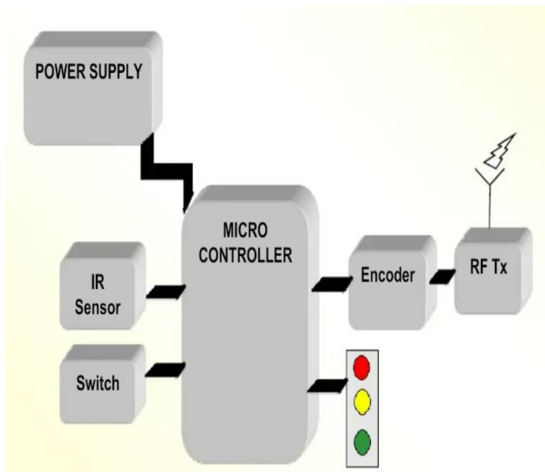

FIG 3.1: Block Diagram of Transmitter

RECEIVER

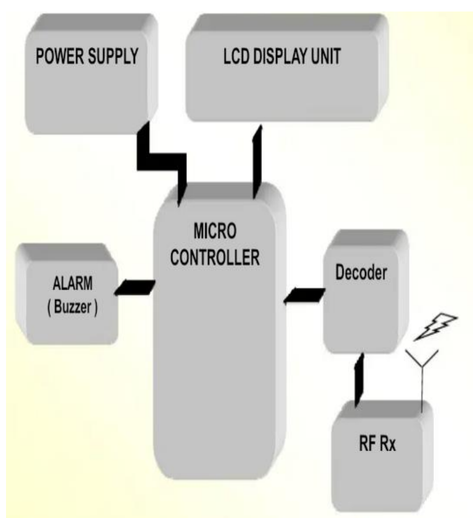

FIG 3.2: Block Diagram of Receiver

3.2 INTERFACING DISCRIPTION

The process begins with the signal data transmitting circuit, here 3 similar cards are used and are constructed with 89C2051 microcontroller chips and 555 timer chips. This card is supposed to be installed just before the signal post by side of train track. The controller chip used here is a tiny device having 20 pins, it occupies very less space. Therefore the data transmitting card is designed as compact, & it is arranged near the signal post. Like this 3 similar circuits are constructed with 3 signal posts. As described in previous chapter, each signal post contains 3 indicators and they are Red, Green and Yellow. The desired signal can be selected through corresponding control key. Whenever any key is activated corresponding signal light will be energized and this information in the form of 8-bit digital code will be transmitted through modulator circuit designed with timer chip and IR LED. Likewise 3 similar circuits are constructed for 3 signal posts independently. The signal selection must be done manually.

The controller used in the data transmitting card generates digital information that is proportionate to the corresponding colour LED, this is a pre-programmed chip always generates the same information that is activated through corresponding key. The digital data produced by the controller is modulated at 38 KHz frequency. Modulation is important here, because the data produced by the controller cannot be travelled as it is as a modulated wave, there by this data is super imposed over this frequency. The frequency produced by the timer chip is performing the function of carrier oscillator; the digital data produced by the controller is mixed with this frequency & transmitted through Infrared LED as a modulated wave. Means the digital information generated by the controller is transmitted through IR LED.

LM555 timer chip is used to modulate infrared light, modulation is necessary to make infrared signal stand out above the noise. The modulation technique makes the IR light source to blink in a particular frequency, so that it can ignore everything else. This timer IC will produce the pulse when a trigger signal is applied to it, here the trigger code or train of pulse can be obtained from the Microcontroller. The output of Microcontroller is fed to reset pin of timer IC and depending up on the resister and capacitor (timing components) connected externally to the timer IC, the pulse length is determined. Irrespective of trigger pulse, since the timer IC is configured as astable mode of operation, depending up on the values of resistor and capacitor, it produces 38 KHz, which is used as IR signal transmitter.

The modulated signal obtained from output pin of timer IC is driving the IR LED through its drive transistor. In Serial Communication we usually speak of 'Marks' and 'Spaces'. The 'Space' is the default signal, which is the off state in the Transmitter case. No light is Emitted during the 'Space' state. During the 'mark' state of the signal the IR light is pulsed on and off at a particular frequency. Frequencies between 30 KHz and 60 KHz are commonly used in consumer electronics, but in this project work 38 KHz is produced to match with TSOP 38 IR Receiver. At the receiver side a high level of the receiver's output represents a 'space'. A 'mark' is than automatically represented by a low level.

The signal delivered from the IR LED transmits the information in uni-direction like a laser beam. This LED must be exposed from the circuit & there should not be any obstacles, the signal delivered from this device must travel in space freely. It is the function of infrared LED to deliver the infrared energy in the form of infrared rays, through which data will be transmitted. Now the range is depending up on the radiating power that is delivered by the IR LED, as it is a proto type module the current flowing through IR LED is restricted to less than 20 milliamps, thereby range is restricted to less than 20". The range depends up on the strength, means radiating power of the LED. If required this range can be enhanced by pumping more current in to the IR signal transmitting LED. But since it is a prototype module and the system is designed as compact, range is restricted.

The prototype module is constructed over a wood plank and for demo purpose train track is simulated with signal posts. Train is also simulated with specially designed grooved metal wheels that move over the metal track. This toy train must be moved manually over the track to gather the signal data from the external signal posts. The IR signal receiver is arranged over this moving body or trolley and it is interfaced with another 89c2051 controller chip. This sensor package that contains all required blocks internally demodulates the data and the original code that is transmitted will be re-developed at the final output. TSOP 1738 is used as IR sensor package and this is a three pin device & operates at 38 KHz frequency. As this sensor package operates at 38 KHz, the signal delivered from the transmitter is modulated at 38 KHz. The modulated frequency produced by the transmitter should be exactly the same with sensor package, and then the communication link will be established between transmitter & receiver.

Whenever the train passes through signal post, the IR sensor (TSOP) will acquire data from the signal post and this information will be passed to the controller chip. In real time as each signal post is equipped with its data transmitter, according to the corresponding signal corresponding code will be transmitted, based on this data the main processor installed in the cabin can recognize the signal code and accordingly the same signal will be displayed inside the cab. Initially the data acquired from the sensor package will be stored in to the controller and later immediately it will be displayed.

3.3 IN THE OFF STATE OF THE ROBOT

All the connections are made & the battery supply is in off state i.e., Robot is in off state

Fig 3.3 in the Off State of the Robot

3.4 IN THE ON STATE OF THE ROBOT

All the connections are made & the battery supply is in ON state i.e., Robot is in ON condition

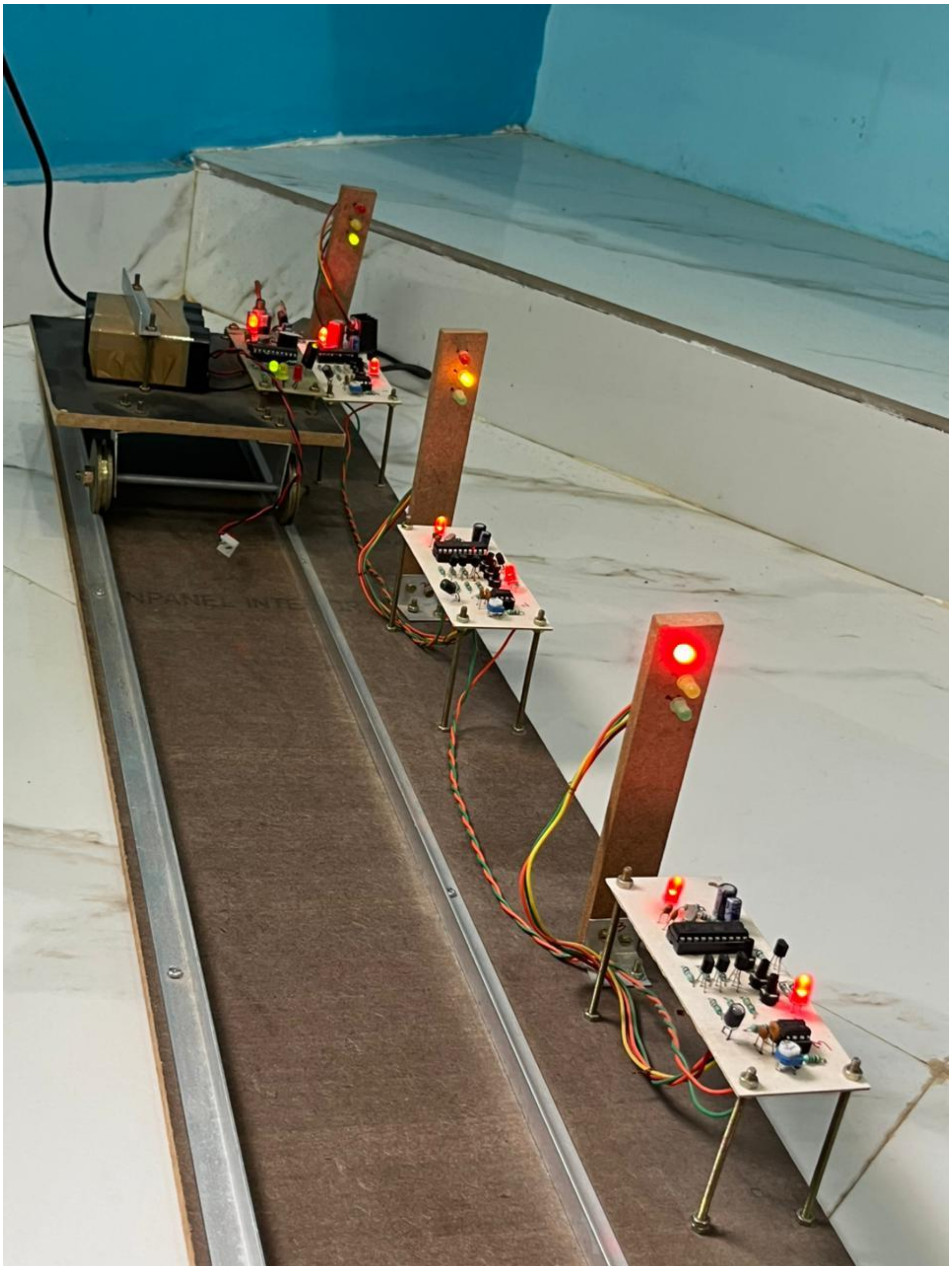

Fig 3.4 In the On State of the Robot

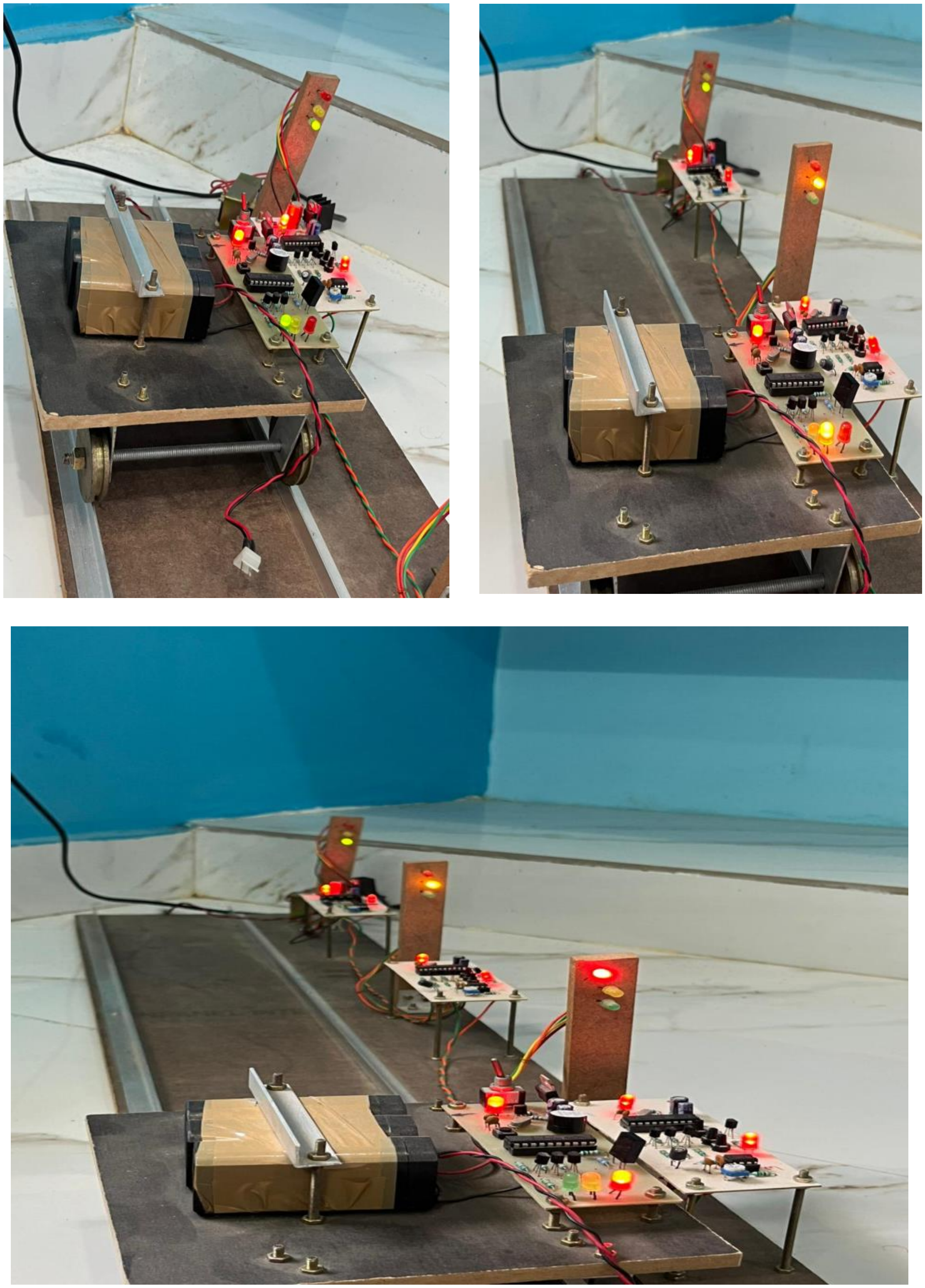

Fig 3.5 IN THE ON STATE OF THE ROBOT

CHAPTER 4

DESCRIPTION OF THE HARDWARE COMPONENT

4.1 HARDWARE COMPONENTS

- IR communication system
- IR Signal Modulator
- Data Receiving Module
- Controller chips
- 8051 Micro controller
- Wheels
- Battery
- ON-OFF dc switch

4.2 COMPONENT DESCRIPTION

4.2.1 IR COMMUNICATION SYSTEM

The communication system is designed with infrared sensors, the digital data produced by the data transmitter is modulated at 38 KHz, and the same is transmitted through IR LED. The data receiving part of the project work is designed with TSOP 1738, this is a sensor package. The data transmitter card designed with 89C2051 Microcontroller generates the digital information that contains signal code and it is transmitted through optical sensor. Infrared LED is used as optical sensor and the digital data produced by the controller chip is transmitted through modulated frequency of 38 KHz produced by the 555 timer IC. The optical sensor transmits the information in uni-direction like a laser beam. The data receiving circuit designed with another 89c2051 controller chip, receives the information through another optical sensor. TSOP 1738 is used as data receiver, which receives the data and demodulates the signal. This information is fed to the controller chip. Since it is prototype module, only 3 signal posts are used. But in practical approach entire posts installed alongside the track data can be obtained by the running train.

As it is a demo module, & narrow path track is considered as a rail track and the range between the IR signal transmitting LED and IR signal detector should not exceed more than 10”. In fact, the range can be increased to a maximum distance of 20 feet, but here it is not required to increase the range, there by the range is restricted through current limiting resistor connected in series with the IR LED that generates & radiates IR signal. In other words, the range can be increased or decreased based on the current flowing through the junction of IR LED. The function of this device is to translate the digital data produced by the controller in to infrared light. The sensor on the other end (TSOP 1738) detects the infrared light and reacts appropriately.

The frequency produced by the modulator circuit is used as carrier and the carrier frequency of such infrared signals is typically around 38 kHz. Usually, the transmitter part is constructed so that the transmitter oscillator, which drives the infrared transmitter LED, can be turned on/off by applying a TTL (transistor-transistor logic) voltage on the modulation-controlled input. On the receiver side, a phototransistor or photodiode takes up the signals.

The approach used in this project work is the modular approach where the overall design was broken into functional block diagrams, where each block in the diagram represents a section of the circuit that carries out a specific function. The system was designed with different functional blocks; each block according to the circuit description is as followed.

IR transmission

The transmitter of an IR Drove inside its circuit, which emanates infrared light for each electric heartbeat given to it. This heartbeat is created as a button on the remote is squeezed, subsequently finishing the circuit, giving inclination to the Drove.

The Drove on being one-sided emanates light of the frequency of 940nm as a progression of heartbeats, relating to the button squeezed. Anyway since alongside the IR Drove numerous different wellsprings of infrared light like us individuals, lights, sun, and so on, the communicated data can be meddled. An answer for this issue is by balance. The sent sign is tweaked utilizing a transporter recurrence of 38 KHz (or some other recurrence between 36 to 46 KHz). The IR Drove is made to waver at this recurrence for the time term of the beat. The data or the light signals are beat width regulated and are contained in the 38 KHz recurrence.

IR recipient

The recipient comprises of a photograph indicator which fosters a result electrical sign as light is occurrence on it. The result of the locator is sifted utilizing a limited band channel that disposes of the relative multitude of frequencies underneath or over the transporter recurrence (38 KHz for this situation). The separated result is then given to the reasonable gadget like a Microcontroller or a Microchip which controls gadgets like a PC or a Robot. The result from the channels can likewise be associated with the Oscilloscope to peruse the beats.

Portions of IR correspondence framework:
IR Transmitter-IR Sensor

The sensors could be used as a piece of estimating the radiation temperature with no contact. For various radiation temperature ranges different channels are accessible. An infrared (IR) sensor is an electronic gadget that emanates or finds infrared radiation to detect some piece of its environmental factors. They are imperceptible to natural eyes.

An infrared sensor could be viewed as a Polaroid that momentarily reviews how a region's infrared radiation appears. It is extremely normal for an infrared sensor to be facilitated into development pointers like those used as an element of private or business security frameworks. An IR sensor is displayed in figure; essentially it has two terminals positive and negative. These sensors are imperceptible to natural eyes. They can gauge the intensity of an item and furthermore recognize development. The district frequency generally from 0.75µm to 1000 µm is the IR locale. The frequency district of 0.75µm to 3 µm is called close infrared, the locale from 3 µm to 6 µm is called mid infrared and the area higher than 6 µm is called far infrared. IR sensors radiates at a recurrence of 38 KHz.

Elements of IR Sensor:
- Input voltage: 5VDC
- Detecting Reach: 5cm
- Yield signal: simple voltage

• Discharging component: Infrared Drove

Model connecting circuit of IR diode and photodiode

IR sensors for the most part utilized in radiation thermometer, gas analyzers, modern applications, IR imaging gadgets, following, and human body location, correspondence and wellbeing perils

Here is a concise portrayal of IR and Photograph diode detecting switch:

An IR diode is associated through a protection from the dc supply. A photograph diode is associated backward one-sided condition through a possible divider of a 10k variable obstruction and 1k in series to the foundation of the semiconductor. While the IR beams fall on the converse one-sided photograph diode it leads that causes a voltage at the foundation of the semiconductor.

The semiconductor then, at that point, works like a switch while the gatherer goes to ground. When the IR beams are discouraged the driving voltage isn't accessible to the semiconductor accordingly its gatherer goes high. This low to high rationale can be utilized for the microcontroller input for any activity according to the program.

IR Beneficiary/TSOP Sensor - Elements and Determinations

TSOP is the standard IR controller collector series, supporting all significant transmission codes. This is equipped for getting infrared radiation adjusted at 38 kHz. IR sensors we have seen up to now stirring only for minimal brief distance up to 6 cm. TSOP is delicate to a particular recurrence so its reach is better difference with customary photograph diode. We can modify it up to 15 cm.

TSOP behaves like as a recipient. It has three pins GND, Versus and OUT. GND is associated with shared view, Versus is associated with +5volts and OUT is associated with yield pin. TSOP sensor has an inbuilt control circuit for intensifying the coded beats from the IR transmitter. These are usually utilized in television far off collectors. As I said above TSOP sensors sense just a specific recurrence.

Highlights:

• The preamplifier and photograph locator both are in single bundle

• Interior channel for PCM recurrence

• Further developed protecting against electrical field unsettling influence
• TTL and CMOS similarity
• Yield dynamic low
• Low power utilization
• High invulnerability against encompassing light
• Persistent information transmission conceivable

Details:

• Supply Voltage is - 0.3-6.0 V
• Supply Current is 5 Mama
• Yield Voltage is - 0.3-6.0 V
• Yield Current is 5 Mama
• Capacity Temperature Reach is - 25-+85 °C
• Working Temperature Reach is - 25-+85°C

The testing of TSOP is extremely straightforward. These are usually utilized in television distant recipients. TSOP comprises of a PIN diode and pre-intensifier inside. Interface TSOP sensor as displayed in circuit. A Drove is associated through an obstruction from the stock to yield. And afterward when we press the button of T.V. Controller before the TSOP sensor, on the off chance that Drove begins squinting, our TSOP sensor and its association is right. The moment that the result of TSOP is low for example at the time it appropriates IR signal from a source, with a middle recurrence of 38 kHz, its result goes low.

TSOP sensor is utilized in our everyday use television, VCD, music framework's controller. Where IR beams are sent by pressing a button on far off which are gotten by TSOP beneficiary inside the gear.

Photograph Credit:

• IR correspondence rule by sb projects

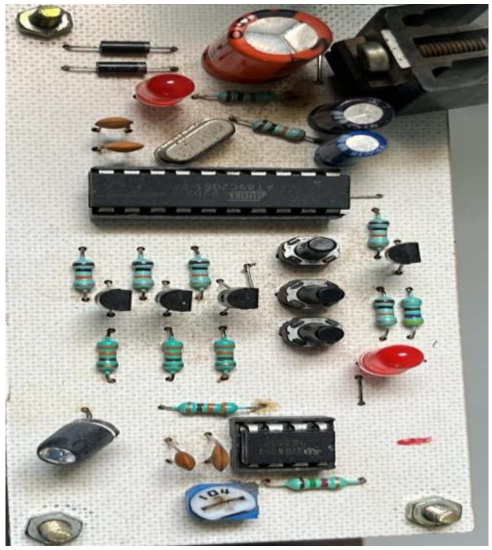

Fig 4.1 IR Communication module

An Infrared (IR) communication system is a technology that enables the transmission of data wirelessly using infrared light. Here's an overview of how IR communication systems work, their applications, and some key considerations:

How IR Communication Works:

Transmitter: The transmitter converts electrical signals containing data into infrared light pulses. These pulses are modulated to encode the data being transmitted.

Infrared Light: The modulated infrared light travels through the air in a line-of-sight path to the receiver. The transmission range depends on factors such as the power of the transmitter, ambient light conditions, and obstacles in the path.

Receiver: The receiver detects the modulated infrared light and converts it back into electrical signals. These signals are then decoded to recover the original data.

Line-of-Sight: IR communication requires an unobstructed line-of-sight path between the transmitter and receiver. Obstacles such as walls or objects can interfere with the transmission and reduce the effective range.

Applications of IR Communication Systems:

Remote Controls: IR communication is commonly used in remote controls for devices such as televisions, DVD players, and air conditioners. The remote sends commands to the device using IR signals.

Data Transfer: IR communication can be used for short-range data transfer between devices, such as smartphones, laptops, and printers. It's often used for tasks like exchanging contact information, sharing files, or synchronizing devices.

Wireless Headphones: Many wireless headphones and audio systems use IR communication to transmit audio signals from the source device to the headphones. This provides freedom of movement without the need for physical cables.

Security Systems: IR communication is employed in security systems for purposes such as transmitting signals from motion sensors, door/window sensors, and alarm panels to a central control unit.

Automotive Applications: IR communication is used in automotive applications for tasks like controlling car entertainment systems, transmitting data between vehicle components, and facilitating communication between cars in autonomous driving scenarios.

Key Considerations:

Line-of-Sight: As mentioned earlier, IR communication requires an unobstructed line-of-sight path between the transmitter and receiver. Obstacles can interfere with the transmission and degrade performance.

Range and Power: The effective range of IR communication is limited compared to other wireless technologies like radio frequency (RF). Increasing the power of the transmitter can extend the range, but it also increases power consumption and may require regulatory compliance.

Interference: Ambient light sources, especially sunlight and certain types of artificial lighting, can interfere with IR communication. Proper shielding and modulation techniques are used to mitigate interference.

Security: IR signals can be intercepted by nearby devices equipped with IR receivers. Encryption and authentication mechanisms may be employed to enhance security and prevent unauthorized access to transmitted data.

Overall, IR communication systems offer a convenient and cost-effective solution for short-range wireless communication in various applications, particularly those requiring line-of-sight transmission and simple data exchange.

4.2.2 IR SIGNAL MODULATOR

In this block 555 timer IC is used to modulate infrared light, modulation is necessary to make infrared signal stand out above the noise. The modulation technique makes the IR light source to blink in a particular frequency, so that it can ignore everything else.

This timer IC will produce the pulse when a trigger signal is applied to it, here the trigger pulse can be obtained from the Microcontroller. The output of Microcontroller is fed to reset pin of timer IC; depending up on the resister and capacitor (timing components) connected externally to the timer IC, the pulse length is determined. Irrespective of trigger pulse, since the timer IC is configured as astable, depending up on the values of resistor and capacitor, it produces 38 KHz, which is used as IR signal transmitter. The modulated signal obtained from output pin of timer IC is driving the IR LED through its drive transistor.

Many circuits are designed to be used as IR transmitters, in this project work 555 timer IC is used as IR transmitter, which consumes very less power. The data to be transmitted through IR LED is obtained from output pin of microcontroller, this digital data is fed to pin no.4 of 555 timer chip as a modulating signal. Since the timer IC is configured as Astable mode of operation, as a self oscillator it is delivering perfect square pulses of 38 KHz (approximately) continuously. The output of the timer IC is fed to infrared LED which is used as data transmitting LED. Since it is a commercial IR LED, the current flowing through the LED is restricted by connecting a current limiting resister of 150 ohms in series with this LED. Depending up on different ratings of IR LED's, the current through the LED can vary from 10 milliamps to 300 milli amps. In Order to get acceptable Control distance the LED Currents have to be as High as possible. LED Currents can be that High because the Pulses driving the LED's are very short, Average Power dissipation of the LED should not exceed the Maximum value according to the data sheet provided by the manufacturer. Another important thing is that the maximum peak current applied to the LED should not exceed. Peak to peak amplitude value is also important that it should not exceed more than 1.5V.

To amplify the LED current, a simple transistor circuit can be used to drive the LED. A Transistor with a suitable Hfe and Switching Speed should be selected for this purpose. The current and voltage limiting resister values can simply be calculated using Ohm's law. Voltage drop across the LED should not exceed more than 1.2V.

The frequency can be set to 38 KHz approximately by varying the value of 50K variable resistor. The timing capacitor connected between pin No.2 to ground is a fixed value capacitor of 0.1Mf, this can be a metalized polyester capacitor, otherwise if we use any ordinary capacitor, value may be differed due to the environmental conditions. When the circuit is energized initially, the discharge pin (pin no.7) is disconnected from ground and output pin is set high because the trigger pin is below 33% Vcc voltage. The capacitor C (.1MF) starts to charge through resisters 1K and 50K. The threshold pin (pin No.6) is used to detect when the voltage across the capacitor reaches 67% Vcc voltage approximately. When the voltage across the capacitor reaches 67%, the output pin is set low and the discharge pin is connected back to ground, after that the capacitor starts discharging through 50K variable resistor. Again when the voltage across the capacitor reaches 33%, the cycle repeats and creates a series of output pulses. An Astable circuit triggers from previous output pulse where as a mono-stable circuit requires an externally applied trigger. The output pin oscillates from high to low creating a series of output pulses.

Fig 4. 2 IR Signal modulator

An Infrared (IR) modulation circuit is an electronic circuit that modulates electrical signals to encode data onto infrared light pulses. It is a key component of IR communication systems, enabling the transmission of data between devices using infrared radiation. This article provides an overview of IR modulation circuits, including their principles of operation, common modulation techniques, and applications.

Principles of Operation

The primary function of an IR modulation circuit is to convert digital or analog electrical signals into modulated IR light pulses. The circuit typically consists of several key elements, including a modulation controller, a driver circuit, and an infrared light-emitting diode (LED) or laser diode.

Modulation Controller: The modulation controller generates the modulated signal that carries the data to be transmitted. It may use various modulation techniques, such as Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), or Pulse Width Modulation (PWM), to encode the data onto the carrier signal.

Driver Circuit: The driver circuit amplifies the modulated signal generated by the modulation controller and provides the necessary current to drive the IR LED or laser diode.

It ensures that the IR emitter emits light pulses with the desired intensity and modulation characteristics.

Infrared Light Emitter: The IR LED or laser diode emits infrared radiation in response to the electrical signals provided by the driver circuit. The emitted light pulses carry the modulated data and propagate through the air to the receiver.

Common Modulation Techniques

Amplitude Shift Keying (ASK)

In ASK modulation, the amplitude of the carrier signal is varied to represent binary data. A high amplitude represents one binary state (e.g., logic 1), while a low amplitude represents the other binary state (e.g., logic 0).

Frequency shift keying (FSK)

FSK modulation involves shifting the frequency of the carrier signal between two predefined frequencies to represent binary data. Each frequency corresponds to a distinct binary state, allowing for reliable data transmission.

Pulse Width Modulation (PWM)

PWM modulation varies the width of the pulses in the carrier signal to encode data. A wide pulse represents one binary state, while a narrow pulse represents the other binary state. PWM modulation is commonly used for controlling the intensity of IR light pulses.

Applications

IR modulation circuits find widespread use in various applications, including:

Remote controls for consumer electronics

Wireless data transfer between devices

Infrared proximity sensors and motion detectors

Security systems and surveillance cameras

Automotive applications such as vehicle communication systems

Future Trends

Advancements in semiconductor technology and modulation techniques continue to drive innovation in IR modulation circuits. Future trends may include:

- Higher data transfer rates and transmission ranges
- Integration with other wireless communication technologies
- Enhanced power efficiency and miniaturization for portable devices
- Improved resistance to interference from ambient light sources

4.2.3 DATA RECEIVING MODULE

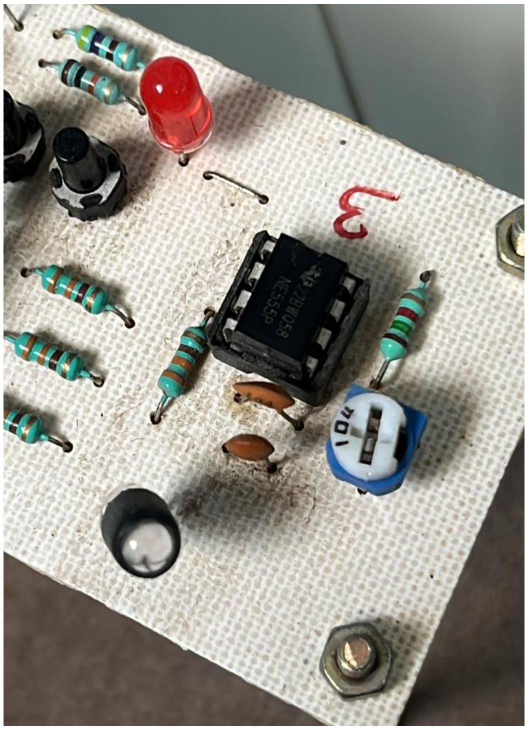

Fig. 4.3 Data receiving module

The data receiving module, i.e. the IR emitter needs to be modulated by a frequency of 38KHz since the detector used in this project work only detects 38KHz modulated IR signal, the modulator circuit in the transmitter generates the same frequency. The detector is set to only see 38 KHz modulated IR because there are random IR sources such as over head lights, the sun, heaters, etc. in most environments that can cause interference if using un-modulated IR.

The circuit is designed to operate at 5V DC, in general the photo diode used in the sensor package conducts at specific voltage applied through a potential dividing network. The reference voltage produced internally varies according to the conduction and non-conduction modes of IR sensor, whenever infrared light falls on the IR sensor, the device conducts. The device saturates fully when proper light falls on it. During the non-conduction mode, means as long as the sensor doesn’t receive any infrared signal, the diode output remains in zero state.

The communication link between the transmitter & receiver will be synchronized, when frequencies are matched. The easiest way to remotely acquire data within a visible range is via Infrared light. Infrared actually is normal light with a particular color. We humans can’t see this colour because its wavelength of 950nm is below the visible spectrum. That’s one of the reasons why IR is chosen for remote applications; we want to use it but were not interested in seeing it. Another reason is because IR LED’s are quite easy to make, and therefore these are cost effective devices.

At the transmitting side, an ordinary commercial IR LED is used, which cannot be used for long distances, here the application is to transfer the data to a nearest sensor, there by the range is restricted. The basic concept of this LED is to emit infra red light, when a small voltage is applied to it. The signal delivered from the LED radiates in uni-direction, like a laser beam. At the receiving side TSOP 1738, which is an optical signal detector, operates at 38 KHz, is used. This is a kind of IR signal receiver package consists of IR detection diode (photo diode), signal amplifier, limiter, Band Pass Filter, Demodulator, Integrator and comparator. The block diagram of IR receiver is shown below.

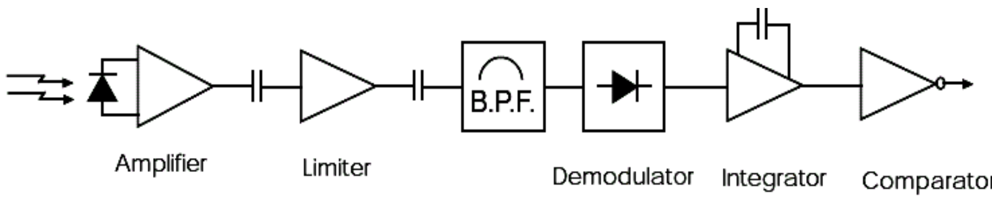

FIG 4.4 ACG

As per the above block diagram provided by the manufacturer of TSOP1738, the receiver IR signal is picked up by the IR detection diode on the left side of the diagram. The signal is amplified and limited by the first 2 stages. The limiter acts as an AGC (Automatic Gain Control) circuit to get a constant pulse level, regardless of the distance to the transmitter. As we can see only the AC signal is sent to the Band pass Filter. The Band Pass filter is tuned to the modulation frequency of the transmitter. Common frequencies range from 30 KHz to 60 KHz in consumer electronics. The next stages are demodulator, integrator and comparator. The purpose of these three blocks is to detect the presence of the modulation frequency. If this modulation frequency is present the output of the comparator will be pulled low. All these blocks are integrated in to a single electronic component. There are many different manufacturers of these components in the market. And most devices are available in several versions each of which are tuned to a particular modulation frequency.

Since the amplifier is set a very high gain, the system tends to start oscillating very easily. Placing a large capacitor of at least 22μF close to the receiver's power connections is mandatory to decouple the power lines. Some data sheets recommend a resistor of 330 ohms in series with the power supply to further decouple the power supply from rest of the circuit.

There are several manufacturers of IR receivers on the market. Siemens, Vishay and Telefunken are the main suppliers. Siemens has its SFH506-xx series, where xx denotes the modulation frequency of 30, 33, 36, 38, and 40 of 56KHz. Telefunken had its TFMS5xx0 and TK18xx series, where xx again indicates the modulation frequency the device is tuned to. It appears that these parts have now become obsolete. They are replaced by the Vishay TSOPxx product series. In this project work TSOP 38 is used, the modulation frequency of this device is 38 KHz. To synchronize this IR signal receiver, the carrier frequency produced by the timer IC, at transmitting module should generate 38 KHz.

A data receiving module, often referred to as a receiver module, is an electronic component designed to detect and demodulate modulated infrared (IR) light pulses transmitted by an IR transmitter. It is a key element in IR communication systems, enabling the reception of data transmitted wirelessly via IR radiation. This article provides an overview of data receiving modules, including their principles of operation, components, and applications.

Principles of Operation

The primary function of a data receiving module is to capture modulated IR light pulses emitted by the IR transmitter and convert them into electrical signals representing the transmitted data. The module typically consists of the following key components:

Photodetector: The photodetector is a semiconductor device that converts incoming IR light into electrical signals. Common types of photodetectors used in IR receivers include photodiodes and phototransistors. When exposed to IR light, these devices generate a current or voltage proportional to the intensity of the received light.

Demodulation Circuitry: The demodulation circuitry extracts the modulated data from the electrical signals generated by the photodetector. Depending on the modulation technique used by the IR transmitter (e.g., ASK, FSK, PWM), the demodulation circuitry applies the corresponding demodulation algorithm to recover the original data.

Signal Processing Circuitry: In some receiver modules, additional signal processing circuitry may be included to filter out noise, amplify the received signals, and perform other signal conditioning tasks. This circuitry ensures reliable and accurate data reception even in noisy environments.

Components

Photodetector

The photodetector is typically a small semiconductor device housed within the receiver module. It is designed to be sensitive to IR radiation within the wavelength range used for communication (usually around 850 nm to 950 nm for consumer-grade IR communication systems).

Demodulation Circuitry

The demodulation circuitry may consist of analog or digital components, depending on the complexity of the modulation scheme used by the IR transmitter. It may include filters, amplifiers, and demodulation algorithms tailored to the specific modulation technique employed.

Signal Processing Circuitry

Signal processing circuitry, if present, may include components such as operational amplifiers, filters, and microcontrollers. These components work together to enhance the quality of the received signals and improve the overall performance of the receiver module.

Applications

Data receiving modules find applications in various industries and consumer products, including:

- Remote controls for TVs, DVD players, and other home entertainment devices
- Wireless data transfer between smartphones, laptops, and other electronic devices
- Infrared proximity sensors and motion detectors for security systems
- Automotive applications such as vehicle communication systems and keyless entry systems
- Industrial automation and control systems requiring wireless data transmission

Future Trends

Advancements in semiconductor technology and signal processing algorithms continue to drive innovation in data receiving modules. Future trends may include:

- Improved sensitivity and signal-to-noise ratio for enhanced range and reliability
- Integration with other wireless communication technologies such as Bluetooth and Wi-Fi
- Miniaturization and cost reduction to enable deployment in compact and portable devices
- Enhanced energy efficiency to prolong battery life in battery-powered applications

4.2.4 CONTROLLER CHIPS

FIG 4.5 Controller chips

The components of a typical microcontroller includes the CPU (Central Processing Unit), RAM (Random Access Memory), ROM (Read only Memory), I/O lines, timers, serial communication interface, etc. The CPU executes the software stored in ROM and controls all other components of that particular microcontroller. The RAM is utilized to store the settings and values used by an executing program. Similarly the ROM is used to store the program; this program can be a permanent data, according to the interrupt signals or any other external data obtained from I/O lines, outputs are controlled accordingly. A designer can have a program and data permanently stored in ROM by the chip manufacturer, or the ROM can be in the form of EPROM or EEPROM, which can be programmed by the user. The software permanently stored in ROM can be referred as firmware. Microcontroller chip manufacturers offer programming devices that can download a compiled machine code file from a PC directly to the EEPROM of the microcontroller. Often the programming devices are called chip burners; the code prepared through PC is delivered through its serial port & downloaded in to microcontroller through programming device. The chip is burnt through special purpose pins & later these pins can usually be used for other purposes once the device is programmed. Additional EEPROM may also be available and used by the program to store settings and parameters generated or modified during execution. The data stored in EEPROM is nonvolatile, which means the program remains as it is, it will not be disturbed by the power failures. In other words, the program can access data when the controller power is turned off and back on again.

The digital I/O (Input/Output) lines allow binary data to be transferred to and from the microcontroller using external pins on the chip. Most of the controllers used for simple applications are eight bit, it delivers data through its ports, and each port contains eight I/O lines. The I/O pins are used to read the information gathered from input devices or data receiving pin, often different types of sensors are used to perform various functions. In some cases interrupt signals will be generated through limit switches, based on these signals external mechanism can be controlled for specific application. The I/O pins can also be used to transmit or receive signals from other microcontrollers or processors to coordinate various functions. The microcontroller can also use a serial port to transmit data to and from external devices based on the restriction such that the external devices must support the same serial communication protocol. In few cases if the program is too lengthy, where as the microcontroller memory is less, in this condition additional memory chips like EEPROM can be interfaced with the existing controller chip. In this case the external memory chip can store huge data for the microcontroller.

The main processing unit designed with another 89C2051 microcontroller is programmed to perform various functions. The primary function is to decode the data that is received through IR signal receiver. The prime use of micro controller in the receiver, which is supposed to energize the signal LED, Initially the process begins from the transmitting section (remote), depending up on the control signals in the form of binary or digital data produced by the micro controller 89C2051 and it is fed to the IR transmitter for modulation. The following is the detailed description about the micro controller.

A digital computer typically consists of three major components: the Central Processing Unit (CPU), program and data memory, and an Input/Output (I/O) system. The CPU controls the flow of information among the components of the computer. It also processes the data by performing digital operations. Most of the processing is done in the Arithmetic-Logic Unit (ALU) within the CPU. When the CPU of a computer is built on a single printed circuit board, the computer is called a minicomputer. A microprocessor is a CPU that is compacted into a single-chip semiconductor device. Microprocessors are general-purpose devices, suitable for many applications. A computer built around a microprocessor is called a microcomputer. The choice of I/O and memory devices of a microcomputer depends on the specific application. For example, most personal computers contain a keyboard and monitor as standard input and output devices.

A micro controller is an entire computer manufactured on a single chip. Micro controllers are usually dedicated devices embedded within an application. For example, micro controllers are used as engine controllers in automobiles and as exposure and focus controllers in cameras. In order to serve these applications, they have a high concentration of on-chip facilities such as serial ports, parallel input output ports, timers, counters; interrupt control, analog-to-digital converters, random access memory, read only memory, etc. The I/O, memory, and on-chip peripherals of a micro controller are selected depending on the specifics of the target application. Since micro controllers are powerful digital processors, the degree of control and programmability they provide significantly enhances the effectiveness of the application.

Embedded control applications also distinguish the micro controller from its relative, the general-purpose microprocessor. Embedded systems often require real-time operation and multitasking capabilities. Real-time operation refers to the fact that the embedded controller must be able to receive and process the signals from its environment as they are received. That is, the environment must not wait for the controller to become available. Similarly, the controller must perform fast enough to output control signals to its environment when they are needed. Again, the environment must not wait for the controller. In other words, the embedded controller should not be a bottleneck in the operation of the system. Multitasking is the capability to perform many functions in a simultaneous or quasi-simultaneous manner. The chip used in the project work belongs 8051 family and hence the following is the description of the 8051 internal structure.

The embedded controller is often responsible of monitoring several aspects of a system and responding accordingly when the need arises. The 8051 is the first micro controller of the MCS-51 family introduced by Intel Corporation at the end of the 1970s.

The 8051 family with its many enhanced members enjoys the largest market share, estimated to be about 40%, among the various micro controller architectures. The architecture of the 8051 family of the micro controllers is presented in this chapter. First, the original 8051 micro controller is discussed, followed by the enhanced features of the 8032, and the 80C515.

4.2.5 8051 MICRO CONTROLLER

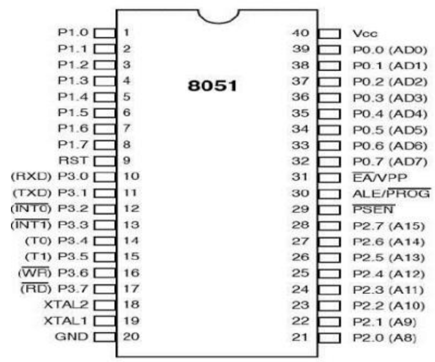

Fig 4.6 8051 MICRO CONTROLLER

The design of the 8051 group of miniature regulators is alluded to as the MCS-51 engineering, or at times essentially as MCS-51. The miniature regulators have a 8-bit information transport. They are equipped for tending to 64K of program memory and a different 64K of information memory. The 8051 have 4K of code memory executed as on-chip Read Just Memory (ROM). The 8051 have 128 bytes of interior Irregular Access Memory (Smash). The 8051 has trickster/counters, a sequential port, 4 broadly useful equal information/yield ports, and hinder control rationale with five wellsprings of intrudes. Other than interior Smash, the 8051 have different Extraordinary Capability Registers (SFR), which are the control and information registers for on-chip offices. The SFRs likewise incorporate the aggregator, the B register, and the Program Status Word (PSW), which contains the central processor banners. Programming the different interior equipment offices of the 8051 is accomplished by putting the fitting control words into the comparing Sfr's. The 8031 is like the 8051, with the exception of it comes up short on-chip ROM.

As expressed, the 8051 can address 64K of outside information memory and 64K of outer program memory. These might be discrete blocks of memory, so that up to 128K of memory can be connected to the miniature regulator. Separate blocks of code and information memory are alluded to as the Harvard design. The 8051 has two separate Read Signals, RD# and PSEN#. The first is initiated when a byte is to be perused from outside information memory, the other, from outer program memory. Both of these signs are purported dynamic low signals. That is, they are cleared to rationale level 0 when actuated. Everything outside code is brought from outer program memory. What's more, bytes from outside program memory might be perused by unique read directions like the MOVC guidance. There are isolated guidelines to peruse from outside information memory, like the MOVX guidance. That is, the guidelines figure out which block of memory is tended to, and the comparing control signal, either RD# or PSEN# is actuated during the memory read cycle. A solitary block of memory might be planned to go about as the two information and program memory. This is alluded to as the Von Neumann1 design. To peruse from a similar block utilizing either the RD# signal or the PSEN# signal, the two signs are joined with a rationale AND activity. Along these lines, the result of the AND door is low when either input is low. The upside of the Harvard engineering isn't just multiplying the memory limit of the miniature regulator. Isolating project and information builds the dependability of the miniature regulator, since there are no directions to keep in touch with the program memory. A ROM gadget is unmistakably fit to act as program memory. The Harvard design is to some degree off-kilter in assessment frameworks, where code should be stacked into program memory. By embracing the Von Neumann design, code might be kept in touch with memory as information bytes, and afterward executed as program directions.

The 8052 have 256 bytes of inner Smash and 8K of inside code ROM. The client can't program the 8051 and 8052 interior ROM. The client should supply the program to the producer, and the maker programs the miniature regulators during creation. Because of the arrangement costs, the manufacturing plant covered ROM choice isn't efficient for little amount creations. The 8751 and 8752 are the Erasable Programmable Perused Just Memory (EPROM) renditions of the 8051 and 8052. Numerous producers offer the EPROM variants in windowed clay and non-windowed plastic bundles. These are client programmable. In any case, the non-windowed renditions can't be eradicated. These are typically alluded to as One-Time-Programmable (OTP) miniature regulators, which are more reasonable for exploratory work or for little creation runs. The 8951 and 8952 contain Streak EPROM's

(Electrically Erasable Programmable Read Just Memory). These chips can be modified as the EPROM renditions, utilizing a chip software engineer. Additionally, the memory might be eradicated. Like Eprom's, Deleting Streak memory sets all information bits (information bytes become FFh). A cycle might be cleared (made 0) by programming. Nonetheless, a zero bit may not be customized to a one. This requires deleting the chip. A few bigger Glimmer recollections are coordinated in banks or areas. As opposed to deleting the whole chip, you might eradicate a given area and keep the leftover areas unaltered.

The 8051 microcontroller is an 8-bit microcontroller architecture originally developed by Intel. It has since been manufactured by numerous semiconductor companies and has become one of the most popular and widely used microcontrollers in embedded systems design. The 8051 microcontroller is known for its simplicity, reliability, and versatility, making it suitable for a wide range of applications in various industries.

Architecture

The 8051 microcontroller architecture is based on the Harvard architecture, which separates program memory and data memory. It Consists of the following Key Components:

Central Processing Unit (CPU): The CPU of the 8051 microcontroller is an 8-bit processor capable of executing a wide range of instructions. It includes an Arithmetic Logic Unit (ALU), several general-purpose registers, and various special function registers (SFRs) for controlling on-chip peripherals.

Memory: The 8051 microcontroller typically includes 4 KB of on-chip Read-Only Memory (ROM) for program storage and 128 bytes of on-chip Random Access Memory (RAM) for data storage. External memory can also be interfaced with the microcontroller for additional storage capacity.

I/O Ports: The 8051 microcontroller features four bidirectional Input/Output (I/O) ports, labeled P0, P1, P2, and P3. These ports can be configured as digital inputs or outputs and are used for interfacing with external devices such as sensors, actuators, and displays.

Timers/Counters: The 8051 microcontroller typically includes two 16-bit Timers/Counters, Timer 0 and Timer 1, which can be used for timing, counting, and generating PWM signals. These timers/counters are essential for various timing-related tasks in embedded systems.

Serial Communication Interface: The 8051 microcontroller often includes a built-in Serial Communication Interface (SCI) or Universal Asynchronous Receiver-Transmitter (UART) for serial communication with external devices such as computers, sensors, and other microcontrollers.

Instruction Set

The instruction set of the 8051 microcontroller consists of over 100 instructions, including data transfer, arithmetic, logic, branching, and I/O manipulation instructions. These instructions are encoded as 8-bit opcodes and provide the necessary functionality for performing a wide range of tasks in embedded systems.

Applications

The 8051 microcontroller is widely used in various applications, including:

- Embedded systems: Control systems, industrial automation, robotics, and home appliances.
- Automotive: Engine control units, dashboard displays, and automotive sensors.
- Consumer electronics: Remote controls, electronic toys, and digital watches.
- Communication: Modems, wireless transceivers, and networking devices.
- Medical devices: Patient monitoring systems, infusion pumps, and diagnostic equipment.

Development Tools

Numerous development tools are available for programming and debugging 8051 microcontroller-based systems, including Integrated Development Environments (IDEs), assemblers, compilers, simulators, and in-circuit emulators. These tools streamline the development process and facilitate rapid prototyping and testing of embedded systems.

89C2051 Microcontrollers are progressively being utilized to execute correspondence frameworks. It is in this way essential to comprehend Microcontroller-controlled framework well. Today, microcontrollers have turned into an indispensable piece of all control frameworks. Committed regulators that utilization microcontrollers, have positively worked on the useful, functional and execution based determinations. The engineering changes in instrumentation and control frameworks where and are because of the registering and correspondence ability of the Miniature regulator gadgets. Miniature regulator should be treated as a device for registering and correspondence.

Any Miniature regulator, that capabilities as per the program written in it. Here the program is ready in such a manner, with the goal that the framework carries out the role of a sign sending and getting units. The program is only a guidance set, and as per the directions got from the remote, the regulator unit completes the predefined task. The guidance set frequently ready in double code, and are alluded as machine code, there by this product is called as machine language. Composing a program in such a code is a talented and extremely monotonous cycle. It is inclined to blunders on the grounds that the program is only a progression of 0's and 1's and the directions are not handily grasped from simply checking the example out. An option is to involve an effortlessly grasped type of shorthand code for the examples 0's and 1's. Miniature regulator can peruse and it can store the data got from the controller unit. Miniature regulators are committed to one assignment and run one explicit program. The program is put away in ROM (read-just memory) and by and large doesn't change. Assuming that there are any adjustments in the capability, or blunders in the product, the current program should be eradicated from the chip and again altered program should be stacked in the chip through chip burner.

The principal vehicle information communicating card is planned with AT89C2051 microcontroller chip, this is a low-voltage, superior execution CMOS 8-cycle microcomputer with 2K bytes of Blaze programmable and erasable read just memory (PEROM). The gadget is produced utilizing Atmel's high-thickness nonvolatile memory innovation and is viable with the business standard MCS-51 guidance set. By joining a flexible 8-bit central processor with Streak on a solid chip, the Atmel AT89C2051 is a strong microcomputer which gives an exceptionally adaptable and savvy answer for some inserted control applications.

The AT89C2051 gives the accompanying standard highlights: 2K bytes of Glimmer, 128 bytes of Slam, 15 I/O lines, two 16-bit clock/counters, a five vector two-level hinder design, a full duplex sequential port, an accuracy simple comparator, on-chip oscillator and clock hardware. Moreover, the AT89C2051 is planned with static rationale for activity down to zero recurrence and supports two programming selectable power saving modes. The Inactive Mode stops the central processor while permitting the Slam, clock/counters, sequential port and interfere with framework to work. The shut down mode saves the Smash contents however freezes the oscillator crippling any remaining chip capabilities until the following equipment reset.

Limitations on Specific Guidelines

The AT89C2051 and is an efficient and financially savvy individual from Atmel's developing group of microcontrollers. It contains 2K bytes of glimmer program memory. It is completely viable with the MCS-51 design (The Intel MCS-51 usually named 8051 is a solitary chip microcontroller MCU series created by Intel in 1980 for use in implanted frameworks)., and can be customized utilizing the MCS-51 guidance set. Be that as it may, there are a couple of contemplations one should remember while using specific guidelines to program this gadget. Every one of the directions connected with hopping or expanding ought to be confined to such an extent that the objective location falls inside the actual program memory space of the gadget, which is 2K for the AT89C2051. This ought to be the obligation of the product software engineer.

For applications including intrudes on the ordinary hinder administration routine location areas of the 80C51 family engineering have been safeguarded. 2. MOVX-related directions, Information Memory: The AT89C2051 contains 128 bytes of inward information memory. Hence, in the AT89C2051 the stack profundity is restricted to 128 bytes, how much accessible Slam. Outside Information memory access isn't upheld in this gadget, nor is outer PROGRAM memory execution. Accordingly, no MOVX [...] directions ought to be remembered for the program. A commonplace 80C51 constructing agent will in any case gather directions, regardless of whether they are written disregarding the limitations referenced previously. It is the obligation of the regulator client to know the actual elements and impediments of the gadget being utilized and change the guidelines utilized correspondingly.

Highlights

• Viable with MCS-51™ Items

• 2K Bytes of Reprogrammable Blaze Memory

- Perseverance: 1,000 Compose/Eradicate Cycles

• 2.7V to 6V Working Reach

• Completely Static Activity: 0 Hz to 24 MHz

• Two-level Program Memory Lock

• 128 x 8-cycle Inside Slam

• 15 Programmable I/O Lines

• Two 16-cycle Clock/Counters

• Six Interfere with Sources

• Programmable Sequential UART Channel

• Direct Drove Drive Results

• On-chip Simple Comparator

• Low-power Inactive and Shut down Modes

Pin Portrayal

VCC

Supply voltage.

GND

Ground.

Port 1

Port 1 is a 8-bit bi-directional I/O port. Port pins P1.2 to P1.7 give interior force ups. P1.0 and P1.1 require outside pull-ups. P1.0 and P1.1 likewise act as the positive info (AIN0) and the negative info (AIN1), individually, of the on-chip accuracy simple comparator. The Port 1 result

cradles can sink 20 Mama and can drive Drove shows straightforwardly. At the point when 1s are composed to Port 1 pins, they can be utilized as information sources. At the point when pins P1.2 to P1.7 are utilized as data sources and are remotely pulled low, they will source current (IIL) due to the inward force ups. Port 1 likewise gets code information during Streak programming and confirmation.

Port-3

Port-3 pins P3.0 to P3.5, P3.7 are seven bi-directional I/O pins with inward draw ups. P3.6 is permanently set up as a contribution to the result of the on-chip comparator and isn't open as a broadly useful I/O pin. The Port 3 result cradles can sink 20 Mama. At the point when 1s are composed to Port 3 pins they are pulled high by the inside pull-ups and can be utilized as information sources. As information sources, Port 3 pins that are remotely being pulled low will source current (IIL) in view of the force ups. Port 3 additionally serves the elements of different unique highlights of the AT89C2051 as recorded underneath:

Port Pin	Alternate Capabilities
P3.0	RXD (sequential info port)
P3.1	TXD (sequential result port)
P3.2	INT0 (outside hinder 0)

P3.3	INT1 (outside hinder 1)
P3.4	T0 (clock 0 outside input)
P3.5	T1 (clock 1 outside input)

Port 3 likewise gets some control signals for Streak programming and check.

RST

Reset input. All I/O pins are reset to 1s when RST goes high. Holding the RST pin high for two machine cycles while the oscillator is running resets the gadget. Each machine cycle takes 12-oscillator or clock cycles.

Each machine cycle takes 12-oscillator or clock cycles. XTAL1 Contribution to the upsetting oscillator speaker and contribution to the interior clock working circuit. XTAL2 Result from the modifying oscillator intensifier.

Oscillator Qualities

XTAL1 and XTAL2 are the info and result, separately, of an altering enhancer which can be arranged for use as an on-chip oscillator, as displayed in Figure 1. Either a quartz c r y s t a l or fired resonator might be utilized. To drive the gadget from an outside clock source, XTAL2 ought to be left detached while XTAL1 is driven as displayed in Figure 2. There are no necessities on the obligation pattern of the outside clock signal, since the contribution to the interior timing hardware is through a separation by-two flip-flop, yet least and proverb u m voltage high and low time particulars should be noticed.

Port 3 likewise gets some control signals for Streak programming and confirmation. RST Res et input. All I/O pins are reset to 1s when RST goes high. Holding the RST pin high for two machine cycles while the oscillator is running resets the gadget.

Conclusion

The 8051 microcontroller remains a popular choice for embedded systems designers due to its simplicity, reliability, and versatility. With a rich ecosystem of development tools, extensive documentation, and widespread availability, the 8051 microcontroller continues to play a vital role in powering embedded systems across various industries.

4.2.6 WHEELS

FIG. 4.7 : WHEELS

In its Crude structure, a wheel is a roundabout block of a hard and sturdy material at whose middle has been drilled an opening through which is set a hub bearing about which the wheel pivots when force is applied to the wheel about its hub. The haggle gathering can be viewed as one of the six basic machines. At the point when put upward under a heap bearing stage or case, the wheel turning on the level pivot makes it conceivable to ship weighty burdens. This game plan is the principal subject of this article, yet there are numerous different utilizations of a wheel tended to in the comparing articles: when set evenly, the wheel turning on its upward hub gives the turning movement used to shape materials (for example a potter's wheel); when mounted on a section associated with a rudder or to the guiding instrument of a wheeled vehicle, it tends to be utilized to control the course of a vessel or vehicle (for example a boat's wheel or directing wheel); when associated with a wrench or motor, a wheel can store, discharge, or send energy (for example the flywheel). A haggle with force applied to make force at one sweep can make an interpretation of this to an alternate power at an alternate span, likewise with an alternate direct speed.

A wheel is a pivoting part (ordinarily roundabout in shape) that is planned to turn on a hub bearing. The wheel is one of the vital parts of the haggle which is one of the six straightforward machines. Wheels, related to axles, permit weighty items to be moved effectively working with development or transportation while supporting a heap, or performing work in machines. Wheels are likewise utilized for different purposes, like a boat's wheel, directing wheel, potter's wheel, and flywheel.

Normal models can be tracked down in transport applications. A wheel decreases erosion by working with movement by moving along with the utilization of axles. For wheels to pivot, a second should be applied to the wheel about its hub, either via gravity or by the utilization of another outside power or force. Utilizing the wheel, Sumerians concocted a gadget that turns mud as a potter shapes it into the ideal article.

A wheel is a plate or circle-formed mechanical gadget. Its fundamental design is to permit things to roll; at the end of the day, the wheel twists, and item on the wheels moves all the more effectively along the ground. It is a Straightforward Machine. The standard in the driver's seat is that of mechanical benefit.

Most Land Vehicles roll on Wheels. Wheels are many times utilized two by two, associated by a pole of wood or metal known as a hub. The haggle turn together. The piece of the wheel that appends to the pivot is known as the center point.

The wheel with a pivot is the premise of many machines, not simply vehicles. The potter's wheel, the machine and the windlass are models. Many machines have wheels with teeth, known as cog wheels.

4.2.7 BATTERY

Fig 4.8 Battery

A lithium-ion or Li-particle battery is a sort of battery-powered battery that utilizes the reversible intercalation of Li+ particles into electronically leading solids to store energy. In correlation with other business battery-powered batteries, Li-particle batteries are described by higher explicit energy, higher energy thickness, higher energy proficiency, a more extended cycle life, and a more drawn out schedule life. Likewise critical is an emotional improvement in lithium-particle battery properties after their market presentation in 1991: inside the following 30 years, their volumetric energy thickness expanded triple while their expense dropped ten times.

The development and commercialization of Li-particle batteries might have had one of the best effects of all advances in mankind's set of experiences, as perceived by the 2019 Nobel Prize in Science. All the more explicitly, Li-particle batteries empowered compact purchaser gadgets, PCs, telephones, and electric vehicles, or what has been known as the e-versatility upheaval. It likewise sees critical use for lattice scale energy capacity as well as military and aviation applications.

Lithium-particle cells can be made to advance energy or power thickness. Handheld gadgets for the most part use lithium polymer batteries , a lithium cobalt oxide cathode material, and a graphite anode, which together proposition high energy thickness. Lithium iron phosphate , lithium manganese oxide and lithium nickel manganese cobalt oxide might offer longer life and a higher release rate. NMC and its subsidiaries are broadly utilized in the charge of transport, one of the principal advancements (joined with sustainable power) for diminishing ozone depleting substance discharges from vehicles.

An electric battery is a wellspring of electric power comprising of at least one electrochemical cells with outer associations for driving electrical gadgets. At the point when a battery is providing power, its positive terminal is the cathode and its adverse terminal is the anode. The terminal checked negative is the wellspring of electrons that will course through an outer electric circuit to the positive terminal. At the point when a battery is associated with an outside electric burden, a redox response changes high-energy reactants over completely to bring down energy items, and the free-energy contrast is conveyed to the outer circuit as electrical energy. Generally the expression "battery" explicitly alluded to a gadget made out of different cells; nonetheless, the use has developed to incorporate gadgets made out of a solitary cell.

Essential (single-use or "dispensable") batteries are utilized once and disposed of, as the cathode materials are irreversibly different during release; a typical model is the basic battery utilized for spotlights and a huge number of compact electronic gadgets. Auxiliary (battery-powered) batteries can be released and re-energized on various occasions utilizing an applied electric flow; the first structure of the cathodes can be reestablished by switch flow. Models incorporate the lead-corrosive batteries utilized in vehicles and lithium-particle batteries utilized for compact gadgets like PCs and cell phones.

Batteries come in many shapes and sizes, from small scale cells used to drive portable amplifiers and wristwatches to, at the biggest limit, tremendous battery banks the size of rooms that give reserve or crisis ability to phone trades and PC server farms. Batteries have a lot of lower explicit energy (energy per unit mass) than normal fills like fuel. In vehicles, this is fairly counterbalanced by the higher productivity of electric engines in switching electrical energy over completely to mechanical work, contrasted with ignition motors.

4.2.8 DC ON-OFF SWITCH

Fig 4.9 Switch

A Switch is an electrical part that can separate or associate the directing way in an electrical circuit, interfering with the electric flow or redirecting it from one conduit to another. The most widely recognized sort of switch is an electromechanical gadget comprising of at least one arrangements of portable electrical contacts associated with outside circuits. At the point when a couple of contacts is contacting current can pass between them, while when the contacts are isolated no current can stream.

Switches are made in a wide range of designs; they might have numerous arrangements of contacts constrained by a similar handle or actuator, and the contacts might work at the same time, consecutively, or on the other hand. A switch might be worked physically, for instance, a light switch or a console button, or may work as a detecting component to detect the place of a machine part, fluid level, strain, or temperature, like an indoor regulator. Many specific structures exist, for example, the flip switch, turning switch, mercury switch, press button switch, switching switch, hand-off, and electrical switch. A typical use is control of lighting, where various switches might be wired into one circuit to permit helpful control of light installations. Switches in powerful circuits should have extraordinary development to forestall horrendous arcing when they are opened.

The most recognizable type of switch is a physically worked electromechanical gadget with at least one arrangements of electrical contacts, which are associated with outer circuits. Each arrangement of contacts can be in one of two states: by the same token "shut" meaning the contacts are contacting and power can stream between them, or "open", meaning the contacts are isolated and the switch is nonconducting. The system inciting the change between these two states (open or shut) is typically (there are different sorts of activities) either an "other activity" (flip the switch for consistent "on" or "off") or "flashing" (push for "on" and discharge for "off") type.

Consequently worked switches can be utilized to control the movements of machines, for instance, to show that a carport entryway has arrived at its full vacant position or that a machine device is in a situation to acknowledge another workpiece. Switches might be worked by process factors like strain, temperature, stream, current, voltage, and power, going about as sensors in a cycle and used to control a framework consequently. For instance, an indoor regulator is a temperature-worked switch used to control a warming cycle. A switch that is worked by another electrical circuit is known as a hand-off. Huge switches might be remotely worked by an engine drive component. A few switches are utilized to seclude electric power from a framework, giving a noticeable mark of detachment that can be locked if important to forestall unintentional activity of a machine during upkeep, or to forestall electric shock.

An ideal switch would have no voltage drop when shut, and would have no restrictions on voltage or current rating. It would have zero ascent time and fall time during state changes, and would change state without "bobbing" among on and off positions. Functional switches miss the mark concerning this ideal; as the consequence of harshness and oxide films, they show contact obstruction, limits on the current and voltage they can deal with, limited exchanging time, and so on. The ideal switch is much of the time utilized in circuit examination as it significantly works on the arrangement of conditions to be tackled, however this can prompt a less precise arrangement. Hypothetical treatment of the impacts of non-ideal properties is expected in the plan of enormous organizations of switches, with respect to model utilized in phone trades.

CHAPTER 5

CAB SIGNALLING SYSTEM

5.1 CAB SIGNALLING SYSTEM

The main purpose of a signal system is to enforce a safe separation between trains and to stop or slow trains in advance of a restrictive situation. The cab signal system is an improvement over the wayside signal system where visual signals beside or above the right-of-way govern the movement of trains, as it provides the train operator with a continuous reminder of the last wayside signal or a continuous indication of the state of the track ahead.

Over view

The first such systems were installed on an experimental basis in the 1910s in the United Kingdom, in the 1920s in the United States, and in the Netherlands in the 1940s. Modern high-speed rail systems such as those in Japan, France, and Germany were all designed from the start to use in-cab signalling due to the impracticality of sighting wayside signals at the new higher train speeds. Worldwide, legacy rail lines continue to see limited adoption of Cab Signalling outside of high density or suburban rail districts and in many cases are precluded by use of older intermittent Automatic Train Stop technology.

In North America, the coded track circuit system developed by the Pennsylvania Railroad (PRR) and Union Switch & Signal (US&S) became the de facto national standard. Variations of this system are also in use on many rapid transit systems and form the basis for several international cab signalling systems such as CAWS in Ireland, BACC in Italy, ALSN in Russia and the first generation Shinkansen signalling developed by Japan National Railways (JNR).

In Europe and elsewhere in the world, cab signalling standards were developed on a country by country basis with limited interoperability, however new technologies like the European Rail Traffic Management System (ERTMS) aim to improve interoperability. The train-control component of ERTMS, termed European Train Control System (ETCS), is a functional specification that incorporates some of the former national standards and allows them to be fully interoperable with a few modifications.

Cab signal types

All cab signalling systems must have a continuous in-cab indication to inform the driver of track condition ahead; however, these fall into two main categories. Intermittent cab signals are updated at discrete points along the rail line and between these points the display will reflect information from the last update. Continuous cab signals receive a continuous flow of information about the state of the track ahead and can have the cab indication change at any time to reflect any updates. The majority of cabs signalling systems, including those that use coded track circuits, are continuous.

Intermittent

The German Indusi and Dutch ATB-NG fall into this category. These and other such systems provide constant reminders to drivers of track conditions ahead, but are only updated at discrete points. This can lead to situations where the information displayed to the driver has become out of date. Intermittent cab signalling systems have functional overlap with many other train protection systems such as trip stops, but the distinction is that a driver or automatic operating system makes continuous reference to the last received update.

The term "intermittent" refers to something that occurs irregularly or sporadically, rather than consistently or continuously. It implies that there are periods of activity or occurrence interspersed with periods of inactivity or absence. Here's a more detailed exploration of the concept:

Characteristics of Intermittent:

Irregular Occurrence: Events or phenomena described as intermittent do not follow a regular pattern or schedule. Instead, they happen unpredictably and inconsistently over time.

Sporadic Nature: Intermittent occurrences are characterized by gaps or intervals between instances of activity. These periods of inactivity can vary in duration and frequency.

Temporary: Intermittent phenomena are usually temporary or short-lived. They may occur for a brief period before ceasing or repeating after a delay.

Variability: The duration, frequency, and intensity of intermittent events can vary widely. They may exhibit different patterns of occurrence depending on external factors or underlying causes.

Examples of Intermittent Phenomena:

Intermittent Fasting: This dietary approach involves alternating periods of fasting and eating. It's characterized by cycles of food consumption followed by periods of fasting, with various fasting protocols ranging from daily to weekly schedules.

Intermittent Explosive Disorder: A psychological disorder characterized by sudden, uncontrollable outbursts of aggression or violence that occur intermittently, often without apparent provocation.

Intermittent Power Supply: In regions with unreliable electricity grids, power supply may be intermittent, with periods of electricity availability interspersed with power outages or load shedding.

Intermittent Internet Connectivity: In areas with poor internet infrastructure or signal coverage, internet connectivity may be intermittent, with periods of stable connection followed by dropouts or disruptions.

Implications and Considerations:

Challenges in Prediction: The irregular nature of intermittent occurrences can make them challenging to predict or anticipate, leading to uncertainty and difficulty in planning or decision-making.

Impact on Functionality: Intermittent phenomena can disrupt normal functioning or operations, particularly in systems or processes that rely on consistent performance or continuity.

Diagnostic Challenges: In fields such as healthcare or engineering, diagnosing and addressing issues related to intermittent problems can be complex, as they may be difficult to reproduce or identify.

Mitigation Strategies: Strategies for managing intermittent occurrences may involve implementing redundancy, backup systems, or contingency plans to minimize the impact of disruptions.

Overall, understanding the concept of intermittent phenomena is essential for addressing challenges associated with irregular occurrences and designing effective strategies for managing variability and unpredictability in various domains.

Continuous

Continuous systems have the added benefit of fail-safe behaviour in the event a train stops receiving the continuous event relied upon by the cab signalling system. Early systems use the rails or loop conductors laid along the track to provide continuous communication between wayside signal systems and the train.[2] These systems provided for the transmission of more information than was typically possible with contemporary intermittent systems and are what enabled the ability to display a miniature signal to the driver; hence the term, "cab signalling". Continuous systems are also more easily paired with Automatic Train Control technology, which can enforce speed restrictions based on information received through the signalling system, because continuous cab signals can change at any time to be more or less restrictive, providing for more efficient operation than intermittent ATC systems.

Information transmission

Cab signals require a means of transmitting information from wayside to train. There are a few main methods to accomplish this information transfer.

Electric or magnetic

This is popular for early intermittent systems that used the presence of a magnetic field or electric current to designate a hazardous condition. The British Rail Automatic Warning System (AWS) is an example of a two-indication cab signal system transmitting information using a magnetic field.

Inductive

Inductive systems are non-contact systems that rely on more than the simple presence or absence of a magnetic field to transmit a message. Inductive systems typically require a beacon or an induction loop to be installed at every signal and other intermediate locations. The inductive coil uses a changing magnetic field to transmit messages to the train. Typically, the frequency of pulses in the inductive coil is assigned different meanings. Continuous inductive systems can be made by using the running rails as one long tuned inductive loop. Examples of intermittent inductive systems include the German Indusi system. Continuous inductive systems include the two-aspect General Railway Signal Company "Automatic Train Control" installed on the Chicago and North Western Railroad among others.

The term "inductive" typically refers to a reasoning process or method of inference in which general principles or conclusions are derived from specific observations or instances. Here's a detailed explanation of what "inductive" means:

Characteristics of the Inductive Reasoning:

Bottom-Up Approach: Inductive reasoning starts with specific observations or data points and then works towards broader generalizations or conclusions. It moves from the particular to the general.

Probabilistic: Inductive reasoning does not guarantee certainty in its conclusions. Instead, it provides probabilistic or likely conclusions based on the evidence available. The strength of the conclusion depends on the quality and quantity of the observations.

Open-Ended: Inductive reasoning does not have a predefined endpoint. It allows for the exploration of new ideas, hypotheses, or theories based on emerging patterns or trends observed in the data.

Generalization: The primary goal of inductive reasoning is to generalize from specific instances to broader principles or theories. These generalizations are often expressed as hypotheses or theories that can be tested and refined through further observation or experimentation.

Examples of the Inductive Reasoning:

Scientific Research: In scientific research, observations or experimental data are analyzed to identify patterns or trends. From these observations, scientists may formulate hypotheses or theories to explain the observed phenomena. For example, observing multiple instances of objects falling to the ground leads to the generalization that all objects are subject to the force of gravity.

Market Research: In market research, companies may collect data on consumer behavior, preferences, and purchasing patterns. By analyzing this data, marketers can identify trends and make predictions about future consumer behavior. For example, observing a preference for eco-friendly products among a sample of consumers may lead to the generalization that there is a growing demand for sustainable products in the market.

Language Learning: When learning a new language, learners often use inductive reasoning to infer grammatical rules and patterns from examples of language use. By observing how words are used in context and identifying recurring patterns, learners can develop an understanding of the language's structure and rules.

Implications and Considerations:

Limitations: Inductive reasoning is subject to limitations such as sample bias, limited data availability, and the potential for errors in observation or interpretation. Conclusions drawn from inductive reasoning are not always accurate or reliable.

Complementarity with Deductive Reasoning: Inductive reasoning is often used in conjunction with deductive reasoning, which involves deriving specific conclusions from general principles. Together, these two methods of reasoning form the basis of scientific inquiry and problem-solving.

Iterative Process: Inductive reasoning is often an iterative process, with observations leading to hypotheses, hypotheses leading to predictions, and predictions tested through further observation or experimentation. This iterative cycle allows for the refinement and validation of scientific theories and models.

In summary, inductive reasoning is a valuable cognitive process that allows us to derive general principles or conclusions from specific observations or instances. It is widely used in scientific research, market analysis, language learning, and various other domains to generate hypotheses, make predictions, and gain insights into complex phenomena.

Coded track circuits

A coded track circuit based system is essentially an inductive system that uses the running rails as information transmitter. The coded track circuits serve a dual purpose: to perform the train detection and rail continuity detection functions of a standard track circuit, and to continuously transmit signal indications to the train. The coded track circuit systems eliminate the need for specialized beacons.

Examples of coded track circuit systems include the Pennsylvania Railroad standard system, a variation of which was used on the London Underground Victoria line,[4] Later, audio frequency (AF) track circuit systems eventually came to replace "power" frequency systems in rapid transit applications as higher frequency signals could self-attenuate reducing the need for insulated rail joints. Some of the first users of AF cab signal systems include the Washington Metro and Bay Area Rapid Transit. More recently, digital systems have become preferred, transmitting speed information to trains using datagram's instead of simple codes. The French TVM makes use of the running rails to transmit the digital signalling information, while the German LZB system makes use of auxiliary wires strung down the centre of the track to continually transmit the signalling information.

Coded track circuits are a type of railway signaling system used to detect the presence of trains on a railway track. Unlike conventional track circuits that simply detect the presence of a train, coded track circuits provide additional information about the train, such as its identity, speed, and direction of travel. Here's a detailed explanation of coded track circuits:

Principle of Operation:

Transmission of Coded Signals: Coded track circuits transmit encoded signals along the railway track using electrical or electromagnetic means. These signals contain information about the presence and characteristics of trains on the track.

Onboard Equipment: Each train equipped with coded track circuit detection capabilities has onboard receivers that can decode the signals transmitted by the track circuits. The receivers extract relevant information from the coded signals, such as the identity of the train and its speed.

Data Exchange: As a train moves along the track, its onboard receiver continuously communicates with the coded track circuits, exchanging information about the train's position, speed, and other parameters. This real-time data exchange enables the signaling system to monitor train movements and maintain safe separation between trains.

Safety Features: Coded track circuits incorporate safety features to ensure reliable detection and communication between trains and the signaling system. Redundant coding schemes, error-checking mechanisms, and fail-safe designs are often employed to minimize the risk of false detections or signal errors.

Components of Coded Track Circuits:

Trackside Transmitters: These are devices installed along the railway track that transmit coded signals to passing trains. They may be installed at regular intervals along the track or at strategic locations such as signaling points and station platforms.

Onboard Receivers: Each train equipped with coded track circuit detection capabilities is fitted with onboard receivers that can decode the signals transmitted by the trackside transmitters. These receivers extract relevant information from the coded signals and communicate it to the train's control systems.

Control Center: A central control center oversees the operation of the coded track circuit signaling system. It monitors train movements, manages the allocation of track resources, and coordinates communication between trains and trackside equipment.

Applications and Benefits:

Enhanced Safety: Coded track circuits provide more comprehensive information about train movements, enabling signaling systems to implement more sophisticated safety measures such as automatic train protection and collision avoidance.

Improved Efficiency: By continuously monitoring train positions and speeds, coded track circuits help optimize the utilization of railway infrastructure and resources, leading to improved operational efficiency and capacity.

Remote Diagnostics: Coded track circuits can facilitate remote diagnostics and condition monitoring of railway assets, allowing maintenance teams to identify and address potential issues before they escalate into safety or operational problems.

Integration with Signaling Systems: Coded track circuits can be integrated with existing railway signaling systems, such as block signaling and interlocking systems, to enhance their functionality and performance.

Challenges and Considerations:

Compatibility: Implementing coded track circuits may require modifications to existing railway infrastructure and rolling stock to ensure compatibility with the signaling system.

Reliability: Coded track circuits must be designed and implemented with robustness and reliability in mind to ensure safe and effective operation in all conditions, including adverse weather and environmental factors.

Cost: The installation and maintenance costs associated with coded track circuits can be significant, particularly for large-scale railway networks or retrofitting existing infrastructure.

Regulatory Compliance: Coded track circuits must comply with applicable safety standards and regulations governing railway signaling systems to ensure interoperability and safe operation.

In summary, coded track circuits offer a sophisticated and reliable means of detecting and monitoring train movements on railway tracks, providing valuable information to signaling systems and operators. While they offer numerous benefits in terms of safety, efficiency, and functionality, their implementation requires careful planning, investment, and adherence to regulatory requirements.

Transponder

Transponder based systems make use of fixed antenna loops or beacons (called balises) that transmit datagram's or other information to a train as it passes overhead. While similar to intermittent inductive systems, transponder based cab signalling transmit more information and can also receive information from the train to aid traffic management. The low cost of loops and beacons allows for a larger number of information points that may have been possible with older systems as well as finer grained signalling information. The British Automatic Train Protection was one example of this technology along with the more recent Dutch ATB-NG.

A transponder is a device that receives a signal from a transmitter and automatically sends a response, typically with additional information. Transponders are commonly used in various applications, including aviation, navigation, telecommunications, and transportation. Here's a detailed overview of transponders:

Principle of Operation:

Reception of Signal: A transponder begins its operation by receiving a signal, usually in the form of radio frequency (RF) waves, from a transmitter. The signal may contain specific instructions, queries, or identification codes.

Processing and Response: Upon receiving the signal, the transponder's internal circuitry processes the incoming information and generates an appropriate response. This response may include additional data, such as the transponder's own identification code or status information.

Transmission of Response: The transponder then transmits its response back to the original transmitter or another designated receiver. The response signal may be modulated onto a carrier wave and transmitted using the same or a different frequency as the incoming signal.

Confirmation and Feedback: In some cases, the transmitter may receive and process the transponder's response, confirming the successful communication or initiating further actions based on the received data.

Types of Transponders:

Passive Transponders: Passive transponders do not have their own power source and rely on the energy transmitted by the interrogating signal to generate a response. They are commonly used in applications such as radio frequency identification (RFID) tags, toll collection systems, and asset tracking.

Active Transponders: Active transponders have their own power source, usually a battery or other energy storage device, which allows them to generate and transmit a response signal without relying on an external power source. They are often used in applications such as aircraft transponders, satellite communication systems, and marine navigation beacons.

Semi-Passive Transponders: Semi-passive transponders have their own power source for generating a response signal but rely on the interrogating signal for activation and communication. They combine the advantages of both passive and active transponders and are used in applications such as electronic toll collection and environmental monitoring.

Applications of Transponders:

Aviation: Transponders are used in aviation for aircraft identification, surveillance, and air traffic control. They transmit coded signals that provide information about the aircraft's identity, altitude, and location to ground-based radar systems and other aircraft.

Navigation: Transponders are used in navigation systems such as the Global Positioning System (GPS) to enhance accuracy and reliability. They transmit correction signals that improve the positioning accuracy of GPS receivers in real-time.

Telecommunications: Transponders are used in telecommunications satellites to receive, amplify, and retransmit signals between ground stations and satellite communication terminals. They play a crucial role in satellite-based communication networks, including television broadcasting, internet access, and mobile communication.

Transportation: Transponders are used in transportation systems for electronic toll collection, vehicle tracking, and automatic identification. They enable efficient and convenient payment processing, traffic management, and security monitoring on roads, bridges, and other infrastructure.

Challenges and Considerations:

Interference: Transponders may be susceptible to interference from other RF sources or environmental factors, which can affect their performance and reliability.

Power Consumption: Active transponders require a continuous power supply, which may limit their operational lifetime and increase maintenance requirements.

Compatibility: Transponders must be compatible with the communication protocols and standards used in the intended application or system to ensure interoperability and seamless operation.

Security: Transponders used in security-sensitive applications such as access control or identity verification must incorporate robust encryption and authentication mechanisms to prevent unauthorized access or tampering.

Conclusion:

Transponders are versatile devices used in a wide range of applications to facilitate communication, identification, and data exchange. They play a crucial role in aviation, navigation, telecommunications, and transportation, enabling efficient and reliable operation of various systems and services. Despite challenges such as interference, power consumption, and compatibility, transponders continue to evolve and find new applications in emerging technologies and industries.

Wireless

Wireless cab signalling systems dispense with all track-based communications infrastructure and instead rely on fixed wireless transmitters to send trains signalling information. This method is most closely associated with communications-based train control. ETCS levels 2 and 3 make use of this system, as do a number of other cab signalling systems under development.

Wireless technology refers to communication or data transmission systems that operate without the need for physical cables or wires. Instead, wireless systems use electromagnetic waves, such as radio frequency (RF) signals, microwaves, or infrared light, to transmit data over the air. Wireless technology has revolutionized communication, networking, and connectivity across various domains. Here's an in-depth look at wireless technology:

Principles of Wireless Technology:

Radio Frequency (RF) Communication: RF communication is the most common form of wireless technology. It involves transmitting and receiving data using electromagnetic waves within the radio frequency spectrum. Devices equipped with RF transmitters and receivers communicate with each other over short or long distances, depending on the frequency, power, and modulation techniques used.

Microwave Communication: Microwave communication operates at higher frequencies than RF, typically in the gigahertz (GHz) range. Microwave signals can carry large amounts of data over long distances and are commonly used in telecommunications, satellite communication, and wireless networking.

Infrared Communication: Infrared communication uses infrared light to transmit data between devices. It is often used for short-range communication in devices such as remote controls, wireless keyboards, and proximity sensors. Infrared signals require a direct line of sight between the transmitter and receiver and are not affected by radio interference.

Types of Wireless Technology:

Wireless Networking: Wireless networking enables devices to connect to a local area network (LAN) or the internet without the need for physical Ethernet cables. Wi-Fi (Wireless Fidelity) is a common wireless networking technology that uses RF signals to transmit data between devices within a limited range, typically within a home, office, or public hotspot.

Cellular Communication: Cellular communication allows mobile devices such as smartphones, tablets, and IoT devices to connect to cellular networks operated by mobile carriers. These networks use a combination of RF and microwave signals to provide voice and data services to subscribers over large geographic areas.

Satellite Communication: Satellite communication uses satellites orbiting the Earth to relay signals between ground stations and remote locations. It enables long-distance communication for applications such as global telephony, television broadcasting, GPS navigation, and internet access in rural or remote areas.

Bluetooth: Bluetooth is a short-range wireless technology used for connecting devices such as smartphones, headphones, speakers, and wearables. It operates in the 2.4 GHz frequency band and enables data transmission over distances of up to a few meters.

NFC (Near Field Communication): NFC is a short-range wireless technology that enables communication between Devices when they are brought into close Proximity, Typically within a few centimeters. It is commonly used for contactless payments, ticketing, access control, and data exchange between Smartphones.

Applications of Wireless Technology:

Mobile Communication: Wireless technology powers mobile communication networks, allowing people to make calls, send messages, and access the internet from anywhere with cellular coverage.

Internet of Things (IoT): Wireless technology enables connectivity between IoT devices, sensors, and actuators, facilitating the exchange of data and the automation of processes in smart homes, cities, industries, and agriculture.

Wireless Sensing and Monitoring: Wireless sensors and monitoring systems use wireless technology to collect and transmit data on environmental conditions, equipment performance, and other parameters in various applications such as environmental monitoring, healthcare, and industrial automation.

Wireless Entertainment: Wireless technology enables streaming of audio and video content to devices such as smartphones, smart TVs, and wireless speakers, providing on-demand entertainment without the need for physical media or cables.

Advantages of Wireless Technology:

Mobility: Wireless technology enables mobility and flexibility by allowing users to access communication and data services from anywhere within the coverage area of a wireless network.

Scalability: Wireless networks can easily scale to accommodate a growing number of users and devices without the need for extensive infrastructure upgrades or cable installations.

Convenience: Wireless technology eliminates the need for physical cables, simplifying device setup, installation, and maintenance.

Accessibility: Wireless technology extends connectivity to remote or hard-to-reach areas where laying cables or installing wired infrastructure is impractical or cost-prohibitive.

Challenges and Considerations:

Interference: Wireless networks may experience interference from other wireless devices, electromagnetic radiation, or physical obstacles, affecting signal quality and reliability.

Security: Wireless communication is susceptible to security threats such as eavesdropping, data interception, and unauthorized access. Encryption, authentication, and access control mechanisms are essential for securing wireless networks and data.

Bandwidth Limitations: Wireless networks have limited bandwidth compared to wired networks, which can impact data transfer speeds and network performance, especially in densely populated areas or high-traffic environments.

Power Consumption: Wireless devices require power to operate, and wireless communication can consume significant battery resources, particularly in mobile and IoT devices. Power-efficient design and optimization are crucial for extending battery life and improving device longevity.

Future Trends in Wireless Technology:

5G Networks: The rollout of 5G networks promises faster data speeds, lower latency, and greater capacity, enabling new applications such as augmented reality (AR), virtual reality (VR), autonomous vehicles, and smart cities.

Wi-Fi 6: Wi-Fi 6 (802.11ax) offers improved performance, efficiency, and capacity compared to previous Wi-Fi standards, enabling higher data rates, better coverage, and support for a larger number of connected devices.

Edge Computing: Edge computing leverages wireless technology to process data closer to the source, reducing latency and bandwidth requirements for real-time applications such as IoT, autonomous systems, and video streaming.

Wireless Charging: Wireless charging technology eliminates the need for physical connectors and cables by transmitting power wirelessly to recharge devices such as smartphones, wearables, and electric vehicles.

Conclusion:

Wireless technology has transformed the way we communicate, access information, and interact with the world around us. From mobile communication and wireless networking to satellite communication and IoT connectivity, wireless technology enables seamless connectivity and mobility in a wide range of applications. As technology continues to evolve, wireless innovations such as 5G, Wi-Fi 6, edge computing, and wireless charging will further shape the future of communication, connectivity, and digital transformation.

Cab display unit

The cab display unit (CDU), (also called a driver machine interface (DMI) in the ERTMS standard) is the interface between the train operator and the cab signalling system. Early CDU's displayed simple warning indications or representations of wayside railway signals and later, many railways and rapid transit systems would dispense with miniature in-cab signals in favour of an indication of what speed the operator was permitted to travel at. Typically this was in conjunction with some sort of Automatic Train Control speed enforcement system where it becomes more important for operators to run their trains at specific speeds instead of using their judgement based on signal indications. One common innovation was to integrate the speedometer and cab signal display, superimposing or juxtaposing the allowed speed with the current speed. Digital cab signalling systems that make use of datagrams with "distance to target" information can use simple displays that simply inform the driver when they are approaching a speed penalty or have triggered a speed penalty or more complex ones that show a moving graph of the minimum braking curves permitted to reach the speed target. CDU's also inform the operator which, if any, mode the system might be in or if it is active at all. CDU's can also be integrated into the alertness system, providing count-downs to the alertness penalty or a means by which to cancel the alarm.

Cab signalling system in the US

Cab signalling in the United States was driven by a 1922 ruling by the Interstate Commerce Commission (ICC) that required 49 railways to install some form of automatic train control in one full passenger division by 1925. While several large railways, including the Santa Fe and New York Central, fulfilled the requirement by installing intermittent inductive train stop devices, the PRR saw an opportunity to improve operational efficiency and installed the first continuous cab signal systems, eventually settling on pulse code cab signalling technology supplied by Union Switch and Signal.

In response to the PRR lead, the ICC mandated that some of the nation's other large railways must equip at least one division with continuous cab signal technology as a test to compare technologies and operating practices. The affected railroads were less than enthusiastic, and many chose to equip one of their more isolated or less trafficked routes to minimize the number of locomotives to be equipped with the apparatus.

Several railways chose the inductive loop system rejected by the PRR. These railways included the Central Railroad of New Jersey (installed on its Southern Division), the Reading Railroad (installed on its Atlantic City Railroad main line), the New York Central, and the Florida East Coast. Both the Chicago and North Western and Illinois Central employed a two-aspect system on select suburban lines near Chicago. The cab signals would display "Clear" or "Restricting" aspects. The CNW went further and eliminated the wayside intermediate signals in the stretch of track between Elmhurst and West Chicago, requiring trains to proceed solely based on the 2-aspect cab signals.

The Chicago, Milwaukee, St. Paul and Pacific Railroad had a 3-aspect system operating by 1935 between Portage, Wisconsin and Minneapolis, Minnesota.

As the Pennsylvania Railroad system was the only one adopted on a large scale, it became a de facto national standard, and most installations of cab signals in the current era have been this type. Recently, there have been several new types of cab signalling which use communications-based technology to reduce the cost of wayside equipment or supplement existing signal technologies to enforce speed restrictions and absolute stops and to respond to grade crossing malfunctions or incursions.

The first of these was the Speed Enforcement System (SES) employed by New Jersey Transit on their low-density Pascack Valley Line as a pilot program using a dedicated fleet of 13 GP40PH-2 locomotives. SES used a system of transponder beacons attached to wayside block signals to enforce signal speed. SES was disliked by engine crews due to its habit of causing immediate penalty brake applications without first sounding an over speed alarm and giving the engineer a chance to decelerate. SES is in the process of being removed from this line, and is being replaced with CSS.

Amtrak uses the Advanced Civil Speed Enforcement System (ACSES) for its *Acela Express* high-speed rail service on the NEC. ACSES was an overlay to the existing PRR-type CSS and uses the same SES transponder technology to enforce both permanent and temporary speed restrictions at curves and other geographic features. The on-board cab signal unit processes both the pulse code "signal speed" and the ACSES "civil speed", and then enforces the lower of the two. ACSES also provides for a positive stop at absolute signals which could be released by a code provided by the dispatcher transmitted from the stopped locomotive via a data radio. Later this was amended to a simpler "stop release" button on the cab signal display.

CHAPTER 6

RESULT

A railroad signal is a visual showcase gadget that conveys guidelines or gives cautioning of directions in regards to the driver's position to proceed. The driver deciphers the's sign and acts in like manner. Normally, a sign could educate the driver regarding the speed at which the train may securely continue or it might teach the driver to stop.

Applications

Initially, signals showed straightforward stop or continue signs. As traffic thickness expanded, this ended up being excessively restricting and refinements were added. One such refinement was the expansion of far off signals on the way to deal with stop signals. The far off signal gave the driver cautioning that they were moving toward a sign which could require a stop. This considered a general speed up, since train drivers no longer needed to drive at a speed inside locating distance of the stop signal.

Under schedule and train request activity, the signs didn't straightforwardly pass orders on to the train group. All things being equal, they guided the group to get orders, conceivably halting to do so assuming the request justified it.

Signals are utilized to show at least one of the accompanying:

- That the line ahead is clear (liberated from any deterrent) or impeded
- That the driver has authorization to continue
- That focuses (additionally called switch or turnout in the US) are set accurately
- What direction focuses are set
- The speed the train might travel
- The condition of the following sign
- That the train orders are to be gotten by the team

Signs can be set:

- Toward the beginning of a segment of track
- On the way to deal with a portable thing of foundation, for example, focuses or switches or a swing span
- Ahead of different signs
- On the way to deal with a level intersection

- At a switch or turnout
- In front of stages or different spots that trains are probably going to be halted
- At train request stations

'Running lines' are normally ceaselessly flagged. Each line of a twofold track rail route is ordinarily motioned in one course just, with all signs confronting a similar heading on one or the other line. Where bidirectional flagging is introduced, signals face in the two bearings on the two tracks (now and again known as 'reversible working' where lines are not ordinarily utilized for bidirectional working). Signals are for the most part not accommodated controlling developments inside sidings or yard regions.

Perspectives and signs

Signals have perspectives and signs. The perspective is the visual appearance of the sign; the sign is the meaning. In American practice the signs have regular names, so that for example "Medium Methodology" signifies "Continue at not surpassing medium speed; be ready to stop at next signal". Various railways generally relegated various implications to a similar viewpoint, so it is normal because of consolidations to find that various divisions of a cutting edge railroad might have various principles overseeing the understanding of sign angles. For instance, stop angle alludes to any flag perspective that doesn't permit the driver to pass the sign.

Dissimilar to a commonplace traffic signal, where both the position and shade of the light when lit convey similar sign, in a sign head with different lights, both the variety and position of lit lights are important to decipher the part of the sign.

Signals control movement beyond the place where the sign stands and into the following segment of track. They may likewise pass on data about the condition of the following sign to be experienced. Signals are some of the time said to "safeguard" the focuses or switches, part of track, and so on that they are in front of. The expression "in front of" can be confounding, so official UK practice is to involve the terms in back of and ahead of. At the point when a train is holding up at a sign it is "in back of" that sign and the peril being safeguarded by the sign is "ahead of" the train and sign.

In North American practice, a qualification should be made between outright signals, which can show a "Stop" (or "Pause and Remain") sign, and lenient signs, which show a "Stop and Continue" viewpoint. Moreover, a lenient sign might be set apart as a Grade Signal where a train doesn't have to genuinely stop for a "Stop and Continue" signal, however just decelerate to a speed sufficiently slow to avoid any impediments. Interlocking ('controlled') signals are regularly outright, while programmed signals (for example those controlled through track inhabitance alone, not by a signalman) are normally tolerant.

Drivers should know about which signs are programmed. In current English practice for instance, programmed signals have a white rectangular plate with a dark flat line across it. In US practice a lenient sign commonly is demonstrated by the presence of a number plate. In the Australian provinces of New South Ridges, Victoria and South Australia, as well as New Zealand, a lenient sign has the lower set of lights offset (normally to one side) from the upper lights; in Victoria and New Zealand, a flat out signal showing a red or white "A" light is likewise treated as a tolerant signal. A few kinds of sign presentation separate lenient and outright stop viewpoints. In Germany, the standards which apply to the separate sign are shown by an upward plate on the sign's post (Mastschild).

Working standards typically indicate that a sign with an irregularity, like one with a stifled light or a completely dim sign, should be deciphered as the most prohibitive perspective - by and large "Stop" or "Pause and Continue".

Signal structures

Signals contrast both in how they show angles and in how they are mounted regarding the track.

Mechanical signs

The most established types of sign shows their various signs by a piece of the sign being truly moved. The earliest kinds involved a board that was either turned face-on and completely noticeable to the driver, or pivoted away to be for all intents and purposes imperceptible. These signs had two or at most three positions.

Semaphore signals were created in France toward the finish of the eighteenth hundred years, prior to being subsequently embraced by the rail lines. The main railroad semaphore was raised by Charles Hutton Gregory on the London and Croydon Rail route (later the Brighton) at New Cross Door, southeast London, in 1841. It was comparable in structure to the optical messages then being supplanted ashore by the electric message. Gregory's establishment was reviewed and endorsed for the Leading group of Exchange by Major-General Charles Pasley. Pasley had created an arrangement of optical telecommunication through semaphores in 1822 for the English military, and seems to have recommended to Gregory the utilization of the semaphore to rail line flagging. The semaphore was a while later quickly taken on as a proper sign almost generally. Circle signals, for example, those made by the Lobby Signal Organization, were once in a while used,] yet semaphores could be perused at significantly longer distances. The creation of the electric light, which could be made more brilliant than oil lights and thus apparent both around evening time and day, brought about the advancement of position light signals and variety light signals toward the start of the twentieth hundred years, which slowly uprooted semaphores. A couple stay in current tasks in the Unified Kingdom.

Mechanical signs might be worked physically, associated with a switch in a sign box, by electric engines, or using pressurized water. The signs are intended to be safeguard so that assuming that power is lost or a linkage is broken, the arm will move by gravity into the even position. In the U.S., semaphores were utilized as train request signals, determined to show to engineers whether they ought to stop to get a broadcast request, and furthermore as essentially one type of block flagging.

Variety light signals

The presentation of electric lights made it conceivable to create variety light signals which were sufficiently splendid to be seen during sunshine, beginning in 1904. The sign head is the part of a variety light sign which shows the perspectives. To show a bigger number of signs, a solitary sign could have different sign heads. A few frameworks utilized a solitary head combined with helper lights to change the essential perspective. Variety light signals come in two structures. The most predominant structure is the multi-unit type, with discrete lights and focal points for each tone, in the way of a traffic signal. Hoods and safeguards are for the most part given to conceal the lights from daylight which could cause bogus signs.

Searchlight signals were the most frequently involved signal sort in the U.S. as of not long ago. In these, a solitary glowing light is utilized in each head, and either an A.C. or then again D.C. transfer component is utilized to move a shaded exhibition (or "roundel") before the light. As such, gravity (safeguard) returns the red roundel into the light's optical way. Essentially, this system is basically the same as the variety light sign that is remembered for an electrically worked semaphore signal, then again, actually the exclusion of the semaphore arm permits the roundels to be scaled down and encased in a weatherproof lodging. Generally utilized in the U.S from The Second Great War ahead, searchlight signals have the burden of having moving parts which might be purposely messed with.

This had prompted them turning out to be more uncommon during the last fifteen to twenty years when defacing started to deliver them powerless against bogus signs.

Notwithstanding, in a few different nations, like on the Italian railroads (FS) as from the Regolamento Segnali, they are as yet the standard variety light sign but with new establishments being as framed underneath.

CHAPTER 7

APPLICATIONS AND ADVANTAGES

7.1 APPLICATIONS

Collision Avoidance: ACSS continuously monitors the position and speed of trains on the track. It provides real-time information to train operators about the distance to the next train or any potential obstructions on the track, helping to prevent collisions.

Speed Control: ACSS regulates the speed of trains based on track conditions, speed limits, and other factors. It automatically adjusts the throttle or braking systems to ensure that trains travel at safe speeds and adhere to regulatory requirements.

Route Optimization: ACSS optimizes train routes by providing operators with information about track occupancy, maintenance schedules, and congestion levels. It helps minimize delays, reduce travel times, and improve overall railway efficiency.

Emergency Response: In the event of an emergency, such as a track obstruction or signaling failure, ACSS can automatically alert train operators and railway control centers. It provides instructions for emergency braking, diversion routes, or other safety protocols to mitigate potential hazards.

Driver Assistance: ACSS serves as a valuable tool for train operators by providing real-time feedback, alerts, and guidance during operation. It assists drivers in maintaining safe distances, navigating complex track layouts, and responding to dynamic traffic conditions.

Data Logging and Analysis: ACSS collects and stores data on train movements, signaling events, and system performance. This data can be analyzed to identify trends, track incidents, and improve overall railway operations and safety protocols.

Integration with Railway Infrastructure: ACSS can be seamlessly integrated with existing railway infrastructure, including track circuits, signaling systems, and control centers. It enhances the functionality of these systems by providing additional safety features and automation capabilities.

Remote Monitoring and Control: ACSS enables remote monitoring and control of trains, track conditions, and signaling equipment from centralized control centers. It allows for proactive maintenance, rapid response to incidents, and efficient coordination of railway operations.

Compatibility with Advanced Train Technologies: ACSS is compatible with advanced train technologies such as Positive Train Control (PTC), Automatic Train Operation (ATO), and Communication-Based Train Control (CBTC). It complements these systems by providing additional safety redundancies and operational enhancements.

Cross-Border and International Operations: ACSS facilitates cross-border and international railway operations by providing standardized signaling and communication protocols. It ensures interoperability between different railway networks, enabling seamless transit and coordination across jurisdictions.

7.2 ADVANTAGES

Enhanced Safety: ACSS provides real-time monitoring of train movements, track conditions, and signaling events. It helps prevent collisions, derailments, and other accidents by alerting train operators to potential hazards and automatically applying safety measures such as emergency braking.

Improved Operational Efficiency: ACSS optimizes train routes, speeds, and schedules based on track occupancy, maintenance requirements, and traffic conditions. It minimizes delays, reduces travel times, and increases overall railway capacity by ensuring efficient use of track infrastructure and resources.

Automated Speed Control: ACSS regulates train speeds according to track conditions, speed limits, and other factors. It helps maintain safe operating speeds and prevents overspeeding by automatically adjusting the throttle or braking systems as needed.

Driver Assistance and Guidance: ACSS assists train operators with real-time feedback, alerts, and guidance during operation. It helps drivers maintain safe distances, navigate complex track layouts, and respond to dynamic traffic conditions, reducing the risk of human error.

Proactive Maintenance: ACSS collects and analyzes data on train movements, signaling events, and system performance. It enables proactive maintenance by identifying potential issues before they escalate into safety or operational problems, reducing downtime and improving overall reliability.

Seamless Integration with Existing Infrastructure: ACSS can be seamlessly integrated with existing railway infrastructure, including track circuits, signaling systems, and control centers. It enhances the functionality of these systems by providing additional safety features and automation capabilities.

Adaptability and Scalability: ACSS is adaptable to different types of trains, track layouts, and operational environments. It can be scaled to accommodate changes in network size, traffic volume, and technology advancements, ensuring long-term compatibility and investment protection.

Cross-Border and International Operations: ACSS facilitates cross-border and international railway operations by providing standardized signaling and communication protocols. It ensures interoperability between different railway networks, enabling seamless transit and coordination across jurisdictions.

Enhanced Communication and Coordination: ACSS enables real-time communication and coordination between train operators, control centers, and maintenance crews. It improves situational awareness, facilitates rapid response to incidents, and enhances overall operational coordination.

Regulatory Compliance and Safety Standards: ACSS complies with regulatory requirements and safety standards governing railway signaling systems. It undergoes rigorous testing, certification, and validation to ensure adherence to industry best practices and safety protocols.

CHAPTER 8

CONCLUSION & FUTURE SCOPE

8.1 CONCLUSION

The project work **"Automatic cab signalling system for rail engines"** is completed successfully and results are found to be satisfactory. During our trail runs we found that, sending data from the track side signal post is very difficult because we won't get any suitable sensors or circuits not available. In this regard we have designed our own circuit, after conducting so many trails over different circuits and finally we could able to achieve the desired result. The ultimate goal of this circuit is to transmit the digital data produced by the microcontroller chip.

Here RF communication is also recommended, but when signal posts are nearby each other, it may be major difficulty that the signals may collide with each other by which the system may not display proper signal. Aim is to send information when the train reaches near to the signal post. In this regard we came to know that the data must be transmitted in uni direction not in Omni direction like as RF transmitter do, therefore IR signal transmitter circuit is constructed using IC 555. Since it is a prototype module, entire circuit including signal posts are arranged over a small wooden plank over which train track is also arranged for live demo. In such case entire system must be constructed packed together and hence short range communication is preferred by pumping less current in to the IR signal transmitting LED.

Finally, a mini model of train and its track is created over a small wooden plank and signal lights, buzzer, sensors, control circuit, etc, are arranged over this plank. After arranging all devices in its position, inter connections are made with thin wire. Now the circuit is constructed fully as per the circuit diagram and suitable program for the controller is prepared. The following is the procedure of chip burning process.

1, Right off the bat interface the recorder information line, and the relating IC attachment into the consuming seat; turn on the PC and burner power.

2. Run the consuming programming: (different consuming attachment relate to various consuming programming).

3, Select the IC brand: After the program start screen shows up, click on the "Gadget" menu, hit up the IC brand choice table, and afterward select the brand you need to consume IC relating, and afterward click "Alright";

4. Select the IC model: Right now, the IC model of the organization where the IC to be singed will show up. Select the model of the IC and snap "Run". To choose the jumper, then, at that point, adhere to the guidance in PC to set the jumper. After the setting, click "Alright". Assuming that there is no jumper in the burner block, it will enter the consuming connection point straightforwardly;

5, Import the product to be singed: click on the menu "Record", select "Burden Document To Developer Cushion", then decide to consume programming, click "Open", then select "00", click alright.

6, Check the product really take a look at code (Cradle Checksum): After the product is stacked, a four-digit check code shows up after the Support Checksum. This code should demonstrate the check code of the Electronic Plan Record Notice. The product to be singed is right. In the event that it is erroneous, it ought to promptly answer applicable offices to tackle.

7, Consuming programming: Snap "Program" button, the IC to be singed into the IC seat, introduced subsequent to consuming the seat on the consume button. After the consuming is finished, "Alright" will be shown assuming the consuming is fruitful, "Blunder" is shown in red assuming the consuming is fizzled, and the mark of each consuming seat relating to the IC of the consuming alright is brilliant, demonstrating that the consuming of the IC is effective. .

8. Cause a to consume mark, consume the alright IC with a sticker, and consume the bombed one into the other consuming seat and once again consume it once. Ensure that the IC is harmed and placed it in the blemished item box and leave an imprint.

8.2 FUTURE SCOPE

The future scope of the Automatic Cab Signalling System (ACSS) for rail engines is promising, with ongoing advancements in technology and a growing focus on enhancing railway safety, efficiency, and reliability. Here are several potential areas of development and innovation for ACSS:

Integration with Advanced Train Control Systems: ACSS can be further integrated with advanced train control systems such as Positive Train Control (PTC), Automatic Train Operation (ATO), and Communication-Based Train Control (CBTC). This integration will enable seamless interoperability between different signaling systems, enhancing safety, efficiency, and capacity on railway networks.

AI and Machine Learning Applications: AI and machine learning algorithms can be applied to ACSS data to analyze train movements, predict potential hazards, and optimize operational parameters in real-time. These technologies can improve decision-making, automate routine tasks, and identify patterns or trends that may impact railway operations.

Predictive Maintenance and Health Monitoring: ACSS can be enhanced with predictive maintenance capabilities to monitor the health and performance of railway assets, including track infrastructure, signaling equipment, and rolling stock. By analyzing data on wear and tear, vibration levels, and other indicators, ACSS can predict maintenance needs and prevent unexpected failures, reducing downtime and maintenance costs.

Enhanced Communication and Connectivity: Future iterations of ACSS can leverage advancements in wireless communication technologies such as 5G, Wi-Fi 6, and satellite communication. This will enable faster, more reliable data transmission between trains, trackside equipment, and control centers, improving situational awareness, coordination, and response times.

Autonomous Train Operation: ACSS can pave the way for autonomous train operation by providing essential safety features and redundancy mechanisms. As autonomous train technologies continue to evolve, ACSS will play a crucial role in ensuring the safe and efficient operation of driverless trains, particularly in urban transit systems and freight railways.

Cybersecurity and Resilience: With increased digitization and connectivity, ACSS will need robust cybersecurity measures to protect against cyber threats, hacking attempts, and unauthorized access. Future developments in cybersecurity technologies will focus on ensuring the integrity, confidentiality, and availability of ACSS data and systems.

Environmental Monitoring and Sustainability: ACSS can be expanded to include environmental monitoring capabilities for assessing air quality, noise levels, and other environmental factors along railway corridors. This data can be used to minimize the environmental impact of railway operations and support sustainability initiatives.

Interoperability and Standardization: ACSS will continue to evolve towards greater interoperability and standardization, enabling seamless integration with existing railway infrastructure and emerging technologies. Standardized protocols, interfaces, and data formats will facilitate interoperability between different signaling systems and ensure compatibility with international railway networks.

User Experience and Human Factors: Future developments in ACSS will prioritize user experience and human factors, considering the needs and preferences of train operators, maintenance crews, and passengers. User-friendly interfaces, ergonomic designs, and intuitive controls will enhance usability, comfort, and safety for all stakeholders.

Regulatory Compliance and Certification: As ACSS evolves, it will need to meet stringent regulatory requirements and safety standards governing railway signaling systems. Ongoing collaboration between industry stakeholders, regulatory authorities, and standardization bodies will ensure that future iterations of ACSS comply with the latest regulatory guidelines and certification requirements.

In summary, the future scope of the Automatic Cab Signalling System for rail engines is characterized by ongoing advancements in technology, innovation, and collaboration. By embracing emerging technologies, addressing evolving operational needs, and prioritizing safety and reliability, ACSS will continue to play a vital role in shaping the future of railway transportation.

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