Industrial Training Report

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-Submitted By-

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TRAINING PERIOD
17/06/2023 - 17/07/2023

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ABSTRACT

This report includes a complete description of the vocational 4 weeks of Industrial Training that I have undergone in various Electronics and related divisions at **Central Electronics Limited**, a Government of India Enterprise under the **Department of Scientific and Industrial Research (DSIR), Ministry of Science & Technology.**

This report explains the critical production and assembly steps of various internal divisions and various manufacturing and testing stages through which products pass before being selected as final for application.

Also, it explains their application and uses by other connected organisations in India. Although it contains all the products and divisions of the company, it mainly focuses on the Microwave Phase Control Module (PCM) under Microwave Electronics Division (MED) for strategic electronic purposes for the defence sector, as well as to serve various other government assets.

Snehlata

ACKNOWLEDGEMENT

I am highly thankful to **Mr Shiv Narain Patel, Manager** for providing me with the opportunity to undergo practical training in the Microwave Electronic Division (MED) at Central Electronics Limited.
And **Mr. Mahesh Chandra, Assistant Technical Manager** who guided me from time to time and gave me dynamic ideas and suggestions by which I am able to complete my training successfully.

I am also thankful to all the Managers & Staff members of various departments who guided me about the work & processing that are being done in their respective departments.

I am also thankful to all those employees at CEL who classified my doubts and confusions during my training period at the firm. It was a greatly satisfying experience to work in such an excellent professional organisation where the process of learning is never-ending. Along with that, I want to extend my heartfelt thanks to the HR Department of CEL for the smooth onboarding and hassle-free documentation process, which made everything so easy.

I also want to thank all the other directly or indirectly associated people who helped me in completing my practical training with great success

Snehlata

INTRODUCTION

CEL, Central Electronics Limited is a Government of India Enterprise under the **Department of Scientific and Industrial Research (DSIR)**, Ministry of Science & Technology. It was established in 1974, with the objective of commercially exploiting indigenous technologies developed by National Laboratories and R&D Institutions in the country.

CEL has developed a number of products for the first time in the country through its own R&D efforts and in close association with the premier National & International Laboratories including Defense Laboratories. In recognition of all these efforts, CEL has been awarded a number of times with prestigious awards including the “National Award for R&D by DSIR”.

CEL is a pioneer in the country in the field of Solar Photovoltaic (SPV) and it has developed the technology with its own R&D efforts. Its solar products have been qualified for International Standards IEC 61215/61730.

CEL has also developed axle counter systems that are being used in Railway signalling systems for the safe running of trains. Railway products include Single Section Digital Axle Counters (SSDAC), High Availability SSDAC (HA-SSDAC), Multi-section Digital Axle Counters (MSDAC) & Block Proving by Axle Counter (BPAC) using Universal Fail Safe Block Interface (UFSBI). These products have been designed and developed in accordance with CENELEC standards.

CEL has developed a number of critical components for strategic applications and is supplying these items to Defence.

Mission

To be a significant player in the field of Solar Photovoltaic Energy particularly for rural applications as also in Railway Safety and Signalling Electronics, Microwave Phase Control Modules and also to diversify into areas like Security Systems, Nuclear Instrumentation and Metro Electronics.

Achievement

CEL has developed a number of products for the first time in the country through its own R&D efforts and in close association with the premier National & International Laboratories including Defense Laboratories. In recognition of all these efforts, CEL has been awarded a number of times with prestigious awards including the "National Award for R&D by DSIR".

Quality policy

The complete manufacturing operation, marketing and installation services of the company are certified under ISO 9002: 1994. The company has enunciated the following quality policy to meet customer needs and expectations by supplying quality products and services. "CEL is committed to strive for leadership in the product market by continuously improving the quality of its products and services and meeting the consumers' needs in time and every time at a competitive price. These shall be achieved through continuous upgrading of technology and application of them in real life.

Departments At Central Electronics Limited

1. **Solar PhotoVoltaic Division (SPVD)**
   Solar Photovoltaic Cells
   Solar Photovoltaic Modules
   Solar Photovoltaic Systems

   Application: Rurals, Industrials, Government Projects

2. **Strategic Electronic Devices- System Production Divisions (SPD)**
   Railways Electronics-
   Single Section Digital Axle Counter **SSDAC DACF-710P**
   High Availability Single Section Digital Axle Counter **HASSDAC DACF-720P**
   Multi Section Digital Axle Counter **MSDAC Model 730**

3. **Microwave Electronics Division (MED)**
   Phase Shifters
   Sintered Ceramic Radome
   Dielectric and Ferrite Substrates
   Piezoelectric Ceramics & Elements
   Drishti Transmissometer System for Airport Visibility

4. **R&D**

Important Abbreviations Used In Document:

1. **CEL -** Central Electronics Limited
2. **DSIR-** Department of Scientific and Industrial Research
3. **DRDO-** Defence Research & Development Organisation
4. **CENELEC-** Comité Européen de Normalisation Électrotechnique
5. **RADAR-** RAdio Detection And Ranging

There is the possibility of many further abbreviations that might be used in the document. All such abbreviations must be clarified on point specifically clearing the scope of any confusion.

Solar PhotoVoltaic Division (SPVD)

Objective

Though my main area of Industrial Training was MED, in the meantime I got an opportunity to visit the SPVD Department. I explored the work done by these big departments that more or less control the heart of Solar Developed across India. The major takeaways from my visit to this department include:

Custom Design & Manufacturing

The CEL team has developed expertise in customising solar panels with options in type, size, appearance and power for seamless integration with any type of structure/system. In its west to provide Intelligence energy solutions at an affordable price without compromising quality, CEL banks on only well-established suppliers

The finished products are subjected to **strict quality control** at each step of the production process and are thoroughly tested to comply with international standards.
CEL has already deployed more than 5,00,000 Solar Photovoltaic (SPV) systems across the country and abroad

Solar Power Plants

With a goal of ensuring a sustainable, clean & carbon-free energy supply, CEL offers a complete portfolio for Off/On Grid Rooftop Power Plants, Ground Mounted Power Plants, and BIPV Power Plants ranging from a few KW up to MW Level CEL has the distinction of having commissioned:

- India's first Solar Power Plant in 1992
- India's first Grid Tied Solar PV Plant in 1994.
- India's first BIPV Plant in 2004
- India's first plant using High-Efficiency IBC modules in 2014
- India's first Solar Power Plant on Railway Coaches/Mobile Assets using indigenous **Flexible Solar PV** modules in 2015
- India's first BIPV Railway Platform in 2017
- Solar Lighting System

Community Lighting (Street Lighting) Across India

CEL's standalone/centralised Solar Street lighting is a solution for community lighting. Solar street lights have been installed throughout the country in rural as well as urban areas.

Home Lighting

CEL'S Home lighting system is a perfect compact solution for an independent power supply in remote locations where electricity is unavailable unreliable or expensive solar home lighting system is used to light up the home and can power small appliances like Fans Television, Mobile Phones etc

Solar Lantern

CEL'S CFL/LED Based Lantern can be used for lighting purposes so villagers can get rid of regular kerosene expenses. The livelihood activities can continue after sunset with the help of Solar Lantern

Smart Tree

CEL's Smart Tree can meaningfully support the Government of India's concept of Smart Cities, with a single synergistic physical structure. This will additionally function as a visible symbol that showcases ways that the government can contribute to smart and sustainable urbanisation.

The smart tree has many applications including lighting surveillance, Weather monitoring station, Air Pollution Monitoring, Wireless Internet access etc.

Energy-Enabled Rural Development

CEL'S Energy Enabled Rural Development program is the holistic and accelerated development of a village in multiple areas like energy, health, sanitation and education to create sustainable social and economic impact.

CEL has been working in remote areas of Rajasthan, Jharkhand, Orissa, Manipur, Jammu 7 Kashmir, Uttar Pradesh Assam and Himachal Pradesh for almost 4 decades.

Architectural Solutions With Building Integrated Photovoltaic (BIPV)

The Building-integrated Photovoltaics (BIPV) Power Plants integrate solar modules into the building envelope such as the roof or the facade By simultaneously serving as building envelope material and power generator BIPV systems can provide savings in electricity costs, reduce the use of fossil fuels and emission of ozone-depleting gases, and add architectural interest to the building. The BIPV power plant allows Natural Sunlight. The BIPV opens numerous Architectural possibilities for Industrial sheds, Green Houses, Railway Platforms, Car Parking, Warehouses, Residential Buildings, Malls/Public Buildings.

By avoiding the cost of conventional materials, the incremental cost of photovoltaics is reduced and its life cycle cost is improved. That is, BIPV systems often have higher overall costs than PV systems requiring separate, dedicated, mounting systems. BIPV systems can either be interfaced with the available utility grid or they may be designed as a stand-alone, off-grid system

System Production Division SPD

Universal Axle Counter For Railways
Introduction

Axle counters were developed as a substitute for track circuiting. Initially, axle counters were imported from Germany to gain experience and to evaluate their suitability for adoption on Indian Railways. Having gained acceptability for an introduction on a wide scale on Indian Railways. It was considered to take up the indigenous development of axle counters, which was taken up in collaboration with **IIT Delhi and DOE.** Two models of axle counters known as single entry/exit axle counters and multi-entry/exit axle counters emerged and after extensive laboratory and field trials under various conditions, the design was finalised and commercialised through the private sector as well as public sector Based on the feedback from the field a new axle counter has been developed by RDSO, known as "Universal Axle Counter.

Need of axle counters
The track circuits are considered vital components of the signalling system to achieve the safety of train operations. Various Accident Enquiry Committees have recommended bringing more and more tracks under track circuiting to safeguard against the reception of trains on occupied lines. The track circuit could not achieve desired progress due to the virtual scarcity of wooden sleepers, prohibitive cost and environmental consciousness in the country and the world at large. Availability of concrete sleepers have solved the problem to some extent but track circuiting on loop lines, points and crossings still suffers for want of adequate supply and insertion of concrete sleepers.

Advantages
The advantages of an Axle Counter over a conventional track circuit are: It does not require wooden sleepers (where concrete sleepers are not available) except for short track circuits to suppress the counts due to the movement of insulated trolleys. An Axle Counter System can cover a very long section of up to 15 km as compared to 750 metres of maximum length of operation of conventional track circuits.

It does not get affected either by flooding of the track or poor maintenance of tracks unlike track

circuits, which are highly susceptible to these conditions. It does not require insulating joints, thus, rails can be continuously welded. This reduces track maintenance costs, lower wear and tear of tracks and vehicles and increases travelling comfort.

Applications

Axle counters are finding more and more uses on modem safety signalling systems in the railways. These are being used presently for the following applications:
Monitoring of berthing tracks in station areas and yards.
Monitoring of point zones in station areas and yards.
Automatic signalling systems.

Block section monitoring (between stations) through axle counters using multiplexers with cable or radio communication (18 GHz).
Level crossing warning system

Principle Of Operation

The signal aspect for train movement is controlled based on the **clear or occupied** status of the track section If a train occupies the track section, the signal at the entry point of the section is made RED and the next train is stopped from entering into the section. When the track section is clear the signal is made GREEN and the train is allowed to proceed into the section. The clear or occupied condition of the track section is decided by Axle Counter by counting the number of axles of the train at the entry and exit points of the section. The axle counter compares the IN and OUT counts and in case of count equality TRACK CLEAR signal is given.

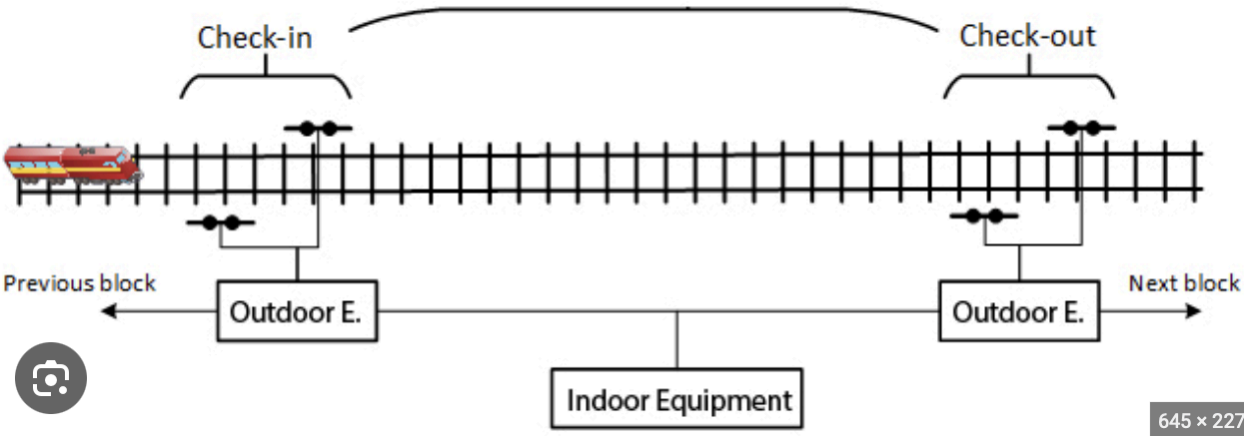


Fig: Representation of Train Check-In Check OUT procedure

Equipment Description

The Axle Counter is an electronic device and the complete system consists of:

- Track mounting and trackside equipment.
- Transmission media between trackside equipment and a central evaluator.
- Central evaluator with EV relays & SUP relays as its output.
- Reset box.
- Line verification box.
- Track mountings and trackside equipment

Fig: The actual transmitter and receiver

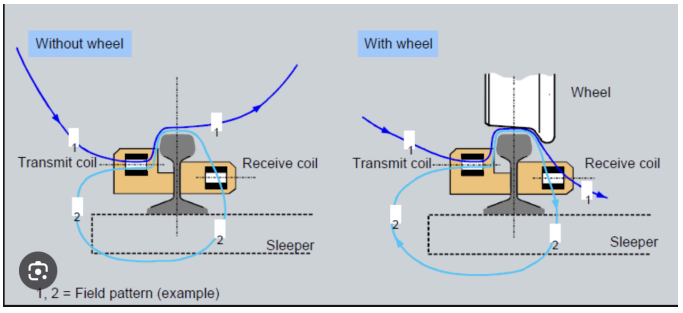


Fig: An Idea of Working

The track mounting equipment consists of a pair of transmitter and receiver coils housed in specially designed housings, which are fixed to the flange of a rail section by means of suitable rail clamps using bolts and nuts. Each detection point has **two sets of such track** devices mounted on the same rail with a fixed stagger between them. The two transmitter coils of a detection point are connected in senes to 5 kHz oscillators housed in an electronic junction box which is installed in a location box by the side of the track. The output of two receiver coils of a detection point serves as inputs to two receiver amplifiers housed in the same electronic junction box through cables which are part of the track mounting equipment. The electronic junction box is powered by a **24 V DC** supply.

Transmission media between trackside equipment and central evaluator, usually held at station offices.

The connection between trackside equipment and the central evaluator is made using balanced twin twisted quad cables of specification IRS: TC/41/90. The output of the electronic junction box and input of the central evaluator are matched for an impedance of about 180 ohms at 5 kHz. There is attenuation of the signal from the electronic junction box to the central evaluator, which limits the length of the cable. Other media such as optic fibre and wireless systems may also be used in place of cable by incorporating appropriate interfacing equipment at transmitting and receiving ends.

Central Evaluator with EV relay and SUP relay as its output

The signals received from electronic junction boxes are processed in the central evaluator first by analogue circuits and then by digital circuits to produce suitable output in terms of picking up or dropping of EV and SUP relays.
The DIPs generated by wheels as they pass over the track devices installed at detection points after they get processed, generate count pulses in a fail-safe manner. These pulses are identified as 'IN COUNTS or OUT COUNTS depending on the direction of movement of vehicles over the monitored section.

The counts are also displayed through the 7- segment display on the front panel of the evaluator. The display unit is useful in fault localization and internal and periodic adjustments. The evaluator is provided with its own power supply unit known as a DC-DC converter mounted in the same rack and requires a 24 V DC supply for its operation. The output of the EV and SUP relays is used to indicate "TRACK CLEARED or TRACK OCCUPIED conditions.

Reset Box: This equipment is installed in the station master's room to enable resetting of the central evaluator in case of failure of the system after observing the prescribed procedure. The reset unit consists of a RESET key (which gets actuated after inserting, turning and pressing), the counter and 3 LED indications (Red, Yellow and Green). This unit requires a 24 V DC supply for its operation. This unit functions in conjunction with the line verification box.

Line Verification Box: This box is required to be kept near the monitored track portion outside the Station Master's (SM) office for achieving co-operative features. This is a box consisting of a lock with a key fixed inside. The lock gets actuated only when the key is inserted, turned and pressed. Whenever there is a failure of the axle counter. SM will depute his ASM/Switchman to verify whether the track section controlled by the axle counter is clear or not. ASM/Switchman, after verification of the track, will report

to SM if the track is found clear who in turn will hand over the key of the line verification box for operation.

Type Of Systems

There are four types of systems used in the Indian Railways.

One Device (1-D) System
Two Devices (2-D) System.
Three Devices (3-D) System
Four Devices (4-D) System.

1-D System

In this system, there is a common detection point at the entry and exit points of the monitored section. This system is useful for monitoring the berthing track of the terminal yard. A train after passing the detection point generates pulses equal to axles in it and these pulses are counted and stored by the evaluator as IN COUNTS. At the time of exit of the train, the same detection point will be encountered and it generates the same number of pulses as that during the entry. These pulses are counted and recorded as 'OUT COUNTS by the evaluator. When the IN COUNTS and OUT COUNTS are equal, the system gives a "Track clear indication otherwise it gives the Track occupied indication.

2-D System

The principle of working of this system is similar to the 1-D System except that in this system there are two detection points, one at each end of the monitored section. This system is useful for providing track circuiting on the berthing track.

3-D System

In this system, there are three detection points. The principle of working of this system is similar to the 2-D system. This system is useful for providing track circuitry on points, crossings and sidings

4-D System

In this system, there are four detection points. The principle of working of this system is similar to the 2-D system. The system is useful for providing track circuiting on branch lines, sidings and points and diamond crossings. The design of a 4-D system is such that it can be converted into a 2-D system or a 3-D system and vice-versa.

High Availability Single-Section Digital Axle Counters

Digital Axle Counters whether Multi-section or Single-section are very effective in the movement of trains so long as they are working without failure. In some Railways, to avoid failures dual detection is provided with the help of conventional track circuits or AFTC along with Digital Axle Counters. For simplicity, ease of maintenance and availability of dual detection in one single system. High Availability Single Section Digital Axle Counter (HASSDAC) is developed by M/s Central Electronics Ltd. which is approved by RDSO. This handbook has been prepared to help field personnel in maintaining HASSDAC

installed in their section for trouble-free performance. Effort has been made to cover all the useful information such as recording of signal levels, maintenance schedule, troubleshooting, error codes etc. of the system in this handbook.

Hassdac-720P

HASSDAC-720P has been designed in accordance with RDSO specification no. RDSO/SPN/177/2012, following CENELEC standards, HASSDAC-720P is an SSDAC, providing high availability of the axle counting system by means of redundancy. It is capable of using either one or two web detectors. It is a fully redundant, two out of two fail-safe system with intelligence for error recovery. It enables railways to achieve higher line capacity by eliminating the requirement of one paper line clear train movement in case of failure of one axle counter.

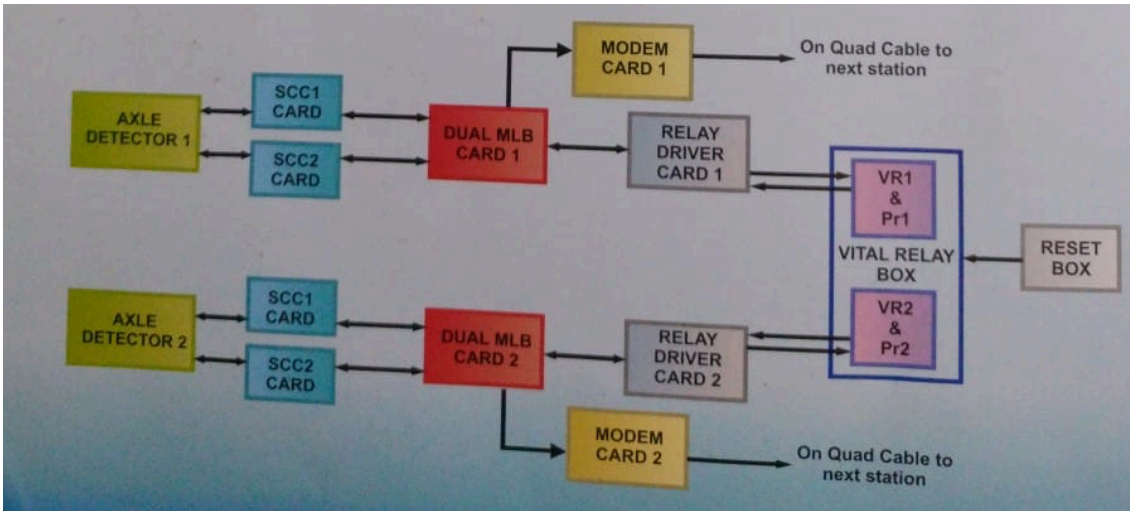


Fig: Functional Block Diagram of HASSDAC Unit

HASSDAC provides the following benefits over SSDAC

- Redundancy is provided in the wheel counting circuit, processing circuit, communication circling relay driver circuit, and DC-DC converter. Fully redundant.
- Any failure in one unit does not affect trains running.
- The failed unit is provided with a reset command automatically after 12s to recover from failure. The failed erroneous system goes into preparatory-reset mode.
- After the movement of one train, the unit in preparatory reset attains a clear state automatically and redundancy is restored.
- Separate counters are provided in vital relay units, for each unit that gets incremented only when an auto reset is applied. This way, an eye can be kept on the number of auto resets applied to both units.
- The reset box has an indication to show that one of the units is not working.
- The station master needs to provide a reset only if both processing units fall simultaneously.
- Station masters reset counter and measures only the manual reset applied by SM.

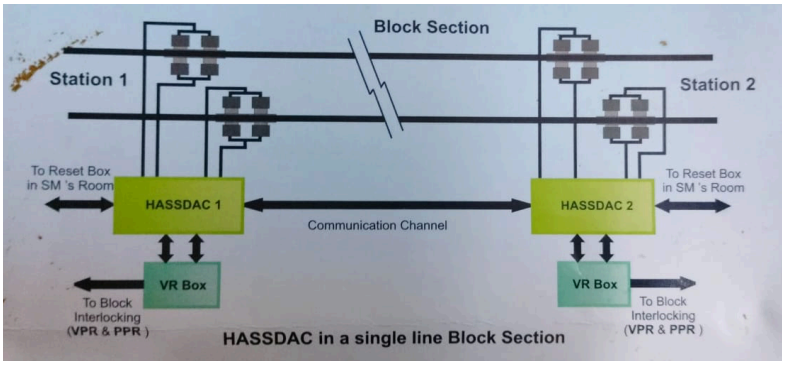


Fig: HASSDAC in a single line

This system consists of the following components:

-Axle Detectors

An Axle Detector consists of 2 transmitter(Tx) and 2 receivers (Rx) coils. One pair of Tx & Rx coils works on 21KHz frequency and the other on 23 Khz. The HASSDAC unit feeds the Tx coils and receives signals from Rx coils. The phase-type axle detectors remain unaffected by the passing of the push trolley. i.e. there is no need for a trolley protection circuit for the working of HASSDAC

-HASSDAC Unit:

The HASSDAC unit is a microcontroller-based embedded system and comprises two SSDAC subunits with some advancement. Each subunit takes signals from Axle Detectors and performs wheel detections and counting, it simultaneously sends and receives the wheel counts from the other side of the section, independently. On the basis of the comparison of wheel counts of both sides, the Clear or Occupied status of the section is given. The HASSDAC unit keeps track of its health and logs the status of each subunit in separate event loggers to record event statistics.

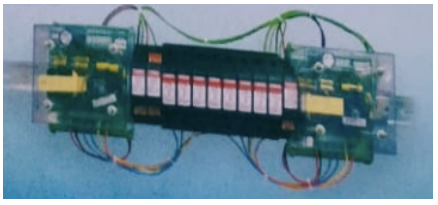
-Vital Relay Box:

The Vital Relay Box (VR Box) encases the Vital Relays of both subunits of HASSDAC Along with these it contains a dual Preparatory Relay and a Reset Relay The auto reset cards of HASSDAC is installed in VR Box which sends reset voltage to the failed unit in the the case of one unit failure. The final output is ORed and extended for railway interlocking to prevent train detention when one unit is failed.

-Reset Box:

The Reset Box of HASSDAC sends a reset command to the trackside unit to normalise the system on the failure of both subunits. It provides the status of the system and error information to the station master. The status of both subunits can be seen on the same display using the select switch.

-Filter and Surge Voltage Protection Device:



To protect the system from the noise all the modem signals and 24V input power lines are passed through a specially designed noise filter and to overcome the effect of surge voltage the 24V input power line and 48V resetting signal are passed through a surge voltage protection device (SVPD).

Multi Section Digital Axle Counter -MSDAC Model 730

MSDAC has a mechanism to reset a particular track section to recover from an error or a failure condition. This is done through the SM's reset panel. The section is to be physically verified by the SM to be unoccupied and then the reset command is to be given from the reset panel. This command is received by the central evaluator and it then sends the command to the respective field units to zero their counts,

The wheel-detection events are converted into pulses and these pulses are counted by the field units. These counts are stored here as well. The stored counts as well as the health of the track sensors are monitored and are continuously transmitted by the field unit, by means of telegram packets to Central Evaluator on the ½ Quad cables that also power the field unit.

The central Evaluator receives the count from each of the field units it is connected to and it then takes the decision of whether the track section is occupied or not. This decision is taken based on 2003 voting logic in a fail-safe manner. MSDAC signals the occupancy of the track section by means of an electro-mechanical relay called a VR relay. The contacts of VR are used in the signalling circuits of the signalling system at the station.

Therefore, the system has the provision to scale up or scale down according to the requirements at the station.

Microwave Electronics Division (MED)

CEL's microwave electronic division is the only one to produce phase control modules in India with different bands (e & x band) with over 44 years of proven experience in the market CEL'S MED products in various radars and defence products.

CEL is one of the very few companies worldwide that have pioneered the production of **ferrite phase shifters for C and X-band.** These phase shifters are indigenously developed and CEL is totally self-reliant for all the materials/components used in it, wherein **X-band is used for detection and C-band is used for Tracing the target.**

CEL has developed various production facilities for meeting the bulk demand for phase shifters. The measurements of the phase shifters are fully automated using customised software.

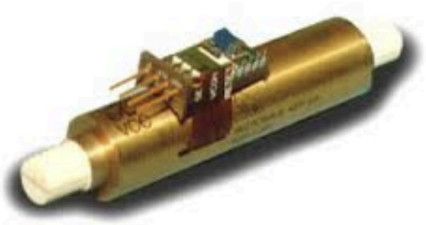


Fig: A Ferrite X- band Phase Shifter

Strength

1. Design and development of ferrite-based components for Microwave Applications
2. Design and development of dielectric of required shapes for various applications
3. Capability to machine (with minor finfish) complex shapes and dielectric used for Microwave Applications

Basic Terms & Definitions Related To RF Phase Shifting

- **Insertion Phase**

The insertion phase of a phase-shifting device is the phase delay experienced between its input and output ports. Referring to the general schematic of a 2 port device if V is the input signal at port 1 and is the insertion phase, then assuming the phase shifter to be ideal, the o/p signal at port 2 is given by Vi exp

- **Insertion Loss**

The transmission coefficient between 2 points in a circuit is expressed in dB and termed Insertion Loss IL. In practice, all phase shifters always have a certain amount of loss. This loss is termed insertion loss.

- **Scattering Matrix**

The S matrix provides a complete description of the network in a similar manner as the impedance and admittance matrix. Scattering parameters can be measured directly with PNA.

- **Directivity**

The directivity of the antenna is defined as "the ratio of radiation intensity in a given direction from the antenna to radiation intensity averaged over all directions."

- **Rx-Tx Difference**

This parameter is specified for reciprocal phase shifters. For a given state of phase shifters, the difference in insertion phase shift in both directions is defined as Rx - Tx difference. For a theoretical reciprocal phase shifter, the value of Rx-Tx is 0.

USP-Unique Selling Point

1. CEL's product is one of the few indigenously developed products inducted by the Indian Defence
2. Indigenous design hence can be customised as per the user's requirement
3. CEL is the sole manufacturer of ferrite-based PCM with quality comparable to that available internationally.

Features

1. Latching
2. Reciprocal
3. Low insertion loss
4. Fast Switching

Specifications of RF Phase Shifters

Over the past 2 decades, considerable efforts have gone into the development of phase shifters for phased array applications. The specifications which have a bearing on the selection of a phased array with a phase shifter per radiating element used are as follows for a typical RF phase shifter
Frequency range, bandwidth, differential phase shift, insertion loss, return loss, and control bits. polarisation, size etc

Applications

Electronic Scanning Phased Array Antenna Systems

Construction Of Ferrite Phase Shifters

1. **Making and Preparation of Ferrite Powder**

   Raw ferrite powder is at first used by the industry in order to prepare usable ferrite rods out of it,

Raw material is passed through the initial preparation that includes baking in Industrial grade Ovens at high temperatures.

After obtaining a perfectly prepared raw material, it is pushed to a further stage which includes filling the powder in moulds like rectangular packets which, after being sealed, is sent in the oven to set and acquire the shape.

2. **Ferrite Rod**

   Once the rods are cooled they are all set to undergo several exhaustive stages of grinding, which includes Axial, Cylindrical, Vertical Grinders, to shape the uneven raw rods into finest ones with an approximate accuracy of 0.1%. Every single grinding operation is done with a precision of 0.001 mm in order to come up with the finest products.

3. **QA 1- Quality Check**
   This stage is specifically meant for checking if the measurements of the rod meets the requirement or not.

4. **Silver Coating of Rods**
   The rods are silver coated, increased conductivity is achieved and then attached with ceramic caps on either side which act as dielectric attachments. These ceramic caps on either side are cut in between and a layer of nichrome material is inserted in between, in order to proceed with the Derive coil attachments.

5. **QA-** several qa checks are done in order to ensure if the attachments done are perfect or not, they are cross verified by Simulating machines in which parameters are observed if they match or not

6. **Rod-Yoke Assembly & covering rod with the derive coil**
   The rod yoke assembly contains 2 halves of a ferrite tube with a long narrow slit along the length of the rod for taking out the drive wires. Yoke elements do not contribute to RF loss: hence a material for the yoke can be selected for which 4pi M is higher than that of the rod.

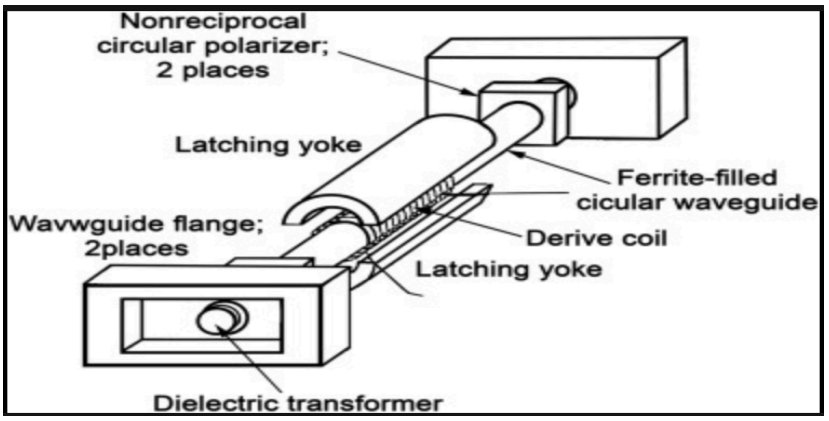


Fig: Assembly of Rod-Yolk

7. **QA- Check -** Checking all parameters through manual testing to ensure every measurement is accurate as of now and nothing is damaged. If at any point any physical damage or error in the value is encountered the entire batch is discarded. Accuracy is the prime move, as each of the devices is used in making RADARs in no of 4000 such X bands / C bands thus precision needs to be checked at each step.

8. **Mounting SoC board containing the microcontroller setup**- This chip is mounted on top and later covered with a metal cap to prevent any physical damage. This chip is a technology indigenously prepared by IIT Delhi and DSIR, the patented technology is provided by them for indigenous manufacturing of chips, CEL takes these chips from other manufacturing companies.

   Control Unit/Driver For Ferrite Phase Shifters- A typical driver/control unit consists of a single DC voltage supply, digital and analog ICs, transistors, capacitors and resistors.

9. **Quality Check-** This ensures if the phase shifters are working completely fine after addition of all attachments.

10. **Last testing phase RF instrument testing, PCM array test,Testing And Evaluation Using PNA-**

    Performance Network Analyzer PNA is used for microwave measurements. It is generally used for measurements by applying a known swept signal and measuring the signal to the test device. The signal transmitted from the device or reflected is then compared with the incident signal generated by a swept RF source. The signal is applied to the receiver for measurement, signal processing and display. A network analyser system consists of a source, signal separation devices, a receiver and display

    CEL has a inhouse facility to conduct PCM array tests where they test X/C band phase shifters on a small scale in batches of about 137 to 280.

Fig: A reference picture of array assembly, not actual photo from CEL

11. **Nonreciprocal Polarizer:**

    It converts a linearly polarised signal into a circularly polarised signal. For the construction of a non-reciprocal polarizer, we insert magnified ferrite pieces in various regions. After the rod diameter is calculated, the next step is to determine the length of the shifter. To get a linear differential phase shift from 0° to 360° at all frequencies, we design the phase shift section for a maximum differential phase shift of 500 degrees at the centre frequency.

12. Moreover the PCM Array test is conducted over a duration of 24 hours in which it is actively monitored for any change in values of error beyond the permissible level the inhouse built softwares are moulded in such a way that they test 360 degree parameter analysis of phase shifters.

13. **Temperature & Variation-** Product quality is tested for smooth functioning at temperature as high as 70 degree and as low as -40 degree celsius, considering the geographical adverse location and situation where in the product could be installed.

Usage - User base of CEL MED - Division

1. Defence units in the nation for manufacturing of object oriented RADARs .
2. Supplying these units to BEL - Bharat Electronics Limited, a yet another gem under the government of India. It utilises these units for making Electronic Scanning Phased Array Antenna Systems
3. Directly or Indirectly any organisation unit that works for govt. of India.

Conclusion

In conclusion, my summer training at **Central Electronics Limited** has been an invaluable experience that has broadened my horizons and deepened my understanding of cutting-edge technologies used in railway signalling and radar communication.

This summer training at Central Electronics Limited has exposed me to the wonderful advancements in the field of electronics. I have witnessed firsthand the incredible strides made in railway signalling, where state-of-the-art technologies are utilised to ensure safe and efficient transportation. The precision and reliability of radar communication systems have also left me in awe, as I observed how these cutting-edge technologies enable seamless and accurate information exchange.

Without participating in this training program, I would not have had the opportunity to witness the sheer power and precision of the advanced machines employed in these fields. Moreover, the training has enabled me to grasp new concepts and advancements in science and technology, leaving me constantly curious and eager to explore the fascinating world of electronics.

This training has opened my eyes to the endless possibilities and potential of electronics. I have learned about the latest developments in circuit design, microwave electronics, and wireless communication, which have the potential to revolutionise various industries. The advancements in miniaturisation have paved the way for smaller, more powerful devices, while breakthroughs in renewable energy systems have contributed to a greener and more sustainable future.

Witnessing the practical applications of these technologies has fueled my passion and ignited a desire to delve deeper into their workings.

Overall, this summer training has been an incredible journey of exploration, knowledge, and inspiration. It has not only provided me with a solid foundation in electronics but has also fueled my curiosity to stay up-to-date with the latest advancements in the field. I am excited to embrace a future where electronics continue to evolve and contribute to a world filled with endless possibilities.

Snehlata

Training Report - Microwave Electronics Division MED
Central Electronics Limited CEL, Sahibabad, U.P.

To HR, CEL

Objective: To learn & explore about Phased Array Antenna Systems at Microwave Electronics.

Introduction:

During my summer training at Central Electronics Limited, from (17-June to 17-July)'23 I had the opportunity to immerse myself in the fascinating world of Phased Array Antenna Systems, and explore the Railway Signalling System. This training provided me with an in-depth understanding of radar communication and the intricate processes involved in creating ferrite phase shifters. In this page, we will delve into the technological references and concepts I explored during this training, shedding light on the key aspects of radar communication and the construction of phase shifters.

Radar Communication via X and C band Ferrite Phase Shifters

Radar communication plays a crucial role in various industries, including aerospace, defence, and meteorology. It involves the transmission and reception of electromagnetic waves to detect, locate, and track objects. Throughout the training, I gained insights into the principles and components of radar systems, including transmitters, receivers, antennas, and signal processing techniques through X and C band phase shifters. Understanding the fundamentals of radar communication laid the groundwork for comprehending the significance of phased array antenna systems.

One of the critical technologies used in phased array systems is ferrite core phase shifters. These devices manipulate the phase of electromagnetic waves to steer the radar beam. Understanding the intricacies of ferrite materials and their behaviour in response to electromagnetic fields was a significant focus of the training. I gained knowledge about the design considerations, manufacturing processes, and applications of ferrite core phase shifters in radar communication systems.

Technological References:

Throughout the training, I extensively studied various technological references related to radar communication and phased array antenna systems. These included academic papers, research articles, industry standards, and books written by experts in the field. These references provided invaluable insights into the latest advancements, challenges, and future directions of radar communication technology.
Moreover the input by my mentors and staff person at CEL, helped me alot in getting all of my doubts clarified.

Conclusion:

My training at Central Electronics Limited on phased array antenna systems and radar communication was a transformative experience. Through comprehensive theoretical study, hands-on practical sessions, and exposure to technological references, and cutting edge machinery.
The training has ignited a passion within me to contribute to the ever-evolving world of radar communication and to explore further research opportunities. The knowledge and skills acquired during this training will undoubtedly shape my future endeavours in the field of electronics .

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